

GATE Overflow Book

October 2016

GATE Overflow Book

This book was created programmatically by GATE Overflow on Nov 4, 2016. If you feel any doubt regarding the answer, click on the question link and give a comment on the site. Studying all these questions might get you 60 marks in GATE but that might not be enough for an IIT. So, read standard books, solve exercise questions and use these questions for cementing the concepts and aim 75+. At least if you are not getting solution to a given problem first refer standard book. If any error is found on any question it shall be updated at <http://gateoverflow.in/corrections>.

An updated Aptitude Overflow book, book for Previous Year Questions including ISRO, UGCNET and a book for Non-previous Year Questions are expected in 1-2 months. An email subscribe option shall be provided on GATE Overflow by November 15 so that those who have subscribed get notification when the book is released.

This book consists of only previous year GATE and TIFR questions (CS from 1991 and all 5 years of IT) both of which are relevant for GATE. Out of syllabus subjects are removed from this book but some out of syllabus topic questions might still be present. This book is mostly stable and is expected to be updated only yearly when new papers come to site. But for GATE2017 a special update shall be made within 2 months which includes all GO Test series questions and previous GATE questions preceding 1991. Also GATECSE book is coming this month describing the topics to be covered and from where and also includes discussions about confusing topics.

Since **GATE Overflow** started in August 2014, a lot of people have dedicated their time and effort in bringing this book now. Initiated by **Omesh Pandita** and **Arjun Suresh** as a Q/A platform for CSE students, **Kathleen** was instrumental in getting all previous year GATE questions here. Then experts like **Praven Saini**, **Happy Mittal**, **Sankaranarayanan**, **Suraj** etc. have contributed a lot to the answers here. **Pragy Agarwal** even after topping GATE has continuously contributed here with his knowledge as well as in making the contents beautiful with fine latex skills. We also have to thank the work by **Jothee**, **Misbah**, **Ishrat** and **Nataliyah** who are continuously adding and keeping the contents here neat and clean. There are also many toppers of GATE 2015, GATE 2016 and probable ones of GATE 2017 who are contributing a lot here. The list of all the contributors can be found [here](#) but even that does not include the contributions of some like Arif Ali in helping design this book, **Arvind Devaraj** and others who have provided guidance and help etc. Last but not the least, we thank all the users of GATE Overflow.

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1

Algorithms (338)

[top](#)

1.0.1 GATE2012_4 [top](#)

<http://gateoverflow.in/36>

Assuming $P \neq NP$, which of the following is **TRUE**?

- (A) $NP\text{-complete} = NP$
- (B) $NP\text{-complete} \cap P = \emptyset$
- (C) $NP\text{-hard} = NP$
- (D) $P = NP\text{-complete}$

[gate2012](#) [algorithms](#) [normal](#)[Answer](#)

1.0.2 GATE1997_4.2 [top](#)

<http://gateoverflow.in/2243>

Let $a = (a_{ij})$ be an n -rowed square matrix and I_{12} be the matrix obtained by interchanging the first and second rows of the n -rowed Identity matrix. Then AI_{12} is such that its first

- A. row is the same as its second row
- B. row is the same as the second row of A
- C. column is the same as the second column of A
- D. row is all zero

[gate1997](#) [linear-algebra](#) [easy](#)[Answer](#)

1.0.3 GATE2015-1_6 [top](#)

<http://gateoverflow.in/8088>

Match the following:

- | | |
|---|---------------------------|
| (P) Prim's algorithm for minimum spanning tree | (i) Backtracking |
| (Q) Floyd-Warshall algorithm for all pairs shortest paths | (ii) Greedy method |
| (R) Mergesort | (iii) Dynamic programming |
| (S) Hamiltonian circuit | (iv) Divide and conquer |

- A. P-iii, Q-ii, R-iv, S-i
- B. P-i, Q-ii, R-iv, S-iii
- C. P-ii, Q-iii, R-iv, S-i
- D. P-ii, Q-i, R-iii, S-iv

[gate2015-1](#) [algorithms](#) [normal](#)[Answer](#)

1.0.4 GATE2005-IT_58 [top](#)

<http://gateoverflow.in/3819>

Let a be an array containing n integers in increasing order. The following algorithm determines whether there are two distinct numbers in the array whose difference is a specified number $S > 0$.

```
i = 0; j = 1;
while (j < n) {
    if (E) j++;
```

```

        else if (a[j] - a[i] == S) break;
    }
if (j < n) printf("yes") else printf ("no");
}

```

Choose the correct expression for E.

- A) $a[j] - a[i] > S$
- B) $a[j] - a[i] < S$
- C) $a[i] - a[j] < S$
- D) $a[i] - a[j] > S$

gate2005-it algorithms normal

[Answer](#)

1.0.5 GATE2005-IT_53 [top](#)

<http://gateoverflow.in/3814>

The following C function takes two ASCII strings and determines whether one is an anagram of the other. An anagram of a string s is a string obtained by permuting the letters in s.

```

int anagram (char *a, char *b) {
    int count [128], j;
    for (j = 0; j < 128; j++) count[j] = 0;
    j = 0;
    while (a[j] && b[j]) {
        A;
        B;
    }
    for (j = 0; j < 128; j++) if (count [j]) return 0;
    return 1;
}

```

Choose the correct alternative for statements A and B.

- A) A : $count[a[j]]++$ and B : $count[b[j]]--$
- B) A : $count[a[j]]++$ and B : $count[b[j]]++$
- C) A : $count[a[j++]]++$ and B : $count[b[j]]--$
- D) A : $count[a[j]]++$ and B : $count[b[j++]]--$

gate2005-it algorithms programming normal

[Answer](#)

1.0.6 GATE2005-IT_15 [top](#)

<http://gateoverflow.in/3760>

In the following table, the left column contains the names of standard graph algorithms and the right column contains the time complexities of the algorithms. Match each algorithm with its time complexity.

| | |
|-----------------------------|-------------------|
| 1. Bellman-Ford algorithm | A : $O(m \log n)$ |
| 2. Kruskal's algorithm | B : $O(n^3)$ |
| 3. Floyd-Warshall algorithm | C : $O(nm)$ |
| 4. Topological sorting | D : $O(n + m)$ |

- 1) $1 \rightarrow C, 2 \rightarrow A, 3 \rightarrow B, 4 \rightarrow D$
- 2) $1 \rightarrow B, 2 \rightarrow D, 3 \rightarrow C, 4 \rightarrow A$
- 3) $1 \rightarrow C, 2 \rightarrow D, 3 \rightarrow A, 4 \rightarrow B$
- 4) $1 \rightarrow B, 2 \rightarrow A, 3 \rightarrow C, 4 \rightarrow D$

gate2005-it algorithms normal

Answer

1.0.7 GATE2005_39 [top](#)<http://gateoverflow.in/784>

Suppose there are $\lceil \log n \rceil$ sorted lists of $\lfloor n / \log n \rfloor$ elements each. The time complexity of producing a sorted list of all these elements is: (Hint: Use a heap data structure)

gate2005 algorithms normal

Answer

1.0.8 GATE2004-IT_58 [top](#)<http://gateoverflow.in/3701>

Consider the following C program which is supposed to compute the transpose of a given 4×4 matrix M. Note that, there is an X in the program which indicates some missing statements. Choose the correct option to replace X in the program.

```
#include<stdio.h>
#define ROW 4
#define COL 4
int M[ROW][COL] = {1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16};
main()
{
    int i, j, t;
    for (i = 0; i < 4; ++i)
    {
        X
    }
    for (i = 0; i < 4; ++i)
        for (j = 0; j < 4; ++j)
            printf ("%d", M[i][j]);
}
```

A)

```
for(j = 0; j < 4; ++j) {
    t = M[i][j];
    M[i][j] = M[j][i];
    M[j][i] = t;
}
```

B)

```
for(j = 0; j < 4; ++j) {
    M[i][j] = t;
    t = M[j][i];
    M[j][i] = M[i][j];
}
```

C)

```
for(j = i; j < 4; ++j) {
    t = M[i][j];
    M[i][j] = M[j][i];
    M[j][i] = t;
}
```

D)

```
for(j = i; j < 4; ++j) {
    M[i][j] = t;
    t = M[j][i];
    M[j][i] = M[i][j];
}
```

gate2004-it algorithms easy

Answer

1.0.9 GATE2002_1.5 [top](#)<http://gateoverflow.in/809>

In the worst case, the number of comparisons needed to search a single linked list of length n for a given element is

- A. $\log n$
 B. $\frac{n}{2}$
 C. $\log_2 n - 1$
 D. n

gate2002 | algorithms | easy

Answer

1.0.10 GATE2004-IT_52 top

<http://gateoverflow.in/3695>

A program attempts to generate as many permutations as possible of the string, 'abcd' by pushing the characters a, b, c, d in the same order onto a stack, but it may pop off the top character at any time. Which one of the following strings CANNOT be generated using this program?

- | | |
|----|-------|
| A) | abcd |
| B) | dcb a |
| C) | cba d |
| D) | cab d |

gate2004-it | algorithms | normal

Answer

1.0.11 GATE2008-IT_4 top

<http://gateoverflow.in/3264>

What is the size of the smallest MIS(Maximal Independent Set) of a chain of nine nodes?

- A) 5
 B) 4
 C) 3
 D) 2

gate2008-it | algorithms | normal

Answer

1.0.12 GATE1996-2.13, ISRO2016-28 top

<http://gateoverflow.in/2742>

The average number of key comparisons required for a successful search for sequential search on n items is

- A. $\frac{n}{2}$
 B. $\frac{n-1}{2}$
 C. $\frac{n+1}{2}$
 D. None of the above

gate1996 | algorithms | easy | isro2016

Answer

1.0.13 GATE1995_2.22 top

<http://gateoverflow.in/2634>

Which of the following statements is true?

- I. As the number of entries in a hash table increases, the number of collisions increases.
- II. Recursive programs are efficient
- III. The worst case complexity for Quicksort is $O(n^2)$
- IV. Binary search using a linear linked list is efficient

- A. I and II
 B. II and III
 C. I and IV
 D. I and III

gate1995 | algorithms

Answer

1.0.14 GATE1995_2.9 [top](#)

<http://gateoverflow.in/2621>

A language with string manipulation facilities uses the following operations

```
head(s): first character of a string
tail(s): all but exclude the first character of a string

concat(s1, s2): s1s2
```

For the string "acbc" what will be the output of

```
concat(head(s), head(tail(tail(s))))
```

- A. ac
 B. bc
 C. ab
 D. cc

gate1995 | algorithms | normal

Answer

1.0.15 GATE1994_1.22 [top](#)

<http://gateoverflow.in/2465>

Which of the following statements is false?

- A. Optimal binary search tree construction can be performed efficiently using dynamic programming
 B. Breadth-first search cannot be used to find connected components of a graph
 C. Given the prefix and postfix walks over a binary tree, the binary tree cannot be uniquely constructed.
 D. Depth-first search can be used to find connected components of a graph

gate1994 | algorithms | normal

Answer

1.0.16 GATE2003_69 [top](#)

<http://gateoverflow.in/956>

The following are the starting and ending times of activities A, B, C, D, E, F, G and H respectively in chronological order: " $a_s b_s c_s a_e d_s c_e e_s f_s b_e d_e g_s e_e f_e h_s g_e h_e$ " . Here, x_s denotes the starting time and x_e denotes the ending time of activity X. We need to schedule the activities in a set of rooms available to us. An activity can be scheduled in a room only if the room is reserved for the activity for its entire duration. What is the minimum number of rooms required?

- A. 3
 B. 4
 C. 5
 D. 6

gate2003 | algorithms | normal

Answer

1.0.17 GATE1997_1.5 [top](#)<http://gateoverflow.in/2221>

The correct matching for the following pairs is

- | | |
|----------------------------------|-------------------------|
| (A) All pairs shortest path | (1) Greedy |
| (B) Quick Sort | (2) Depth-First search |
| (C) Minimum weight spanning tree | (3) Dynamic Programming |
| (D) Connected Components | (D) Divide and Conquer |
- A. A-2 B-4 C-1 D-3
 B. A-3 B-4 C-1 D-2
 C. A-3 B-4 C-2 D-1
 D. A-4 B-1 C-2 D-3

[gate1997](#) [algorithms](#) [normal](#)
[Answer](#)
1.0.18 GATE2015-2_36 [top](#)<http://gateoverflow.in/8161>

Given below are some algorithms, and some algorithm design paradigms.

| | |
|--|-------------------------|
| 1. Dijkstra's Shortest Path | i. Divide and Conquer |
| 2. Floyd-Warshall algorithm to compute all pairs shortest path | ii. Dynamic Programming |
| 3. Binary search on a sorted array | iii. Greedy design |
| 4. Backtracking search on a graph | iv. Depth-first search |
| | v. Breadth-first search |

Match the above algorithms on the left to the corresponding design paradigm they follow.

- A. 1-i, 2-iii, 3-i, 4-v
 B. 1-iii, 2-iii, 3-i, 4-v
 C. 1-iii, 2-ii, 3-i, 4-iv
 D. 1-iii, 2-ii, 3-i, 4-v

[gate2015-2](#) [algorithms](#) [easy](#)
[Answer](#)
1.0.19 GATE2014-1_39 [top](#)<http://gateoverflow.in/1917>

The minimum number of comparisons required to find the minimum and the maximum of 100 numbers is _____

[gate2014-1](#) [algorithms](#) [numerical-answers](#) [normal](#)
[Answer](#)
1.0.20 GATE1999_1.13 [top](#)<http://gateoverflow.in/1466>

Suppose we want to arrange the n numbers stored in any array such that all negative values occur before all positive ones. Minimum number of exchanges required in the worst case is

- A. $n - 1$
 B. n
 C. $n + 1$
 D. None of the above

[gate1999](#) [algorithms](#) [normal](#)
Answer**1.0.21 GATE1999_1.16** [top](#)<http://gateoverflow.in/1469>

If n is a power of 2, then the minimum number of multiplications needed to compute a^n is

- (a) $\log_2 n$
- (b) \sqrt{n}
- (c) $n - 1$
- (d) n

[gate1999](#) [algorithms](#) [normal](#)
Answer**1.0.22 GATE1999_8** [top](#)<http://gateoverflow.in/1507>

Let A be an $n \times n$ matrix such that the elements in each row and each column are arranged in ascending order. Draw a decision tree, which finds 1st, 2nd and 3rd smallest elements in minimum number of comparisons.

[gate1999](#) [algorithms](#) [normal](#) [descriptive](#)
Answer**1.0.23 GATE2006_50** [top](#)<http://gateoverflow.in/1828>

A set X can be represented by an array $x[n]$ as follows:

$$x[i] = \begin{cases} 1 & \text{if } i \in X \\ 0 & \text{otherwise} \end{cases}$$

Consider the following algorithm in which x , y , and z are Boolean arrays of size n :

```
algorithm zzz(x[], y[], z[]) {
    int i;

    for(i=0; i<n; ++i)
        z[i] = (x[i] ∧ ~y[i]) ∨ (~x[i] ∧ y[i]);
}
```

The set Z computed by the algorithm is:

- (A) $(X \cup Y)$
- (B) $(X \cap Y)$
- (C) $(X - Y) \cap (Y - X)$
- (D) $(X - Y) \cup (Y - X)$

[gate2006](#) [algorithms](#) [normal](#)
Answer**1.0.24 GATE2006_54** [top](#)<http://gateoverflow.in/1822>

Given two arrays of numbers a_1, \dots, a_n and b_1, \dots, b_n where each number is 0 or 1, the fastest algorithm to find the largest span (i, j) such that $a_i + a_{i+1} + \dots + a_j = b_i + b_{i+1} + \dots + b_j$ or report that there is not such span,

- (A) Takes $O(3^n)$ and $\Omega(2^n)$ time if hashing is permitted

- (B) Takes $O(n^3)$ and $\Omega(n^{2.5})$ time in the key comparison mode
 (C) Takes $\Theta(n)$ time and space
 (D) Takes $O(\sqrt{n})$ time only if the sum of the $2n$ elements is an even number

gate2006 | algorithms | normal

[Answer](#)

1.0.25 GATE2014-1_37 [top](#)

<http://gateoverflow.in/1915>

There are 5 bags labeled 1 to 5. All the coins in a given bag have the same weight. Some bags have coins of weight 10 gm, others have coins of weight 11 gm. I pick 1, 2, 4, 8, 16 coins respectively from bags 1 to 5. Their total weight comes out to 323 gm. Then the product of the labels of the bags having 11 gm coins is ____.

gate2014-1 | algorithms | numerical-answers | normal

[Answer](#)

1.0.26 GATE2014-2_37 [top](#)

<http://gateoverflow.in/1996>

Consider two strings

$A = "qpqrr"$ and

$B = "pqprqrp"$. Let

x be the length of the longest common subsequence (*not necessarily contiguous*) between

A and

B and let

y be the number of such longest common subsequences between

A and

B . Then

$x + 10y = \text{_____}$.

gate2014-2 | algorithms | normal

[Answer](#)

1.0.27 GATE2006_15 [top](#)

<http://gateoverflow.in/976>

Consider the following C-program fragment in which i , j and n are integer variables.

```
for( i = n, j = 0; i > 0; i /= 2, j += i );
```

Let $\text{val}(j)$ denote the value stored in the variable j after termination of the for loop. Which one of the following is true?

(A) $\text{val}(j) = \Theta(\log n)$

(B) $\text{val}(j) = \Theta(\sqrt{n})$

(C) $\text{val}(j) = \Theta(n)$

(D) $\text{val}(j) = \Theta(n \log n)$

gate2006 | algorithms | normal

[Answer](#)

1.0.28 GATE2014-3_37 [top](#)

<http://gateoverflow.in/2071>

Suppose you want to move from

0 to

100 on the number line. In each step, you either move right by a unit distance or you take a *shortcut*. A shortcut is simply a pre-specified pair of integers i , j with $i < j$. Given a shortcut

i , j if you are at position

i on the number line, you may directly move to

j . Suppose

$T(k)$ denotes the smallest number of steps needed to move from

k to 100. Suppose further that there is at most 1 shortcut involving any number, and in particular from 9 there is a shortcut to 15. Let

y and
 z be such that
 $T(9) = 1 + \min(T(y), T(z))$. Then the value of the product
 yz is ____.

gate2014-3 | algorithms | normal

Answer

1.0.29 GATE2011_25 [top](#)

<http://gateoverflow.in/2127>

An algorithm to find the length of the longest monotonically increasing sequence of numbers in an array $A[0 : n - 1]$ is given below.

Let
 L_i , denote the length of the longest monotonically increasing sequence starting at index i in the array.

Initialize
 $L_{n-1} = 1$.

For all
 i such that
 $0 \leq i \leq n - 2$

$$L_i = \begin{cases} 1 + L_{i+1} & \text{if } A[i] < A[i+1] \\ 1 & \text{Otherwise} \end{cases}$$

Finally the the length of the longest monotonically increasing sequence is
 $\text{Max}(L_0, L_1, \dots, L_{n-1})$.

Which of the following statements is **TRUE**?

- (A) The algorithm uses dynamic programming paradigm
- (B) The algorithm has a linear complexity and uses branch and bound paradigm
- (C) The algorithm has a non-linear polynomial complexity and uses branch and bound paradigm
- (D) The algorithm uses divide and conquer paradigm

gate2011 | algorithms | easy

Answer

1.0.30 GATE2004_41 [top](#)

<http://gateoverflow.in/1038>

Consider the following C program

```
main()
{
    int x, y, m, n;
    scanf("%d %d", &x, &y);
    /* Assume x>0 and y>0 */
    m = x; n = y;
    while(m != n)
    {
        if (m > n)
            m = m-n;
        else
            n = n-m;
    }
    printf("%d", n);
}
```

The program computes

- A. $x + y$ using repeated subtraction
- B. $x \bmod y$ using repeated subtraction
- C. the greatest common divisor of x and y

- D. the least common multiple of x and y

gate2004 | algorithms | normal

[Answer](#)

1.0.31 GATE2012_5 [top](#)

<http://gateoverflow.in/37>

The worst case running time to search for an element in a balanced binary search tree with $n \cdot 2^n$ elements is

- (A) $\Theta(n \log n)$ (B) $\Theta(n2^n)$ (C) $\Theta(n)$ (D) $\Theta(\log n)$

gate2012 | algorithms | normal

[Answer](#)

1.0.32 GATE2006_17 [top](#)

<http://gateoverflow.in/978>

An element in an array X is called a leader if it is greater than all elements to the right of it in X . The best algorithm to find all leaders in an array

- (A) Solves it in linear time using a left to right pass of the array
 (B) Solves it in linear time using a right to left pass of the array
 (C) Solves it using divide and conquer in time $\Theta(n \log n)$
 (D) Solves it in time $\Theta(n^2)$

gate2006 | algorithms | normal

[Answer](#)

1.0.33 GATE2010-34 [top](#)

<http://gateoverflow.in/2208>

The weight of a sequence a_0, a_1, \dots, a_{n-1} of real numbers is defined as $a_0 + a_1/2 + \dots + a_{n-1}/2^{n-1}$. A subsequence of a sequence is obtained by deleting some elements from the sequence, keeping the order of the remaining elements the same. Let X denote the maximum possible weight of a subsequence of a_0, a_1, \dots, a_{n-1} and Y the maximum possible weight of a subsequence of a_1, a_2, \dots, a_{n-1} . Then X is equal to

- A. $\max(Y, a_0 + Y)$
 B. $\max(Y, a_0 + Y/2)$
 C. $\max(Y, a_0 + 2Y)$
 D. $a_0 + Y/2$

gate2010 | algorithms | normal

[Answer](#)

1.0.34 GATE2000-16 [top](#)

<http://gateoverflow.in/687>

A recursive program to compute Fibonacci numbers is shown below. Assume you are also given an array $f[0.....m]$ with all elements initialized to 0

```
fib(n) {
    if (n > M) error ();
    if (n == 0) return 1;
    if (n == 1) return 1;
    if (n == 2)
        return _____ (1)
    t = fib(n - 1) + fib(n - 2);
    _____ (2)
    return t;
}
```

- A. Fill in the boxes with expressions/statements to make $\text{fib}()$ store and reuse computed Fibonacci values. Write the box

- number and the corresponding contents in your answer book.
 B. What is the time complexity of the resulting program when computing fib(n)?

[gate2000](#) [algorithms](#) [normal](#)

[Answer](#)

1.0.35 GATE2008-81 [top](#)

<http://gateoverflow.in/43484>

The subset-sum problem is defined as follows. Given a set of n positive integers, $S = \{a_1, a_2, a_3, \dots, a_n\}$, and positive integer W , is there a subset of S whose elements sum to W ? A dynamic program for solving this problem uses a 2-dimensional Boolean array, X , with n rows and $W+1$ columns. $X[i, j], 1 \leq i \leq n, 0 \leq j \leq W$, is TRUE, if and only if there is a subset of $\{a_1, a_2, \dots, a_i\}$ whose elements sum to j .

Which entry of the array X , if TRUE, implies that there is a subset whose elements sum to W ?

- A. $X[1, W]$
- B. $X[n, 0]$
- C. $X[n, W]$
- D. $X[n - 1, n]$

[gate2008](#) [algorithms](#) [normal](#)

[Answer](#)

1.0.36 TIFR2013-B-5 [top](#)

<http://gateoverflow.in/25666>

Given a weighted directed graph with n vertices where edge weights are integers (positive, zero, or negative), determining whether there are paths of arbitrarily large weight can be performed in time

- a. $O(n)$
- b. $O(n \cdot \log(n))$ but not $O(n)$
- c. $O(n^{1.5})$ but not $O(n \log n)$
- d. $O(n^3)$ but not $O(n^{1.5})$
- e. $O(2^n)$ but not $O(n^3)$

[tifr2013](#) [algorithms](#)

[Answer](#)

1.0.37 TIFR2014-B-10 [top](#)

<http://gateoverflow.in/27198>

Given a set of n distinct numbers, we would like to determine both the smallest and the largest number. Which of the following statements is TRUE?

- a. These two elements can be determined using $O(\log^{100} n)$ comparisons.
- b. $O(\log^{100} n)$ comparisons do not suffice, however these two elements can be determined using $n + O(\log n)$ comparisons.
- c. $n + O(\log n)$ comparisons do not suffice, however these two elements can be determined using $3\lceil n/2 \rceil$ comparisons.
- d. $3\lceil n/2 \rceil$ comparisons do not suffice, however these two elements can be determined using $2(n - 1)$ comparisons.
- e. None of the above.

[tifr2014](#) [algorithms](#)

[Answer](#)

1.0.38 TIFR2011-B-38 [top](#)

<http://gateoverflow.in/20923>

Consider the class of recursive and iterative programs. Which of the following is false?

- a. Recursive programs are more powerful than iterative programs.
- b. For every iterative program there is an equivalent recursive program.

- c. Recursive programs require dynamic memory management.
- d. Recursive programs do not terminate sometimes.
- e. Iterative programs and recursive programs are equally expressive.

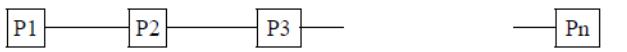
[tifr2011](#) [algorithms](#)

[Answer](#)

1.0.39 TIFR2013-B-20 [top](#)

<http://gateoverflow.in/25878>

Suppose n processors are connected in a linear array as shown below. Each processor has a number. The processors need to exchange numbers so that the numbers eventually appear in ascending order (the processor P_1 should have the minimum value and the processor P_n should have the maximum value).



The algorithm to be employed is the following. Odd numbered processors and even numbered processors are activated alternate steps; assume that in the first step all the even numbered processors are activated. When a processor is activated, the number it holds is compared with the number held by its right-hand neighbour (if one exists) and the smaller of the two numbers is retained by the activated processor and the bigger stored in its right hand neighbour.

How long does it take for the processors to sort the values?

- a. $n \log n$ steps
- b. n^2 steps
- c. n steps
- d. $n^{1.5}$ steps
- e. The algorithm is not guaranteed to sort

[tifr2013](#) [algorithms](#)

[Answer](#)

1.0.40 GATE1991_03,viii [top](#)

<http://gateoverflow.in/523>

Choose the correct alternatives (more than one may be correct) and write the corresponding letters only:

Consider the following Pascal function:

```

Function X(M:integer):integer;
Var i:integer;
Begin
  i := 0;
  while i*i < M
  do i:= i+1
  X := i
end
  
```

The function call $X(N)$, if N is positive, will return

- (a). $\lfloor \sqrt{N} \rfloor$
- (b). $\lfloor \sqrt{N} \rfloor + 1$
- (c). $\lceil \sqrt{N} \rceil$
- (d). $\lceil \sqrt{N} \rceil + 1$
- (e). None of the above

[gate1991](#) [algorithms](#) [easy](#)

[Answer](#)

1.0.41 TIFR2014-B-6 [top](#)

<http://gateoverflow.in/27183>

Consider the problem of computing the minimum of a set of n distinct numbers. We choose a permutation uniformly at random (i.e., each of the $n!$ permutations of $\{1, \dots, n\}$ is chosen with probability $(1/n!)$) and we inspect the numbers in the order given by this permutation. We maintain a variable MIN that holds the minimum value seen so far. MIN is initialized

to ∞ and if we see a value smaller than MIN during our inspection, then MIN is updated. For example, in the inspection given by the following sequence, MIN is updated four times.

5 9 4 2 6 8 0 3 1 7

What is the expected number of times MIN is updated?

- a. $O(1)$
- b. $H_n = \sum_{i=1}^n 1/i$
- c. \sqrt{n}
- d. $n/2$
- e. n

tifr2014 algorithms

Answer

1.0.42 TIFR2011-B-29 top

<http://gateoverflow.in/20576>

You are given ten rings numbered from 1 to 10, and three pegs labeled A, B, and C. Initially all the rings are on peg A, arranged from top to bottom in ascending order of their numbers. The goal is to move all the rings to peg B in the minimum number of moves obeying the following constraints:

- (i) In one move, only one ring can be moved.
- (ii) A ring can only be moved from the top of its peg to the top of a new peg.
- (iii) At no point can a ring be placed on top of another ring with a lower number.

How many moves are required?

- a. 501
- b. 1023
- c. 2011
- d. 10079
- e. None of the above.

tifr2011 algorithms

Answer

1.0.43 GATE2008-80 top

<http://gateoverflow.in/498>

The subset-sum problem is defined as follows. Given a set of n positive integers, $S = \{a_1, a_2, a_3, \dots, a_n\}$, and positive integer W , is there a subset of S whose elements sum to W ? A dynamic program for solving this problem uses a 2-dimensional Boolean array, X , with n rows and $W+1$ columns. $X[i, j], 1 \leq i \leq n, 0 \leq j \leq W$, is TRUE, if and only if there is a subset of $\{a_1, a_2, \dots, a_i\}$ whose elements sum to j .

Which of the following is valid for

$2 \leq i \leq n$, and
 $a_i \leq j \leq W$?

- A. $X[i, j] = X[i - 1, j] \vee X[i, j - a_i]$
- B. $X[i, j] = X[i - 1, j] \vee X[i - 1, j - a_i]$
- C. $X[i, j] = X[i - 1, j] \wedge X[i, j - a_i]$
- D. $X[i, j] = X[i - 1, j] \wedge X[i - 1, j - a_i]$

gate2008 algorithms normal

Answer

1.0.44 TIFR2014-B-9 top

<http://gateoverflow.in/27194>

Given a set of n distinct numbers, we would like to determine the smallest three numbers in this set using comparisons. Which of the following statements is TRUE?

- a. These three elements can be determined using $O(\log^2 n)$ comparisons.

- b. $O(\log^2 n)$ comparisons do not suffice, however these three elements can be determined using $n + O(1)$ comparisons.
 c. $n + O(1)$ comparisons do not suffice, however these three elements can be determined using $n + O(\log n)$ comparisons.
 d. $n + O(\log n)$ comparisons do not suffice, however these three elements can be determined using $O(n)$ comparisons.
 e. None of the above.

tifr2014 algorithms

Answer

1.0.45 GATE2008-40 [top](#)<http://gateoverflow.in/452>

The minimum number of comparisons required to determine if an integer appears more than $\frac{n}{2}$ times in a sorted array of n integers is

- A. $\Theta(n)$
- B. $\Theta(\log n)$
- C. $\Theta(\log^* n)$
- D. $\Theta(1)$

gate2008 normal algorithms

Answer

1.0.46 TIFR2012-B-6 [top](#)<http://gateoverflow.in/25106>

Let n be a large integer. Which of the following statements is TRUE?

- a. $2\sqrt{2 \log n} < \frac{n}{\log n} < n^{1/3}$
- b. $\frac{n}{\log n} < n^{1/3} < 2\sqrt{2 \log n}$
- c. $2\sqrt{2 \log n} < n^{1/3} < \frac{n}{\log n}$
- d. $n^{1/3} < 2\sqrt{2 \log n} < \frac{n}{\log n}$
- e. $\frac{n}{\log n} < 2\sqrt{2 \log n} < n^{1/3}$

tifr2012 algorithms

Answer

1.0.47 GATE2015-2_45 [top](#)<http://gateoverflow.in/8243>

Suppose you are provided with the following function declaration in the C programming language.

```
int partition(int a[], int n);
```

The function treats the first element of $a[]$ as a pivot and rearranges the array so that all elements less than or equal to the pivot is in the left part of the array, and all elements greater than the pivot is in the right part. In addition, it moves the pivot so that the pivot is the last element of the left part. The return value is the number of elements in the left part.

The following partially given function in the C programming language is used to find the k^{th} smallest element in an array $a[]$ of size n using the partition function. We assume $k \leq n$.

```
int kth_smallest (int a[], int n, int k)
{
    int left_end = partition (a, n);
    if (left_end+1==k) {
        return a[left_end];
    }
    if (left_end+1 > k) {
        return kth_smallest (_____);
    } else {
        return kth_smallest (_____);
    }
}
```

The missing arguments lists are respectively

- A. (a, left_end, k) and (a+left_end+1, n-left_end-1, k-left_end-1)
- B. (a, left_end, k) and (a, n-left_end-1, k-left_end-1)
- C. (a, left_end+1, n-left_end-1, k-left_end-1) and (a, left_end, k)
- D. (a, n-left_end-1, k-left_end-1) and (a, left_end, k)

gate2015-2 algorithms normal

Answer

1.0.48 TIFR2014-B-20 [top](#)

<http://gateoverflow.in/27354>

Consider the following game. There is a list of distinct numbers. At any round, a player arbitrarily chooses two numbers a, b from the list and generates a new number c by subtracting the smaller number from the larger one. The numbers a and b are put back in the list. If the number c is non-zero and is not yet in the list, c is added to the list. The player is allowed to play as many rounds as the player wants. The score of a player at the end is the size of the final list.

Suppose at the beginning of the game the list contains the following numbers: 48, 99, 120, 165 and 273. What is the score of the best player for this game?

- a. 40
- b. 16
- c. 33
- d. 91
- e. 123

tifr2014 algorithms

Answer

1.0.49 TIFR2010-B-24 [top](#)

<http://gateoverflow.in/18742>

Consider the following program operating on four variables u, v, x, y , and two constants X and Y .

```
x, y, u, v := X, Y, Y, X;
While (x ≠ y)
do
    if (x > y) then x, v := x - y, v + u;
    else if (y > x) then y, u := y - x, u + v;
od;
print ((x + y) / 2); print ((u + v) / 2);
```

Given $X > 0 \wedge Y > 0$, pick the true statement out of the following:

- a. The program prints $\text{gcd}(X, Y)$ and the first prime larger than both X and Y .
- b. The program prints $\text{gcd}(X, Y)$ followed by $\text{lcm}(X, Y)$.
- c. The program prints $\text{gcd}(X, Y)$ followed by $\frac{1}{2} \times \text{lcm}(X, Y)$.
- d. The program prints $\frac{1}{2} \times \text{gcd}(X, Y)$ followed by $\frac{1}{2} \times \text{lcm}(X, Y)$.
- e. The program does none of the above.

tifr2010 algorithms

Answer

1.0.50 TIFR2012-B-15 [top](#)

<http://gateoverflow.in/25212>

Let T be a tree of n nodes. Consider the following algorithm, that constructs a sequence of leaves u_1, u_2, \dots . Let u_1 be some leaf of tree. Let u_2 be a leaf that is farthest from u_1 . Let u_3 be the leaf that is farthest from u_2 , and, in general, let u_{i+1} be a leaf of T that is farthest from u_i (if there are many choices for u_{i+1} , pick one arbitrarily). The algorithm stops when some u_i is visited again. What can you say about the distance between u_i and u_{i+1} , as $i = 1, 2, \dots$?

- a. For some trees, the distance strictly reduces in each step.
- b. For some trees, the distance increases initially and then decreases.
- c. For all trees, the path connecting u_2 and u_3 is a longest path in the tree.

- d. For some trees, the distance reduces initially, but then stays constant.
e. For the same tree, the distance between the last two vertices visited can be different, based on the choice of the first leaf u_1 .

tifr2012 | algorithms

Answer

1.0.51 GATE2012_18 top<http://gateoverflow.in/50>

Let $W(n)$ and $A(n)$ denote respectively, the worst case and average case running time of an algorithm executed on an input of size n . Which of the following is **ALWAYS TRUE**?

- (A) $A(n) = \Omega(W(n))$
(B) $A(n) = \Theta(W(n))$
(C) $A(n) = O(W(n))$
(D) $A(n) = o(W(n))$

gate2012 | algorithms | easy

Answer

1.0.52 GATE2012_16 top<http://gateoverflow.in/48>

The recurrence relation capturing the optimal execution time of the *Towers of Hanoi* problem with n discs is

- (A) $T(n) = 2T(n - 2) + 2$
(B) $T(n) = 2T(n - 1) + n$
(C) $T(n) = 2T(n/2) + 1$
(D) $T(n) = 2T(n - 1) + 1$

gate2012 | algorithms | easy

Answer

1.0.53 GATE2015-1_31 top<http://gateoverflow.in/8263>

Consider the following C function.

```
int fun1 (int n) {
    int i, j, k, p, q = 0;
    for (i = 1; i < n; ++i) {
        p = 0;
        for (j = n; j > 1; j = j/2)
            ++p;
        for (k = 1; k < p; k = k * 2)
            ++q;
    }
    return q;
}
```

Which one of the following most closely approximates the return value of the function `fun1`?

- A. n^3
B. $n(\log n)^2$
C. $n \log n$
D. $n \log(\log n)$

gate2015-1 | algorithms | normal

Answer

1.0.54 GATE1992_08 top<http://gateoverflow.in/587>

Let T be a Depth First Tree of a undirected graph G . An array P indexed by the vertices of G is given. $P[V]$ is the parent of vertex V , in T . Parent of the root is the root itself.

Give a method for finding and printing the cycle formed if the edge (u, v) of G not in T (i.e., $e \in G - T$) is now added to T .

Time taken by your method must be proportional to the length of the cycle.

Describe the algorithm in a PASCAL – like language. Assume that the variables have been suitably declared.

gate1992 | algorithms | descriptive

Answer

1.0.55 GATE2000-1.13 [top](#)

<http://gateoverflow.in/636>

The most appropriate matching for the following pairs

| | |
|-------------------------|----------|
| X: depth first search | 1: heap |
| Y: breadth-first search | 2: queue |
| Z: sorting | 3: stack |

is:

- A. X - 1 Y - 2 Z - 3
- B. X - 3 Y - 1 Z - 2
- C. X - 3 Y - 2 Z - 1
- D. X - 2 Y - 3 Z - 1

gate2000 | algorithms | easy

Answer

1.0.56 GATE1999_2.20 [top](#)

<http://gateoverflow.in/666>

The minimum number of record movements required to merge five files A (with 10 records), B (with 20 records), C (with 15 records), D (with 5 records) and E (with 25 records) is:

- (a) 165 (b) 90 (c) 75 (d) 65

gate1999 | algorithms | normal

Answer

1.0.57 GATE2000-1.15 [top](#)

<http://gateoverflow.in/638>

Let S be a sorted array of n integers. Let $t(n)$ denote the time taken for the most efficient algorithm to determine if there are two elements with sum less than 1000 in S . Which of the following statement is true?

- A. $t(n)$ is $O(1)$
- B. $n \leq t(n) \leq n \log_2 n$
- C. $n \log_2 n \leq t(n) < \frac{n}{2}$
- D. $t(n) = \left(\frac{n}{2}\right)$

gate2000 | easy | algorithms

Answer

1.0.58 GATE2000-2.15 [top](#)

<http://gateoverflow.in/662>

Suppose you are given an array $s[1....n]$ and a procedure $\text{reverse}(s, i, j)$ which reverses the order of elements in s between positions i and j (both inclusive). What does the following sequence do, where $1 \leq k \leq n$:

```
reverse (s, 1, k);
reverse (s, k+1, n);
reverse (s, 1, n);
```

- A. Rotates s left by k positions
- B. Leaves s unchanged
- C. Reverses all elements of s

D. None of the above

gate2000 | algorithms | normal

[Answer](#)

Answers:

1.0.1 GATE2012_4 [top](#)

<http://gateoverflow.in/36>



Selected Answer

Answer is (B) NP-complete

$$\cap P = \emptyset$$

Since, P

$\neq NP$, there is at least one problem in NP , which is harder than all P problems. Lets take the hardest such problem, say X . Since, P

$\neq NP$,

$X \notin P$.

Now, by definition, NP-complete problems are the hardest problems in NP and so

X problem is in NP -complete. And being in NP ,

X can be reduced to all problems in NP -complete, making any other NP -complete problem as hard as

X . So, since

$X \notin P$, none of the other NP -complete problems also cannot be in P .

7 votes

-- Arjun Suresh (150k points)

1.0.2 GATE1997_4.2 [top](#)

<http://gateoverflow.in/2243>



Selected Answer

c is the answer, in A_{12} matrix will result into the same matrix as A but first column will be exchanged with second column.

A matrix:

a b c
d e f
g h i

I_{12} matrix

0 1 0
1 0 0
0 0 1

resulted matrix

b a c
e d f
h g i

5 votes

-- Manu Thakur (5.6k points)

1.0.3 GATE2015-1_6 [top](#)

<http://gateoverflow.in/8088>



Selected Answer

option c is correct ..

8 votes

-- Anoop Sonkar (4.5k points)

1.0.4 GATE2005-IT_58 [top](#)<http://gateoverflow.in/3819>

Selected Answer

Answer is (B)

For some 'i' if we find that difference of (A[j] - A[i] < S) we increment 'j' to make this difference wider so that it becomes equal to S .

If at times difference becomes greater than S we know that it wont reduce further for same 'i' and so we increment the 'i'.

We do it for each 'i' if not found in previous iteration until i=n

6 votes

-- Sandeep_Uniyal (5.5k points)

1.0.5 GATE2005-IT_53 [top](#)<http://gateoverflow.in/3814>

Selected Answer

The answer is D

```
#include <stdio.h>
int main(void) {
    return 0;
}

int anagram (char *a, char *b) {
/*
ASCII characters are of 7-bits
so we use count array to represent all the ASCII characters
(ranging 0-127)
*/
int count [128], j;

/*
so this loop will initialize count of all the ASCII characters to be
0 (zero)
*/
for (j = 0; j < 128; j++) count[j] = 0;

j = 0;
/*
"a[j] && b[j]" ensures that anagram returns 0 (false) in case both
strings have different length. Because different length strings cannot
be anagram of each other
*/
/*
Logic:
Below while loop increments ASCII equivalent position for its occurrence
in array 'a' in count array; and decrements ASCII equivalent position
for its occurrence in array 'b' in count array.

Example: a = "ISS" and b = "SIS"
ASCII equivalent of:
I - 73
S - 83

j = 0: Statement A will increment count[ASCII of 'I'] ==> count[73]
count[73] = 0 --> 1
Statement B will decrement count[ASCII of 'S'] ==> count[83]
count[83] = 0 --> -1 and will increment j j = 0 --> 1

j = 1: Statement A will increment count[ASCII of 'S'] ==> count[83]
count[83] = -1 --> 0
Statement B will decrement count[ASCII of 'I'] ==> count[73]
count[73] = 1 --> 0 and will increment j j = 1 --> 2

j = 2: Statement A will increment count[ASCII of 'S'] ==> count[83]
count[83] = 0 --> 1
Statement B will decrement count[ASCII of 'S'] ==> count[83]
count[83] = 1 --> 0 and will increment j j = 2 --> 3

*** END OF LOOP ***

```

```

/*
while (a[j] && b[j]) {

A; //count [a[j]]++

/*
Note: j will be increment after count[]-- will execute
Resource: http://www.c4learn.com/c-programming/increment-operator-inside-printf
*/
B; //count[b[j++]]--
}

/*
This loop checks that the number of occurrences of the individual ASCII
characters is same or not.
If count[i] = 0 ---> same number of occurrences for ASCII character i
---> return 1 (true)

if count[i]!= 0 ---> different number of occurrences for ASCII character i
---> return 0 (false)
*/

for (j = 0; j < 128; j++) if (count [j]) return 0;
return 1;
}

```

6 votes

-- Sohil Ladhani (153 points)

1.0.6 GATE2005-IT_15 [top](#)<http://gateoverflow.in/3760>

Selected Answer

1. Bellman-Ford algorithm =>: O (nm) Assuming n as edges , m as vertices, for every vertex we relax all edges. m*n , O(mn)
2. Kruskal's algorithm => Remaining Option ,A : O (m log n)
3. Floyd-Warshall algorithm => Dynamic Programming Algo, O(N³)
4. Topological sorting => Boils Down to DFS, O(V+E) D

Answer A)

2 votes

-- Akash (31.7k points)

1.0.7 GATE2005_39 [top](#)<http://gateoverflow.in/784>

Selected Answer

Since we have $\log n$ lists we can make a min-heap of $\log n$ elements by taking the first element from each of the $\log n$ sorted lists. Now, we start deleting the min-element from the heap and put the next element from the sorted list from which that element was added to the heap. (This identity can be done by making a structure of two values, one for the number and one for identifying the origin sorted list of that number and storing this structure in the heap). In this way each delete and the corresponding insert will take $O(\log \log n)$ time as delete in heap of size n is $O(\log n)$ and inserting an element on a heap of size n is also $O(\log n)$. (here, heap size is $\log n$). Now, we have a total of $\log n \times \frac{n}{\log n} = n$ elements. So, total time will be $O(n \log \log n)$.

12 votes

-- gatecse (10.7k points)

1.0.8 GATE2004-IT_58 [top](#)<http://gateoverflow.in/3701>

Selected Answer

option C:

look at the initial value of j, if j starts with 0, then double for loop will swap M[i][j] with M[j][i] and also M[j][i]

and $M[i][j]$ so the matrix M will remain unchanged, so to avoid this double swapping we need to initialize $j = i$ and swap only upper triangular matrix with lower triangular matrix.

```
for(j = i; j < 4; ++j) {
    // code for swapping M[i][j] with M[j][i]
    t = M[i][j];
    M[i][j] = M[j][i];
    M[j][i] = t;
}
```

7 votes

-- Vikrant Singh (11k points)

1.0.9 GATE2002_1.5 [top](#)

<http://gateoverflow.in/809>



Selected Answer

A & C is not correct as we can not do binary search in Linked list.

B seems like average case, be we are asked for worst case.

Worst case is we do not find the element in list. We might end up searching entire list & comparing with each element. So answer -> D. n

5 votes

-- Akash (31.7k points)

1.0.10 GATE2004-IT_52 [top](#)

<http://gateoverflow.in/3695>



Selected Answer

A. push a & pop a, push b & pop b, push c & pop c, and finally push d and pop d sequence of popped elements will come to abcd

B. first push abcd, and after that pop one by one sequence of popped elements will come to dcba

C. push abc, and after that pop one by one sequence of popped elements will come to cba, now push d and pop d, final sequence comes to cbad

D. this sequence is not possible because 'a' can not be popped before 'b' any how

5 votes

-- Manu Thakur (5.6k points)

1.0.11 GATE2008-IT_4 [top](#)

<http://gateoverflow.in/3264>



Selected Answer

Answer: C

1--2--3--4--5--6--7--8--9

(2,5,8) is the maximal independent set for a chain of 9 nodes. If we add any other node to the set then it will not be MIS.

6 votes

-- Rajarshi Sarkar (29.7k points)

1.0.12 GATE1996-2.13, ISRO2016-28 [top](#)

<http://gateoverflow.in/2742>



Selected Answer

Expected number of comparisons

$= 1 \times \text{Probability of first element be } x + 2 \times \text{Probability of second element be } x + \dots + n \times \text{Probability of last element be } x.$

$$= \frac{1}{n} + \frac{2}{n} + \frac{3}{n} + \dots + \frac{n}{n}$$

$$= \frac{\left(\frac{n(n+1)}{2}\right)}{n}$$

$$= \frac{n+1}{2}$$

12 votes

-- Arjun Suresh (150k points)

1.0.13 GATE1995_2.22 top

<http://gateoverflow.in/2634>



Selected Answer

Its D according to me.

Binary search using linked list is not efficient as it will not give $O(\log n)$, because we will not be able to find the mid in constant time. Finding mid in linked list takes $O(n)$ time.

Recursive programs are not efficient because they take a lot of space, Recursive methods will often throw StackOverflowException while processing big sets. moreover it has its own advantages too.

11 votes

-- Gate Keeda (17.7k points)

1.0.14 GATE1995_2.9 top

<http://gateoverflow.in/2621>



Selected Answer

C.

concat(a,head(tail(tail(acbc))))

concat(a,head(tail(cbc)))

concat(a,head(bc))

concat(a,b)

ab.

8 votes

-- Gate Keeda (17.7k points)

1.0.15 GATE1994_1.22 top

<http://gateoverflow.in/2465>

Answer: B

- (a) True.
- (b) False.
- (c) True.
- (d) True.

5 votes

-- Rajarshi Sarkar (29.7k points)

1.0.16 GATE2003_69 top

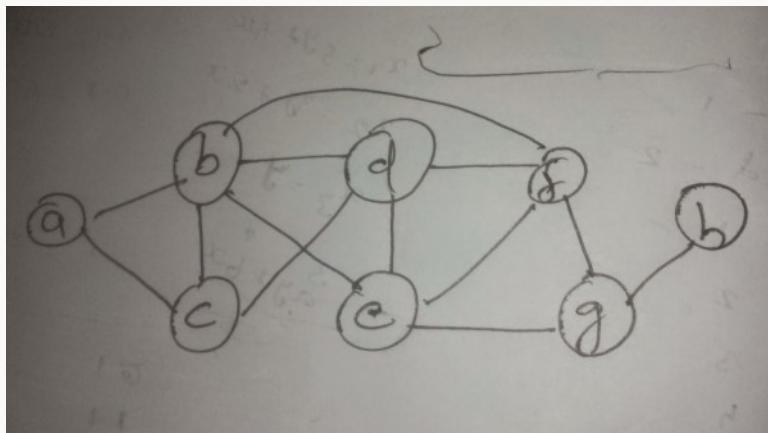
<http://gateoverflow.in/956>



Selected Answer

Solution: B

The problem can be modeled as a graph coloring problem. Construct a graph with one node corresponding to each activity \$A,B,C,D,E,F,G\$ and \$H\$. Connect the activities that occur between the start and end time of an activity now the chromatic number of the graph is the number of rooms required.



7 votes

-- Gowthaman Arumugam (1.1k points)

1.0.17 GATE1997_1.5 top

<http://gateoverflow.in/2221>



Selected Answer

answer B

6 votes

-- ankitrokdeonsns (8.4k points)

1.0.18 GATE2015-2_36 top

<http://gateoverflow.in/8161>

Answer: C

9 votes

-- Rajarshi Sarkar (29.7k points)

1.0.19 GATE2014-1_39 top

<http://gateoverflow.in/1917>



Selected Answer

Ans: minimum number of comparison require to find minimum and maximum is: Approach is divide and conquer

```
T(n) = T(floor(n/2)) + T(ceil(n/2)) + 2
T(2) = 1 // if two element then compare both and return max and min
T(1) = 0 // if one element then return both max and min same
```

If n is a power of 2, then we can write T(n) as:

```
T(n) = 2T(n/2) + 2
```

After solving above recursion, we get

```
T(n) = 3/2n - 2
```

Thus, the approach does $3/2n - 2$ comparisons if n is a power of 2. And it **does more than $3/2n - 2$ comparisons if n is not a power of 2**.

So, here in this case put n=100 and we will get $(3/2)(100) - 2 = 148$ comparison

15 votes

-- Jay (1.1k points)

1.0.20 GATE1999_1.13 top

<http://gateoverflow.in/1466>



Selected Answer

Answer is (d) None of these

We just require $n/2$ swaps in the worst case. The algorithm is as given below:

Find positive number from left side and negative number from right side and do exchange. Since, at least one of them must be less than or equal to $n/2$, there cannot be more than $n/2$ exchanges. An implementation is given below:

http://gatetcse.in/wiki/Moving_Negative_Numbers_to_the_Beginning_of_Array

9 votes

-- Arjun Suresh (150k points)

1.0.21 GATE1999_1.16 top

<http://gateoverflow.in/1469>



Selected Answer

a. $\log n$

For $n = 8$, we can do

$$b = a \times a$$

$$b = b \times b$$

$$b = b \times b \text{ and we get } b = a^8$$

3 votes

-- Arjun Suresh (150k points)

1.0.22 GATE1999_8 top

<http://gateoverflow.in/1507>

If all elements are distinct we have to check 1st row and 1st column. So complexity will be $O(n^2)$

Here minimum no of comparison could be 1, because $a[0][0]$ will be minimum always, now we have to check between $a[0][1]$ and $a[1][0]$

| | 0 | 1 | 2 |
|---|---|---|---|
| 0 | 1 | 2 | 7 |
| 1 | 3 | 4 | 8 |
| 2 | 5 | 6 | 9 |

| | 0 | 1 | 2 |
|---|---|---|---|
| 0 | 1 | 2 | 3 |
| 1 | 4 | 5 | 6 |
| 2 | 7 | 8 | 9 |

if all elements are not distinct we have to search all elements of the array

| | 0 | 1 | 2 |
|---|---|---|---|
| 0 | 1 | 1 | 1 |
| 1 | 1 | 1 | 8 |
| 2 | 1 | 6 | 9 |

So, minimum comparison could be O(1)

1 votes

-- srestha (27.8k points)

1.0.23 GATE2006_50 [top](#)

<http://gateoverflow.in/1828>



Selected Answer

Option (d)

In the given algorithm the for loop contains a logical expression

```
z[i] = (x[i] & ~y[i]) | (~x[i] & y[i]);
```

The equivalent set representation of a given logical expression if we assume z[i] = z, X[i] = X, Y[i] = Y then

$z = (X \wedge Y') \vee (X' \wedge Y)$

$z = (X - Y) \vee (Y - X) [A \wedge B' = A - B]$

4 votes

-- Prasanna Ranganathan (2.5k points)

1.0.24 GATE2006_54 [top](#)

<http://gateoverflow.in/1832>



Selected Answer

Answer is (C). Following algorithm would do.

Since array is binary, the max sum will go until n and so the sum difference of the two arrays can vary between $-n$ and n . We use array start to keep the starting index of each possible sum (hence of size $2n + 1$) and array end to keep the ending index (these two arrays work like hash tables and since we have only $2n + 1$ possible keys, we can do a perfect hashing). So, our required solution will be $\max(\text{end}[i] - \text{start}[i])$ provided both are assigned values.

The algorithm works as follows:

1. Initialize diff array to contain the difference of sum of elements of array a and b. i.e., $\text{diff}[i] = \sum_{i=0}^n a[i] - b[i]$.
2. Now $\text{diff}[i]$ can have values from $-n$ to n which gives $2n + 1$ possible values and the first occurrence of a diff value marks the beginning of a span and the last occurrence marks the end. We use start and end array for storing these two positions for the $2n + 1$ possible values.
3. Now, the largest value of $\text{end}[i] - \text{start}[i]$ for any i , will be the largest span and the start of it will be $\text{start}[i] + 1$, and end will be $\text{end}[i]$. If the span is starting from first position itself (arrays a and b have same first elements), then it will start from $\text{start}[i]$ itself.

```
#include <stdio.h>

#define size 100 //assume n is less than 100
int main()
{
    int n, a[size], b[size];
    int start[2*size+1], end[2*size+1];
```

```

int sum1 = 0, sum2 = 0, i;
int diff[size];
printf("Enter n: ");
scanf("%d", &n);
for(i = 0; i < n; i++)
{
    printf("Enter a[%d]: ", i);
    scanf("%d", &a[i]);
}
for(i = 0; i < n; i++)
{
    printf("Enter b[%d]: ", i);
    scanf("%d", &b[i]);
}

for(i = 0; i < n; i++)
{
    if(a[i]) sum1++;
    if(b[i]) sum2++;
    diff[i] = sum1 - sum2;
}
for(i = 0; i < 2*n; i++)
    start[i] = -1, end[i] = -1;
start[n] = end[n] = 0;
//initially sum is 0 at the beginning of array and
//the first n-1 elements of start and end are used
//if sum of A till ith element is less than sum of B till ith element
for(i=0; i < n; i++)
{
    if(start[diff[i] + n] == -1)//interested only in the first occurrence of diff[i]
        start[diff[i] + n] = i;
    end[diff[i] + n] = i;//interested in the last occurrence of diff[i]
}
int max = -1;
int savei = -1; //savei is for storing the sum having the largest span

for(i = 0; i < 2*n; i++)
{
    if(start[i] > -1 && (end[i] - start[i] > max))
    {
        max = end[i] - start[i];
        savei = i;
    }
}
if(savei >= 0)
{
    printf("The largest span is from %d to %d\n", start[savei]+(savei != n), end[savei]);
    //when sum zero is having the largest span, span starts from first element itself.
    //Else, the span starts from the next element from which the span does not change
}
else
{
    printf("No span\n");
}
}

```

3 votes

-- Arjun Suresh (150k points)

1.0.25 GATE2014-1_37 [top](#)

<http://gateoverflow.in/1915>



Selected Answer

There are 5 bags , I assumed initially all bags are having 10 gm coins, and picked them as per the given condition

1,2,4,8,16 of all bags have 10 gm coins then total weight will come to

$10 + 20 + 40 + 80 + 160 = 310$ but total weight should be 323, but 13 is less, i divided 13 into $1 + 4 + 8$
 $11 + 20 + 44 + 88 + 160$, means 1st, 3rd and 4th bags have 11 gm coins. so product of labels will be $1 \times 3 \times 4 = 12$

10 votes

-- Manu Thakur (5.6k points)

1.0.26 GATE2014-2_37 top<http://gateoverflow.in/1996>

34

qprr

Pqrr

qpqr

In first string

If we want to get 4 as max len den lcs should end with either rr or qr

Only 4 combinations possible for lcs with len 4

qpqr

qqrr

pqrr

qprr

Now check for matching sequences in second string, except for qqrr all possible

6 votes

-- Anurag Semwal (5.5k points)

1.0.27 GATE2006_15 top<http://gateoverflow.in/976>

Selected Answer

Answer will be theta(n)

 $j = n/2 + n/4 + n/2 + \dots + 1$ number of iteration will be $2^k = n$ or $k = \log n$ this is in gp find sum till $\log n = \theta(n)$

8 votes

-- rahulkkr (427 points)

1.0.28 GATE2014-3_37 top<http://gateoverflow.in/2071>

Selected Answer

 $T(9) = \text{Distance from 9 to 100}$ $T(9) = 1 + \min(T(y), T(z)) = 1 + \min(\text{Distance from } y \text{ to 100}, \text{Distance from } z \text{ to 100})$

There are only two such values where we can reach from 9, one is simple step to right on number line, i.e 10 and another is 15 (given shortcut)

Hence, $y=10, z=15$
 $yz = 10 \times 15 = 150$

9 votes

-- Srinath Sri (2.9k points)

1.0.29 GATE2011_25 top<http://gateoverflow.in/2127>



Selected Answer

(A) is the answer.

The algorithm is storing the optimal solutions to subproblems at each point (for each i), and then using it to derive the optimal solution of a bigger problem. And that is dynamic programming approach. And the program has linear time complexity. <http://www.cs.cornell.edu/~wdtseng/icpc/notes/bt2.pdf>

<http://stackoverflow.com/questions/1065433/what-is-dynamic-programming>

Now, branch and bound comes when we explore all possible solutions (branch) and backtracks as soon as we find we won't get a solution (in classical backtracking we will retreat only when we won't find the solution). So, backtracking gives all possible solutions while branch and bound will give only the optimal one. <http://www.cs.cornell.edu/~wdtseng/icpc/notes/bt2.pdf>

The given algorithm here is neither backtracking nor branch and bound. Because we are not branching anywhere in the solution space.

And the algorithm is not divide and conquer as we are not dividing the problem and then merging the solution as in the case of merge sort (where merge is the conquer step).

https://en.wikipedia.org/wiki/Divide_and_conquer_algorithms

10 votes

-- Arjun Suresh (150k points)

1.0.30 GATE2004_41 [top](#)

<http://gateoverflow.in/1038>



Selected Answer

It is a simple algorithm of gcd

here while loop executes until m==n

take any two number as m,n and compute it , get the answer

Ans will be (C)

2 votes

-- srestha (27.8k points)

1.0.31 GATE2012_5 [top](#)

<http://gateoverflow.in/37>



Selected Answer

Binary search takes $\Theta(\log n)$ for n elements in the worst case. So, with $(n2^n)$ elements, the worst case time will be

$$\Theta(\log(n2^n))$$

$$= \Theta(\log n + \log 2^n)$$

$$= \Theta(\log n + n)$$

$$= \Theta(n)$$

8 votes

-- Arjun Suresh (150k points)

1.0.32 GATE2006_17 [top](#)

<http://gateoverflow.in/978>



Selected Answer

Ans B should be correct.

We can move from right keeping a note of the maximum element(suppose current_max). At the start the right most element will always be a leader. If an element is greater than our current_max, it will a leader. Add this element to leaders. Set current_max to this element and carry on leftward. Time Complexity would be O(n)

6 votes

-- Madhur Rawat (2.4k points)

1.0.33 GATE2010-34 [top](#)

<http://gateoverflow.in/2208>



Selected Answer

$$\begin{aligned} S &= \langle a_0, S_1 \rangle \\ S_1 &= \langle a_1, a_2, a_3 \dots a_{n-1} \rangle \end{aligned}$$

Two possible cases arise:

1. a_0 is included in the max weight subsequence of S :

In this case, $X = \text{weight}(\langle a_0, S_1 \rangle) = a_0 + \frac{Y}{2}$

2. a_0 is not included in the max weight subsequence of S :

In this case, $X = \text{weight}(S_1) = Y$

Since the value of a_0 can be anything (negative or $< \frac{Y}{2}$ in general) $\{ \because a_i \in \mathbb{R} \}$, it is possible that $Y > a_0 + \frac{Y}{2}$.

The maximum possible weight of a subsequence of S is given by:

$$X = \max \left(Y, a_0 + \frac{Y}{2} \right)$$

Thus, option B is correct.

12 votes

-- Pragy Agarwal (14.4k points)

1.0.34 GATE2000-16 [top](#)

<http://gateoverflow.in/687>



Selected Answer

Array f is used to store the fib() values calculated in order to save repeated calls. Since n = 0 and n = 1 are special cases we can store fib(2) to f[0], fib(3) to f[1] and so on. The missing code completed would be:

```
if (f[n - 2] != 0) {
    return f[n-2];
}
t = fib(n-1) + fib(n-2);
f[n-2] = t;
return t;
```

In this code, fib(i) will do a recursion only once as once fib(i) is calculated it is stored in array. So, the time complexity for fib(n) would be $\Theta(n)$.

PS: We can also store fib(n) in f(n), the above code just saves 2 elements' space in the array.

7 votes

-- Arjun Suresh (150k points)

1.0.35 GATE2008-81 [top](#)

<http://gateoverflow.in/43484>

ANS) C ,If LAST ROW and LAST COLUMN entry is 1, then there exists subset whose elements sum to W

2 votes

-- Shivam Bhardwaj (31 points)

1.0.36 TIFR2013-B-5 [top](#)

<http://gateoverflow.in/25666>

I think arbitrary large weights means having positive weight cycle...so bellmanford algo can be used..O(VE)....changing sign of weights of edges....

2 votes

-- papesh pathare (349 points)

1.0.37 TIFR2014-B-10 [top](#)

<http://gateoverflow.in/27198>

I think ans will be C)

to be accurate it will be need $3n/2 - 2$ comparisons .

3 votes

-- Pranay Datta (6.8k points)

1.0.38 TIFR2011-B-38 [top](#)

<http://gateoverflow.in/20923>



Selected Answer

answer = **option E**

Computable function: those which can be incorporated in a program using for/while loops.

Total Function: Defined for all possible inputs

Well Defined: if its definition assigns it a unique value.

It was a belief in early 1900s that every Computable function was also Primitively Recursive. But the discovery of Ackermann function provided a counter to it.

The class of primitive recursive functions is a small subclass of the class of recursive functions. This means that there are some functions which are Well-Defined Total Functions and are Computable BUT **Not** primitively recursive; eg. Ackermann function.

This makes all options from option A to option D as True.

But **option E** as

FALSE. As iterative programs are equivalent to only Primitively Recursive class.

2 votes

-- Amar Vashishth (20.7k points)

1.0.39 TIFR2013-B-20 [top](#)

<http://gateoverflow.in/25878>



Selected Answer

OPTION C is correct.

5 votes

-- venky.victory35 (565 points)

1.0.40 GATE1991_03,viii [top](#)

<http://gateoverflow.in/523>



Selected Answer

For N=9, it returns 3.

For N=10 it returns 4.

For N=16 it returns 4.

For N=17 it returns 5.

So answer should be C.

3 votes

-- Pepper (1.9k points)

1.0.41 TIFR2014-B-6 [top](#)

<http://gateoverflow.in/27183>



Selected Answer

Let us consider 3 numbers {1,2,3}

We will consider the permutation along with min no of times MIN is updated .

Permutation : No of times MIN updated (Minimum)

| | |
|-------|---|
| 1,2,3 | 1 |
| 1,3,2 | 1 |
| 2,1,3 | 2 |
| 2,3,1 | 2 |
| 3,1,2 | 2 |
| 3,2,1 | 3 |

Total number of times MIN updated is : 11 .

Average no of times MIN updated is : (11/6)

Now going by the options i am getting B .

$$H_3 = 1 + 1/2 + 1/3 = 11/6 .$$

H₃ is the answer and that is option B .

5 votes

-- Riya Roy(Arayana) (5.6k points)

1.0.42 TIFR2011-B-29 [top](#)

<http://gateoverflow.in/20576>

I think its Tower of Hanoi problem.

Therefore Total number of function call $2^n - 1 = 1023$ option B

2 votes

-- Umang Raman (11.3k points)

1.0.43 GATE2008-80 [top](#)

<http://gateoverflow.in/498>

I think answers are

80. (B)

$$X[i][j] = X[i-1][j] \cup X[i-1][j-a_i]$$

We calculate the value of $X[i][j]$ as if we include the value a_i in the subset $X[i-1][j-a_i]$ or we do not include the value in the subset. $X[i-1][j]$.

81. (C)

```

// Returns true if there is a subset of set[] with sum equal to given sum
bool isSubsetSum(int set[], int n, int sum)
{
    // The value of subset[i][j] will be true if there is a subset of set[0..j-1]
    // with sum equal to i
    bool subset[sum+1][n+1];

    // If sum is 0, then answer is true
    for (int i = 0; i <= n; i++)
        subset[0][i] = true;

    // If sum is not 0 and set is empty, then answer is false
    for (int i = 1; i <= sum; i++)
        subset[i][0] = false;

    // Fill the subset table in bottom up manner
    for (int i = 1; i <= sum; i++)
    {
        for (int j = 1; j <= n; j++)
        {
            subset[i][j] = subset[i][j-1];
            if (i >= set[j-1])
                subset[i][j] = subset[i][j] || subset[i - set[j-1]][j-1];
        }
    }

    /* // uncomment this code to print table
    for (int i = 0; i <= sum; i++)
    {
        for (int j = 0; j <= n; j++)
            printf ("%4d", subset[i][j]);
        printf ("\n");
    } */

    return subset[sum][n];
}

```

1 votes

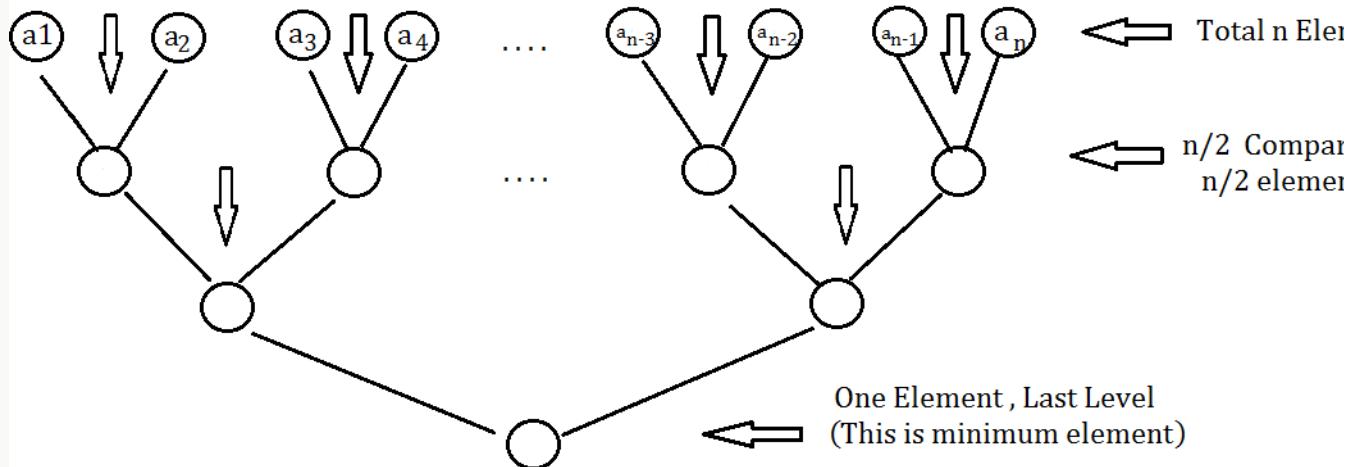
-- Sona Praneeth Akula (3.8k points)

1.0.44 TIFR2014-B-9 [top](#)<http://gateoverflow.in/27194>

Selected Answer

Option (C) is correct .. Reason is as follows :

One Comparison
to get minimum



Here , At first level we are Given n elements , out of which we have to find smallest 3 numbers.

we compare 2 -2 elements as shown in figure & get $n/2$ elements at Second level.

Note: Minimum element is in these $n/2$ elements.

So, comparisons for this is $n/2..$

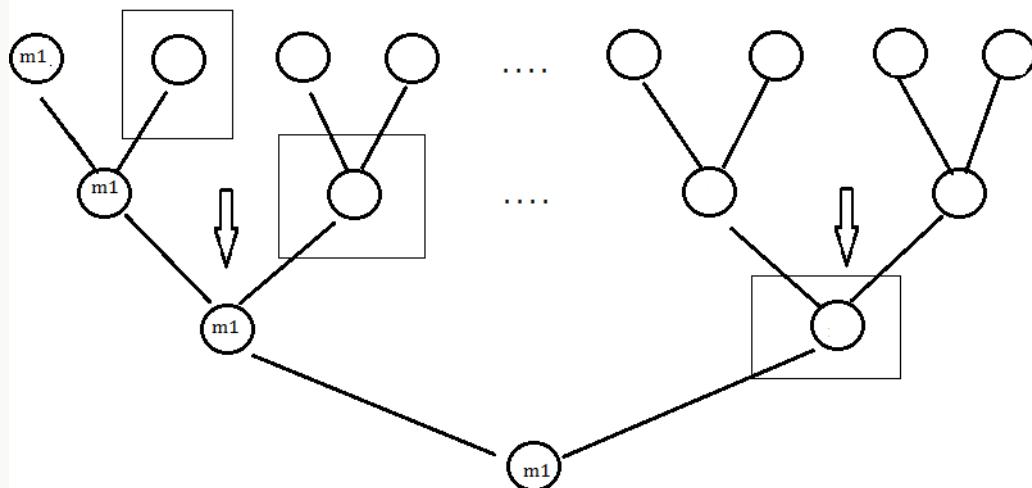
Similarly for next level we have $n/4$ Comparisons & $n/2$ elements..and so on..

Total Comparisons till now is $n/2 + n/4 + n/8 + \dots + 4 + 2 + 1 = (2^{\log n} - 1) = n-1$ {Use G.P. sum}

Now we have to get smallest 3..

We have 1st smallest at last level already $\Rightarrow 0$ Comparison for this..

$\Rightarrow 2^{\text{nd}}$ & 3^{rd} smallest can be found in $O(\log n)$ time as shown below:



Minimum Element must have descended down from some path from top to Bottom..

\Rightarrow SQUARES represent Candidates for 2nd minimum..

every element that is just below m_1 (first minimum) is a candidate for second minimum..

So, $O(\log n)$ Comparisons for finding second smallest..

\Rightarrow similarly for 3rd minimum we get $O(\log n)$ time.. As, every element that is just below 1st & 2nd minimum is a candidate for 3rd minimum ..

3 votes

-- Himanshu Agarwal (9.8k points)

1.0.45 GATE2008-40 top

<http://gateoverflow.in/452>



Selected Answer

answer = **option B**

whenever there exists an element which is present in the array : more than $\frac{n}{2}$ times, then definitely it will be present at the middle index position; in addition to that it will also be present at anyone of the neighbourhood indices namely $i - 1$ and $i + 1$

No matter how we push that stream of **More than $\frac{n}{2}$** times of elements of same value around the Sorted Array, it is bound to be present at the middle index + atleast anyone of its neighbourhood

once we got the element which should have occurred more than $n/2$ times we count its total occurrences in $\mathcal{O}(\log n)$

time.

13 votes

-- Amar Vashishth (20.7k points)

1.0.46 TIFR2012-B-6 [top](#)

<http://gateoverflow.in/25106>



Selected Answer

Ans will be C

Take $n = 2^{1024}$

Now, $2^{\sqrt{2 \log n}} \approx 2^{45}$

$n^{\frac{1}{3}} \approx 2^{341}$

$n / \log n = 2^{1024} / 1024 \approx 2^{1014}$

Just one value is not enough to confirm growth rate. So, take $n = 1024$.

Now, $2^{\sqrt{2 \log n}} \approx 2^4$

$n^{\frac{1}{3}} \approx 2^3$

$n / \log n = 2^{10} / 10 \approx 2^7$

So, as n increases the gap between second and third function increases and also the second function overtakes the first.
So, $f_1 < f_2 < f_3$.

2 votes

-- srestha (27.8k points)

1.0.47 GATE2015-2_45 [top](#)

<http://gateoverflow.in/8243>

Ans A.

4 votes

-- Vikrant Singh (11k points)

1.0.48 TIFR2014-B-20 [top](#)

<http://gateoverflow.in/27354>



Selected Answer

OPTION d is correct

Here the list is (48, 99, 120, 165 ,273.)

$\text{Gcd}(48,99)=3$,means if we subtract($99-48=51$) that no is also % 3,

so the no's like (3,6,9----99) are added , total no's= $99/3=33$

//y $\text{Gcd}(48,120)=24$,so the no's %24 are added like (24,48,---120) ,total no's= $120/24=5$

/y $\text{Gcd}(48,165)=3$,so the nos(3,6,9,--24--48--99--120---165) are added ,totally $165/3=55$

at end $\text{Gcd}(48,273)=3$,so the no's(3,6,9--24---48---99---120--165---273) are added(which covers all the above no's)

so total no's added to this list= $273/3=91$

4 votes

-- venky.victory35 (565 points)

1.0.49 TIFR2010-B-24 [top](#)

<http://gateoverflow.in/18742>

It prints with $\text{gcd}(x,y)$ and $\text{lcm}(x,y)$

consider $x,y,u,v=17,3,3,17$

$X=14, v=20$

$X=11, v=23$

$X=8, v=26$

$X=5, v=29$

$X=2, v=32$

$Y=1, u=35$

$X=1, v=67$

This is the value obtained

lastly print $(x+y)/2$ and $(v+u)/2$ gives 1 and 51

1 votes

-- zambus (169 points)

1.0.50 TIFR2012-B-15 top

<http://gateoverflow.in/25212>

This post explains it nicely

<https://www.quora.com/How-does-following-algorithm-for-finding-longest-path-in-free-work>

1 votes

-- sudipta roy (289 points)

1.0.51 GATE2012_18 top

<http://gateoverflow.in/50>



Selected Answer

Worst case complexity can never be lower than the average case complexity, but it can be higher. So, (C) is the answer.

$$A(n) = O(W(n))$$

8 votes

-- Arjun Suresh (150k points)

1.0.52 GATE2012_16 top

<http://gateoverflow.in/48>



Selected Answer

Recurrence relation for **Towers of Hanoi** is

$$T(1) = 1$$

$$T(n) = 2 T(n-1) + 1$$

So Answer should be (D)

8 votes

-- Narayan Kunal (389 points)

1.0.53 GATE2015-1_31 top

<http://gateoverflow.in/8263>



Selected Answer

i loop is executing n times. j loop is executing log n times for each i, and so value of p is log n. k loop is executing log p times, which is log log n times for each iteration of i. In each of these q is incremented. So, over all iterations of i, q will be incremented n log log n times. So, D choice.

17 votes

-- Arjun Suresh (150k points)

1.0.54 GATE1992_08 top

<http://gateoverflow.in/587>

Union-Find Algorithm can be used to find the cycle.

Ref: <http://www.geeksforgeeks.org/union-find/>

3 votes

-- Rajarshi Sarkar (29.7k points)

1.0.55 GATE2000-1.13 top

<http://gateoverflow.in/636>

Answer: C

4 votes

-- Rajarshi Sarkar (29.7k points)

1.0.56 GATE1999_2.20 top

<http://gateoverflow.in/466>



Selected Answer

Arrange files in increasing order of records

D A C B E

5 10 15 20 25

75

30

45

15

15(C) 20 (B) 25(E)

5(D) 10(A)

No of movements=15+30+45+75=165

5 votes

-- Pooja (25.9k points)

1.0.57 GATE2000-1.15 top

<http://gateoverflow.in/638>



Selected Answer

Because array is always sorted just check the 1st two elements. option a.

9 votes

-- anshu (2.5k points)

1.0.58 GATE2000-2.15 top

<http://gateoverflow.in/662>



Selected Answer

Answer is (a)

Effect of the above 3 reversal for any K is equivalent to left rotation of the array of size n by k.

Let , S[1.....7]

| | | | | | | |
|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|

so, n=7 ,k = 2

reverse(S,1,2) we get [2,1,3,4,5,6,7]

reverse(S,3,7) we get [2,1,7,6,5,4,3]

reverse(S,1,7) we get [3,4,5,6,7,1,2]

hence option (a) Rotates s left by k position is correct

11 votes

-- Kalpana Bhargav (3k points)

1.1

Arrays top

1.1.1 Arrays: GATE1994_25 top

<http://gateoverflow.in/2521>

An array A contains n integers in non-decreasing order, $A[1] \leq A[2] \leq \dots \leq A[n]$. Describe, using Pascal like pseudo code, a linear time algorithm to find i, j , such that $A[i] + A[j] = a$ given integer M , if such i, j exist.

gate1994 algorithms arrays normal

Answer

1.1.2 Arrays: TIFR2011-B-30 top

<http://gateoverflow.in/20611>

Consider an array $A[1..n]$. It consists of a permutation of numbers $1...n$. Now compute another array $B[1..n]$ as follows: $B[A[i]] := i$ for all i . Which of the following is true?

- a. B will be a sorted array.
- b. B is a permutation of array A .
- c. Doing the same transformation twice will not give the same array.
- d. B is not a permutation of array A .
- e. None of the above.

tifr2011 algorithms arrays

Answer

1.1.3 Arrays: GATE1993_12 top

<http://gateoverflow.in/2309>

The following Pascal program segments finds the largest number in a two-dimensional integer array $A[0..n-1, 0..n-1]$ using a single loop. Fill up the boxes to complete the program and write against \boxed{A} , \boxed{B} , \boxed{C} and \boxed{D} in your answer book. Assume that max is a variable to store the largest value and i, j are the indices to the array.

```
begin
  max:=|A|, i:=0, j:=0;
  while |B| do
  begin
    if A[i, j]>max then max:=A[i, j];
    if |C| then j:=j+1;
    else begin
      j:=0;
      i:=|D|
    end
  end
end
```

gate1993 algorithms arrays normal

Answer

1.1.4 Arrays: GATE1997_17 [top](#)<http://gateoverflow.in/2277>

An array A contains

$n \geq 1$ positive integers in the locations

$A[1], A[2], \dots, A[n]$. The following program fragment prints the length of a shortest sequence of consecutive elements of A,

$A[i], A[i+1], \dots, A[j]$ such that the sum of their values is

$\geq M$, a given positive number. It prints 'n+1' if no such sequence exists. Complete the program by filling in the boxes. In each case use the simplest possible expression. Write only the line number and the contents of the box.

```

begin
i:=1; j:=1;
sum := 0;
min:=n; finish:=false;
while not finish do
  if 0 then
    if j=n then finish:=true
    else
      begin
        j:=j+1;
        sum:= 0
      end
    else
      begin
        if (j-i) < min then min:=j-i;
        sum:=sum -A[i];
        i:=i+1;
      end
  writeln (min +1);
end.

```

[gate1997](#) [algorithms](#) [arrays](#) [normal](#)

Answer

Answers: Arrays**1.1.1 Arrays: GATE1994_25** [top](#)<http://gateoverflow.in/2521>

Selected Answer

```

i = 1;
j = n;
while(i != j) {
  if(A[i] + A[j] == M) break;
  else if(A[i] + A[j] < M) i++;
  else j--;
}

```

9 votes

-- ankitrokdeonsns (8.4k points)

1.1.2 Arrays: TIFR2011-B-30 [top](#)<http://gateoverflow.in/20611>

Selected Answer

Option b)
B is a permutation of array A.

Infact, B gives the reverse index of all the elements of array A. Since the array A contains numbers [1..n] mapped to

the locations $[1..n]$ and A is a permutation of the numbers $[1..n]$, the array B will also be a permutation of the numbers $[1..n]$.

For example:

| index | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|-------|---|---|---|---|---|---|---|---|
| A | 5 | 1 | 3 | 7 | 6 | 2 | 8 | 4 |
| B | 2 | 6 | 3 | 8 | 1 | 5 | 4 | 7 |

To see that option c is incorrect, let array C be the array attained from doing the same transformation twice, that is, $C[B[i]] = i, \forall i \in [1..n]$. We get,

| index | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|-------|---|---|---|---|---|---|---|---|
| A | 5 | 1 | 3 | 7 | 6 | 2 | 8 | 4 |
| B | 2 | 6 | 3 | 8 | 1 | 5 | 4 | 7 |
| C | 5 | 1 | 3 | 7 | 6 | 2 | 8 | 4 |

We can see that $C = A$, which makes option c incorrect.

4 votes

-- Pragy Agarwal (14.4k points)

1.1.3 Arrays: GATE1993_12 [top](#)

<http://gateoverflow.in/2309>

We have to traverse all elements in array. The code is doing this row wise.

```

begin
    max:=A[0,0], i:=0, j:=0;
    while (i < n) do
    begin
        if A[i, j]>max then max:=A[i, j];
        if (j < n-1) then j:=j+1;
        else begin
            j:=0;
            i:=i++;
        end
    end
end

```

3 votes

-- Arjun Suresh (150k points)

1.1.4 Arrays: GATE1997_17 [top](#)

<http://gateoverflow.in/2277>



Selected Answer

```

begin
i:=1;j:=1;
sum := A[1];
min:=n; finish:=false;
while not finish do
  if sum < M then
    if j=n then finish:=true
    else
      begin
        j:=j+1;
        sum:= sum + A[j];
      end
    else
      begin
        if(j-i) < min then min:=j-i;
        sum:=sum - A[i];
        i:=i+1;
      end
  writeln (min +1);
end.

```

Algorithm

'i' indicates the starting marker and 'j' acts as ending marker for the sum sequence. 'sum' is initialised as the first element in the array because the algorithm proceeds by taking the sum of remaining elements. 'finish' is a boolean variable that indicates exit from the loop.

After entering the loop for the first time with 'finish' as false, the sum is checked if it's strictly less than "M". If that's the case j is incremented and the sum is modified to sum + A[j]. When 'sum' becomes greater than or equal to 'M', 'min' is modified to the latest number of elements that make the sum greater than or equal to 'M' and then, the first element is stripped off from the sum and 'i' is incremented by one to move the initial marker of the sum sequence. The loop runs till 'j' reaches the end of the array.

The algorithm keeps track of 'min' i.e. the number of elements in the minimum sum sequence. This is very similar to the way we find the minimum value in an array by modifying the min value whenever a lesser value is encountered.

5 votes

-- krish__ (303 points)

1.2

Asymptotic Notations

top

1.2.1 Asymptotic Notations: GATE2011_37

<http://gateoverflow.in/2139>

Which of the given options provides the increasing order of asymptotic complexity of functions f_1, f_2, f_3 and f_4 ?

- $f_1(n) = 2^n$
- $f_2(n) = n^{3/2}$
- $f_3(n) = n \log_2 n$
- $f_4(n) = n^{\log_2 n}$

(A)
 f_3, f_2, f_4, f_1

(B)
 f_3, f_2, f_1, f_4

(C)
 f_2, f_3, f_1, f_4

(D)
 f_2, f_3, f_4, f_1

[gate2011](#) [algorithms](#) [asymptotic-notations](#) [normal](#)

Answer

1.2.2 Asymptotic Notations: GATE2000-2.17 [top](#)

<http://gateoverflow.in/664>

Consider the following functions

- $f(n) = 3n\sqrt{n}$
- $g(n) = 2\sqrt{n}\log_2 n$
- $h(n) = n!$

Which of the following is true?

- $h(n)$ is $O(f(n))$
- $h(n)$ is $O(g(n))$
- $g(n)$ is not $O(f(n))$
- $f(n)$ is $O(g(n))$

[gate2000](#) [algorithms](#) [asymptotic-notations](#) [normal](#)

[Answer](#)

1.2.3 Asymptotic Notations: GATE2004_29 [top](#)

<http://gateoverflow.in/1026>

The tightest lower bound on the number of comparisons, in the worst case, for comparison-based sorting is of the order of

- n
- n^2
- $n \log n$
- $n \log^2 n$

[gate2004](#) [algorithms](#) [sorting](#) [asymptotic-notations](#) [easy](#)

[Answer](#)

1.2.4 Asymptotic Notations: GATE2008-39 [top](#)

<http://gateoverflow.in/450>

Consider the following functions:

$$f(n) = 2^n$$

$$g(n) = n!$$

$$h(n) = n^{\log n}$$

Which of the following statements about the asymptotic behavior of $f(n)$, $g(n)$ and $h(n)$ is true?

- $f(n) = O(g(n)); g(n) = O(h(n))$
- $f(n) = \Omega(g(n)); g(n) = O(h(n))$
- $g(n) = O(f(n)); h(n) = O(f(n))$
- $h(n) = O(f(n)); g(n) = \Omega(f(n))$

[gate2008](#) [algorithms](#) [asymptotic-notations](#) [normal](#)

[Answer](#)

1.2.5 Asymptotic Notations: GATE1999_2.21 [top](#)

<http://gateoverflow.in/1498>

If $T_1 = O(1)$, give the correct matching for the following pairs:

- | | |
|--------------------------------|-------------------------|
| (M) $T_n = T_{n-1} + n$ | (U) $T_n = O(n)$ |
| (N) $T_n = T_{n/2} + n$ | (V) $T_n = O(n \log n)$ |
| (O) $T_n = T_{n/2} + n \log n$ | (W) $T = O(n^2)$ |
| (P) $T_n = T_{n-1} + \log n$ | (X) $T_n = O(\log^2 n)$ |

- (A) M-W N-V O-U P-X
 (B) M-W N-U O-X P-V
 (C) M-V N-W O-X P-U
 (D) M-W N-U O-V P-X

gate1999 | algorithms | recurrence | asymptotic-notations | normal

[Answer](#)

1.2.6 Asymptotic Notations: GATE2005_37 [top](#)

<http://gateoverflow.in/1373>

Suppose $T(n) = 2T\left(\frac{n}{2}\right) + n$, $T(0) = T(1) = 1$

Which one of the following is FALSE?

- A. $T(n) = O(n^2)$
- B. $T(n) = \Theta(n \log n)$
- C. $T(n) = \Omega(n^2)$
- D. $T(n) = O(n \log n)$

gate2005 | algorithms | asymptotic-notations | recurrence | normal

[Answer](#)

1.2.7 Asymptotic Notations: TIFR2014-B-8 [top](#)

<http://gateoverflow.in/27192>

Which of these functions grows fastest with n ?

- a. e^n/n .
- b. $e^{n-0.9} \log n$.
- c. 2^n .
- d. $(\log n)^{n-1}$.
- e. None of the above.

tifr2014 | algorithms | asymptotic-notations

[Answer](#)

1.2.8 Asymptotic Notations: GATE2004-IT_55 [top](#)

<http://gateoverflow.in/3698>

Let $f(n)$, $g(n)$ and $h(n)$ be functions defined for positive integers such that $f(n) = O(g(n))$, $g(n) \neq O(f(n))$, $g(n) = O(h(n))$, and $h(n) = O(g(n))$.

Which one of the following statements is FALSE?

- A) $f(n) + g(n) = O(h(n)) + h(n)$
- B) $f(n) = O(h(n))$

- C) $h(n) \neq O(f(n))$
 D) $f(n)h(n) \neq O(g(n)h(n))$

gate2004-it | algorithms | asymptotic-notations | normal

Answer

1.2.9 Asymptotic Notations: GATE2015-3_42 [top](#)

<http://gateoverflow.in/8501>

Let $f(n) = n$ and $g(n) = n^{(1+\sin n)}$ where n is a positive integer. Which of the following statements is/are correct?

- I. $f(n) = O(g(n))$
 II. $f(n) = \Omega(g(n))$

- A. Only I
 B. Only II
 C. Both I and II
 D. Neither I nor II

gate2015-3 | algorithms | asymptotic-notations | normal

Answer

1.2.10 Asymptotic Notations: GATE1994_1.23 [top](#)

<http://gateoverflow.in/2466>

Consider the following two functions:

$$g_1(n) = \begin{cases} n^3 & \text{for } 0 \leq n \leq 10,000 \\ n^2 & \text{for } n \geq 10,000 \end{cases}$$

$$g_2(n) = \begin{cases} n & \text{for } 0 \leq n \leq 100 \\ n^3 & \text{for } n > 100 \end{cases}$$

Which of the following is true?

- A. $g_1(n)$ is $O(g_2(n))$
 B. $g_1(n)$ is $O(n^3)$
 C. $g_2(n)$ is $O(g_1(n))$
 D. $g_2(n)$ is $O(n)$

gate1994 | algorithms | asymptotic-notations | normal

Answer

1.2.11 Asymptotic Notations: GATE2003_20 [top](#)

<http://gateoverflow.in/910>

Consider the following three claims

- I. $(n+k)^m = \Theta(n^m)$ where k and m are constants
 II. $2^{n+1} = O(2^n)$
 III. $2^{2n+1} = O(2^n)$

Which of the following claims are correct

- A. I and II
 B. I and III
 C. II and III
 D. I, II, and III

[gate2003](#)
[algorithms](#)
[asymptotic-notations](#)
[normal](#)
Answer**1.2.12 Asymptotic Notations: GATE2001-1.16** [top](#)<http://gateoverflow.in/709>

Let $f(n) = n^2 \log n$ and $g(n) = n(\log n)^{10}$ be two positive functions of n . Which of the following statements is correct?

- A. $f(n) = O(g(n))$ and $g(n) \neq O(f(n))$
- B. $g(n) = O(f(n))$ and $f(n) \neq O(g(n))$
- C. $f(n) \neq O(g(n))$ and $g(n) \neq O(f(n))$
- D. $f(n) = O(g(n))$ and $g(n) = O(f(n))$

[gate2001](#)
[algorithms](#)
[asymptotic-notations](#)
[time-complexity](#)
[normal](#)
Answer**1.2.13 Asymptotic Notations: GATE1996_1.11** [top](#)<http://gateoverflow.in/2715>

Which of the following is false?

- A. $100n \log n = (\frac{n \log n}{100})$
- B. $\sqrt{\log n} = O(\log \log n)$
- C. If $0 < x < y$ then $n^x = O(n^y)$
- D. $2^n \neq O(nk)$

[gate1996](#)
[algorithms](#)
[asymptotic-notations](#)
[normal](#)
Answer**1.2.14 Asymptotic Notations: TIFR2011-B-27** [top](#)<http://gateoverflow.in/20573>

Let n be a large integer. Which of the following statements is TRUE?

- A. $n^{1/\sqrt{\log_2 n}} < \sqrt{\log_2 n} < n^{1/100}$
- B. $n^{1/100} < n^{1/\sqrt{\log_2 n}} < \sqrt{\log_2 n}$
- C. $n^{1/\sqrt{\log_2 n}} < n^{1/100} < \sqrt{\log_2 n}$
- D. $\sqrt{\log_2 n} < n^{1/\sqrt{\log_2 n}} < n^{1/100}$
- E. $\sqrt{\log_2 n} < n^{1/100} < n^{1/\sqrt{\log_2 n}}$

[tifr2011](#)
[asymptotic-notations](#)
Answer**1.2.15 Asymptotic Notations: GATE2015-3_4** [top](#)<http://gateoverflow.in/8398>

Consider the equality $\sum_{(i=0)}^n i^3 = X$ and the following choices for X

- I. $\Theta(n^4)$
- II. $\Theta(n^5)$
- III. $O(n^5)$
- IV. $\Omega(n^3)$

The equality above remains correct if X is replaced by

- A. Only I
- B. Only II
- C. I or III or IV but not II
- D. II or III or IV but not I

[gate2015-3](#) | [algorithms](#) | [asymptotic-notations](#) | [normal](#)

[Answer](#)

1.2.16 Asymptotic Notations: GATE2008-IT_10 [top](#)

<http://gateoverflow.in/3270>

Arrange the following functions in increasing asymptotic order:

- A. $n^{1/3}$
- B. e^n
- C. $n^{7/4}$
- D. $n \log^9 n$
- E. 1.0000001^n

- | | |
|----|---------------|
| A) | A, D, C, E, B |
| B) | D, A, C, E, B |
| C) | A, C, D, E, B |
| D) | A, C, D, B, E |

[gate2008-it](#) | [algorithms](#) | [asymptotic-notations](#) | [normal](#)

[Answer](#)

Answers: Asymptotic Notations

1.2.1 Asymptotic Notations: GATE2011_37 [top](#)

<http://gateoverflow.in/2139>



Selected Answer

[EDIT]

answer A

$n \log_2 n < n^{3/2}$ is quite straightforward

also $n^{3/2} < n^{\log_2 n}$ and $n^{3/2} < 2^n$

now only $n^{\log_2 n}$ and 2^n need to be compared

taking log of both $(\log_2 n)^2$ and n

$n > (\log_2 n)^2$

hence $2^n > n^{\log_2 n}$

6 votes

-- ankitrokdeonsns (8.4k points)

1.2.2 Asymptotic Notations: GATE2000-2.17 [top](#)

<http://gateoverflow.in/664>



Selected Answer

| | $n = 256$ | $n = 65536$ |
|--------------------------------|---|---|
| $f(n) = 3n^{\sqrt{n}}$ | 3×256^{16} $= 3 \times 2^{128}$ | 3×65536^{256} $= 3 \times 2^{16 \times 256}$ $= 3 \times 2^{4096}$ |
| $g(n) = 2^{\sqrt{n} \log_2 n}$ | $2^{16 \times 8}$ $= 2^{128}$ | $2^{256 \times 16}$ $= 2^{4096}$ |
| $h(n) = n!$ | $256!$ $= O((2^8)^{256})$ $= O(2^{2048})$ | $65536!$ $= O((2^{16})^{65536})$ $= O(2^{1M})$ |

Case of $h(n)$ is given only by an upper bound but factorial has higher growth rate than exponential.

<http://math.stackexchange.com/questions/351815/do-factorials-really-grow-faster-than-exponential-functions>

$f(n)$ and $g(n)$ are having same order of growth as $f(n)$ is simply 3 $g(n)$ (we can prove this by taking log also). So, (d) is correct and all other choices are false.

11 votes

-- Arjun Suresh (150k points)

1.2.3 Asymptotic Notations: GATE2004_29 [top](#)

<http://gateoverflow.in/1026>



Selected Answer

For comparison-based sorting the asymptotically tight bound for worst case is given by $\Theta(n \log n)$, which means it is the tightest upper bound (big O) as well as the tightest lower bound (big omega). So, answer is $n \log n$.

Tightest lower bound of sorting (say $S(n)$) is $n \log n$ means there is no function f which has an order of growth larger than $n \log n$ and $f(n) = \Omega(S(n))$ holds.

A usual mistake is to think worst case changes with lower and upper bounds, but that is not the case. Worst case is defined for the algorithm and it is always the input which causes the algorithm the maximum complexity.

10 votes

-- Arjun Suresh (150k points)

1.2.4 Asymptotic Notations: GATE2008-39 [top](#)

<http://gateoverflow.in/450>



Selected Answer

$g(n) = n!$ on expanding factorial we get $g(n) = \mathcal{O}(n^n)$:

$$\begin{aligned} n^n &> n^{\log n} \\ n^n &> 2^n \end{aligned}$$

this condition is violated by option A, B and C by first statements of each Hence, they cannot be said true.

second statement of option D says that $g(n)$ is asymptotically biggest of all.

answer = **option D**

4 votes

-- Amar Vashishth (20.7k points)

1.2.5 Asymptotic Notations: GATE1999_2.21 [top](#)

<http://gateoverflow.in/1498>

Selected Answer

(M) $T(n) = \text{Sum of first } n \text{ natural numbers} = \frac{n(n+1)}{2} = O(n^2)$

(N) $T(n) = \Theta(n) = O(n)$, third case of Master theorem

$(f(n) = n = \Omega(n^{\log_b a + \epsilon}) = \Omega(n^{\log_2 1 + \epsilon}) = \Omega(n^{0+\epsilon})$, satisfied for any positive $\epsilon \leq 1$. Also, $af\left(\frac{n}{b}\right) < cf(n) \implies f\left(\frac{n}{2}\right) < cf(n) \implies \frac{n}{2} < cn$, satisfied for any c between 0 and 0.5)

(O) $T(n) = \Theta(n \log n) = O(n \log n)$, third case of Master theorem

$(f(n) = n \log n = \Omega(n^{\log_b a + \epsilon}) = \Omega(n^{\log_2 1 + \epsilon}) = \Omega(n^{0.5+\epsilon})$, satisfied for positive $\epsilon = 0.5$. Also, $af\left(\frac{n}{b}\right) < cf(n) \implies f\left(\frac{n}{2}\right) < cf(n) \implies \frac{n}{2} \log \frac{n}{2} < cn \log n$, satisfied for $c = 0.5$)

(P) Like in (M), here we are adding the log of the first n natural numbers. So,

$$T_n = \log 1 + \log 2 + \log 3 + \dots + \log n$$

$$= \log(1 \times 2 \times \dots \times n)$$

$$= \log(n!)$$

$= \Theta(n \log n)$ (Stirling's Approximation)

10 votes

-- Arjun Suresh (150k points)

1.2.6 Asymptotic Notations: GATE2005_37 [top](#)

<http://gateoverflow.in/1373>

Selected Answer

Applying Masters theorem $T(n) = \Theta(n \log n)$ So, it can't be $\Omega(n^2)$

Hence answer is C.

11 votes

-- shreya ghosh (2.9k points)

1.2.7 Asymptotic Notations: TIFR2014-B-8 [top](#)

<http://gateoverflow.in/27192>

Selected Answer

Assuming that the base of the log in the question is e .

Let us try to rewrite each of these functions in the form $e^{\text{something}}$, to make the comparison easier.

$$\begin{array}{lll}
 a. & e^n / n & = \frac{e^n}{e(\ln n)} = e(n - \ln n) \\
 b. & e^{n-0.9\ln n} & = e(n - 0.9\ln n) \\
 c. & 2^n & = (e^{\ln 2})^n = e(n \ln 2) \\
 d. & (\ln n)^{n-1} & = (e^{\ln \ln n})^{n-1} = e(n \ln \ln n - \ln \ln n)
 \end{array}$$

Now, if we just compare the exponents of all, we can clearly see that $(n \ln \ln n - \ln \ln n)$ grows faster than the rest. Note that in option c. the multiplicative $\ln 2$ is a constant, and hence grows slower than the multiplicative $\ln \ln n$ from option d.

This implies that $e(n \ln \ln n - \ln \ln n)$ grows the fastest, and hence, $(\ln n)^{n-1}$ grows the fastest.

Thus, option d. is the correct answer.

7 votes

-- Pragy Agarwal (14.4k points)

1.2.8 Asymptotic Notations: GATE2004-IT_55 [top](#)

<http://gateoverflow.in/3698>

Answer is (D)

We can verify as : $f \leq g$ BUT $g \neq f$. Therefore $f < g$

Also $g = h$ as $g = O(h)$ and $h = O(g)$

5 votes

-- Sandeep_Uniyal (5.5k points)

1.2.9 Asymptotic Notations: GATE2015-3_42 [top](#)

<http://gateoverflow.in/8501>



Selected Answer

The answer is option D.

Since the value of $\sin(n)$ will always range from -1 to +1, hence $g(n)$ can take values 1, n , n^2 .

Hence, if $g(n) = 1$, Statement I is incorrect.

And, if $g(n) = n^2$, then Statement II is incorrect.

14 votes

-- saurabhrk (1.3k points)

1.2.10 Asymptotic Notations: GATE1994_1.23 [top](#)

<http://gateoverflow.in/2466>



Selected Answer

For asymptotic complexity, we assume sufficiently large n . So, $g_1(n) = n^2$ and $g_2(n) = n^3$. Growth rate of g_1 is less than that of g_2 . i.e., $g_1(n) = O(g_2(n))$.

Options A and B are true here.

7 votes

-- Arjun Suresh (150k points)

1.2.11 Asymptotic Notations: GATE2003_20 [top](#)

<http://gateoverflow.in/910>



Selected Answer

1) Clearly rate of growth of $(n+k)^m = n^m$ as k and m are constants

so TRUE

2) $2^{n+1} = 2 * (2^n) = \Theta(2^n)$ as 2 is a constant here

As 2^{n+1} is both upper and lower bounded by 2^n we can say $2^{n+1} = O(2^n)$

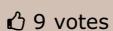
so TRUE

3) 2^{2n+1} has same rate of growth as 2^{2n}

$$2^{2n} = 2^{n^2}$$

2^n is upper bounded by $(2^n)^2$, not the other way round

so FALSE



9 votes

-- Danish (2.4k points)

1.2.12 Asymptotic Notations: GATE2001-1.16 [top](#)

<http://gateoverflow.in/709>



Selected Answer

| | f(n) | g(n) |
|---------------|---------------------------|----------------------|
| $n = 2^{10}$ | $10 * 2^{10} * 2^{10}$ | $2^{10} * 10^{10}$ |
| $n = 2^{256}$ | $256 * 2^{256} * 2^{256}$ | $2^{256} * 256^{10}$ |

So, as n is going larger, $f(n)$ is overtaking $g(n)$ and the growth rate of f is faster than that of g . So, $g(n) = O(f(n))$ and $f(n) \neq O(g(n))$.

B choice.



12 votes

-- Arjun Suresh (150k points)

1.2.13 Asymptotic Notations: GATE1996_1.11 [top](#)

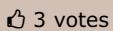
<http://gateoverflow.in/2715>



Selected Answer

- $100n \log n = (\frac{n \log n}{100})$: cant do comment about it not given properly in paper.
- $\sqrt{\log n} = O(\log \log n)$: false take any long value like 256 LHS results 16 But RHS results 4 only . generally we take log left side but that is wrong.
- $0 < x < y$ then $n^x = O(n^y)$: true since y is always greater than x so RHS is always greater than LHS.
- $2^n \neq O(nk)$: true since k is constant .so for large value of n LHS is very higher than RHS (exponential function always greater than linear)

Only B is false



3 votes

-- Anirudh Pratap Singh (17.7k points)

1.2.14 Asymptotic Notations: TIFR2011-B-27 [top](#)

<http://gateoverflow.in/20573>

Let $n = 2^x$. Then, $\log_2 n = x$

$$f(n) = n^{1/\sqrt{\log_2 n}} = (2^x)^{1/\sqrt{x}} = 2^{x/\sqrt{x}} = 2^{\sqrt{x}}$$

$$g(n) = \sqrt{\log_2 n} = \sqrt{\log_2(2^x)} = \sqrt{x}$$

$$h(n) = n^{1/100} = (2^x)^{1/100} = 2^{x/100}$$

Since exponentials grow faster than polynomials, $h(n) > g(n)$ for large n .

Since linear functions grow faster than square roots, $\frac{x}{100} > \sqrt{x}$ for large x . Thus, $h(n) > f(n)$ for large n .

Since exponentials grow faster than polynomials, $2^{\sqrt{x}} > \sqrt{x}$ for large \sqrt{x} . Thus, $f(n) > g(n)$ for large n .

Hence, the relation is,

$$g(n) < f(n) < h(n)$$

Thus, option D is correct.

1 3 votes

-- Pragy Agarwal (14.4k points)

1.2.15 Asymptotic Notations: GATE2015-3_4 top

<http://gateoverflow.in/8398>



Selected Answer

Sum of the cubes of the first n natural numbers is given by $(n(n+1)/2)^2$ which is $\Theta(n^4)$. So, I, III and IV are correct. II is wrong. C choice.

1 16 votes

-- Arjun Suresh (150k points)

1.2.16 Asymptotic Notations: GATE2008-IT_10 top

<http://gateoverflow.in/3270>



Selected Answer

A < C and A < D

E < B

and

C, D < E as E is exponential function.

Now, we just need to see if C or D is larger.

In C we have a term $n^{3/4}$ and correspondingly in D we have $\log^9 n$ (after taking n out).

$n^{3/4}$ is asymptotically larger than $\log^9 n$ as when $n = \underbrace{10^{10 \dots x}}_{9 \text{ times}}$, $\log^9 n$ gives x , while $n^{3/4}$ gives a much higher value and this is true for all higher values of n . So, D < C.

Thus A is correct.

1 11 votes

-- Arjun Suresh (150k points)

1.3

Binary Heap top

1.3.1 Binary Heap: GATE2006_10 [top](#)

<http://gateoverflow.in/889>

In a binary max heap containing n numbers, the smallest element can be found in time

- (A) $O(n)$
- (B) $O(\log n)$
- (C) $O(\log \log n)$
- (D) $O(1)$

[gate2006](#) [data-structure](#) [heap](#) [binary-heap](#) [easy](#)

[Answer](#)

Answers: Binary Heap

1.3.1 Binary Heap: GATE2006_10 [top](#)

<http://gateoverflow.in/889>



Selected Answer

- (A) $O(n)$

In a max heap, the smallest element is always present at a leaf node. Heap being a complete binary tree, there can be up to $\frac{n}{2}$ leaf nodes and to examine all of them we would need $O(n)$ time.

6 votes

-- Keith Kr (6k points)

1.4

Binary Search [top](#)

1.4.1 Binary Search: GATE2008-85 [top](#)

<http://gateoverflow.in/43508>

Consider the following C program that attempts to locate an element x in an array $Y[]$ using binary search. The program is erroneous.

```
f (int Y[10] , int x) {
    int u, j, k;
    i= 0; j = 9;
    do {
        k = (i+ j) / 2;
        if( Y[k] < x) i = k; else j = k;
        } while (Y[k] != x) && (i < j));
        if(Y[k] == x) printf(" x is in the array ");
        else printf(" x is not in the array ");
    }
```

The correction needed in the program to make it work properly is

- A. Change line 6 to: if ($Y[k] < x$) $i = k + 1$; else $j = k - 1$;
- B. Change line 6 to: if ($Y[k] < x$) $i = k - 1$; else $j = k + 1$;
- C. Change line 6 to: if ($Y[k] < x$) $i = k$; else $j = k$;
- D. Change line 7 to: } while (($Y[k] == x$) && ($i < j$));

[gate2008](#) [algorithms](#) [binary-search](#) [normal](#)

[Answer](#)

1.4.2 Binary Search: GATE1996_18 [top](#)

<http://gateoverflow.in/2770>

Consider the following program that attempts to locate an element x in an array $a[]$ using binary search. Assume $N > 1$. The program is erroneous. Under what conditions does the program fail?

```
var i,j,k: integer; x: integer;
a: array [1..N] of integer;
begin i:= 1; j:= n;
repeat
  k:=(i+j) div 2;
  if a[k] < x then i:= k
  else j:= k
until (a[k] = x) or (i >= j);

if (a[k] = x) then
  writeln ('x is not in the array')
else
  writeln ('x is not in the array')
end;
```

[gate1996](#) [algorithms](#) [binary-search](#) [normal](#)

Answer

1.4.3 Binary Search: TIFR2012-B-11 [top](#)

<http://gateoverflow.in/25140>

Consider the following three version of the binary search program. Assume that the elements of type T can be compared with each other; also assume that the array is sorted.

```
i, j, k : integer;
a : array [1....N] of T;
x : T;

Program 1 : i := 1; j := N;
repeat
  k := (i + j) div 2;
  if a[k] < x then i := k else j := k
until (a[k] = x) or (i > j)

Program 2 : i := 1; j := N;
repeat
  k := (i + j) div 2;
  if x < a[k] then j := k - 1;
  if a[k] < x then i := k + 1;
until i > j

Program 3 : i := 1; j := N
repeat
  k := (i + j) div 2;
  if x < a[k] then j := k else i := k + 1
until i > j
```

A binary search program is called correct provided it terminates with $a[k] = x$ whenever such an element exists, or it terminates with $a[k] \neq x$ if there exists no array element with value x . Which of the following statements is correct?

- a. Only Program 1 is correct
- b. Only Program 2 is correct
- c. Only Program 1 and 2 are correct.
- d. Both Program 2 and 3 are correct
- e. All the three programs are wrong

[tifr2012](#) [algorithms](#) [binary-search](#)

Answer

1.4.4 Binary Search: TIFR2010-B-29 [top](#)

<http://gateoverflow.in/18752>

Suppose you are given an array A with $2n$ numbers.

The numbers in odd positions are sorted in ascending order, that is, $A[1] \leq A[3] \leq \dots \leq A[2n-1]$.

The numbers in even positions are sorted in descending order, that is, $A[2] \geq A[4] \geq \dots \geq A[2n]$.

What is the method you would recommend for determining if a given number is in the array?

- A. Sort the array using quick-sort and then use binary search.
- B. Merge the sorted lists and perform binary search.

- C. Perform a single binary search on the entire array.
 D. Perform separate binary searches on the odd positions and the even positions.
 E. Search sequentially from the end of the array.

[tifr2010](#) [binary-search](#)

[Answer](#)

1.4.5 Binary Search: GATE2008-84 [top](#)

<http://gateoverflow.in/394>

Consider the following C program that attempts to locate an element x in an array $Y[]$ using binary search. The program is erroneous.

```
f (int Y[10] , int x) {
    int u, j, k;
    i= 0; j = 9;
    do {
        k = (i+ j) / 2;
        if( Y[k] < x) i = k;else j = k;
        } while (Y[k] != x) && (i < j));
        if(Y[k] == x) printf(" x is in the array ");
        else printf(" x is not in the array ");
    }
```

On which of the following contents of Y and x does the program fail?

- A. Y is $[1 \ 2 \ 3 \ 4 \ 5 \ 6 \ 7 \ 8 \ 9 \ 10]$ and $x < 10$
 B. Y is $[1 \ 3 \ 5 \ 7 \ 9 \ 11 \ 13 \ 15 \ 17 \ 19]$ and $x < 1$
 C. Y is $[2 \ 2 \ 2 \ 2 \ 2 \ 2 \ 2 \ 2 \ 2 \ 2]$ and $x > 2$
 D. Y is $[2 \ 4 \ 6 \ 8 \ 10 \ 12 \ 14 \ 16 \ 18 \ 20]$ and $2 < x < 20$ and x is even

[gate2008](#) [algorithms](#) [binary-search](#) [normal](#)

[Answer](#)

Answers: Binary Search

1.4.1 Binary Search: GATE2008-85 [top](#)

<http://gateoverflow.in/43508>



Selected Answer

Ans should be A

```
if( Y[k] < x) then i = k + 1;
```

if given element that we are searching is greater then searching will be continued upper half of array
 otherwise $j = k - 1$;

lower half.

Take few case in consideration i.e.

1. all elements are same
2. increasing order with no repetition
3. increasing order with repetition.

1 votes

-- Manoj Kumar (23.1k points)

1.4.2 Binary Search: GATE1996_18 [top](#)

<http://gateoverflow.in/2770>

the code is wrong here $k=(i+j) / 2;$

if($a[k] < x$) then $i = k$;
else $j = k$;
the (correct) code should be ..

```

k=(i+j) / 2;

if( $a[k] < x$ ) then  $i = k + 1$  ;
else  $j = k - 1$  ;
try an example ....with given code in question
let an array      a[1,2,3,4,5,6,7,8,9,10]
index number      1,2,3,4,5,6,7,8,9,10
and  $x=10$  ; now run the code ;

initially  $i = 1$ ,  $j=10$ ;
first time  $k = (i+j) / 2 = 11/2 = 5.5 = 5$  (because of integer type) = $i$ 
second time =  $k = (i+j) / 2 = 15/2 = 7.5 = 7 = i$ 
third time =  $k = (i+j) / 2 = 17/2 = 8.5 = 8 = i$ 

fourth time =  $k = (i+j) / 2 = 18/2 = 9 = i$ 

fifth time =  $k = (i+j) / 2 = 19/2 = 9.5 = 9 = i$ 

sixth time =  $k = (i+j) / 2 = 19/2 = 9.5 = 9 = i$ 

seventh time =  $k = (i+j) / 2 = 19/2 = 9.5 = 9 = i$ 
.....
going to infinite loop (run time error) .... ;

for terminating loop , it should be ,  $i = k + 1$  instead of  $i = k$  ;and  $j = k - 1$  instead of  $j = k$  ;
correct me ....???
```

6 votes

-- Mithlesh Upadhyay (3.6k points)

1.4.3 Binary Search: TIFR2012-B-11 [top](#)

<http://gateoverflow.in/25140>

first program wont work if array has elements same..it may go into infinite loop .To make it work it properly we have to do following changes $j=k-1$ and $i=k+1$

For second program $a[k]==x$ condition is missing so it is wrong

Third program is also wrong as $j!=k-1$ and condition $a[k]==x$ is missing

So ans is e

1 votes

-- Pooja (25.9k points)

1.4.4 Binary Search: TIFR2010-B-29 [top](#)

<http://gateoverflow.in/18752>

Selected Answer

Option D is the correct answer.

We can simply use clever indexing to binary search the element in the odd positions, and in the even positions separately.

This will take $O(\log n)$ time and $O(1)$ space in the worst case.

- A: Sorting using Quicksort will take $O(n^2)$ time.
- B: Merging will take $O(n)$ time and $O(n)$ space.
- C: Binary search only works on a sorted array.
- E: Sequential search will take $O(n)$ time.

5 votes

-- Pragy Agarwal (14.4k points)

1.4.5 Binary Search: GATE2008-84 [top](#)

<http://gateoverflow.in/394>



Selected Answer

for Q.84

when it is **option C** the control will continue to iterate as $i = 8$ and $j = 9$; again and again i will be assigned k which itself equals 8 as $\frac{8+9}{2}$ being stored in an integer type variable, will evaluate to 8 .

For option A, with $x = 9$, k will take the following values:

- 4
- 6
- 7
- $8 - y[8] = 9$, x found

For option D, with $x = 10$, k will take the following values:

- $4, y[4] = 10$, x found

9 votes

-- Amar Vashishth (20.7k points)

1.5

Binary Tree top

1.5.1 Binary Tree: GATE2012_47 top

<http://gateoverflow.in/2163>

The height of a tree is defined as the number of edges on the longest path in the tree. The function shown in the pseudo-code below is invoked as `height(root)` to compute the height of a binary tree rooted at the tree pointer `root`.

```
int height (treeptr n)
{ if (n == NULL) return -1;
  if (n → left == NULL)
    if (n → right == NULL) return 0;
    else return [B1] ;                                // Box 1
  else { h1 = height (n → left);
         if (n → right == NULL) return (1+h1);
         else { h2 = height (n → right);
                  return [B2] ;                      // Box 2
                }
  }
}
```

(A)

B1: $(1 + \text{height}(n \rightarrow \text{right}))$

B2: $(1 + \max(h1, h2))$

(B)

B1: $(\text{height}(n \rightarrow \text{right}))$

B2: $(1 + \max(h1, h2))$

(C)

B1: $\text{height}(n \rightarrow \text{right})$

B2: $\max(h1, h2)$

(D)

B1: $(1 + \text{height}(n \rightarrow \text{right}))$

B2: $\max(h1, h2)$

[gate2012](#) [algorithms](#) [binary-tree](#) [normal](#)
[Answer](#)

1.5.2 Binary Tree: GATE2007_46 [top](#)

<http://gateoverflow.in/1244>

Consider the following C program segment where CellNode represents a node in a binary tree:

```
struct CellNode {
    struct CellNode *leftChild;
    int element;
    struct CellNode *rightChild;
};

int Getvalue (struct CellNode *ptr) {
    int value = 0;
    if (ptr != NULL) {
        if ((ptr->leftChild == NULL) &&
            (ptr->rightChild == NULL))
            value = 1;
        else
            value = value + GetValue(ptr->leftChild)
                + GetValue(ptr->rightChild);
    }
    return(value);
}
```

The value returned by GetValue when a pointer to the root of a binary tree is passed as its argument is:

- A. the number of nodes in the tree
- B. the number of internal nodes in the tree
- C. the number of leaf nodes in the tree
- D. the height of the tree

[gate2007](#) [algorithms](#) [binary-tree](#) [normal](#)
[Answer](#)

1.5.3 Binary Tree: GATE2013_43 [top](#)

<http://gateoverflow.in/1554>

The preorder traversal sequence of a binary search tree is 30, 20, 10, 15, 25, 23, 39, 35, 42. Which one of the following is the postorder traversal sequence of the same tree?

- (A) 10, 20, 15, 23, 25, 35, 42, 39, 30
- (B) 15, 10, 25, 23, 20, 42, 35, 39, 30
- (C) 15, 20, 10, 23, 25, 42, 35, 39, 30
- (D) 15, 10, 23, 25, 20, 35, 42, 39, 30

[gate2013](#) [algorithms](#) [binary-tree](#) [normal](#)
[Answer](#)

1.5.4 Binary Tree: GATE2014-3_39 [top](#)

<http://gateoverflow.in/2073>

Suppose we have a balanced binary search tree T holding n numbers. We are given two numbers L and H and wish to sum up all the numbers in T that lie between L and H . Suppose there are m such numbers in T . If the tightest upper bound on the time to compute the sum is $O(n^a \log^b n + m^c \log^d n)$, the value of $a + 10b + 100c + 1000d$ is _____.

[gate2014-3](#) [algorithms](#) [binary-tree](#) [time-complexity](#) [numerical-answers](#) [normal](#)
[Answer](#)

1.5.5 Binary Tree: GATE1997_4.5 [top](#)

<http://gateoverflow.in/2246>

A binary search tree contains the value 1, 2, 3, 4, 5, 6, 7, 8. The tree is traversed in pre-order and the values are printed out. Which of the following sequences is a valid output?

- A. 5 3 1 2 4 7 8 6
- B. 5 3 1 2 6 4 8 7
- C. 5 3 2 4 1 6 7 8
- D. 5 3 1 2 4 7 6 8

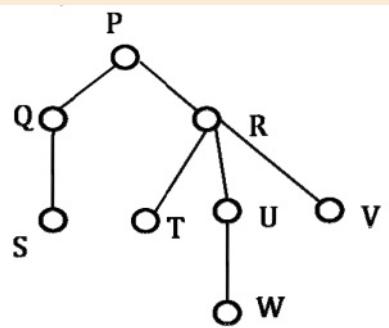
gate1997 | algorithms | binary-tree | normal

[Answer](#)

1.5.6 Binary Tree: GATE2014-3_12 [top](#)

<http://gateoverflow.in/2046>

Consider the following rooted tree with the vertex labeled P as the root:



The order in which the nodes are visited during an in-order traversal of the tree is

- (A) SQPTRWUV
- (B) SQPTUWRV
- (C) SQPTWUVR
- (D) SQPTRUWV

gate2014-3 | algorithms | binary-tree | easy

[Answer](#)

1.5.7 Binary Tree: GATE2008-46 [top](#)

<http://gateoverflow.in/458>

You are given the postorder traversal, P , of a binary search tree on the n elements $1, 2, \dots, n$. You have to determine the unique binary search tree that has P as its postorder traversal. What is the time complexity of the most efficient algorithm for doing this?

- A. $\Theta(\log n)$
- B. $\Theta(n)$
- C. $\Theta(n \log n)$
- D. None of the above, as the tree cannot be uniquely determined

gate2008 | algorithms | binary-tree | normal

[Answer](#)

1.5.8 Binary Tree: GATE2000-2.16 [top](#)

<http://gateoverflow.in/663>

Let LASTPOST, LASTIN and LASTPRE denote the last vertex visited in a postorder, inorder and preorder traversal

respectively, of a complete binary tree. Which of the following is always true?

- A. LASTIN = LASTPOST
- B. LASTIN = LASTPRE
- C. LASTPRE = LASTPOST
- D. None of the above

[gate2000](#) [algorithms](#) [binary-tree](#) [normal](#)

[Answer](#)

1.5.9 Binary Tree: GATE2004_85 [top](#)

<http://gateoverflow.in/1079>

A program takes as input a balanced binary search tree with n leaf nodes and computes the value of a function $g(x)$ for each node x . If the cost of computing $g(x)$ is:

$$\min \left(\frac{\text{number of leaf-nodes in left-subtree of } x}{\text{number of leaf-nodes in right-subtree of } x} \right)$$

Then the worst-case time complexity of the program is?

- A. $\Theta(n)$
- B. $\Theta(n \log n)$
- C. $\Theta(n^2)$
- D. $\Theta(n^2 \log n)$

[gate2004](#) [algorithms](#) [binary-tree](#) [normal](#) [time-complexity](#)

[Answer](#)

1.5.10 Binary Tree: GATE2007_13 [top](#)

<http://gateoverflow.in/1211>

The maximum number of binary trees that can be formed with three unlabeled nodes is:

- A. 1
- B. 5
- C. 4
- D. 3

[gate2007](#) [algorithms](#) [binary-tree](#) [normal](#)

[Answer](#)

1.5.11 Binary Tree: GATE2007-39, UGCNET-June2015-II-22 [top](#)

<http://gateoverflow.in/1237>

The inorder and preorder traversal of a binary tree are

d b e a f c g and a b d e c f g, respectively

The postorder traversal of the binary tree is:

- A. d e b f g c a
- B. e d b g f c a

- C. e d b f g c a
 D. d e f g b c a

gate2007 | algorithms | binary-tree | normal | ugcnetjune2015ii

Answer

Answers: Binary Tree

1.5.1 Binary Tree: GATE2012_47 [top](#)

<http://gateoverflow.in/2163>



Selected Answer

answer = **option A**

From the diagram below we are able to see how this works :

```

int height (treeptr n)
{
    if (n == NULL) return -1;
    if (n->left == NULL)
        if (n->right == NULL) return 0;
        else return 1 + height (n->right);
    else if (n->right == NULL) return 1 + height (n->left);
    else {
        int h1 = height (n->left);
        int h2 = height (n->right);
        return 1 + max(h1, h2);
    }
}
  
```

The appropriate expressions for the two boxes B1 and B2 are

| | |
|------------------------------|------------------------------|
| (A) B1: $(1 + \max(h1, h2))$ | (B) B1: $(\max(h1, h2))$ |
| B2: $(1 + \max(h1, h2))$ | B2: $(1 + \max(h1, h2))$ |
| (C) B1: $\max(h1, h2)$ | (D) B1: $(1 + \max(h1, h2))$ |
| B2: $(1 + \max(h1, h2))$ | B2: $(1 + \max(h1, h2))$ |

7 votes

-- Amar Vashishth (20.7k points)

1.5.2 Binary Tree: GATE2007_46 [top](#)

<http://gateoverflow.in/1244>



Selected Answer

Answer: C

As the function returns 1 if and only if any node has both left & right children as NULL (that node is a leaf node). Hence, value gets incremented at each leaf node.

5 votes

-- Rajarshi Sarkar (29.7k points)

1.5.3 Binary Tree: GATE2013_43 [top](#)

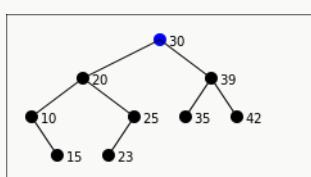
<http://gateoverflow.in/1554>



Selected Answer

Since it is a binary search tree, its inorder traversal produces a sorted sequence i.e. 10, 15, 20, 23, 25, 30, 35, 39, 42.

Now given inorder and preorder traversals, we get following tree :



From this, we can give postorder traversal sequence as 15,10,23,25,20,35,42,39,30 i.e. option (D).

9 votes

-- Happy Mittal (9.5k points)

1.5.4 Binary Tree: GATE2014-3_39 [top](#)

<http://gateoverflow.in/2073>



Selected Answer

In worst case for finding L and H it will take $O(\log n)$ time as the given tree is **balanced** binary search tree. Now there are m elements between L and H . So to traverse m element it will take $O(m)$ time (traversal algorithm given below). So, total

$$O(m + \log n) \implies a = 0, b = 1, c = 1, d = 0$$

$$\therefore 0 + (10 \times 1) + (100 \times 1) + (1000 \times 0) = 110 .$$

To find all the numbers from L to H we can do an inorder traversal from root and discard all elements before L and after H . But this has $O(n)$ time complexity. So, we can do a modification to inorder traversal and combine with binary search as follows:

1. Find L using binary search and keep all nodes encountered in the search in a stack.
2. After finding L add it to stack as well and initialize sum = 0.
3. Now, for all nodes in stack, do an inorder traversal starting from their right node and adding the node value to sum. If H is found, stop the algorithm.

18 votes

-- Kalpish Singhal (1.7k points)

1.5.5 Binary Tree: GATE1997_4.5 [top](#)

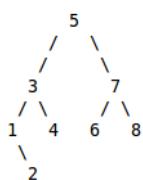
<http://gateoverflow.in/2246>



Selected Answer

Answer: D

The tree is:



5 votes

-- Rajarshi Sarkar (29.7k points)

1.5.6 Binary Tree: GATE2014-3_12 [top](#)

<http://gateoverflow.in/2046>



Selected Answer

A.

the inorder traversal order of a ternary tree is left-->root-->middle-->right.

11 votes

-- Gate Keeda (17.7k points)

1.5.7 Binary Tree: GATE2008-46 top

<http://gateoverflow.in/458>

Selected Answer

Last element in post order is the root of tree- find this element in inorder- $\log n$ time.

Now as in quick sort consider this as pivot and split the post order array into 2- possible because all elements smaller than pivot goes to left and all elements larger than pivot goes to right and suppose we have x elements smaller than pivot, these elements will be same in both inorder as well as postorder (order may change). We already got the root, now left child is the left split and right child is the right split.

So, doing this recursively gives time complexity of this approach as

$$T(n) = T(k) + T(n - k - 1) + \log n$$

Solving would give $T(n) = O(n \log n)$ in worst case, by putting $k = 0$ and shown at bottom.

But searching for an element in the inorder traversal of given BST can be done in $O(1)$ because we have n elements from $1..n$ so there is no need to search for an element- if last element in post order is say 5 we take it as root and since 4 elements (1..4) are smaller we split the post order array in to two- (first 4 elements), (6th element onward) and solve recursively. Time complexity for this would be

$$T(n) = T(k) + T(n - k - 1) + O(1)$$

which gives $T(n) = O(n)$.

Since we know that all elements must be traversed at least once, $T(n) = \Omega(n)$ also and so

$$T(n) = \Theta(n).$$

The following code is doing this.

```
//Install graphviz (sudo apt-get install graphviz on Ubuntu) to view output tree
#include<stdio.h>
#include<stdlib.h>
struct tree
{
    struct tree* left;
    struct tree* right;
    int x;
};
struct tree* makenode(int x)
{
    struct tree * root = malloc(sizeof(struct tree));
    root -> x = x;
    root -> left = root -> right = NULL;
    return root;
}

struct tree* makeBST(int *post, int start, int n, int inorder)
{
    if(n <= 0)
        return NULL;
    int pivot = post[start + n - 1];
    struct tree * root = makenode(pivot);
    root -> left = makeBST(post, start, pivot - 1 - inorder, inorder );
    root -> right = makeBST(post, pivot - inorder - 1, n - (pivot - inorder), pivot);
    return root;
}
void preorder(struct tree* node)
{
    if(node == NULL)
        return;
    printf("%d ", node->x);
    preorder(node->left);
    preorder(node->right);
}
void printdot(struct tree* node, FILE * f)
{
    if(node == NULL)
        return;
    if(node-> left != NULL)
    {
        fprintf(f, "%d -- %d\n", node->x, node->left->x);
    }
    if(node-> right != NULL)
    {
        fprintf(f, "%d -- %d\n", node->x, node->right->x);
    }
    printdot(node->left, f);
    printdot(node->right, f);
}
```

```

int main() {
    int i, n, *a;
    printf("Enter n: ");
    scanf("%d", &n);
    a = malloc(n * sizeof(int));
    printf ("Enter post order traversal: ");
    for(i = 0; i < n; i++)
    {
        scanf("%d", &a[i]);
    }
    struct tree * tree = makeBST(a, 0, n, 0);
    printf("Pre order traversal is : ");
    preorder(tree);
    printf("\n");
    FILE * f = fopen("tree.dot", "w");
    fprintf(f, "graph tree { \n");
    printdot(tree, f);
    fprintf(f, " }\n");
    fclose(f);

    #if defined(__linux__)
        system("dot -Tpng tree.dot -o output.png; eog output.png");
    #endif
}

```

$$T(n) = T(k) + T(n - k - 1) + \log n$$

Solving would give $T(n) = O(n \log n)$, by putting $k = 0$,
 $T(n) = T(0) + T(n - 1) + \log n, \Rightarrow T(n) = O(1) + \log n + \log(n - 1) + \log(n - 2) + \dots + \log 1 \Rightarrow T(n) = n + \log(n!)$
[\(Stirling's Approximation\)](#)

13 votes

-- Arjun Suresh (150k points)

1.5.8 Binary Tree: GATE2000-2.16 [top](#)

<http://gateoverflow.in/663>



Selected Answer

The answer is D.

Take any random sequence and check for the inorder, postorder and preorder Last Node.

8 votes

-- Gate Keeda (17.7k points)

1.5.9 Binary Tree: GATE2004_85 [top](#)

<http://gateoverflow.in/1079>



Selected Answer

B. At the root node (first level) the cost would be $\Theta\left(\frac{n}{2}\right)$ as the tree is **balanced**.

At next level, we have 2 nodes and for each of them cost of computing $g(x)$ will be $\Theta\left(\frac{n}{4}\right)$. So, total cost at second level = $\Theta\left(\frac{n}{2}\right)$. Similarly at **each level** (total cost per level and not the cost per node in a level) the cost would be $\Theta\left(\frac{n}{2}\right)$ and so for $\log n$ levels it would be $\Theta(n \log n)$.

PS: Even if we change min to max in the definition of $g(x)$ we get the same answer.

14 votes

-- Shaun Patel (5.8k points)

1.5.10 Binary Tree: GATE2007_13 [top](#)

<http://gateoverflow.in/1211>



Selected Answer

can be found with formula... $(2nCn/n+1)$... n being the number of nodes. for the given question... where n=3... answer is 5. Let me also specify here.. that number of Binary Search Trees with n nodes is equal to number of unlabeled Binary trees.

http://gatecse.in/wiki/Number_of_Binary_trees_possible_with_n_nodes

6 votes

-- Gate Keeda (17.7k points)

1.5.11 Binary Tree: GATE2007-39, UGCNET-June2015-II-22 [top](#)

<http://gateoverflow.in/1237>

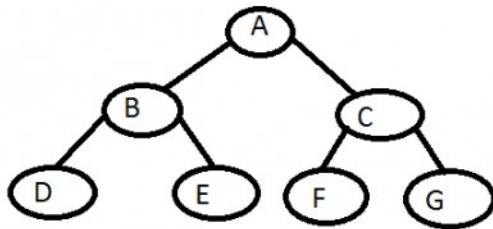


Selected Answer

The answer is A.

Take the first node in preorder traversal - 'a' will be the root of the tree
All nodes to the left of 'a' in inorder traversal will be in the left subtree of 'a' and all elements on the right will be in the right subtree of 'a'.

Take the second element from preorder traversal - 'b' - goes to left subtree of 'a' as it is in the left of 'a' in inorder list.
Proceeding likewise we can construct the binary tree as:



3 votes

-- Gate Keeda (17.7k points)

1.6

Connected Components [top](#)

1.6.1 Connected Components: GATE2014-1_3 [top](#)

<http://gateoverflow.in/1754>

Let

$G = (V, E)$ be a directed graph where

V is the set of vertices and

E the set of edges. Then which one of the following graphs has the same strongly connected components as G ?

(A)

$G_1 = (V, E_1)$ where
 $E_1 = \{(u, v) \mid (u, v) \notin E\}$

(B)

$G_2 = (V, E_2)$ where
 $E_2 = \{(u, v) \mid (v, u) \in E\}$

(C)

$G_3 =$

(V, E_3) where
 $E_3 = \{(u, v) |$ there is a path of length
 ≤ 2 from
 u to
 v in
 $E\}$

(D)
 $G_4 =$
 (V_4, E) where
 V_4 is the set of vertices in
 G which are not isolated

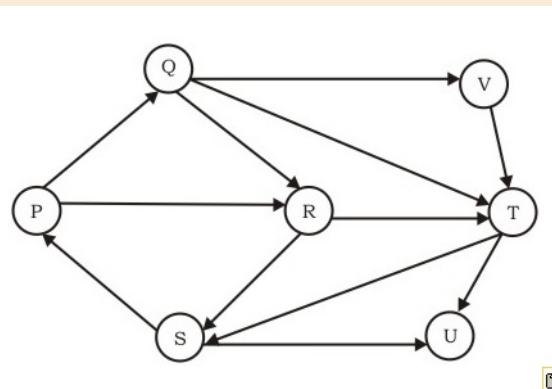
gate2014-1 algorithms graph-algorithms connected-components normal

Answer

1.6.2 Connected Components: GATE2006-IT_46 [top](#)

<http://gateoverflow.in/3589>

Which of the following is the correct decomposition of the directed graph given below into its strongly connected components?



- A) {P, Q, R, S}, {T}, {U}, {V}
- B) {P, Q, R, S, T, V}, {U}
- C) {P, Q, S, T, V}, {R}, {U}
- D) {P, Q, R, S, T, U, V}

gate2006-it algorithms graph-algorithms connected-components normal

Answer

1.6.3 Connected Components: GATE2006-IT_47 [top](#)

<http://gateoverflow.in/3590>

Consider the depth-first-search of an undirected graph with 3 vertices P, Q, and R. Let discovery time $d(u)$ represent the time instant when the vertex u is first visited, and finish time $f(u)$ represent the time instant when the vertex u is last visited. Given that

$$\begin{aligned} d(P) &= 5 \text{ units} & f(P) &= 12 \text{ units} \\ d(Q) &= 6 \text{ units} & f(Q) &= 10 \text{ units} \\ d(R) &= 14 \text{ unit} & f(R) &= 18 \text{ units} \end{aligned}$$

which one of the following statements is TRUE about the graph

- A) There is only one connected component
- B) There are two connected components, and P and R are connected
- C) There are two connected components, and Q and R are connected
- D) There are two connected components, and P and Q are connected

gate2006-it algorithms graph-algorithms connected-components normal

Answer

1.6.4 Connected Components: GATE2005-IT-14 [top](#)

<http://gateoverflow.in/3759>

In a depth-first traversal of a graph G with n vertices, k edges are marked as tree edges. The number of connected components in G is

- A. k
- B. $k + 1$
- C. $n - k - 1$
- D. $n - k$

[gate2005-it](#) [algorithms](#) [graph-algorithms](#) [connected-components](#) [normal](#)

[Answer](#)

1.6.5 Connected Components: GATE1997_6.2 [top](#)

<http://gateoverflow.in/2258>

Let G be the graph with 100 vertices numbered 1 to 100. Two vertices i and j are adjacent if

$|i - j| = 8$ or

$|i - j| = 12$. The number of connected components in G is

- a. 8
- b. 4
- c. 12
- d. 25

[gate1997](#) [algorithms](#) [graph-algorithms](#) [connected-components](#) [normal](#)

[Answer](#)

1.6.6 Connected Components: GATE1992_03,iii [top](#)

<http://gateoverflow.in/580>

How many edges can there be in a forest with p components having n vertices in all?

[gate1992](#) [algorithms](#) [connected-components](#) [easy](#)

[Answer](#)

Answers: Connected Components

1.6.1 Connected Components: GATE2014-1_3 [top](#)

<http://gateoverflow.in/1754>



Selected Answer

A is false. Consider just two vertices connected to each other. So, we have one SCC. The new graph won't have any edges and so 2 SCC.

B is true. In a directed graph a SCC will have a path from each vertex to every other vertex. So, changing the direction of all the edges, won't change the SCC.

D is false. Consider any graph with isolated vertices- we loose those components.

C is a bit tricky. Any edge is a path of length 1. So, the new graph will have all the edges from old one. Also, we are adding new edges (u, v) . So, does this modify any SCC? No, because we add an edge (u, v) , only if there is already a path of length ≤ 2 from u to v - so we do not create a new path. So, both B and C must be answers though GATE key says only B.

12 votes

-- Arjun Suresh (150k points)

1.6.2 Connected Components: GATE2006-IT_46 [top](#)

<http://gateoverflow.in/3589>



Selected Answer

Here ans is B.

A graph is said to be **strongly connected** if every vertex is reachable from every other vertex.

Strongly connected component is always maximal that is if x is strongly connected component there should not exist another strongly connected component which contains x .

If we take R as strongly connected component but which is part of PQRS and PQRS is part of PQRSVT.

3 votes

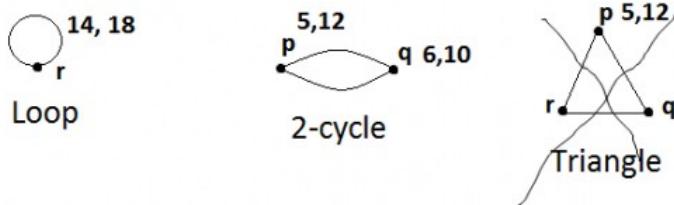
-- Gabbar (10.2k points)

1.6.3 Connected Components: GATE2006-IT_47 [top](#)

<http://gateoverflow.in/3590>



Selected Answer



As seen in question after 10 we have to go for p again and since p is finish and then r is start so r must be disconnected because if there are edges from q to r then r must be visited before q and p ending.

D is answer

3 votes

-- Anirudh Pratap Singh (17.7k points)

1.6.4 Connected Components: GATE2005-IT-14 [top](#)

<http://gateoverflow.in/3759>



Selected Answer

Answer D => $n-k$

Why ?

If Graph is connected , while doing DFS we will visit some spanning Tree of Graph. So no of edges will be $n-1$ &

No of components => $n - (n-1) => 1$

If Graph is not connected in that case when we do the DFS on those disconnected graph,

For every disconnected component with say x vertices, we will get $x-1$ Tree edge. When we sum up all vertices we will get total no of vertices. When we sum up all edges in spanning tree of each component, we will get => Total no of vertices - Total No of connected component (Due to for each connected component we are getting tree of no of vertices in that connected component - 1)

So Total connected component => D) n-k

8 votes

-- Akash (31.7k points)

1.6.5 Connected Components: GATE1997_6.2 [top](#)

<http://gateoverflow.in/2258>



Selected Answer

From the description it is clear that vertices are connected as follows:

1-9-17-...-97
2-10-18-...-98
3-11-19-...-99
4-12-20-...-100
5-13-21-...-93
6-14-22-...-94
7-15-23-...-95
8-16-24-...-96

We have covered all vertices using 8 vertex sets considering only $|i - j| = 8$. Using $|i - j| = 12$ we can see the vertex 1 is connected to 13, 2-14, 3-15 and 4-16, so the top 4 vertex sets are in fact connected to the bottom 4 sets, thus reducing the connected components to 4.

8 votes

-- Arjun Suresh (150k points)

1.6.6 Connected Components: GATE1992_03,iii [top](#)

<http://gateoverflow.in/580>



Selected Answer

Answer: n-p

Corollary: If G is a forest with n vertices and p components, then G has n-p edges.

As, 0 edges for p-1 vertices (p-1 components) and n-p edges for n-p+1 vertices (1 component). So, total of n-p edges for p components.

3 votes

-- Rajarshi Sarkar (29.7k points)

1.7

Decidability [top](#)

1.7.1 Decidability: GATE2005_45 [top](#)

<http://gateoverflow.in/1375>

Consider three decision problems P₁, P₂ and P₃. It is known that P₁ is decidable and P₂ is undecidable. Which one of the following is TRUE?

- A. P₃ is decidable if P₁ is reducible to P₃
- B. P₃ is undecidable if P₃ is reducible to P₂
- C. P₃ is undecidable if P₂ is reducible to P₃
- D. P₃ is decidable if P₃ is reducible to P₂'s complement

gate2005 | algorithms | decidability | normal

Answer

Answers: Decidability

1.7.1 Decidability: GATE2005_45 [top](#)

<http://gateoverflow.in/1375>



Selected Answer

- (A) If P_1 is reducible to P_3 , then P_3 is at least as hard as P_1 . So, no guarantee if P_3 is decidable.
- (B) If P_3 is reducible to P_2 , then P_3 cannot be harder than P_2 . But P_2 being undecidable, this can't say P_3 is undecidable.
- (C) If P_2 is reducible to P_3 , then P_3 is at least as hard as P_2 . Since, P_2 is undecidable, this means P_3 is also undecidable - hence the answer.
- (D) Complement of an undecidable problem is undecidable. Now, reducing to an undecidable problem can't prove P_3 is decidable.

http://gatecse.in/wiki/Some_Reduction_Inferences

13 votes

-- Arjun Suresh (150k points)

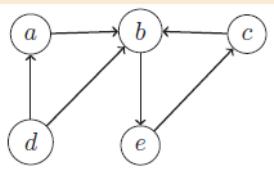
1.8

Dfs top

1.8.1 Dfs: TIFR2014-B-3 top

<http://gateoverflow.in/27137>

Consider the following directed graph.



Suppose a depth-first traversal of this graph is performed, assuming that whenever there is a choice, the vertex earlier in the alphabetical order is to be chosen. Suppose the number of tree edges is T , the number of back edges is B and the number of cross edges is C . Then

- $B = 1$, $C = 1$, and $T = 4$.
- $B = 0$, $C = 2$, and $T = 4$.
- $B = 2$, $C = 1$, and $T = 3$.
- $B = 1$, $C = 2$, and $T = 3$.
- $B = 2$, $C = 2$, and $T = 1$.

[tifr2014](#) [dfs](#) [data-structure](#) [graph-algorithms](#)

[Answer](#)

Answers: Dfs

1.8.1 Dfs: TIFR2014-B-3 top

<http://gateoverflow.in/27137>



Selected Answer

Since they said that whenever their is a choice we will have to select the node which is alphabetically earlier , therefore we choose the starting node as A .

The tree then becomes A-B-E-C . Therefore no of tree edges is 3 that is ($T=3$) .

Now there is one cycle B-E-C so we will get a back edge from C to B while performing DFS. Hence $B=1$.

Now D becomes disconnected node and it can only contribute in forming cross edge . There are 2 cross edges D-A , D-B . Therefore $C=2$.

Answer is Option D .

Correct me if am going wrong.

5 votes

-- Riya Roy(Arayana) (5.6k points)

1.9

Distance Vector Routing top

1.9.1 Distance Vector Routing: GATE2011-49 top

<http://gateoverflow.in/43324>

Consider the following recursive C function that takes two arguments.

```
unsigned int foo(unsigned int n, unsigned int r) {
    if (n>0) return ((n%r) + foo(n/r, r));
    else return 0;
}
```

What is the return value of the function
foo when it is called as
foo(513, 2)?

- A. 9
- B. 8
- C. 5
- D. 2

[gate2011](#) [algorithms](#) [recursion](#) [identify-function](#) [distance-vector-routing](#) [normal](#)

[Answer](#)

Answers: Distance Vector Routing

1.9.1 Distance Vector Routing: GATE2011-49 top

<http://gateoverflow.in/43324>



Selected Answer

The function returns the sum of digits in a binary representation of the given number

so $1+0+0+0+0+0+0+0+0+1 = 2$

3 votes

-- Sandeep_Uniyal (5.5k points)

1.10

Dynamic Programming top

1.10.1 Dynamic Programming: GATE2009-54 top

<http://gateoverflow.in/43476>

A sub-sequence of a given sequence is just the given sequence with some elements (possibly none or all) left out. We are given two sequences $X[m]$ and $Y[n]$ of lengths m and n, respectively with indexes of X and Y starting from 0.

We wish to find the length of the longest common sub-sequence (LCS) of $X[m]$ and $Y[n]$ as $l(m, n)$, where an incomplete recursive definition for the function $I(i, j)$ to compute the length of the LCS of $X[m]$ and $Y[n]$ is given below:

$$\begin{aligned} I(i,j) &= 0, \text{ if either } i = 0 \text{ or } j = 0 \\ &= \text{expr1, if } i,j > 0 \text{ and } X[i-1] = Y[j-1] \\ &= \text{expr2, if } i,j > 0 \text{ and } X[i-1] \neq Y[j-1] \end{aligned}$$

The value of $l(i, j)$ could be obtained by dynamic programming based on the correct recursive definition of $l(i, j)$ of the form given above, using an array $L[M, N]$, where $M = m + 1$ and $N = n + 1$, such that $L[i, j] = l(i, j)$.

Which one of the following statements would be TRUE regarding the dynamic programming solution for the recursive definition of $l(i, j)$?

- A. All elements of L should be initialized to 0 for the values of $l(i, j)$ to be properly computed.
 B. The values of $l(i, j)$ may be computed in a row major order or column major order of $L[M, N]$.
 C. The values of $l(i, j)$ cannot be computed in either row major order or column major order of $L[M, N]$.
 D. $L[p, q]$ needs to be computed before $L[r, s]$ if either $p < r$ or $q < s$.

gate2009 normal algorithms dynamic-programming recursion

[Answer](#)

1.10.2 Dynamic Programming: GATE2009-53 [top](#)

<http://gateoverflow.in/1338>

A sub-sequence of a given sequence is just the given sequence with some elements (possibly none or all) left out. We are given two sequences $X[m]$ and $Y[n]$ of lengths m and n , respectively with indexes of X and Y starting from 0.

We wish to find the length of the longest common sub-sequence (LCS) of $X[m]$ and $Y[n]$ as $l(m, n)$, where an incomplete recursive definition for the function $I(i, j)$ to compute the length of the LCS of $X[m]$ and $Y[n]$ is given below:

```
l(i,j) = 0, if either i = 0 or j = 0
      = expr1, if i,j > 0 and X[i-1] = Y[j-1]
      = expr2, if i,j > 0 and X[i-1] ≠ Y[j-1]
```

Which one of the following options is correct?

- A. $\text{expr1} = l(i - 1, j) + 1$
 B. $\text{expr1} = l(i, j - 1)$
 C. $\text{expr2} = \max(l(i - 1, j), l(i, j - 1))$
 D. $\text{expr2} = \max(l(i - 1, j - 1), l(i, j))$

gate2009 algorithms normal dynamic-programming recursion

[Answer](#)

Answers: Dynamic Programming

1.10.1 Dynamic Programming: GATE2009-54 [top](#)

<http://gateoverflow.in/43476>

$$\text{expr2} = \max(l(i - 1, j), l(i, j - 1))$$

When the currently compared elements doesn't match, we have two possibilities for the LCS, one including $X[i]$ but not $Y[j]$ and other including $Y[j]$ but not $X[i]$.

Answer is **B**. We can either use Row Major or column major order.

Issue of option D -> Read option D carefully.

$L[p,q]$ needs to be computed before $L[r,s]$ if either $p < q$ or $r < s$

Assuming that we want to compute $L(3,3)$. We need not compute $L(4,2)$ if we are using Row Major Order ! Here $L(4,2) = L[p,q] \& L(3,3) = L[r,s]$. Then $q < s$ still we need not compute it ! so **D IS FALSE**

6 votes

-- Akash (31.7k points)

1.10.2 Dynamic Programming: GATE2009-53 [top](#)

<http://gateoverflow.in/1338>



Selected Answer

Answer is **C**. When the currently compared elements doesn't match, we have two possibilities for the LCS, one including $X[i]$ but not $Y[j]$ and other including $Y[j]$ but not $X[i]$.

10 votes

-- Akash (31.7k points)

1.11**Expectation** [top](#)**1.11.1 Expectation: GATE2003-61** [top](#)<http://gateoverflow.in/949>

In a permutation $a_1 \dots a_n$, of n distinct integers, an inversion is a pair (a_i, a_j) such that $i < j$ and $a_i > a_j$.

If all permutations are equally likely, what is the expected number of inversions in a randomly chosen permutation of $1 \dots n$?

- A. $\frac{n(n-1)}{2}$
- B. $\frac{n(n-1)}{4}$
- C. $\frac{n(n+1)}{4}$
- D. $2n[\log_2 n]$

[gate2003](#) [algorithms](#) [sorting](#) [expectation](#) [normal](#)

[Answer](#)

1.11.2 Expectation: GATE2003-62 [top](#)<http://gateoverflow.in/43576>

In a permutation $a_1 \dots a_n$, of n distinct integers, an inversion is a pair (a_i, a_j) such that $i < j$ and $a_i > a_j$.

What would be the worst case time complexity of the Insertion Sort algorithm, if the inputs are restricted to permutations of $1 \dots n$ with at most n inversions?

- A. $\Theta(n^2)$
- B. $\Theta(n \log n)$
- C. $\Theta(n^{1.5})$
- D. $\Theta(n)$

[gate2003](#) [algorithms](#) [sorting](#) [expectation](#) [normal](#)

[Answer](#)

Answers: Expectation**1.11.1 Expectation: GATE2003-61** [top](#)<http://gateoverflow.in/949>

They are asking the average number of inversion. basically what i learned about averages from dbms indexing is.

average apart from the standard definition can be calculated as (best case + worst case)/2

and inversion is like 9,5.

so best case will be sorted array - 1,2,3,4,5 no inversion . = zero

worst case = 9,5,4,3,2,1 . here total number of inversion will be $n(n-1)/2$ as . 9 can be paired with any 5 elements (5,4,3,2,1) will form a inversion pair. similarly 5 with 4.elements .

so we can say if we have n elements then. it will be $(n-1)+(n-2)+(n-3)\dots+2+1$ which is the sum of first $n-1$ natural numbers. so it is $n(n-1)/2$

so expected average number of inversion = $(n(n-1)/2 + zero (best case)) /2= n(n-1)/4$

so option b.

second question.

we all know that insertion sort has complexity due to swapping and movements, if we have n n inversion pair then the movements and comparision will be restricted to n only . like if inversion is 1 , then array must be sorted and only the inversion should exist at the end, like 1,2,3,5,4. otherwise more than one inversion pair will form. so to sort this. for two it will be 1,2,3,7,5,4. so to sort this type of array using insertion sort atmost N swaps will be required, so d

6 votes

-- Ravi Singh (8.2k points)

1.11.2 Expectation: GATE2003-62 top<http://gateoverflow.in/43576>Ans is D: $\Theta(n)$,Insertion sort runs in $\Theta(n + f(n))$ time, where $f(n)$ denotes the number of inversion initially present in the array being sorted.Read more at <http://geeksquiz.com/gate-gate-cs-2003-question-62/>

6 votes

-- Pepper (1.9k points)

ANSWER: D. $\Theta(n)$

REASON:

Count of number of times the inner loop of insertion sort executes is actually equal to number of inversions in input permutation a_1, a_2, \dots, a_n . Since for each value of $i = 1..n$, j take the value $1..i-1$, which means for every $j < i$ it checks if $a[j] > a[i]$.

In any given permutation, maximum number of inversions possible is $n(n - 1)/2$ which is $O(n^2)$. It is the case where the array is sorted in reverse order. Therefore, to resolve all inversions i.e., worst case time complexity of insertion sort is $\Theta(n^2)$.

However, as per the question the number of inversion in input array is restricted to n . The worst case time complexity of insertion sort reduces to $\Theta(n)$.

[INSERTION SORT ALGORITHM](#) (for reference)

6 votes

-- Prateek Dwivedi (1.1k points)

1.12**Graph Algorithms** top**1.12.1 Graph Algorithms: GATE2001-2.14** top<http://gateoverflow.in/732>

Consider an undirected unweighted graph G . Let a breadth-first traversal of G be done starting from a node r . Let $d(r,u)$ and $d(r,v)$ be the lengths of the shortest paths from r to u and v respectively in G . if u visited before v during the breadth-first traversal, which of the following statements is correct?

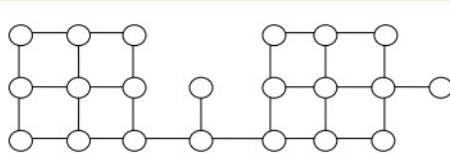
- A. $d(r, u) < d(r, v)$
- B. $d(r, u) > d(r, v)$
- C. $d(r, u) \leq d(r, v)$
- D. None of the above

[gate2001](#) [algorithms](#) [graph-algorithms](#) [normal](#)

Answer

1.12.2 Graph Algorithms: GATE2014-3_13 top<http://gateoverflow.in/2047>

Suppose depth first search is executed on the graph below starting at some unknown vertex. Assume that a recursive call to visit a vertex is made only after first checking that the vertex has not been visited earlier. Then the maximum possible recursion depth (including the initial call) is _____.



[gate2014-3](#) [algorithms](#) [graph-algorithms](#) [numerical-answers](#) [normal](#)
Answer

1.12.3 Graph Algorithms: GATE2003_70 [top](#)

<http://gateoverflow.in/957>

Let $G = (V, E)$ be a directed graph with n vertices. A path from v_i to v_j in G is a sequence of vertices $(v_i, v_{i+1}, \dots, v_j)$ such that $(v_k, v_{k+1}) \in E$ for all k in i through $j - 1$. A simple path is a path in which no vertex appears more than once.

Let A be an $n \times n$ array initialized as follows.

$$A[j, k] = \begin{cases} 1 & \text{if } (j, k) \in E \\ 0 & \text{otherwise} \end{cases}$$

Consider the following algorithm.

```
for i=1 to n
    for j=1 to n
        for k=1 to n
            A[j, k] = max(A[j, k], A[j, i] + A[i, k]);
```

Which of the following statements is necessarily true for all j and k after termination of the above algorithm?

- A. $A[j, k] \leq n$
- B. If $A[j, j] \geq n - 1$ then G has a Hamiltonian cycle
- C. If there exists a path from j to k , $A[j, k]$ contains the longest path length from j to k
- D. If there exists a path from j to k , every simple path from j to k contains at most $A[j, k]$ edges

[gate2003](#) [algorithms](#) [graph-algorithms](#) [normal](#)
Answer

1.12.4 Graph Algorithms: GATE2003_67 [top](#)

<http://gateoverflow.in/954>

Let $G = (V, E)$ be an undirected graph with a subgraph $G_1 = (V_1, E_1)$. Weights are assigned to edges of G as follows.

$$w(e) = \begin{cases} 0 & \text{if } e \in E_1 \\ 1 & \text{otherwise} \end{cases}$$

A single-source shortest path algorithm is executed on the weighted graph (V, E, w) with an arbitrary vertex v_1 of V_1 as the source. Which of the following can always be inferred from the path costs computed?

- A. The number of edges in the shortest paths from v_1 to all vertices of G
- B. G_1 is connected
- C. V_1 forms a clique in G
- D. G_1 is a tree

[gate2003](#) [algorithms](#) [graph-algorithms](#) [normal](#)
Answer

1.12.5 Graph Algorithms: GATE1998-1.21, ISRO2008-16 [top](#)

<http://gateoverflow.in/1658>

Which one of the following algorithm design techniques is used in finding all pairs of shortest distances in a graph?

- A. Dynamic programming
- B. Backtracking
- C. Greedy

D. Divide and Conquer

[gate1998](#) [algorithms](#) [graph-algorithms](#) [easy](#) [isro2008](#)
[Answer](#)**1.12.6 Graph Algorithms: GATE2005-IT_84a** [top](#)<http://gateoverflow.in/3856>

A sink in a directed graph is a vertex i such that there is an edge from every vertex $j \neq i$ to i and there is no edge from i to any other vertex. A directed graph G with n vertices is represented by its adjacency matrix A , where $A[i][j] = 1$ if there is an edge directed from vertex i to j and 0 otherwise. The following algorithm determines whether there is a sink in the graph G .

```
i = 0;
do {
    j = i + 1;
    while ((j < n) && E1) j++;
    if (j < n) E2;
} while (j < n);
flag = 1;
for (j = 0; j < n; j++)
    if ((j! = i) && E3) flag = 0;
if (flag) printf("Sink exists");
else printf ("Sink does not exist");
```

Choose the correct expressions for E_1 and E_2

- A) $E_1 : A[i][j]$ and $E_2 : i = j$;
- B) $E_1 : !A[i][j]$ and $E_2 : i = j + 1$;
- C) $E_1 : !A[i][j]$ and $E_2 : i = j$;
- D) $E_1 : A[i][j]$ and $E_2 : i = j + 1$;

[gate2005-it](#) [algorithms](#) [graph-algorithms](#) [normal](#)
[Answer](#)**1.12.7 Graph Algorithms: GATE2014-1_11** [top](#)<http://gateoverflow.in/1771>

Let
 G be a graph with
 n vertices and
 m edges. What is the tightest upper bound on the running time of Depth First Search on
 G , when
 G is represented as an adjacency matrix?

- (A) $\Theta(n)$
- (B) $\Theta(n + m)$
- (C) $\Theta(n^2)$
- (D) $\Theta(m^2)$

[gate2014-1](#) [algorithms](#) [graph-algorithms](#) [normal](#)
[Answer](#)

1.12.8 Graph Algorithms: GATE2005-IT_84b [top](#)

<http://gateoverflow.in/3857>

A sink in a directed graph is a vertex i such that there is an edge from every vertex $j \neq i$ to i and there is no edge from i to any other vertex. A directed graph G with n vertices is represented by its adjacency matrix A , where $A[i][j] = 1$ if there is an edge directed from vertex i to j and 0 otherwise. The following algorithm determines whether there is a sink in the graph G .

```
i = 0;
do {
    j = i + 1;
    while ((j < n) && E1) j++;
    if (j < n) E2;
} while (j < n);
flag = 1;
for (j = 0; j < n; j++)
    if ((j! = i) && E3) flag = 0;
if (flag) printf("Sink exists");
else printf ("Sink does not exist");
```

Choose the correct expression for E3

- A) $(A[i][j] \&\& !A[j][i])$
- B) $(!A[i][j] \&\& A[j][i])$
- C) $(!A[i][j] \mid\mid A[j][i])$
- D) $(A[i][j] \mid\mid !A[j][i])$

[gate2005-it](#) [algorithms](#) [graph-algorithms](#) [normal](#)

[Answer](#)

1.12.9 Graph Algorithms: Gate2000-2.19 [top](#)

<http://gateoverflow.in/4208>

Let G be an undirected graph. Consider a depth-first traversal of G , and let T be the resulting depth-first search tree. Let u be a vertex in G and let v be the first new (unvisited) vertex visited after visiting u in the traversal. Which of the following statement is always true?

- A. $\{u, v\}$ must be an edge in G , and u is a descendant of v in T
- B. $\{u, v\}$ must be an edge in G , and v is a descendant of u in T
- C. If $\{u, v\}$ is not an edge in G then u is a leaf in T
- D. If $\{u, v\}$ is not an edge in G then u and v must have the same parent in T

[gate2000](#) [algorithms](#) [graph-algorithms](#) [normal](#)

[Answer](#)

1.12.10 Graph Algorithms: GATE2006_48 [top](#)

<http://gateoverflow.in/1824>

Let T be a depth first search tree in an undirected graph G . Vertices u and v are leaves of this tree T . The degrees of both u and v in G are at least 2. which one of the following statements is true?

- (A) There must exist a vertex w adjacent to both u and v in G
- (B) There must exist a vertex w whose removal disconnects u and v in G
- (C) There must exist a cycle in G containing u and v
- (D) There must exist a cycle in G containing u and all its neighbours in G .

[gate2006](#) [algorithms](#) [graph-algorithms](#) [normal](#)

[Answer](#)

1.12.11 Graph Algorithms: GATE2007-IT-24 [top](#)

<http://gateoverflow.in/3457>

A depth-first search is performed on a directed acyclic graph. Let $d[u]$ denote the time at which vertex u is visited for the first time and $f[u]$ the time at which the dfs call to the vertex u terminates. Which of the following statements is always true for all edges (u, v) in the graph ?

- A. $d[u] < d[v]$
- B. $d[u] < f[v]$
- C. $f[u] < f[v]$

D. $f[u] > f[v]$

gate2007-it | algorithms | graph-algorithms | normal

Answer

1.12.12 Graph Algorithms: GATE2013_19 [top](#)

<http://gateoverflow.in/1441>

What is the time complexity of Bellman-Ford single-source shortest path algorithm on a complete graph of n vertices?

- (A) $\theta(n^2)$ (B) $\theta(n^2 \log n)$ (C) $\theta(n^3)$ (D) $\theta(n^3 \log n)$

gate2013 | algorithms | graph-algorithms | normal

Answer

1.12.13 Graph Algorithms: GATE2002_12 [top](#)

<http://gateoverflow.in/865>

Fill in the blanks in the following template of an algorithm to compute all pairs shortest path lengths in a directed graph G with $n \times n$ adjacency matrix A . $A[i,j]$ equals 1 if there is an edge in G from i to j , and 0 otherwise. Your aim in filling in the blanks is to ensure that the algorithm is correct.

```
INITIALIZATION: For i = 1 ... n
    {For j = 1 ... n
        { if a[i,j] = 0 then P[i,j] = _____ else P[i,j] = _____; }

ALGORITHM: For i = 1 ... n
    {For j = 1 ... n
        {For k = 1 ... n
            {P[____,____] = min(_____,_____); }
        }
    }
```

- Copy the complete line containing the blanks in the Initialization step and fill in the blanks.
- Copy the complete line containing the blanks in the Algorithm step and fill in the blanks.
- Fill in the blank: The running time of the Algorithm is $O(\underline{\hspace{2cm}})$.

gate2002 | algorithms | graph-algorithms | time-complexity | normal

Answer

1.12.14 Graph Algorithms: GATE2008-7 [top](#)

<http://gateoverflow.in/405>

The most efficient algorithm for finding the number of connected components in an undirected graph on n vertices and m edges has time complexity

- A. $\Theta(n)$
- B. $\Theta(m)$
- C. $\Theta(m+n)$
- D. $\Theta(mn)$

gate2008 | algorithms | graph-algorithms | time-complexity | normal

Answer

1.12.15 Graph Algorithms: GATE2006_12 [top](#)

<http://gateoverflow.in/891>

To implement Dijkstra's shortest path algorithm on unweighted graphs so that it runs in linear time, the data structure to be used is:

- (A) Queue
- (B) Stack
- (C) Heap
- (D) B-Tree

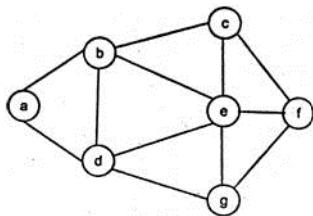
gate2006 | algorithms | graph-algorithms | easy

Answer**1.12.16 Graph Algorithms: GATE2008-IT_47** [top](#)<http://gateoverflow.in/3357>

Consider the following sequence of nodes for the undirected graph given below.

1. a b e f d g c
2. a b e f c g d
3. a d g e b c f
4. a d b c g e f

A Depth First Search (DFS) is started at node a. The nodes are listed in the order they are first visited. Which all of the above is (are) possible output(s)?



(Ctrl) ▾

- A) 1 and 3 only
- B) 2 and 3 only
- C) 2, 3 and 4 only
- D) 1, 2 and 3 only

[gate2008-it](#) [algorithms](#) [graph-algorithms](#) [normal](#)

Answer**1.12.17 Graph Algorithms: GATE2009-13** [top](#)<http://gateoverflow.in/1305>

Which of the following statement(s) is/are correct regarding Bellman-Ford shortest path algorithm?

P: Always finds a negative weighted cycle, if one exists.

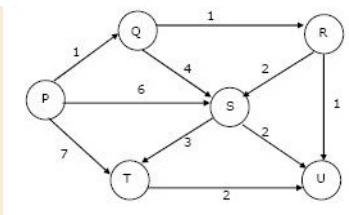
Q: Finds whether any negative weighted cycle is reachable from the source.

- A. P only
- B. Q only
- C. Both P and Q
- D. Neither P nor Q

[gate2009](#) [algorithms](#) [graph-algorithms](#) [normal](#)

Answer**1.12.18 Graph Algorithms: GATE2004_44** [top](#)<http://gateoverflow.in/1041>

Suppose we run Dijkstra's single source shortest-path algorithm on the following edge-weighted directed graph with vertex P as the source.



In what order do the nodes get included into the set of vertices for which the shortest path distances are finalized?

- A. P,Q,R,S,T,U
- B. P,Q,R,U,S,T
- C. P,Q,R,U,T,S
- D. P,Q,T,R,U,S

gate2004 algorithms graph-algorithms normal

[Answer](#)

1.12.19 Graph Algorithms: GATE2007-IT-3, UGCNET-June2012-III-34 <http://gateoverflow.in/3434>

[top](#)

Consider a weighted undirected graph with positive edge weights and let uv be an edge in the graph. It is known that the shortest path from the source vertex s to u has weight 53 and the shortest path from s to v has weight 65. Which one of the following statements is always true?

- A. Weight $(u,v) \leq 12$
- B. Weight $(u,v) = 12$
- C. Weight $(u,v) \geq 12$
- D. Weight $(u,v) > 12$

gate2007-it algorithms graph-algorithms normal ugcnetjune2012iii

[Answer](#)

1.12.20 Graph Algorithms: GATE2007-41 [top](#)

<http://gateoverflow.in/1239>

In an unweighted, undirected connected graph, the shortest path from a node S to every other node is computed most efficiently, in terms of *time complexity*, by

- A. Dijkstra's algorithm starting from S .
- B. Warshall's algorithm.
- C. Performing a DFS starting from S .
- D. Performing a BFS starting from S .

gate2007 algorithms graph-algorithms easy

[Answer](#)

1.12.21 Graph Algorithms: GATE1994_24 [top](#)

<http://gateoverflow.in/2520>

An independent set in a graph is a subset of vertices such that no two vertices in the subset are connected by an edge. An incomplete scheme for a greedy algorithm to find a maximum independent set in a tree is given below:

```

V: Set of all vertices in the tree;
I := φ
while V ≠ φ do
begin
  select a vertex u ∈ V such that
  _____;
  V := V - {u};
  if u is such that
  _____ then I := I ∪ {u}
  _____;

```

```
end;
Output(I);
```

- Complete the algorithm by specifying the property of vertex u in each case.
- What is the time complexity of the algorithm

gate1994 | algorithms | graph-algorithms | normal

Answer

1.12.22 Graph Algorithms: GATE2004_81 [top](#)

<http://gateoverflow.in/1075>

Let $G_1 = (V, E_1)$ and $G_2 = (V, E_2)$ be connected graphs on the same vertex set V with more than two vertices. If $G_1 \cap G_2 = (V, E_1 \cap E_2)$ is not a connected graph, then the graph $G_1 \cup G_2 = (V, E_1 \cup E_2)$

- cannot have a cut vertex.
- must have a cycle
- must have a cut-edge (bridge).
- Has chromatic number strictly greater than those of G_1 and G_2

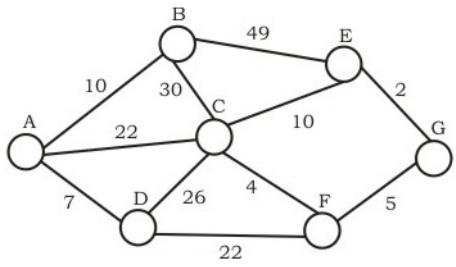
gate2004 | algorithms | graph-algorithms | normal

Answer

1.12.23 Graph Algorithms: GATE2004-IT_56 [top](#)

<http://gateoverflow.in/3699>

Consider the undirected graph below:



Using Prim's algorithm to construct a minimum spanning tree starting with node A, which one of the following sequences of edges represents a possible order in which the edges would be added to construct the minimum spanning tree?

- (E, G), (C, F), (F, G), (A, D), (A, B), (A, C)
- (A, D), (A, B), (A, C), (C, F), (G, E), (F, G)
- (A, B), (A, D), (D, F), (F, G), (G, E), (F, C)
- (A, D), (A, B), (D, F), (F, C), (F, G), (G, E)

gate2004-it | algorithms | graph-algorithms | normal

Answer

1.12.24 Graph Algorithms: GATE2005_38 [top](#)

<http://gateoverflow.in/1374>

Let $G(V, E)$ be an undirected graph with positive edge weights. Dijkstra's single source shortest path algorithm can be implemented using the binary heap data structure with time complexity:

A. $O(|V|^2)$

- B. $O(|E| + |V|\log|V|)$
- C. $O(|V|\log|V|)$
- D. $O((|E| + |V|)\log|V|)$

gate2005 algorithms graph-algorithms normal

[Answer](#)

1.12.25 Graph Algorithms: GATE2014-2_14 [top](#)

<http://gateoverflow.in/1969>

Consider the tree arcs of a BFS traversal from a source node W in an unweighted, connected, undirected graph. The tree T formed by the tree arcs is a data structure for computing

- (A) the shortest path between every pair of vertices.
- (B) the shortest path from W to every vertex in the graph.
- (C) the shortest paths from W to only those nodes that are leaves of T .
- (D) the longest path in the graph.

gate2014-2 algorithms graph-algorithms normal

[Answer](#)

1.12.26 Graph Algorithms: GATE2005_82 [top](#)

<http://gateoverflow.in/1404>

Statement for linked Answer Questions 82a & 82b:

Let s and t be two vertices in a undirected graph $G = (V, E)$ having distinct positive edge weights. Let $[X, Y]$ be a partition of V such that $s \in X$ and $t \in Y$. Consider the edge e having the minimum weight amongst all those edges that have one vertex in X and one vertex in Y .

(A) The edge e must definitely belong to:

- A. the minimum weighted spanning tree of G
- B. the weighted shortest path from s to t
- C. each path from s to t
- D. the weighted longest path from s to t

(B) Let the weight of an edge e denote the congestion on that edge. The congestion on a path is defined to be the maximum of the congestions on the edges of the path. We wish to find the path from s to t having minimum congestion. Which of the following paths is always such a path of minimum congestion?

- A. a path from s to t in the minimum weighted spanning tree
- B. a weighted shortest path from s to t
- C. an Euler walk from s to t
- D. a Hamiltonian path from s to t

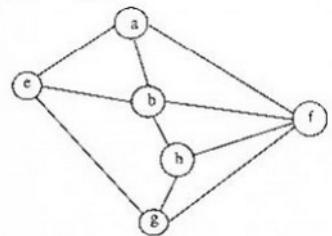
gate2005 algorithms graph-algorithms normal

[Answer](#)

1.12.27 Graph Algorithms: GATE2003_21 [top](#)

<http://gateoverflow.in/911>

Consider the following graph



Among the following sequences

- I. abeghf
- II. abfehg
- III. abfhge
- IV. afghbe

which are depth first traversals of the above graph?

- A. I, II and IV only
- B. I and IV only
- C. II, III and IV only
- D. I, III and IV only

[gate2003](#) [algorithms](#) [graph-algorithms](#) [normal](#)

[Answer](#)

1.12.28 Graph Algorithms: TIFR2013-B-15 [top](#)

<http://gateoverflow.in/25798>

Let G be an undirected graph with n vertices. For any subset S of vertices, the set of neighbours of S consists of the union of S and the set of vertices S' that are connected to some vertex in S by an edge of G . The graph G has the nice property that every subset of vertices S of size at most $n/2$ has at least $1.5|S|$ -many neighbours. What is the length of a longest path in G ?

- a. $O(1)$
- b. $O(\log \log n)$ but not $O(1)$
- c. $O(\log n)$ but not $O(\log \log n)$
- d. $O(\sqrt{n})$ but not $O(\log n)$
- e. $O(n)$ but not $O(\sqrt{n})$

[tifr2013](#) [graph-algorithms](#)

[Answer](#)

1.12.29 Graph Algorithms: GATE2016-2-41 [top](#)

<http://gateoverflow.in/39620>

In an adjacency list representation of an undirected simple graph $G = (V, E)$, each edge (u, v) has two adjacency list entries: $[v]$ in the adjacency list of u , and $[u]$ in the adjacency list of v . These are called twins of each other. A twin pointer is a pointer from an adjacency list entry to its twin. If $|E| = m$ and $|V| = n$, and the memory size is not a constraint, what is the time complexity of the most efficient algorithm to set the twin pointer in each entry in each adjacency list?

- A. $\Theta(n^2)$
- B. $\Theta(n + m)$
- C. $\Theta(m^2)$
- D. $\Theta(n^4)$

[gate2016-2](#) [algorithms](#) [graph-algorithms](#) [normal](#)

Answer

Answers: Graph Algorithms

1.12.1 Graph Algorithms: GATE2001-2.14 top

<http://gateoverflow.in/732>


Selected Answer

Ans :->

C.

BFS is used to count shortest path from source (If all path costs are 1 !)

now if u is visited before v it means 2 things.

1. Either u is closer to v.
2. if u & v are same distance from r, then our BFS algo chose to visit u before v.

thumb up 5 votes

-- Akash (31.7k points)

1.12.2 Graph Algorithms: GATE2014-3_13 top

<http://gateoverflow.in/2047>


Selected Answer

19. apply DFS.

thumb up 10 votes

-- Gate Keeda (17.7k points)

1.12.3 Graph Algorithms: GATE2003_70 top

<http://gateoverflow.in/957>


Selected Answer

D is correct.

Consider a graph with 2 nodes and one edge from to V_1 and V_2 ,

Running the above algorithm will result in A being

| | | |
|----------|----------|----------|
| A | 1 | 2 |
| 1 | 1 | 2 |
| 2 | 1 | 2 |

Clearly options B and C are wrong. Since

1. $A[1][1]$ and $A[2][2] > n-1$ and there exists no Hamiltonian cycle. Hence invalid
2. The longest path between V_1 and V_2 is 1, but $A[1][2]$ is 2, which is invalid. And no path between V_2 and V_1 yet $A[2][1] = 1$ // **it should be max cost path between j and k not path length.**

Hence A or D could be valid.

Now consider a graph with 2 nodes and two edges, one from V_1 and V_2 and other form V_2 and V_1 . Running the above algorithm will result in A being

| | | |
|----------|----------|----------|
| A | 1 | 2 |
| 1 | 2 | 3 |
| 2 | 3 | 4 |

Hence option A is invalid, as $A[i][j]$ can be $>n$

D is correct

6 votes

-- ryan sequeira (1.6k points)

1.12.4 Graph Algorithms: GATE2003_67 top<http://gateoverflow.in/954>

Selected Answer

After applying the shortest path algorithm, check cost of vertex from source to every vertex in G_1 . If G_1 is connected all these costs must be 0 as edge weights of subgraph G_1 is 0 and that should be the shortest path. If cost is not 0, to at least one vertex in G_1 (not necessarily G), then G_1 is disconnected.

Ans is b

11 votes

-- Anurag Semwal (5.5k points)

1.12.5 Graph Algorithms: GATE1998-1.21, ISRO2008-16 top<http://gateoverflow.in/1658>

Selected Answer

Answer is A because floyd warshall algorithm used to find all shortest path which is a dynamic programming approach.

5 votes

-- shashi shekhar (387 points)

1.12.6 Graph Algorithms: GATE2005-IT_84a top<http://gateoverflow.in/3856>

Selected Answer

If there is a sink in the graph, the adjacency matrix will contain all 1's (except diagonal) in one column and all 0's (except diagonal) in the corresponding row of that vertex. The given algorithm is a smart way of doing this as it finds the sink in $O(n)$ time complexity.

The first part of the code, is finding if there is any vertex which doesn't have any outgoing edge to any vertex coming after it in adjacency matrix. The smart part of the code is E2, which makes rows skip when there is no edge from i to it, making it impossible them to form a sink. This is done through

E1: !A[i][j]
and
E2: i = j;

E1 makes sure that there is no edge from i to j and i is a potential sink till A[i][j] becomes 1. If A[i][j] becomes 1, i can no longer be a sink, similarly all previous j can also not be a sink (as there was no edge from i to them and a sink requires an edge from all other vertices). Now, the next potential candidate for sink is j. So, in E2, we must make i = j.

So, answer is (C)

For E3,
http://gateoverflow.in/3857/gate2005-it_84b

6 votes

-- Arjun Suresh (150k points)

1.12.7 Graph Algorithms: GATE2014-1_11 top<http://gateoverflow.in/1771>

Selected Answer

Ans (C)

<http://web.eecs.utk.edu/~huangj/CS302S04/notes/graph-searching.html>

10 votes

-- Keith Kr (6k points)

1.12.8 Graph Algorithms: GATE2005-IT_84b [top](#)

<http://gateoverflow.in/3857>



Selected Answer

If there is a sink in the graph, the adjacency matrix will contain all 1s (except diagonal) in one column and all 0s (except diagonal) in the corresponding row of that vertex. The given algorithm is a smart way of doing this as it finds the sink in $O(n)$ time complexity.

The first part of the code, is finding if there is any vertex which does not have any outgoing edge to any vertex coming after it in adjacency matrix. The smart part of the code is E2, which makes rows skip when there is no edge from i to it, making it impossible them to form a sink. This is done through

E1: $\text{!A}[i][j]$
and
E2: $i = j;$

E1 makes sure that there is no edge from i to j and i is a potential sink till $\text{A}[i][j]$ becomes 1. If $\text{A}[i][j]$ becomes 1, i can no longer be a sink, similarly all previous j can also not be a sink (as there was no edge from i to them and a sink requires an edge from all other vertices). Now, the next potential candidate for sink is j. So, in E2, we must make $i = j$.

Now, the loop breaks when we found a potential sink- that is a vertex which does not have any outgoing edge to any coming after it in adjacency matrix. So, if the column in which this vertex comes is all 1s and the row is all 0s (except diagonal), this is the sink. Otherwise there is no sink in the graph. So, E3 is checking this condition.

But in the code flag is used for storing the state that sink is present or not. And as per the usage of flag in code, by default sink is considered present. So, the condition in E3 must make flag = 0, if the found i is not a sink. So, the condition should be:

$\text{A}[i][j] \text{ || !A}[j][i]$

So, (D) is the answer.

6 votes

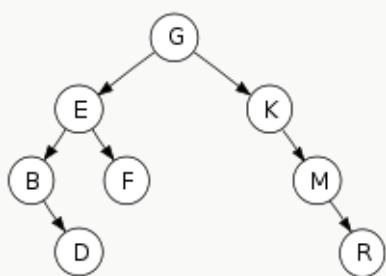
-- Arjun Suresh (150k points)

1.12.9 Graph Algorithms: Gate2000-2.19 [top](#)

<http://gateoverflow.in/4208>



Selected Answer



let this be the dfs order of tree then

$u = D$ and $v = F$

so what we conclude

1. its not necessary their is edge b/w them .
2. if thier is no edge then u must be leaf i.e. D is leaf here.
3. it not always possible u and v have same parent . but they have same ancestor]

7 votes

-- Anirudh Pratap Singh (17.7k points)

1.12.10 Graph Algorithms: GATE2006_48 [top](#)

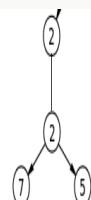
<http://gateoverflow.in/1824>



Selected Answer



Consider following graph



Dfs is .

so D is answer.

4 votes

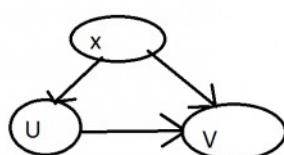
-- Nikunj Vinchhi (131 points)

1.12.11 Graph Algorithms: GATE2007-IT-24 [top](#)

<http://gateoverflow.in/3457>



Selected Answer



I'm gonna disprove all wrong options here.

A) $d[u] < d[v]$, Counter Example => Well if we directly start DFS on V first. Then I call DFS on X which visits U.

B) $d[u] < f[v]$ Counter example => Same as A)

C) $f[u] < f[v]$ Counter example => Same as A) again 😊

So answer is D)

6 votes

-- Akash (31.7k points)

1.12.12 Graph Algorithms: GATE2013_19 [top](#)

<http://gateoverflow.in/1441>



Selected Answer

Time complexity of Bellman-Ford algorithm is $\Theta(VE)$ where V is number of vertices and E is number of edges. If the graph is complete, the value of E becomes $\Theta(V^2)$. So overall time complexity becomes $\Theta(V^3)$. And given here is n vertices... so answers ends up to $\Theta(n^3)$.

16 votes

-- Gate Keeda (17.7k points)

1.12.13 Graph Algorithms: GATE2002_12 [top](#)

<http://gateoverflow.in/865>



Selected Answer

```
INITIALIZATION: For i = 1 ... n
    {For j = 1 ... n
        { if a[i,j] = 0 then P[i,j] = infinite // i.e. if there is no direct path then put infinite
            else P[i,j] = a[i,j];
        }
    }
ALGORITHM:
For i = 1 ... n
    {For j = 1 ... n
        {For k = 1 ... n
            {
                P[i, j] = min( p[i,j] , p[i,k] + p[k,j])
            };
        }
    }
```

time complexity $O(n^3)$

this algorithm is for weighted graph but it will work for unweighted graph too because if $p[i,j]=1$, $p[i,k]=1$ and $p[k,j]=1$ then according to the algo $p[i,j] = \min(p[i,j], p[i,k] + p[k,j]) = \min(1,2) = 1$

And all the other case is also satisfied.(like as if $p[i,j]$ was 0 in last iteration and there exist a path via k)

2 votes

-- Saurav Kumar Gupta (1.7k points)

1.12.14 Graph Algorithms: GATE2008-7 [top](#)

<http://gateoverflow.in/405>



Selected Answer

Run DFS to find connected components. Its time complexity is $\Theta(m + n)$, hence (C) is the answer.

11 votes

-- Happy Mittal (9.5k points)

1.12.15 Graph Algorithms: GATE2006_12 [top](#)

<http://gateoverflow.in/891>

Answer is A) Queue

we can find single source shortest path in unweighted graph by using Breadth first search (BFS) algorithm which uses "Queue" data structure, which time $O(m+n)$ (i.e. linear with respect to the number of vertices and edges.)

11 votes

-- Mithlesh Upadhyay (3.6k points)

1.12.16 Graph Algorithms: GATE2008-IT_47 [top](#)

<http://gateoverflow.in/3357>



Selected Answer

Answer: B

1. After f is visited, c or g should be visited next. So, the traversal is incorrect.
 4. After c is visited, e or f should be visited next. So, the traversal is incorrect.
- 2 and 3 are correct.

4 votes

-- Rajarshi Sarkar (29.7k points)

1.12.17 Graph Algorithms: GATE2009-13 [top](#)

<http://gateoverflow.in/1305>



Selected Answer

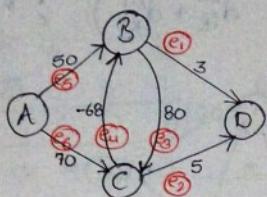
Bellmann Ford's Algorithm

Single Source Shortest Path $O(VE)$

Relax every edge once in each iteration.

$$\underbrace{E \times (V-1)}_{\text{at most } V-1 \text{ edges can be there}} = EV - E = O(VE).$$

at most $V-1$ edges can be there



| | A | B | C | D | |
|-------|------|----------|----------|----------|--|
| 0 | 0 | ∞ | ∞ | ∞ | |
| null | null | null | null | null | |
| $i=0$ | 0 | 50 | 70 | ∞ | $(E \times 1) \text{ times}$ Decrease key |
| | x | A | A | x | |
| $i=1$ | 0 | 2 | 70 | 53 | $(E \times 1) \text{ times}$ Decrease key |
| | x | C | A | B | |
| $i=2$ | 0 | 2 | 70 | 5 | |
| | x | C | A | B | |
| $i=3$ | 0 | 2 | 70 | 5 | |
| | x | C | A | B | |

$$(V-1)E = O(VE).$$

as we can see that last step is the verification step. In that step values remained unchanged. If there was a negative edge weight cycle reachable from source then at verification step also those values will be different from the values above.

In case the cycle is not reachable from source then we can see that they will be at ∞ distance(or cost) from the source from the beginning till the last step. As take anything away from the ∞ it will still be infinite.

But it can also be the case that there are some points which are not forming a cycle and are still unreachable from source those also will be at ∞ distance from the source from the beginning till end.

Hence, we won't be able to make a distinction among the cycle and such vertices. Thus, we say that this algorithm can detect negative edge weight cycles only if they are reachable from the source.

answer = **option B**

7 votes

-- Amar Vashishth (20.7k points)

1.12.18 Graph Algorithms: GATE2004_44 [top](#)

<http://gateoverflow.in/1041>



Selected Answer

Ans is (B). In Dijkstra's algorithm at each point we choose the smallest weight edge which starts from any one of the vertices in the shortest path found so far and add it to the shortest path.

7 votes

-- gate_asp (573 points)

1.12.19 Graph Algorithms: GATE2007-IT-3, UGCNET-June2012-III-34 [top](#)

<http://gateoverflow.in/3434>



Selected Answer

D. $\text{weight}(u,v) \geq 12$

If weight $(u, v) < 12$, then the min. weight of $(s, v) = \text{weight of } (s, u) + \text{weight of } (u, v) = 53 + (<12)$ will be less than 65.

12 votes

-- Arjun Suresh (150k points)

1.12.20 Graph Algorithms: GATE2007-41 [top](#)

<http://gateoverflow.in/1239>



Selected Answer

In BFS traversal .1st we note those vertices which can be reached directly from starting vertex..next we note the vertices which can be reached in 2 steps from starting vertex ..then as follows so it is the best choice i can make

8 votes

-- Bhagirathi Nayak (11.3k points)

1.12.21 Graph Algorithms: GATE1994_24 [top](#)

<http://gateoverflow.in/2520>

(a) While adding vertex u to I it should not have an edge with any node in I .

(b) The algorithm runs till V is empty (in $O(n)$ time) and is checking u with each vertex v in set I (in $O(n)$ time). So, overall complexity $O(n^2)$.

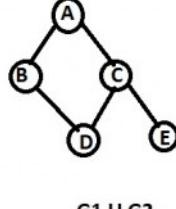
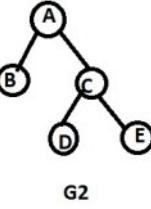
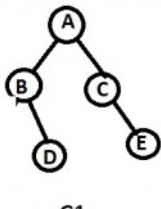
3 votes

-- Rajarshi Sarkar (29.7k points)

1.12.22 Graph Algorithms: GATE2004_81 [top](#)<http://gateoverflow.in/1075>

Selected Answer

Take a tree for example



- (A) False. Every vertex of tree(other than leaves) is a cut vertex
 (B) True
 (C) False. Without E in G1 and G2, G1 U G2 has no bridge.
 (D) False. G1 U G2, G1, G2 three graphs have same chromatic number of 2.

4 votes

-- srestha (27.8k points)

1.12.23 Graph Algorithms: GATE2004-IT_56 [top](#)<http://gateoverflow.in/3699>

Selected Answer

Answer is (D)

- (A) and (B) produce disconnected components with the GIVEN order in options which is NEVER allowed by prim's algorithm.**
(C) produces connected component every instant a new edge is added BUT when first vertex is chosen(first vertex is chosen randomly) first edge must be the minimum weight edge that is chosen . Therefore (A,D) MUST be chosen BEFORE (A,B). Therefore (C) is FALSE

6 votes

-- Sandeep_Uniyal (5.5k points)

1.12.24 Graph Algorithms: GATE2005_38 [top](#)<http://gateoverflow.in/1374>

Selected Answer

- D.- Binary heap. $|E|$ decrease key operations and each taking $O(\log |V|)$ time plus $|V|$ extract-min operations each taking $O(\log |V|)$.
 B- Fibonacci heap. $|E|$ decrease key operations and each taking $O(1)$ time plus $|V|$ extract-min operations each taking $O(\log |V|)$.
 A- Array. Finding min-vertex in each iteration takes $O(V)$ and this needs to be done $|V|$ times.
 Binomial Heap- same as Binary heap here as the critical operations are decrease key and extract-min.

10 votes

-- Gate Keeda (17.7k points)

1.12.25 Graph Algorithms: GATE2014-2_14 [top](#)<http://gateoverflow.in/1969>

Selected Answer

BFS always having starting node. It does not calculate shortest path between every pair but it computes shortest path between W and any other vertex ..

7 votes

-- Digvijay (35.8k points)

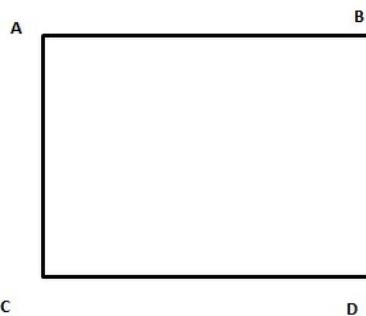
1.12.26 Graph Algorithms: GATE2005_82 [top](#)<http://gateoverflow.in/1404>

Selected Answer

For 82a The answer should be Option A because edge 'e' is the lightest safe edge connecting X and Y so the minimum spanning tree of G must contain 'e' (Greedy and optimal choice).

While B might seem correct but it is not always true. One such case is when G is not connected therefore there might not be any path between 's' and 't'.

Since the question is about definitely true B is incorrect and A is the only correct option



Lets say AC = 1 CD = 2 BD = 3 and AB=4

Then if s= A and t= B then AC is the lightest edge crossing X and Y where X = { A } and Y = { C, B, D} But clearly AC is not on the shortest path from A to B. The shortest path is AB = 4.

2 votes

-- chandan1223 (137 points)

1.12.27 Graph Algorithms: GATE2003_21 [top](#)<http://gateoverflow.in/911>

In dfs think of a stack as if every adjacent node is being put on top of it lifo and chosen randomly while in bfs think of a queue i.e. fifo here option d.

2 votes

-- anshu (2.5k points)

1.12.28 Graph Algorithms: TIFR2013-B-15 [top](#)<http://gateoverflow.in/25798>

Here we have to find the longest path in Graph.

Let's start with 1 node(chose any one) & find the number of hops in which whole Graph is reachable i.e. all the n vertices are reachable.

From First node (say A) -

(1) within 1 hop(1 edge traversal) we can reach atleast = $\frac{3}{2}$ nodes

{as neighbourhood of A has atleast $\frac{3}{2}$ nodes}

(2) within 2 hops we can reach atleast

$$\left(\frac{3}{2}\right)^2 \text{ nodes}$$

(3) within 3 hops we can reach atleast

$$\left(\frac{3}{2}\right)^3 \text{ nodes}$$

and so on.. like this when our nodes reach

$$\left(\frac{n}{2}\right) \text{ within 1 more hop we can reach upto}$$

$$\left(\frac{n}{2}\right) * \frac{3}{2} = \frac{3n}{4} \text{ nodes..}$$

uptill here we will take $O(\log n)$ hops {to reach $\frac{3n}{4}$ nodes}.

But this property is valid upto a subset of size atmost $n/2$.. so, here I stuck to proceed..

Hope it helps.. Also any suggestions to proceed further are welcome..

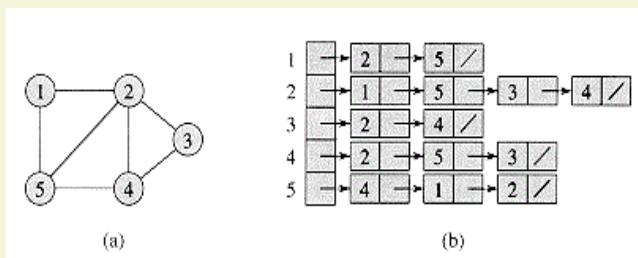
0 votes

-- Himanshu Agarwal (9.8k points)

1.12.29 Graph Algorithms: GATE2016-2-41 [top](#)

<http://gateoverflow.in/39620>

Applying BFS on Undirected graph give you twin pointer .Visit every vertex level-wise for every vertex fill adjacent vertex in the adjacency list. BFS take $O(m+n)$ time.



take extra field for storing no. of linked list for particular vertex. take extra $m+n$ time(m vertex and n edges).

So B is answer

7 votes

-- Anirudh Pratap Singh (17.7k points)

1.13

Graph Search [top](#)

1.13.1 Graph Search: GATE2015-1_45 [top](#)

<http://gateoverflow.in/8321>

Let $G = (V, E)$ be a simple undirected graph, and s be a particular vertex in it called the source. For $x \in V$, let $d(x)$ denote the shortest distance in G from s to x . A breadth first search (BFS) is performed starting at s . Let T be the resultant BFS tree. If (u, v) is an edge of G that is not in T , then which one of the following CANNOT be the value of $d(u) - d(v)$?

- A. -1
- B. 0
- C. 1
- D. 2

gate2015-1 algorithms graph-search bfs normal

Answer

Answers: Graph Search

1.13.1 Graph Search: GATE2015-1_45 [top](#)

<http://gateoverflow.in/8321>



Selected Answer

2 is the answer.

$d(u) - d(v) = 0$ is possible when both u and v have an edge from t and t is in the shortest path from s to u or v .

$d(u) - d(v) = 1$ is possible when v and t are in the shortest path from s to u and both t and v are siblings- same distance from s to both t and v causing $t - u$ edge to be in BFS tree and not $v - u$.

$d(u) - d(v) = -1$ is possible as explained above by interchanging u and v .

$d(u) - d(v) = 2$ is not possible. This is because on BFS traversal we either visit u first or v . Let's take u first. Now, we put all neighbors of u on queue. Since v is a neighbour and v is not visited before as assumed, $d(v)$ will become $d(u) + 1$. Similarly, for v being visited first.

4 14 votes

-- Arjun Suresh (150k points)

1.14

Greedy Algorithm [top](#)

1.14.1 Greedy Algorithm: GATE2005_84 [top](#)

<http://gateoverflow.in/1406>

Statement for the Linked Answer Questions 84a & 84b:

We are given 9 tasks T_1, T_2, \dots, T_9 . The execution of each task requires one unit of time. We can execute one task at a time. Each task T_i has a profit P_i and a deadline d_i . Profit P_i is earned if the task is completed before the end of the d_i^{th} unit of time.

| Task | T_1 | T_2 | T_3 | T_4 | T_5 | T_6 | T_7 | T_8 | T_9 |
|----------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| Profit | 15 | 20 | 30 | 18 | 18 | 10 | 23 | 16 | 25 |
| Deadline | 7 | 2 | 5 | 3 | 4 | 5 | 2 | 7 | 3 |

(A) Are all tasks completed in the schedule that gives maximum profit?

- A. All tasks are completed
- B. T_1 and T_6 are left out
- C. T_1 and T_8 are left out
- D. T_4 and T_6 are left out

(B) What is the maximum profit earned?

- A. 147
- B. 165
- C. 167
- D. 175

[gate2005](#) [algorithms](#) [greedy-algorithm](#) [process-schedule](#) [normal](#)

Answer

Answers: Greedy Algorithm

1.14.1 Greedy Algorithm: GATE2005_84 [top](#)<http://gateoverflow.in/1406>

Selected Answer

The most important statement in question is

each task requires one unit of time

This shows that we can greedily choose the better task and that should give us the optimal solution. The best task would be the one with maximum profit. Thus we can sort the tasks based on deadline and then profit as follows:

| Task | T7 | T2 | T9 | T4 | T5 | T3 | T6 | T8 | T1 |
|----------|----|----|----|----|----|----|----|----|----|
| Deadline | 2 | 2 | 3 | 3 | 4 | 5 | 5 | 7 | 7 |

a) 0 ----T7 ----- 1----T2-----2----T9-----3----T5-----4----T3-----5----T8-----6----T1-----7

T4 and T6 left out

b) profit=147

6 votes

-- Pooja (25.9k points)

1.15**Hashing** [top](#)**1.15.1 Hashing: GATE2015-2_33** [top](#)<http://gateoverflow.in/8152>

Which one of the following hash functions on integers will distribute keys most uniformly over 10 buckets numbered 0 to 9 for i ranging from 0 to 2020?

- A. $h(i) = i^2 \bmod 10$
- B. $h(i) = i^3 \bmod 10$
- C. $h(i) = (11 * i^2) \bmod 10$
- D. $h(i) = (12 * i^2) \bmod 10$

gate2015-2 algorithms hashing normal

Answer

1.15.2 Hashing: GATE2007_40 [top](#)<http://gateoverflow.in/1238>

Consider a hash table of size seven, with starting index zero, and a hash function $(3x + 4) \bmod 7$. Assuming the hash table is initially empty, which of the following is the contents of the table when the sequence 1, 3, 8, 10 is inserted into the table using closed hashing? Note that – denotes an empty location in the table.

- A. 8, -, -, -, -, -, 10
- B. 1, 8, 10, -, -, -, 3
- C. 1, -, -, -, -, -, 3
- D. 1, 10, 8, -, -, -, 3

gate2007 algorithms hashing easy

Answer

Answers: Hashing

1.15.1 Hashing: GATE2015-2_33 [top](#)

<http://gateoverflow.in/8152>



Selected Answer

Since mod 10 is used, the last digit matters.

If you do cube all numbers from 0 to 9, you get following

| Number | Cube | Last Digit in Cube |
|--------|------|--------------------|
| 0 | 0 | 0 |
| 1 | 1 | 1 |
| 2 | 8 | 8 |
| 3 | 27 | 7 |
| 4 | 64 | 4 |
| 5 | 125 | 5 |
| 6 | 216 | 6 |
| 7 | 343 | 3 |
| 8 | 512 | 2 |
| 9 | 729 | 9 |

Therefore all numbers from 0 to 2020 are equally divided in 10 buckets. If we make a table for square, we don't get equal distribution. In the following table. 1, 4, 6 and 9 are repeated, so these buckets would have more entries and buckets 2, 3, 7 and 8 would be empty.

| Number | Square | Last Digit in Cube |
|--------|--------|--------------------|
| 0 | 0 | 0 |
| 1 | 1 | 1 |
| 2 | 4 | 4 |
| 3 | 9 | 9 |
| 4 | 16 | 6 |
| 5 | 25 | 5 |
| 6 | 36 | 6 |
| 7 | 49 | 9 |
| 8 | 64 | 4 |
| 9 | 81 | 1 |

<http://geeksquiz.com/gate-gate-cs-2015-set-2-question-43/>

12 votes

-- Anu (9k points)

1.15.2 Hashing: GATE2007_40 [top](#)

<http://gateoverflow.in/1238>



Selected Answer

The answer is B.

1 will occupy location 0, 3 will occupy location 6, 8 hashed to location 0 which is already occupied so, it will be hashed to one location next to it. i.e. to location 1.

Since 10 also clashes, so it will be hashed to location 2.

4 votes

-- Gate Keeda (17.7k points)

1.16

Heap [top](#)

1.16.1 Heap: GATE2007_47 [top](#)

<http://gateoverflow.in/1245>

Consider the process of inserting an element into a *Max Heap*, where the *Max Heap* is represented by an *array*. Suppose we perform a binary search on the path from the new leaf to the root to find the position for the newly inserted element, the number of *comparisons* performed is:

- A. $\Theta(\log_2 n)$
- B. $\Theta(\log_2 \log_2 n)$
- C. $\Theta(n)$
- D. $\Theta(n \log_2 n)$

[gate2007](#) [algorithms](#) [time-complexity](#) [heap](#) [normal](#)

[Answer](#)

1.16.2 Heap: GATE2003_23 [top](#)

<http://gateoverflow.in/1110>

In a min-heap of size n the 7th smallest element can be found in

[gate2003](#) [algorithms](#) [data-structure](#) [heap](#) [time-complexity](#)

[Answer](#)

1.16.3 Heap: TIFR2011-B-21 [top](#)

<http://gateoverflow.in/2034>

Let $S = \{x_1, \dots, x_n\}$ be a set of n numbers. Consider the problem of storing the elements of S in an array $A[1\dots n]$ such that the following min-heap property is maintained for all $2 \leq i \leq n : A[\lfloor i/2 \rfloor] \leq A[i]$. (Note that $\lfloor x \rfloor$ is the largest integer that is at most x). Which of the following statements is TRUE?

- a. This problem can be solved in $O(\log n)$ time.
- b. This problem can be solved in $O(n)$ time but not in $O(\log n)$ time.
- c. This problem can be solved in $O(n \log n)$ time but not in $O(n)$ time.
- d. This problem can be solved in $O(n^2)$ time but not in $O(n \log n)$ time.
- e. None of the above.

[tifr2011](#) [algorithms](#) [sorting](#) [heap](#)

[Answer](#)

1.16.4 Heap: GATE2013_30 [top](#)

<http://gateoverflow.in/1541>

The number of elements that can be sorted in $\Theta(\log n)$ time using heap sort is

- A. $\Theta(1)$
- B. $\Theta(\sqrt{\log n})$
- C. $\Theta(\frac{\log n}{\log \log n})$
- D. $\Theta(\log n)$

[gate2013](#) [algorithms](#) [sorting](#) [heap](#) [normal](#)

[Answer](#)

Answers: Heap

1.16.1 Heap: GATE2007_47 [top](#)

<http://gateoverflow.in/1245>



Selected Answer

number of elements in the path from new leaf to root = $\log n$, and all elements are sorted from leaf to root so we can do a binary search which will result in $O(\log \log n)$ number of comparisons.

Since in heap is a complete binary tree, in an array implementation, from every node index, we can know its depth and this will be the n for binary search.

12 votes

-- Vikrant Singh (11k points)

1.16.2 Heap: GATE2003_23 [top](#)

<http://gateoverflow.in/1110>



Selected Answer

Time to find the smallest element on a min-heap- one retrieve operation - $\Theta(1)$

Time to find the second smallest element on a min-heap- requires $2^2 - 1 = 3$ check operations to find the second smallest element out of 3 elements - $\Theta(1)$

Time to find the 7th smallest element - requires $O(2^7 - 1) = O(127)$ check operations to find the seventh smallest element out of 127 possible ones - $\Theta(1)$

In short if the number of required operations is independent of the input size n , then it is always $\Theta(1)$.

(Here, we are doing a level order traversal of the heap and checking the elements)

If we are not allowed to traverse the heap and allowed only default heap-operations, we will be restricted with doing Extract-min 7 times which would be $O(\log n)$.

22 votes

-- gatecse (10.7k points)

1.16.3 Heap: TIFR2011-B-21 [top](#)

<http://gateoverflow.in/20324>



Selected Answer

store the elements in an array and then call build_heap(A). the build_heap takes $O(n)$ time.

so, option 'b' is correct.

but, if we try building heap by inserting each element one by one, the total complexity will be then $O(n \log n)$. cause insertion takes $O(\log n)$ and inserting ' n ' elements will take $O(n \log n)$.

6 votes

-- Sujit Kumar Muduli (179 points)

1.16.4 Heap: GATE2013_30 [top](#)

<http://gateoverflow.in/1541>



Selected Answer

To sort k elements in a heap, complexity is $\Theta(k \log k)$. Lets assume there are $\frac{\log n}{\log \log n}$ elements in the heap.

$$\text{Complexity} = \Theta\left(\frac{\log n}{\log \log n} \log\left(\frac{\log n}{\log \log n}\right)\right)$$

$$= \Theta\left(\frac{\log n}{\log \log n} (\log \log n - \log \log \log n)\right)$$

$$= \Theta\left(\log n - \frac{\log n \log \log \log n}{\log \log n}\right)$$

$= \Theta(\log n)$ (as shown below)

So, (c) is the answer.

$$\log \log n > \log \log \log n$$

$$\implies \frac{\log \log \log n}{\log \log n} < 1$$

$$\implies \frac{\log n \log \log \log n}{\log \log n} < \log n$$

$$\implies \Theta\left(\log n - \frac{\log n \log \log \log n}{\log \log n}\right) = \Theta(\log n)$$

36 votes

-- Arjun Suresh (150k points)

1.17

Huffman Code top

1.17.1 Huffman Code: GATE2007-77 top

<http://gateoverflow.in/43513>

Suppose the letters a, b, c, d, e, f have probabilities $\frac{1}{2}, \frac{1}{4}, \frac{1}{8}, \frac{1}{16}, \frac{1}{32}, \frac{1}{32}$, respectively.

What is the average length of the Huffman code for the letters a, b, c, d, e, f ?

- A. 3
- B. 2.1875
- C. 2.25
- D. 1.9375

[gate2007](#) [algorithms](#) [huffman-code](#) [normal](#)

Answer

1.17.2 Huffman Code: GATE2006-IT_48 top

<http://gateoverflow.in/3591>

The characters a to h have the set of frequencies based on the first 8 Fibonacci numbers as follows
 $a : 1, b : 1, c : 2, d : 3, e : 5, f : 8, g : 13, h : 21$

A Huffman code is used to represent the characters. What is the sequence of characters corresponding to the following code?
110111100111010

- | | |
|----|-------|
| A) | fdheg |
| B) | ecgdf |
| C) | dchfg |
| D) | fehdg |

[gate2006-it](#) [algorithms](#) [huffman-code](#) [normal](#)

Answer

1.17.3 Huffman Code: GATE2007-76 top

<http://gateoverflow.in/1271>

Suppose the letters

a, b, c, d, e, f have probabilities
 $\frac{1}{2}, \frac{1}{4}, \frac{1}{8}, \frac{1}{16}, \frac{1}{32}, \frac{1}{32}$, respectively.

Which of the following is the Huffman code for the letter a, b, c, d, e, f ?

- A. 0, 10, 110, 1110, 11110, 11111
- B. 11, 10, 011, 010, 001, 000

- C. 11, 10, 01, 001, 0001, 0000
 D. 110, 100, 010, 000, 001, 111

gate2007 | algorithms | huffman-code | normal

[Answer](#)

Answers: Huffman Code

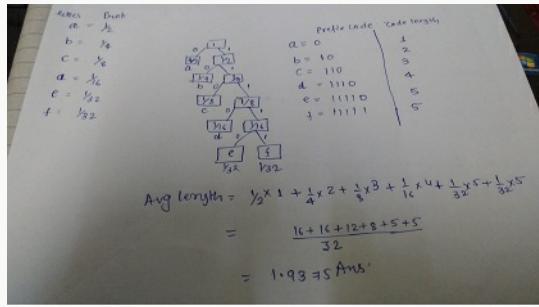
1.17.1 Huffman Code: GATE2007-77 [top](#)

<http://gateoverflow.in/43513>



Selected Answer

Ans should be D)



3 votes

-- sonam vyas (8.1k points)

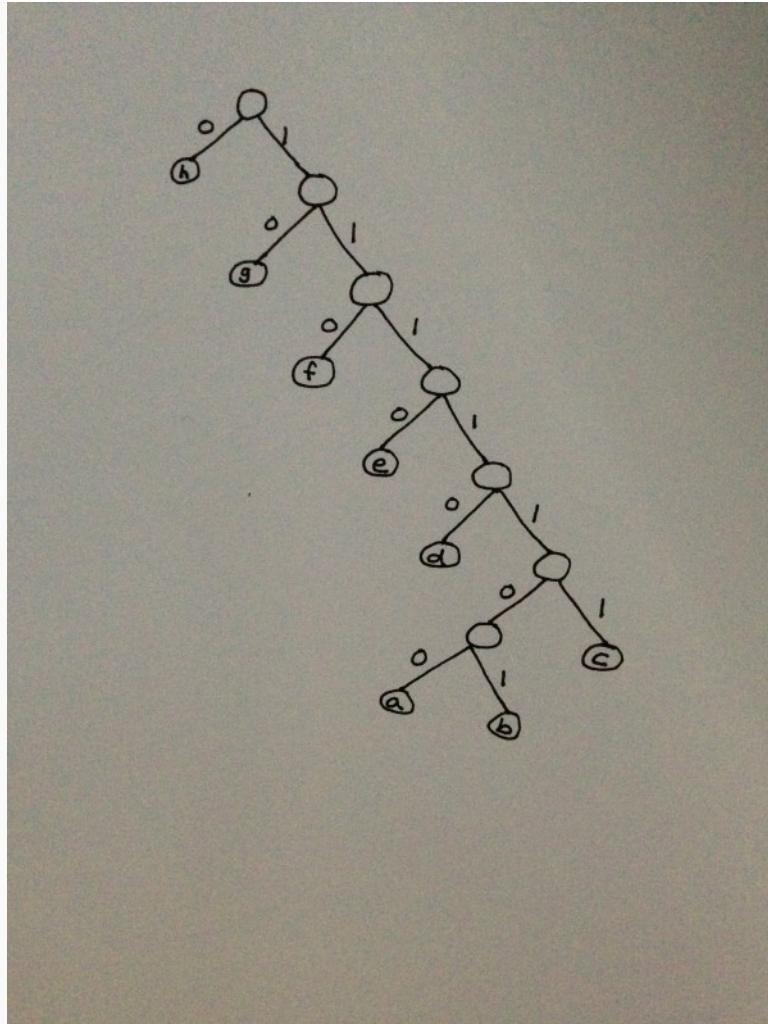
1.17.2 Huffman Code: GATE2006-IT_48 [top](#)

<http://gateoverflow.in/3591>



Selected Answer

Answer is A. Huffman's tree is as follows. The two least frequent characters are taken as the children of a newly made node and the frequency of the newly made node is made equal to the sum of those two child nodes. Then the same procedure is repeated till all nodes are finished.



110111100111010 = 110 11110 0 1110 10 = fdheg

6 votes

-- Arjun Suresh (150k points)

1.17.3 Huffman Code: GATE2007-76 top

<http://gateoverflow.in/1271>

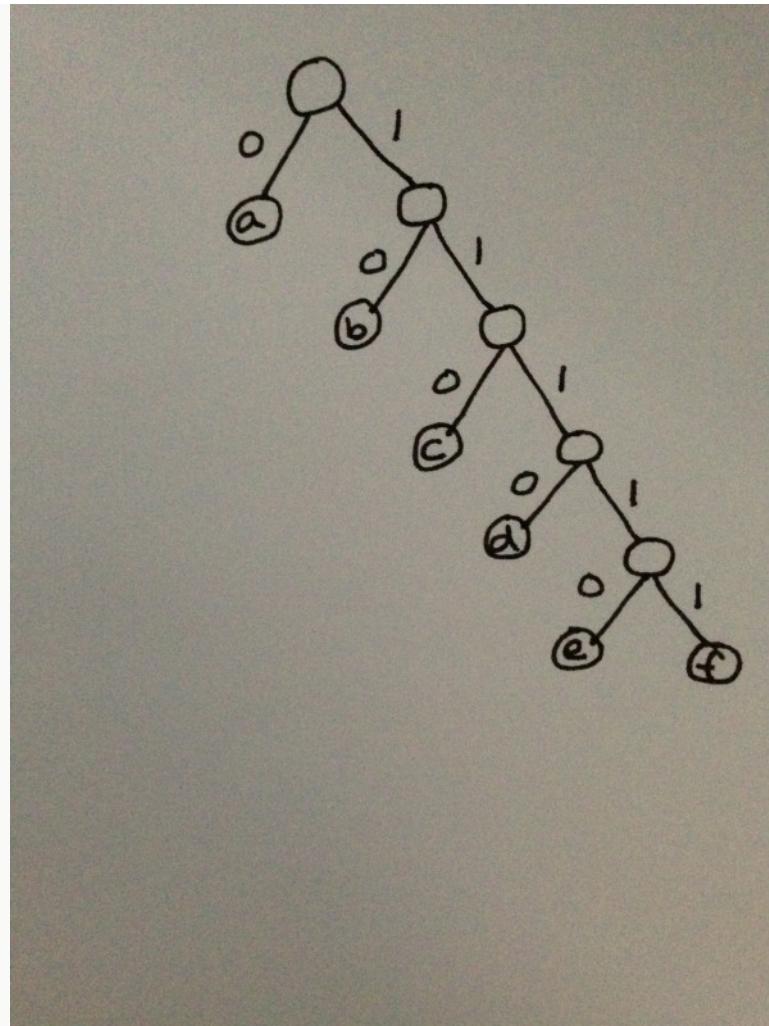


Selected Answer

Based on the probabilities, we can say the probable frequency of the letters will be

16, 8, 4, 2, 1, 1

Now, the Huffman tree can be constructed as follows:



So, A is the answer for 76.

https://www.siggraph.org/education/materials/HyperGraph/video/mpeg/mpegfaq/huffman_tutorial.html

4 5 votes

-- Arjun Suresh (150k points)

1.18

Identify Function top

1.18.1 Identify Function: GATE2015-2_11 top

<http://gateoverflow.in/8060>

Consider the following C function.

```
int fun(int n) {
    int x=1, k;
    if (n==1) return x;
    for (k=1; k<n; ++k)
        x = x + fun(k) * fun (n-k);
    return x;
}
```

The return value of $\text{fun}(5)$ is _____.

[gate2015-2](#) [algorithms](#) [identify-function](#) [recurrence](#) [normal](#)

Answer

1.18.2 Identify Function: GATE2003_88 top

<http://gateoverflow.in/971>

In the following C program fragment, j, k, n and TwoLog_n are integer variables, and A is an array of integers. The variable n is initialized to an integer ≥ 3 , and TwoLog_n is initialized to the value of $2^{\lceil \log_2(n) \rceil}$

```
for (k = 3; k <= n; k++)
    A[k] = 0;
for (k = 2; k <= TwoLog_n; k++)
    for (j = k+1; j <= n; j++)
        A[j] = A[j] || (j%k);
for (j = 3; j <= n; j++)
    if (!A[j]) printf("%d", j);
```

The set of numbers printed by this program fragment is

- A. $\{m \mid m \leq n, (\exists i)[m = i!]\}$
- B. $\{m \mid m \leq n, (\exists i)[m = i^2]\}$
- C. $\{m \mid m \leq n, m \text{ is prime}\}$
- D. {}

[gate2003](#) [algorithms](#) [identify-function](#) [normal](#)

[Answer](#)

1.18.3 Identify Function: GATE1993_7.4 [top](#)

<http://gateoverflow.in/2292>

What does the following code do?

```
var a, b: integer;
begin
    a:=a+b;
    b:=a-b;
    a:=a-b;
end;
```

- A. exchanges a and b
- B. doubles a and stores in b
- C. doubles b and stores in a
- D. leaves a and b unchanged
- E. none of the above

[gate1993](#) [algorithms](#) [identify-function](#) [easy](#)

[Answer](#)

1.18.4 Identify Function: GATE2005-IT_57 [top](#)

<http://gateoverflow.in/3818>

What is the output printed by the following program?

```
#include <stdio.h>

int f(int n, int k) {
    if (n == 0) return 0;
    else if (n % 2) return f(n/2, 2*k) + k;
    else return f(n/2, 2*k) - k;
}

int main () {
    printf("%d", f(20, 1));
    return 0;
}
```

- | | |
|----|---|
| A) | 5 |
| B) | 8 |
| C) | 9 |

D)

20

gate2005-it | algorithms | identify-function | normal

Answer

1.18.5 Identify Function: GATE2003_1 [top](#)<http://gateoverflow.in/892>

Consider the following C function.

For large values of y , the return value of the function f best approximates

```
float f,(float x, int y) {
    float p, s; int i;
    for (s=1,p=1,i=1; i<y; i++) {
        p *= x/i;
        s += p;
    }
    return s;
}
```

- A. x^y
- B. e^x
- C. $\ln(1+x)$
- D. x^x

gate2003 | algorithms | identify-function | normal

Answer

1.18.6 Identify Function: GATE2006-IT_52 [top](#)<http://gateoverflow.in/3595>

The following function computes the value of $\binom{m}{n}$ correctly for all legal values m and n ($m \geq 1, n \geq 0$ and $m > n$)

```
int func(int m, int n)
{
    if (E) return 1;
    else return(func(m - 1, n) + func(m - 1, n - 1));
}
```

In the above function, which of the following is the correct expression for E?

- A) $(n == 0) || (m == 1)$
- B) $(n == 0) \&& (m == 1)$
- C) $(n == 0) || (m == n)$
- D) $(n == 0) \&& (m == n)$

gate2006-it | algorithms | identify-function | normal

Answer

1.18.7 Identify Function: GATE2004_42 [top](#)<http://gateoverflow.in/1039>

What does the following algorithm approximate? (Assume $m > 1, \epsilon > 0$).

```
x = m;
y = 1;
While (x-y > e)
{
    x = (x+y)/2;
    y = m/x;
}
print(x);
```

- A. $\log m$
- B. m^2
- C. $m^{\frac{1}{2}}$
- D. $m^{\frac{1}{3}}$

[gate2004](#) | [algorithms](#) | [identify-function](#) | [normal](#)

[Answer](#)

1.18.8 Identify Function: GATE1994_6 [top](#)

<http://gateoverflow.in/2502>

What function of x, n is computed by this program?

```
Function what(x, n:integer): integer;
Var
  value : integer
begin
  value := 1
  if n > 0 then
  begin
    if n mod 2 = 1 then
      value := value * x;
    value := value * what(x*x, n div 2);
  end;
  what := value;
end;
```

[gate1994](#) | [algorithms](#) | [identify-function](#) | [normal](#)

[Answer](#)

1.18.9 Identify Function: GATE1995_1.4 [top](#)

<http://gateoverflow.in/2591>

In the following Pascal program segment, what is the value of X after the execution of the program segment?

```
X := -10; Y := 20;
If X > Y then if X < 0 then X := abs(X) else X := 2*X;
```

- A. 10
- B. -20
- C. -10
- D. None

[gate1995](#) | [algorithms](#) | [identify-function](#) | [easy](#)

[Answer](#)

1.18.10 Identify Function: GATE1995_2.3 [top](#)

<http://gateoverflow.in/2615>

Assume that X and Y are non-zero positive integers. What does the following Pascal program segment do?

```
while X <> Y do
if X > Y then
  X := X - Y
else
  Y := Y - X;
writeln(X);
```

- A. Computes the LCM of two numbers
- B. Divides the larger number by the smaller number
- C. Computes the GCD of two numbers
- D. None of the above

[gate1995](#) [algorithms](#) [identify-function](#) [normal](#)
Answer

1.18.11 Identify Function: GATE2015-3_49 [top](#)

<http://gateoverflow.in/8558>

Suppose $c = \langle c[0], \dots, c[k-1] \rangle$ is an array of length k , where all the entries are from the set $\{0, 1\}$. For any positive integers a and n , consider the following pseudocode.

DOSOMETHING (c, a, n)

```

z ← 1
for
i ← 0 to k – 1
    do
z ← z2 mod n
    if C[i]=1
        then
z ← (z × a) mod n
return z

```

If $k = 4, c = \langle 1, 0, 1, 1 \rangle, a = 2$, and $n = 8$, then the output of DOSOMETHING(c, a, n) is _____.

[gate2015-3](#) [algorithms](#) [identify-function](#) [normal](#) [numerical-answers](#)
Answer

1.18.12 Identify Function: GATE2014-1_41 [top](#)

<http://gateoverflow.in/1919>

Consider the following C function in which **size** is the number of elements in the array **E**:

```

int MyX(int *E, unsigned int size)
{
    int Y = 0;
    int Z;
    int i, j, k;

    for(i = 0; i < size; i++)
        Y = Y + E[i];

    for(i=0; i < size; i++)
        for(j = i; j < size; j++)
        {
            Z = 0;
            for(k = i; k <= j; k++)
                Z = Z + E[k];
            if(Z > Y)
                Y = Z;
        }
    return Y;
}

```

The value returned by the function **MyX** is the

- (A) maximum possible sum of elements in any sub-array of array **E**.
- (B) maximum element in any sub-array of array **E**.
- (C) sum of the maximum elements in all possible sub-arrays of array **E**.
- (D) the sum of all the elements in the array **E**.

[gate2014-1](#) [algorithms](#) [identify-function](#) [normal](#)
Answer

1.18.13 Identify Function: GATE1995_4 [top](#)

<http://gateoverflow.in/2640>

- a. Consider the following Pascal function where A and B are non-zero positive integers. What is the value of $GET(3, 2)$?

```

function GET(A,B:integer): integer;
begin
  if B=0 then
    GET:= 1
  else if A < B then
    GET:= 0
  else
    GET:= GET(A-1, B) + GET(A-1, B-1)
end;

```

- b. The Pascal procedure given for computing the transpose of an $N \times N$, ($N > 1$) matrix A of integers has an error. Find the error and correct it. Assume that the following declaration are made in the main program

```

const
  MAXSIZE=20;
type
  INTARR=array [1..MAXSIZE,1..MAXSIZE] of integer;
Procedure TRANSPOSE (var A: INTARR; N : integer);
var
  I, J, TMP: integer;
begin
  for I:=1 to N - 1 do
  for J:=1 to N do
  begin
    TMP:= A[I, J];
    A[I, J]:= A[J, I];
    A[J, I]:= TMP
  end
end;

```

[gate1995](#) [algorithms](#) [identify-function](#) [normal](#)

Answer

1.18.14 Identify Function: GATE2006_53 [top](#)

<http://gateoverflow.in/1831>

Consider the following C-function in which $a[n]$ and $b[m]$ are two sorted integer arrays and $c[n+m]$ be another integer array,

```

void xyz(int a[], int b [], int c []){
  int i,j,k;
  i=j=k=0;
  while ((i<n) && (j<m))
    if (a[i] < b[j]) c[k++] = a[i++];
    else c[k++] = b[j++];
}

```

Which of the following condition(s) hold(s) after the termination of the while loop?

- i. $j < m, k = n + j - 1$ and $a[n - 1] < b[j]$ if $i = n$
- ii. $i < n, k = m + i - 1$ and $b[m - 1] \leq a[i]$ if $j = m$

- (A) only (i)
- (B) only (ii)
- (C) either (i) or (ii) but not both
- (D) neither (i) nor (ii)

[gate2006](#) [algorithms](#) [identify-function](#) [normal](#)

Answer

1.18.15 Identify Function: GATE2014-3_10 [top](#)

<http://gateoverflow.in/2044>

Let A be the square matrix of size $n \times n$. Consider the following pseudocode. What is the expected output?

```

C=100;
for i=1 to n do
  for j=1 to n do
  {
    Temp = A[i][j]+C;
    A[i][j] = A[j][i];
    A[j][i] = Temp -C;
  }
for i=1 to n do

```

```
for j=1 to n do
    output (A[i][j]);
```

- (A) The matrix A itself
 (B) Transpose of the matrix A
 (C) Adding 100 to the upper diagonal elements and subtracting 100 from lower diagonal elements of A
 (D) None of the above

gate2014-3 | algorithms | identify-function | easy

[Answer](#)

1.18.16 Identify Function: TIFR2014-B-2 [top](#)

<http://gateoverflow.in/27136>

Consider the following code.

```
def brian(n):
    count = 0

    while (n != 0):
        n = n & (n-1)
        count = count + 1

    return count
```

Here n is meant to be an unsigned integer. The operator $\&$ considers its arguments in binary and computes their bit wise *AND*. For example, 22 $\&$ 15 gives 6, because the binary (say 8-bit) representation of 22 is 00010110 and the binary representation of 15 is 00001111, and the bit-wise *AND* of these binary strings is 00000110, which is the binary representation of 6. What does the function *brian* return?

- a. The highest power of 2 dividing n , but zero if n is zero.
- b. The number obtained by complementing the binary representation of n .
- c. The number of ones in the binary representation of n .
- d. The code might go into an infinite loop for some n .
- e. The result depends on the number of bits used to store unsigned integers.

tifr2014 | algorithms | identify-function

[Answer](#)

1.18.17 Identify Function: GATE2013_31 [top](#)

<http://gateoverflow.in/1542>

Consider the following function:

```
int unknown(int n) {
    int i, j, k=0;
    for (i=n/2; i<=n; i++)
        for (j=2; j<=n; j=j*2)
            k = k + n/2;
    return (k);
}
```

The return value of the function is

- (A) $\Theta(n^2)$ (B) $\Theta(n^2 \log n)$ (C) $\Theta(n^3)$ (D) $\Theta(n^3 \log n)$

gate2013 | algorithms | identify-function | normal

[Answer](#)

1.18.18 Identify Function: GATE1999_2.24 [top](#)

<http://gateoverflow.in/1501>

Consider the following C function definition

```
int Trial (int a, int b, int c)
{
    if ((a>=b) && (c<b)) return b;
    else if (a>=b) return Trial(a, c, b);
    else return Trial(b, a, c);
```

}

The functional Trial:

- A. Finds the maximum of a, b, and c
- B. Finds the minimum of a, b, and c
- C. Finds the middle number of a, b, c
- D. None of the above

gate1999 | algorithms | identify-function | normal

[Answer](#)

1.18.19 Identify Function: GATE2014-2_10 [top](#)

<http://gateoverflow.in/1964>

Consider the function func shown below:

```
int func(int num) {
    int count = 0;
    while (num) {
        count++;
        num>>= 1;
    }
    return (count);
}
```

The value returned by func(435) is _____

gate2014-2 | algorithms | identify-function | numerical-answers | easy

[Answer](#)

Answers: Identify Function

1.18.1 Identify Function: GATE2015-2_11 [top](#)

<http://gateoverflow.in/8060>



Selected Answer

```
fun(1) = 1;
fun(2) = 1 + fun(1) * fun(1) = 1 + 1 = 2;
fun(3) = 1 + fun(1) * fun(2) + fun(2) * fun(1) = 5;
fun(4) = 1 + fun(1) * fun(3) + fun(2) * fun(2) + fun(3) * fun(1) = 1 + 5 + 4 + 5 = 15;
fun(5) = 1 + fun(1) * fun(4) + fun(2) * fun(3) + fun(3) * fun(2) + fun(4) * fun(1) = 1 + 15 + 10 + 10 + 15 = 51;
```

More formal way:

The recurrence relation is

$$f(n) = \begin{cases} 1, & n = 1 \\ 1 + \sum_{i=1}^{n-1} f(i) \times f(n-i), & n > 1 \end{cases}$$

$$f(1) = 1$$

$$f(2) = 1 + f(1). f(1) = 1 + 1.1 = 2$$

$$f(3) = 1 + f(1). f(2) + f(2). f(1) = 1 + 1.2 + 2.1 = 5$$

$$f(4) = 1 + f(1). f(3) + f(2). f(2) + f(3). f(2) = 1 + 1.5 + 2.2 + 5.1 = 15$$

$$f(5) = 1 + f(1). f(4) + f(2). f(3) + f(3). f(2) + f(4). f(1) = 1 + 1.15 + 2.5 + 5.2 + 15.1 = 51$$

16 votes

-- Arjun Suresh (150k points)

1.18.2 Identify Function: GATE2003_88 [top](#)

<http://gateoverflow.in/971>



Selected Answer

The nested loop is taking all integers from 2 to $2 * \log_2 n$ and take all their non-multiples before n , and make the corresponding entry in A as 1. For example, for 2, and $n = 10$, A[3], A[5], A[7], and A[9] are made 1. Similarly for 3, 4, ... till $2 * \log n$. So, if any entry $A[p]$ is 1 means it must be a multiple of 2, 3, ..., $2\log_2 n$, which is $(2 \log n)!$ and is greater than n . So, for no index p , $A[p]$ will be 0. So, answer is D.

Suppose the line

```
A[j] = A[j] || (j%k);
```

is replaced with

```
A[j] = A[j] || ! (j%k);
```

Now, the nested loop is taking all integers from 2 to $\log_2 n$, take all their multiples before n , and make the corresponding entry in A as 1. For example, for 2, and $n = 10$, A[4], A[6], A[8] and A[10] are made 1. Similarly for 3, 4, ... till $2 * \log n$. So, for all non-prime indices of A, we will have a 1, and for prime indices we have a 0. And we print i if A[j] is 0 meaning j is prime.

4 votes

-- Arjun Suresh (150k points)

1.18.3 Identify Function: GATE1993_7.4 [top](#)

<http://gateoverflow.in/2292>



Selected Answer

Answer is simply A i.e. it swaps the values of the two.. Take any two values for A and B. and perform the given operations over them.

7 votes

-- Gate Keeda (17.7k points)

1.18.4 Identify Function: GATE2005-IT_57 [top](#)

<http://gateoverflow.in/3818>



Selected Answer

The sequence has to be followed.

$$6.) f(20,1) = 9.$$

$$5.) f(10,2) - 1 = 9$$

$$4.) f(5,4) - 2 = 10$$

$$3.) f(2,8) + 4 = 12$$

- 2.) $f(1,16) - 8 = 8$
 1.) $f(0,32) + 16 = 16$

7 votes

-- Gate Keeda (17.7k points)

1.18.5 Identify Function: GATE2003_1 [top](#)

<http://gateoverflow.in/892>



Selected Answer

$$i = 1 \quad \text{then} \quad p = 1 \quad \& \quad s = 1 + x$$

$$i = 2 \quad \text{then} \quad p = \frac{x^2}{2} \quad \& \quad s = 1 + x + \frac{x^2}{2}$$

As y tends to infinity, s tends to e^x .

Hence, the correct answer is option B.

12 votes

-- Pooja (25.9k points)

1.18.6 Identify Function: GATE2006-IT_52 [top](#)

<http://gateoverflow.in/3595>



Selected Answer

Answer: C

Because $\binom{m}{0} = 1$ and $\binom{n}{n} = 1$.

7 votes

-- Rajarshi Sarkar (29.7k points)

1.18.7 Identify Function: GATE2004_42 [top](#)

<http://gateoverflow.in/1039>



Selected Answer

by putting $y = m/x$ into $x = (x + y)/2$

$$x = (x + m/x)/2$$

$$\Rightarrow 2x^2 = x^2 + m$$

$$\Rightarrow x = m^{1/2}$$

or we can check by putting 2-3 different values also.

11 votes

-- gate_asp (573 points)

1.18.8 Identify Function: GATE1994_6 [top](#)

<http://gateoverflow.in/2502>



Selected Answer

answer - x^n

5 votes

-- ankitrokdeonsns (8.4k points)

1.18.9 Identify Function: GATE1995_1.4 [top](#)

<http://gateoverflow.in/2591>



Selected Answer

Ans of X remains unchanged. As the if condition becomes false.

X := -10

ans is C . This is classic example of if-else issue. Always else matches for nesting to closest if in C Programming & Pascal .

https://en.wikipedia.org/wiki/Dangling_else

```
if (x>y)
{
    if (x<0)
        x=abs(x)
    else
        x=2*x
}
```

4 votes

-- Akash (31.7k points)

1.18.10 Identify Function: GATE1995_2.3 [top](#)

<http://gateoverflow.in/2615>



Selected Answer

Answer: C

Let X = 3 and Y = 7.

1st pass: X=3, Y=4

2nd pass: X=3, Y=1

3rd pass: X=2, Y=1

4th pass: X=1, Y=1

write (X), which writes 1.

Ref: <http://www.naturalnumbers.org/EuclidSubtract.html>

4 votes

-- Rajarshi Sarkar (29.7k points)

1.18.11 Identify Function: GATE2015-3_49 [top](#)

<http://gateoverflow.in/8558>



Selected Answer

Initially **k = 4, c = [1, 0, 1, 1], a = 2, n = 8**

now let's iterate through the function step by step :

z = 1 (at the start of do-something)

i = 0 (start of external for loop)

in the do loop

z = 1*1 % 8 = 1 (non zero value so considered as true and continue)

c[0] = 1 so in the if clause z = 1*2 % 8 = 2

in the do loop

z = 2*2 % 8 = 4 (since now z = 2) (non zero value so considered as true and continue)

c[0] = 1 so in the if clause z = 4*2 % 8 = 0

now no need to check further :

reason all the operations that update Z are multiplicative operations and hence the value of Z will never change from 0.

12 votes

-- Tamojit Chatterjee (1.9k points)

1.18.12 Identify Function: GATE2014-1_41 [top](#)

<http://gateoverflow.in/1919>



Selected Answer

answer is (A) maximum possible sum of elements in any sub-array of array E.

```
int MyX ( int * E, unsinged int size )
{
    int Y= 0;
    int z;
    int i, j, k;
    // calculate sum of the elements of the array E and stores it in Y
    for i 0;i<size;i++)
        Y = Y+E[i];
    //calculate the sum of all possible subaarays (starting from postion 0..n-1)
    for (i=0;i<size;i++)
        for(j=i;j<size ;j++)
        {
            z = 0;
            for(k=i; k<=j;k++)
                z=z+E[k];
            // checks whether sum of elements of each subarray is greater than the current max, if so, then assign it to currentmax
            if(z>Y)
                Y = z;
        }
    // ultimately returns the maximum possible sum of elements in any sub array of given array E
    return Y;
}
```

12 votes

-- Kalpana Bhargav (3k points)

1.18.13 Identify Function: GATE1995_4 [top](#)

<http://gateoverflow.in/2640>



Selected Answer

A. = 3

For B.

begin

for I:=2 to N do

for J:=1 to (I-1) do

begin

TMP:= A[I, J];

A[I, J]:= A[J, I];

A[J, I]:= TMP

end

Should be the condition...

1 votes

-- Gabbar (10.2k points)

1.18.14 Identify Function: GATE2006_53 [top](#)

<http://gateoverflow.in/1831>



Selected Answer

The while loop add elements from a and b (whichever is smaller) to c and terminates when either of them exhausts. So, when loop terminates either $i = n$ or $j = m$.

Suppose $i = n$. This would mean all elements from array a are added to c $\Rightarrow k$ must be incremented by n. c would also contain j elements from array b. So, number of elements in c would be $n+j$ and hence $k = n + j$.

Similarly, when $j = m$, $k = m + i$.

Hence, option (D) is correct. (Had k started from -1 and not 0 and we used $++k$ inside loop, answer would have been option (C))

13 votes

-- Arjun Suresh (150k points)

1.18.15 Identify Function: GATE2014-3_10 [top](#)

<http://gateoverflow.in/2044>

Selected Answer

A.

In the computation of given pseudo code for each row and column of Matrix A, each upper triangular element will be interchanged by its mirror image in the lower triangular and after that the same lower triangular element will be again re-interchanged by its mirror image in the upper triangular, resulting the final computed Matrix A same as input Matrix A.

10 votes

-- Gate Keeda (17.7k points)

1.18.16 Identify Function: TIFR2014-B-2 [top](#)

<http://gateoverflow.in/27136>

Selected Answer

option c. It return no of 1's in binary representation of n.
here $n \& (n-1)$ reset rightmost bit of n in each iteration.

e.g

Suppose $n=15=00001111$ (binary)

$n-1=14(00001110)$

```

00001111
^ 00001110
-----
00001110
  
```

4 votes

-- Avdhesh Singh Rana (1.7k points)

1.18.17 Identify Function: GATE2013_31 [top](#)

<http://gateoverflow.in/1542>

Selected Answer

The outer loop is running for $n/2$ times and inner loop is running for $\log_2 n$ times (each iteration doubles j and j stops at n means $\log_2 n$ times j loop will iterate).

Now in each iteration k is incremented by $n/2$. So, overall k will be added $n/2 * \log n * n/2$ with an initial value of 0. So, final value of k will be $\Theta(n^2 \log n)$

14 votes

-- Arjun Suresh (150k points)

1.18.18 Identify Function: GATE1999_2.24 [top](#)

<http://gateoverflow.in/1501>



Selected Answer

| | | | |
|---|---|---|--|
| a | b | c | Return |
| 1 | 1 | 1 | The final return statement is $c < b$, so this never returns. Answer D. |

13 votes

-- Arjun Suresh (150k points)

1.18.19 Identify Function: GATE2014-2_10 [top](#)

<http://gateoverflow.in/1964>



Selected Answer

Ans - 9

435-(110110011)

num $>= 1$; implies a num is shifted one bit right in every while loop execution. While loop is executed 9 times successfully and 10th time num is zero.

So count is incremented 9 times.

Note:

Shifting a number "1" bit position to the right will have the effect of dividing by 2:

```
8 >> 1 = 4 // In binary: (00001000) >> 1 = (00000100)
```

6 votes

-- Prasanna Ranganathan (2.5k points)

1.19

Insertion Sort [top](#)

1.19.1 Insertion Sort: TIFR2010-B-27 [top](#)

<http://gateoverflow.in/19036>

Consider the Insertion Sort procedure given below, which sorts an array L of size n (≥ 2) in ascending order:

```
begin
    for xindex:= 2 to n do
        x := L [xindex];
        j:= xindex - 1;
        while j > 0 and L[j] > x do
            L[j + 1]:= L[j];
            j:= j - 1;
        end {while}
        L [j + 1]:=x;
    end{for}
end
```

It is known that insertion sort makes at most $n(n - 1)/2$ comparisons. Which of the following is true?

- a. There is no input on which insertion Sort makes $n(n - 1)/2$ comparisons.
- b. Insertion Sort makes $n(n - 1)/2$ comparisons when the input is already sorted in ascending order.
- c. Insertion Sort makes $n(n - 1)/2$ comparisons only when the input is sorted in descending order.
- d. There are more than one input orderings where insertion sort makes $n(n - 1)/2$ comparisons.
- e. Insertion Sort makes $n(n - 1)/2$ comparisons whenever all the elements of L are not distinct.

tifr2010 algorithms sorting insertion-sort

Answer

Answers: Insertion Sort**1.19.1 Insertion Sort: TIFR2010-B-27** [top](#)<http://gateoverflow.in/19036>

Selected Answer

In worst case Insertion sort will have $N(N-1)/2$ comparisons i.e. when input is sorted in descending order.

50 40 30 20 10

pass 1 50 40 30 20 10.....n 0 compare

pass 2 40 50 30 20 10.....n 1 compare

.

.

.

pass n n10 20 30 40 50 n-1 compare

$1+2+3+...+n-1 = N(N-1)/2$ comparisons

2 votes

-- Umang Raman (11.3k points)

1.20**Lines Curves** [top](#)**1.20.1 Lines Curves: GATE2007-IT-81** [top](#)<http://gateoverflow.in/3533>

Let P_1, P_2, \dots, P_n be n points in the xy -plane such that no three of them are collinear. For every pair of points P_i and P_j , let L_{ij} be the line passing through them. Let L_{ab} be the line with the steepest gradient among all $n(n - 1)/2$ lines.

The time complexity of the best algorithm for finding P_a and P_b is

- A. $\Theta(n)$
- B. $\Theta(n \log n)$
- C. $\Theta(n \log^2 n)$
- D. $\Theta(n^2)$

gate2007-it algorithms lines-curves time-complexity normal

Answer

Answers: Lines Curves**1.20.1 Lines Curves: GATE2007-IT-81** [top](#)<http://gateoverflow.in/3533>

I think D, for each and every pair we have to check.

1 votes

-- Shreya Roy (773 points)

1.21**Linked Lists** [top](#)

1.21.1 Linked Lists: GATE2010-36 [top](#)

<http://gateoverflow.in/2337>

The following C function takes a singly-linked list as input argument. It modifies the list by moving the last element to the front of the list and returns the modified list. Some part of the code is left blank.

```
typedef struct node
{
    int value;
    struct node *next;
} node;
Node *move_to_front(Node *head)
{
    Node *p, *q;
    if ((head == NULL) || (head -> next == NULL))
        return head;
    q = NULL;
    p = head;
    while (p->next != NULL)
    {
        q=p;
        p=p->next;
    }
    _____
    return head;
}
```

Choose the correct alternative to replace the blank line.

- A. q=NULL; p->next = head; head = p;
- B. q->next = NULL; head = p; p->next = head;
- C. head = p; p->next =q; q->next = NULL;
- D. q->next = NULL; p->next = head; head = p;

[gate2010](#) [algorithms](#) [linked-lists](#) [normal](#)

[Answer](#)

1.21.2 Linked Lists: GATE1993_13 [top](#)

<http://gateoverflow.in/2310>

Consider a singly linked list having n nodes. The data items d_1, d_2, \dots, d_n are stored in these n nodes. Let X be a pointer to the j^{th} node ($1 \leq j \leq n$) in which d_j is stored. A new data item d stored in node with address Y is to be inserted. Give an algorithm to insert d into the list to obtain a list having items $d_1, d_2, \dots, d_j, d, \dots, d_n$ in order without using the header.

[gate1993](#) [algorithms](#) [linked-lists](#) [normal](#)

[Answer](#)

1.21.3 Linked Lists: GATE1994-1.17, UGCNET-Sep2013-II-32 [top](#)

<http://gateoverflow.in/2460>

Linked lists are not suitable data structures for which one of the following problems?

- A. Insertion sort
- B. Binary search
- C. Radix sort
- D. Polynomial manipulation

[gate1994](#) [algorithms](#) [linked-lists](#) [normal](#) [ugcnetsep2013ii](#)

[Answer](#)

1.21.4 Linked Lists: GATE2004-IT_13 [top](#)

<http://gateoverflow.in/3654>

Let P be a singly linked list. Let Q be the pointer to an intermediate node x in the list. What is the worst-case time complexity of the best-known algorithm to delete the node x from the list ?

- A) $O(n)$
 B) $O(\log^2 n)$
 C) $O(\log n)$
 D) $O(1)$

gate2004-it | algorithms | linked-lists | time-complexity | normal

Answer

1.21.5 Linked Lists: GATE1997_18 [top](#)

<http://gateoverflow.in/2278>

Consider the following piece of 'C' code fragment that removes duplicates from an ordered list of integers.

```
Node *remove-duplicates (Node* head, int *j)
{
    Node *t1, *t2;
    *j=0;
    t1 = head;
    if (t1 != NULL) t2 = t1 ->next;
    else return head;
    *j = 1;
    if(t2 == NULL)
        return head;
    while t2 != NULL)
    {
        if (t1.val != t2.val) -----> S1
        {
            (*j)++;
            t1 -> next = t2;
            t1 = t2; -----> (S2)
        }
        t2 = t2 ->next;
    }
    t1 -> next = NULL;
    return head;
}
```

Assume the list contains n elements ($n \geq 2$) in the following questions.

- How many times is the comparison in statement S1 made?
- What is the minimum and the maximum number of times statements marked S2 get executed?
- What is the significance of the value in the integer pointed to by j when the function completes?

gate1997 | algorithms | data-structure | linked-lists | normal

Answer

Answers: Linked Lists

1.21.1 Linked Lists: GATE2010-36 [top](#)

<http://gateoverflow.in/2337>



Selected Answer

as per given code p points to last node which should be head in modified.

q is the previous node of tail which should be tail for modified

answer D

10 votes

-- Sankaranarayanan P.N (9.8k points)

1.21.2 Linked Lists: GATE1993_13 [top](#)

<http://gateoverflow.in/2310>



Selected Answer

these steps are mandatory for the algorithm :

```

temp = X → next
X → next = Y
Y → next = temp

```

3 votes

-- Amar Vashishth (20.7k points)

1.21.3 Linked Lists: GATE1994-1.17, UGCNET-Sep2013-II-32 [top](#)



Selected Answer

B. Because in binary search we need to have access to the mid of the list in constant time, and finding the mid itself in a linked list takes $O(n)$ time which makes no sense to Binary search which otherwise takes $O(\log n)$.

11 votes

-- Gate Keeda (17.7k points)

1.21.4 Linked Lists: GATE2004-IT_13 [top](#)

<http://gateoverflow.in/2460>

In the worst case x could be last or second last node, In that case full traversal of the list is required. Therefore answer is (A).

13 votes

-- suraj (3.7k points)

1.21.5 Linked Lists: GATE1997_18 [top](#)

<http://gateoverflow.in/2278>

- a. As we are comparing here pair wise so for n elements we require compulsory $n-1$ comparision
- b. S2 is executed only for distinct elements so max $n-1$ times and min 0 when all r duplicates.
- c. j holds the count on no. of distinct elements in the ordered list.

1 votes

-- Rajesh Pradhan (5.4k points)

1.22

Loop Invariants [top](#)

1.22.1 Loop Invariants: TIFR2010-B-30 [top](#)

<http://gateoverflow.in/19042>

Consider the following program for summing the entries of the array b : array $[0..N-1]$ of integers, where N is a positive integer. (The symbol ' $<>$ ' denotes 'not equal to').

```

var
  i, s: integer;
Program
  i:= 0;
  s:= 0;
[*] while i <> N do
    s := s + b[i];
    i := i + 1;
  od

```

Which of the following gives the invariant that holds at the beginning of each loop, that is, each time the program arrives at point [*] ?

- A. $s = \sum_{j=0}^N b[j] \& 0 \leq i \leq N$
- B. $s = \sum_{j=0}^{i-1} b[j] \& 0 \leq i < N$
- C. $s = \sum_{j=0}^i b[j] \& 0 < i \leq N$

- D. $s = \sum_{j=1}^N b[j] \& 0 \leq i < N$
- E. $s = \sum_{j=0}^{i-1} b[j] \& 0 \leq i \leq N$

tifr2010 | algorithms | loop-invariants

Answer

1.22.2 Loop Invariants: GATE 2016-2-35 [top](#)

<http://gateoverflow.in/39578>

The following function computes X^Y for positive integers X and Y .

```
int exp (int X, int Y) {
    int res = 1, a = X, b = Y;

    while (b != 0) {
        if (b % 2 == 0) {a = a * a; b = b/2; }
        else             {res = res * a; b = b - 1; }
    }
    return res;
}
```

Which one of the following conditions is TRUE before every iteration of the loop?

- A. $X^Y = a^b$
 B. $(res * a)^Y = (res * X)^b$
 C. $X^Y = res * a^b$
 D. $X^Y = (res * a)^b$

gate2016-2 | algorithms | loop-invariants | normal

Answer

Answers: Loop Invariants

1.22.1 Loop Invariants: TIFR2010-B-30 [top](#)

<http://gateoverflow.in/19042>



Selected Answer

Whenever we encounter the [*], the variable s holds the sum of all elements $b[0]$ to $b[i - 1]$.

When we first enter the loop, $i = 0$, and s doesn't have any elements summed up.

When we last enter the loop, $i = (N - 1)$ and s contains the sum of elements $b[0]$ through $b[N - 2]$.

We leave the loop when $i = N$, and s gets the sum of elements $b[0]$ to $b[N - 1]$

The only option that matches this behavior is **option E**

$$s = \sum_{j=0}^{i-1} b[j] \& 0 \leq i \leq N$$

3 votes

-- Pragy Agarwal (14.4k points)

1.22.2 Loop Invariants: GATE 2016-2-35 [top](#)

<http://gateoverflow.in/39578>



Selected Answer

$$\text{Take } x = 10, y = 3$$

In that case

Iteration 1 (Before)

$$\text{res} = 1$$

$$a = 10$$

$$b = 3$$

$$b^{y/2} = 1$$

$$\text{res} = \text{res} \times a = 1 \times 10 = 10$$

$$b = 3 - 1 = 2$$

Iteration 2 (Before)

$$\text{res} = 10 \quad \text{OPT } X \text{ is wrong here}$$

$$a = 10$$

$$X^y = 1000$$

$$b = 2$$

$$a^{b/2} = 100$$

$$X^y \neq a^b$$

(D) $(\text{res} \times a)^{b/2} = X^y$ D is not correct

$$(10 \times 10)^{1/2} = 10^3$$

$$(100)^2 \neq 1000$$

one

Using ~~iteration~~ we eliminated option A and D

Iteration 3 (Before)

$$\text{res} = b^{y/2} = 0$$

$$a = 10 \times 10 = 100$$

$$b = 2/2 = 1$$

Now

$$\text{res} = 10$$

$$a = 100$$

$$b = 1$$

$$\textcircled{B} \quad (\text{res} \times a)^{b/2} = (\text{res} \times a)^b$$

$$(10 \times 100)^{1/2} = (10 \times 10)^1$$

$$1000 \neq 100$$

Before 3rd iteration we eliminated option B. Ans is ~~C~~ C

Answer ==> C

12 votes

-- Akash (31.7k points)

1.23**Matrix Chain Ordering** top**1.23.1 Matrix Chain Ordering: GATE 2016-2-38** top<http://gateoverflow.in/39587>

Let A_1, A_2, A_3 and A_4 be four matrices of dimensions $10 \times 5, 5 \times 20, 20 \times 10$, and 10×5 , respectively. The minimum number of scalar multiplications required to find the product $A_1 A_2 A_3 A_4$ using the basic matrix multiplication method is _____.

[gate2016-2](#) [dynamic-programming](#) [matrix-chain-ordering](#) [normal](#) [numerical-answers](#)
Answer**1.23.2 Matrix Chain Ordering: GATE2011_38** top<http://gateoverflow.in/2140>

Four Matrices M_1, M_2, M_3 , and M_4 of dimensions $p \times q, q \times r, r \times s$ and $s \times t$ respectively can be multiplied in several ways with different number of total scalar multiplications. For example when multiplied as $((M_1 \times M_2) \times (M_3 \times M_4))$, the total number of scalar multiplications is $pqr + rst + prt$. When multiplied as $((((M_1 \times M_2) \times M_3) \times M_4))$, the total number of scalar multiplications is $pqr + prs + pst$.

If $p = 10, q = 100, r = 20, s = 5$ and $t = 80$, then the minimum number of scalar multiplications needed is

- (A) 248000
- (B) 44000
- (C) 19000
- (D) 25000

[gate2011](#) [algorithms](#) [dynamic-programming](#) [matrix-chain-ordering](#) [normal](#)
Answer**Answers: Matrix Chain Ordering****1.23.1 Matrix Chain Ordering: GATE 2016-2-38** top<http://gateoverflow.in/39587>

Selected Answer

Answer is 1500 !

Matrix Paranthesizing => $A_1 ((A_2 A_3) A_4)$

Check my solution below, using dynamic programming (There was little mistake while writing in parentheses in this image, ignore it Check parenthesis above) =>

Handwritten notes for matrix chain multiplication:

- $A_1 \ A_2 \ A_3 \ A_4$
- $10 \times 5 \ 5 \times 20 \ 20 \times 10 \ 10 \times 5$
- $A_{12} = 10 \times 5 \times 20 = 1000$
- $A_{23} = 5 \times 20 \times 10 = 1000$
- $A_{34} = 20 \times 10 \times 5 = 1000$
- $A_{13} = \min \begin{cases} 1000 & 0 \\ A_{12} + A_{33} + 10 \times 20 \times 10 = 2000 \\ A_{11} + A_{23} + 10 \times 5 \times 10 = 1500 \\ 0 & 1000 \end{cases}$
- $A_{24} = \min \begin{cases} 1000 & 0 \\ A_{23} + A_{44} + 5 \times 10 \times 5 = 1250 \\ A_{22} + A_{34} + 5 \times 20 \times 5 = 1500 \\ 0 & 1000 \end{cases}$
- $A_{14} = \min \begin{cases} A_{11} + A_{24} + 10 \times 5 \times 5 = 1500 \\ A_{12} + A_{34} + 10 \times 20 \times 5 = 2000 \\ A_{13} + A_{44} + 10 \times 10 \times 5 = 2000 \\ 1500 & 0 \end{cases}$
- $\text{Ans} = A_{13} + A_{24} = 1500$
- $(A_1 (A_2 A_3) A_4)$

8 votes

-- Akash (31.7k points)

1.23.2 Matrix Chain Ordering: GATE2011_38 top

<http://gateoverflow.in/2140>

Selected Answer

Answer is C.

Ordering:

First Multiply $M_2 \times M_3$. This requires $100 \times 20 \times 5$ multiplications.Then Multiply $M_1 \times (M_2 \times M_3)$. This requires $10 \times 100 \times 5$ multiplications.Then Multiply $(M_1 \times (M_2 \times M_3)) \times M_4$. This requires $10 \times 5 \times 8$ multiplications.

Total 19000 Multiplications.

Brute Force approach - anyone can do.No. of possible ordering for 4 matrices is C_3 where C_3 is the 3rd Catalan number and given by $n = 3$ in $\frac{1}{n+1}^{2n} C_n = 5$.

So, here we have

1. $(M_1 \times M_2) \times (M_3 \times M_4)$
2. $(M_1 \times (M_2 \times M_3)) \times M_4$

3. $((M_1 \times M_2) \times M_3) \times M_4$
4. $M_1 \times (M_2 \times (M_3 \times M_4))$
5. $M_1 \times ((M_2 \times M_3) \times M_4)$

Each of these would give no. of multiplications required as

1. $pqr + rst + prt$
2. $qrs + pqs + pst$
3. $pqr + prs + pst$
4. $rst + qrt + pqt$
5. $qrs + qst + pst$

The last 2 are having qt terms which are the highest terms by far and hence we can avoid them from consideration
 $qt = 8000$ multiplied by one other term would be larger than any value in choice. So, just find the value of first 3 terms.

1. $pqr + rst + prt = 20000 + 8000 + 16000 = 44000$
2. $qrs + pqs + pst = 10000 + 5000 + 4000 = 19000$ - smallest value in choice, we can stop here.
3. $pqr + prs + pst$

Dynamic Programming Solution (should know [Matrix Chain Ordering algorithm](#))

Here we have a chain of length 4.

Dynamic programming solution of Matrix chain ordering has the solution

$$m[i, j] = \begin{cases} 0 & \text{if } i = j \\ \min_{i \leq k < j} m[i][k] + m[k+1][j] + p_{i-1}p_jp_k & \text{if } i < j \end{cases}$$

So, we can fill the following table starting with the diagonals and moving upward diagonally. Here
 $k < j$ but
 $\geq i$.

| | j=1 | j=2 | j=3 | j=4 |
|-----|-----|---------------------|---|--|
| i=1 | 0 | $p_0p_1p_2 = 20000$ | $\min(10000 + p_0p_1p_3, 20000 + p_0 + p_2p_3) = 15000$ | $\min(18000 + p_0p_1p_4, 20000 + 8000 + p_0 + p_2 + p_4, 15000 + p_0p_3p_4) = 19000$ |
| i=2 | 0 | | $p_1p_2p_3 = 10000$ | $\min(10000 + p_2p_3p_4, p_1p_3p_4) = 18000$ |
| i=3 | | | 0 | $p_2p_3p_4 = 8000$ |
| i=4 | | | | 0 |

Our required answer is given by $m[1, 4] = 19000$.

4 7 votes

-- Sona Praneeth Akula (3.8k points)

1.24

Median top

1.24.1 Median: TIFR2013-B-12 top

<http://gateoverflow.in/25774>

It takes $O(n)$ time to find the median in a list of n elements, which are not necessarily in sorted order while it takes only $O(1)$ time to find the median in a list of n sorted elements. How much time does it take to find the median of $2n$ elements which are given as two lists of n sorted elements each?

- a. $O(1)$
- b. $O(\log n)$ but not $O(1)$
- c. $O(\sqrt{n})$ but not $O(\log n)$
- d. $O(n)$ but not $O(\sqrt{n})$

- e. $O(n \log n)$ but not $O(n)$

tifr2013 algorithms median

Answer

Answers: Median

1.24.1 Median: TIFR2013-B-12 [top](#)

<http://gateoverflow.in/25774>



Selected Answer

- 1) Calculate the medians m1 and m2 of the input arrays ar1[] and ar2[] respectively.
- 2) If m1 and m2 both are equal.
 return m1 (or m2)
- 3) If m1 is greater than m2, then median is present in one of the below two subarrays.
 - a) From first element of ar1 to m1 (ar1[0 to n/2])
 - b) From m2 to last element of ar2 (ar2[n/2 to n-1])
- 4) If m2 is greater than m1, then median is present in one of the below two subarrays.
 - a) From m1 to last element of ar1 (ar1[n/2 to n-1])
 - b) From first element of ar2 to m2 (ar2[0 to n/2])
- 5) Repeat the above process until size of both the subarrays becomes 2.
- 6) If size of the two arrays is 2 then
 the median.
 Median = $(\max(ar1[0], ar2[0]) + \min(ar1[1], ar2[1]))/2$
 Time complexity $O(\log n)$

<http://www.geeksforgeeks.org/median-of-two-sorted-arrays/>

4 3 votes

-- Umang Raman (11.3k points)

1.25

Merge Sort [top](#)

1.25.1 Merge Sort: GATE1995_1.16 [top](#)

<http://gateoverflow.in/2603>

For merging two sorted lists of sizes m and n into a sorted list of size $m + n$, we require comparisons of

- A. $O(m)$
- B. $O(n)$
- C. $O(m + n)$
- D. $O(\log m + \log n)$

gate1995 algorithms sorting merge-sort normal

Answer

1.25.2 Merge Sort: GATE2005-IT_59 [top](#)

<http://gateoverflow.in/3820>

Let a and b be two sorted arrays containing n integers each, in non-decreasing order. Let c be a sorted array containing $2n$ integers obtained by merging the two arrays a and b. Assuming the arrays are indexed starting from 0, consider the following four statements

- I. $a[i] \geq b[i] \Rightarrow c[2i] \geq a[i]$
- II. $a[i] \geq b[i] \Rightarrow c[2i] \geq b[i]$
- III. $a[i] \geq b[i] \Rightarrow c[2i] \leq a[i]$

IV. $a[i] \geq b[i] \Rightarrow c[2i] \leq b[i]$

Which of the following is TRUE?

- A) only I and II
- B) only I and IV
- C) only II and III
- D) only III and IV

[gate2005-it](#) [algorithms](#) [sorting](#) [merge-sort](#) [normal](#)

[Answer](#)

1.25.3 Merge Sort: GATE2015-3_27 [top](#)

<http://gateoverflow.in/8480>

Assume that a mergesort algorithm in the worst case takes 30 seconds for an input of size 64. Which of the following most closely approximates the maximum input size of a problem that can be solved in 6 minutes?

- A. 256
- B. 512
- C. 1024
- D. 2018

[gate2015-3](#) [algorithms](#) [sorting](#) [merge-sort](#)

[Answer](#)

Answers: Merge Sort

1.25.1 Merge Sort: GATE1995_1.16 [top](#)

<http://gateoverflow.in/2603>



Selected Answer

It is C.

The number of moves are however always $m+n$ so that we can term it as $\theta(m+n)$. But the number of comparisons vary as per the input. In the best case the comparisons are $\min(m,n)$ and in worst case they are $m+n-1$.

10 votes

-- Gate Keeda (17.7k points)

1.25.2 Merge Sort: GATE2005-IT_59 [top](#)

<http://gateoverflow.in/3820>



Selected Answer

$a[i] \geq b[i]$

Since both a and b are sorted in the beginning, there are i elements smaller than or equal to $a[i]$ (i starts from 0), and similarly i elements smaller than or equal to $b[i]$. So, $a[i] \geq b[i]$ means there are $2i$ elements smaller than or equal to $a[i]$, and hence in the merged array $a[i]$ will come after these $2i$ elements (its index will be $> 2i$). So, $c[2i] \leq a[i]$ (equality takes care of the "equal to" case which comes when array contains repeated elements).

Similarly, $a[i] \geq b[i]$ says for b that, there are not more than $2i$ elements smaller than $b[i]$ in the sorted array (i elements from b, and maximum another i elements from a). So, $b[i] \leq c[2i]$

So, II and III are correct \Rightarrow option (C)

7 votes

-- Arjun Suresh (150k points)

1.25.3 Merge Sort: GATE2015-3_27 [top](#)

<http://gateoverflow.in/8480>



Selected Answer

The worst case time complexity of Mergesort is $k \times n \log n$ for an input of size n .

For an input of size 64, the algorithm takes 30s. Therefore,

$$\begin{aligned} k \times 64 \log_2 64 &= 30s \\ k \times 384 &= 30s \\ \implies k &= 0.078125s \end{aligned}$$

Let the size of the problem that can be solved in 6 minutes be x . Then,

$$k \times x \log_2 x = 360s$$

From this, we get:

$$\begin{aligned} x \log_2 x &= \frac{360s}{0.078125s} \\ \implies x &= 512 \end{aligned}$$

24 votes

-- Pragy Agarwal (14.4k points)

1.26

Minimum top

1.26.1 Minimum: GATE2008-42 top

<http://gateoverflow.in/1872>

G is a graph on n vertices and $2n - 2$ edges. The edges of G can be partitioned into two edge-disjoint spanning trees. Which of the following is NOT true for G ?

- A. For every subset of k vertices, the induced subgraph has at most $2k - 2$ edges.
- B. The minimum cut in G has at least 2 edges.
- C. There are at least 2 edge-disjoint paths between every pair of vertices.
- D. There are at least 2 vertex-disjoint paths between every pair of vertices.

[gate2008](#) [algorithms](#) [graph-algorithms](#) [minimum](#) [spanning-tree](#) [normal](#)

Answer

Answers: Minimum

1.26.1 Minimum: GATE2008-42 top

<http://gateoverflow.in/1872>



Selected Answer

There are 2 spanning trees (a spanning tree connects all n vertices) for G which are edge disjoint. A spanning tree for n nodes require $n - 1$ edges and so 2 edge-disjoint spanning trees requires $2n - 2$ edges. As G has only $2n - 2$ edges, it is clear that it doesn't have any edge outside that of the two spanning trees. Now lets see the cases:

Lets take any subgraph of G with k vertices. The remaining subgraph will have $n - k$ vertices. Between these two subgraphs (provided both has at least one vertex) there should be at least 2 edges, as we have 2 spanning trees in G . So, (b) is TRUE. Also, in the subgraph with k vertices, we cannot have more than $2k - 2$ edges as this would mean that in the other subgraph with $n - k$ vertices, we would have less than $2n - 2k$ edges, making 2 spanning trees impossible in it. So, (a) is also TRUE.

A spanning tree covers all the vertices. So, 2 edge-disjoint spanning trees in G means, between every pair of vertices in

G we have two edge-disjoint paths (length of paths may vary). So, (c) is also TRUE.

So, that leaves option (d) as answer. It is not quite hard to give a counter example for (d).

9 votes

-- Arjun Suresh (150k points)

1.27

Minimum Spanning Trees top

1.27.1 Minimum Spanning Trees: GATE 2016-1-14 top

<http://gateoverflow.in/39673>

Let G be a weighted connected undirected graph with distinct positive edge weights. If every edge weight is increased by the same value, then which of the following statements is/are TRUE?

- P: Minimum spanning tree of G does not change.
 - Q: Shortest path between any pair of vertices does not change.
- A. P only
 B. Q only
 C. Neither P nor Q
 D. Both P and Q

[gate2016-1](#) [algorithms](#) [graph-algorithms](#) [minimum-spanning-trees](#) [shortest-path](#) [normal](#)

Answer

1.27.2 Minimum Spanning Trees: GATE 2016-1-40 top

<http://gateoverflow.in/39727>

$G = (V, E)$ is an undirected simple graph in which each edge has a distinct weight, and e is a particular edge of G . Which of the following statements about the minimum spanning trees ($MSTs$) of G is/are TRUE?

- I. If e is the lightest edge of some cycle in G , then every MST of G includes e .
 II. If e is the heaviest edge of some cycle in G , then every MST of G excludes e .
- A. I only.
 B. II only.
 C. Both I and II.
 D. Neither I nor II.

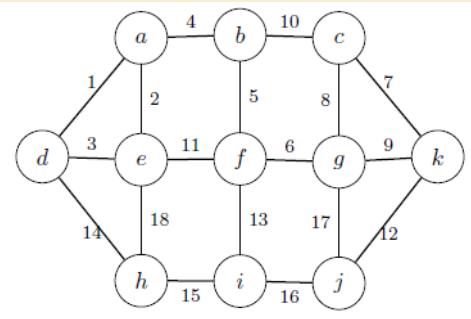
[gate2016-1](#) [algorithms](#) [graph-algorithms](#) [minimum-spanning-trees](#) [normal](#)

Answer

1.27.3 Minimum Spanning Trees: TIFR2015-B-2 top

<http://gateoverflow.in/29844>

Consider the following undirected connected graph G with weights on its edges as given in the figure below. A minimum spanning tree is a spanning tree of least weight and a maximum spanning tree is one with largest weight. A second best minimum spanning tree whose weight is the smallest among all spanning trees that are not minimum spanning trees in G .



Which of the following statements is TRUE in the above graph? (Note that all the edge weights are distinct in the above

graph)

- There is more than one minimum spanning tree and similarly, there is more than one maximum spanning tree here.
- There is a unique minimum spanning tree, however there is more than one maximum spanning tree here.
- There is more than one minimum spanning tree, however there is a unique maximum spanning tree here.
- There is more than one minimum spanning tree and similarly, there is more than one second-best minimum spanning tree here.
- There is unique minimum spanning tree, however there is more than one second-best minimum spanning tree here.

tifr2015 | minimum-spanning-trees

[Answer](#)

1.27.4 Minimum Spanning Trees: GATE 2016-1-39 [top](#)

<http://gateoverflow.in/39725>

Let G be a complete undirected graph on 4 vertices, having 6 edges with weights being 1, 2, 3, 4, 5, and 6. The maximum possible weight that a minimum weight spanning tree of G can have is _____

gate2016-1 | algorithms | graph-algorithms | minimum-spanning-trees | normal | numerical-answers

[Answer](#)

Answers: Minimum Spanning Trees

1.27.1 Minimum Spanning Trees: GATE 2016-1-14 [top](#)

<http://gateoverflow.in/39673>



Selected Answer

Statement P is true.

For statement Q consider a simple graph with 3 nodes.

| | A | B | C |
|---|-----|---|-----|
| A | 0 | 1 | 100 |
| B | 1 | 0 | 2 |
| C | 100 | 2 | 0 |

Shortest path from A to C is A-B-C = $1 + 2 = 3$

Now if the value of each edge is increased by 100,

| | A | B | C |
|---|-----|-----|-----|
| A | 0 | 101 | 200 |
| B | 101 | 0 | 102 |
| C | 200 | 102 | 0 |

The shortest path from A to C is A-C = 200, (A-B-C = $101 + 102 = 203$)

Hence option **A is correct.**

21 votes

-- ryan sequeira (1.6k points)

1.27.2 Minimum Spanning Trees: GATE 2016-1-40 [top](#)

<http://gateoverflow.in/39727>



Selected Answer

I think answer is option B

Statement 2 is correct absolutely. if e is the heaviest edge in cycle every mst excludes it.

Regarding statement 1, It is not fully right i think. When we think of a complete graph with 4 vertices and edge weights 1,2,5,6 in non diagonal and diagonal edges 3 and 4. 4,5,6 will create a cycle and we can exclude the lightest edge e (4) from it, in a MST

So i think answer could be B

1 20 votes

-- Sreyas S (1.6k points)

1.27.3 Minimum Spanning Trees: TIFR2015-B-2 [top](#)

<http://gateoverflow.in/29844>



Selected Answer

In the graph we have all edge weights are distinct so we will get unique minimum and maximum spanning tree.

Each Cycle must exclude maximum weight edge in minimum spanning tree.

Here we have two cycle of 3 edges , ade and cgk .

for second best minimum spanning tree = exclude ae edge and include de edge

other way : second best minimum spanning tree= exclude cg edge and include gk edge.

so e should be the ans.

1 1 votes

-- Gabbar (10.2k points)

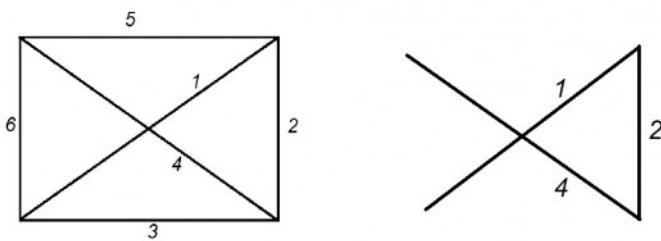
1.27.4 Minimum Spanning Trees: GATE 2016-1-39 [top](#)

<http://gateoverflow.in/39725>



Selected Answer

Graph G can be like this:



Weight: $1 + 2 + 4 = 7$

1 18 votes

-- shaiklam09 (199 points)

1.28

P Np Npc Nph [top](#)

1.28.1 P Np Npc Nph: TIFR2010-B-39 [top](#)

<http://gateoverflow.in/18754>

Suppose a language L is NP complete. Then which of the following is FALSE?

- A. $L \in NP$
- B. Every problem in P is polynomial time reducible to L .
- C. Every problem in NP is polynomial time reducible to L .
- D. The Hamilton cycle problem is polynomial time reducible to L .
- E. $P \neq NP$ and $L \in P$.

Answer

1.28.2 P Np Npc Nph: GATE1995_11 [top](#)<http://gateoverflow.in/2647>

Let L be a language over Σ i.e., $L \subseteq \Sigma^*$. Suppose L satisfies the two conditions given below.

- i. L is in NP and
- ii. For every n , there is exactly one string of length n that belongs to L . Let L^c be the complement of L over Σ^* . Show that L^c is also in NP.

[gate1995](#) [algorithms](#) [p-np-npc-nph](#) [normal](#)

Answer

1.28.3 P Np Npc Nph: GATE2009-14 [top](#)<http://gateoverflow.in/1306>

Let π_A be a problem that belongs to the class NP. Then which one of the following is TRUE?

- A. There is no polynomial time algorithm for π_A .
- B. If π_A can be solved deterministically in polynomial time, then $P = NP$.
- C. If π_A is NP-hard, then it is NP-complete.
- D. π_A may be undecidable.

[gate2009](#) [algorithms](#) [p-np-npc-nph](#) [easy](#)

Answer

1.28.4 P Np Npc Nph: GATE2008-44 [top](#)<http://gateoverflow.in/456>

The subset-sum problem is defined as follows: Given a set S of n positive integers and a positive integer W , determine whether there is a subset of S whose elements sum to W . An algorithm Q solves this problem in $O(nW)$ time. Which of the following statements is false?

- A. Q solves the subset-sum problem in polynomial time when the input is encoded in unary
- B. Q solves the subset-sum problem in polynomial time when the input is encoded in binary
- C. The subset sum problem belongs to the class NP
- D. The subset sum problem is NP-hard

[gate2008](#) [algorithms](#) [p-np-npc-nph](#) [normal](#)

Answer

1.28.5 P Np Npc Nph: GATE2013_18 [top](#)<http://gateoverflow.in/1440>

Which of the following statements are **TRUE**?

1. The problem of determining whether there exists a cycle in an undirected graph is in P.
2. The problem of determining whether there exists a cycle in an undirected graph is in NP.
3. If a problem A is NP-Complete, there exists a non-deterministic polynomial time algorithm to solve A.

- (A) 1, 2 and 3 (B) 1 and 2 only (C) 2 and 3 only (D) 1 and 3 only

gate2013 | algorithms | p-np-npc-nph | normal

[Answer](#)

1.28.6 P Np Npc Nph: GATE2005_58 [top](#)

<http://gateoverflow.in/1381>

Consider the following two problems on undirected graphs:

- α : Given $G(V, E)$, does G have an independent set of size $|V| - 4$?
- β : Given $G(V, E)$, does G have an independent set of size 5?

Which one of the following is TRUE?

- A. α is in P and β is NP-complete
- B. α is NP-complete and β is in P
- C. Both α and β are NP-complete
- D. Both α and β are in P

gate2005 | algorithms | p-np-npc-nph | normal

[Answer](#)

1.28.7 P Np Npc Nph: TIFR2011-B-25 [top](#)

<http://gateoverflow.in/20404>

Let A_{TM} be defined as follows:

$$A_{TM} = \{\langle M, w \rangle \mid \text{The Turning machine } M \text{ accepts the word } w\}$$

And let L be some NP – complete language. Which of the following statements is FALSE?

- a. $L \in \text{NP}$
- b. Every problem in NP is polynomial time reducible to L .
- c. Every problem in NP is polynomial time reducible to A_{TM} .
- d. Since L is NP – complete, A_{TM} is polynomial time reducible to L .
- e. $A_{TM} \notin \text{NP}$.

tifr2011 | theory-of-computation | algorithms | p-np-npc-nph

[Answer](#)

1.28.8 P Np Npc Nph: GATE2004_30 [top](#)

<http://gateoverflow.in/1027>

The problem 3-SAT and 2-SAT are

- A. both in P
- B. both NP complete
- C. NP-complete and in P respectively
- D. undecidable and NP complete respectively

gate2004 | algorithms | p-np-npc-nph | easy

[Answer](#)

1.28.9 P Np Npc Nph: GATE2006_31 [top](#)<http://gateoverflow.in/994>

Let SHAM₃ be the problem of finding a Hamiltonian cycle in a graph G=(V,E) with |V| divisible by 3 and DHAM₃ be the problem of determining if a Hamiltonian cycle exists in such graphs. Which one of the following is true?

- (A) Both DHAM₃ and SHAM₃ are NP-hard
- (B) SHAM₃ is NP-hard, but DHAM₃ is not
- (C) DHAM₃ is NP-hard, but SHAM₃ is not
- (D) Neither DHAM₃ nor SHAM₃ is NP-hard

[gate2006](#) [algorithms](#) [p-np-npc-nph](#) [normal](#)

[Answer](#)

1.28.10 P Np Npc Nph: TIFR2013-B-7 [top](#)<http://gateoverflow.in/25668>

Which of the following is not implied by $P = NP$?

- a. 3SAT can be solved in polynomial time.
- b. Halting problem can be solved in polynomial time.
- c. Factoring can be solved in polynomial time.
- d. Graph isomorphism can be solved in polynomial time.
- e. Travelling salesman problem can be solved in polynomial time.

[tifr2013](#) [algorithms](#) [p-np-npc-nph](#)

[Answer](#)

1.28.11 P Np Npc Nph: GATE2006_16 [top](#)<http://gateoverflow.in/977>

Let S be an NP-complete problem and Q and R be two other problems not known to be in NP. Q is polynomial time reducible to S and S is polynomial-time reducible to R. Which one of the following statements is true?

- (A) R is NP-complete
- (B) R is NP-hard
- (C) Q is NP-complete
- (D) Q is NP-hard

[gate2006](#) [algorithms](#) [p-np-npc-nph](#) [normal](#)

[Answer](#)

1.28.12 P Np Npc Nph: GATE1992_02,vi [top](#)<http://gateoverflow.in/561>

02. Choose the correct alternatives (more than one may be correct) and write the corresponding letters only:

(vi) Which of the following problems is not NP-hard?

- a. Hamiltonian circuit problem
- b. The 0/1 Knapsack problem
- c. Finding bi-connected components of a graph
- d. The graph coloring problem

[gate1992](#) [p-np-npc-nph](#) [algorithms](#)

[Answer](#)

1.28.13 P Np Npc Nph: TIFR2011-B-37 [top](#)<http://gateoverflow.in/20922>

Given an integer $n \geq 3$, consider the problem of determining if there exist integers $a, b \geq 2$ such that $n = a^b$. Call this the forward problem. The reverse problem is: given a and b , compute $a^b \pmod{b}$. Note that the input length for the forward problem is $\lfloor \log n \rfloor + 1$, while the input length for the reverse problem is $\lfloor \log a \rfloor + \lfloor \log b \rfloor + 2$. Which of the following statements is TRUE?

- Both the forward and reverse problems can be solved in time polynomial in the lengths of their respective inputs.
- The forward problem can be solved in polynomial time, however the reverse problem is NP -hard.
- The reverse problem can be solved in polynomial time, however the forward problem is NP -hard.
- Both the forward and reverse problem are NP -hard.
- None of the above.

[tifr2011](#) [algorithms](#) [p-np-npc-nph](#)

[Answer](#)

1.28.14 P Np Npc Nph: GATE2003_12 [top](#)

<http://gateoverflow.in/903>

Ram and Shyam have been asked to show that a certain problem Π is NP-complete. Ram shows a polynomial time reduction from the 3-SAT problem to Π , and Shyam shows a polynomial time reduction from Π to 3-SAT. Which of the following can be inferred from these reductions?

- Π is NP-hard but not NP-complete
- Π is in NP, but is not NP-complete
- Π is NP-complete
- Π is neither NP-hard, nor in NP

[gate2003](#) [algorithms](#) [p-np-npc-nph](#) [normal](#)

[Answer](#)

Answers: P Np Npc Nph

1.28.1 P Np Npc Nph: TIFR2010-B-39 [top](#)

<http://gateoverflow.in/18754>



Selected Answer

Option E leads to a contradiction, hence is false.

We know that L is NPC, hence $L \in NP$. If $P \neq NP$, then L can't be in P

4 votes

-- Pragy Agarwal (14.4k points)

1.28.2 P Np Npc Nph: GATE1995_11 [top](#)

<http://gateoverflow.in/2647>



Selected Answer

Since L is in NP it is decidable (recursive) and so is its complement L^c . Now, L^c may or may not be in NP. But we are given that for any string length n , exactly one string belongs to L , which means for any string length all but one string belongs to L^c .

Now, definition of NP says that all "yes" instances of the problem can be solved in polynomial time using a nondeterministic TM. So, given an instance of $\langle L^c, x \rangle$, we nondeterministically take all words of length n , where n is the length of w , and see if it is in L . As soon as we get the word (such a word is sure to exist as exactly one word of length n belongs to L), we see if this word is same as x . If it is not same (and only if it is not same), $x \in L^c$ and we get this answer in polynomial time making L^c an NP problem.

4 votes

-- Arjun Suresh (150k points)

1.28.3 P Np Npc Nph: GATE2009-14 [top](#)<http://gateoverflow.in/1306>

Selected Answer

A problem which is in P, is also in NP- so A is false. If problem can be solved deterministically in Polynomial time, then also we can't comment anything about P=NP, we just put this problem in P. So, B also false. C is TRUE because that is the definition of NP-complete.

D is false because all NP problems are not only decidable but decidable in polynomial time using a non-deterministic Turing machine.

6 votes

-- shreya ghosh (2,9k points)

1.28.4 P Np Npc Nph: GATE2008-44 [top](#)<http://gateoverflow.in/456>

Selected Answer

Subset problem is NP-Complete - there is reduction proof but I don't remember (Can see the below link). So, (C) and (D) are true as an NPC problem is in NP as well as NPH.

https://en.wikipedia.org/wiki/Subset_sum_problem

Now, complexity of Q is $O(nW)$, where W is an integer.

(a) Input is encoded in unary. So, length of input is equal to the value of the input. So, complexity = $O(nW)$ where both n and W are linear multiples of the length of the inputs. So, the complexity is polynomial in terms of the input length. So, (a) is true.

(b) Input is encoded in binary. So, length of W will be $\lg W$. (for $W=1024$, input length will be just 10). So, now W is exponential in terms of the input length of W and $O(nW)$ also becomes exponential in terms of the input lengths. So, Q is not a polynomial time algorithm. So, (B) is false.

7 votes

-- Arjun Suresh (150k points)

1.28.5 P Np Npc Nph: GATE2013_18 [top](#)<http://gateoverflow.in/1440>

Selected Answer

Cycle detection in graph is in P as it can be done using a graph traversal ($O(V+E)$)

Ref: <http://www.geeksforgeeks.org/detect-cycle-undirected-graph/>

If a problem is in P then it is also in NP as P is a subset of NP. So, both 1 and 2 are TRUE.

Statement 3 is also true as NP-Complete requires a problem to be in NP and for any problem in NP, we have a non-deterministic polynomial time algorithm.

So, answer is A- 1, 2 and 3 are TRUE.

7 votes

-- Arjun Suresh (150k points)

1.28.6 P Np Npc Nph: GATE2005_58 [top](#)<http://gateoverflow.in/1381>

Selected Answer

Independent Set- a set of vertices in a graph no two of which are adjacent.

Maximal Independent set problem - Given a graph G , find the size of the maximal independent set in it. This problem in

NP-hard.

Independent set decision problem - Given a graph G and a number k , does G have an independent set of size k . This problem is NP-complete (NP-hard but in NP).

Now, in the given problem β corresponds to the Independent set decision problem. But there is a difference there. We have 5 instead of k . And this drastically changes the problem statement. We can now give a polynomial time **deterministic** algorithm for β .

- Find all vertex sets of size 5. We get $|V|C_5$ such vertex sets
- For each of them check if there is any adjacent vertices. This check can be done in constant time if we use an Adjacency matrix representation

Thus the whole time complexity reduces to $|V|C_5$ which is $O(|V|^5)$ and hence polynomial. ($|V|C_k$ is not polynomial but $|V|C_5$ is).

Problem α is asking for an independent set of size $|V| - 4$. This is equivalent to asking if G has a vertex cover of size 4. Following a similar approach as done for β this problem also can be done in polynomial time.

So, both α and β are in P .

D choice.

Independent Set and Vertex cover Reduction: <https://www.cs.cmu.edu/~ckingsf/bioinfo-lectures/npcomplete.pdf>

3 votes

-- Arjun Suresh (150k points)

1.28.7 P Np Npc Nph: TIFR2011-B-25 [top](#)

<http://gateoverflow.in/20404>



Selected Answer

A_{TM} is the language of the Halting Problem. It is undecidable, but Recursively Enumerable.

L is NPC

- True. Any language in NPC is also in NP by definition.
- True. By definition, any problem in NP is polynomial time reducible to any NPC problem.
- True. A_{TM} is undecidable. Any language that is decidable is polynomial time reducible to A_{TM} !
- False.**
 A_{TM} is undecidable. No Turing Machine can guarantee an answer in a finite time, let alone a polynomial time.
- True. A_{TM} is undecidable. It is certainly not in NP.

Hence, the correct answer is option d.

5 votes

-- Pragy Agarwal (14.4k points)

1.28.8 P Np Npc Nph: GATE2004_30 [top](#)

<http://gateoverflow.in/1027>



Selected Answer

Option c.

<http://cstheory.stackexchange.com/questions/6864/why-is-2sat-in-p>

4 votes

-- anshu (2.5k points)

1.28.9 P Np Npc Nph: GATE2006_31 [top](#)

<http://gateoverflow.in/994>



Selected Answer

The only difference between SHAM and DHAM, in SHAM $|V|$ is divisible by 3.. which can be checked in constant amount of time.. So the hardness of the two problems will be the same... Next, finding hamiltonian cycle comes under NPC problem and NPC problem is a subset of NPH, so both are NPH..

So, option (A)

5 votes

-- Vicky Bajoria (3.4k points)

1.28.10 P Np Npc Nph: TIFR2013-B-7 [top](#)

<http://gateoverflow.in/25668>



Selected Answer

I believe Umang is right, Option B is the correct answer.

Intractability : We are looking for EFFICIENT algorithms.

Intractable Problems are problems that are decidable, although the algorithm to decide that problem might be efficient (P) or inefficient (NP), but at least an algorithm exists to solve these problems.

Here we talk about efficient vs inefficient computations.

Thus the language of problems in P and NP classes is the language of Decidable Problems i.e. Recursive Language.

Undecidability: We are looking for algorithms.

Undecidable Problems are problems for which there is no algorithm to solve these problems.

Here we talk about what can or can not be computed.

The language of Undecidable Problems are "Recursively Enumerable but not recursive languages" & "Not Recursively Enumerable Languages".

Clearly we can talk about the intractability of any problem if we know at least one algorithm to solve the problem, if there is no algorithm to solve a problem how can we talk about efficiency?

Halting Problem is undecidable.

I guess, all other problems mentioned here are decidable.

I don't know the most efficient algorithms to solve these problems but at least I can say that Brute force approach will work on all the other options except the Halting Problem.

What P = NP implies?

"Any problem that is solved by a non deterministic Turing machine in polynomial time also be solved by some deterministic Turing machine in polynomial time, even if the degree of the polynomial is higher."

and

There is neither a Non Deterministic Turing Machine nor Deterministic Turing Machine that can solve the Halting Problem.

So any inference about P & NP is not going to affect the solvability of Halting Problem, since it is undecidable.

4 votes

-- Anurag Pandey (9.7k points)

1.28.11 P Np Npc Nph: GATE2006_16 [top](#)

<http://gateoverflow.in/977>



Selected Answer

Q cannot be NP hard as no np hard problems(unless they are np) can be polynomial time reducible to np complete. Answer is B, as npc problem can be reducible to np hard problem. But there is confusion if Q is not NP hard then what complexity class it is in!!

7 votes

-- Shaun Patel (5.8k points)

1.28.12 P Np Npc Nph: GATE1992_02,vi top

<http://gateoverflow.in/561>

- a. Is NPC and hence NP hard.
- b. Is again NP hard (optimization version is NP hard and decision version is NPC).
Ref: <http://stackoverflow.com/questions/3907545/how-to-understand-the-knapsack-problem-is-np-complete>
- c. Is in P. See the algorithm here based on DFS: http://en.wikipedia.org/wiki/Biconnected_component
- d. NPC and hence NP hard.

4 votes

-- Arjun Suresh (150k points)

1.28.13 P Np Npc Nph: TIFR2011-B-37 top

<http://gateoverflow.in/20922>

Selected Answer

The reverse problem can be solved in polynomial time as a^b requires at most $\log b$ recursive calls using the approach given below:

```
pow(int a, int b)
{
    if(b%2)
        return a* pow(a*a, b/2);
    else
        return pow(a*a, b/2);
}
```

Now, the forward problem is also solvable in polynomial time. We need to check for all the roots of n (from \sqrt{n} till $n^{\frac{1}{\log n}}$) whether it is an integer. But each of these check can be done in $\log n$ time using a binary search on the set of integers from $2..n$ and so, the overall complexity will be $(\log n)^2$ which is polynomial in $\log n$ ($\log n$ is the size of input). So, (a) must be the answer.

3 votes

-- gatecse (10.7k points)

1.28.14 P Np Npc Nph: GATE2003_12 top

<http://gateoverflow.in/903>

Selected Answer

C

Ram's reduction shows Π is NP hard.
Shyam's reduction shows Π is in NP.

So NPC.

8 votes

-- Anurag Semwal (5.5k points)

1.29**Programming In C** top**1.29.1 Programming In C: GATE2015-3_30** top<http://gateoverflow.in/3486>

Consider the following two C code segments. Y and X are one and two dimensional arrays of size n and $n \times n$ respectively, where $2 \leq n \leq 10$. Assume that in both code segments, elements of Y are initialized to 0 and each element $X[i][j]$ of array X is initialized to $i + j$. Further assume that when stored in main memory all elements of X are in same main memory page frame.

Code segment 1:

```
// initialize elements of Y to 0
// initialize elements of X[i][j] of X to i+j
for (i=0; i<n; i++)
    Y[i] += X[0][i];
```

Code segment 2:

```
// initialize elements of Y to 0
// initialize elements of X[i][j] of X to i+j
for (i=0; i<n; i++)
    Y[i] += X[i][0];
```

Which of the following statements is/are correct?

- S1: Final contents of array Y will be same in both code segments
- S2: Elements of array X accessed inside the for loop shown in code segment 1 are contiguous in main memory
- S3: Elements of array X accessed inside the for loop shown in code segment 2 are contiguous in main memory

- A. Only S2 is correct
- B. Only S3 is correct
- C. Only S1 and S2 are correct
- D. Only S1 and S3 are correct

[gate2015-3](#) [algorithms](#) [programming-in-c](#) [normal](#)

Answer

1.29.2 Programming In C: GATE 2016-1-34 top<http://gateoverflow.in/39704>

The following function computes the maximum value contained in an integer array $P[]$ of size n ($n \geq 1$).

```
int max (int *p, int n) {
    int a = 0, b=n-1;

    while (_____) {
        if (p[a] <= p[b]) {a = a+1;}
        else                {b = b-1;}
    }
    return p[a];
}
```

The missing loop condition is

- A. $a! = n$
- B. $b! = 0$
- C. $b > (a + 1)$
- D. $b! = a$

[gate2016-1](#) [algorithms](#) [programming-in-c](#) [normal](#)

Answer

Answers: Programming In C

1.29.1 Programming In C: GATE2015-3_30 [top](#)

<http://gateoverflow.in/8486>



Selected Answer

option C. Only S1 and S2 are correct because Y have same element in both code and in code1

```
Y[i] += X[0][i];
```

this row major order (In C, arrays are stored in row-major order) which gives address of each element in sequential order(1,2,3,...,n) means we cross single element each time to move next shows contiguous in main memory but in code2 for

```
Y[i] += X[i][0];
```

we are crossing n element (row crossing with n element)to move next

11 votes

-- Anoop Sonkar (4.5k points)

1.29.2 Programming In C: GATE 2016-1-34 [top](#)

<http://gateoverflow.in/39704>



Selected Answer

d, solved through basic C fundamental approach

Option C fails for $n = 2, p = [1, 2]$.

14 votes

-- sukanyaC (171 points)

1.30

Quicksort [top](#)

1.30.1 Quicksort: GATE1992_03,iv [top](#)

<http://gateoverflow.in/581>

Assume that the last element of the set is used as partition element in Quicksort. If n distinct elements from the set $[1 \dots n]$ are to be sorted, give an input for which Quicksort takes maximum time.

gate1992 algorithms sorting quicksort easy

Answer

1.30.2 Quicksort: GATE2008-43 [top](#)

<http://gateoverflow.in/455>

Consider the Quicksort algorithm. Suppose there is a procedure for finding a pivot element which splits the list into two sublists each of which contains at least one-fifth of the elements. Let $T(n)$ be the number of comparisons required to sort n elements. Then

- A. $T(n) \leq 2T(n/5) + n$
- B. $T(n) \leq T(n/5) + T(4n/5) + n$
- C. $T(n) \leq 2T(4n/5) + n$
- D. $T(n) \leq 2T(n/2) + n$

gate2008 algorithms sorting quicksort easy

Answer

1.30.3 Quicksort: TIFR2012-B-14 [top](#)

<http://gateoverflow.in/25209>

Consider the quick sort algorithm on a set of n numbers, where in every recursive subroutine of the algorithm, the algorithm chooses the median of that set as the pivot. Then which of the following statements is TRUE?

- The running time of the algorithm is $\Theta(n)$.
- The running time of the algorithm is $\Theta(n \log n)$.
- The running time of the algorithm is $\Theta(n^{1.5})$.
- The running time of the algorithm is $\Theta(n^2)$.
- None of the above.

[tifr2012](#) [algorithms](#) [sorting](#) [quicksort](#)

Answer

Answers: Quicksort

1.30.1 Quicksort: GATE1992_03,iv [top](#)

<http://gateoverflow.in/581>



Selected Answer

The algorithm will take maximum time when:

- 1) The array is already sorted in same order.
- 2) The array is already sorted in reverse order.
- 3) All elements are same in the array.

Upvote 9 votes

-- Rajarshi Sarkar (29.7k points)

1.30.2 Quicksort: GATE2008-43 [top](#)

<http://gateoverflow.in/455>



Selected Answer

$$T(n) \leq T(n/5) + T(4n/5) + n$$

One part contains $n/5$ elements
and the other part contains $4n/5$ elements
 $+n$ is common to all options, so we need not to worry about it.

Hence, answer = **option B**

Upvote 8 votes

-- Amar Vashishth (20.7k points)

1.30.3 Quicksort: TIFR2012-B-14 [top](#)

<http://gateoverflow.in/25209>



Selected Answer

Algorithm is choosing median = $n/2$ smallest element as pivot.

Hence, the array is divided as:

| | | |
|---------------------------------|---|---------------------------------|
| $(\frac{n}{2} - 1)$ elements | Median at $\frac{n}{2}$ th location | $(n - \frac{n}{2})$ elements |
|---------------------------------|---|---------------------------------|

Therefore quick sort recurrence relation is given by:

$$\begin{aligned} T(n) &= T\left(\frac{n}{2} - 1\right) + T\left(n - \frac{n}{2}\right) + \Theta(n) \\ &= \Theta(n \log n) \end{aligned}$$

Hence, Option B is the correct answer.

Upvote 5 votes

-- Umang Raman (11.3k points)

1.31

Radix Sort top

1.31.1 Radix Sort: GATE2008-IT_43 top

<http://gateoverflow.in/3353>

If we use Radix Sort to sort n integers in the range $(n^{k/2}, n^k]$, for some $k > 0$ which is independent of n , the time taken would be?

- A) $\Theta(n)$
- B) $\Theta(kn)$
- C) $\Theta(n \log n)$
- D) $\Theta(n^2)$

gate2008-it algorithms sorting radix-sort normal

Answer

Answers: Radix Sort

1.31.1 Radix Sort: GATE2008-IT_43 top

<http://gateoverflow.in/3353>



Selected Answer

Answer: C

The complexity of Radix Sort is $O(wn)$, for n keys which are integers of word size w .

Here, $w = \log_2(n^k) = k \times \log_2(n)$

So, the complexity is $O(wn) = O(k \times \log_2(n) \times n)$, which leads to option C.

Upvote 9 votes

-- Rajarshi Sarkar (29.7k points)

1.32

Recurrence top

1.32.1 Recurrence: GATE2002_2.11 top

<http://gateoverflow.in/841>

The running time of the following algorithm

Procedure A(n)

If $n \leq 2$ return (1) else return $(A(\lceil \sqrt{n} \rceil))$;

is best described by

- A. $O(n)$
- B. $O(\log n)$
- C. $O(\log \log n)$
- D. $O(1)$

[gate2002](#) [algorithms](#) [recurrence](#) [normal](#)
Answer**1.32.2 Recurrence: GATE2002_1.3** [top](#)<http://gateoverflow.in/807>

The solution to the recurrence equation $T(2^k) = 3T(2^{k-1}) + 1, T(1) = 1$ is

- A. 2^k
- B. $\frac{(3^{k+1}-1)}{2}$
- C. $3^{\log_2 k}$
- D. $2^{\log_3 k}$

[gate2002](#) [algorithms](#) [recurrence](#) [normal](#)
Answer**1.32.3 Recurrence: GATE2004-IT_57** [top](#)<http://gateoverflow.in/3700>

Consider a list of recursive algorithms and a list of recurrence relations as shown below. Each recurrence relation corresponds to exactly one algorithm and is used to derive the time complexity of the algorithm.

| | Recursive Algorithm | Recurrence Relation |
|----|----------------------------|--------------------------------|
| P. | Binary search | I. $T(n) = T(n-k) + T(k) + cn$ |
| Q. | Merge sort | II. $T(n) = 2T(n-1) + 1$ |
| R. | Quick sort | III. $T(n) = 2T(n/2) + cn$ |
| S. | Tower of Hanoi | IV. $T(n) = T(n/2) + 1$ |

Which of the following is the correct match between the algorithms and their recurrence relations?

- A) P-II, Q-III, R-IV, S-I
- B) P-IV, Q-III, R-I, S-II
- C) P-III, Q-II, R-IV, S-I
- D) P-IV, Q-II, R-I, S-III

[gate2004-it](#) [algorithms](#) [recurrence](#) [normal](#)
Answer**1.32.4 Recurrence: GATE2005-IT_51** [top](#)<http://gateoverflow.in/3812>

Let $T(n)$ be a function defined by the recurrence

$$T(n) = 2T(n/2) + \sqrt{n} \text{ for } n \geq 2 \text{ and}$$

$$T(1) = 1$$

Which of the following statements is TRUE?

- A) $T(n) = \Theta(\log n)$
- B) $T(n) = \Theta(\sqrt{n})$
- C) $T(n) = \Theta(n)$
- D) $T(n) = \Theta(n \log n)$

[gate2005-it](#) [algorithms](#) [recurrence](#) [easy](#)
[Answer](#)

1.32.5 Recurrence: GATE1992-07a [top](#)

<http://gateoverflow.in/586>

Consider the function F(n) for which the pseudocode is given below :

```
Function F(n)
begin
F1 ← 1
if(n=1) then F ← 3
else
  For i = 1 to n do
    begin
      C ← 0
      For j = 1 to n - 1 do
        begin C ← C + 1 end
        F1 = F1 * C
      end
    F = F1
  end
end
```

[n is a positive integer greater than zero]

(a) Derive a recurrence relation for F(n)

[gate1992](#) [algorithms](#) [recurrence](#) [descriptive](#)
[Answer](#)

1.32.6 Recurrence: GATE2015-1_49 [top](#)

<http://gateoverflow.in/8355>

Let a_n represent the number of bit strings of length n containing two consecutive 1s. What is the recurrence relation for a_n ?

- A. $a_{n-2} + a_{n-1} + 2^{n-2}$
- B. $a_{n-2} + 2a_{n-1} + 2^{n-2}$
- C. $2a_{n-2} + a_{n-1} + 2^{n-2}$
- D. $2a_{n-2} + 2a_{n-1} + 2^{n-2}$

[gate2015-1](#) [algorithms](#) [recurrence](#) [normal](#)
[Answer](#)

1.32.7 Recurrence: GATE2015-3_39 [top](#)

<http://gateoverflow.in/8498>

Consider the following recursive C function.

```
void get(int n)
{
  if (n<1) return;
  get (n-1);
  get (n-3);
  printf("%d", n);
}
```

If get(6) function is being called in main() then how many times will the get() function be invoked before returning to the main()?

- A. 15
- B. 25
- C. 35
- D. 45

[gate2015-3](#) [algorithms](#) [recurrence](#) [normal](#)
[Answer](#)

1.32.8 Recurrence: GATE2008-78 [top](#)<http://gateoverflow.in/497>

Let x_n denote the number of binary strings of length n that contain no consecutive 0s.

Which of the following recurrences does x_n satisfy?

- A. $x_n = 2x_{n-1}$
- B. $x_n = x_{\lfloor n/2 \rfloor} + 1$
- C. $x_n = x_{\lfloor n/2 \rfloor} + n$
- D. $x_n = x_{n-1} + x_{n-2}$

[gate2008](#) [algorithms](#) [recurrence](#) [normal](#)

[Answer](#)

1.32.9 Recurrence: GATE1992-07b [top](#)<http://gateoverflow.in/43600>

Consider the function $F(n)$ for which the pseudocode is given below :

```
Function F(n)
begin
F1 ← 1
if(n=1) then F ← 3
else
  For i = 1 to n do
    begin
      C ← 0
      For j = 1 to n - 1 do
        begin C ← C + 1 end
      F1 = F1 * C
    end
  F = F1
end
```

[n is a positive integer greater than zero]

Solve the recurrence relation for a closed form solution of $F(n)$.

[gate1992](#) [algorithms](#) [recurrence](#) [descriptive](#)

[Answer](#)

1.32.10 Recurrence: TIFR2014-B-11 [top](#)<http://gateoverflow.in/27308>

Consider the following recurrence relation:

$$T(n) = \begin{cases} T\left(\frac{n}{k}\right) + T\left(\frac{3n}{4}\right) + n & \text{if } n \geq 2 \\ 1 & \text{if } n = 1 \end{cases}$$

Which of the following statements is FALSE?

- a. $T(n)$ is $O(n^{3/2})$ when $k = 3$.
- b. $T(n)$ is $O(n \log n)$ when $k = 3$.
- c. $T(n)$ is $O(n \log n)$ when $k = 4$.
- d. $T(n)$ is $O(n \log n)$ when $k = 5$.
- e. $T(n)$ is $O(n)$ when $k = 5$.

[tifr2014](#) [algorithms](#) [recurrence](#)

[Answer](#)

1.32.11 Recurrence: GATE1998-6a [top](#)<http://gateoverflow.in/44584>

Solve the following recurrence relation

$$x_n = 2x_{n-1} - 1, n > 1$$

$$x_1 = 2$$

[gate1998](#)
[algorithms](#)
[recurrence](#)
[descriptive](#)

Answer

1.32.12 Recurrence: TIFR2015-B-1 [top](#)

<http://gateoverflow.in/29657>

Consider the following recurrence relation:

$$T(n) = \begin{cases} 2T(\lfloor \sqrt{n} \rfloor) + \log n & \text{if } n \geq 2 \\ 1 & \text{if } n = 1 \end{cases}$$

Which of the following statements is TRUE?

- a. $T(n)$ is $O(\log n)$.
- b. $T(n)$ is $O(\log n \cdot \log \log n)$ but not $O(\log n)$.
- c. $T(n)$ is $O(\log^{3/2} n)$ but not $O(\log n \cdot \log \log n)$.
- d. $T(n)$ is $O(\log^2 n)$ but not $O(\log^{3/2} n)$.
- e. $T(n)$ is $O(\log^2 n \cdot \log \log n)$ but not $O(\log^2 n)$.

[tifr2015](#)
[algorithms](#)
[recurrence](#)
[time-complexity](#)

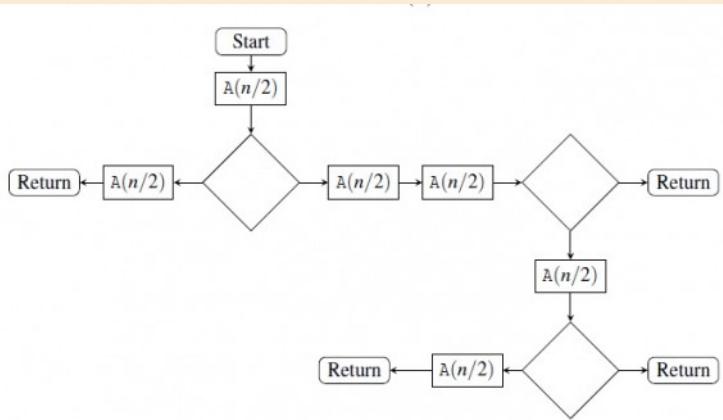
Answer

1.32.13 Recurrence: GATE 2016-2-39 [top](#)

<http://gateoverflow.in/39581>

The given diagram shows the flowchart for a recursive function $A(n)$. Assume that all statements, except for the recursive calls, have $O(1)$ time complexity. If the worst case time complexity of this function is $O(n^\alpha)$, then the least possible value (accurate up to two decimal positions) of α is _____.

Flow chart for Recursive Function $A(n)$.



```

    else
        return (recursive (n-1) + recursive (n-1));
}

```

- A. $O(n)$
 B. $O(n \log n)$
 C. $O(n^2)$
 D. $O(2^n)$

gate2004 | algorithms | recurrence | time-complexity | normal | isro2015

Answer

1.32.15 Recurrence: GATE2008-79 [top](#)

<http://gateoverflow.in/43485>

Let x_n denote the number of binary strings of length n that contain no consecutive 0s.

The value of x_5 is

- A. 5
 B. 7
 C. 8
 D. 16

gate2008 | algorithms | recurrence | normal

Answer

1.32.16 Recurrence: GATE1994_1.7 [top](#)

<http://gateoverflow.in/2444>

The recurrence relation that arises in relation with the complexity of binary search is:

- A. $T(n) = T\left(\frac{n}{2}\right) + k$, k is a constant
 B. $T(n) = 2T\left(\frac{n}{2}\right) + k$, k is a constant
 C. $T(n) = T\left(\frac{n}{2}\right) + \log n$
 D. $T(n) = T\left(\frac{n}{2}\right) + n$

gate1994 | algorithms | recurrence | easy

Answer

1.32.17 Recurrence: GATE2008-IT_44 [top](#)

<http://gateoverflow.in/3354>

When $n = 2^{2k}$ for some $k \geq 0$, the recurrence relation

$$T(n) = \sqrt{2} T(n/2) + \sqrt{n}, T(1) = 1$$

evaluates to :

- A) $\sqrt{n} (\log n + 1)$
 B) $\sqrt{n} \log n$
 C) $\sqrt{n} \log \sqrt{n}$
 D) $n \log \sqrt{n}$

gate2008-it | algorithms | recurrence | normal

Answer

1.32.18 Recurrence: GATE1993_15 [top](#)

<http://gateoverflow.in/2312>

Consider the recursive algorithm given below:

```
procedure bubblesort (n);
var i,j: index; temp : item;
begin
    for i:=1 to n-1 do
        if A[i] > A[i+1] then
            begin
                temp := A[i];
                A[i] := A[i+1];
                A[i+1] := temp;
            end;
    bubblesort (n-1)
end
```

Let a_n be the number of times the 'if...then...' statement gets executed when the algorithm is run with value n . Set up the recurrence relation by defining a_n in terms of a_{n-1} . Solve for a_n .

[gate1993](#) [algorithms](#) [recurrence](#) [normal](#)

[Answer](#)

1.32.19 Recurrence: GATE1996_2.12 [top](#)

<http://gateoverflow.in/2741>

The recurrence relation

- $T(1) = 2$
- $T(n) = 3T(\frac{n}{4}) + n$

has the solution $T(n)$ equal to

- A. $O(n)$
- B. $O(\log n)$
- C. $O\left(n^{\frac{3}{4}}\right)$
- D. None of the above

[gate1996](#) [algorithms](#) [recurrence](#) [normal](#)

[Answer](#)

1.32.20 Recurrence: GATE2009-35 [top](#)

<http://gateoverflow.in/1321>

The running time of an algorithm is represented by the following recurrence relation:

$$T(n) = \begin{cases} n & n \leq 3 \\ T\left(\frac{n}{3}\right) + cn & \text{otherwise} \end{cases}$$

Which one of the following represents the time complexity of the algorithm?

- A. $\Theta(n)$
- B. $\Theta(n \log n)$
- C. $\Theta(n^2)$
- D. $\Theta(n^2 \log n)$

[gate2009](#) [algorithms](#) [recurrence](#) [time-complexity](#) [normal](#)

[Answer](#)

1.32.21 Recurrence: GATE1997_15 [top](#)

<http://gateoverflow.in/2275>

Consider the following function.

```
Function F(n, m:integer) :integer;
begin
  If (n<=0 or (m<=0) then F:=1
  else
    F:=F(n-1, m) + F(n, m-1);
  end;
```

Use the recurrence relation $\binom{n}{k} = \binom{n-1}{k} + \binom{n-1}{k-1}$ to answer the following questions. Assume that n, m are positive integers. Write only the answers without any explanation.

- What is the value of $F(n, 2)$?
- What is the value of $F(n, m)$?
- How many recursive calls are made to the function F , including the original call, when evaluating $F(n, m)$.

[gate1997](#) [algorithms](#) [recurrence](#) [normal](#)

[Answer](#)

1.32.22 Recurrence: GATE2003_35 [top](#)

<http://gateoverflow.in/925>

Consider the following recurrence relation

$$T(1) = 1$$

$$T(n+1) = T(n) + \lfloor \sqrt{n+1} \rfloor \text{ for all } n \geq 1$$

The value of $T(m^2)$ for $m \geq 1$ is

- A. $\frac{m}{6}(21m - 39) + 4$
- B. $\frac{m}{6}(4m^2 - 3m + 5)$
- C. $\frac{m}{2}(3m^{2.5} - 11m + 20) - 5$
- D. $\frac{m}{6}(5m^3 - 34m^2 + 137m - 104) + \frac{5}{6}$

[gate2003](#) [algorithms](#) [time-complexity](#) [recurrence](#)

[Answer](#)

1.32.23 Recurrence: GATE1997_4.6 [top](#)

<http://gateoverflow.in/2247>

Let

$T(n)$ be the function defined by
 $T(1) = 1$, $T(n) = 2T(\lfloor \frac{n}{2} \rfloor) + \sqrt{n}$ for
 $n \geq 2$.

Which of the following statements is true?

- A. $T(n) = O\sqrt{n}$
- B. $T(n) = O(n)$
- C. $T(n) = O(\log n)$
- D. None of the above

[gate1997](#) [algorithms](#) [recurrence](#) [normal](#)

[Answer](#)

1.32.24 Recurrence: GATE2006-51, ISRO2016-34 [top](#)<http://gateoverflow.in/1829>

Consider the following recurrence:

$$T(n) = 2T(\sqrt{n}) + 1, \quad T(1) = 1$$

Which one of the following is true?

- A. $T(n) = \Theta(\log \log n)$
- B. $T(n) = \Theta(\log n)$
- C. $T(n) = \Theta(\sqrt{n})$
- D. $T(n) = \Theta(n)$

[algorithms](#) [recurrence](#) [isro2016](#) [gate2006](#)

[Answer](#)

1.32.25 Recurrence: GATE2004_84 [top](#)<http://gateoverflow.in/1078>

The recurrence equation

$$T(1) = 1$$

$$T(n) = 2T(n - 1) + n, n \geq 2$$

evaluates to

- (a) $2^{n+1} - n - 2$
- (b) $2^n - n$
- (c) $2^{n+1} - 2n - 2$
- (d) $2^n + n$

[gate2004](#) [algorithms](#) [recurrence](#) [normal](#)

[Answer](#)

1.32.26 Recurrence: GATE2014-2_13 [top](#)<http://gateoverflow.in/1968>

Which one of the following correctly determines the solution of the recurrence relation with $T(1) = 1$?

$$T(n) = 2T\left(\frac{n}{2}\right) + \log n$$

- (A) $\Theta(n)$
- (B) $\Theta(n \log n)$
- (C) $\Theta(n^2)$
- (D) $\Theta(\log n)$

[gate2014-2](#) [algorithms](#) [recurrence](#) [normal](#)

[Answer](#)

Answers: Recurrence**1.32.1 Recurrence: GATE2002_2.11** [top](#)<http://gateoverflow.in/841>



Selected Answer

The complexity will be the number of times the recursion happens which is equal to the number of times we can take square root of n recursively, till n becomes 2.

$$T(n) = T(\lceil \sqrt{n} \rceil) + 1$$

$$T(2) = 1$$

$$T(2^2) = T(2) + 1 = 2$$

$$T(2^{2^2}) = T(4) + 1 = 3$$

$$T(2^{2^3}) = T(16) + 1 = 4$$

$$\text{So, } T(n) = \lg \lg n + 1 = O(\log \log n)$$

14 votes

-- Arjun Suresh (150k points)

1.32.2 Recurrence: GATE2002_1.3 [top](#)

<http://gateoverflow.in/807>

Selected Answer

$$\text{Let } x = 2^k$$

$$T(x) = 3T\left(\frac{x}{2}\right) + 1$$

We can apply Master's theorem case 1 with $a = 3$ and $b = 2$ as $f(x) = 1 = O(x^{\log_2 3 - \epsilon})$

$$\text{So, } T(x) = \Theta(x^{\log_2 3}) = \Theta(2^{k \log_2 3}) = \Theta(2^{\log_2 3^k}) = \Theta(3^k)$$

So, only option possible is B.

We can also directly solve as follows:

$$T(x) = 3T\left(\frac{x}{2}\right) + 1 = 9T\left(\frac{x}{4}\right) + 1 + 3 \dots = 3^{\log_2 2^k} + (1 + 3 + 9 + \dots + 3^{\log_2 2^k - 1}) \quad (\text{recursion depth is } \log_2 x \text{ and } x = 2^k)$$

OR

$$T(2^k) = 3T(2^{k-1}) + 1 = 3^2 T(2^{k-2}) + 1 + 3 \dots = 3^k T(2^{k-k}) + (1 + 3 + 9 + \dots + 3^{k-1}) \quad (\text{recursion depth is } k) = 3^k + \frac{3}{2}(3^k - 1)$$

12 votes

-- Arjun Suresh (150k points)

1.32.3 Recurrence: GATE2004-IT_57 [top](#)

<http://gateoverflow.in/3700>

Selected Answer

answer B

5 votes

-- Sankaranarayanan P.N (9.8k points)

1.32.4 Recurrence: GATE2005-IT_51 [top](#)

<http://gateoverflow.in/3812>



Selected Answer

Option C it can be done by Master theorem.

$$n^{\log_a a} = n^{\log_2 2} = n .$$

$$f(n) = \sqrt{n} = n^{\frac{1}{2}} .$$

So, $f(n) = O(n^{\log_a a - \epsilon})$ is true for any real ϵ , $0 < \epsilon < \frac{1}{2}$. Hence Master theorem Case 1 satisfied,

$$T(n) = \Theta(n^{\log_a a}) = \Theta(n).$$

6 votes

-- Bhagirathi Nayak (11.3k points)

1.32.5 Recurrence: GATE1992-07a [top](#)

<http://gateoverflow.in/586>



Selected Answer

1 - The function $F(n)$ is NOT a recursive function. You can't have a recurrence relation for it in the first place!

2 - $F(n)$ calculates $(n - 1)^n$.

The equivalent C++ code is as follows: ([You can try it out here: http://ideone.com/w0u4lk](http://ideone.com/w0u4lk))

```
long F(long n) {
    long F1 = 1;

    if(n==1) { return 3; }
    else {
        for(long i = 1; i <= n; i++) {
            long C = 0;
            // Note: the before For loop only has one line
            for(long j = 1; j <= n-1; j++) { C = C+1; }
            // At the end of this for loop, C will be = (n-1)
            F1 = F1 * C;
        }
    }
    return F1;
}
```

It is clear that the inner for loop can be replaced by a single statement as follows:

```
long F(long n) {
    long F1 = 1;

    if(n==1) { return 3; }
    else {
        for(long i = 1; i <= n; i++)
            F1 = F1 * (n-1);
    }
    return F1;
}
```

And this calculates
 $(n - 1)^n$

5 votes

-- Pragy Agarwal (14.4k points)

1.32.6 Recurrence: GATE2015-1_49 [top](#)

<http://gateoverflow.in/835>



Selected Answer

Counting the number of bit strings NOT containing two consecutive 1's. (It is easy to derive a recurrence relation for the NOT case as shown below.)

0 1

00 01 10 - 3 (append both 0 and 1 to any string ending in 0, and append 0 to any string ending in 1)
 000 001 010 100 101 - 5 (all strings ending in 0 give two strings and those ending in 1 give 1 string)

0000 0001 0010 0100 0101 1000 1001 1010 - 8

....

$a_n' = a_{n-1}' + a_{n-2}'$ (where a_n denote the number of bit strings of length n containing two consecutive 1s)

$$2^n - a_n = (2^{n-1} - a_{n-1}) + (2^{n-2} - a_{n-2})$$

$$a_n = 2^{n-2}(4 - 2 - 1) + a_{n-1} + a_{n-2}$$

$$a_n = a_{n-1} + a_{n-2} + 2^{n-2}$$

A choice.

13 votes

-- Arjun Suresh (150k points)

1.32.7 Recurrence: GATE2015-3_39 [top](#)

<http://gateoverflow.in/8498>



Selected Answer

$T(n) = T(n-1) + T(n-3) + 2$, here $T(n)$ denotes the number of times a recursive call is made for input n . 2 denotes the two direct recursive calls.

$$\begin{aligned} T(n \leq 0) &= 0 \\ T(1) &= 2 \\ T(2) &= 4 \\ T(3) &= 6 \\ T(4) &= 10 \\ T(5) &= 16 \\ T(6) &= 24 \end{aligned}$$

So, answer is $24 + 1$ call from main = 25.

16 votes

-- Arjun Suresh (150k points)

1.32.8 Recurrence: GATE2008-78 [top](#)

<http://gateoverflow.in/497>



Selected Answer

0 1 -2
 01 10 11 -3
 010 011 101 110 111 -5
 0101 0110 0111 1010 1011 1101 1110 1111 -8

So, $x_n = x_{n-1} + x_{n-2}$ (For all the strings ending in 1, we get two new strings and for all strings ending in 0, we get a new string. So, the new set of strings for $n+1$, will have exactly n strings ending in 1)

$$x_5 = 8+5 = 13$$

9 votes

-- Arjun Suresh (150k points)

1.32.9 Recurrence: GATE1992-07b [top](#)<http://gateoverflow.in/43600>

$$F(n) = (n-1)^n \quad \text{When } n \geq 2$$

$$F(n) = 3 \quad \text{When } n == 1$$

1 votes

-- Rdr Deva (1.5k points)

1.32.10 Recurrence: TIFR2014-B-11 [top](#)<http://gateoverflow.in/27308>

OPTION b is false

c) apply Akra-Bazzi method .

for ex k=4, then eq is $T(n)=T(n/4)+T(3n/4)+n$

let $g(n)=n$ and $a_1=1, b_1=1/4, a_2=1, b_2=3/4$

then $\sum a_i b_i p = 1 \Rightarrow 1(1/4)p + 1(3/4)p = 1 \Rightarrow p=1$

then $T(n)=O(np(1+1\∫n / g(u) / u1+p).du)$

$=n(1+1\∫n / u/u2 du$

$=n(1+\log n)$

$=O(n \log n) \quad :: \text{option c is correct}$

d) apply back substitution

if $k=5 \quad T(n)=T(n/5) + T(3n/4)+n \quad ---\text{eq1}$

$T(n/5)=T(n/52) + T((1/5)(3/4)n)+n/5$

$T(3n/4)=T((3/4)((1/5)n)+T((3/4)2n)+3n/4 \text{ substitute in eq1}$

we got $T(n)=T(n/52) + 2 T((1/5)(3/4)n)+T((3/4)2n)+n(1/5+3/4) +n$

in the next we get $T(n)=T(n/53)+\dots+n(1/5+3/4)2+n(1/5+3/4) +n$

$T(n)=T(n/53)+\dots+n(19/20)2+n(19/20) +n$

$T(n)=T(n/5k) + \dots+n(1+(19/20)+(19/20)2)+\dots+(19/20)k-1$

$T(n)=T(n/5k)+\dots+n(-(19/20)k + 1)/(1/20))$

$n/5k=1 \Rightarrow k=\log n$

$:: T(n)=1+ 20 n - 20 n(19/20)\log n$

$:: T(n)=O(n) \text{ which inturn } O(n \log n) \text{ both d,e are correct}$

a) by observing option a & b $T(n)=(n \sqrt{n}) \quad T(n)=O(n \log n) \quad \text{and} \quad \log n=O(\sqrt{n})$

so if option b is correct then option a is also correct ----> so option b is false (we can eliminate)

2 votes

-- venky.victory35 (565 points)

1.32.11 Recurrence: GATE1998-6a [top](#)<http://gateoverflow.in/44584>

Selected Answer

$$T(n) = 2T(n-1) - 1 = 2(2T(n-2) - 1) - 1 = 2^2T(n-2) - 2 - 1 = 2^2(2T(n-3) - 1) - 2 - 1 = 2^3T(n-3) - 2^2 - 2$$

5 votes

-- srestha (27.8k points)

Another alternative is:

$$x_n = 2x_{n-1} - 1$$

Complete Sol. = H.S. + P.S ... ①

Homogeneous Eqn.

$$x_n - 2x_{n-1} = 0$$

$$\lambda - 2 = 0$$

$$\lambda = 2$$

$$H.S. = C \cdot 2^n$$

Particular Sol.

$$d = ad - 1$$

$$d = 1$$

From eqn (1), We get

$$x_n = C \cdot 2^n + 1 \quad \dots ②$$

$$x_1 = 2C + 1$$

$$2 = 2C + 1 \quad (\text{Given } x_1 = 2)$$

$$C = 1/2$$

From (2),

$$x_n = \frac{1}{2} (2^n) + 1$$

$$\boxed{x_n = 2^{n-1} + 1}$$

5 votes

-- Manoj Kumar (23.1k points)

1.32.12 Recurrence: TIFR2015-B-1 [top](#)

<http://gateoverflow.in/29657>



Selected Answer

Let $n = 2^k$

$$T(2^k) = 2T(2^{k/2}) + k$$

$$\text{Let } T(2^k) = S(k) \implies T(2^{k/2}) = S(k/2)$$

$$S(k) = 2S(k/2) + k$$

This gives $S(k) = \Theta(k \log k)$ (Master theorem case 2)

$$= \Theta(\log n \log \log n)$$

So ans is b

3 votes

-- Pooja (25.9k points)

1.32.13 Recurrence: GATE 2016-2-39[top](#)<http://gateoverflow.in/39581>

Selected Answer

If they are asking for worst case complexity hence,
By calling A(n) we get A(n/2) 5 times,

$$A(n) = 5A(n/2) + O(1)$$

Hence by applying masters theorem,
Case 1 : $a > b^k$

$$n^{\log_2 5}$$

Thus value of alpha will be 2.32

17 votes

-- Shashank Chavan (2.6k points)

1.32.14 Recurrence: GATE2004-83, ISRO2015-40[top](#)<http://gateoverflow.in/1077>

Selected Answer

option D

```
int recursive (int n) {
    if(n == 1)           // takes constant time say 'A' time
        return (1);       // takes constant time say 'A' time
    else
        return (recursive (n-1) + recursive (n-1)); // takes T(n-1) + T(n-1) time
}
```

$T(n) = 2T(n - 1) + a$ is the recurrence equation found from the pseudo code .

Solving the Recurrence Equation By Back Substitution Method

$$T(n) = 2T(n - 1) + a \text{ ----- (equation 1)}$$

$$T(n - 1) = 2T(n - 2) + a$$

$$T(n - 2) = 2T(n - 3) + a$$

We can re write Equation 1 as

$$\begin{aligned} T(n) &= 2[2T(n - 2) + a] + a = 4T(n - 2) + 3a \\ &= 2[2T(n - 3) + a] + 3a = 8T(n - 3) + 7a \\ &\quad \dots \quad \text{----- (Equation 2)} \\ &= 2^k T(n - k) + 2^{k-1} a \end{aligned}$$

On Substituting Limiting Condition

$$T(1) = 1 \text{ implies } n - k = 1 \implies k = n - 1$$

Therefore Equation 2 becomes

$$2^{n-1} + 2^{n-2} a = O(2^n)$$

8 votes

-- Akhil Nadh Pullolikkal Chandran (6.9k points)

1.32.15 Recurrence: GATE2008-79[top](#)<http://gateoverflow.in/43485>



Selected Answer

Number of binary strings of length n that contain no consecutive 0s, following will be the required recurrence relation:

$$T(n) = T(n-1) + T(n-2) \quad n > 2$$

base condition $T(1) = 2$ and $T(2) = 3$

| | |
|-----------------------------------|--|
| $T(1) = 2$ | There will be 2 strings of length 1, i.e 0 & 1 |
| $T(2) = 3$ | There will be 3 strings of length 2, i.e. 01,10,11 |
| $T(3) = T(1) + T(2) = 2+3 = 5$ | |
| $T(4) = T(3) + T(2) = 5 + 3 = 8$ | |
| $T(5) = T(4) + T(3) = 8 + 5 = 13$ | |

Hence, answer is 13, but no option matches!

1 votes

-- Vijay Thakur (1.5k points)

1.32.16 Recurrence: GATE1994_1.7 [top](#)

<http://gateoverflow.in/2444>



Selected Answer

It is A. searching for only one half of the list. leading to $T(n/2) + \text{constant time}$ in comparing and finding mid element.

9 votes

-- Gate Keeda (17.7k points)

1.32.17 Recurrence: GATE2008-IT_44 [top](#)

<http://gateoverflow.in/3354>



Selected Answer

$$\begin{aligned} T(n) &= \sqrt{2}T\left(\frac{n}{2}\right) + \sqrt{n} \\ &= \sqrt{2}^2 T\left(\frac{n}{2^2}\right) + \sqrt{2}\sqrt{\frac{n}{2}} + \sqrt{n} \\ &\dots \\ &= \sqrt{2^{\lg n}} T(1) + \lg n \sqrt{n} \\ &= \sqrt{n} + \lg n \sqrt{n} \\ &= \sqrt{n} (\lg n + 1) \end{aligned}$$

If we use Master theorem we get option B. But one must know that Master theorem is used to find the asymptotic bound and not an EXACT value. And in the question here it explicitly says "**evaluates to**".

15 votes

-- Arjun Suresh (150k points)

1.32.18 Recurrence: GATE1993_15 [top](#)

<http://gateoverflow.in/2312>



Selected Answer

$$a_n = a_{n-1} + n-1 \quad (\text{n-1 comparisons for } n \text{ numbers})$$

$$a_n = a_{n-2} + (n-2) + (n-1)$$

$$a_n = a_{n-3} + (n-3) + (n-2) + (n-1)$$

.

$$a_n = a_{n-n} + (n-n) + (n-(n-1)) + \dots + (n-3) + (n-2) + (n-1)$$

$$a_n = 0 + 1 + 2 + \dots + (n-3) + (n-2) + (n-1)$$

which given $a_n = \frac{(n-1) \times (n)}{2}$

6 votes

-- Rajarshi Sarkar (29.7k points)

1.32.19 Recurrence: GATE1996_2.12 [top](#)

<http://gateoverflow.in/2741>



Selected Answer

Answer: A

According to Master theorem,

$T(n) = aT(\frac{n}{b}) + f(n)$ can be expressed as:

$$T(n) = [n^{\log_b a}] [T(1) + u(n)]$$

where $u(n) = \Theta(h(n))$ where $h(n) = \frac{f(n)}{n^{\log_b a}} = \frac{n}{n^{\log_3 4}} = n^{1-\log_3 4}$ as $h(n) = n^r$ where $r > 0$.

$$\text{So, } T(n) = [n^{\log_3 4}] [T(1) + u(n)] = T(n) = [n^{\log_3 4}] [T(1) + \Theta(n^{1-\log_3 4})] = \Theta(n^1)$$

5 votes

-- Rajarshi Sarkar (29.7k points)

Master theorem: $n^{\log_3 4} < n$ so it is $O(n)$.

5 votes

-- Bhagirathi Nayak (11.3k points)

1.32.20 Recurrence: GATE2009-35 [top](#)

<http://gateoverflow.in/1321>



Selected Answer

$$a = 1, b = 3, \log_b a = 0$$

$$\text{So } n^{\log_b a} = n^0 = 1$$

$$f(n) = n$$

$$\text{So, } f(n) = \Omega(1)$$

To, check Master theorem case 3, we need $c > 0$,

$$f(n/3) \leq c f(n)$$

$$c = 1$$

So using case three of master theorem

$$T(n) = \Theta(f(n)) = \Theta(n)$$

answer is a

7 votes

-- Pooja (25.9k points)

1.32.21 Recurrence: GATE1997_15 [top](#)

<http://gateoverflow.in/2275>

a) $\frac{n(n-1)}{2}$

b) $\frac{n(n-m+1)}{m!}$

1 votes

-- Anirudh Pratap Singh (17.7k points)

1.32.22 Recurrence: GATE2003_35 [top](#)

<http://gateoverflow.in/925>



Selected Answer

$$\begin{aligned}
 T(m^2) &= T(m^2 - 1) + \lfloor \sqrt{(m^2)} \rfloor \\
 &= T(m^2 - 2) + \lfloor \sqrt{(m^2 - 1)} \rfloor + \lfloor \sqrt{(m^2)} \rfloor \\
 &= T(m^2 - 3) + \lfloor \sqrt{(m^2 - 2)} \rfloor + \lfloor \sqrt{(m^2 - 1)} \rfloor + \lfloor \sqrt{(m^2)} \rfloor \\
 &= \dots \\
 &= T(1) + \lfloor \sqrt{(2)} \rfloor + \lfloor \sqrt{(3)} \rfloor + \dots + \lfloor \sqrt{(m^2)} \rfloor
 \end{aligned}$$

$= 3 \times 1 + 5 \times 2 + \dots + (2m - 1) \times (m - 1) + m$ (We are taking floor of square root of numbers, and between successive square roots number of numbers are in the series 3, 5, 7... like 3 numbers from 1..4, 5 numbers from 5 – 9 and so on).

We can try out options here or solve as shown at end:

Put $m = 5, T(25) = 3 \times 1 + 5 \times 2 + 7 \times 3 + 9 \times 4 + 5 = 75$

Option A: 59

Option B: 75

Option C: non-integer

Option D: 297.5

So, answer must be B.

$$T(m^2) = 3 \times 1 + 5 \times 2 + \dots + (2m - 1) \times (m - 1) + m = m + \sum_i = 1^{m-1} (2i + 1). (i) = m + \sum_i = 1^{m-1} 2i^2 + i = m + \dots$$

[Sum of the first
 n natural numbers
 $= \frac{n(n+1)}{2}$.]

Sum of the squares of first
 n natural numbers
 $= \frac{n(n+1)(2n+1)}{6}$.]

4 votes

-- Arjun Suresh (150k points)

1.32.23 Recurrence: GATE1997_4.6 [top](#)

<http://gateoverflow.in/2247>



Selected Answer

answer B

using master method (case 1)

where $a = 2, b = 2$

$$O(n^{1/2}) < O(n^{\log_b a})$$

$$O(n^{1/2}) < O(n^{\log_2 2})$$

6 votes

-- ankitrokdeonsns (8.4k points)

1.32.24 Recurrence: GATE2006-51, ISRO2016-34 <http://gateoverflow.in/1829>

Selected Answer

$$T(n) = 2T\left(n^{\frac{1}{2}}\right) + 1 = 2\left(T\left(n^{\frac{1}{2^2}}\right) + 1\right) + 1 = 2 \times T\left(n^{\frac{1}{2^2}}\right) + 3 = 4 \times T\left(n^{\frac{1}{2^3}}\right) + 5 \dots = 2^{(\lg \lg n)} + 2 \times \lg \lg n + 1 \text{ (Prov)}$$

$n^{\frac{1}{2^k}} = 2$ (Putting 2 so that we can take log. One more step of recurrence can't change the complexity.) $\Rightarrow \frac{1}{2^k} \lg n = 1$

So, answer is B, $T(n) = \Theta(\log n)$

12 votes

-- Arjun Suresh (150k points)

1.32.25 Recurrence: GATE2004_84 <http://gateoverflow.in/1078>

Selected Answer

$$T(n) = 2T(n-1) + n, n \geq 2, T(1) = 1$$

$$\begin{aligned} T(n) &= n + 2(n-1) + 2^2(n-2) + \dots + 2^{(n-1)}(n-(n-1)) \\ &= n(1+2+\dots+2^{n-1}) - (1.2+2.2^2+3.2^3+\dots+(n-1).2^{n-1}) \\ &= n(2^n - 1) - (n.2^n - 2^{n+1} + 2) \\ &= 2^{n+1} - n - 2 \end{aligned}$$

17 votes

-- suraj (3.7k points)

1.32.26 Recurrence: GATE2014-2_13 <http://gateoverflow.in/1968>

Selected Answer

$$f(n) = \log n$$

$$a = 2, b = 2 \Rightarrow n^{\log_b a} = n$$

So, $f(n) = \log n = O(n^{1-\epsilon})$, we can take any ϵ from 0-1 for example 0.5 which gives $\log n = O(\sqrt{n})$, whose proof is given here: <http://math.stackexchange.com/questions/145739/prove-that-log-n-is-sqrt-n>

So, Master theorem Case 1, and answer will be $O(n^{\log_2 2}) = O(n)$

Alternate way:

$$T(1) = 1T(2) = 2T(1) + \log 2 = 3 = 3n - 2T(4) = 2T(2) + \log 4 = 8 = 3n - 4T(8) = 2T(4) + \log 8 = 19 = 3n - 5T(16) \dots$$

The second term being subtracted is growing at a lower rate than the first term. So, we can say $T(n) = O(n)$.

11 votes

-- Arjun Suresh (150k points)

1.33

Recursion top1.33.1 Recursion: GATE2011-48 top<http://gateoverflow.in/2154>

Consider the following recursive C function that takes two arguments.

```
unsigned int foo(unsigned int n, unsigned int r) {
    if (n>0) return ((n%r) + foo(n/r, r));
    else return 0;
}
```

What is the return value of the function `foo` when it is called as `foo(345, 10)`?

- A. 345
- B. 12
- C. 5
- D. 3

[gate2011](#) [algorithms](#) [recursion](#) [identify-function](#) [normal](#)

Answer

1.33.2 Recursion: GATE2005_31 top<http://gateoverflow.in/1367>

Consider the following C-program:

```
void foo (int n, int sum) {
    int k = 0, j = 0;
    if (n == 0) return;
    k = n % 10; j = n/10;
    sum = sum + k;
    foo (j, sum);
    printf ("%d", k);
}

int main() {
    int a = 2048, sum = 0;
    foo(a, sum);
    printf("%d\n", sum);
}
```

What does the above program print?

- A. 8, 4, 0, 2, 14
- B. 8, 4, 0, 2, 0
- C. 2, 0, 4, 8, 14
- D. 2, 0, 4, 8, 0

[gate2005](#) [algorithms](#) [identify-function](#) [recursion](#) [normal](#)

Answer

1.33.3 Recursion: GATE2009-18 top<http://gateoverflow.in/1310>

Consider the program below:

```
#include <stdio.h>
int fun(int n, int *f_p) {
    int t, f;
    if (n <= 1) {
        *f_p = 1;
        return 1;
    }
    t = fun(n-1, f_p);
    f = t + *f_p;
    *f_p = t;
}
```

```

    return f;
}

int main() {
    int x = 15;
    printf("%d/n", fun(5, &x));
    return 0;
}

```

The value printed is

- A. 6
- B. 8
- C. 14
- D. 15

[gate2009](#) [algorithms](#) [recursion](#) [identify-function](#) [normal](#)

[Answer](#)

1.33.4 Recursion: GATE2010-35 [top](#)

<http://gateoverflow.in/2336>

What is the value printed by the following C program?

```

#include<stdio.h>

int f(int *a, int n)
{
    if (n <= 0) return 0;
    else if (*a % 2 == 0) return *a+f(a+1, n-1);
    else return *a - f(a+1, n-1);
}

int main()
{
    int a[] = {12, 7, 13, 4, 11, 6};
    printf("%d", f(a, 6));
    return 0;
}

```

- A. -9
- B. 5
- C. 15
- D. 19

[gate2010](#) [algorithms](#) [recursion](#) [identify-function](#) [normal](#)

[Answer](#)

1.33.5 Recursion: GATE2014-2_40 [top](#)

<http://gateoverflow.in/2000>

Consider the following function

```

double f(double x) {
    if( abs(x*x - 3) < 0.01)
        return x;
    else
        return f(x/2 + 1.5/x);
}

```

Give a value
 q (to 2 decimals) such that
 $f(q)$ will return
 q : _____.

[gate2014-2](#) [algorithms](#) [recursion](#) [numerical-answers](#) [normal](#)

[Answer](#)

1.33.6 Recursion: GATE2007_42 [top](#)

<http://gateoverflow.in/1240>

Consider the following C function:

```
int f(int n)
{
    static int r = 0;
    if (n <= 0) return 1;
    if (n > 3)
    {
        r = n;
        return f(n-2) + 2;
    }
    return f(n-1) + r;
}
```

What is the value of $f(5)$?

- A. 5
- B. 7
- C. 9
- D. 18

[gate2007](#) [algorithms](#) [recursion](#) [normal](#)

Answer

1.33.7 Recursion: GATE2007_45 [top](#)

<http://gateoverflow.in/1243>

What is the time complexity of the following recursive function?

```
int DoSomething (int n) {
    if (n <= 2)
        return 1;
    else
        return (DoSomething (floor (sqrt(n))) + n);
}
```

- A. $\Theta(n^2)$
- B. $\Theta(n \log_2 n)$
- C. $\Theta(\log_2 n)$
- D. $\Theta(\log_2 \log_2 n)$

[gate2007](#) [algorithms](#) [recursion](#) [time-complexity](#) [normal](#)

Answer

1.33.8 Recursion: GATE2007_44 [top](#)

<http://gateoverflow.in/1242>

In the following C function, let $n \geq m$.

```
int gcd(n,m) {
    if (n%m == 0) return m;
    n = n%m;
    return gcd(m,n);
}
```

How many recursive calls are made by this function?

- A. $\Theta(\log_2 n)$
- B. $\Omega(n)$
- C. $\Theta(\log_2 \log_2 n)$
- D. $\Theta(\sqrt{n})$

[gate2007](#) [algorithms](#) [recursion](#) [time-complexity](#) [normal](#)
Answer

1.33.9 Recursion: GATE2007-IT_27 [top](#)

<http://gateoverflow.in/3460>

The function f is defined as follows:

```
int f (int n) {
    if (n <= 1) return 1;
    else if (n % 2 == 0) return f(n/2);
    else return f(3n - 1);
}
```

Assuming that arbitrarily large integers can be passed as a parameter to the function, consider the following statements.

- i. The function f terminates for finitely many different values of $n \geq 1$.
- ii. The function f terminates for infinitely many different values of $n \geq 1$.
- iii. The function f does not terminate for finitely many different values of $n \geq 1$.
- iv. The function f does not terminate for infinitely many different values of $n \geq 1$.

Which one of the following options is true of the above?

- | | |
|----|----------------|
| A) | (i) and (iii) |
| B) | (i) and (iv) |
| C) | (ii) and (iii) |
| D) | (ii) and (iv) |

[gate2007-it](#) [algorithms](#) [recursion](#) [normal](#)
Answer

1.33.10 Recursion: GATE1991_01,x [top](#)

<http://gateoverflow.in/507>

Consider the following recursive definition of fib :

```
fib(n) := if n = 0 then 1
          else if n = 1 then 1
          else fib(n-1) + fib(n-2)
```

The number of times fib is called (including the first call) for evaluation of $fib(7)$ is_____.

[gate1991](#) [algorithms](#) [recursion](#) [recurrence](#) [normal](#)
Answer

1.33.11 Recursion: GATE2008-IT_82 [top](#)

<http://gateoverflow.in/3406>

Consider the code fragment written in C below :

```
void f (int n)
{
    if (n <=1) {
        printf ("%d", n);
    }
    else {
        f (n/2);
        printf ("%d", n%2);
    }
}
```

What does $f(173)$ print?

- | | |
|----|-----------|
| 1) | 010110101 |
| 2) | 010101101 |
| 3) | 10110101 |

4) 10101101

gate2008-it algorithms recursion identify-function normal

Answer

1.33.12 Recursion: GATE2008-IT_83 [top](#)<http://gateoverflow.in/3407>

Consider the code fragment written in C below :

```
void f (int n)
{
    if (n <= 1) {
        printf ("%d", n);
    }
    else {
        f (n/2);
        printf ("%d", n%2);
    }
}
```

Which of the following implementations will produce the same output for $f(173)$ as the above code?

P1

```
void f (int n)
{
    if (n/2) {
        f(n/2);
    }
    printf ("%d", n%2);
}
```

P2

```
void f (int n)
{
    if (n <=1) {
        printf ("%d", n);
    }
    else {
        printf ("%d", n%2);
        f (n/2);
    }
}
```

- A) Both P1 and P2
- B) P2 only
- C) P1 only
- D) Neither P1 nor P2

gate2008-it algorithms recursion identify-function normal

Answer

1.33.13 Recursion: GATE2002_11 [top](#)<http://gateoverflow.in/864>

The following recursive function in C is a solution to the Towers of Hanoi problem.

```
void move(int n, char A, char B, char C) {
    if (.....) {
        move (.....);
        printf("Move disk %d from pole %c to pole %c\n", n, A,C);
        move (.....);
    }
}
```

Fill in the dotted parts of the solution.

gate2002 algorithms recursion normal

Answer

1.33.14 Recursion: GATE1998_2.12 [top](#)<http://gateoverflow.in/1684>

What value would the following function return for the input $x = 95$?

```
Function fun (x:integer):integer;
Begin
  If x > 100 then fun := x - 10
  Else fun := fun(fun (x+11))
End;
```

- A. 89
 B. 90
 C. 91
 D. 92

gate1998 | algorithms | recursion | identify-function | normal

[Answer](#)

Answers: Recursion

1.33.1 Recursion: GATE2011-48 [top](#)

<http://gateoverflow.in/2154>



Selected Answer

A) The function returns the sum of digits of the given number.

so $5+4+3 = 12$

6 votes

-- Danish (2.4k points)

1.33.2 Recursion: GATE2005_31 [top](#)

<http://gateoverflow.in/1367>



Selected Answer

Option d.

foo is printing the lowest digit. But the printf inside it is after the recursive call. This forces the output to be in reverse order

2, 0, 4, 8

The final value "sum" printed will be 0 as C uses pass by value and hence the modified value inside foo won't be visible inside main.

8 votes

-- anshu (2.5k points)

1.33.3 Recursion: GATE2009-18 [top](#)

<http://gateoverflow.in/1310>



Selected Answer

The answer is B.

Let the address of x be 1000.

1.f(5,1000) = 8

2.f(4,1000) = 5

3.f(3,1000) = 3

4.f(2,1000) = 2

5.f(1,1000) = 1.

The evaluation is done from 5 to 1. Since recursion is used.

Upvote 5 votes

-- Gate Keeda (17.7k points)

1.33.4 Recursion: GATE2010-35 [top](#)

<http://gateoverflow.in/2336>



Selected Answer

It will print

$$\begin{aligned} & 12 + (7 - (13 - (4 + (11 - (6 + 0))))) \\ & = 12 + (7 - (13 - (4 + (11 - 6)))) \\ & = 12 + 7 - 13 + 9 \\ & = 15 \end{aligned}$$

Upvote 8 votes

-- gatecse (10.7k points)

1.33.5 Recursion: GATE2014-2_40 [top](#)

<http://gateoverflow.in/2000>



Selected Answer

(We can directly go to the "if" part to get one answer, but we need to solve "else" part too to get all possible answers which though is not asked in question)

Solving the else part:

$$\frac{x}{2} + \frac{3}{2x} = \frac{x^2+3}{2x}$$

So, the new value of x will be $\frac{x^2+3}{2x}$ and we need it equal to x .

$$\frac{x^2+3}{2x} = x \implies x^2 + 3 = 2x^2 \implies x^2 = 3 \implies x = 1.732$$

Now solving the if part.

`abs(x*x - 3) < 0.01`

So, $x^2 - 3 < 0.01$ and $-(x^2 - 3) < 0.01 \implies x^2 < 3.01$ and $x^2 > 2.99 \implies x < 1.735$ and $x > 1.729$

Corrected to 2 decimal places answer should be 1.73 or 1.74.

Upvote 8 votes

-- Arjun Suresh (150k points)

1.33.6 Recursion: GATE2007_42 [top](#)

<http://gateoverflow.in/1240>



Selected Answer

The answer is D.

$$f(5) = 18.$$

$$f(3) + 2 = 16 + 2 = 18$$

$$f(2) + 5 = 11 + 5 = 16$$

$$f(1) + 5 = 6 + 5 = 11$$

$$f(0) + 5 = 1+5 = 6$$

Consider from last to first. Since it is recursive function.

6 votes

-- Gate Keeda (17.7k points)

1.33.7 Recursion: GATE2007_45 top

<http://gateoverflow.in/1243>



Selected Answer

We are asked the time complexity which will be the number of recursive calls in the function as in each call we perform a constant no. of operations and a recursive call. The recurrence relation for this is (considering constant time "c" as 1)

$$T(n) = T(\sqrt{n}) + 1 = T(n^{1/4}) + 2 = T(n^{1/8}) + 3$$

Going like this we will eventually reach $T(3)$ or $T(2)$. For asymptotic case this doesn't matter and we can assume we reach $T(2)$ and in next step reach $T(1)$. So, all we want to know is how many steps it takes to reach $T(1)$ which will be 1+ no. of steps to reach $T(2)$.

From the recurrence relation we know that $T(2)$ happens when $n^{\left(\frac{1}{2^k}\right)} = 2$.

Taking log and equating,

$$\frac{1}{2^k} \log n = 12^k = \log nk = \log \log n .$$

So, $T(1)$ happens in $\log \log n + 1$ calls, but for asymptotic complexity we can write as $\Theta(\log \log n)$

Alternatively,

Substituting values

$$T(1) = 1$$

$$T(2) = 1$$

$$T(3) = T(1) + 1 = 2$$

$$\dots$$

$$T(8) = T(2) + 1 = 2$$

$$T(9) = T(3) + 1 = 3$$

...

$$T\left(\left((2^2)^2\right)^2\right) = T\left((2^2)^2\right) + 1 = T(2^2) + 2 = T(2) + 3 = 1 + 3 = 4, \log \log n = 3 \text{ as } n = 256 .$$

$$T\left(\left(\left((2^2)^2\right)^2\right)^2\right) = 6, \log \log n = 5 \text{ as } n = 65536 \times 65536 = 2^{32}$$

$$T(2^{2^{10}}) = T(2^{512}) + 1 = T(2^{256}) + 2 = T(2^{128}) + 3 = T(2^{64}) + 4 = T(2^{32}) + 5 = T(2^{16}) + 6 = T(2^8) + 7 = T(2^4) + 8 =$$

So, answer is D

<http://stackoverflow.com/questions/16472012/what-would-cause-an-algorithm-to-have-olog-log-n-complexity>

11 votes

-- Arjun Suresh (150k points)

1.33.8 Recursion: GATE2007_44 top

<http://gateoverflow.in/1242>



Selected Answer

Worst case will arise when both n and m are consecutive Fibonacci numbers.

$$\gcd(F_n, F_{n-1}) = \gcd(F_{n-1}, F_{n-2}) = \dots = \gcd(F_1, F_0) = 1$$

and n^{th} Fibonacci number is 1.618^n , where 1.618 is the [Golden ratio](#).

So, to find $\gcd(n, m)$, number of recursive calls will be $\Theta(\log n)$.

11 votes

-- Vikrant Singh (11k points)

1.33.9 Recursion: GATE2007-IT_27 [top](#)

<http://gateoverflow.in/3460>



Selected Answer

The function terminates for all powers of 2 (which is infinite), hence (i) is false and (ii) is TRUE.

Let $n = 5$.

Now, recursive calls will go like 5 - 14 - 7 - 20 - 10 - 5 -

And this goes into infinite recursion. And if we multiply 5 with any power of 2, also result will be infinite recursion. Since, there are infinite powers of 2 possible, there are infinite recursions possible (even considering this case only). So, (iv) is TRUE and (iii) is false.

So, correct answer is (D)

12 votes

-- Arjun Suresh (150k points)

1.33.10 Recursion: GATE1991_01,x [top](#)

<http://gateoverflow.in/507>



Selected Answer

The recurrence relation for the no. of calls is

$$T(n) = T(n-1) + T(n-2) + 2$$

$T(0) = T(1) = 0$ (for fib(0) and fib(1), there are no recursive calls).

$$T(2) = 2$$

$$T(3) = 4$$

$$T(4) = 8$$

$$T(5) = 14$$

$$T(6) = 24$$

$$T(7) = 40.$$

Counting the initial call we get $40 + 1 = 41$.

6 votes

-- Arjun Suresh (150k points)

1.33.11 Recursion: GATE2008-IT_82 [top](#)

<http://gateoverflow.in/3406>



Selected Answer

Answer: D

The function prints the binary equivalent of the number n.

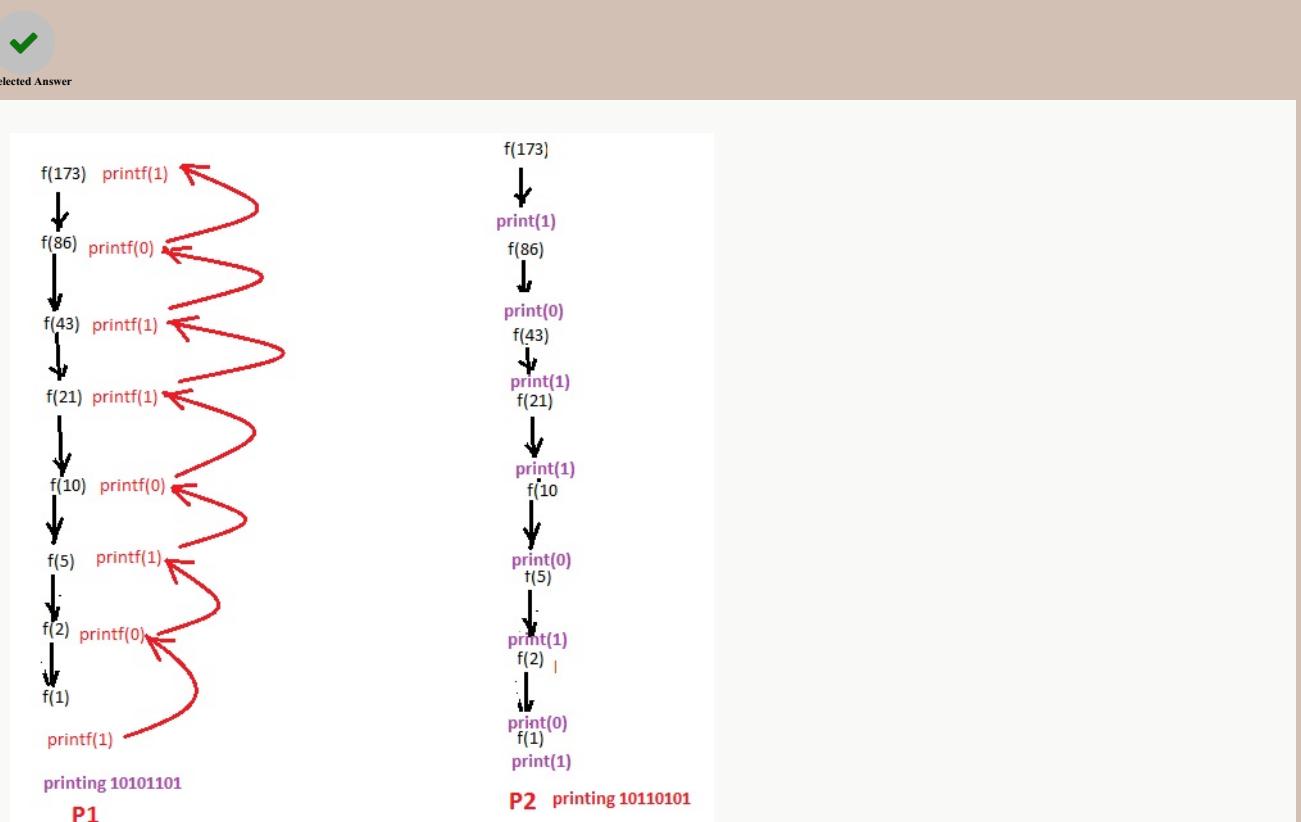
Binary equivalent of 173 is 10101101.

8 votes

-- Rajarshi Sarkar (29.7k points)

1.33.12 Recursion: GATE2008-IT_83 [top](#)

<http://gateoverflow.in/3407>



here P1 and P2 will print opposite in direction as shown in diagram

and given code fragment will print like P1 and not like P2

Hence ans will be (C)

1 votes

-- srestha (27.8k points)

1.33.13 Recursion: GATE2002_11 [top](#)

<http://gateoverflow.in/864>



7 votes

-- sonam vyas (8.1k points)

1.33.14 Recursion: GATE1998_2.12 [top](#)

<http://gateoverflow.in/1684>



Selected Answer

value $\text{fun}(95) = \text{fun}(\text{fun}(106)) = \text{fun}(96) = \text{fun}(\text{fun}(107)) = \text{fun}(97) = \text{fun}(\text{fun}(108)) = \text{fun}(98) = \text{fun}(\text{fun}(109)) = .$ return

9 votes

-- Digvijay (35.8k points)

1.34

Reduction [top](#)1.34.1 Reduction: GATE2015-3_53 [top](#)<http://gateoverflow.in/8562>

Language L_1 is polynomial time reducible to language L_2 . Language L_3 is polynomial time reducible to language L_2 , which in turn polynomial time reducible to language L_4 . Which of the following is/are true?

- I. if $L_4 \in P$, then $L_2 \in P$
- II. if $L_1 \in P$ or $L_3 \in P$, then $L_2 \in P$
- III. $L_1 \in P$, if and only if $L_3 \in P$
- IV. if $L_4 \in P$, then $L_3 \in P$

- A. II only
- B. III only
- C. I and IV only
- D. I only

[gate2015-3](#) [algorithms](#) [reduction](#) [normal](#)

Answer

Answers: Reduction

1.34.1 Reduction: GATE2015-3_53 [top](#)<http://gateoverflow.in/8562>

Selected Answer

1. L_1 is polynomial time reducible to L_2 . So, L_2 is at least as hard as L_1 .
2. L_3 is polynomial time reducible to L_2 . So, L_2 is at least as hard as L_3 .
3. L_2 is polynomial time reducible to L_4 . So, L_4 is at least as hard as L_2 .

If L_4 is in P , L_3 , L_2 and L_1 must also be in P . So, I and IV are true.

We can have L_1 in P and L_2 not in P , and none of the given conditions are violated. So, II is false.

Assume L_3 not in P . Now, Since L_2 must be at least as hard as L_3 , it must also be not in P . But L_1 is less harder than L_1 as per condition 1, and it can be in P without violating any given conditions. So, III is false.

Hence C choice.

More Info: http://gatecse.in/wiki/Some_Reduction_Inferences

10 votes

-- Arjun Suresh (150k points)

1.35

Runtime Environments [top](#)1.35.1 Runtime Environments: GATE1994_21 [top](#)<http://gateoverflow.in/2517>

Consider the following recursive function:

```
function fib (n:integer);integer;
begin
if (n=0) or (n=1) then fib := 1
else fib := fib(n-1) + fib(n-2)
end;
```

The above function is run on a computer with a stack of 64 bytes. Assuming that only return address and parameter are passed on the stack, and that an integer value and an address takes 2 bytes each, estimate the maximum value of n for which the stack will not overflow. Give reasons for your answer.

gate1994 | algorithms | runtime-environments | recursion | normal

[Answer](#)

Answers: Runtime Environments

1.35.1 Runtime Environments: GATE1994_21 [top](#)

<http://gateoverflow.in/2517>



Selected Answer

Size of an activation record = $2 + 2 = 4$ bytes.

So, no. of possible activation records which can be live at a time = $64/4 = 16$.

So, we can have 16 function calls live at a time (recursion depth = 16), meaning the maximum value for n without stack overflow is 16 (calls from 1-16). For $n = 17$, stack will overflow.

This is different from the total no. of recursive calls which will be as follows:

| n | No. of calls |
|---|--------------|
| 1 | 1 |
| 2 | 3 |
| 3 | 5 |
| 4 | 9 |
| 5 | 15 |
| 6 | 25 |

7 votes

-- Arjun Suresh (150k points)

1.36

Shortest Path [top](#)

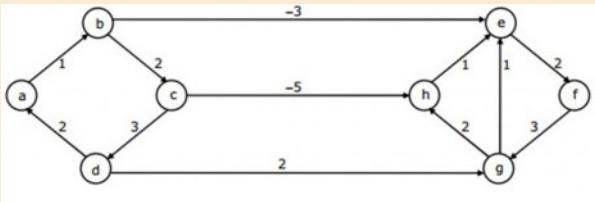
1.36.1 Shortest Path: GATE 2016-1-38 [top](#)

<http://gateoverflow.in/39731>

Consider the weighted undirected graph with 4 vertices, where the weight of edge $\{i,j\}$ is given by the entry W_{ij} in the matrix W .

$$W = \begin{bmatrix} 0 & 2 & 8 & 5 \\ 2 & 0 & 5 & 8 \\ 8 & 5 & 0 & x \\ 5 & 8 & x & 0 \end{bmatrix}$$

The largest possible integer value of x , for which at least one shortest path between some pair of vertices will contain the edge with weight x is _____

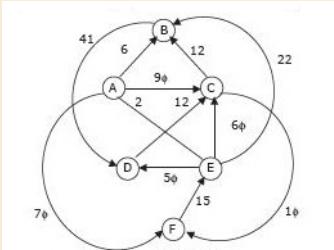
Answer**1.36.2 Shortest Path: GATE2008-45** [top](#)<http://gateoverflow.in/457>

Dijkstra's single source shortest path algorithm when run from vertex a in the above graph, computes the correct shortest path distance to

- A. only vertex a
- B. only vertices a, e, f, g, h
- C. only vertices a, b, c, d
- D. all the vertices

Answer**1.36.3 Shortest Path: GATE1996_17** [top](#)<http://gateoverflow.in/276>

Let G be the directed, weighted graph shown in below figure



We are interested in the shortest paths from A .

- a. Output the sequence of vertices identified by the Dijkstra's algorithm for single source shortest path when the algorithm is started at node A
- b. Write down sequence of vertices in the shortest path from A to E
- c. What is the cost of the shortest path from A to E ?

Answer**1.36.4 Shortest Path: GATE 2016-2-14** [top](#)<http://gateoverflow.in/39570>

The Floyd-Warshall algorithm for all-pair shortest paths computation is based on

- A. Greedy paradigm.
- B. Divide-and-conquer paradigm.
- C. Dynamic Programming paradigm.
- D. Neither Greedy nor Divide-and-Conquer nor Dynamic Programming paradigm.

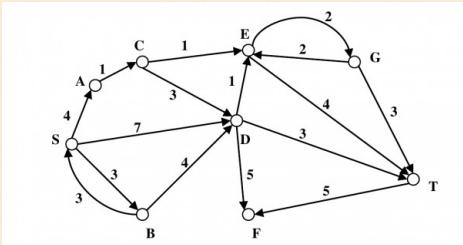
[gate2016-2](#) [algorithms](#) [graph-algorithms](#) [shortest-path](#) [dynamic-programming](#) [easy](#)

Answer

1.36.5 Shortest Path: GATE2012_40 [top](#)

<http://gateoverflow.in/1765>

Consider the directed graph shown in the figure below. There are multiple shortest paths between vertices S and T . Which one will be reported by Dijkstra's shortest path algorithm? Assume that, in any iteration, the shortest path to a vertex v is updated only when a strictly shorter path to v is discovered.



- A. SDT
- B. SBDT
- C. SACDT
- D. SACET

[gate2012](#) [algorithms](#) [graph-algorithms](#) [shortest-path](#) [normal](#)

Answer

Answers: Shortest Path

1.36.1 Shortest Path: GATE 2016-1-38 [top](#)

<http://gateoverflow.in/39731>

Selected Answer

Answer is $x=12$. Here, when we read the last sentence of the question, i.e the largest possible integer value of x . when $x=11$, shortest path is edge with weight x only. But when $x=12$, there are 2 shortest paths, and we can say that the edge with weight x is also a shortest path. Atleast 1 shortest path contain edge x . So answer will be 12.

16 votes

-- Sreyas S (1.6k points)

1.36.2 Shortest Path: GATE2008-45 [top](#)

<http://gateoverflow.in/457>

Selected Answer

(d) all the vertices. Just simulate the Dijkstra's algorithm on it. Dijkstra's algorithm is not meant for graphs with negative edges as it might not always work, but here it does give the correct shortest path.

9 votes

-- Arjun Suresh (150k points)

1.36.3 Shortest Path: GATE1996_17 [top](#)

<http://gateoverflow.in/2769>

Part a: A B D C F E

Part b: A B D C F E

Part c : 84

1 votes

-- Himanshu Agarwal (9.8k points)

AEBDCF

shortest path between A and E is AE itself

length of 2

Someone plz verify this

1 votes

-- Gate Mm (437 points)

1.36.4 Shortest Path: GATE 2016-2-14 [top](#)

<http://gateoverflow.in/39570>



Selected Answer

In floyd warshalls we calculate all possibilities and select best one so its neither dac nor greedy but based on Dynamic Programming Paradigm.

12 votes

-- Anurag Semwal (5.5k points)

1.36.5 Shortest Path: GATE2012_40 [top](#)

<http://gateoverflow.in/1765>



Selected Answer

Relaxation at every vertex is as follows

Note the next vertex is taken out here is in RED colour

| A | B | C | D | E | F | G | T |
|---|--------------|------------|----------------------------|-------------|---------------|-----------------------|----|
| S | 4 3(by s) | ∞ | 7 | ∞ | ∞ | ∞ | ∞ |
| B | 4(by s) | ∞ | 7 ::(4+3 also=7) (S->d) | ∞ | ∞ | ∞ | ∞ |
| A | | 5(S->B->A) | 7 | ∞ | ∞ | ∞ | ∞ |
| C | | | 7 | 6(S->B->C) | ∞ | ∞ | ∞ |
| E | | | 7(S->D) | ∞ | 8(S->A->C->E) | 10(S->A->C->E) | |
| D | | | | 12(S->B->D) | 8 | 10(same so no change) | |
| E | | | | | 12 | | 10 |
| T | | | | | 12 | | |

Now We see for S to T its (S->A->C->E->.T)

which is Option
D

13 votes

-- Kalpish Singh (1.7k points)

1.37

Sorting [top](#)

1.37.1 Sorting: TIFR2011-B-31 [top](#)

<http://gateoverflow.in/20617>

Given a set of $n = 2^k$ distinct numbers, we would like to determine the smallest and the second smallest using comparisons. Which of the following statements is TRUE?

- a. Both these elements can be determined using $2k$ comparisons.
- b. Both these elements can be determined using $n - 2$ comparisons.
- c. Both these elements can be determined using $n + k - 2$ comparisons.
- d. $2n - 3$ comparisons are necessary to determine these two elements.
- e. nk comparisons are necessary to determine these two elements.

[tifr2011](#) [algorithms](#) [sorting](#)

[Answer](#)

1.37.2 Sorting: GATE2014-1_14 [top](#)

<http://gateoverflow.in/1780>

Let

P be quicksort program to sort numbers in ascending order using the first element as the pivot. Let t_1 and

t_2 be the number of comparisons made by P for the inputs [1 2 3 4 5] and [4 1 5 3 2] respectively. Which one of the following holds?

- (A) $t_1 = 5$
- (B) $t_1 < t_2$
- (C) $t_1 > t_2$
- (D) $t_1 = t_2$

[gate2014-1](#) [algorithms](#) [sorting](#) [easy](#)

[Answer](#)

1.37.3 Sorting: GATE2013_6 [top](#)

<http://gateoverflow.in/1415>

Which one of the following is the tightest upper bound that represents the number of swaps required to sort n numbers using selection sort?

- (A) $O(\log n)$
- (B) $O(n)$
- (C) $O(n \log n)$
- (D) $O(n^2)$

[gate2013](#) [algorithms](#) [sorting](#) [easy](#)

[Answer](#)

1.37.4 Sorting: GATE1992_02,ix [top](#)

<http://gateoverflow.in/559>

Choose the correct alternatives (more than one may be correct) and write the corresponding letters only:

Following algorithm(s) can be used to sort n in the range $[1.....n^3]$ in $O(n)$ time

- (a). Heap sort
- (b). Quick sort
- (c). Merge sort
- (d). Radix sort

[gate1992](#) [easy](#) [algorithms](#) [sorting](#)

[Answer](#)

1.37.5 Sorting: GATE2006_52 [top](#)

<http://gateoverflow.in/1830>

The median of n elements can be found in $O(n)$ time. Which one of the following is correct about the complexity of quick sort, in which median is selected as pivot?

- (A) $\Theta(n)$
- (B) $\Theta(n \log n)$
- (C) $\Theta(n^2)$
- (D) $\Theta(n^3)$

gate2006 algorithms sorting easy

[Answer](#)

1.37.6 Sorting: TIFR2012-B-13 [top](#)

<http://gateoverflow.in/25207>

An array A contains n integers. We wish to sort A in ascending order. We are told that initially no element of A is more than a distance k away from its final position in the sorted list. Assume that n and k are large and k is much smaller than n . Which of the following is true for the worst case complexity of sorting A ?

- a. A can be sorted with constant $.kn$ comparison but not with fewer comparisons.
- b. A cannot be sorted with less than constant $.n \log n$ comparisons.
- c. A can be sorted with constant $.n$ comparisons.
- d. A can be sorted with constant $.n \log k$ comparisons but not with fewer comparisons.
- e. A can be sorted with constant $.k^2 n$ comparisons but not fewer.

tifr2012 algorithms sorting

[Answer](#)

1.37.7 Sorting: GATE2012_39 [top](#)

<http://gateoverflow.in/1762>

A list of n strings, each of length n , is sorted into lexicographic order using the merge-sort algorithm. The worst case running time of this computation is

- (A) $O(n \log n)$
- (B) $O(n^2 \log n)$
- (C) $O(n^2 + \log n)$
- (D) $O(n^2)$

gate2012 algorithms sorting normal

[Answer](#)

1.37.8 Sorting: GATE1991_01,vii [top](#)

<http://gateoverflow.in/505>

The minimum number of comparisons required to sort 5 elements is _____

gate1991 normal algorithms sorting

[Answer](#)

1.37.9 Sorting: TIFR2011-B-39 [top](#)

<http://gateoverflow.in/20935>

The first n cells of an array L contain positive integers sorted in decreasing order, and the remaining $m - n$ cells all contain 0. Then, given an integer x , in how many comparisons can one find the position of x in L ?

- a. At least n comparisons are necessary in the worst case.
- b. At least $\log m$ comparisons are necessary in the worst case.
- c. $O(\log(m - n))$ comparisons suffice.
- d. $O(\log n)$ comparisons suffice.
- e. $O(\log(m/n))$ comparisons suffice.

tifr2011 algorithms sorting

Answer**1.37.10 Sorting: GATE1991_13** [top](#)<http://gateoverflow.in/540>

Give an optimal algorithm in pseudo-code for sorting a sequence of n numbers which has only k distinct numbers (k is not known a Priori). Give a brief analysis for the time-complexity of your algorithm.

[gate1991](#) [sorting](#) [time-complexity](#) [algorithms](#) [difficult](#)**Answer****1.37.11 Sorting: TIFR2010-B-23** [top](#)<http://gateoverflow.in/18623>

Suppose you are given n numbers and you sort them in descending order as follows:

First find the maximum. Remove this element from the list and find the maximum of the remaining elements, remove this element, and so on, until all elements are exhausted. How many comparisons does this method require in the worst case?

- A. Linear in n .
- B. $O(n^2)$ but not better.
- C. $O(n \log n)$
- D. Same as heap sort.
- E. $O(n^{1.5})$ but not better.

[tifr2010](#) [algorithms](#) [time-complexity](#) [sorting](#)**Answer****1.37.12 Sorting: GATE1999_1.12** [top](#)<http://gateoverflow.in/1465>

A sorting technique is called stable if

- A. it takes $O(n \log n)$ time
- B. it maintains the relative order of occurrence of non-distinct elements
- C. it uses divide and conquer paradigm
- D. it takes $O(n)$ space

[gate1999](#) [algorithms](#) [sorting](#) [easy](#)**Answer****1.37.13 Sorting: GATE1999-1.14, ISRO2015-42** [top](#)<http://gateoverflow.in/1467>

If one uses straight two-way merge sort algorithm to sort the following elements in ascending order:

20, 47, 15, 8, 9, 4, 40, 30, 12, 17

then the order of these elements after second pass of the algorithm is:

- A. 8, 9, 15, 20, 47, 4, 12, 17, 30, 40
- B. 8, 15, 20, 47, 4, 9, 30, 40, 12, 17
- C. 15, 20, 47, 4, 8, 9, 12, 30, 40, 17
- D. 4, 8, 9, 15, 20, 47, 12, 17, 30, 40

[gate1999](#) [algorithms](#) [sorting](#) [normal](#) [isro2015](#)**Answer**

1.37.14 Sorting: GATE2006-14, ISRO2011-14 [top](#)

<http://gateoverflow.in/975>

Which one of the following in place sorting algorithms needs the minimum number of swaps?

- A. Quick sort
- B. Insertion sort
- C. Selection sort
- D. Heap sort

[gate2006](#) [algorithms](#) [sorting](#) [easy](#) [isro2011](#)

[Answer](#)

1.37.15 Sorting: GATE1998_1.22 [top](#)

<http://gateoverflow.in/1659>

Give the correct matching for the following pairs:

- | | |
|-------------------|--------------------|
| (A) $O(\log n)$ | (P) Selection |
| (B) $O(n)$ | (Q) Insertion sort |
| (C) $O(n \log n)$ | (R) Binary search |
| (D) $O(n^2)$ | (S) Merge sort |

- A. A-R B-P C-Q D-S
- B. A-R B-P C-S D-Q
- C. A-P B-R C-S D-Q
- D. A-P B-S C-R D-Q

[gate1998](#) [algorithms](#) [sorting](#) [easy](#)

[Answer](#)

1.37.16 Sorting: GATE2009-11 [top](#)

<http://gateoverflow.in/1303>

What is the number of swaps required to sort n elements using selection sort, in the worst case?

- A. $\Theta(n)$
- B. $\Theta(n \log n)$
- C. $\Theta(n^2)$
- D. $\Theta(n^2 \log n)$

[gate2009](#) [algorithms](#) [sorting](#) [easy](#)

[Answer](#)

1.37.17 Sorting: GATE1996_14 [top](#)

<http://gateoverflow.in/2766>

A two dimensional array $A[1..n][1..n]$ of integers is partially sorted if $\forall i, j \in [1..n - 1], A[i][j] < A[i][j + 1]$ and $A[i][j] < A[i + 1][j]$

Fill in the blanks:

- The smallest item in the array is at $A[i][j]$ where $i = \underline{\hspace{2cm}}$ and $j = \underline{\hspace{2cm}}$.
- The smallest item is deleted. Complete the following $O(n)$ procedure to insert item x (which is guaranteed to be smaller than any item in the last row or column) still keeping A partially sorted.

```

procedure insert (x: integer);
var i,j: integer;
begin
  i:=1; j:=1, A[i][j]:=x;
  while (x > _____ or x > _____) do
    if A[i+1][j] < A[i][j] then begin
      A[i][j]:=A[i+1][j]; i:=i+1;
    end
    else begin
      _____
    end
  A[i][j]:= _____
end

```

gate1996 | algorithms | sorting | normal

Answer

1.37.18 Sorting: GATE1996_2.15 [top](#)

<http://gateoverflow.in/2744>

Quick-sort is run on two inputs shown below to sort in ascending order

- i. $1, 2, 3, \dots, n$
- ii. $n, n-1, n-2, \dots, 2, 1$

Let C_1 and C_2 be the number of comparisons made for the inputs (i) and (ii) respectively. Then,

- A. $C_1 < C_2$
- B. $C_1 > C_2$
- C. $C_1 = C_2$
- D. we cannot say anything for arbitrary n

gate1996 | algorithms | sorting | normal

Answer

1.37.19 Sorting: GATE 2016-2-13 [top](#)

<http://gateoverflow.in/39561>

Assume that the algorithms considered here sort the input sequences in ascending order. If the input is already in the ascending order, which of the following are TRUE?

- I. Quicksort runs in $\Theta(n^2)$ time
- II. Bubblesort runs in $\Theta(n^2)$ time
- III. Mergesort runs in $\Theta(n)$ time
- IV. Insertion sort runs in $\Theta(n)$ time

- A. I and II only
- B. I and III only
- C. II and IV only
- D. I and IV only

gate2016-2 | algorithms | sorting | time-complexity | normal | ambiguous

Answer

1.37.20 Sorting: GATE1995_12 [top](#)

<http://gateoverflow.in/2648>

Consider the following sequence of numbers

92, 37, 52, 12, 11, 25

Use bubblesort to arrange the sequence in ascending order. Give the sequence at the end of each of the first five passes.

gate1995 | algorithms | sorting | easy

Answer

1.37.21 Sorting: GATE1995_1.5 top

<http://gateoverflow.in/2592>

Merge sort uses

- A. Divide and conquer strategy
- B. Backtracking approach
- C. Heuristic search
- D. Greedy approach

gate1995 | algorithms | sorting | easy

Answer

1.37.22 Sorting: GATE2003_22 top

<http://gateoverflow.in/912>

The unusual $\Theta(n^2)$ implementation of Insertion Sort to sort an array uses linear search to identify the position where an element is to be inserted into the already sorted part of the array. If, instead, we use binary search to identify the position, the worst case running time will

- A. remain $\Theta(n^2)$
- B. become $\Theta(n(\log n)^2)$
- C. become $\Theta(n \log n)$
- D. become $\Theta(n)$

gate2003 | algorithms | sorting | time-complexity | normal

Answer

1.37.23 Sorting: GATE1994-1.19, ISRO2016-31 top

<http://gateoverflow.in/2462>

Algorithm design technique used in quicksort algorithm is?

- A. Dynamic programming
- B. Backtracking
- C. Divide and conquer
- D. Greedy method

gate1994 | algorithms | sorting | easy | isro2016

Answer

1.37.24 Sorting: GATE 2016-1-13 top

<http://gateoverflow.in/39660>

The worst case running times of *Insertion sort*, *Merge sort* and *Quick sort*, respectively are:

- A. $\Theta(n \log n)$, $\Theta(n \log n)$ and $\Theta(n^2)$
- B. $\Theta(n^2)$, $\Theta(n^2)$ and $\Theta(n \log n)$
- C. $\Theta(n^2)$, $\Theta(n \log n)$ and $\Theta(n \log n)$

- D. $\Theta(n^2)$, $\Theta(n \log n)$ and $\Theta(n^2)$

gate2016-1 | algorithms | sorting | easy

[Answer](#)

1.37.25 Sorting: GATE2001-1.14 [top](#)

<http://gateoverflow.in/707>

Randomized quicksort is an extension of quicksort where the pivot is chosen randomly. What is the worst case complexity of sorting n numbers using Randomized quicksort?

- A. $O(n)$
- B. $O(n \log n)$
- C. $O(n^2)$
- D. $O(n!)$

gate2001 | algorithms | sorting | time-complexity | easy

[Answer](#)

1.37.26 Sorting: GATE2015-1_2 [top](#)

<http://gateoverflow.in/8017>

Which one of the following is the recurrence equation for the worst case time complexity of the quick sort algorithm for sorting n (≥ 2) numbers? In the recurrence equations given in the options below, c is a constant.

- A. $T(n) = 2 T(n/2) + cn$
- B. $T(n) = T(n - 1) + T(1) + cn$
- C. $T(n) = 2T(n - 1) + cn$
- D. $T(n) = T(n/2) + cn$

gate2015-1 | algorithms | recurrence | sorting | easy

[Answer](#)

1.37.27 Sorting: GATE2000-17 [top](#)

<http://gateoverflow.in/688>

An array contains four occurrences of 0, five occurrences of 1, and three occurrences of 2 in any order. The array is to be sorted using swap operations (elements that are swapped need to be adjacent).

- a. What is the minimum number of swaps needed to sort such an array in the worst case?
- b. Give an ordering of elements in the above array so that the minimum number of swaps needed to sort the array is maximum.

gate2000 | algorithms | sorting | normal

[Answer](#)

1.37.28 Sorting: GATE2007_14 [top](#)

<http://gateoverflow.in/1212>

Which of the following sorting algorithms has the lowest worse-case complexity?

- A. Merge sort
- B. Bubble sort
- C. Quick sort
- D. Selection sort

gate2007 | algorithms | sorting | time-complexity | easy

Answer**1.37.29 Sorting: GATE2009-39** [top](#)<http://gateoverflow.in/1325>

In quick-sort, for sorting n elements, the $(n/4)^{th}$ smallest element is selected as pivot using an $O(n)$ time algorithm. What is the worst case time complexity of the quick sort?

- A. $\Theta(n)$
- B. $\Theta(n \log n)$
- C. $\Theta(n^2)$
- D. $\Theta(n^2 \log n)$

[gate2009](#) [algorithms](#) [sorting](#) [normal](#)
Answer**1.37.30 Sorting: GATE2014-3_14** [top](#)<http://gateoverflow.in/2048>

You have an array of n elements. Suppose you implement quicksort by always choosing the central element of the array as the pivot. Then the tightest upper bound for the worst case performance is

- (A) $O(n^2)$
- (B) $O(n \log n)$
- (C) $\Theta(n \log n)$
- (D) $O(n^3)$

[gate2014-3](#) [algorithms](#) [sorting](#) [easy](#)
Answer**1.37.31 Sorting: GATE2014-2_38** [top](#)<http://gateoverflow.in/1997>

Suppose P, Q, R, S, T are sorted sequences having lengths 20, 24, 30, 35, 50 respectively. They are to be merged into a single sequence by merging together two sequences at a time. The number of comparisons that will be needed in the worst case by the optimal algorithm for doing this is ____.

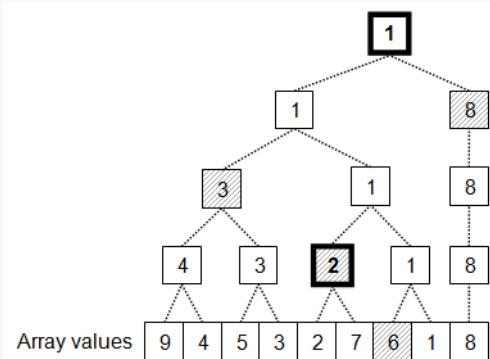
[gate2014-2](#) [algorithms](#) [sorting](#) [normal](#)
Answer**Answers: Sorting****1.37.1 Sorting: TIFR2011-B-31** [top](#)<http://gateoverflow.in/2067>

Selected Answer

Option c) $n + k - 2$

Here is a nice explanation of the algorithm: <http://www.codinghelmet.com/?path=exercises/two-smallest>

it is solution to the problem known for ages, and it has to do with tennis tournaments. The question was, knowing the outcome of the tennis tournament, how can we tell which player was the second best? The defeated finalist is a good candidate, but there are other players that were defeated directly by the tournament winner and any of them could also be a good candidate for the second best. So the solution to the problem is quite simple: Once the tournament finishes, pick up the $\log N$ competitors that were beaten by the tournament winner and hold a mini-tournament to find which one is the best among them. If we imagine that better players correspond with smaller numbers, the algorithm now goes like this. Hold the tournament to find the smallest number (requires $N-1$ comparisons). During this step, for each number construct the list of numbers it was smaller than. Finally, pick the list of numbers associated with the smallest number and find their minimum in $\log N-1$ steps. This algorithm requires $N+\log N-2$ comparisons to complete, but unfortunately it requires additional space proportional to N (each element except the winner will ultimately be added to someone's list); it also requires more time per step because of the relatively complex enlisting logic involved in each comparison. When this optimized algorithm is applied to example array, we get the following figure.



Tournament held among numbers promotes value 1 as the smallest number. That operation, performed on an array with nine numbers, requires exactly eight comparisons. While promoting the smallest number, this operation has also flagged four numbers that were removed from competition by direct comparison with the future winner: 6, 2, 3 and 8 in that order. Another sequence of three comparisons is required to promote number 2 as the second-smallest number in the array. This totals 11 comparisons, while naive algorithm requires 17 comparisons to come up with the same result.

All in all, this algorithm that minimizes number of comparisons looks to be good only for real tournaments, while number cracking algorithms should keep with the simple logic explained above. Implementation of simple algorithm may look like this:

```
a = array containing n elements
min1 = a[0] - candidate for the smallest value
min2 = a[1] - candidate for the second smallest value
if min2 < min1
    min1 = a[1]
    min2 = a[0]
for i = 2 to n - 1
    if a[i] < min1
        min2 = min1
        min1 = a[i]
    else if a[i] < min2
        min2 = a[i]
```

by Zoran Horvat [@zoranh75](#)

11 votes

-- Pragy Agarwal (14.4k points)

1.37.2 Sorting: GATE2014-1_14 [top](#)

<http://gateoverflow.in/1780>



Selected Answer

it would be $t_1 > t_2$, because the first case is the worst case of quicksort i.e. minimum number is chosen as pivot. Hence in the worst case the comparisons are high.

The splitting occurs as

- [1] [2345]
- [2] [345]
- [3] [45]
- [4] [5]

and

[123] [45]
 [1] [23] [4][5]
 [2] [3]

Number of recursive calls remain the same, but in second case the number of elements passed for the recursive call is less and hence the number of comparisons also less.

10 votes

-- Parul Agarwal (783 points)

1.37.3 Sorting: GATE2013_6 [top](#)

<http://gateoverflow.in/1415>



Selected Answer

In selection max you can do is n swaps..selecting the smallest element from all the elements and replacing it correct position so $O(n)$

6 votes

-- Bhagirathi Nayak (11.3k points)

1.37.4 Sorting: GATE1992_02,ix [top](#)

<http://gateoverflow.in/559>

Answer: D

Radix sort complexity is $O(wn)$ for n keys which are integers of word size w .

3 votes

-- Rajarshi Sarkar (29.7k points)

1.37.5 Sorting: GATE2006_52 [top](#)

<http://gateoverflow.in/1830>



Selected Answer

as we choose the pivot a median element ...so every time we are going to have good splits guranteed so the best case $O(nlogn)$

8 votes

-- Bhagirathi Nayak (11.3k points)

1.37.6 Sorting: TIFR2012-B-13 [top](#)

<http://gateoverflow.in/25207>



Selected Answer

Let Array element be {4,3,2,1,7,5,6,9,10,8} and K be 3 here no element is more than 3 distance away from its final position

So if we take

arr(1 to 6) and sort then surely first three element will be sorted in its final position {12345769108} $O(6log6)$
 then sort arr(3 to 9) then 3 to 6 will be sorted {12345679108} $O(6log6)$
 then at last arr(6 to 9) less than $O(6log6)$ {12345678910}

in general

Sort arr(0 to 2k)

Now we know that arr[0 to k] are in their final sorted positions
 and arr(k to 2k) may be not sorted.

Sort arr(k to 3k)

Now we know that arr[k to 2k] are in their final sorted positions
 and arr(2k to 3k) may be not sorted.

.

.

.

.

sort till arr(ik..N)
in final sorting there will be less than 2k element.

in each step it will take $O(2k\log 2k)$
and there will $\frac{n}{k}$ steps so $O(n\log k)$
option D.

6 votes

-- Umang Raman (11.3k points)

1.37.7 Sorting: GATE2012_39 [top](#)



Selected Answer

i thought like this:

you are given the first character of each n strings to sort it will take $O(n\log n)$ time..in the worst case we may have to do the above process 2 times,3 times,.....,n times so $n*O(n\log n)=O(n^2 \log n)$ please correct me if my approach is wrong...

9 votes

-- Bhagirathi Nayak (11.3k points)

1.37.8 Sorting: GATE1991_01,vii [top](#)



Selected Answer

Answer: 7

Minimum number of comparisons = $\lceil \log(n!) \rceil = \lceil \log(5!) \rceil = \lceil \log(120) \rceil = 7$.

Ref: http://en.wikipedia.org/wiki/Comparison_sort#Number_of_comparisons_required_to_sort_a_list

6 votes

-- Rajarshi Sarkar (29.7k points)

1.37.9 Sorting: TIFR2011-B-39 [top](#)



Selected Answer

d)
 $O(\log n)$ comparisons suffice.

Since it is possible that $m \gg n$, we need to restrict ourselves to the first $O(n)$ elements to perform the binary search.

We start with the first element (index $i = 1$), and check if it is equal to 0. If not, we double the value of i , and check again. We repeat this process until we hit a 0.

```
i = 1;
while(arr[i] != 0)
    i *= 2;
```

Once we hit a 0, the largest possible value (worst case) of i can be $2n - 2$. This will happen if $n = 2^k + 1$ for some k . Then, our 2nd last value of i will be 2^k , and then we get 2^{k+1} , which is equal to $2n - 2$.

Now that we've hit a 0, and the array contains positive numbers in decreasing order, if x is present in L , it must be in the first i elements.

We can binary search the first i elements in $O(\log i)$ comparisons.

Since the largest possible value of $i = 2n - 2$, our algorithm takes $O(\log(2n - 2)) = O(\log n)$ comparisons.

4 votes

-- Pragy Agarwal (14.4k points)

1.37.10 Sorting: GATE1991_13 [top](#)<http://gateoverflow.in/540>

use a hash map with chaining to sort all the numbers in $\mathcal{O}(n)$ time and constant space.

2 votes

-- Amar Vashishth (20.7k points)

1.37.11 Sorting: TIFR2010-B-23 [top](#)<http://gateoverflow.in/18623>

well it is given that we have to follow the same procedure as stated . so i think it will be option b not better than $O(n^2)$.

for first n comparision in worst case then $(n-1)$ thn $(n-2)$ till it becomes 1.

so $1+2 \dots + (n-2) + (n-1) + n = n(n+1)/2$

$O(n^2)$.

1 votes

-- Ravi Singh (8.2k points)

Answer should be (D) same as Heap Sort, the details what they have mentioned in the question points out the heap-sort procedure, every time we remove max element and then find next max element to be removed and so on..

1 votes

-- Vijay Thakur (1.5k points)

1.37.12 Sorting: GATE1999_1.12 [top](#)<http://gateoverflow.in/1465>

Selected Answer

(b) If it maintains the relative order of occurrence of non-distinct elements.

(from definition of stable sorting)

5 votes

-- Arjun Suresh (150k points)

1.37.13 Sorting: GATE1999-1.14, ISRO2015-42 [top](#)<http://gateoverflow.in/1467>

Selected Answer

```

20 47 15 8 9 4 40 30 12 17
\ / \ / \ / / \ / / \ / after 1st pass
20 47 8 15 4 9 30 40 12 17
\ / \ / \ / / \ / / \ / after 2nd pass
8,15,20,47   4,9, 30,40   12,17

```

Ans. B

21 votes

-- Vikrant Singh (11k points)

1.37.14 Sorting: GATE2006-14, ISRO2011-14 [top](#)<http://gateoverflow.in/975>

Selected Answer

(C) Selection sort

5 votes

-- Keith Kr (6k points)

1.37.15 Sorting: GATE1998_1.22 [top](#)<http://gateoverflow.in/1659>

Selected Answer

selection sort $O(n^2)$ merge sort $O(n \log n)$ binary search ($\log n$)insertion sort $O(n)$ note if you use $O(n^2)$ here you will not be left with any choice to fill selection sort

6 votes

-- Bhagirathi Nayak (11.3k points)

1.37.16 Sorting: GATE2009-11 [top](#)<http://gateoverflow.in/1303>

Selected Answer

The answer is A.

we have 1 swap in each loop and hence n swaps at max for 1 to n. Therefore the worst case number of swaps is $\Theta(n)$

8 votes

-- Gate Keeda (17.7k points)

1.37.17 Sorting: GATE1996_14 [top](#)<http://gateoverflow.in/2766>

Selected Answer

(a). $i=1$ and $j=1$ (smallest item in the array)
 (b). here in while loop ($x > A[i+1][j]$ or $x > A[i][j+1]$)
 $A[i][j]:=A[i+1][j]; i:=i+1;$
 else begin
 $A[i][j]:=A[i][j+1]; j=j+1;$
 end
 $A[i][j]:=x;$

6 votes

-- munna kumar (329 points)

1.37.18 Sorting: GATE1996_2.15 [top](#)<http://gateoverflow.in/2744>

Selected Answer

C.

both are the worst cases of quick sort.

i) is sorted in ascending order.

ii) is sorted in descending order.

8 votes

-- Gate Keeda (17.7k points)

1.37.19 Sorting: GATE 2016-2-13 [top](#)

<http://gateoverflow.in/39561>



Selected Answer

$Q = Q$ can be used instead of Theta

I) Quicksort takes $Q(N^2)$ in case of already sorted input. This is true

II) This is false. If no swap happens then bubble sort can stop in single loop. $Q(N)$ is best case. This is false !

iii) Mergesort never takes more than $Q(N \log N)$ This is false

IV) This is true. Insertion sort will finish in $Q(N)$ time in case of sorted input.

Answer D) I and IV

Proof Bubble sort has best case $O(N) \Rightarrow$

Ref -> https://en.wikipedia.org/wiki/Bubble_sort, Aduni lecture

Following Photo from Art of Computer Programming , Sorting and Searching (Volume 3)

five more elements are known to be in final position as a result of Pass 4. On the final pass, no exchanges are performed at all. With these observations we are ready to formulate the algorithm.

Algorithm B (Bubble sort). Records R_1, \dots, R_N are rearranged in place; after sorting is complete their keys will be in order, $K_1 \leq \dots \leq K_N$.

B1. [Initialize BOUND.] Set $\text{BOUND} \leftarrow N$. (BOUND is the highest index for which the record is not known to be in its final position; thus we are indicating that nothing is known at this point.)

B2. [Loop on j .] Set $t \leftarrow 0$. Perform step B3 for $j = 1, 2, \dots, \text{BOUND} - 1$, and then go to step B4. (If $\text{BOUND} = 1$, this means go directly to B4.)

B3. [Compare/exchange $R_j : R_{j+1}$.] If $K_j > K_{j+1}$, interchange $R_j \leftrightarrow R_{j+1}$ and set $t \leftarrow j$.

B4. [Any exchanges?] If $t = 0$, terminate the algorithm. Otherwise set $\text{BOUND} \leftarrow t$ and return to step B2. ■

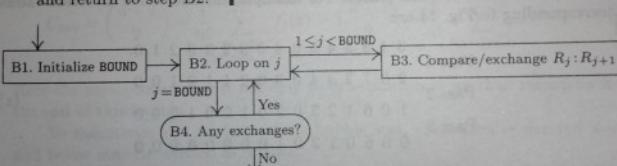


Fig. 15. Flow chart for bubble sorting.

Program B (Bubble sort). As in previous MIX programs of this chapter, we assume that the items to be sorted are in locations INPUT+1 through INPUT+N.

Now quicksort taking $O(N)$ can happen in some cases but not all cases, so that is why I) should be considered true. Whereas Bubble sort time complexity in best case is always $O(N)$. So D is any time stronger answer than C

14 votes

-- Akash (31.7k points)

1.37.20 Sorting: GATE1995_12 [top](#)

<http://gateoverflow.in/2648>



Selected Answer

1st Pass: 37 52 12 11 25 92

2nd Pass: 37 12 11 25 52 92

3rd Pass: 12 11 25 37 52 92

4th Pass: 11 12 25 37 52 92

5th Pass: 11 12 25 37 52 92

8 votes

-- Gate Keeda (17.7k points)

1.37.21 Sorting: GATE1995_1.5 [top](#)



Selected Answer

It is A.

One of the best examples of Divide and conquer strategy.

9 votes

-- Gate Keeda (17.7k points)

1.37.22 Sorting: GATE2003_22 [top](#)



Selected Answer

In insertion sort, with linear search, it takes

(worst case) n comparisons for searching the right position, and n swaps to make room to place the element.

Hence for n elements, a total of $n \times (n + n)$; n for search and n for swaps.

$$= \Theta(2n^2) = \Theta(n^2)$$

If we replace it with binary search, it takes

(worst case)

$\log n$ comparisons for searching the right position, and n swaps to make room to place the element.

Hence for n elements, a total of

$$n \times (\log n + n);$$

n for search and

n for swaps.

$$= \Theta(n \times \log n + n^2) = \Theta(n^2)$$

Hence **answer is A**

7 votes

-- ryan sequeira (1.6k points)

1.37.23 Sorting: GATE1994-1.19, ISRO2016-31 [top](#)



Selected Answer

C. it is one of the efficient algorithms in Divide and Conquer strategy.

10 votes

-- Gate Keeda (17.7k points)

1.37.24 Sorting: GATE 2016-1-13 [top](#)<http://gateoverflow.in/39660>

Selected Answer

Answer is D..

15 votes

-- Abhilash Panicker (7k points)

1.37.25 Sorting: GATE2001-1.14 [top](#)<http://gateoverflow.in/707>

Selected Answer

In worst case, we may pick pivot elements in the increasing order (input also given in sorted order) which will result in running time of $O(n^2)$

Both the deterministic and randomized quicksort algorithms have the same best-case running times of $O(n\lg n)$ and the same worst-case running times of $O(n^2)$. The difference is that with the deterministic algorithm, a particular input can elicit that worst-case behavior.

The reason it matters is that, depending on how partitioning is implemented, an input that is already sorted--or almost sorted--can elicit the worst-case behavior in deterministic quicksort.

source: Thomas Cormen

Ans. C

14 votes

-- Vikrant Singh (11k points)

1.37.26 Sorting: GATE2015-1_2 [top](#)<http://gateoverflow.in/8017>

Selected Answer

B.

Worst case for quick sort happens when 1 element is on one list and $n-1$ elements on another list.

13 votes

-- Arjun Suresh (150k points)

1.37.27 Sorting: GATE2000-17 [top](#)<http://gateoverflow.in/688>

Selected Answer

Since swaps are needed to be of adjacent elements only, the algorithm is actually Bubble sort.

In bubble sort, all smaller elements to right of an element are required to be swapped. So if have ordering

$[2, 2, 2, 1, 1, 1, 1, 0, 0, 0, 0]$, then we need total 47 swaps, and this will be the worst case.

so it answers actually both parts.

10 votes

-- Happy Mittal (9.5k points)

1.37.28 Sorting: GATE2007_14 [top](#)<http://gateoverflow.in/1212>

Selected Answer

A.

Irrespective of the input, Merge sort always have a time complexity of $\Theta(n \log n)$.

7 votes

-- Gate Keeda (17.7k points)

1.37.29 Sorting: GATE2009-39 [top](#)

<http://gateoverflow.in/1325>



Selected Answer

B.

$T(n) = O(n)$ pivot selection time + $T(n/4 - 1) + T(3n/4)$

which'll give $\Theta(n \log n)$.

Pivot selection complexity is given in questions. Pivot being the $(n/4)$ th smallest element, once it is found, we have two sub arrays- one of size $(n/4 - 1)$ and other of size $(3n/4)$ and for both of these we solve recursively.

13 votes

-- Gate Keeda (17.7k points)

1.37.30 Sorting: GATE2014-3_14 [top](#)

<http://gateoverflow.in/2048>



Selected Answer

(A) $O(n^2)$ is the answer. When we choose the first element as the pivot, the worst case of quick sort comes if the input is sorted- either in ascending or descending order. Now, when we choose the middle element as pivot, sorted input no longer gives worst case behaviour. But, there will be some permutation of the input numbers which will be giving the same worst case behaviour. For example,

1 2 3 4 5 6 7

This array gives worst case behaviour for quick sort when the first element is pivot.

6 4 2 1 3 5 7

This array gives the worst case behaviour of $O(n^2)$ if we take middle element as the pivot- each split will be 1 element on one side and $n-1$ elements on other side. Similarly, for any input, we can have a permutation where the behaviour is like this. So, whichever element we take as pivot it gives worst case complexity of $O(n^2)$ as long as pivot is from a fixed position (not random position as in randomized quick sort).

15 votes

-- Arjun Suresh (150k points)

1.37.31 Sorting: GATE2014-2_38 [top](#)

<http://gateoverflow.in/1997>



Selected Answer

The optimal algorithm always chooses the smallest sequences for merging.

20 24 -44, 43 comparisons

30 35 -65, 64 comparisons

44 50 -94, 93 comparisons

65 94 -159, 158 comparisons

so, totally $43 + 64 + 93 + 158 = 358$ comparisons.

21 votes

-- Arjun Suresh (150k points)

1.38

Space Complexity [top](#)1.38.1 Space Complexity: GATE2005_81 [top](#)<http://gateoverflow.in/1403>

```
double foo(int n)
{
    int i;
    double sum;
    if(n == 0)
    {
        return 1.0;
    }
    else
    {
        sum = 0.0;
        for(i = 0; i < n; i++)
        {
            sum += foo(i);
        }
        return sum;
    }
}
```

(A) The space complexity of the above code is?

- (a) $O(1)$ (b) $O(n)$ (c) $O(n!)$ (d) n^n

(b) Suppose we modify the above function `foo()` and stores the value of `foo(i)` $0 \leq i < n$, as and when they are computed. With this modification the time complexity for function `foo()` is significantly reduced. The space complexity of the modified function would be:

- (a) $O(1)$ (b) $O(n)$ (c) $O(n^2)$ (d) $n!$

[gate2005](#) [algorithms](#) [space-complexity](#) [normal](#)

Answer

Answers: Space Complexity

1.38.1 Space Complexity: GATE2005_81 [top](#)<http://gateoverflow.in/1403>

Selected Answer

A. The code here is storing only local variables. So, the space complexity will be the recursion depth- maximum happening for the last iteration of the for loop- `foo(n-1)` - `foo(n-2)` - - `foo(0)` all live giving space complexity $O(n)$.

B. To store the n values we need space complexity $O(n)$. So, the space complexity won't change and will be $O(n)$.

13 votes

-- Arjun Suresh (150k points)

1.39

Spanning Tree [top](#)1.39.1 Spanning Tree: TIFR2014-B-5 [top](#)<http://gateoverflow.in/27180>

Let $G = (V, E)$ be an undirected connected simple (i.e., no parallel edges or self-loops) graph with the weight function $w : E \rightarrow \mathbb{R}$ on its edge set. Let $w(e_1) < w(e_2) < \dots < w(e_m)$, where $E = \{e_1, e_2, \dots, e_m\}$. Suppose T is a minimum spanning tree of G . Which of the following statements is FALSE?

- a. The tree T has to contain the edge e_1 .

- b. The tree T has to contain the edge e_2 .
- c. The minimum weight edge incident on each vertex has to be present in T .
- d. T is the unique minimum spanning tree in G .
- e. If we replace each edge weight $w_i = w(e_i)$ by its square w_i^2 , then T must still be a minimum spanning tree of this new instance.

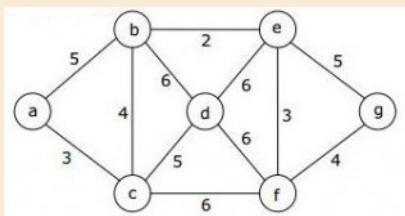
[tifr2014](#) [algorithms](#) [spanning-tree](#)

Answer

1.39.2 Spanning Tree: GATE2009-38 [top](#)

<http://gateoverflow.in/1324>

Consider the following graph:



Which one of the following is NOT the sequence of edges added to the minimum spanning tree using Kruskal's algorithm?

- A. (b, e) (e, f) (a, c) (b, c) (f, g) (c, d)
- B. (b, e) (e, f) (a, c) (f, g) (b, c) (c, d)
- C. (b, e) (a, c) (e, f) (b, c) (f, g) (c, d)
- D. (b, e) (e, f) (b, c) (a, c) (f, g) (c, d)

[gate2009](#) [algorithms](#) [spanning-tree](#) [normal](#)

Answer

1.39.3 Spanning Tree: GATE2005_6 [top](#)

<http://gateoverflow.in/1348>

An undirected graph G has n nodes. Its adjacency matrix is given by an $n \times n$ square matrix whose (i) diagonal elements are 0's and (ii) non-diagonal elements are 1's. Which one of the following is TRUE?

- A. Graph G has no minimum spanning tree (MST)
- B. Graph G has unique MST of cost $n - 1$
- C. Graph G has multiple distinct MSTs, each of cost $n - 1$
- D. Graph G has multiple spanning trees of different costs

[gate2005](#) [algorithms](#) [spanning-tree](#) [normal](#)

Answer

1.39.4 Spanning Tree: GATE2007_49 [top](#)

<http://gateoverflow.in/1247>

Let w be the minimum weight among all edge weights in an undirected connected graph. Let e be a specific edge of weight w . Which of the following is FALSE?

- A. There is a minimum spanning tree containing e

- B. If e is not in a minimum spanning tree T , then in the cycle formed by adding e to T , all edges have the same weight.
 C. Every minimum spanning tree has an edge of weight w
 D. e is present in every minimum spanning tree

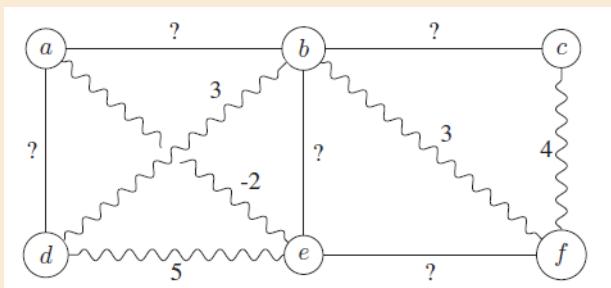
gate2007 | algorithms | spanning-tree | normal

Answer

1.39.5 Spanning Tree: TIFR2014-B-4 [top](#)

<http://gateoverflow.in/27174>

Consider the following undirected graph with some edge costs missing.



Suppose the wavy edges form a Minimum Cost Spanning Tree for G . Then, which of the following inequalities NEED NOT hold?

- $\text{cost}(a, b) \geq 6$.
- $\text{cost}(b, e) \geq 5$.
- $\text{cost}(e, f) \geq 5$.
- $\text{cost}(a, d) \geq 4$.
- $\text{cost}(b, c) \geq 4$.

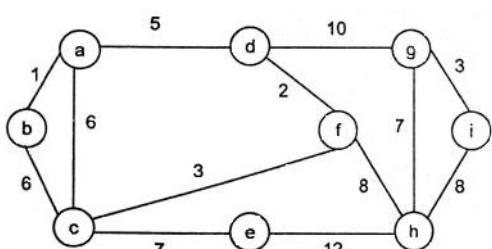
tifr2014 | algorithms | graph-algorithms | spanning-tree

Answer

1.39.6 Spanning Tree: GATE2008-IT_45 [top](#)

<http://gateoverflow.in/335>

For the undirected, weighted graph given below, which of the following sequences of edges represents a correct execution of Prim's algorithm to construct a Minimum Spanning Tree?



Ctrl

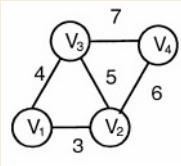
- (a, b), (d, f), (f, c), (g, i), (d, a), (g, h), (c, e), (f, h)
- (c, e), (c, f), (f, d), (d, a), (a, b), (g, h), (h, f), (g, i)
- (d, f), (f, c), (d, a), (a, b), (c, e), (f, h), (g, h), (g, i)
- (h, g), (g, i), (h, f), (f, c), (f, d), (d, a), (a, b), (c, e)

[gate2008-it](#) [algorithms](#) [graph-algorithms](#) [spanning-tree](#) [normal](#)
Answer

1.39.7 Spanning Tree: GATE2011-55 [top](#)

<http://gateoverflow.in/43325>

An undirected graph $G(V, E)$ contains n ($n > 2$) nodes named v_1, v_2, \dots, v_n . Two nodes v_i, v_j are connected if and only if $0 < |i - j| \leq 2$. Each edge (v_i, v_j) is assigned a weight $i + j$. A sample graph with $n = 4$ is shown below.



The length of the path from v_5 to v_6 in the MST of previous question with $n = 10$ is

- A. 11
- B. 25
- C. 31
- D. 41

[gate2011](#) [algorithms](#) [graph-algorithms](#) [spanning-tree](#) [normal](#)
Answer

1.39.8 Spanning Tree: GATE1997_9 [top](#)

<http://gateoverflow.in/2269>

Consider a graph whose vertices are points in the plane with integer co-ordinates (x, y) such that $1 \leq x \leq n$ and $1 \leq y \leq n$, where $n \geq 2$ is an integer. Two vertices (x_1, y_1) and (x_2, y_2) are adjacent iff $|x_1 - x_2| \leq 1$ and $|y_1 - y_2| \leq 1$. The weight of an edge $\{(x_1, y_1), (x_2, y_2)\}$ is $\sqrt{(x_1 - x_2)^2 + (y_1 - y_2)^2}$

- a. What is the weight of a minimum weight-spanning tree in this graph? Write only the answer without any explanations.
- b. What is the weight of a maximum weight-spanning tree in this graph? Write only the answer without any explanations.

[gate1997](#) [algorithms](#) [spanning-tree](#) [normal](#)
Answer

1.39.9 Spanning Tree: GATE2006_11 [top](#)

<http://gateoverflow.in/890>

Consider a weighted complete graph G on the vertex set $\{v_1, v_2, \dots, v_n\}$ such that the weight of the edge (v_i, v_j) is $2|i - j|$. The weight of a minimum spanning tree of G is:

- (A) $n - 1$
- (B) $2n - 3$
- (C) $\binom{n}{2}$
- (D) n^2

[gate2006](#) [algorithms](#) [spanning-tree](#) [normal](#)
[Answer](#)

1.39.10 Spanning Tree: GATE1996_16 [top](#)

<http://gateoverflow.in/2768>

A complete, undirected, weighted graph G is given on the vertex $\{0, 1, \dots, n - 1\}$ for any fixed 'n'. Draw the minimum spanning tree of G if

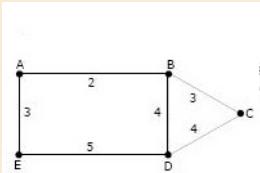
- the weight of the edge (u, v) is $|u - v|$
- the weight of the edge (u, v) is $u + v$

[gate1996](#) [algorithms](#) [graph-algorithms](#) [spanning-tree](#) [normal](#)
[Answer](#)

1.39.11 Spanning Tree: GATE1995_22 [top](#)

<http://gateoverflow.in/2660>

How many minimum spanning trees does the following graph have? Draw them. (Weights are assigned to edges).


[gate1995](#) [algorithms](#) [graph-algorithms](#) [spanning-tree](#) [easy](#)
[Answer](#)

1.39.12 Spanning Tree: GATE2012_29 [top](#)

<http://gateoverflow.in/786>

Let G be a weighted graph with edge weights greater than one and G' be the graph constructed by squaring the weights of edges in G . Let T and T' be the minimum spanning trees of G and G' , respectively, with total weights t and t' . Which of the following statements is **TRUE**?

- (A) $T' = T$ with total weight $t' = t^2$
- (B) $T' = T$ with total weight $t' < t^2$
- (C) $T' \neq T$ but total weight $t' = t^2$
- (D) None of the above

[gate2012](#) [algorithms](#) [spanning-tree](#) [normal](#) [marks-to-all](#)
[Answer](#)

1.39.13 Spanning Tree: GATE2001-15 [top](#)

<http://gateoverflow.in/756>

Consider a weighted undirected graph with vertex set $V = \{n_1, n_2, n_3, n_4, n_5, n_6\}$ and edge set $E = \{(n_1, n_2, 2), (n_1, n_3, 8), (n_1, n_6, 3), (n_2, n_4, 4), (n_2, n_5, 12), (n_3, n_4, 7), (n_4, n_5, 9), (n_4, n_6, 4)\}$. The third value in each tuple represents the weight of the edge specified in the tuple.

- List the edges of a minimum spanning tree of the graph.
- How many distinct minimum spanning trees does this graph have?
- Is the minimum among the edge weights of a minimum spanning tree unique over all possible minimum spanning trees of a graph?
- Is the maximum among the edge weights of a minimum spanning tree unique over all possible minimum spanning tree of a graph?

[gate2001](#) [algorithms](#) [spanning-tree](#) [normal](#)
Answer**1.39.14 Spanning Tree: GATE2005-IT_52** [top](#)<http://gateoverflow.in/3813>

Let G be a weighted undirected graph and e be an edge with maximum weight in G . Suppose there is a minimum weight spanning tree in G containing the edge e . Which of the following statements is always TRUE?

- A) There exists a cutset in G having all edges of maximum weight.
- B) There exists a cycle in G having all edges of maximum weight.
- C) Edge e cannot be contained in a cycle.
- D) All edges in G have the same weight.

[gate2005-it](#) [algorithms](#) [spanning-tree](#) [normal](#)
Answer**1.39.15 Spanning Tree: GATE2010-50** [top](#)<http://gateoverflow.in/2355>

Consider a complete undirected graph with vertex set $\{0, 1, 2, 3, 4\}$. Entry W_{ij} in the matrix

W below is the weight of the edge $\{i, j\}$

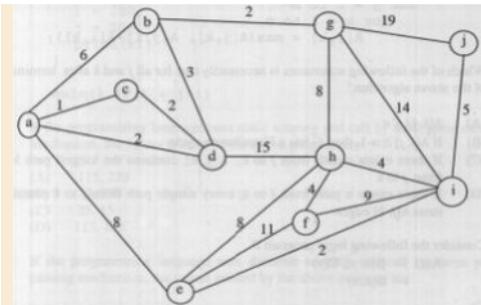
$$W = \begin{pmatrix} 0 & 1 & 8 & 1 & 4 \\ 1 & 0 & 12 & 4 & 9 \\ 8 & 12 & 0 & 7 & 3 \\ 1 & 4 & 7 & 0 & 2 \\ 4 & 9 & 3 & 2 & 0 \end{pmatrix}$$

What is the minimum possible weight of a spanning tree T in this graph such that vertex 0 is a leaf node in the tree T ?

- A. 7
- B. 8
- C. 9
- D. 10

[gate2010](#) [algorithms](#) [spanning-tree](#) [normal](#)
Answer**1.39.16 Spanning Tree: GATE2003_68** [top](#)<http://gateoverflow.in/955>

What is the weight of a minimum spanning tree of the following graph?



- A. 29
B. 31
C. 38
D. 41

gate2003 | algorithms | spanning-tree | normal

Answer

1.39.17 Spanning Tree: GATE2000-2.18 [top](#)

<http://gateoverflow.in/665>

Let G be an undirected connected graph with distinct edge weights. Let e_{max} be the edge with maximum weight and e_{min} the edge with minimum weight. Which of the following statements is false?

- A. Every minimum spanning tree of G must contain e_{min}
 B. If e_{max} is in a minimum spanning tree, then its removal must disconnect G
 C. No minimum spanning tree contains e_{max}
 D. G has a unique minimum spanning tree

gate2000 | algorithms | spanning-tree | normal

Answer

1.39.18 Spanning Tree: TIFR2011-B-35 [top](#)

<http://gateoverflow.in/20842>

Let G be a connected simple graph (no self-loops or parallel edges) on $n \geq 3$ vertices, with distinct edge weights. Let e_1, e_2, \dots, e_m be an ordering of the edges in decreasing order of weight. Which of the following statements is FALSE?

- a. The edge e_1 has to be present in every maximum weight spanning tree.
 b. Both e_1 and e_2 have to be present in every maximum weight spanning tree.
 c. The edge e_m has to be present in every minimum weight spanning tree.
 d. The edge e_m is never present in any maximum weight spanning tree.
 e. G has a unique maximum weight spanning tree.

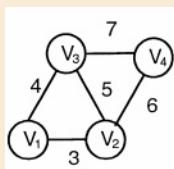
tifr2011 | algorithms | graph-algorithms | spanning-tree

Answer

1.39.19 Spanning Tree: GATE2011-54 [top](#)

<http://gateoverflow.in/2162>

An undirected graph $G(V, E)$ contains n ($n > 2$) nodes named v_1, v_2, \dots, v_n . Two nodes v_i, v_j are connected if and only if $0 < |i - j| \leq 2$. Each edge (v_i, v_j) is assigned a weight $i + j$. A sample graph with $n = 4$ is shown below.



What will be the cost of the minimum spanning tree (MST) of such a graph with n nodes?

- A. $\frac{1}{12}(11n^2 - 5n)$
- B. $n^2 - n + 1$
- C. $6n - 11$
- D. $2n + 1$

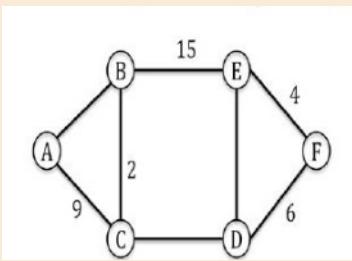
[gate2011](#) [algorithms](#) [graph-algorithms](#) [spanning-tree](#) [normal](#)

[Answer](#)

1.39.20 Spanning Tree: GATE2015-1_43 [top](#)

<http://gateoverflow.in/8313>

The graph shown below has 8 edges with distinct integer edge weights. The minimum spanning tree (MST) is of weight 36 and contains the edges: $\{(A, C), (B, C), (B, E), (E, F), (D, F)\}$. The edge weights of only those edges which are in the MST are given in the figure shown below. The minimum possible sum of weights of all 8 edges of this graph is _____.



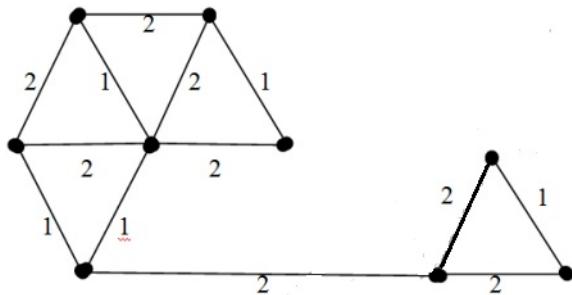
[gate2015-1](#) [algorithms](#) [spanning-tree](#) [normal](#)

[Answer](#)

1.39.21 Spanning Tree: GATE2014-2_52 [top](#)

<http://gateoverflow.in/2019>

The number of distinct minimum spanning trees for the weighted graph below is _____



[gate2014-2](#) [algorithms](#) [spanning-tree](#) [numerical-answers](#) [normal](#)

[Answer](#)

1.39.22 Spanning Tree: GATE2015-3_40 [top](#)

<http://gateoverflow.in/8499>

Let G be a connected undirected graph of 100 vertices and 300 edges. The weight of a minimum spanning tree of G is 500. When the weight of each edge of G is increased by five, the weight of a minimum spanning tree becomes _____.

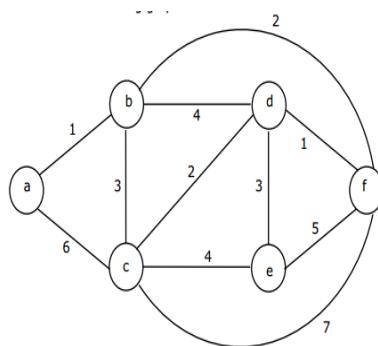
[gate2015-3](#) [algorithms](#) [spanning-tree](#) [easy](#) [numerical-answers](#)

[Answer](#)

1.39.23 Spanning Tree: GATE2006_47 [top](#)

<http://gateoverflow.in/1823>

Consider the following graph:



Which one of the following cannot be the sequence of edges added, **in that order**, to a minimum spanning tree using Kruskal's algorithm?

- (A) $(a - b), (d - f), (b - f), (d - c), (d - e)$
- (B) $(a - b), (d - f), (d - c), (b - f), (d - e)$
- (C) $(d - f), (a - b), (d - c), (b - f), (d - e)$
- (D) $(d - f), (a - b), (b - f), (d - e), (d - c)$

[gate2006](#) [algorithms](#) [graph-algorithms](#) [spanning-tree](#) [normal](#)

Answer

1.39.24 Spanning Tree: GATE2010-51 [top](#)

<http://gateoverflow.in/43328>

Consider a complete undirected graph with vertex set $\{0, 1, 2, 3, 4\}$. Entry W_{ij} in the matrix W below is the weight of the edge $\{i, j\}$

$$W = \begin{pmatrix} 0 & 1 & 8 & 1 & 4 \\ 1 & 0 & 12 & 4 & 9 \\ 8 & 12 & 0 & 7 & 3 \\ 1 & 4 & 7 & 0 & 2 \\ 4 & 9 & 3 & 2 & 0 \end{pmatrix}$$

What is the minimum possible weight of a path P from vertex 1 to vertex 2 in this graph such that P contains at most 3 edges?

- A. 7
- B. 8
- C. 9
- D. 10

[gate2010](#) [normal](#) [algorithms](#) [spanning-tree](#)

Answer

1.39.25 Spanning Tree: GATE1992_01,ix [top](#)

<http://gateoverflow.in/549>

Complexity of Kruskal's algorithm for finding the minimum spanning tree of an undirected graph containing n vertices and m edges if the edges are sorted is _____

[gate1992](#) [spanning-tree](#) [algorithms](#) [time-complexity](#) [easy](#)

Answer

1.39.26 Spanning Tree: GATE1991_03,vi [top](#)

<http://gateoverflow.in/521>

Choose the correct alternatives (more than one may be correct) and write the corresponding letters only:

Kruskal's algorithm for finding a minimum spanning tree of a weighted graph G with n vertices and m edges has the time complexity of:

- (a). $O(n^2)$
- (b). $O(mn)$
- (c). $O(m + n)$
- (d). $O(m \log n)$
- (e). $O(m^2)$

gate1991 | algorithms | spanning-tree | easy

[Answer](#)

Answers: Spanning Tree

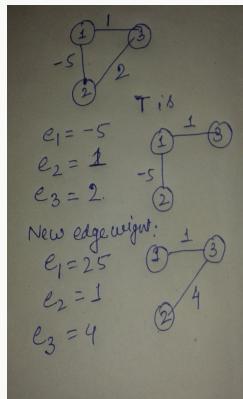
1.39.1 Spanning Tree: TIFR2014-B-5 [top](#)

<http://gateoverflow.in/27180>



Selected Answer

Answer is E . The catch here is Edges weights belongs to real number . Therefore edge weight can be negative . In that case the minimum spanning tree may be different .



4 votes

-- Riya Roy(Arayana) (5.6k points)

1.39.2 Spanning Tree: GATE2009-38 [top](#)

<http://gateoverflow.in/1348>



Selected Answer

in option d b-c with weight 4 is added before a-c with weight 3 is added. In kruskal's algorithm edges should be added in non decreasing order of weight

So option D may be correct

7 votes

-- Sankaranarayanan P.N (9.8k points)

1.39.3 Spanning Tree: GATE2005_6 [top](#)

<http://gateoverflow.in/1348>



Selected Answer

Graph G has multiple distinct MSTs, each of cost $n - 1$

From the given data given graph is a complete graph with all edge weights 1. A MST will contain $n - 1$ edges . Hence weight of MST is $n - 1$.

The graph will have multiple MST. In fact all spanning trees of the given graph will be MSTs also since all edge weights are equal.

7 votes

-- Sankaranarayanan P.N (9.8k points)

1.39.4 Spanning Tree: GATE2007_49 top

<http://gateoverflow.in/1247>



Selected Answer

D is the false statement.

A minimum spanning tree must have the edge with the smallest weight (In Kruskal's algorithm we start from the smallest weight edge). So, C is TRUE.

If e is not part of a minimum spanning tree, then all edges which are part of a cycle with e, must have weight $\leq e$, as otherwise we can interchange that edge with e and get another minimum spanning tree of lower weight. So, B and A are also TRUE.

6 votes

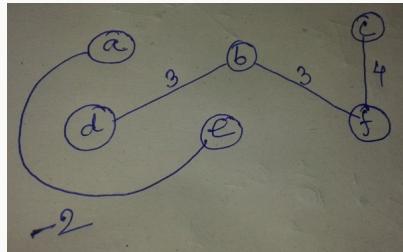
-- Arjun Suresh (150k points)

1.39.5 Spanning Tree: TIFR2014-B-4 top

<http://gateoverflow.in/27174>



Selected Answer



Now check this diagram, this is forest obtained from above given graph using Kruskal's algorithm for MST.

So according to the question edge $d - e$ has weight 5 and it is included in the formation of MST. Now if edges $b - e$ and $e - f$ has weight greater than 5 than it is not a problem for our MST because still we will get the given tree as Kruskal's algorithm takes the smallest weighted edge without forming a cycle.

Cost of edge $b - c \geq 4$ may also lead us to the same tree as above though Kruskal's algorithm will have choice between $c - f$ and $b - c$.

Now if the edge weight of $a - d$ becomes 4, it is guaranteed that Kruskal's algorithm will not select edge $d - e$ because its edge cost is 5, and hence the tree structure will change. But there can be the case where edge weight is greater than 4 and we still get the same tree (happens when $a - d \geq 5$). Because in the question they asked to point out an unnecessary condition this case is not the answer as we need $a - d \geq 5$ which implies $a - d \geq 4$.

Now notice option A. Put $a - b = 5$. The given MST would not change. So, this condition is not always necessary and hence is the answer..

Therefore option A is the answer .

5 votes

-- Riya Roy(Arayana) (5.6k points)

1.39.6 Spanning Tree: GATE2008-IT_45 top

<http://gateoverflow.in/3355>



Selected Answer

Prim's algorithm starts with from any vertex and expands the MST by adding one vertex in each step which is close to the Intermediate MST(made till previous step).

Therefore correct answer would be (C).

(A): (d,f) is chosen but neither d nor f vertices are part of the previous MST(MST made till previous step).

(B): (g,h) is chosen but neither g or h vertices are part of the previous MST(MST made till previous step).

(D): (f,c) is chosen but at that point (f,d) is close to the intermediate MST.

7 votes

-- suraj (3.7k points)

1.39.7 Spanning Tree: GATE2011-55 [top](#)

<http://gateoverflow.in/43325>



Selected Answer

There is no direct edge between V_i and V_{i+1} vertex in mst except V_1 to V_2 so path from V_i and V_{i+1} includes all edges from v_1 to V_{i+1} which are in mst:

edge weights in mst:

$$=3 + 4 + 6 + 8 + 10 + 12 + \dots + *(2(n-1))$$

$$=1+(2+4+6+\dots \text{ till } n-1 \text{ terms})$$

$$=1+2(1+2+3+4+\dots+n-1)$$

$$=1+(n-1)*n=n^2-n+1$$

In this case $v_6 = 6^2 - 6 + 1 = 31$

2 votes

-- Gabbar (10.2k points)

1.39.8 Spanning Tree: GATE1997_9 [top](#)

<http://gateoverflow.in/2269>



Selected Answer

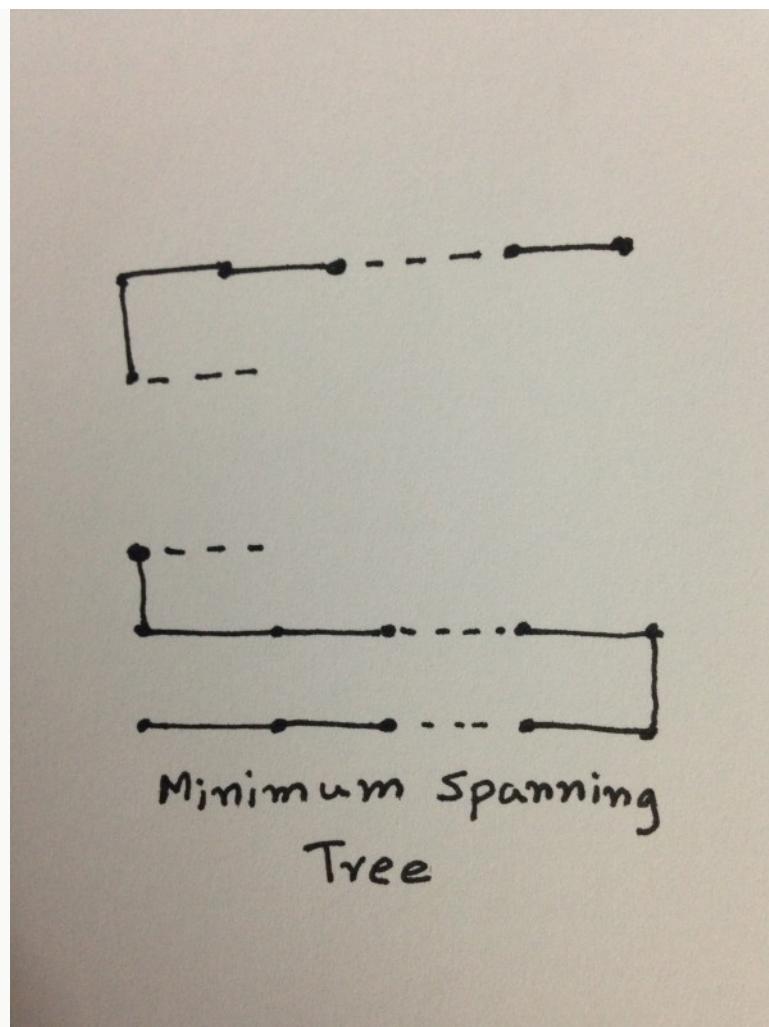
A. In the graph start applying Kruskal algorithm. So, we select all edges of cost 1 first.

For each $y = i$, there will be $n - 1$ unit length path. Total cost = $n(n - 1)$

Then we can join these n lines by one vertical line whose length is $n - 1$.

Total:

$$n(n - 1) + (n - 1) = (n - 1) \cdot (n + 1) = n^2 - 1$$



B. We can apply Kruskal's algorithm by taking maximum weight edge ([ref](#)). Maximum weight edge here is $\sqrt{2}$ as we are taking Euclidean distance as mentioned in question.

All diagonals will sum to:

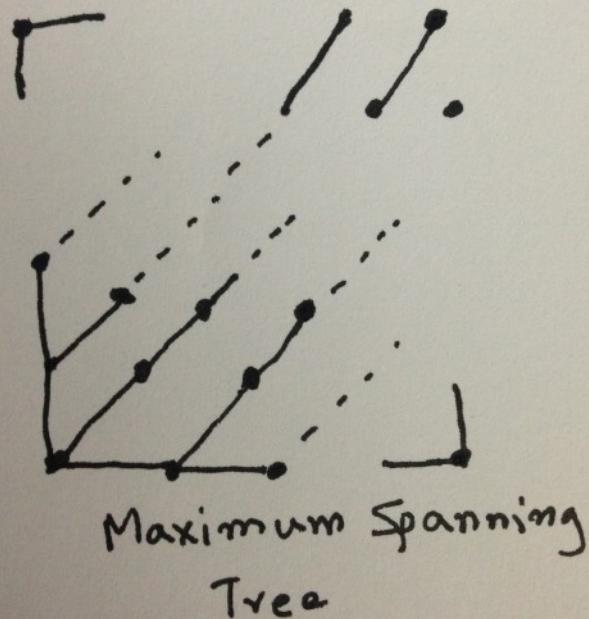
$$\sqrt{2}(n - 1) + 2 \quad ($$

(One main diagonal and
($n - 1$) diagonals on either side of it).

Now, we can no more add any edge of weight $\sqrt{2}$ without forming a cycle.

So, we take $2(n - 1)$ edges of weight 1 to interconnect these diagonals

$$= \sqrt{2}(n - 1)^2 + 2(n - 1) = \sqrt{2} \cdot (n - 1) \cdot (n - 1 + \sqrt{2})$$



4 votes

-- Digvijay (35.8k points)

1.39.9 Spanning Tree: GATE2006_11 top

<http://gateoverflow.in/890>



Selected Answer

2(n-1) the spanning tree will traverse adjacent edges since they contain the least weight.

5 votes

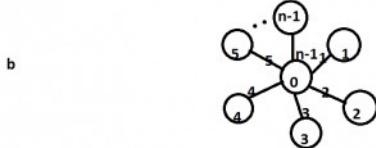
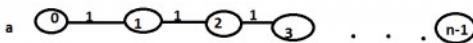
-- anshu (2.5k points)

1.39.10 Spanning Tree: GATE1996_16 top

<http://gateoverflow.in/2768>



Selected Answer



minimum spanning tree

7 votes

-- Anu (9k points)

1.39.11 Spanning Tree: GATE1995_22 [top](#)

<http://gateoverflow.in/2660>



Selected Answer

2 only.

{AB,BC,AE,BD} and {AB,BC,AE,CD}.

13 votes

-- Gate Keeda (17.7k points)

1.39.12 Spanning Tree: GATE2012_29 [top](#)

<http://gateoverflow.in/786>



Selected Answer

When the edge weights are squared the minimum spanning tree won't change.

$t' < t^2$, because sum of squares is always less than the square of the sums except for a single element case.

Hence, B is the general answer and A is also true for a single edge graph. Hence, in GATE 2012, marks were given to all.

13 votes

-- gatecse (10.7k points)

1.39.13 Spanning Tree: GATE2001-15 [top](#)

<http://gateoverflow.in/756>



Selected Answer

- a) edges with weight: 2,3,4,7,9
- b) no of distinct minimum spanning tree: 2 (2nd with different edge of weight 4)
- c) yes
- d) yes

4 votes

-- jayendra (6.6k points)

1.39.14 Spanning Tree: GATE2005-IT_52 [top](#)

<http://gateoverflow.in/3813>



Selected Answer

Option a is always true

Option b is not true when e is not part of a cycle.

Option c is not true when e is part of a cycle and all edge weights are same in that cycle

Option d is need not be true when e is not part of a cycle

Option a is always true as only the min weight edge in a cut set will be part of a minimum spanning tree.

7 votes

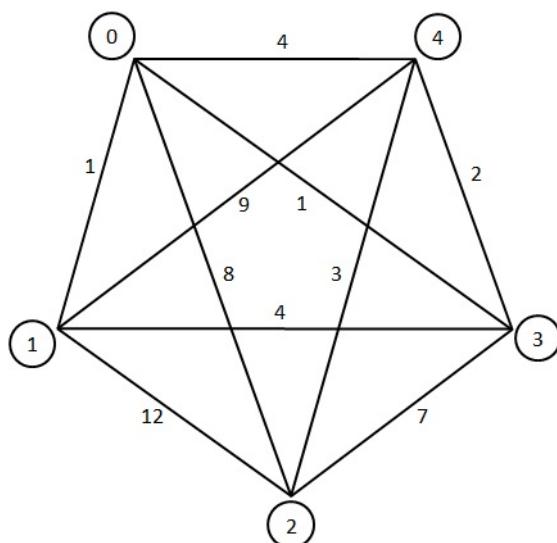
-- Bhagirathi Nayak (11.3k points)

1.39.15 Spanning Tree: GATE2010-50 [top](#)

<http://gateoverflow.in/2355>



Selected Answer



Answer is (D) 10. The edges of the spanning tree are: 0 - 1, 1 - 3, 3 - 4, 4 - 2. Total Weight = 10

11 votes

-- Ashis Kumar Sahoo (797 points)

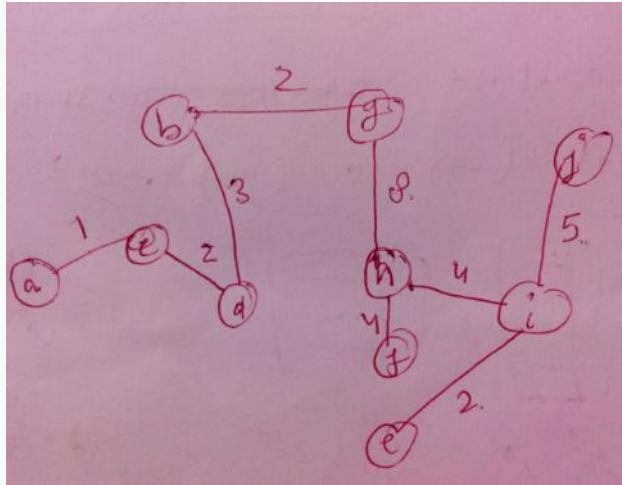
1.39.16 Spanning Tree: GATE2003_68 [top](#)

<http://gateoverflow.in/955>



Selected Answer

Apply Prim's algorithm, start from A as shown in figure below.



add all the weights in the given figure which would be equal to 31.

3 votes

-- Monanshi Jain (6.5k points)

1.39.17 Spanning Tree: GATE2000-2.18 [top](#)

<http://gateoverflow.in/665>



Selected Answer

C. the case should be written as "may or may not", to be true.

D will always be true as per the question saying that the graph has distinct weights.

10 votes

-- Gate Keeda (17.7k points)

1.39.18 Spanning Tree: TIFR2011-B-35 [top](#)

<http://gateoverflow.in/20842>



Selected Answer

a) & c) are trivially true. Edge with max value e_1 must be present in Maximum spanning tree & same with minimum.

e) This is true, because all edge weights are distinct. maximum spanning tree is unique.

b) e_1 & e_2 must be present in Maximum spanning tree. I'll prove it using Kruskal Algorithm.

We will first insert weight with biggest value, e_1 . Then we insert e_2 (second highest). 2 edges do not create **cycle**. Then we can go on from there inserting edges according to edge weights. As they have just asked for top 2 edges, using Kruskal Algo we can say that top 2 edges must be in Maximum spanning tree.

d)

This is false. There are chances that this e_m weight edge is **cut edge(Bridge)**. Then it must be inserted to form any spanning tree.

D is answer !

We can not say the same for Top 3 as they can create cycle & They we can not take a_3 to make spanning tree.

Kruskal Algo Reference -> <http://stackoverflow.com/questions/4992664/how-to-find-maximum-spanning-tree>

1 votes

-- Akash (31.7k points)

1.39.19 Spanning Tree: GATE2011-54 [top](#)

<http://gateoverflow.in/2162>



Selected Answer

Q 54. Answer is **B**

We observe a pattern in the weight of MST being formed

For $n=3$ $(1 + 2 + 3) + (1)$

For $n=4$ $(1 + 2 + 3 + 4) + (1 + 2)$

For $n=5$ $(1 + 2 + 3 + 4 + 5) + (1 + 2 + 3)$

These can be obtained by drawing graphs for these graphs.

\therefore Total weight of MST is $\sum_{i=1}^n i + \sum_{i=1}^{n-2} i = n^2 - n + 1$

Upvote 6 votes

-- Sona Praneeth Akula (3.8k points)

1.39.20 Spanning Tree: GATE2015-1_43 [top](#)

<http://gateoverflow.in/8313>



Selected Answer

Consider the cycle ABC. AC and AB are part of minimum spanning tree. So, AB should be greater than $\max(AC, BC)$ (greater and not equal as edge weights are given to be distinct), as otherwise we could add AB to the minimum spanning tree and removed the greater of AC, BC and we could have got another minimum spanning tree. So, $AB > 9$.

Similarly, for the cycle DEF, ED > 6.

And for the cycle BCDE, CD > 15.

So, minimum possible sum of these will be $10 + 7 + 16 = 33$. Adding the weight of spanning tree, we get the total sum of edge weights

$$= 33 + 36 = 69$$

Upvote 20 votes

-- Arjun Suresh (150k points)

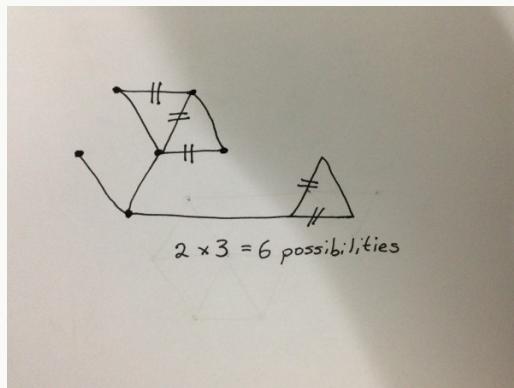
1.39.21 Spanning Tree: GATE2014-2_52 [top](#)

<http://gateoverflow.in/2019>



Selected Answer

6 is the answer.



Upvote 14 votes

-- Arjun Suresh (150k points)

1.39.22 Spanning Tree: GATE2015-3_40 [top](#)

<http://gateoverflow.in/8499>



Selected Answer

first find no of edges in mst...
 mst has $n-1$ edges where n is no of vertices. $100-1 = 99$ edges
 each 99 edges in mst increases by 5 so weight in mst increased $99*5=495$
 now total weight of mst = $500+495=995$

16 votes

-- Anoop Sonkar (4.5k points)

1.39.23 Spanning Tree: GATE2006_47 top<http://gateoverflow.in/1823>

Selected Answer

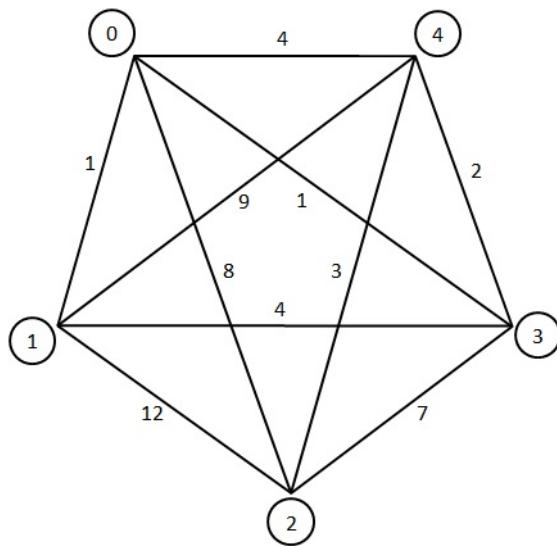
in kruskal's algo the edges are added in non decreasing order of their weight. But in Option D edge d-e with weight 3 is added before edge d-c with weight 2. Hence Option D is wrong option

6 votes

-- Sankaranarayanan P.N (9.8k points)

1.39.24 Spanning Tree: GATE2010-51 top<http://gateoverflow.in/43328>

Selected Answer



Answer is (B) 8. The possible path is: 1 - 0, 0 - 4, 4 - 2.

6 votes

-- Ashis Kumar Sahoo (797 points)

1.39.25 Spanning Tree: GATE1992_01,ix top<http://gateoverflow.in/549>

Selected Answer

if all edges are already sorted then this problem will reduced to union-find problem on a graph with E edges and V vertices.

```
for each edge (u,v) in E
    if (FIND-SET(u) != FIND-SET(v))
        UNION(u,v)
```

FIND-SET(v) and UNION(u,v) runs in $\alpha(|V|)$
 where $\alpha(n)$ is inverse ackermann function i.e $\log^*(n)$
 So overall complexity becomes $O(|E| \cdot \alpha(|V|))$

8 votes

-- Vikrant Singh (11k points)

1.39.26 Spanning Tree: GATE1991_03,vi [top](#)

<http://gateoverflow.in/521>



Selected Answer

Answer: D

When Union-Find algorithm is used to detect cycle while constructing the MST.

Ref: <http://www.geeksforgeeks.org/greedy-algorithms-set-2-kruskals-minimum-spanning-tree-mst/>

5 votes

-- Rajarshi Sarkar (29.7k points)

1.40

Test Cases [top](#)

1.40.1 Test Cases: GATE2013-51 [top](#)

<http://gateoverflow.in/4329>

The procedure given below is required to find and replace certain characters inside an input character string supplied in array A. The characters to be replaced are supplied in array oldc, while their respective replacement characters are supplied in array newc. Array A has a fixed length of five characters, while arrays oldc and newc contain three characters each. However, the procedure is flawed.

```
void find_and_replace (char *A, char *oldc, char *newc) {
    for (int i=0; i<5; i++)
        for (int j=0; j<3; j++)
            if (A[i] == oldc[j])
                A[i] = newc[j];
}
```

The procedure is tested with the following four test cases.

- (1) oldc = "abc", newc = "dab" (2) oldc = "cde", newc = "bcd"
- (3) oldc = "bca", newc = "cda" (4) oldc = "abc", newc = "bac"

If array A is made to hold the string "abcde", which of the above four test cases will be successful in exposing the flaw in this procedure?

- A. None
- B. 2 only
- C. 3 and 4 only
- D. 4 only

[gate2013](#) [algorithms](#) [test-cases](#) [normal](#)

Answer

1.40.2 Test Cases: GATE2013-50 [top](#)

<http://gateoverflow.in/1557>

The procedure given below is required to find and replace certain characters inside an input character string supplied in array A. The characters to be replaced are supplied in array oldc, while their respective replacement characters are supplied in array newc. Array A has a fixed length of five characters, while arrays oldc and newc contain three characters each. However, the procedure is flawed.

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void find_and_replace (char *A, char *oldc, char *newc) {
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The procedure is tested with the following four test cases.

- (1) oldc = "abc", newc = "dab" (2) oldc = "cde", newc = "bcd"
 (3) oldc = "bca", newc = "cda" (4) oldc = "abc", newc = "bac"

The tester now tests the program on all input strings of length five consisting of characters 'a', 'b', 'c', 'd' and 'e' with duplicates allowed. If the tester carries out this testing with the four test cases given above, how many test cases will be able to capture the flaw?

- A. Only one
- B. Only two
- C. Only three
- D. All four

[gate2013](#) [algorithms](#) [test-cases](#) [normal](#)

[Answer](#)

Answers: Test Cases

1.40.1 Test Cases: GATE2013-51 [top](#)

<http://gateoverflow.in/43291>

| | |
|------|--|
| A | |
| oldc | |
| newc | |

for (1)

Here when the element of array A and oldc match , we replace that array element of A with array element of newc . For every element of A array update occurs maximum one time.

Similarly for (2) array element of A has updated with array element of newc less than or equal to one time,

| | |
|------|--|
| A | |
| oldc | |
| newc | |

for (3)

Now, for (3) when $i=0$, value of A match with oldc[2] i.e.'a' , and replace with newc[2] i.e. also 'a'. So, no changes

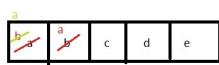
when $i=1$ value of array $A[1]=b'$

match with oldc[0]='b' and replace with newc[0]='c'.

Now, $A[1]='c'$ which equal with next element of oldc[1]='c'.

So, replace again with newc[1]='d'.

Now, we can say here in array $A[1]$ value replace with newc[0] value , and that newc[0] value replace with next newc[1] value.



| | | | |
|------|---|---|---|
| oldc | a | b | c |
| newc | b | a | c |

for (4)

Similarly for (4) here 2 times replacement for A[0] with element newc[0] and newc[1]

Updating of newc value with another newc value is calling flaw here

So Ans (C)

2 votes

-- srestha (27.8k points)

1.40.2 Test Cases: GATE2013-50 topic

<http://gateoverflow.in/1557>



Selected Answer



| | | | |
|------|---|---|---|
| oldc | a | b | c |
| newc | d | a | b |

for (1)

Here when the element of array A and oldc match , we replace that array element of A with array element of newc . For every element of A array update occurs maximum one time.

Similarly for (2) array element of A has updated with array element of newc less than or equal to one time,



| | | | |
|------|---|---|---|
| oldc | b | c | a |
| newc | c | d | a |

for (3)

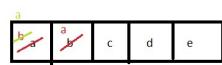
Now, for (3) when i=0 , value of A match with oldc[2] i.e.'a' , and replace with newc[2] i.e. also 'a'. So, no changes when i=1 value of array A[1]='b'

match with oldc[0]='b' and replace with newc[0]='c'.

Now, A[1]='c' which equal with next element of oldc[1]='c'.

So, replace again with newc[1]='d'.

Now, we can say here in array A[1] value replace with newc[0] value , and that newc[0] value replace with next newc[1] value.



| | | | | |
|------|---|---|---|--|
| oldc | a | b | c | |
| newc | b | a | c | |

for (4)

Similarly for (4) here 2 times replacement for A[0] with element newc[0] and newc[1]

Updating of newc value with another newc value is calling flaw here

So Ans B

4 votes

-- srestha (27.8k points)

1.41

Time Complexity top

1.41.1 Time Complexity: GATE2008-75 top

<http://gateoverflow.in/43489>

Consider the following C functions:

```
int f1 (int n)
{
    if(n == 0 || n == 1)
        return n;
    else
        return (2 * f1(n-1) + 3 * f1(n-2));
}
int f2(int n)
{
    int i;
    int X[N], Y[N], Z[N];
    X[0] = Y[0] = Z[0] = 0;
    X[1] = 1; Y[1] = 2; Z[1] = 3;
    for(i = 2; i <= n; i++)
    {
        X[i] = Y[i-1] + Z[i-2];
        Y[i] = 2 * X[i];
        Z[i] = 3 * X[i];
    }
    return X[n];
}
```

f1(8) and f2(8) return the values

- A. 1661 and 1640
- B. 59 and 59
- C. 1640 and 1640
- D. 1640 and 1661

[gate2008](#) [normal](#) [algorithms](#) [time-complexity](#)

Answer

1.41.2 Time Complexity: GATE2010-12 top

<http://gateoverflow.in/2185>

Two alternative packages A and B are available for processing a database having 10^k records. Package A requires $0.0001n^2$ time units and package B requires $10n \log_{10} n$ time units to process n records. What is the smallest value of k for which package B will be preferred over A ?

- A. 12
- B. 10
- C. 6
- D. 5

[gate2010](#) [algorithms](#) [time-complexity](#) [easy](#)

Answer

1.41.3 Time Complexity: GATE2007-15,ISRO2016-26 top

<http://gateoverflow.in/56129>

Consider the following segment of C-code:

```
int j, n;
j = 1;
while (j <= n)
    j = j * 2;
```

The number of comparisons made in the execution of the loop for any $n > 0$ is:

- A. $\lceil \log_2 n \rceil + 1$
- B. n
- C. $\lceil \log_2 n \rceil$
- D. $\lfloor \log_2 n \rfloor + 1$

[gate2007](#) [algorithms](#) [time-complexity](#) [normal](#) [isro2016](#)

[Answer](#)

1.41.4 Time Complexity: GATE2004_82 [top](#)

<http://gateoverflow.in/1076>

Let $A[1, \dots, n]$ be an array storing a bit (1 or 0) at each location, and $f(m)$ is a function whose time complexity is $\Theta(m)$. Consider the following program fragment written in a C like language:

```
counter = 0;
for (i=1; i<=n; i++)
{ if a[i] == 1) counter++;
else {f (counter); counter = 0;}
}
```

The complexity of this program fragment is

- A. $\Omega(n^2)$
- B. $\Omega(n \log n)$ and $O(n^2)$
- C. $\Theta(n)$
- D. $o(n)$

[gate2004](#) [algorithms](#) [time-complexity](#) [normal](#)

[Answer](#)

1.41.5 Time Complexity: GATE2003_66 [top](#)

<http://gateoverflow.in/258>

The cube root of a natural number n is defined as the largest natural number m such that $(m^3 \leq n)$. The complexity of computing the cube root of n (n is represented by binary notation) is

- (A) $O(n)$ but not $O(n^{0.5})$
- (B) $O(n^{0.5})$ but not $O((\log n)^k)$ for any constant $k > 0$
- (C) $O((\log n)^k)$ for some constant

- $k > 0$, but not
 $O((\log \log n)^m)$ for any constant
 $m > 0$
(D)
 $O((\log \log n)^k)$ for some constant
 $k > 0.5$, but not
 $O((\log \log n)^{0.5})$

gate2003 | algorithms | time-complexity | normal

Answer

1.41.6 Time Complexity: TIFR2014-B-7 [top](#)

<http://gateoverflow.in/27189>

Which of the following statements is TRUE for all sufficiently large n ?

- a. $(\log n)^{\log \log n} < 2^{\sqrt{\log n}} < n^{1/4}$
- b. $2^{\sqrt{\log n}} < n^{1/4} < (\log n)^{\log \log n}$
- c. $n^{1/4} < (\log n)^{\log \log n} < 2^{\sqrt{\log n}}$
- d. $(\log n)^{\log \log n} < n^{1/4} < 2^{\sqrt{\log n}}$
- e. $2^{\sqrt{\log n}} < (\log n)^{\log \log n} < n^{1/4}$

tifr2014 | algorithms | time-complexity

Answer

1.41.7 Time Complexity: GATE2015-2_22 [top](#)

<http://gateoverflow.in/8113>

An unordered list contains n distinct elements. The number of comparisons to find an element in this list that is neither maximum nor minimum is

- A. $\Theta(n \log n)$
- B. $\Theta(n)$
- C. $\Theta(\log n)$
- D. $\Theta(1)$

gate2015-2 | algorithms | time-complexity | easy

Answer

1.41.8 Time Complexity: GATE2007-IT_17 [top](#)

<http://gateoverflow.in/3450>

Exponentiation is a heavily used operation in public key cryptography. Which of the following options is the tightest upper bound on the number of multiplications required to compute $b^n \bmod m$, $0 \leq b, n \leq m$?

- | | |
|---|----------------------------------|
| A | $O(\log n)$ |
| B | $O(\sqrt{n})$ |
| C | $O\left(\frac{n}{\log n}\right)$ |
| D | $O(n)$ |

gate2007-it | algorithms | time-complexity | normal

Answer

1.41.9 Time Complexity: GATE2008-47 [top](#)

<http://gateoverflow.in/459>

We have a binary heap on n elements and wish to insert n more elements (not necessarily one after another) into this heap. The total time required for this is

- A. $\Theta(\log n)$
- B. $\Theta(n)$
- C. $\Theta(n \log n)$
- D. $\Theta(n^2)$

[gate2008](#) [algorithms](#) [time-complexity](#) [normal](#)

Answer

1.41.10 Time Complexity: GATE2008-74 [top](#)

<http://gateoverflow.in/495>

Consider the following C functions:

```
int f1 (int n)
{
    if(n == 0 || n == 1)
        return n;
    else
        return (2 * f1(n-1) + 3 * f1(n-2));
}
int f2(int n)
{
    int i;
    int X[N], Y[N], Z[N];
    X[0] = Y[0] = Z[0] = 0;
    X[1] = 1; Y[1] = 2; Z[1] = 3;
    for(i = 2; i <= n; i++) {
        X[i] = Y[i-1] + Z[i-2];
        Y[i] = 2 * X[i];
        Z[i] = 3 * X[i];
    }
    return X[n];
}
```

The running time of $f1(n)$ and $f2(n)$ are

- A. $\Theta(n)$ and $\Theta(n)$
- B. $\Theta(2^n)$ and $\Theta(n)$
- C. $\Theta(n)$ and $\Theta(2^n)$
- D. $\Theta(2^n)$ and $\Theta(2^n)$

[gate2008](#) [algorithms](#) [time-complexity](#) [normal](#)

Answer

1.41.11 Time Complexity: GATE1993_8.7 [top](#)

<http://gateoverflow.in/2305>

$\sum_{1 \leq k \leq n} O(n)$, where $O(n)$ stands for order n is:

- a. $O(n)$
- b. $O(n^2)$
- c. $O(n^3)$
- d. $O(3n^2)$
- e. $O(1.5n^2)$

[gate1993](#) [algorithms](#) [time-complexity](#) [easy](#)

Answer

1.41.12 Time Complexity: GATE2004_39 [top](#)

<http://gateoverflow.in/1036>

Two matrices M_1 and M_2 are to be stored in arrays A and B respectively. Each array can be stored either in row-major or column-major order in contiguous memory locations. The time complexity of an algorithm to compute $M_1 \times M_2$ will be

- A. best if A is in row-major, and B is in column-major order
- B. best if both are in row-major order
- C. best if both are in column-major order
- D. independent of the storage scheme

[gate2004](#) [algorithms](#) [time-complexity](#) [easy](#)

Answer

1.41.13 Time Complexity: GATE2014-1_42 [top](#)

<http://gateoverflow.in/1920>

Consider the following pseudo code. What is the total number of multiplications to be performed?

```
D = 2
for i = 1 to n do
    for j = i to n do
        for k = j + 1 to n do
            D = D * 3
```

- (A) Half of the product of the 3 consecutive integers.
- (B) One-third of the product of the 3 consecutive integers.
- (C) One-sixth of the product of the 3 consecutive integers.
- (D) None of the above.

[gate2014-1](#) [algorithms](#) [time-complexity](#) [normal](#)

Answer

1.41.14 Time Complexity: TIFR2015-B-3 [top](#)

<http://gateoverflow.in/2986>

Consider the following code fragment in the C programming language when run on a non-negative integer n .

```
int f (int n)
{
    if (n==0 || n==1)
        return 1;
    else
        return f (n - 1) + f(n - 2);
}
```

Assuming a typical implementation of the language, what is the running time of this algorithm and how does it compare to the optimal running time for this problem?

- a. This algorithm runs in polynomial time in n but the optimal running time is exponential in n .
- b. This algorithm runs in exponential time in n and the optimal running time is exponential in n .
- c. This algorithm runs in exponential time in n but the optimal running time is polynomial in n .
- d. This algorithm runs in polynomial time in n and the optimal running time is polynomial in n .
- e. The algorithm does not terminate.

[tifr2015](#) [time-complexity](#)

Answer

1.41.15 Time Complexity: GATE1999_11 [top](#)

<http://gateoverflow.in/1510>

- a. Consider the following algorithms. Assume, procedure A and procedure B take $O(1)$ and $O(1/n)$ unit of time respectively. Derive the time complexity of the algorithm in O -notation.

```
algorithm what (n)
begin
    if n = 1 then call A
    else
        begin
            what (n-1);
            call B(n)
        end
    end
end.
```

- b. Write a constant time algorithm to insert a node with data D just before the node with address p of a singly linked list.

[gate1999](#) [algorithms](#) [time-complexity](#) [normal](#)

Answer

1.41.16 Time Complexity: GATE2007_51 [top](#)

<http://gateoverflow.in/1249>

Consider the following C program segment:

```
int IsPrime(n)
{
    int i, n;
    for (i=2; i<=sqrt(n); i++)
        if(n%i == 0)
            {printf("Not Prime \n"); return 0;}
    return 1;
}
```

Let $T(n)$ denote number of times the *for* loop is executed by the program on input n . Which of the following is TRUE?

- A. $T(n) = O(\sqrt{n})$ and $T(n) = \Omega(\sqrt{n})$
- B. $T(n) = O(\sqrt{n})$ and $T(n) = \Omega(1)$
- C. $T(n) = O(n)$ and $T(n) = \Omega(\sqrt{n})$
- D. None of the above

[gate2007](#) [algorithms](#) [time-complexity](#) [normal](#)

Answer

1.41.17 Time Complexity: GATE2007_50 [top](#)

<http://gateoverflow.in/1248>

An array of n numbers is given, where n is an even number. The maximum as well as the minimum of these n numbers needs to be determined. Which of the following is **TRUE** about the number of comparisons needed?

- A. At least $2n - c$ comparisons, for some constant c are needed.
- B. At most $1.5n - 2$ comparisons are needed.
- C. At least $n \log_2 n$ comparisons are needed
- D. None of the above

gate2007 | algorithms | time-complexity | easy

Answer

Answers: Time Complexity**1.41.1 Time Complexity: GATE2008-75** top<http://gateoverflow.in/43489>

Here Ans C. 1640 and 1640

f1(8)

$$\begin{aligned}
 & f_1(8) \\
 & 2 + f_1(7) + 3 \cdot f_1(6) = 1640 \\
 & 2 + f_1(6) + 3 \cdot f_1(5) = 547 \\
 & 2 + f_1(5) + 3 \cdot f_1(4) = 182 \\
 & 2 + f_1(4) + 3 \cdot f_1(3) = 61 \\
 & 2 + f_1(3) + 3 \cdot f_1(2) = 20 \\
 & 2 + f_1(2) + 3 \cdot f_1(1) = 7 \\
 & 2 + f_1(1) + 3 \cdot f_1(0) = 2
 \end{aligned}$$

Here $f_1(1) = 1$
 $f_1(0) = 0$

f2(8) will return

| | | | | | | | | | | | | | | | | | | | |
|---|---|---|----|----|-----|-----|------|------|------|------|---|---|---|---|---|---|---|---|---|
| X | <table border="1"> <tr><td>0</td><td>1</td><td>2</td><td>7</td><td>20</td><td>61</td><td>182</td><td>547</td><td>1640</td></tr> <tr><td>0</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td></tr> </table> | 0 | 1 | 2 | 7 | 20 | 61 | 182 | 547 | 1640 | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| 0 | 1 | 2 | 7 | 20 | 61 | 182 | 547 | 1640 | | | | | | | | | | | |
| 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | | | | | | | | | | | |
| Y | <table border="1"> <tr><td>0</td><td>2</td><td>4</td><td>14</td><td>40</td><td>125</td><td>364</td><td>1094</td><td>3280</td></tr> <tr><td>0</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td></tr> </table> | 0 | 2 | 4 | 14 | 40 | 125 | 364 | 1094 | 3280 | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| 0 | 2 | 4 | 14 | 40 | 125 | 364 | 1094 | 3280 | | | | | | | | | | | |
| 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | | | | | | | | | | | |
| Z | <table border="1"> <tr><td>0</td><td>3</td><td>6</td><td>21</td><td>60</td><td>183</td><td>546</td><td>1641</td><td>4920</td></tr> <tr><td>0</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td></tr> </table> | 0 | 3 | 6 | 21 | 60 | 183 | 546 | 1641 | 4920 | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| 0 | 3 | 6 | 21 | 60 | 183 | 546 | 1641 | 4920 | | | | | | | | | | | |
| 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | | | | | | | | | | | |

return X[8] = 1640

4 votes

-- Manoj Kumar (23.1k points)

1.41.2 Time Complexity: GATE2010-12 top<http://gateoverflow.in/2185>

Selected Answer

$$\begin{aligned} 10n \log_{10} n &\leq 0.0001n^2 \\ \implies 10 \times 10^k \log_{10} 10^k &\leq 0.0001(10^k)^2 \\ \implies 10^{k+1}k &\leq 0.0001 \times 10^{2k} \\ \implies k &\leq 10^{2k-k-1-4} \\ \implies k &\leq 10^{k-5} \end{aligned}$$

Trying the values, 5 doesn't satisfy this but 6 satisfies.

9 votes

-- Arjun Suresh (150k points)

1.41.3 Time Complexity: GATE2007-15,ISRO2016-26 [top](#)

<http://gateoverflow.in/56129>

| n | no. of comparision | Ceil(log ₂ n) + 1 |
|---|--------------------------|------------------------------|
| 1 | 2 (j = 1, 2) | 1 |
| 2 | 3 (j = 1,2, 4) | 2 |
| 3 | 3 (j = 1,2, 4) | 2 |
| 4 | 4 (j = 1,2,4, 8) | 3 |
| 5 | 4 (j = 1,2,4, 8) | 4 |

may be we have to count those comparisons which results in the execution of loop.

Answer should be Ceil(log₂n) + 1

EDIT: but answer could be: floor(log₂n) + 2

5 votes

-- Vikrant Singh (11k points)

Assuming that "comparisons made in the execution of the loop" means that comparison made while loop is executing, last comparison is not counted.

Say we have j = 7.

Then successful comparisons are 1,2,4. (We get out in next comparison.) So 3 comparisons

Then

A) Incorrect as We get 21 != 3.

B) Incorrect, this is 8.

C) Correct

D) Correct

C & D both gave 3

In C & D for tie breaking, we can take j = 8. No of comparisons (Successful) -> 1,2,4,8.(We get out of loop in 16)

C) 3 != 4. Incorrect

D) 4 Correct

Answer -> D

5 votes

-- Akash (31.7k points)

1.41.4 Time Complexity: GATE2004_82 [top](#)

<http://gateoverflow.in/1076>



Selected Answer

The key part in the code is "counter = 0" in the else part as we can see below.

Lets take the best case. This happens when $a[i] = 1$ for all i , and then the loop executes with time complexity $\Theta(1)$ for each iteration and hence overall time complexity of $\Theta(n)$ and we can say time complexity of the code fragment is $\Omega(n)$ and hence options a and b are false.

Now, consider the worst case. This happens when $a[i] = 0$ or when else part is executed. Here, the time complexity of each iteration will be $\Theta(counter)$ and after each else, counter is reset to 0. Let k iterations go to the else part during the worst case. Then the worst case time complexity will be $\Theta(x_1) + \Theta(x_2) + \dots + \Theta(x_k) + \Theta(n - k)$, where x_i is the value of the counter when, $A[i] = 0$ and $f(counter)$ is called. But due to $counter = 0$ after each call to $f()$, we have, $x_1 + x_2 + \dots + x_k = n$. So, $\Theta(x_1) + \Theta(x_2) + \dots + \Theta(x_k) + \Theta(n - k) = \Theta(n) + \Theta(n - k) = \Theta(n)$.

Since the time complexity is $\Omega(n)$ and $\Theta(n)$ we can say it is $\Theta(n)$ - Option (C). (Option D is false because the small o needs the growth rate to be **STRICTLY lower** and not equal to or lower as the case for big O)

If $counter = 0$ was not there in else part, then time complexity would be $\Omega(n)$ and $O(n^2)$ as in worst case we can have equal number of 0's and 1's in array a giving time complexity $\Theta(1) + \Theta(2) + \dots + \Theta(n/2) + \Theta(n/2)$ would give $O(n^2)$.

7 votes

-- Arjun Suresh (150k points)

1.41.5 Time Complexity: GATE2003_66 [top](#)

<http://gateoverflow.in/258>

Selected Answer

We can simply do a binary search in the array of natural numbers from $1..n$ and check if the cube of the number matches n (i.e., check if $a[i] * a[i] * a[i] == n$). In this way we can find the cube root in $O(\log n)$. So, options (A) and (B) are wrong.

Now, a number is represented in binary using $\log n$ bit. Since each bit is important in finding the cube root, any cube root finding algorithm must examine each bit at least once. This ensures that complexity of cube root finding algorithm cannot be lower than $\log n$. (It must be $\Theta(\log n)$). So, (D) is also false and (C) is the correct answer.

19 votes

-- gatecse (10.7k points)

1.41.6 Time Complexity: TIFR2014-B-7 [top](#)

<http://gateoverflow.in/27189>

Selected Answer

Let us take log for each function.

1. $\log(\log n)^{\log \log n} = (\log \log n)^2$
2. $\log 2\sqrt{\log n} = \sqrt{\log n} = (\log n)^{0.5}$
3. $\log n^{1/4} = 1/4 \log n$

Here, If we consider $\log n$ as a term (which is common in all 3), first 1 is a log function, second one is sqrt function and third one is linear function of $\log n$. Order of growth of these functions are [well known](#) and log is the slowest growing followed by sqrt and then linear. So, option A is the correct answer here.

PS: After taking log is we arrive at functions distinguished by some constant terms only, then we can not conclude the order of growth of the original functions using the log function. Examples are $f(n) = 2^n, g(n) = 3^n$.

5 votes

-- srestha (27.8k points)

1.41.7 Time Complexity: GATE2015-2_22 [top](#)

<http://gateoverflow.in/8113>



Selected Answer

Ans $O(1)$, because all elements are distinct, select any three numbers and output 2nd largest from them.

28 votes

-- Vikrant Singh (11k points)

1.41.8 Time Complexity: GATE2007-IT_17 [top](#)

<http://gateoverflow.in/3450>



Selected Answer

Answer is (A)

We need to divide n recursively and compute like following:

$C_1 = b^{\frac{n}{2}} \times b^{\frac{n}{2}}$. In this, we need to calculate $b^{\frac{n}{2}}$ only once.

$$C_2 = b^{\frac{n}{4}} \times b^{\frac{n}{4}}$$

⋮

$$C_k = b^2 \times b^2 \quad \left\{ k = \log n \right.$$

Recurrence relation: $T(n) = T\left(\frac{n}{2}\right) + O(1)$

$$T(n) = O(\log n)$$

11 votes

-- Sandeep_Uniyal (5.5k points)

1.41.9 Time Complexity: GATE2008-47 [top](#)

<http://gateoverflow.in/459>



Selected Answer

an insert operation on a binary heap takes $\mathcal{O}(\log n)$ time, but an alternative approach we can use. which requires us to insert n elements in heap without any computation i.e. in constant time. after which we can apply Heapify operation(this operation creates heap in linear time) on the array of those element and Hence obtain a Heap in $\mathcal{O}(n)$ time.

12 votes

-- Amar Vashishth (20.7k points)

1.41.10 Time Complexity: GATE2008-74 [top](#)

<http://gateoverflow.in/495>



Selected Answer

Q.74 = option B
Q.75 = option C

Time complexity of f1 is given by

$T(n) = T(n-1) + T(n-2)$, (multiplication by 2 and 3 won't affect complexity as it is a constant time operation)
 $T(0) = T(1) = 1$

The solution to this (fibonacci series) is given by Golden ratio. https://en.wikipedia.org/wiki/Golden_ratio which is $O(2^n)$. (Using theta in question must be a mistake)

Time complexity of f2 is $\Theta(n)$ as here all recursive calls are avoided by saving the results in an array (dynamic programming).

So, answer to 74 is (B).

75. Both f1 and f2 are calculating the same function. So,

$$\begin{aligned}f_1(2) &= 2f_1(1) + 3f_1(0) = 2 \\f_1(3) &= 2f_1(2) + 3f_1(1) = 7 \\f_1(4) &= 20 \\f_1(5) &= 61 \\f_1(6) &= 182 \\f_1(7) &= 547 \\f_1(8) &= 1640 = f_2(8)\end{aligned}$$

12 votes

-- Arjun Suresh (150k points)

1.41.11 Time Complexity: GATE1993_8.7 [top](#)

<http://gateoverflow.in/2305>



Selected Answer

This is N added itself N times. So it is N^2 . Even if you consider as sum of $O(1) + O(2) + \dots + O(n-1) + O(N)$, it will add up to N^2 .

So answer is

A) $O(N)$ this is false.

B,C,D,E) All of this are true. We have N^2 here, so all options apart from A are correct.

In fact B = D = E these three options are same. and N^3 is always upper bound of N^2 . So $O(N^3)$ is also true.

6 votes

-- Akash (31.7k points)

1.41.12 Time Complexity: GATE2004_39 [top](#)

<http://gateoverflow.in/1036>



Selected Answer

D is correct

Here time complexity is asked, for each access of array element it will be constant,

So the time complexity will not depend upon storage. If at all program execution time is asked

a is true

10 votes

-- Anurag Semwal (5.5k points)

1.41.13 Time Complexity: GATE2014-1_42 [top](#)

<http://gateoverflow.in/1920>



Selected Answer

Total number of multiplications

$$= \sum_{i=1}^n \sum_{j=i}^n \sum_{k=j+1}^n 1 = \sum_{i=1}^n \sum_{j=i}^n (n-j) = \sum_{i=1}^n (n-i) + (n-(i+1)) + \dots + (n-n) = \frac{1}{2} \sum_{i=1}^n (n-i)(n-i+1)$$

Therefore, correct answer would be (C).

10 votes

-- suraj (3.7k points)

1.41.14 Time Complexity: TIFR2015-B-3 [top](#)<http://gateoverflow.in/29846>

Selected Answer

Ans : C

it is fibanacci series generation. it takes exponential time if we won't use dynamic programming.

if we use dynamic programming then it takes $O(n)$

4 votes

-- pramod (2.3k points)

1.41.15 Time Complexity: GATE1999_11 [top](#)<http://gateoverflow.in/1510>

The recurrence relation for time complexity is

$$T(n) = T(n - 1) + \frac{1}{n} + c \quad (O(1/n) \text{ replaced with } 1/n \text{ and so our answer will also be in } O \text{ only and not } \Theta).$$

$$T(n) = T(n - 2) + \frac{1}{n-1} + \frac{1}{n} + 2c = T(1) + \frac{1}{2} + \frac{1}{3} + \dots + \frac{1}{n} + (n - 1)c = A(1) + \frac{1}{2} + \frac{1}{3} + \dots + \frac{1}{n} + nc = 1 + \frac{1}{2} + \frac{1}{3} + \dots + \frac{1}{n}$$

(Sum of the first
 n terms in harmonic series is
 $\Theta(\log n)$)

So, our time complexity will be
 $O(n)$.

6 votes

-- Arjun Suresh (150k points)

1.41.16 Time Complexity: GATE2007_51 [top](#)<http://gateoverflow.in/1249>

Selected Answer

Answer = **option B**

Worst Case : $T(n) = \mathcal{O}(\sqrt{n})$

Best Case : When $n = 1$ body of *for* loop is not executed. $\therefore T(n) = \Omega(1)$

11 votes

-- Gate Keeda (17.7k points)

1.41.17 Time Complexity: GATE2007_50 [top](#)<http://gateoverflow.in/1248>

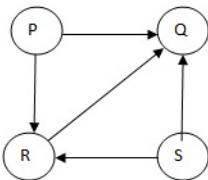
divide and conquer gives $1.5n - 2$ comparison

6 votes

-- Digvijay (35.8k points)

1.42**Topological Sort** [top](#)**1.42.1 Topological Sort: GATE2014-1_13** [top](#)<http://gateoverflow.in/1779>

Consider the directed graph below given.



Which one of the following is **TRUE**?

- (A) The graph does not have any topological ordering.
- (B) Both PQRS and SRQP are topological orderings.
- (C) Both PSRQ and SPRQ are topological orderings.
- (D) PSRQ is the only topological ordering.

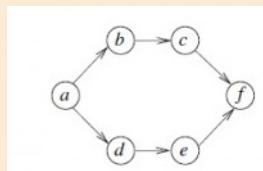
[gate2014-1](#) [topological-sort](#) [dfs](#) [easy](#)

Answer

1.42.2 Topological Sort: GATE 2016-1-11 [top](#)

<http://gateoverflow.in/39669>

Consider the following directed graph:



The number of different topological orderings of the vertices of the graph is _____.

[gate2016-1](#) [algorithms](#) [topological-sort](#) [normal](#) [numerical-answers](#)

Answer

Answers: Topological Sort

1.42.1 Topological Sort: GATE2014-1_13 [top](#)

<http://gateoverflow.in/1779>



Selected Answer

The C option has been copied wrongly
 C) Both PSRQ and SPRQ are topological orderings
 i) Apply DFS by choosing P or S as starting vertices
 ii) As the vertex gets a finishing time assign it to the head of a linked list
 iii) The linked list is your required topological ordering

7 votes

-- Akshay Jindal (351 points)

choose vertex in the graph which has 0 indegree . now see graph has such two vertices ie P,S so we can start topological sort either from vertex P or from Q .

lets first start from vertex P now remove this vertex from graph ,we left with three vertices named as Q,S,R from these

vertices see which vertex has INDEGREE 0,S vertex HAS indegree 0 therefore sequence IS P,S,R,Q

repeat the above step from wuth vertex S we get sequence as S,P,R,Q

7 votes

-- kunal chalotra (6.3k points)

1.42.2 Topological Sort: GATE 2016-1-11 [top](#)

<http://gateoverflow.in/39669>



Selected Answer

Answer is

a _ _ _ f.. blanks spaces are to be filled with b, c, d, e such that b comes before c, and d comes before e..

Number of ways to arrange b,c,d,e such that b comes before c and d comes before e.

$$4!/(2!*2!) = 6$$

18 votes

-- Abhilash Panicker (7k points)

1.43

Transactions [top](#)

1.43.1 Transactions: GATE 2016-2-22 [top](#)

<http://gateoverflow.in/39550>

Suppose a database schedule

S involves transactions

T_1, \dots, T_n . Construct the precedence graph of

S with vertices representing the transactions and edges representing the conflicts. If

S is serializable, which one of the following orderings of the vertices of the precedence graph is guaranteed to yield a serial schedule?

- A). Topological order
- B). Depth-first order
- C). Breadth- first order
- D). Ascending order of the transaction indices.

[gate2016-2](#) [databases](#) [transactions](#) [normal](#)

Answer

Answers: Transactions

1.43.1 Transactions: GATE 2016-2-22 [top](#)

<http://gateoverflow.in/39550>



Selected Answer

Topological Order.

9 votes

-- Sharathkumar Anbu (697 points)

1.44

Trees [top](#)

1.44.1 Trees: GATE2014-3_41 [top](#)

<http://gateoverflow.in/2075>

Consider the pseudocode given below. The function

DoSomething() takes as argument a pointer to the root of an arbitrary tree represented by the *leftMostChild – rightSibling* representation. Each node of the tree is of type *treeNode*.

```
typedef struct treeNode* treeptr;

struct treeNode
{
    treeptr leftMostChild, rightSibling;
};

int DoSomething (treeptr tree)
{
    int value=0;
    if (tree != NULL) {
        if (tree->leftMostChild == NULL)
            value = 1;
        else
            value = DoSomething(tree->leftMostChild);
        value = value + DoSomething(tree->rightSibling);
    }
    return (value);
}
```

When the pointer to the root of a tree is passed as the argument to *DoSomething*, the value returned by the function corresponds to the

- (A) number of internal nodes in the tree.
- (B) height of the tree.
- (C) number of nodes without a right sibling in the tree.
- (D) number of leaf nodes in the tree

gate2014-3 | algorithms | trees | identify-function | normal

Answer

1.44.2 Trees: GATE2004_6 [top](#)

<http://gateoverflow.in/1003>

Level order traversal of a rooted tree can be done by starting from the root and performing

- A. preorder traversal
- B. in-order traversal
- C. depth first search
- D. breadth first search

gate2004 | algorithms | trees | easy

Answer

1.44.3 Trees: GATE2008-IT_12 [top](#)

<http://gateoverflow.in/3272>

Which of the following is TRUE?

- 1) The cost of searching an AVL tree is $\theta(\log n)$ but that of a binary search tree is $O(n)$
- 2) The cost of searching an AVL tree is $\theta(\log n)$ but that of a complete binary tree is $\theta(n \log n)$
- 3) The cost of searching a binary search tree is $O(\log n)$ but that of an AVL tree is $\theta(n)$
- 4) The cost of searching an AVL tree is $\theta(n \log n)$ but that of a binary search tree is $O(n)$

gate2008-it | algorithms | trees | easy

Answer

1.44.4 Trees: GATE2008-IT_46 [top](#)<http://gateoverflow.in/3356>

The following three are known to be the preorder, inorder and postorder sequences of a binary tree. But it is not known which is which.

- I. MBCAFHPYK
- II. KAMCBYPFH
- III. MABCKYFPH

Pick the true statement from the following.

- A) I and II are preorder and inorder sequences, respectively
- B) I and III are preorder and postorder sequences, respectively
- C) II is the inorder sequence, but nothing more can be said about the other two sequences
- D) II and III are the preorder and inorder sequences, respectively

[gate2008-it](#) [algorithms](#) [trees](#) [normal](#)

Answer

Answers: Trees**1.44.1 Trees: GATE2014-3_41** [top](#)<http://gateoverflow.in/2075>

Selected Answer

Here, the condition for count value = 1 is

if (tree→leftMostchild == Null)

- so, if there is no left-most child of the tree (or the sub-tree or the current node called in recursion)
- Which means there is no child to that particular node (since if there is no left-most child, there is no child at all as per the tree representation given).
- ∴ the node under consideration is a leaf node.
- The function recursively counts, and adds to value, whenever a leaf node is encountered.
- So, The function returns the number of leaf nodes in the tree.

8 votes

-- Kalpish Singhal (1.7k points)

1.44.2 Trees: GATE2004_6 [top](#)<http://gateoverflow.in/1003>

Selected Answer

answer = **option D**

Breadth first seach.

3 votes

-- anshu (2.5k points)

1.44.3 Trees: GATE2008-IT_12 [top](#)<http://gateoverflow.in/3272>

Selected Answer

1) is true as AVL tree is a balanced search tree that has time complexity of searching $\theta(\lg n)$, but in binary search tree, we can have a completely left/right skewed tree, in which search is $O(n)$.

7 votes

-- Happy Mittal (9.5k points)

1.44.4 Trees: GATE2008-IT_46 top<http://gateoverflow.in/3356>

Selected Answer

In preorder, root comes at the beginning of the traversal sequence and in postorder, root comes at the last of the traversal sequence. So, out of the given sequences only 1 and 2 are having such kind of order i.e K at the beginning and at the last.

Therefore, 2 is the preorder and 1 is postorder and the left sequence i.e 3 will definitely be inorder.

So, option d is correct.

8 votes

-- Vivek sharma (1.3k points)

2 CO & Architecture (160) [top](#)

2.0.1 GATE 1990 [top](#)

<http://gateoverflow.in/45191>

in two level virtual memory the memory access time for main memory , $ta_1=10^{-8}$ sec, and the memory access time for the secondary memory , $ta_2=10^{-3}$ sec. what must be the hit ratio , h such that the access efficiency is within 80 % of its maximum value.

gate1990

Answer

2.0.2 GATE1992_01,iii [top](#)

<http://gateoverflow.in/547>

(iii) Many microprocessors have a specified lower limit on clock frequency (apart from the maximum clock frequency limit) because _____

gate1992 normal co&architecture

Answer

2.0.3 GATE2006_43 [top](#)

<http://gateoverflow.in/1819>

Consider a new instruction named branch-on-bit-set (mnemonic bbs). The instruction "bbs reg, pos, label" jumps to label if bit in position pos of register operand reg is one. A register is 32 bits wide and the bits are numbered 0 to 31, bit in position 0 being the least significant. Consider the following emulation of this instruction on a processor that does not have bbs implemented.

$temp \leftarrow reg \& mask$

Branch to label if temp is non-zero. The variable temp is a temporary register. For correct emulation, the variable mask must be generated by

- (A) $mask \leftarrow 0x1 << pos$
- (B) $mask \leftarrow 0xffffffff << pos$
- (C) $mask \leftarrow pos$
- (D) $mask \leftarrow 0xf$

gate2006 co&architecture normal

Answer

2.0.4 GATE2014-1_55 [top](#)

<http://gateoverflow.in/1935>

Consider two processors

P_1 and

P_2 executing the same instruction set. Assume that under identical conditions, for the same input, a program running on P_2 takes 25% less time but incurs 20% more CPI (clock cycles per instruction) as compared to the program running on P_1 . If the clock frequency of

P_1 is 1GHz, then the clock frequency of P_2 (in GHz) is _____.

gate2014-1 co&architecture numerical-answers normal

Answer

2.0.5 GATE1997_2.4 [top](#)

<http://gateoverflow.in/2230>

The correct matching for the following pairs is:

- | | |
|-------------|--------------------|
| (A) DMA I/O | (1) High speed RAM |
|-------------|--------------------|

- | | |
|-----------------------------|-------------|
| (B) Cache | (2) Disk |
| (C) Interrupt I/O | (3) Printer |
| (D) Condition Code Register | (4) ALU |
- A. A-4 B-3 C-1 D-2
 B. A-2 B-1 C-3 D-4
 C. A-4 B-3 C-2 D-1
 D. A-2 B-3 C-4 D-1

[gate1997](#) | [co&architecture](#) | [normal](#)

[Answer](#)

2.0.6 GATE2002_1.13 [top](#)

<http://gateoverflow.in/817>

Which of the following is not a form of memory

- A. instruction cache
- B. instruction register
- C. instruction opcode
- D. translation look-a-side buffer

[gate2002](#) | [co&architecture](#) | [easy](#)

[Answer](#)

2.0.7 GATE1995_1.2 [top](#)

<http://gateoverflow.in/2589>

Which of the following statements is true?

- A. ROM is a Read/Write memory
- B. PC points to the last instruction that was executed
- C. Stack works on the principle of LIFO
- D. All instructions affect the flags

[gate1995](#) | [co&architecture](#) | [normal](#)

[Answer](#)

2.0.8 GATE2001-1.10, UGCNET-Dec2012-III-36 [top](#)

<http://gateoverflow.in/703>

Suppose a processor does not have any stack pointer registers, which of the following statements is true?

- A. It cannot have subroutine call instruction
- B. It cannot have nested subroutines call
- C. Interrupts are not possible
- D. All subroutine calls and interrupts are possible

[gate2001](#) | [co&architecture](#) | [normal](#) | [ugcnetdec2012iii](#)

[Answer](#)

2.0.9 GATE2000-1.10 [top](#)

<http://gateoverflow.in/633>

The most appropriate matching for the following pairs

| | |
|-------------------------|-------------|
| X: Indirect addressing | 1: Loops |
| Y: Immediate addressing | 2: Pointers |

Z: Auto decrement addressing 3: Constants

is

- A. X - 3 Y - 2 Z - 1
- B. X - 1 Y - 3 Z - 2
- C. X - 2 Y - 3 Z - 1
- D. X - 3 Y - 1 Z - 2

[gate2000](#) [co&architecture](#) [normal](#)

[Answer](#)

2.0.10 GATE1992_02,iii [top](#)

<http://gateoverflow.in/557>

Choose the correct alternatives (more than one may be correct) and write the corresponding letters only:

Bit-slice processors

- (a). can be cascaded to get any desired word length processor
- (b). speed of operation is independent of the word length configured
- (c). do not contain anything equivalent of program counter in a 'normal' microprocessor
- (d). Contain only the data path of a 'normal' CPU

[gate1992](#) [co&architecture](#) [normal](#)

[Answer](#)

2.0.11 GATE2007-IT-36 [top](#)

<http://gateoverflow.in/3469>

The floating point unit of a processor using a design D takes $2t$ cycles compared to t cycles taken by the fixed point unit. There are two more design suggestions D_1 and D_2 . D_1 uses 30% more cycles for fixed point unit but 30% less cycles for floating point unit as compared to design D . D_2 uses 40% less cycles for fixed point unit but 10% more cycles for floating point unit as compared to design D . For a given program which has 80% fixed point operations and 20% floating point operations, which of the following ordering reflects the relative performances of three designs?
($D_i > D_j$ denotes that D_i is faster than D_j)

- A. $D_1 > D > D_2$
- B. $D_2 > D > D_1$
- C. $D > D_2 > D_1$
- D. $D > D_1 > D_2$

[gate2007-it](#) [co&architecture](#) [normal](#)

[Answer](#)

2.0.12 GATE1992_01,iv [top](#)

<http://gateoverflow.in/548>

Many of the advanced microprocessors prefetch instructions and store it in an instruction buffer to speed up processing. This speed up is achieved because _____

[gate1992](#) [co&architecture](#) [easy](#)

[Answer](#)

2.0.13 GATE2004-IT-50 [top](#)

<http://gateoverflow.in/790>

In an enhancement of a design of a CPU, the speed of a floating point until has been increased by 20% and the speed of a fixed point unit has been increased by 10%. What is the overall speedup achieved if the ratio of the number of floating point operations to the number of fixed point operations is 2:3 and the floating point operation used to take twice the time taken by the fixed point operation in the original design?

- A. 1.155
- B. 1.185
- C. 1.255

D. 1.285

gate2004-it | normal | co&architecture

[Answer](#)

2.0.14 GATE1999_2.22 [top](#)

<http://gateoverflow.in/1499>

The main difference(s) between a CISC and a RISC processor is/are that a RISC processor typically

- (a) has fewer instructions
- (b) has fewer addressing modes
- (c) has more registers
- (d) is easier to implement using hard-wired logic

gate1999 | co&architecture | normal

[Answer](#)

2.0.15 GATE2008-37, ISRO2009-38 [top](#)

<http://gateoverflow.in/448>

The use of multiple register windows with overlap causes a reduction in the number of memory accesses for

- I. Function locals and parameters
- II. Register saves and restores
- III. Instruction fetches
 - A. I only
 - B. II only
 - C. III only
 - D. I, II and III

gate2008 | co&architecture | normal | isro2009

[Answer](#)

2.0.16 GATE1991_01,ii [top](#)

<http://gateoverflow.in/499>

In interleaved memory organization, consecutive words are stored in consecutive memory modules in _____ interleaving, whereas consecutive words are stored within the module in _____ interleaving.

gate1991 | co&architecture | normal

[Answer](#)

Answers:

2.0.1 GATE 1990 [top](#)

<http://gateoverflow.in/45191>

access efficiency = useful access/total access

useful access=h*ta1, h is hit ration

total = h*ta1 + (1-h)*(ta1+ta2)

so, $0.8 = h * 10^{-8} / (h * 10^{-8} + (1-h) * (10^{-8} + 10^{-3}))$

solving then we get h

am I correct?

0 votes

-- LOVELY GUPTA (3.5k points)

if nothing is mentioned use default hierarchy[$T_{avg} = ht_1 + (1 - h)t_2$] instead of strict hierarchy[$T_{avg} = ht_1 + (1 - h)(t_1 + t_2)$]
 therefore $0.8 * 10^{-3} = h * 10^{-8} + (1 - h) * 10^{-3}$
 we get $h = 20\%$

0 votes

-- vineet tiwari (39 points)

2.0.2 GATE1992_01,iii [top](#)

<http://gateoverflow.in/547>

Selected Answer

Clock frequency becomes low means time period of clock becomes high. When this time period increases beyond the time period in which the non-volatile memory contents must be refreshed, we lose those contents. So, clock frequency can't go below this value.

Ref: http://gateoverflow.in/261/microprocessors-specified-frequency-frequency-_____

2 votes

-- Rajarshi Sarkar (29.7k points)

2.0.3 GATE2006_43 [top](#)

<http://gateoverflow.in/1819>

a. $mask \leftarrow 0x1 << pos$

We want to check for a particular bit position say 2 (third from right). Let the number be 0xA2A7 (last 4 bits being 0111). Here, the bit at position 2 from right is 1. So, we have to AND this with 0x0004 as any other flag would give wrong value (may count other bits or discard the bit at position "pos"). And 0x0004 is obtained by $0x1 << 2$ (by shifting 1 "pos" times to the left we get a flag with 1 being set only for the "pos" bit position).

3 votes

-- Arjun Suresh (150k points)

2.0.4 GATE2014-1_55 [top](#)

<http://gateoverflow.in/1935>

Selected Answer

CPU TIME (T) = No. of Instructions(I) x No. of Cycles Per Instruction (c) x Cycle Time (t)

OR

CPU TIME (T) = No. of Instructions(I) x No. of Cycles Per Instruction (c) x [Clock frequency (f)] $^{-1}$

$$\Rightarrow T = I \times c \times f^{-1} \Rightarrow f = (I \times c) / T$$

P1 & P2 executing same instruction set ----> No. of Instructions same for both = $I_1 = I_2 = I$

If P1 takes T1 time ----> $T_2 = 0.75 \times T_1$ ----> $T_2 / T_1 = 0.75$

If P1 incurs c1 clock cycles per instruction----> $c_2 = 1.2 \times c_1$ ----> $c_2 / c_1 = 1.2$

Since I is same for both ----> $(f_1 \times T_1) / c_1 = (f_2 \times T_2) / c_2$ and $f_1 = 1$ GHz

$$\Rightarrow f_2 = (c_2 / c_1) \times (T_1 / T_2) \times f_1 = 1.2 / 0.75 \times 1 \text{ GHz} = 1.6 \text{ GHz}$$

Hence, the clock frequency of P2 is = 1.6 GHz.

16 votes

-- Suraj Kaushal (327 points)

2.0.5 GATE1997_2.4 [top](#)

<http://gateoverflow.in/2230>



Selected Answer

Answer: B

4 votes

-- Rajarshi Sarkar (29.7k points)

2.0.6 GATE2002_1.13 [top](#)<http://gateoverflow.in/817>

Selected Answer

The instruction opcode is a part of the instruction which tells the processor what operation is to be performed so it is not a form of memory while the others are

8 votes

-- Bhagirathi Nayak (11.3k points)

2.0.7 GATE1995_1.2 [top](#)<http://gateoverflow.in/2589>

Selected Answer

It is C.

Only the top of the stack can be accessed at any time. You can imagine a stack to be opened from only one side data structure. So that if we put one thing over the other, we are able to access the last thing we inserted first. That is Last in First Out (LIFO).

ROM is Read Only Memory.

PC points to the next instruction to be executed.

Not all instructions affect the flags.

7 votes

-- Gate Keeda (17.7k points)

2.0.8 GATE2001-1.10, UGCNET-Dec2012-III-36 [top](#)<http://gateoverflow.in/703>

i think ans is B.

because in nested subroutine calls we used to push old subroutines into stack and pointing most recent call with stack pointer.

8 votes

-- jayendra (6.6k points)

2.0.9 GATE2000-1.10 [top](#)<http://gateoverflow.in/633>

Selected Answer

C is the most appropriate one

7 votes

-- Bhagirathi Nayak (11.3k points)

2.0.10 GATE1992_02,iii [top](#)<http://gateoverflow.in/557>

answer: A

0 votes

-- Laksin (11 points)

2.0.11 GATE2007-IT-36 [top](#)<http://gateoverflow.in/3469>

Selected Answer

(B)

$$T = 0.8 \times \text{time taken in fixed point} + 0.2 \times \text{time taken in floating point}$$

$$D = 0.8 \times t + 0.2 \times 2t = 1.2t$$

$$D_1 = 0.8 \times 1.3t + 0.2 \times 0.7 \times 2t = 1.04t + .28t = 1.32t$$

$$D_2 = 0.8 \times 0.6t + 0.2 \times 1.1 \times 2t = 0.48t + .44t = 0.92t$$

So, D_2 is the best design for this given program followed by D and then D_1 . Option B.

7 votes

-- Vicky Bajoria (3.4k points)

2.0.12 GATE1992_01,iv [top](#)<http://gateoverflow.in/548>

Selected Answer

Because CPU is faster than memory. Fetching instructions from memory would require considerable amount of time while CPU is much faster. So, prefetching the instructions to be executed can save considerable amount of waiting time.

1 votes

-- Arjun Suresh (150k points)

2.0.13 GATE2004-IT-50 [top](#)<http://gateoverflow.in/790>

Selected Answer

Speed up = Original time taken/ new time taken
 Let x be the time for a fixed point operation
 Original time taken = $(3x + 2*2x)/5 = 7x/5$
 New time taken = $((3x/1.1) + (4x/1.2))/5 = 8x/1.32*5$
 So, speed up = $7*1.32/8 = 1.155$

10 votes

-- gatecse (10.7k points)

2.0.14 GATE1999_2.22 [top](#)<http://gateoverflow.in/1499>

Selected Answer

All are properties of RISC processor..

<http://cs.stanford.edu/people/eroberts/courses/soco/projects/risc/whatis/index.html>

<http://cs.stanford.edu/people/eroberts/courses/soco/projects/risc/riscisc/index.html>

http://homepage3.nifty.com/alpha-1/computer/Control_E.html

5 votes

-- Digvijay (35.8k points)

2.0.15 GATE2008-37, ISRO2009-38 [top](#)<http://gateoverflow.in/448>

Selected Answer

I. Functions locals and parameters

this is true because overlapped registers eliminates the need for memory accesses. we here got to use registers instead.

II. Register saves and restores

this is false bc we need to see where memory accesses are reduced here before also we were using register as it says Register saves... later also (i.e. after using multiple register windows) registers will be referred. So NO memory accesses are reduced here.

III. Instruction fetches

it has nothing to do with reduction in memory accesses.

Hence, **option A** is correct.

7 votes

-- Amar Vashishth (20.7k points)

2.0.16 GATE1991_01,ii [top](#)

<http://gateoverflow.in/499>



Selected Answer

Consecutive words in consecutive memory modules in low order interleaving as the lower order bits determine the module.

Consecutive words in same memory module in high order interleaving as the higher order bits determine the module.

<http://heather.cs.ucdavis.edu/~matloff/154A/PLN/Interleaving.pdf>

3 votes

-- Arjun Suresh (150k points)

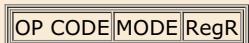
2.1

Addressing Modes [top](#)

2.1.1 Addressing Modes: GATE1993_10 [top](#)

<http://gateoverflow.in/2307>

The instruction format of a CPU is:



_____ one memory word _____

Mode and RegR together specify the operand. RegR specifies a CPU register and Mode specifies an addressing mode. In particular, Mode = 2 specifies that 'the register RegR contains the address of the operand, after fetching the operand, the contents of R RegR are incremented by 1'.

An instruction at memory location 2000 specifies Mode = 2 and the RegR refers to program counter (PC).

- What is the address of the operand?
- Assuming that is a non-jump instruction, what are the contents of PC after the execution of this instruction?

[gate1993](#) [co&architecture](#) [addressing-modes](#) [normal](#)

Answer

2.1.2 Addressing Modes: GATE2002_1.24 [top](#)

<http://gateoverflow.in/829>

In the absolute addressing mode

- the operand is inside the instruction
- the address of the operand is inside the instruction
- the register containing the address of the operand is specified inside the instruction

- D. the location of the operand is implicit

[gate2002](#) [co&architecture](#) [addressing-modes](#) [easy](#)

[Answer](#)

2.1.3 Addressing Modes: GATE2008-33, ISRO2009-80 [top](#)

<http://gateoverflow.in/444>

Which of the following is/are true of the auto-increment addressing mode?

- I. It is useful in creating self-relocating code
 - II. If it is included in an Instruction Set Architecture, then an additional ALU is required for effective address calculation
 - III. The amount of increment depends on the size of the data item accessed
- A. I only
 - B. II only
 - C. III only
 - D. II and III only

[gate2008](#) [addressing-modes](#) [co&architecture](#) [normal](#) [isro2009](#)

[Answer](#)

2.1.4 Addressing Modes: GATE2011_21 [top](#)

<http://gateoverflow.in/2123>

Consider a hypothetical processor with an instruction of type

LW R1 , 20(R2) , which during execution reads a 32-bit word from memory and stores it in a 32-bit register

R1. The effective address of the memory location is obtained by the addition of a constant 20 and the contents of register R2. Which of the following best reflects the addressing mode implemented by this instruction for the operand in memory?

- (A) Immediate addressing
- (B) Register addressing
- (C) Register Indirect Scaled Addressing
- (D) Base Indexed Addressing

[gate2011](#) [co&architecture](#) [addressing-modes](#) [easy](#)

[Answer](#)

2.1.5 Addressing Modes: GATE1996-1.16, ISRO2016-42 [top](#)

<http://gateoverflow.in/2720>

Relative mode of addressing is most relevant to writing

- A. Co-routines
- B. Position – independent code
- C. Shareable code
- D. Interrupt Handlers

[gate1996](#) [co&architecture](#) [addressing-modes](#) [easy](#) [isro2016](#)

[Answer](#)

2.1.6 Addressing Modes: GATE2001-2.9 [top](#)

<http://gateoverflow.in/727>

Which is the most appropriate match for the items in the first column with the items in the second column

| | |
|------------------------|------------------------------|
| X. Indirect Addressing | I. Array implementation |
| Y. Indexed addressing | II. Writing relocatable code |

Z. Base Register Addressing | III. Passing array as parameter

- A. (X, III) (Y, I) (Z, II)
 - B. (B) (X, II) (Y, III) (Z, I)
 - C. (C) (X, III) (Y, II) (Z, I)
 - D. (D) (X, I) (Y, III) (Z, II)

gate2001 co&architecture addressing-modes normal

Answer

2.1.7 Addressing Modes: GATE2004_20

<http://gateoverflow.in/1017>

Which of the following addressing modes are suitable for program relocation at run time?

- I. Absolute addressing
 - II. Based addressing
 - III. Relative addressing
 - IV. Indirect addressing
 - A. (I) and (IV)
 - B. (I) and (II)
 - C. (II) and (III)
 - D. (I), (II) and (IV)

gate2004 co&architecture addressing-modes easy

Answer

2.1.8 Addressing Modes: GATE2005_65

<http://gateoverflow.in/1388>

Consider a three word machine instruction

ADD A[R0], @B

The first operand (destination) "A[R0]" uses indexed addressing mode with R0 as the index register. The second operand (source) "@B" uses indirect addressing mode. A and B are memory addresses residing at the second and third words, respectively. The first word of the instruction specifies the opcode, the index register designation and the source and destination addressing modes. During execution of ADD instruction, the two operands are added and stored in the destination (first operand).

The number of memory cycles needed during the execution cycle of the instruction is:

- A. 3
 - B. 4
 - C. 5
 - D. 6

gate2005 co&architecture addressing-modes norma

Answer

2.1.9 Addressing Modes: GATE2005_66 top

<http://gateoverflow.in/1389>

Match each of the high level language statements given on the left hand side with the most natural addressing mode from those listed on the right hand side.

- (1) $A[I] = B[J]$ (a) Indirect addressing

- (2) while (*A++); (b) Indexed addressing
(3) int temp = *x (C) Auto increment

- A. (1, c), (2, b) (3, a)
 - B. (1, c), (2, c) (3, b)
 - C. (1, b), (2, c) (3, a)
 - D. (1, a), (2, b) (3, c)

gate2005 co&architecture addressing-modes easy

Answer

2.1.10 Addressing Modes: GATE1998_1.19

<http://gateoverflow.in/1656>

Which of the following addressing modes permits relocation without any change whatsoever in the code?

- A. Indirect addressing
 - B. Indexed addressing
 - C. Base register addressing
 - D. PC relative addressing

gate1998 co&architecture addressing-modes easy

Answer

2.1.11 Addressing Modes: GATE1999_2.23 [top](#)

<http://gateoverflow.in/1500>

A certain processor supports only the immediate and the direct addressing modes. Which of the following programming language features cannot be implemented on this processor?

- A. Pointers
 - B. Arrays
 - C. Records
 - D. Recursive procedures with local variables

gate1999 co&architecture addressing-modes normal

Answer

2.1.12 Addressing Modes: GATE2006-IT_40

<http://gateoverflow.in/3581>

The memory locations 1000, 1001 and 1020 have data values 18, 1 and 16 respectively before the following program is executed.

```
MOVI  Rs, 1           ; Move immediate
LOAD  Rd, 1000(Rs)   ; Load from memory
ADDI  Rd, 1000        ; Add immediate
STOREI 0(Rd), 20     ; Store immediate
```

Which of the statements below is TRUE after the program is executed ?

- A) Memory location 1000 has value 20
 - B) Memory location 1020 has value 20
 - C) Memory location 1021 has value 20
 - D) Memory location 1001 has value 20

gate2006-it co&architecture addressing-modes normal

Answer**2.1.13 Addressing Modes: GATE2006-IT_39, ISRO2009-42** [top](#)<http://gateoverflow.in/3578>

Which of the following statements about relative addressing mode is FALSE?

- A. It enables reduced instruction size
- B. It allows indexing of array element with same instruction
- C. It enables easy relocation of data
- D. It enables faster address calculation than absolute addressing

[gate2006-it](#) [co&architecture](#) [addressing-modes](#) [normal](#) [isro2009](#)
Answer**Answers: Addressing Modes****2.1.1 Addressing Modes: GATE1993_10** [top](#)<http://gateoverflow.in/2307>

Selected Answer

a) Address of the operand = content of PC = 2001 as PC holds the address of the next instruction to be executed and instruction size is 1 word as given in the diagram.

b) After execution PC will be automatically incremented by 1 and also one extra increment will be done by operand fetch. So, PC = 2003. If we assume operand fetch is not done, it should be 2002.

4 votes

-- Arjun Suresh (150k points)

2.1.2 Addressing Modes: GATE2002_1.24 [top](#)<http://gateoverflow.in/829>

Selected Answer

(b) is the answer. Absolute addressing mode means address of operand is given in the instruction.

- (a) operand is inside the instruction -> immediate addressing
- (c) register containing the address is specified in operand-> register Indirect addressing
- (d) the location of operand is implicit-> implicit addressing

17 votes

-- gatecse (10.7k points)

2.1.3 Addressing Modes: GATE2008-33, ISRO2009-80 [top](#)<http://gateoverflow.in/444>

Selected Answer

In auto increment addressing mode, the base address is incremented after operand fetch. This is useful in fetching elements from an array. But this has no effect in self-relocating code (where code can be loaded to any address) as this works on the basis of an initial base address.

An additional ALU is desirable for better execution especially with pipelining, but never a necessity.

Amount of increment depends on the size of the data item accessed as there is no need to fetch a part of a data.

So, answer must be C only.

14 votes

-- Arjun Suresh (150k points)

2.1.4 Addressing Modes: GATE2011_21 [top](#)

<http://gateoverflow.in/2123>



Selected Answer

Answer: D

Base Index Addressing, as the content of register R2 will serve as the index and 20 will be the Base address.

Upvote: 6 votes

-- Rajarshi Sarkar (29.7k points)

2.1.5 Addressing Modes: GATE1996-1.16, ISRO2016-42 [top](#)

<http://gateoverflow.in/2720>



Selected Answer

Answer: B

Relative mode addressing is most relevant to writing a position-independent code.

Ref: http://en.wikipedia.org/wiki/Addressing_mode#PC-relative

Upvote: 9 votes

-- Rajarshi Sarkar (29.7k points)

2.1.6 Addressing Modes: GATE2001-2.9 [top](#)

<http://gateoverflow.in/727>



Selected Answer

(A) is the answer.

Array implementation can use Indexed addressing

While passing array as parameter we can make use of a pointer (as in C) and hence can use Indirect addressing

Base Register addressing can be used to write relocatable code by changing the content of Base Register.

Upvote: 13 votes

-- Arjun Suresh (150k points)

2.1.7 Addressing Modes: GATE2004_20 [top](#)

<http://gateoverflow.in/1017>



Selected Answer

Answer: C

A displacement type addressing should be preferred. So, I is not the answer.

Indirect Addressing leads to extra memory reference which is not preferable at run time. So, IV is not the answer.

Upvote: 7 votes

-- Rajarshi Sarkar (29.7k points)

2.1.8 Addressing Modes: GATE2005_65 [top](#)

<http://gateoverflow.in/1388>



Selected Answer

1 memory read - get first operand from memory address A+R0 (A is given as part of instruction)
 1 memory read - get address of second operand (since second uses indirect addressing)

1 memory read - to get second operand from the address given by the previous memory read

1 memory write - to store to first operand (which is the destination)

So, totally 4 memory cycles once the instruction is fetched.

The second and third words of the instruction are loaded as part of the Instruction fetch and not during the execute stage:
Ref: <http://www.cs.iit.edu/~cs561/cs350/fetch/fetch.html>

20 votes

-- Arjun Suresh (150k points)

2.1.9 Addressing Modes: GATE2005_66 [top](#)



Selected Answer

(c) is the answer.
 $A[i] = B[j]$; Indexed addressing
 $\text{while}(*A++);$ Auto increment
 $\text{temp} = *x;$ Indirect addressing

7 votes

-- Arjun Suresh (150k points)

2.1.10 Addressing Modes: GATE1998_1.19 [top](#)



Selected Answer

PC relative addressing is the best option. For Base register addressing, we have to change the address in the base register while in PC relative there is absolutely no change in code needed.

4 votes

-- Arjun Suresh (150k points)

2.1.11 Addressing Modes: GATE1999_2.23 [top](#)



Selected Answer

Pointer access requires indirect addressing which can be simulated with indexed addressing or register indirect addressing but not with direct and immediate addressing. An array and record access needs a pointer access. So, options A, B and C cannot be implemented on such a processor.

Now, to handle recursive procedures we need to use stack. A local variable inside the stack will be accessed as $*(\text{SP}+\text{offset})$ which is nothing but a pointer access and requires indirect addressing. Usually this is done by moving the SP value to Base register and then using Base Relative addressing to avoid unnecessary memory accesses for indirect addressing- but not possible with just direct and immediate addressing.

So, options A, B, C and D are correct.

9 votes

-- Arjun Suresh (150k points)

2.1.12 Addressing Modes: GATE2006-IT_40 [top](#)



Selected Answer

D) Memory location 1001 has value 20.
 $\text{Rs} < -1$
 $\text{Rd} < -1$
 $\text{Rd} < -1001$
 store in address 1001 $<- 20$

11 votes

-- Abhinav Rana (529 points)

2.1.13 Addressing Modes: GATE2006-IT_39, ISRO2009-42 [top](#)<http://gateoverflow.in/3578>

Selected Answer

(D) is false. Relative addressing cannot be faster than absolute addressing as absolute address must be calculated from relative address. With specialized hardware unit, this can perform equally as good as absolute addressing but not faster.

(A) is true as instead of absolute address we can use a much smaller relative address in instructions which results in smaller instruction size.

(B) By using the base address of array we can index array elements using relative addressing.

(C) is true as we only need to change the base address in case of relocation- instructions remain the same.

16 votes

-- Arjun Suresh (150k points)

2.2**Cache** [top](#)**2.2.1 Cache: GATE2016-2-32** [top](#)<http://gateoverflow.in/39622>

The width of the physical address on a machine is 40 bits. The width of the tag field in a 512 KB 8-way set associative cache is _____ bits.

[gate2016-2](#) [computer-organization](#) [cache](#) [normal](#) [numerical-answers](#)

Answer

Answers: Cache**2.2.1 Cache: GATE2016-2-32** [top](#)<http://gateoverflow.in/39622>

Selected Answer

Physical Address = 40

=> Tag + Set + Block Offset = 40

=> T + S + B = 40 ----- (1)

We have , **Cache Size** = **number of sets * blocks per set * Block size**

=> 512 KB = number of sets * 8 * Block size

=> number of sets * Block size = 512/8 KB = 64 KB

=> S + B = 16 ----- (2)

from (1) & (2)

T = 24 bits (Ans)

14 votes

-- Himanshu Agarwal (9.8k points)

2.3**Cache Memory** [top](#)

2.3.1 Cache Memory: GATE1998_18 [top](#)

<http://gateoverflow.in/1732>

For a set-associative Cache organization, the parameters are as follows:

| | |
|--------------|-------------------------|
| t_c | Cache access time |
| t_m | Main memory access time |
| l | number of sets |
| b | block size |
| $k \times b$ | set size |

Calculate the hit ratio for a loop executed 100 times where the size of the loop is $n \times b$, and $n = k \times m$ is a non-zero integer and $1 < m \leq l$.

Give the value of the hit ratio for $l = 1$.

[gate1998](#) [co&architecture](#) [cache-memory](#) [descriptive](#)

[Answer](#)

2.3.2 Cache Memory: GATE2006-74 [top](#)

<http://gateoverflow.in/1851>

Consider two cache organizations. First one is 32 kb 2-way set associative with 32 byte block size, the second is of same size but direct mapped. The size of an address is 32 bits in both cases. A 2-to-1 multiplexer has latency of 0.6ns while a

k -bit comparator has latency of $\frac{k}{10}\text{ns}$. The hit latency of the set associative organization is h_1 while that of direct mapped is h_2 .

The value of h_1 is:

- A. 2.4 ns
- B. 2.3 ns
- C. 1.8 ns
- D. 1.7 ns

[gate2006](#) [co&architecture](#) [cache-memory](#) [normal](#)

[Answer](#)

2.3.3 Cache Memory: GATE2006-80 [top](#)

<http://gateoverflow.in/1854>

A CPU has a 32 KB direct mapped cache with 128 byte-block size. Suppose A is two dimensional array of size 512×512 with elements that occupy 8-bytes each. Consider the following two C code segments, P1 and P2.

P1:

```
for (i=0; i<512; i++)
{
    for (j=0; j<512; j++)
    {
        x += A[i][j];
    }
}
```

P2:

```
for (i=0; i<512; i++)
{
    for (j=0; j<512; j++)
    {
        x += A[j][i];
    }
}
```

P1 and P2 are executed independently with the same initial state, namely, the array A is not in the cache and i, j, x are in registers. Let the number of cache misses experienced by P1 be M_1 and that for P2 be M_2 .

The value of M_1 is:

- A. 0
- B. 2048
- C. 16384
- D. 262144

[gate2006](#) [co&architecture](#) [cache-memory](#) [normal](#)

[Answer](#)

2.3.4 Cache Memory: GATE2014-1_44 [top](#)

<http://gateoverflow.in/1922>

An access sequence of cache block addresses is of length N and contains n unique block addresses. The number of unique block addresses between two consecutive accesses to the same block address is bounded above by k . What is the miss ratio if the access sequence is passed through a cache of associativity $A \geq k$ exercising least-recently-used replacement policy?

- (A) n/N
- (B) $1/N$
- (C) $1/A$
- (D) k/n

[gate2014-1](#) [co&architecture](#) [cache-memory](#) [normal](#)

[Answer](#)

2.3.5 Cache Memory: GATE2014-2_9 [top](#)

<http://gateoverflow.in/1963>

A 4-way set-associative cache memory unit with a capacity of 16 KB is built using a block size of 8 words. The word length is 32 bits. The size of the physical address space is 4 GB. The number of bits for the TAG field is _____

[gate2014-2](#) [co&architecture](#) [cache-memory](#) [numerical-answers](#) [normal](#)

[Answer](#)

2.3.6 Cache Memory: GATE2014-2_43 [top](#)

<http://gateoverflow.in/2009>

In designing a computer's cache system, the cache block (or cache line) size is an important parameter. Which one of the following statements is correct in this context?

- (A) A smaller block size implies better spatial locality
- (B) A smaller block size implies a smaller cache tag and hence lower cache tag overhead
- (C) A smaller block size implies a larger cache tag and hence lower cache hit time
- (D) A smaller block size incurs a lower cache miss penalty

[gate2014-2](#) [co&architecture](#) [cache-memory](#) [normal](#)

[Answer](#)

2.3.7 Cache Memory: GATE2014-2_44 [top](#)

<http://gateoverflow.in/2010>

If the associativity of a processor cache is doubled while keeping the capacity and block size unchanged, which one of the following is guaranteed to be NOT affected?

- (A) Width of tag comparator
- (B) Width of set index decoder
- (C) Width of way selection multiplexor

(D) Width of processor to main memory data bus

gate2014-2 | co&architecture | cache-memory | normal

[Answer](#)

2.3.8 Cache Memory: GATE2005-IT_61 [top](#)

<http://gateoverflow.in/3822>

Consider a 2-way set associative cache memory with 4 sets and total 8 cache blocks (0-7) and a main memory with 128 blocks (0-127). What memory blocks will be present in the cache after the following sequence of memory block references if LRU policy is used for cache block replacement. Assuming that initially the cache did not have any memory block from the current job?

0 5 3 9 7 0 16 55

- A) 0 3 5 7 16 55
- B) 0 3 5 7 9 16 55
- C) 0 5 7 9 16 55
- D) 3 5 7 9 16 55

gate2005-it | co&architecture | cache-memory | normal

[Answer](#)

2.3.9 Cache Memory: GATE2007-IT_37 [top](#)

<http://gateoverflow.in/3470>

Consider a Direct Mapped Cache with 8 cache blocks (numbered 0-7). If the memory block requests are in the following order

3, 5, 2, 8, 0, 63, 9, 16, 20, 17, 25, 18, 30, 24, 2, 63, 5, 82, 17, 24.

Which of the following memory blocks will not be in the cache at the end of the sequence ?

- A) 3
- B) 18
- C) 20
- D) 30

gate2007-it | co&architecture | cache-memory | normal

[Answer](#)

2.3.10 Cache Memory: GATE2014-3_44 [top](#)

<http://gateoverflow.in/2078>

The memory access time is 1 nanosecond for a read operation with a hit in cache, 5 nanoseconds for a read operation with a miss in cache, 2 nanoseconds for a write operation with a hit in cache and 10 nanoseconds for a write operation with a miss in cache. Execution of a sequence of instructions involves 100 instruction fetch operations, 60 memory operand read operations and 40 memory operand write operations. The cache hit-ratio is 0.9. The average memory access time (in nanoseconds) in executing the sequence of instructions is _____.

gate2014-3 | co&architecture | cache-memory | numerical-answers | normal

[Answer](#)

2.3.11 Cache Memory: GATE2011_43 [top](#)

<http://gateoverflow.in/2145>

An 8KB direct-mapped write-back cache is organized as multiple blocks, each size of 32-bytes. The processor generates 32-bit addresses. The cache controller contains the tag information for each cache block comprising of the following.

- 1 valid bit
- 1 modified bit
- As many bits as the minimum needed to identify the memory block mapped in the cache.

What is the total size of memory needed at the cache controller to store meta-data (tags) for the cache?

- (A) 4864 bits
- (B) 6144 bits
- (C) 6656 bits
- (D) 5376 bits

[gate2011](#) [co&architecture](#) [cache-memory](#) [normal](#)

[Answer](#)

2.3.12 Cache Memory: GATE2012-54 [top](#)

<http://gateoverflow.in/2192>

A computer has a

256-

KByte, 4-way set associative, write back data cache with block size of

32

Bytes. The processor sends

32

bit addresses to the cache controller. Each cache tag directory entry contains, in addition to address tag,

2 valid bits,

1 modified bit and

1 replacement bit.

The number of bits in the tag field of an address is

- A. 11
- B. 14
- C. 16
- D. 27

[gate2012](#) [co&architecture](#) [cache-memory](#) [normal](#)

[Answer](#)

2.3.13 Cache Memory: GATE1993_11 [top](#)

<http://gateoverflow.in/2308>

In the three-level memory hierarchy shown in the following table, p_i denotes the probability that an access request will refer to M_i .

| Hierarchy Level (M_i) | Access Time (t_i) | Probability of access (p_i) | Page Transfer Time (T_i) |
|------------------------------|--------------------------|------------------------------------|---------------------------------|
| M_1 | 10^{-6} | 0.99000 | 0.001 sec |
| M_2 | 10^{-5} | 0.00998 | 0.1 sec |
| M_3 | 10^{-4} | 0.00002 | -- |

If a miss occurs at level M_i , a page transfer occurs from M_{i+1} to M_i and the average time required for such a page swap is T_i . Calculate the average time t_A required for a processor to read one word from this memory system.

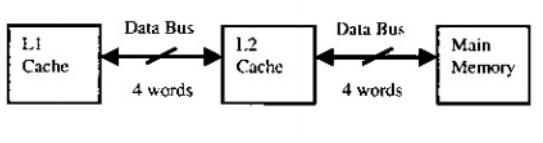
[gate1993](#) [co&architecture](#) [cache-memory](#) [normal](#)

[Answer](#)

2.3.14 Cache Memory: GATE2010-48 [top](#)

<http://gateoverflow.in/2352>

A computer system has an L1 cache, an L2 cache, and a main memory unit connected as shown below. The block size in L1 cache is 4 words. The block size in L2 cache is 16 words. The memory access times are 2 nanoseconds, 20 nanoseconds and 200 nanoseconds for L1 cache, L2 cache and the main memory unit respectively.



When there is a miss in L1 cache and a hit in L2 cache, a block is transferred from L2 cache to L1 cache. What is the time taken for this transfer?

- A. 2 nanoseconds
- B. 20 nanoseconds
- C. 22 nanoseconds
- D. 88 nanoseconds

[gate2010](#) [co&architecture](#) [cache-memory](#) [normal](#)

[Answer](#)

2.3.15 Cache Memory: GATE2004-IT-12, ISRO2016-77 [top](#)

<http://gateoverflow.in/3653>

Consider a system with 2 level cache. Access times of Level 1 cache, Level 2 cache and main memory are 1 ns, 10 ns, and 500 ns, respectively. The hit rates of Level 1 and Level 2 caches are 0.8 and 0.9, respectively. What is the average access time of the system ignoring the search time within the cache?

- A. 13.0
- B. 12.8
- C. 12.6
- D. 12.4

[gate2004-it](#) [co&architecture](#) [cache-memory](#) [normal](#) [isro2016](#)

[Answer](#)

2.3.16 Cache Memory: GATE2015-3_14 [top](#)

<http://gateoverflow.in/8410>

Consider a machine with a byte addressable main memory of 2^{20} bytes, block size of 16 bytes and a direct mapped cache having 2^{12} cache lines. Let the addresses of two consecutive bytes in main memory be $(E201F)_{16}$ and $(E2020)_{16}$. What are the tag and cache line addresses (in hex) for main memory address $(E201F)_{16}$?

- A. E, 201
- B. F, 201
- C. E, E20
- D. 2, 01F

[gate2015-3](#) [co&architecture](#) [cache-memory](#) [normal](#)

[Answer](#)

2.3.17 Cache Memory: GATE1999_1.22 [top](#)

<http://gateoverflow.in/1475>

The main memory of a computer has 2^m blocks while the cache has 2^c blocks. If the cache uses the set associative mapping scheme with 2 blocks per set, then block k of the main memory maps to the set

- A. $(k \bmod m)$ of the cache
- B. $(k \bmod c)$ of the cache
- C. $(k \bmod 2c)$ of the cache
- D. $(k \bmod 2^m)$ of the cache

[gate1999](#) [co&architecture](#) [cache-memory](#) [normal](#)

Answer**2.3.18 Cache Memory: GATE1995_1.6** [top](#)<http://gateoverflow.in/2593>

The principle of locality justifies the use of

- (a) Interrupts
- (b) DMA
- (c) Polling
- (d) Cache Memory

[gate1995](#) [co&architecture](#) [cache-memory](#) [easy](#)
Answer**2.3.19 Cache Memory: GATE1995_2.25** [top](#)<http://gateoverflow.in/2638>

A computer system has a 4 K word cache organized in block-set-associative manner with 4 blocks per set, 64 words per block. The number of bits in the SET and WORD fields of the main memory address format is:

- (A) 15, 40
- (B) 6, 4
- (C) 7, 2
- (D) 4, 6

[gate1995](#) [co&architecture](#) [cache-memory](#) [normal](#)
Answer**2.3.20 Cache Memory: GATE1996_26** [top](#)<http://gateoverflow.in/2778>

A computer system has a three level memory hierarchy, with access time and hit ratios as shown below:

Level 1 (Cache memory)

Access time = 50 nsec/byte

| Size | Hit Ratio |
|-----------|-----------|
| 8 M byte | 0.80 |
| 16 M byte | 0.90 |
| 64 M byte | 0.95 |

Level 2 (main memory)

Access time = 200 nsec/byte

| Size | Hit ratio |
|-----------|-----------|
| 4M byte | 0.98 |
| 16 M byte | 0.99 |
| 64 M byte | 0.995 |

Level 3

| Size | Hit ratio |
|-----------|-----------|
| 260 Mbyte | 1.0 |

- A. What should be the minimum sizes of level 1 and 2 memories to achieve an average access time of less than 100 nsec
- B. What is the average access time achieved using the chosen sizes of level 1 and level 2 memories?

26. A computer system has a three level memory hierarchy, with access time and hit ratios as shown below:

| Level 1 (Cache memory) | | Level 2 (main memory) | | Level 3 | |
|----------------------------|-----------------------------|--------------------------------|-----------|-----------|-----------|
| Access time = 50 nsec/byte | Access time = 200 nsec/byte | Access time = 5 μ sec/byte | | Size | Hit ratio |
| Size | Hit ratio | Size | Hit ratio | Size | Hit ratio |
| 8 M byte | 0.80 | 4M byte | 0.98 | 260 Mbyte | 1.0 |
| 16 M byte | 0.90 | 16 M byte | 0.99 | | |
| 64 M byte | 0.95 | 64 M byte | 0.995 | | |

- (a) What should be the minimum sizes of level 1 and 2 memories to achieve an average access time of less than 100 nsec?
 (b) What is the average access time achieved using the chosen sizes of level 1 and level 2 memories?

gate1996 co&architecture cache-memory normal

Answer

2.3.21 Cache Memory: GATE2006-IT_43 [top](#)

<http://gateoverflow.in/3586>

A computer system has a level-1 instruction cache (I-cache), a level-1 data cache (D-cache) and a level-2 cache (L2-cache) with the following specifications:

| | Capacity | Mapping Method | Block size |
|----------|-----------|-------------------------------|------------|
| I-cache | 4K words | Direct mapping | 4 Words |
| D-cache | 4K words | 2-way set associative mapping | 4 Words |
| L2-cache | 64K words | 4-way set associative mapping | 16 Words |

The length of the physical address of a word in the main memory is 30 bits. The capacity of the tag memory in the I-cache, D-cache and L2-cache is, respectively,

- A) 1 K x 18-bit, 1 K x 19-bit, 4 K x 16-bit
- B) 1 K x 16-bit, 1 K x 19-bit, 4 K x 18-bit
- C) 1 K x 16-bit, 512 x 18-bit, 1 K x 16-bit
- D) 1 K x 18-bit, 512 x 18-bit, 1 K x 18-bit

gate2006-it co&architecture cache-memory normal

Answer

2.3.22 Cache Memory: GATE2008-IT_80 [top](#)

<http://gateoverflow.in/3403>

Consider a computer with a 4-ways set-associative mapped cache of the following characteristics: a total of 1 MB of main memory, a word size of 1 byte, a block size of 128 words and a cache size of 8 KB.

The number of bits in the TAG, SET and WORD fields, respectively are:

- A. 7, 6, 7
- B. 8, 5, 7
- C. 8, 6, 6
- D. 9, 4, 7

gate2008-it co&architecture cache-memory normal

Answer

2.3.23 Cache Memory: GATE2008-IT_81 [top](#)

<http://gateoverflow.in/3405>

Consider a computer with a 4-ways set-associative mapped cache of the following characteristics: a total of 1 MB of main memory, a word size of 1 byte, a block size of 128 words and a cache size of 8 KB.

While accessing the memory location 0C795H by the CPU, the contents of the TAG field of the corresponding cache line is

- A. 000011000
- B. 110001111
- C. 00011000
- D. 110010101

[gate2008-it](#) [co&architecture](#) [cache-memory](#) [normal](#)

[Answer](#)

2.3.24 Cache Memory: GATE2006-IT_42 [top](#)

<http://gateoverflow.in/3585>

A cache line is 64 bytes. The main memory has latency 32ns and bandwidth 1G.Bytes/s. The time required to fetch the entire cache line from the main memory is

- A) 32 ns
- B) 64 ns
- C) 96 ns
- D) 128 ns

[gate2006-it](#) [co&architecture](#) [cache-memory](#) [normal](#)

[Answer](#)

2.3.25 Cache Memory: GATE2004-IT_48 [top](#)

<http://gateoverflow.in/3691>

Consider a fully associative cache with 8 cache blocks (numbered 0-7) and the following sequence of memory block requests:

4, 3, 25, 8, 19, 6, 25, 8, 16, 35, 45, 22, 8, 3, 16, 25, 7

If LRU replacement policy is used, which cache block will have memory block 7?

- | | |
|----|---|
| A) | 4 |
| B) | 5 |
| C) | 6 |
| D) | 7 |

[gate2004-it](#) [co&architecture](#) [cache-memory](#) [normal](#)

[Answer](#)

2.3.26 Cache Memory: GATE2015-2_24 [top](#)

<http://gateoverflow.in/8119>

Assume that for a certain processor, a read request takes 50 nanoseconds on a cache miss and 5 nanoseconds on a cache hit. Suppose while running a program, it was observed that 80% of the processor's read requests result in a cache hit. The average read access time in nanoseconds is _____.

[gate2015-2](#) [co&architecture](#) [cache-memory](#) [easy](#)

[Answer](#)

2.3.27 Cache Memory: GATE2013_20 [top](#)

<http://gateoverflow.in/1442>

In a k -way set associative cache, the cache is divided into v sets, each of which consists of k lines. The lines of a set are placed in sequence one after another. The lines in set s are sequenced before the lines in set $(s + 1)$. The main memory blocks are numbered 0 onwards. The main memory block numbered j must be mapped to any one of the cache lines from

- (A) $(j \bmod v) * k$ to $(j \bmod v) * k + (k - 1)$

- (B) $(j \bmod v)$ to $(j \bmod v) + (k - 1)$
 (C) $(j \bmod k)$ to $(j \bmod k) + (v - 1)$
 (D) $(j \bmod k) * v$ to $(j \bmod k) * v + (v - 1)$

gate2013 | co&architecture | cache-memory | normal

Answer

2.3.28 Cache Memory: GATE2012-55 [top](#)

<http://gateoverflow.in/43311>

A computer has a 256-KByte, 4-way set associative, write back data cache with block size of 32 Bytes. The processor sends 32 bit addresses to the cache controller. Each cache tag directory entry contains, in addition to address tag, 2 valid bits, 1 modified bit and 1 replacement bit.

The size of the cache tag directory is

- A. 160 Kbits
- B. 136 Kbits
- C. 40 Kbits
- D. 32 Kbits

normal | gate2012 | co&architecture | cache-memory

Answer

2.3.29 Cache Memory: GATE2002_10 [top](#)

<http://gateoverflow.in/863>

In a C program, an array is declared as float A[2048]. Each array element is 4 Bytes in size, and the starting address of the array is 0x00000000. This program is run on a computer that has a direct mapped data cache of size 8 Kbytes, with block (line) size of 16 Bytes.

- Which elements of the array conflict with element A[0] in the data cache? Justify your answer briefly.
- If the program accesses the elements of this array one by one in reverse order i.e., starting with the last element and ending with the first element, how many data cache misses would occur? Justify your answer briefly. Assume that the data cache is initially empty and that no other data or instruction accesses are to be considered.

gate2002 | co&architecture | cache-memory | normal

Answer

2.3.30 Cache Memory: GATE2008-73 [top](#)

<http://gateoverflow.in/43491>

Consider a machine with a 2-way set associative data cache of size 64 Kbytes and block size 16 bytes. The cache is managed using 32 bit virtual addresses and the page size is 4 Kbytes. A program to be run on this machine begins as follows:

```
double ARR[1024][1024];
int i, j;
/*Initialize array ARR to 0.0 */
for(i = 0; i < 1024; i++)
    for(j = 0; j < 1024; j++)
        ARR[i][j] = 0.0;
```

The size of double is 8 bytes. Array ARR is located in memory starting at the beginning of virtual page 0xFF000 and stored in row major order. The cache is initially empty and no pre-fetching is done. The only data memory references made by the program are those to array ARR.

The cache hit ratio for this initialization loop is

- A. 0%
- B. 25%
- C. 50%
- D. 75%

[gate2008](#) [co&architecture](#) [cache-memory](#) [normal](#)
Answer

2.3.31 Cache Memory: GATE2004_65 [top](#)

<http://gateoverflow.in/1059>

Consider a small two-way set-associative cache memory, consisting of four blocks. For choosing the block to be replaced, use the least recently used (LRU) scheme. The number of cache misses for the following sequence of block addresses is

8, 12, 0, 12, 8

- A. 2
- B. 3
- C. 4
- D. 5

[gate2004](#) [co&architecture](#) [cache-memory](#) [normal](#)
Answer

2.3.32 Cache Memory: GATE2007-81 [top](#)

<http://gateoverflow.in/43511>

Consider a machine with a byte addressable main memory of 216 bytes. Assume that a direct mapped data cache consisting of 32 lines of 64 bytes each is used in the system. A 50×50 two-dimensional array of bytes is stored in the main memory starting from memory location 1100H. Assume that the data cache is initially empty. The complete array is accessed twice. Assume that the contents of the data cache do not change in between the two accesses.

Which of the following lines of the data cache will be replaced by new blocks in accessing the array for the second time?

- A. line 4 to line 11
- B. line 4 to line 12
- C. line 0 to line 7
- D. line 0 to line 8

[gate2007](#) [co&architecture](#) [cache-memory](#) [normal](#)
Answer

2.3.33 Cache Memory: GATE2001-9 [top](#)

<http://gateoverflow.in/750>

A CPU has 32-bit memory address and a 256 KB cache memory. The cache is organized as a 4-way set associative cache with cache block size of 16 bytes.

- a. What is the number of sets in the cache?
- b. What is the size (in bits) of the tag field per cache block?
- c. What is the number and size of comparators required for tag matching?
- d. How many address bits are required to find the byte offset within a cache block?
- e. What is the total amount of extra memory (in bytes) required for the tag bits?

[gate2001](#) [co&architecture](#) [cache-memory](#) [normal](#)
Answer

2.3.34 Cache Memory: GATE2007_10 [top](#)

<http://gateoverflow.in/1208>

Consider a 4-way set associative cache consisting of 128 lines with a line size of 64 words. The CPU generates a 20-bit address of a word in main memory. The number of bits in the TAG, LINE and WORD fields are respectively:

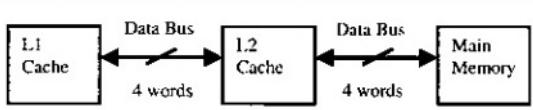
- A. 9, 6, 5
- B. 7, 7, 6
- C. 7, 5, 8
- D. 9, 5, 6

[gate2007](#) [co&architecture](#) [cache-memory](#) [normal](#)
Answer

2.3.35 Cache Memory: GATE2010-49 [top](#)

<http://gateoverflow.in/43329>

A computer system has an L1 cache, an L2 cache, and a main memory unit connected as shown below. The block size in L1 cache is 4 words. The block size in L2 cache is 16 words. The memory access times are 2 nanoseconds, 20 nanoseconds and 200 nanoseconds for L1 cache, L2 cache and the main memory unit respectively.



When there is a miss in both L1 cache and L2 cache, first a block is transferred from main memory to L2 cache, and then a block is transferred from L2 cache to L1 cache. What is the total time taken for these transfers?

- A. 222 nanoseconds
- B. 888 nanoseconds
- C. 902 nanoseconds
- D. 968 nanoseconds

[gate2010](#) [co&architecture](#) [cache-memory](#) [normal](#)
Answer

2.3.36 Cache Memory: GATE1992-5,a [top](#)

<http://gateoverflow.in/584>

The access times of the main memory and the Cache memory, in a computer system, are 500 n sec and 50 n sec, respectively. It is estimated that 80% of the main memory request are for read the rest for write. The hit ratio for the read access only is 0.9 and a write-through policy (where both main and cache memories are updated simultaneously) is used. Determine the average time of the main memory.

[gate1992](#) [co&architecture](#) [cache-memory](#) [normal](#)
Answer

2.3.37 Cache Memory: GATE2007-80 [top](#)

<http://gateoverflow.in/1273>

Consider a machine with a byte addressable main memory of 2^{16} bytes. Assume that a direct mapped data cache consisting of 32 lines of 64 bytes each is used in the system. A 50×50 two-dimensional array of bytes is stored in the main memory starting from memory location 1100H. Assume that the data cache is initially empty. The complete array is accessed twice. Assume that the contents of the data cache do not change in between the two accesses.

How many data misses will occur in total?

- A. 48
- B. 50
- C. 56
- D. 59

[gate2007](#) [co&architecture](#) [cache-memory](#) [normal](#)
Answer

2.3.38 Cache Memory: GATE2008-72 [top](#)

<http://gateoverflow.in/43490>

Consider a machine with a 2-way set associative data cache of size 64 Kbytes and block size 16 bytes. The cache is managed using 32 bit virtual addresses and the page size is 4 Kbytes. A program to be run on this machine begins as follows:

```

double ARR[1024][1024];
int i, j;
/*Initialize array ARR to 0.0 */
for(i = 0; i < 1024; i++)
    for(j = 0; j < 1024; j++)
        
```

```
ARR[i][j] = 0.0;
```

The size of double is 8 bytes. Array ARR is located in memory starting at the beginning of virtual page 0xFF000 and stored in row major order. The cache is initially empty and no pre-fetching is done. The only data memory references made by the program are those to array ARR.

Which of the following array elements have the same cache index as ARR[0][0]?

- A. ARR[0][4]
- B. ARR[4][0]
- C. ARR[0][5]
- D. ARR[5][0]

[gate2008](#) [co&architecture](#) [cache-memory](#) [normal](#)

[Answer](#)

2.3.39 Cache Memory: GATE2006-81 [top](#)

<http://gateoverflow.in/43517>

A CPU has a 32 KB direct mapped cache with 128 byte-block size. Suppose A is two dimensional array of size 512×512 with elements that occupy 8-bytes each. Consider the following two C code segments, P1 and P2.

P1:

```
for (i=0; i<512; i++)
{
    for (j=0; j<512; j++)
    {
        x += A[i][j];
    }
}
```

P2:

```
for (i=0; i<512; i++)
{
    for (j=0; j<512; j++)
    {
        x += A[j][i];
    }
}
```

P1 and P2 are executed independently with the same initial state, namely, the array A is not in the cache and i, j, x are in registers. Let the number of cache misses experienced by P1 be M1 and that for P2 be M2.

The value of the ratio $\frac{M_1}{M_2}$

- A. 0
- B. $\frac{1}{16}$
- C. $\frac{1}{8}$
- D. 16

[co&architecture](#) [cache-memory](#) [normal](#) [gate2006](#)

[Answer](#)

2.3.40 Cache Memory: GATE2006-75 [top](#)

<http://gateoverflow.in/43565>

Consider two cache organizations. First one is 32 kb 2-way set associative with 32 byte block size, the second is of same size but direct mapped. The size of an address is 32 bits in both cases. A 2-to-1 multiplexer has latency of 0.6ns while a k -bit comparator has latency of $\frac{k}{10}\text{ns}$. The hit latency of the set associative organization is h_1 while that of direct mapped is h_2 . The value of h_2 is:

- A. 2.4 ns
- B. 2.3 ns
- C. 1.8 ns
- D. 1.7 ns

[gate2006](#) [co&architecture](#) [cache-memory](#) [normal](#)

Answer**2.3.41 Cache Memory: GATE2008-35** [top](#)<http://gateoverflow.in/446>

For inclusion to hold between two cache levels L1 and L2 in a multi-level cache hierarchy, which of the following are necessary?

- I. L1 must be write-through cache
 - II. L2 must be a write-through cache
 - III. The associativity of L2 must be greater than that of L1
 - IV. The L2 cache must be at least as large as the L1 cache
- A. IV only
 - B. I and IV only
 - C. I, II and IV only
 - D. I, II, III and IV

[gate2008](#) [co&architecture](#) [cache-memory](#) [normal](#)
Answer**2.3.42 Cache Memory: GATE2005_67** [top](#)<http://gateoverflow.in/1390>

Consider a direct mapped cache of size 32 KB with block size 32 bytes. The CPU generates 32 bit addresses. The number of bits needed for cache indexing and the number of tag bits are respectively,

- A. 10, 17
- B. 10, 22
- C. 15, 17
- D. 5, 17

[gate2005](#) [co&architecture](#) [cache-memory](#) [easy](#)
Answer**2.3.43 Cache Memory: GATE2008-71** [top](#)<http://gateoverflow.in/494>

Consider a machine with a 2-way set associative data cache of size 64 Kbytes and block size 16 bytes. The cache is managed using 32 bit virtual addresses and the page size is 4 Kbytes. A program to be run on this machine begins as follows:

```
double ARR[1024][1024];
int i, j;
/*Initialize array ARR to 0.0 */
for(i = 0; i < 1024; i++)
    for(j = 0; j < 1024; j++)
        ARR[i][j] = 0.0;
```

The size of double is 8 bytes. Array ARR is located in memory starting at the beginning of virtual page 0xFF000 and stored in row major order. The cache is initially empty and no pre-fetching is done. The only data memory references made by the program are those to array ARR.

The total size of the tags in the cache directory is

- A. 32 Kbits
- B. 34 Kbits
- C. 64 Kbits
- D. 68 Kbits

[gate2008](#) [co&architecture](#) [cache-memory](#) [normal](#)
Answer**2.3.44 Cache Memory: GATE2009-29** [top](#)<http://gateoverflow.in/1315>

Consider a 4-way set associative cache (initially empty) with total 16 cache blocks. The main memory consists of 256 blocks and the request for memory blocks are in the following order:

0, 255, 1, 4, 3, 8, 133, 159, 216, 129, 63, 8, 48, 32, 73, 92, 155.

Which one of the following memory block will NOT be in cache if LRU replacement policy is used?

- A. 3
- B. 8
- C. 129
- D. 216

[gate2009](#) [co&architecture](#) [cache-memory](#) [normal](#)

[Answer](#)

Answers: Cache Memory

2.3.1 Cache Memory: GATE1998_18 [top](#)

<http://gateoverflow.in/1732>



Selected Answer

Size of the loop = $n \times b = k \times m \times b$

Size of a set = $k \times b$ (k - way associative)

Here, size of the loop is smaller than size of a set as $m \leq l$. Now, however be the mapping (whether all be mapped to the same set or not), we are guaranteed that the entire loop is in cache without any replacement.

For the first iteration:

No. of accesses = $n \times b$

No. of misses = n as each new block access is a miss and loop body has n blocks each of size b for a total size of $n \times b$.

For, the remaining 99 iterations:

No. of accesses = $n \times b$

No. of misses = 0

So, total no. of accesses = $100nb$

Total no. of hits = Total no. of accesses – Total no. of misses

= $100nb - n$

So, hit ratio = $\frac{100nb - n}{100nb} = 1 - \frac{1}{100b}$

The hit ratio is independent if l , so for $l = 1$ also we have hit ratio = $1 - \frac{1}{100b}$

3 votes

-- Arjun Suresh (150k points)

2.3.2 Cache Memory: GATE2006-74 [top](#)

<http://gateoverflow.in/1851>



Selected Answer

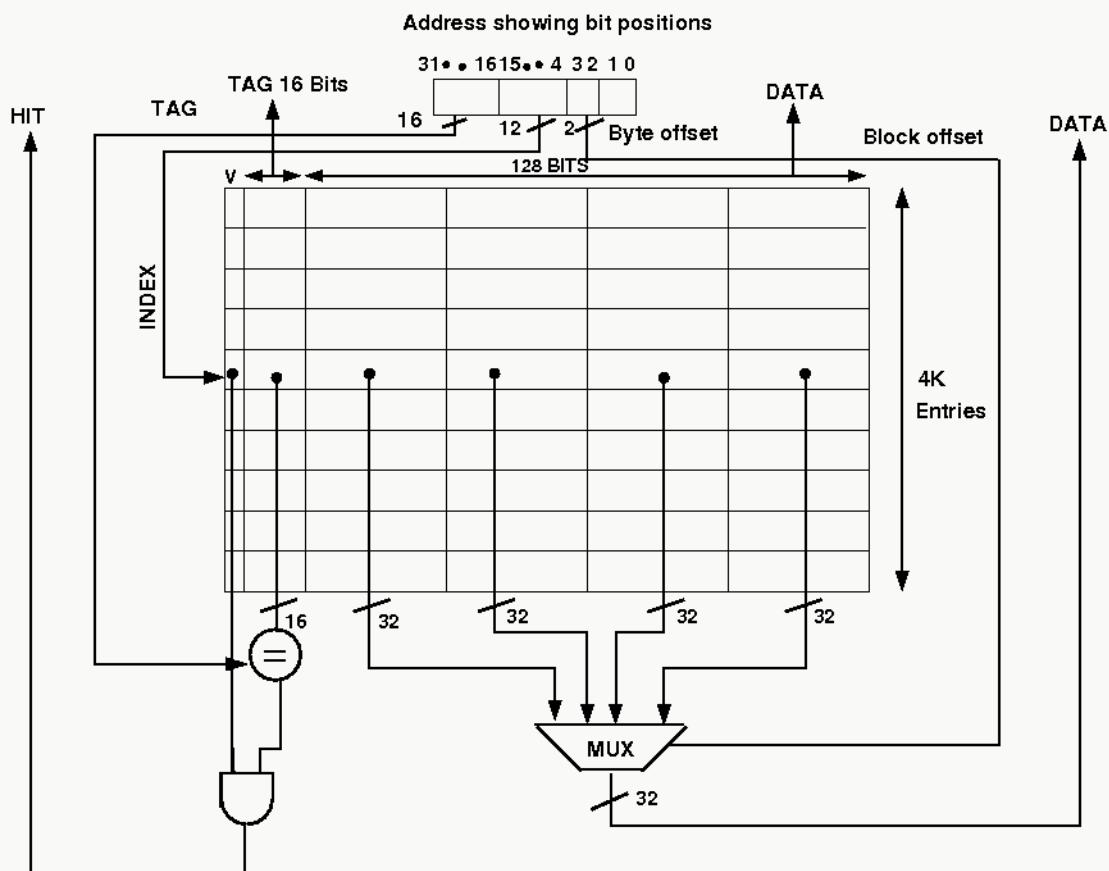
Cache size is 32 KB and cache block size is 32 B. So,

$$\begin{aligned} \text{number of sets} &= \frac{\text{cache size}}{\text{no. of blocks in a set} \times \text{block size}} \\ &= \frac{32KB}{2 \times 32B} = 512 \end{aligned}$$

So, number of index bits needed = 9 (since $2^9 = 512$). Number of offset bits = 5 (since $2^5 = 32$ B is the block size and assuming byte addressing). So, number of tag bits = $32 - 9 - 5 = 18$ (as memory address is of 32 bits).

So, time for comparing the data = Time to compare the data + Time to select the block in set = $0.6 + 18/10 \text{ ns} = 2.4 \text{ ns}$. (Two comparisons of tag bits need to be done for each block in a set, but they can be carried out in parallel and the succeeding one multiplexed as the output).

Ref: <https://courses.cs.washington.edu/courses/cse378/09au/lectures/cse378au09-19.pdf>



13 votes

-- Arjun Suresh (150k points)

2.3.3 Cache Memory: GATE2006-80 [top](#)

<http://gateoverflow.in/194>



Selected Answer

Code being C implies array layout is row-major.

http://en.wikipedia.org/wiki/Row-major_order

When $A[0][0]$ is fetched, 128 consecutive bytes are moved to cache. So, for the next $128/8 - 1 = 15$ memory references there won't be a cache miss. For the next iteration of i loop also the same thing happens as there is no temporal locality in the code. So, number of cache misses for P1

$$= \frac{512}{16} \times 512$$

$$= 32 \times 512$$

$$= 2^{14} = 16384$$

12 votes

-- Arjun Suresh (150k points)

2.3.4 Cache Memory: GATE2014-1_44 [top](#)

<http://gateoverflow.in/1922>



Selected Answer

There are N accesses to cache.

Out of these n are unique block addresses.

Now, we need to find the number of misses. (min. n misses are guaranteed whatever be the access sequence due to n unique block addresses)

We are given that between two consecutive accesses to the same block, there can be only k unique block addresses. So, for a block to get replaced we can assume that all the next k block addresses goes to the same set (given cache is set-associative) which will be the worst case scenario (they may also go to a different set but then there is lesser chance of a replacement). Now, if associativity size is $\geq k$, and if we use LRU (Least Recently Used) replacement policy, we can guarantee that these k accesses won't throw out our previously accessed cache entry (for that we need at least k accesses). So, this means we are at the best-cache scenario for cache replacement -- out of N accesses we miss only n (which are unique and can not be helped from getting missed and there is no block replacement in cache). So, miss ratio is n/N .

PS: In question it is given "bounded above by k", which should mean k unique block accesses as k is an integer, but to ensure no replacement this must be 'k-1'. Guess, a mistake in question.

27 votes

-- Arjun Suresh (150k points)

2.3.5 Cache Memory: GATE2014-2_9 [top](#)

<http://gateoverflow.in/1963>



Selected Answer

Number of sets = cache size / sizeof a set

Size of a set = blocksize * no. of blocks in a set
 $= 8 \text{ words} * 4$ (4-way set-associative)
 $= 8*4*4$ (since a word is 32 bits = 4 bytes)
 $= 128 \text{ bytes}$.

So, number of sets = $16 \text{ KB} / (128 \text{ B}) = 128$

Now, we can divide the physical address space equally between these 128 sets. So, the number of bytes each set can access
 $= 4 \text{ GB} / 128$
 $= 32 \text{ MB}$
 $= 32/4 = 8 \text{ M words} = 1 \text{ M blocks. } (2^{20} \text{ blocks})$

So, we need 20 tag bits to identify these 2^{20} blocks.

14 votes

-- Arjun Suresh (150k points)

2.3.6 Cache Memory: GATE2014-2_43 [top](#)

<http://gateoverflow.in/2009>



Selected Answer

(A) A smaller block size means during a memory access only a smaller part of near by addresses are brought to cache-meaning spatial locality is reduced.

(B) A smaller block size means more number of blocks (assuming cache size constant)and hence we need more cache tag bits to identify the correct block. So, cache tag becomes bigger.

(C) A smaller block size implying larger cache tag is true, but this can't lower cache hit time in any way.

(D) A smaller block size incurs a lower cache miss penalty. This is because during a cache miss, an entire cache block is fetched from next lower level of memory. So, a smaller block size means only a smaller amount of data needs to be fetched and hence reduces the miss penalty (Cache block size can go til the size of data bus to the next level of memory, and beyond this only increasing the cache block size increases the cache miss penalty).

11 votes

-- Arjun Suresh (150k points)

2.3.7 Cache Memory: GATE2014-2_44 [top](#)

<http://gateoverflow.in/2010>



Selected Answer

If associativity is doubled, keeping the capacity and block size constant, then the number of sets gets halved. So, width of set index decoder can surely decrease - (B) is false.

Width of way-selection multiplexer must be increased as we have to double the ways to choose from- (C) is false

As the number of sets gets decreased, the number of possible cache block entries that a set maps to gets increased. So, we need more tag bits to identify the correct entry. So, (A) is also false.

(D) is the correct answer- main memory data bus has nothing to do with cache associativity- this can be answered without even looking at other options.

8 votes

-- Arjun Suresh (150k points)

2.3.8 Cache Memory: GATE2005-IT_61 [top](#)

<http://gateoverflow.in/3822>



Selected Answer

128 main memory blocks are mapped to 4 sets in cache. So, each set maps 32 blocks each. And in each set there is place for two blocks (2-way set).

Now, we have 4 sets meaning 2 index bits. Also, 32 blocks going to one set means 5 tag bits.

Now, these 7 bits identify a memory block and tag bits are placed before index bits. (otherwise adjacent memory references- spatial locality- will hamper cache performance)

So, based on the two index bits (lower 2 bits) blocks will be going to sets as follows:

| Set Number | Block Numbers |
|------------|---------------|
| 0 | 0, 16 |
| 1 | 5, 9 |
| 2 | |
| 3 | 3, 7, 55 |

Since, each set has only 2 places, 3 will be thrown out as it's the least recently used block. So, final content of cache will be

0 5 7 9 16 55

(C) choice.

13 votes

-- Arjun Suresh (150k points)

2.3.9 Cache Memory: GATE2007-IT_37 [top](#)

<http://gateoverflow.in/3470>



Selected Answer

ans is B

cache location (memory block) = block req mod number of cache blocks. Since each block has only one location (associativity is 1) the last mod 8 request will be in cache (no need of any replacement policy as mapping is direct).

3, 5, 2, 8, 0, 63, 9, 16, 20, 17, 25, 18, 30, 24, 2, 63, 5, 82, 17, 24

Block 0- 8, 0, 16, 24. At end contains 24.

1- 9, 17, 25, 63, 17.

2- 2, 18, 2, 82.

3- 3.

4- 20.

5- 5, 5.
6- 30.
7- 63 63.

So, memory block 18 is not in cache while 3, 20 and 30 are in cache.

5 votes

-- rajsh3kar (831 points)

2.3.10 Cache Memory: GATE2014-3_44 [top](#)

<http://gateoverflow.in/2078>



Selected Answer

Fetch is also a memory read operation.

$$\text{Avg access time} = \frac{160(0.9 \times 1 + 0.1 \times 5) + 40(0.9 \times 2 + 0.1 \times 10)}{200} = \frac{160 \times 1.4 + 40 \times 2.8}{200} = \frac{336}{200} = 1.68$$

14 votes

-- aravind90 (609 points)

2.3.11 Cache Memory: GATE2011_43 [top](#)

<http://gateoverflow.in/2145>



Selected Answer

$$\begin{aligned} \text{Number of cache blocks} &= \text{cache size / size of a block} \\ &= 8 \text{ KB}/32 \text{ B} \\ &= 256 \end{aligned}$$

So, we need 8 bits for indexing the 256 blocks of the cache. And since a block is 32 bytes we need 5 WORD bits to address each byte. So, out of the remaining 19 bits (32 - 8 - 5) should be tag bits.

$$\begin{aligned} \text{So, a tag entry size} &= 19 + 1(\text{valid bit}) + 1(\text{modified bit}) = 21 \text{ bits.} \\ \text{Total size of metadata} &= 21 * \text{Number of cache blocks} \\ &= 21 * 256 \\ &= 5376 \text{ bits} \end{aligned}$$

8 votes

-- Arjun Suresh (150k points)

2.3.12 Cache Memory: GATE2012-54 [top](#)

<http://gateoverflow.in/2192>



Selected Answer

$$\begin{aligned} \text{Total cache size} &= 256 \text{ KB} \\ \text{Cache block size} &= 32 \text{ Bytes} \\ \text{So, number of cache entries} &= 256 \text{ K} / 32 = 8 \text{ K} \end{aligned}$$

Number of sets in cache = 8 K/4 = 2 K as cache is 4-way associative.

So, $\log(2048) = 11$ bits are needed for accessing a set. Inside a set we need to identify the cache entry.

No. of memory block possible = Memory size/Cache block size

$$= \frac{2^{32}}{32} = 2^{27}.$$

So, no. of memory block that can go to a single cache set

$$= \frac{2^{27}}{2^{11}} = 2^{16}.$$

So, we need 16 tag bits along with each cache entry to identify which of the possible 2^{16} blocks is being mapped there.

9 votes

-- Arjun Suresh (150k points)

2.3.13 Cache Memory: GATE1993_11 [top](#)

<http://gateoverflow.in/2308>

We are given the probability of access being a hit in each level (clear since their sum adds to 1). So, we can get the average access time as:

$$t_A = 0.99 \times 10^{-6} + 0.00998 \times (10^{-6} + 10^{-5} + 0.001) + 0.00002 \times (10^{-6} + 10^{-5} + 10^{-4} + 0.1 + 0.001) \approx (0.99 + 1 + 2)$$

We can also use the following formula- for 100% of accesses M_1 is accessed, whenever M_1 is a miss, M_2 is accessed and when both misses only M_3 is accessed. So, average memory access time,

$$t_A = 10^{-6} + (1 - 0.99) \times (10^{-5} + 0.001) + 0.00002 \times (10^{-4} + 0.1) = 1 + 1.01 + 2 = 4.01\mu s.$$

2 votes

-- Arjun Suresh (150k points)

2.3.14 Cache Memory: GATE2010-48 [top](#)

<http://gateoverflow.in/2352>



Selected Answer

Ideally the answer should be 20 ns as it is the time to transfer a block from L2 to L1 and this time only is asked in question. But there is confusion regarding access time of L2 as this means the time to read data from L2 till CPU but here we need the time till L1 only. So, I assume the following is what is meant by the question.

A block is transferred from L2 to L1. And L1 block size being 4 words (since L1 is requesting we need to consider L1 block size and not L2 block size) and data width being 4 bytes, it requires one L2 access (for read) and one L1 access (for store). So, time = 20+2 = 22 ns.

23 votes

-- Arjun Suresh (150k points)

2.3.15 Cache Memory: GATE2004-IT-12, ISRO2016-77 [top](#)

<http://gateoverflow.in/3653>



Selected Answer

By default we consider hierarchical access - because that is the common implementation and simultaneous access cache has great practical difficulty. But here the question is a bit ambiguous -- it says to ignore search time within the cache - usually search is applicable for an associative cache but here no such information given. So, may be they are telling to ignore the search time for L1 and just consider the time for L2 for an L1 miss and similarly just consider memory access time for L2 miss. This is nothing but simultaneous access.

$$\text{Access time for hierarchical access} = t_1 + (1 - h_1) \times t_2 + (1 - h_1)(1 - h_2)t_m = 1 + 0.2 \times 10 + 0.2 \times 0.1 \times 500 = 13ns.$$

$$\text{Access time for simultaneous access} = h_1 \times t_1 + (1 - h_1)h_2 \times t_2 + (1 - h_1)(1 - h_2)t_m = 0.8 + 0.2 \times 0.9 \times 10 + 0.2 \times 0.1 \times 500 = 12.6ns.$$

Both options in choice - :O

10 votes

-- Arjun Suresh (150k points)

option C

$$t_1 * h_1 + (1 - h_1) h_2 t_2 + (1 - h_1) (1 - h_2) t_m$$

t_m- main memory access time

10 votes

-- rajsh3kar (831 points)

2.3.16 Cache Memory: GATE2015-3_14 [top](#)

<http://gateoverflow.in/8410>



Selected Answer

Block size of 16 bytes means we need 4 offset bits. (The lowest 4 digits of memory address are offset bits)

Number of sets in cache (cache lines) = 2^{12} so the next lower 12 bits are used for set indexing.

The top 4 bits (out of 20) are tag bits.

So, Answer A.

10 votes

-- Arjun Suresh (150k points)

2.3.17 Cache Memory: GATE1999_1.22 [top](#)

<http://gateoverflow.in/1475>



Selected Answer

Number of cache blocks = 2^c

Number of sets in cache = $2^c/2 = c$ since each set has 2 blocks. Now, a block of main memory gets mapped to a set (associativity of 2 just means there are space for 2 memory blocks in a cache set), and we have 2^cm blocks being mapped to c sets. So, in each set 2^m different main memory blocks can come and block k of main memory will be mapped to $k \bmod c$.

7 votes

-- Arjun Suresh (150k points)

2.3.18 Cache Memory: GATE1995_1.6 [top](#)

<http://gateoverflow.in/2593>



Selected Answer

It is D.

Locality of reference is actually the frequent accessing of any storage location or some value. We can say in simple language that whatever things are used more frequently, they are stored in the locality of reference. So we have cache memory for the purpose.

8 votes

-- Gate Keeda (17.7k points)

2.3.19 Cache Memory: GATE1995_2.25 [top](#)

<http://gateoverflow.in/2638>



Selected Answer

Number of sets = $4K / (64 * 4) = 16$. So, we need 4 bits to identify a set => SET = 4 bits.

64 words per block means WORD is 6 bits.

So, (D)

7 votes

-- Arjun Suresh (150k points)

2.3.20 Cache Memory: GATE1996_26 [top](#)

<http://gateoverflow.in/2778>



Selected Answer

The equation for access time can be written as follows (assuming a, b are the hit ratios of level1 and level2 respectively).

$$T = T_1 + (1 - a)T_2 + (1 - a) \times (1 - b)T_3$$

Here $T \leq 100$, $T_1 = 50\text{ns}$, $T_2 = 200\text{ns}$ and $T_3 = 5000\text{ns}$. On substituting the a, b for the first case we get

$$T = 95\text{ns} \text{ for } a = 0.8 \text{ and } b = 0.995. \text{ i.e., L1 = 8M and L2 = 64M.}$$

T = 75ns for a = 0.9 and b = 0.99. i.e., L1 = 16M and L2 = 4M

b.

1. $L_1 = 8M, a = 0.8, L_2 = 4M, b = 0.98$. So,
 $T = 50 + 0.2 \times 200 + 0.2 \times 0.02 \times 5000 = 50 + 40 + 20 = 110\text{ns}$
2. $L_1 = 16M, a = 0.9, L_2 = 16M, b = 0.99$. So,
 $T = 50 + 0.1 \times 200 + 0.1 \times 0.01 \times 5000 = 50 + 20 + 5 = 75\text{ns}$
3. $L_1 = 64M, a = 0.95, L_2 = 64M, b = 0.995$. So,
 $T = 50 + 0.05 \times 200 + 0.05 \times 0.005 \times 5000 = 50 + 10 + 1.25 = 61.25\text{ns}$

2 votes

-- kireeti (1k points)

2.3.21 Cache Memory: GATE2006-IT_43 [top](#)

<http://gateoverflow.in/3586>



Selected Answer

1. I-cache

- Number of blocks in cache = $4K/4 = 2^{10}$ blocks
- Bits to represent blocks = 10
- Number of words in a block = $4 = 2^2$ words
- Bits to represent words = 2
- tag bits = $30 - (10+2) = 18$
- Each block will have its own tag bits. So total tag bits = $1K \times 18$ bits.

2. D-cache

- Number of blocks in cache = $4K/4 = 2^{10}$ blocks
- Number of sets in cache = $2^{10}/2 = 2^9$ sets
- Bits to represent sets = 9
- Number of words in a block = $4 = 2^2$ words
- Bits to represent words = 2
- tag bits = $30 - (+2) = 19$
- Each block will have its own tag bits. So total tag bits = $1K \times 19$ bits.

3. L2 cache

- Number of blocks in cache = $64K/16 = 2^{12}$ blocks
- Number of sets in cache = $2^{12}/4 = 2^{10}$ sets
- Bits to represent sets = 10
- Number of words in cache = $16 = 2^4$ words
- Bits to represent words = 4
- tag bits = $30 - (10+4) = 16$
- Each block will have its own tag bits. So total tag bits = $2^{12} \times 16$ bits = $4K \times 16$ bits

Option A.

7 votes

-- Viral Kapoor (1.8k points)

2.3.22 Cache Memory: GATE2008-IT_80 [top](#)

<http://gateoverflow.in/3403>



Selected Answer

Number of cache blocks = $8\text{KB}/(128*1) = 64$

Number of sets in cache = Number of cache blocks/ 4 (4-way set)
 $= 64 / 4 = 16$

So, number of SET bits required = 4 (as $2^4 = 16$, and with 4 bits we can get 16 possible outputs)

We can now straight away choose (D) as answer but for confirmation can proceed further.

Since, only physical memory information is given we can assume cache is physically tagged (which is anyway the common case even in case of virtual memory). So, we can divide the physical memory into 16 regions so that, each set maps into only its assigned region. So, size of a region a set can address = $1\text{MB}/16 = 2^{16}$ Bytes = $2^{16}/128 = 2^9$ cache blocks (as cache block size is 128 words = 128 bytes). So, when an access comes to an cache entry, it must be able to determine which out of the 2^9 possible physical block it is. In short it needs 9 bits for TAG.

Now, cache block size is 128 words and so to identify a word we need 7 bits for WORD.

7 votes

-- Arjun Suresh (150k points)

2.3.23 Cache Memory: GATE2008-IT_81 [top](#)

<http://gateoverflow.in/3405>



Selected Answer

As shown in https://gateoverflow.in/3403/gate2008-it_80 we have 16 sets in cache and correspondingly 16 regions in physical memory to which each set is mapped. Now, WORD bit size is 7 as we need 7 bits to address 128 possible words in a cache block. So, the lowest 7 bits of 0C795H will be used for this giving us the remaining bits as 0000 1100 0111 1

Of these bits, the lower 4 are used for addressing the 16 possible sets, giving us the tag bits: 0000 1100 0 in (A) choice.

9 votes

-- Arjun Suresh (150k points)

2.3.24 Cache Memory: GATE2006-IT_42 [top](#)

<http://gateoverflow.in/3585>



Selected Answer

ans : c

for 1 sec it is 10^9 bytes

so for 64 bytes?

it is $64 * 1 / 10^9$ so it is 64 ns but mm latency is 32 so total time required to place cache line is

$64+32 = 96$ ns

10 votes

-- rajsh3kar (831 points)

2.3.25 Cache Memory: GATE2004-IT_48 [top](#)

<http://gateoverflow.in/3691>



Selected Answer

When 45 comes, the cache contents are
4 3 25 8 19 6 16 35

LRU array (first element being least recently used)

[4 3 19 6 25 8 16 35]

So, 45 replaces 4

45 3 25 8 19 6 16 35 [3 19 6 25 8 16 35 45]

Similarly 22 replaces 3 to give

45 22 25 8 19 6 16 35 [19 6 25 8 16 35 45 22]

8 hits in cache

45 22 25 8 19 6 16 35 [19 6 25 16 35 45 22 8]

3 replaces 19

45 22 25 8 3 6 16 35 [6 25 16 35 45 22 8 3]

16 and 25 hits in cache

45 22 25 8 3 6 16 35 [6 35 45 22 8 16 25 3]

Finally 7 replaces 6, which is in block 5.

So, answer is (B)

6 votes

-- Arjun Suresh (150k points)

2.3.26 Cache Memory: GATE2015-2_24 [top](#)

<http://gateoverflow.in/8119>



Selected Answer

Ans 14 ns = 0.8(5) + 0.2(50)

10 votes

-- Vikrant Singh (11k points)

2.3.27 Cache Memory: GATE2013_20 [top](#)

<http://gateoverflow.in/1442>



Selected Answer

Number of sets in cache = v . The question gives a sequencing for the cache lines. For set 0, the cache lines are numbered 0, 1, .., $k-1$. Now for set 1, the cache lines are numbered k , $k+1$, ..., $k+k-1$ and so on. So, main memory block j will be mapped to set $(j \bmod v)$, which will be any one of the cache lines from $(j \bmod v) * k$ to $(j \bmod v) * k + (k-1)$. (Associativity plays no role in mapping- k -way associativity means there are k spaces for a block and hence reduces the chances of replacement.)

15 votes

-- Arjun Suresh (150k points)

2.3.28 Cache Memory: GATE2012-55 [top](#)

<http://gateoverflow.in/43311>



Selected Answer

Total cache size = 256 KB

Cache block size = 32 Bytes

So, number of cache entries = $256 \text{ K} / 32 = 8 \text{ K}$

Number of sets in cache = $8 \text{ K}/4 = 2 \text{ K}$ as cache is 4-way associative.

So, $\log(2048) = 11$ bits are needed for accessing a set. Inside a set we need to identify the cache entry.

Total number of distinct cache entries = $2^{32}/\text{cache entry size} = 2^{32}/32 = 2^{27}$

Out of this 2^{27} , each set will be getting only $2^{27}/2^{11} = 2^{16}$ possible distinct cache entries as we use the first 11 bits to identify a set. So, we need 16 bits to identify a cache entry in a set, which is the number of bits in the tag field.

Size of cache tag directory = Size of tag entry * Number of tag entries
 $= 16 + (2+1+1)$ bits (2 valid, 1 modified, 1 replacement as given in question) * 8 K
 $= 20 * 8 = 160 \text{ Kbits}$

Not needed for this question, still:

Valid bit: Tells if the memory referenced by the cache entry is valid. Initially, when a process is loaded all entries are

invalid. Only when a page is loaded, its entry becomes valid.

Modified bit: When processor writes to a cache location its modified bit is made 1. This information is used when a cache entry is replaced- entry 0 means no update to main memory needed. Entry 1 means an update is needed.

Replacement bit: This is needed for the cache replacement policy. Explained in the below link:
<https://www.seas.upenn.edu/~cit595/cit595s10/handouts/LRUreplacementpolicy.pdf>

3 votes

-- Arjun Suresh (150k points)

2.3.29 Cache Memory: GATE2002_10 [top](#)

<http://gateoverflow.in/863>



Selected Answer

(a)

Data cache size = 8KB.

Block line size = 16B.

Since each array element occupies 4B, four consecutive array elements occupy a block line (elements are aligned as starting address is 0)

Number of cache blocks = $8\text{KB}/16\text{B} = 512$. Number of cache blocks needed for the array = $2048/4 = 512$. So, all the array elements has its own cache block and there is no collision.

We can also explain this with respect to array address. Starting address is $0x00000000 = 0b0000..0$ (32 0's). Ending address is $0x00001FFF = 0b0000..011111111111$ ($4*2048 = 8192$ location).

Here, the last 4 bits are used as OFFSET bits and the next 9 bits are used as SET bits. So, since the ending address is not extending beyond these 9 bits, all cache accesses are to diff sets.

(b) If the last element is accessed first, its cache block is fetched. (which should contain the previous 3 elements of the array also since each cache block hold 4 elements of array and 2048 is an exact multiple of 4). Thus, for every 4 accesses, we will have a cache miss \Rightarrow for 2048 accesses we will have 512 cache misses. (This would be same even if we access array in forward order).

10 votes

-- Arjun Suresh (150k points)

2.3.30 Cache Memory: GATE2008-73 [top](#)

<http://gateoverflow.in/43491>



Selected Answer

block size=16B and one element=8B.so in one block 2 element will be stored.

for $1024*1024$ element num of block required= $1024*1024/2 = 2^{19}$ blocks required.

in one block first element will be a miss and second one is hit(since we are transferring two unit at a time)

\Rightarrow hit ratio=total hit/total reference

$$=2^{19}/2^{20}$$

$$=1/2=0.5$$

$$=0.5*100=50\%$$

3 votes

-- asutosh kumar Biswal (5.9k points)

2.3.31 Cache Memory: GATE2004_65 [top](#)

<http://gateoverflow.in/1059>



Selected Answer

We have 4 blocks and 2 blocks in a set

=> there are 2 sets. So blocks will go
to sets as follows:

| Set Number | Block Number |
|------------|--------------|
| 0 | 0, 8, 12 |
| 1 | |

since the lowest bit of block address is used for indexing into the set.

So, 8, 12 and 0 first miss in cache with 0 replacing 8 (there are two slots in each set due to 2-way set) and then 12 hits in cache and 8 again misses. So totally 4 misses.

8 votes

-- Arjun Suresh (150k points)

2.3.32 Cache Memory: GATE2007-81 [top](#)

<http://gateoverflow.in/43511>



Selected Answer

Cache Organization:

Starting Address=1100H = $16^3 + 16^2 + 0 + 0 = 4352B$ is the starting address.

We need to find Starting block = $4352B / 64B = 68^{\text{th}}$ block in main memory from where array start storing elements.

$50 * 50B = \text{array size} = 50 * 50B / 64B = 39.0625$ blocks needed = approx = 40 blocks

68,69,70....107 block we need = 40 blocks

starting block is $68 \bmod 32 = 4^{\text{th}}$ cache block and after that in sequence they will be accessed.

as shown in below table line no 4 to 11 has been replaced by array in second time

| Cache block No. | First Cycle | Second Cycle |
|-----------------|-------------|--------------|
| 0 | 96 | |
| 1 | 97 | |
| 2 | 98 | |
| 3 | 99 | |
| 4 | 68 //100 | 68 |
| 5 | 69 //101 | 69 |
| 6 | 70 //102 | 70 |
| 7 | 71 //103 | 71 |
| 8 | 72 //104 | 72 |
| 9 | 73 //105 | 73 |
| 10 | 74 //106 | 74 |
| 11 | 75 //107 | 75 |
| 12 | 76 | |
| 13 | 77 | |
| 14 | 78 | |
| 15 | 79 | |
| 16 | 80 | |
| 17 | 81 | |
| 18 | 82 | |
| 19 | 83 | |
| 20 | 84 | |
| 21 | 85 | |
| 22 | 86 | |
| 23 | 87 | |

| | | |
|----|----|--|
| 24 | 88 | |
| 25 | 89 | |
| 26 | 90 | |
| 27 | 91 | |
| 28 | 92 | |
| 29 | 93 | |
| 30 | 94 | |
| 31 | 95 | |

2 votes

-- Gabbar (10.2k points)

2.3.33 Cache Memory: GATE2001-9 [top](#)

<http://gateoverflow.in/750>

Selected Answer

What is the number of sets in the cache?

$$\begin{aligned}\text{Number of sets} &= \text{Cache memory}/(\text{set associativity} * \text{cache block size}) \\ &= 256\text{KB}/(4*16 \text{ B}) \\ &= 4096\end{aligned}$$

What is the size (in bits) of the tag field per cache block?

Memory address size = 32-bit

Number of bits required to identify a particular set = 12 (Number of sets = 4096)

Number of bits required to identify a particular location in cache line = 4 (cache block size = 16)

size of tag field = $32 - 12 - 4 = 16$ -bit

What is the number and size of comparators required for tag matching?

We use 4-way set associate cache. So, we need 4 comparators each of size 16 bits

<http://ecee.colorado.edu/~ecen2120/Manual/caches/cache.html>**How many address bits are required to find the byte offset within a cache block?**

Cache block size is 16 byte. so 4 bits are required to find the byte offset within a cache block.

What is the total amount of extra memory (in bytes) required for the tag bits?

size of tag = 16 bits

Number of sets = 4096

Set associativity = 4

Extramemory required to store the tag bits = $16 * 4096 * 4$ bits = 2^{15} bytes

11 votes

-- suraj (3.7k points)

2.3.34 Cache Memory: GATE2007_10 [top](#)

<http://gateoverflow.in/1208>

Selected Answer

Number of sets = cache size/(size of a block * No. of blocks in a set)

$$= 128 * 64 / (64 * 4) \text{ (4 way set associative means 4 blocks in a set)}$$

$$= 32.$$

So, number of index (LINE) bits = 5 and number of WORD bits = 6 size cache block (line) size is 64. So, number of TAG bits = $20 - 6 - 5 = 9$.

Answer is (D) choice

5 votes

-- Arjun Suresh (150k points)

2.3.35 Cache Memory: GATE2010-49 top

<http://gateoverflow.in/43329>



Selected Answer

The transfer time should be $4 * 200 + 20 = 820$ ns. But this is not in option. So, I assume the following is what is meant by the question.

L2 block size being 16 words and data width between memory and L2 being 4 words, we require 4 memory accesses(for read) and 4 L2 accesses (for store). Now, we need to send the requested block to L1 which would require one more L2 access (for read) and one L1 access (for store). So, total time

$$= 4 * (200 + 20) + (20 + 2)$$

$$= 880 + 22$$

$$= 902 \text{ ns}$$

3 votes

-- Arjun Suresh (150k points)

2.3.36 Cache Memory: GATE1992-5,a top

<http://gateoverflow.in/584>



Selected Answer

Average memory access time = Time spend for read + Time spend for write

= Read time when cache hit + Read time when cache miss
+ Write time when cache hit + Write time when cache miss

= $0.8 \times 0.9 \times 50 + 0.8 \times 0.1 \times (500+50)$ (assuming hierarchical read from memory and cache as only simultaneous write is mentioned in question)
+ $0.2 \times 0.9 \times 500 + 0.2 \times 0.1 \times 500$ (simultaneous write mentioned in question)

$$= 36 + 44 + 90 + 10 = 180 \text{ ns}$$

<http://www.howardhuang.us/teaching/cs232/24-Cache-writes-and-examples.pdf>

6 votes

-- Arjun Suresh (150k points)

2.3.37 Cache Memory: GATE2007-80 top

<http://gateoverflow.in/1273>



Selected Answer

bits used to represent the address = $\log_2 2^{16} = 16$

each cache line size = 64 bytes; means offset requires 6 bits

total number of lines in cache = 32; means line# requires 5 bits

so, tag bits = $16 - 6 - 5 = 5$

we have a 2D array each of its element is of size = 1 Byte;
total size of this array = $50 \times 50 \times 1\text{Byte} = 2500\text{Bytes}$

so, total number of lines it will require to get contain in cache = $\frac{2500B}{64B} = 39.0625 \approx 40$

starting address of array = $1100H = 00010\ 00100\ 000000$
the group of bits in middle represents Cache Line number \implies array starts from cache line number 4,
we require 40 cache lines to hold all array elements, but we have only 32 cache lines

Lets group/partition our 2500 array elements in those 40 array lines, we call this first array line as A_0 which will have 64 of its elements. this line(group of 64 elements) of array will be mapped to cache line number 4 as found by analysis of starting address of array above.

This all means that among those 40 array lines some array lines will be mapped to same cache line, coz there are just 32 cache lines but 40 of array lines.

this is how mapping is :

| | |
|----|---------------|
| 0 | A_{28} |
| 1 | A_{29} |
| 2 | A_{30} |
| 3 | A_{31} |
| 4 | $A_0\ A_{32}$ |
| 5 | $A_1\ A_{33}$ |
| 6 | $A_2\ A_{34}$ |
| 7 | $A_3\ A_{35}$ |
| 8 | $A_4\ A_{36}$ |
| 9 | $A_5\ A_{37}$ |
| 10 | $A_6\ A_{38}$ |
| 11 | $A_7\ A_{39}$ |
| 12 | A_8 |
| | : |
| 30 | A_{26} |
| 31 | A_{27} |

so, if we access complete array twice we get = $32 + 8 + 8 + 8 = 56$ miss
coz only 8 lines from cache line number 4 to 11 are miss operation, rest are Hits(not counted) or Compulsory misses(first 32).

Hence, Q.80 answer = **option C**

32 votes

-- Amar Vashishth (20.7k points)

2.3.38 Cache Memory: GATE2008-72 [top](#)

<http://gateoverflow.in/43490>

[Need @arjun sir to verify this solution]

Every element = 8B

Total Size Required By the Array = $1024 * 1024 * 8 = 2^{23}$ B

Every Block = 16 B

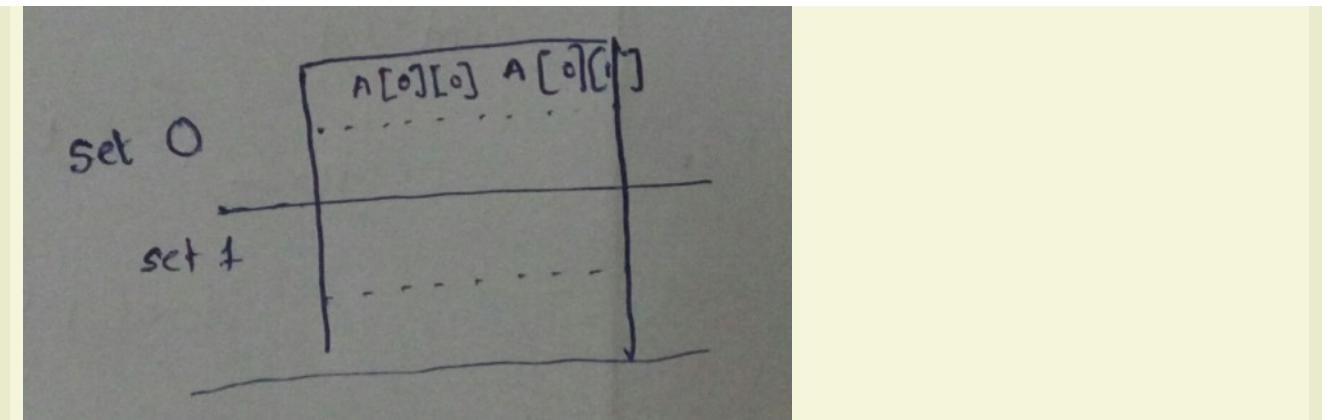
Number of blocks for Array = $\frac{2^{23}}{2^4} = 2^{19}$

Elements in one block = $\frac{16}{8} = 2$

Number of blocks in cache = $\frac{2^{16}}{2^4} = 2^{12}$

Number of Sets = $\frac{2^{12}}{2^1} = 2^{11}$

\Rightarrow 2 elements in one block



MM block $0 \in 0 \bmod 2^{11} = \text{set 0}$

MM block $1 \in 1 \bmod 2^{11} = \text{set 1}$

..

..

MM block $2048 \in 2048 \bmod 2^{11} = \text{set 0} // \text{ sharing same set}$

Each Row of array has 1024 elements \Rightarrow 512 blocks required

Row 0 : 0-511 blocks

Row1 : 511-1024

..

..

Row 'x' : 2048-2560

We need to find 'x'

$$x = \frac{2048}{512} = 4$$

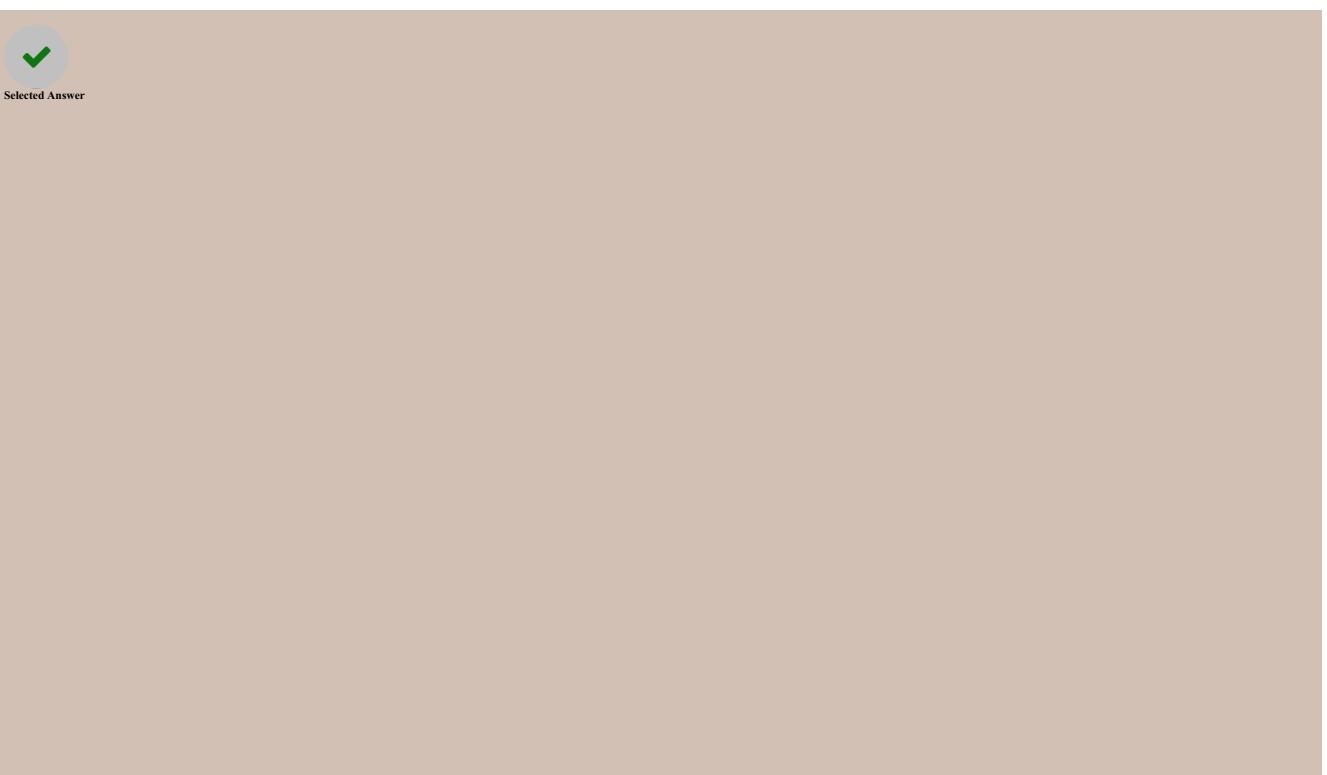
$\Rightarrow A[4][0]$ shares same set that of $A[0][0]$

5 votes

-- Akhil Nadh Pulloorikkal Chandran (6.9k points)

2.3.39 Cache Memory: GATE2006-81 [top](#)

<http://gateoverflow.in/43517>



$$\begin{aligned} \text{Number of Cache Lines} &= \frac{2^{15}B}{128B} \\ &= 256 \end{aligned}$$

$$\text{In 1 Cache Line} = \frac{128B}{8B} = 16 \text{ elements}$$

$$\begin{aligned} P_1 &= \frac{\text{total elements in array}}{\text{elements in a cache line}} \\ &= \frac{512 \times 512}{16} \\ &= 2^{14} \\ &= 16384 \end{aligned}$$

$$\begin{aligned} P_2 &= 512 \times 512 \\ &= 2^{18} \end{aligned}$$

$$\begin{aligned} \frac{P_1}{P_2} &= \frac{16384}{512 \times 512} \\ &= 2^{14-18} \\ &= 2^{-4} \\ &= \frac{1}{16} \end{aligned}$$

It is so because for

P_1 for every line there is a miss, and once a miss is processed we get 16 elements in memory. So another miss happens after 16 elements.

for

P_2 for every element there is a miss coz storage is row major order(by default) and we are accessing column wise.

Hence,

answer = option B

7 votes

-- Amar Vashishth (20.7k points)

2.3.40 Cache Memory: GATE2006-75 top

<http://gateoverflow.in/43565>

$$\begin{aligned} \text{number of sets} &= \frac{\text{cache size}}{\text{no. of blocks in a set} \times \text{block size}} \\ &= \frac{32KB}{1 \times 32B} = 1024 \end{aligned}$$

So, number of index bits = 10, and number of tag bits = $32 - 10 - 5 = 17$. So, h_2

$$= 17/10 = 1.7 \text{ ns}$$

3 votes

-- Arjun Suresh (150k points)

word offset=5bit
 block offset=32kb/32=10bit
 so tag bit=32-10-5=17bit
 hit latency=mux delay+comparator delay

1. mux is not required in direct mapped cache coz we have only one comparator(IF IT IS 2 WAY SET ASSOCIATIVE THEN COMPARATOR WILL BE 2 AND WE NEED A MUX OF 2-TO-1 TO DECIDE HIT/MISS) so mux delay=..

$$2 \text{ comp. delay}=k/10=17/10=1.7.$$

so $h_2 = 1.7$

3 votes

-- asutosh kumar Biswal (5.9k points)

2.3.41 Cache Memory: GATE2008-35 [top](#)

<http://gateoverflow.in/446>



Selected Answer

1st is not correct as data need not to be exactly same at the same point of time and so write back policy can be used in this.

2nd is not needed when talking only about L1 and L2.

For 3rd, associativity can be equal.

So only 4th statement is Necessarily true - A choice.

7 votes

-- Shaun Patel (5.8k points)

2.3.42 Cache Memory: GATE2005_67 [top](#)

<http://gateoverflow.in/1390>



Selected Answer

Number of blocks = cache size/block size = $32\text{KB}/32 = 1024$ bytes. So, indexing requires 10 bits. Number of OFFSET bits required to access 32 bit block = 5. So, number of TAG bits = $32 - 10 - 5 = 17$. So, answer is (A).

7 votes

-- Arjun Suresh (150k points)

2.3.43 Cache Memory: GATE2008-71 [top](#)

<http://gateoverflow.in/494>



Selected Answer

Number of sets = cache size/ size of a set
 $= 64\text{ KB} / (16\text{ B} * 2)$ (two blocks per set)
 $= 2\text{ K} = 2^{11}$

So, we need 11 bits for set indexing.

Number of WORD bits required = 4 as a cache block consists of 16 bytes and we need 4 bits to address each of them.

So, number of tag bits = $32 - 11 - 4 = 17$

Total size of the tag = $17 * \text{Number of cache blocks}$
 $= 17 * 2^{11} * 2$ (since each set has 2 blocks)

$= 68\text{ KB}$

We use the top 17 bits for tag and the next 11 bits for indexing and next 4 for offset. So, for two addresses to have the same cache index, their 11 address bits after the 4 offset bits from right must be same.

$\text{ARR}[0][0]$ is located at virtual address 0x FF000 000. (FF000 is page address and 000 is page offset). So, index bits are 00000000000

Address of $\text{ARR}[0][4] = 0xFF000 + 4 * \text{sizeof (double)} = 0xFF000 000 + 4*8 = 0xFF000 020$ (32 = 20 in hex) (index bits differ)

Address of $\text{ARR}[4][0] = 0xFF000 + 4 * 1024 * \text{sizeof (double)}$ [since we use row major storage] = $0xFF000 000 + 4096*8 = 0xFF000 000 + 0x8000 = 0xFF008 000$ (index bits matches that of $\text{ARR}[0][0]$ as both read 000 0000 0000)

Address of $\text{ARR}[0][5] = 0xFF000 + 5 * \text{sizeof (double)} = 0xFF000 000 + 5*8 = 0xFF000 028$ (40 = 28 in hex) (index bits differ)

Address of $\text{ARR}[5][0] = 0xFF000 + 5 * 1024 * \text{sizeof (double)}$ [since we use row major storage] = $0xFF000 000 + 5120*8 = 0xFF000 000 + 0xA000 = 0xFF00A 000$ (index bits differ)

So, only ARR[4][0] and ARR[0][0] have the same cache index.

The inner loop is iterating from 0 to 1023, so consecutive memory locations are accessed in sequence. Since cache block size is only 16 bytes and our element being double is of size 8 bytes, during a memory access only the next element gets filled in the cache. i.e.; every alternative memory access is a cache miss giving a hit ratio of 50%. (If loops i and j are reversed, all accesses will be misses and hit ratio will become 0).

20 votes

-- Arjun Suresh (150k points)

2.3.44 Cache Memory: GATE2009-29 [top](#)

<http://gateoverflow.in/1315>



Selected Answer

16 blocks and sets with 4 blocks each means there are 4 sets. So, the lower 2 bits are used for getting a set. And 4 way associative means in a set only the last 4 cache accesses can be stored.

0, 255, 1, 4, 3, 8, 133, 159, 216, 129, 63, 8, 48, 32, 73, 92, 155

Mod 4 gives

0, 3, 1, 0, 3, 0, 1, 3, 0, 1, 3, 0, 0, 0, 1, 0, 3

Now for each of 0..3, the last 4 accesses will be in cache. So, {92, 32, 48, 8}, {155, 63, 159, 3}, {73, 129, 133, 1} and {} will be in cache. So, the missing element from choice is 216.

14 votes

-- Arjun Suresh (150k points)

2.4

Computer Organization [top](#)

2.4.1 Computer Organization: GATE 2016-2-33 [top](#)

<http://gateoverflow.in/39580>

Consider a

3 GHz (gigahertz) processor with a three stage pipeline and stage latencies

τ_1, τ_2 and

τ_3 such that

$\tau_1 = \frac{3\tau_2}{4} = 2\tau_3$. If the longest pipeline stage is split into two pipeline stages of equal latency , the new frequency is

GHz, ignoring delays in the pipeline registers.

[gate2016-2](#) [computer-organization](#) [pipeline](#) [normal](#) [numerical-answers](#)

Answer

2.4.2 Computer Organization: GATE 2016-1-09 [top](#)

<http://gateoverflow.in/39632>

A processor can support a maximum memory of 4GB, where the memory is word-addressable (a word consists of two bytes). The size of address bus of the processor is at least _____ bits.

[gate2016-1](#) [computer-organization](#) [easy](#) [numerical-answers](#)

Answer

2.4.3 Computer Organization: GATE2005_69 [top](#)

<http://gateoverflow.in/1392>

A device with data transfer rate 10 KB/sec is connected to a CPU. Data is transferred byte-wise. Let the interrupt overhead be $4\mu\text{sec}$. The byte transfer time between the device interface register and CPU or memory is negligible. What is the minimum performance gain of operating the device under interrupt mode over operating it under program-controlled mode?

- A. 15
B. 25
C. 35
D. 45

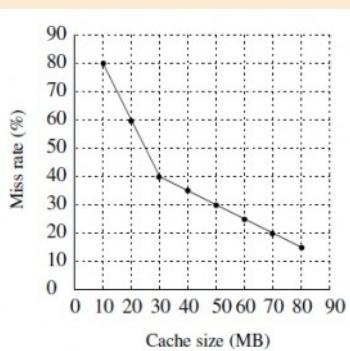
gate2005 computer-organization

Answer

2.4.4 Computer Organization: GATE 2016-2-50 [top](#)

<http://gateoverflow.in/39592>

A file system uses an in-memory cache to cache disk blocks. The miss rate of the cache is shown in the figure. The latency to read a block from the cache is 1 ms and to read a block from the disk is 10 ms. Assume that the cost of checking whether a block exists in the cache is negligible. Available cache sizes are in multiples of 10 MB.



The smallest cache size required to ensure an average read latency of less than 6 ms is _____ MB.

gate2016-2 computer-organization cache-memory normal numerical-answers

Answer

Answers: Computer Organization

2.4.1 Computer Organization: GATE 2016-2-33 [top](#)

<http://gateoverflow.in/39580>



Selected Answer

Answer is 4 GHz.

Given 3 stage pipeline , with 3 GHz processor.

$$\text{Given , } e_1 = 3 e_2 / 4 = 2 e_3$$

$$\text{Put } e_1 = 6x$$

$$\text{we get, } e_2 = 8x, e_3 = 3x$$

Now largest stage time is $8x$.

So, frequency is

$$\frac{1}{8x}$$

$$=>$$

$$\frac{1}{8x} = 3 \text{ GHz}$$

=>

$$\frac{1}{x} = 24 \text{ GHz} \quad \dots\dots\dots(1)$$

Now, we divide e_2 into two stages of $4x$ & $4x$.

New processor has 4 stages -

$6x$, $4x$, $4x$, $3x$.

Now largest stage time is $6x$.

So, new frequency is

$$\frac{1}{\frac{6x}{24}} = \frac{1}{\frac{6}{24}} = \frac{1}{\frac{1}{4}} = 4 \text{ GHz (Ans)}$$

----- from (1)

14 votes

-- Himanshu Agarwal (9.8k points)

2.4.2 Computer Organization: GATE 2016-1-09 [top](#)

<http://gateoverflow.in/39622>



Selected Answer

Size of Memory = No of words (Addresses)
 \times No of bits per word

$$2^{32}B = \text{No of words (Addresses)} \\ \times \\ 2B$$

$$\text{No of words (Addresses)} = 2^{31}$$

$$\text{Number of Address lines} = 31$$

19 votes

-- Praveen Saini (38.4k points)

2.4.3 Computer Organization: GATE2005_69 [top](#)

<http://gateoverflow.in/1392>



Selected Answer

In Programmed I/O, the CPU issues a command and waits for I/O operations to complete.

So here, CPU will wait for 1sec to transfer 10KB of data.

overhead in programmed I/O = 1 sec

In Interrupt mode , data is transferred word by word (here word size is 1 byte as mentioned in question "Data is transferred byte-wise").

So to transfer 1 byte of data overhead is 4×10^{-6} sec

Thus to transfer 10 KB of data overhead is $= 4 \times 10^{-6} \times 10^4$ sec

$$\text{Performance gain} = \frac{1}{4 \times 10^{-6} \times 10^4} = \frac{1}{4 \times 10^{-2}} = 25$$

Thus, (b) is correct answer.

14 votes

-- ashwini anand (289 points)

2.4.4 Computer Organization: GATE 2016-2-50 [top](#)

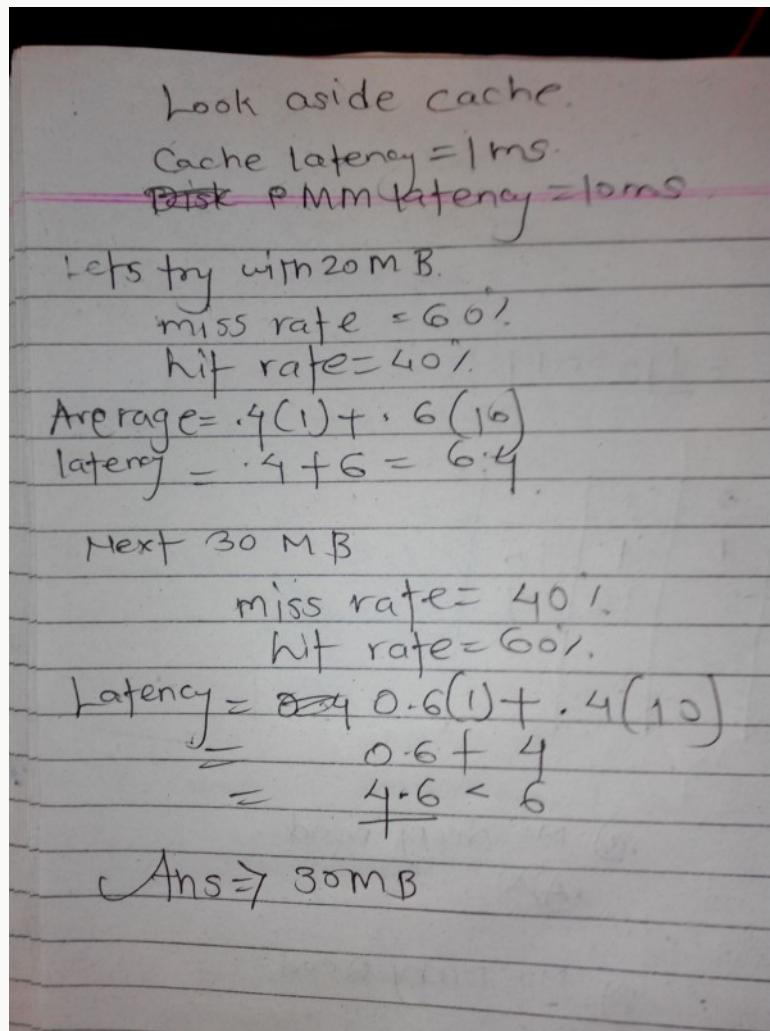
<http://gateoverflow.in/39592>



Selected Answer

Ans => 30 MB

How ?



12 votes

-- Akash (31.7k points)

2.5

Data Dependencies [top](#)

2.5.1 Data Dependencies: GATE2007-IT_39 [top](#)

<http://gateoverflow.in/3472>

Data forwarding techniques can be used to speed up the operation in presence of data dependencies. Consider the following replacements of LHS with RHS.

- | | |
|---------------------------|---------------|
| (i) R1 → Loc, Loc → R2 ≡ | R1 → R2, R1 → |
| (ii) R1 → Loc, Loc → R2 ≡ | Loc |
| (iii) R1 → Loc, R2 → | R1 → R2 |
| Loc | ≡ |
| (iv) R1 → Loc, R2 → | R1 → Loc |
| Loc | ≡ |

In which of the following options, will the result of executing the RHS be the same as executing the LHS irrespective of the instructions that follow ?

- A) (i) and (iii)
- B) (i) and (iv)
- C) (ii) and (iii)
- D) (ii) and (iv)

[gate2007-it](#) [data-dependencies](#)

[Answer](#)

2.5.2 Data Dependencies: GATE2015-3_47 [top](#)

<http://gateoverflow.in/8556>

Consider the following code sequence having five instructions from I_1 to I_5 . Each of these instructions has the following format.

OP Ri, Rj, Rk

Where operation OP is performed on contents of registers Rj and Rk and the result is stored in register Ri.

I_1 : ADD R1, R2, R3

I_2 : MUL R7, R1, R3

I_3 : SUB R4, R1, R5

I_4 : ADD R3, R2, R4

I_5 : MUL R7, R8, R9

Consider the following three statements.

S1: There is an anti-dependence between instructions I_2 and I_5

S2: There is an anti-dependence between instructions I_2 and I_4

S3: Within an instruction pipeline an anti-dependence always creates one or more stalls

Which one of the above statements is/are correct?

- A. Only S1 is true
- B. Only S2 is true
- C. Only S1 and S3 are true
- D. Only S2 and S3 are true

[gate2015-3](#) [co&architecture](#) [pipeline](#) [data-dependencies](#) [normal](#)

[Answer](#)

Answers: Data Dependencies

2.5.1 Data Dependencies: GATE2007-IT_39 [top](#)

<http://gateoverflow.in/3472>

(iii) and (iv) are the same!! and both are wrong because R2 is writing last, not R1..

(i) is true...

(ii) false, because R2 get the correct data, but location has not got updated..

No option.. (bonus marks :D)

4 votes

-- Vicky Bajoria (3.4k points)

2.5.2 Data Dependencies: GATE2015-3_47 [top](#)

<http://gateoverflow.in/8556>



Selected Answer

Answer should be B.

Anti-dependence can be overcome in pipeline using register renaming. So, "always" in S3 makes it false. Also, if I2 is completed before I4 (execution stage of MUL), then also there won't be any stall.

12 votes

-- ppm (559 points)

2.6

Data Path top

2.6.1 Data Path: GATE 2016-2-30 top

<http://gateoverflow.in/39627>

Suppose the functions F and G can be computed in 5 and 3 nanoseconds by functional units U_F and U_G , respectively. Given two instances of U_F and two instances of U_G , it is required to implement the computation $F(G(X_i))$ for $1 \leq i \leq 10$. Ignoring all other delays, the minimum time required to complete this computation is _____ nanoseconds.

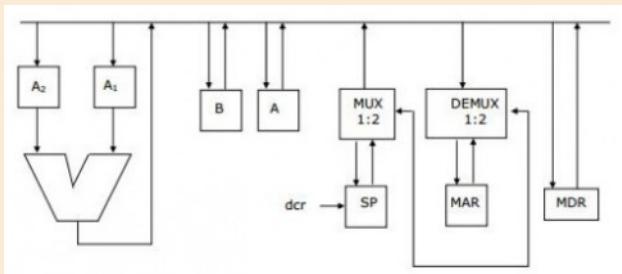
gate2016-2 co&architecture data-path normal numerical-answers

Answer

2.6.2 Data Path: GATE2001-2.13 top

<http://gateoverflow.in/731>

Consider the following data path of a simple non-pipelined CPU. The registers A, B, A_1 , A_2 , MDR, the bus and the ALU are 8-bit wide. SP and MAR are 16-bit registers. The MUX is of size $8 \times (2 : 1)$ and the DEMUX is of size $8 \times (1 : 2)$. Each memory operation takes 2 CPU clock cycles and uses MAR (Memory Address Register) and MDR (Memory Date Register). SP can be decremented locally.



The CPU instruction "push r" where, $r = A$ or B has the specification

$$M[SP] \leftarrow r$$

$$SP \leftarrow SP - 1$$

How many CPU clock cycles are required to execute the "push r" instruction?

- A. 2
- B. 3
- C. 4
- D. 5

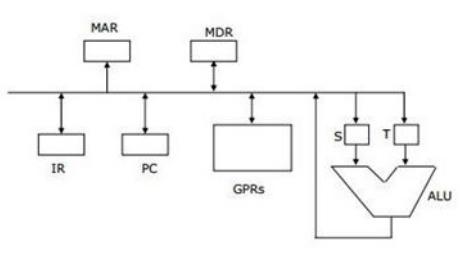
gate2001 co&architecture data-path machine-instructions normal

Answer

2.6.3 Data Path: GATE2005-80 top

<http://gateoverflow.in/43568>

The ALU, the bus and all the registers in the data path are of identical size. All operations including incrementation of the PC and the GPRs are to be carried out in the ALU. Two clock cycles are needed for memory read operation – the first one for loading address in the MAR and the next one for loading data from the memory bus into the MDR.



The instruction "call Rn, sub" is a two word instruction. Assuming that PC is incremented during the fetch cycle of the first word of the instruction, its register transfer interpretation is

$$Rn \leq PC + 1;$$

$$PC \leq M[PC];$$

The minimum number of CPU clock cycles needed during the execution cycle of this instruction is:

- A. 2
- B. 3
- C. 4
- D. 5

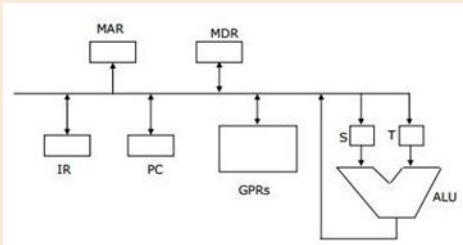
[co&architecture](#) [normal](#) [gate2005](#) [data-path](#) [machine-instructions](#)

Answer

2.6.4 Data Path: GATE2005-79 [top](#)

<http://gateoverflow.in/1402>

Consider the following data path of a CPU.



The ALU, the bus and all the registers in the data path are of identical size. All operations including incrementation of the PC and the GPRs are to be carried out in the ALU. Two clock cycles are needed for memory read operation – the first one for loading address in the MAR and the next one for loading data from the memory bus into the MDR.

The instruction "add R0, R1" has the register transfer interpretation $R0 \leq R0 + R1$. The minimum number of clock cycles needed for execution cycle of this instruction is:

- A. 2
- B. 3
- C. 4
- D. 5

[gate2005](#) [co&architecture](#) [machine-instructions](#) [data-path](#) [normal](#)

Answer

Answers: Data Path

2.6.1 Data Path: GATE 2016-2-30 [top](#)

<http://gateoverflow.in/39627>



Selected Answer

The same concept is used in pipelining. Bottleneck here is U_F as it takes 5 ns while U_G takes 3ns only. We have to do 10 such calculations and we have 2 instances of U_F and U_G respectively. So, U_F can be done in $50/2 = 25$ nano seconds.

For the start U_F needs to wait for U_G output for 3 ns and rest all are pipelined and hence no more wait. So, answer is

$$3 + 25 = 28\text{ns}.$$

17 votes

-- Arjun Suresh (150k points)

2.6.2 Data Path: GATE2001-2.13 [top](#)

<http://gateoverflow.in/731>

A stack pointer is a small register that stores the address of the last program request in a stack

A stack is a specialized buffer which stores data from the top down. As new requests come in, they push down the older ones. The most recently entered request always resides at the top of the stack, and the program always takes requests from the top.

And SP decremented locally doesn't require any extra cycle

therefore memory operation required 2 cycles as mentioned in question. option A

2 votes

-- Umang Raman (11.3k points)

2.6.3 Data Path: GATE2005-80 [top](#)

<http://gateoverflow.in/43568>

MAR <- PC 1 cycle

S <- PC (Since these two actions are independent they can be done in same cycle)

MDR <- M[MAR] 2nd cycle

RN <- S + 1 (ALU is free and the two actions are independent.)

PC <- MDR ----- 3rd cycle

Therefore 3 cycles needed.

7 votes

-- Riya Roy(Arayana) (5.6k points)

2.6.4 Data Path: GATE2005-79 [top](#)

<http://gateoverflow.in/1402>

S <- R0 1cycle (Since the buses are of same size as the

T <- R1 2nd cycle

R0 <- R0 + R1 3rd cycle

therefore we need 3 cycles.

6 votes

-- Riya Roy(Arayana) (5.6k points)

2.7

Dma [top](#)

2.7.1 Dma: GATE 2016-1-31 [top](#)

<http://gateoverflow.in/39698>

The size of the data count register of a

DMA controller is

16bits. The processor needs to transfer a file of 29,154 kilobytes from disk to main memory. The memory is byte addressable. The minimum number of times the

DMA controller needs to get the control of the system bus from the processor to transfer the file from the disk to main memory is _____.

[gate2016-1](#) [co&architecture](#) [dma](#) [normal](#) [numerical-answers](#)

Answer

2.7.2 Dma: GATE2011_28 [top](#)<http://gateoverflow.in/2130>

On a non-pipelined sequential processor, a program segment, which is the part of the interrupt service routine, is given to transfer 500 bytes from an I/O device to memory.

```

Initialize the address register
Initialize the count to 500
LOOP: Load a byte from device
      Store in memory at address given by address register
      Increment the address register
      Decrement the count
      If count !=0 go to LOOP
  
```

Assume that each statement in this program is equivalent to a machine instruction which takes one clock cycle to execute if it is a non-load/store instruction. The load-store instructions take two clock cycles to execute.

The designer of the system also has an alternate approach of using the DMA controller to implement the same transfer. The DMA controller requires 20 clock cycles for initialization and other overheads. Each DMA transfer cycle takes two clock cycles to transfer one byte of data from the device to the memory.

What is the approximate speed up when the DMA controller based design is used in place of the interrupt driven program based input-output?

- (A) 3.4
- (B) 4.4
- (C) 5.1
- (D) 6.7

[gate2011](#) [co&architecture](#) [dma](#) [normal](#)

Answer

Answers: Dma**2.7.1 Dma: GATE 2016-1-31** [top](#)<http://gateoverflow.in/39698>

Selected Answer

Data count register gives the number of words the DMA can transfer in a single cycle..
 Here it is 16 bits.. so max 2^{16} words can be transferred in one cycle.. since memory is byte addressable..
 1 word = 1 byte
 so 2^{16} bytes in 1 cycle..
 Now for the given file..
 File size = 29154KB = $29154 * 2^{10}$ B
 in 1 cycle => DMA transfers 2^{16} B
 i.e
 1 B transferred by DMA => $1/2^{16}$ cycles.

Now for full file of size 29154 KB, minimum number of cycles = $(29154 * 2^{10} \text{ B}) / 2^{16} = 455.53$
 but number of cycles is asked so 455.53 => 456..

7 votes

-- Abhilash Panicker (7k points)

2.7.2 Dma: GATE2011_28 [top](#)<http://gateoverflow.in/2130>

Selected Answer

| STATEMENT | CLOCK CYCLE (S) NEEDED |
|--|------------------------|
| Initialize the address register | 1 |
| Initialize the count to 500 | 1 |
| LOOP: Load a byte from device | 2 |
| Store in memory at address given by address register | 2 |
| Increment the address register | 1 |
| Decrement the count | 1 |
| If count != 0 go to LOOP | 1 |
| Interrupt driven transfer time = $1+1+500 \times (2+2+1+1)$ = 3502 | |
| DMA based transfer time = $20+500 \times 2$ = 1020 | |
| Speedup = $3502/1020 = 3.4$ | |

Interrupt driven transfer time = $1+1+500 \times (2+2+1+1)$ = 3502
DMA based transfer time = $20+500 \times 2$ = 1020
Speedup = $3502/1020 = 3.4$

19 votes

-- Manu Thakur (5.6k points)

2.8

Instruction Format [top](#)

2.8.1 Instruction Format: GATE1992_01,vi [top](#)

<http://gateoverflow.in/551>

In an 11-bit computer instruction format, the size of address field is 4-bits. The computer uses expanding OP code technique and has 5 two-address instructions and 32 one-address instructions. The number of zero-address instructions it can support is _____

[gate1992](#) [co&architecture](#) [machine-instructions](#) [instruction-format](#) [normal](#)

[Answer](#)

2.8.2 Instruction Format: GATE1994_3.2 [top](#)

<http://gateoverflow.in/2479>

State True or False with one line explanation

Expanding opcode instruction formats are commonly employed in RISC. (Reduced Instruction Set Computers) machines.

[gate1994](#) [co&architecture](#) [machine-instructions](#) [instruction-format](#) [normal](#)

[Answer](#)

2.8.3 Instruction Format: GATE2014-1_9 [top](#)

<http://gateoverflow.in/1767>

A machine has a 32-bit architecture, with 1-word long instructions. It has 64 registers, each of which is 32 bits long. It needs to support 45 instructions, which have an immediate operand in addition to two register operands. Assuming that the immediate operand is an unsigned integer, the maximum value of the immediate operand is _____

[gate2014-1](#) [co&architecture](#) [machine-instructions](#) [instruction-format](#) [numerical-answers](#) [normal](#)

[Answer](#)

2.8.4 Instruction Format: GATE 2016-2-31 [top](#)

<http://gateoverflow.in/39601>

Consider a processor with 64 registers and an instruction set of size twelve. Each instruction has five distinct fields, namely, opcode, two source register identifiers, one destination register identifier, and twelve-bit immediate value. Each instruction must be stored in memory in a byte-aligned fashion. If a program has 100 instructions, the amount of memory (in bytes) consumed by the program text is _____.

[gate2016-2](#) [instruction-format](#) [machine-instructions](#) [computer-organization](#) [normal](#) [numerical-answers](#)

[Answer](#)

Answers: Instruction Format

2.8.1 Instruction Format: GATE1992_01,vi [top](#)

<http://gateoverflow.in/551>



Selected Answer

No. of possible instruction encoding = $2^{11} = 2048$

No. of encoding taken by two-address instructions = $5 \times 2^4 \times 2^4 = 1280$

No. of encoding taken by one-address instructions = $32 \times 2^4 = 512$

So, no. of possible zero-address instructions = $2048 - (1280 + 512) = 256$

11 votes

-- Arjun Suresh (150k points)

2.8.2 Instruction Format: GATE1994_3.2 [top](#)

<http://gateoverflow.in/2479>

Selected Answer

FALSE

This expanding opcode scheme makes the decoding more complex. Instead of simply looking at a bit pattern and deciding which instruction it is, we need to decode the instruction something like this:

```
if (leftmost four bits != 1111) {
    Execute appropriate three-address instruction
} else if (leftmost seven bits != 1111 111) {
    Execute appropriate two-address instruction
} else if (leftmost twelve bits != 1111 1111 1111) {
    Execute appropriate one-address instruction
} else {
    Execute appropriate zero-address instruction
}
```

At each stage, one spare code is used to indicate that we should now look at more bits. This is another example of the types of trade-offs hardware designers continually face: Here, we trade opcode space for operand space.

Ref: http://www.fatih.edu.tr/~emanetn/courses/spring2006/ceng252/ceng252_lecture3.pdf

Being more complex and RISC not needing more instructions expanding opcode is not a common RISC technique. But this is there in many RISC machines.

1 votes

-- Arjun Suresh (150k points)

2.8.3 Instruction Format: GATE2014-1_9 [top](#)

<http://gateoverflow.in/1767>

Selected Answer

64 registers means 6 bits for a register operand. So, 2 register operand requires 12 bits. Now, 45 instructions require another 6 bits for opcode. So, totally 18 bits. So, we have $32 - 18 = 14$ bits left for the immediate operand. So, the max value will be $2^{14} - 1 = 16383$ (as the operand is unsigned we don't need a sign bit and with 14 bits we can represent from 0 to $2^{14} - 1$)

14 votes

-- Arjun Suresh (150k points)

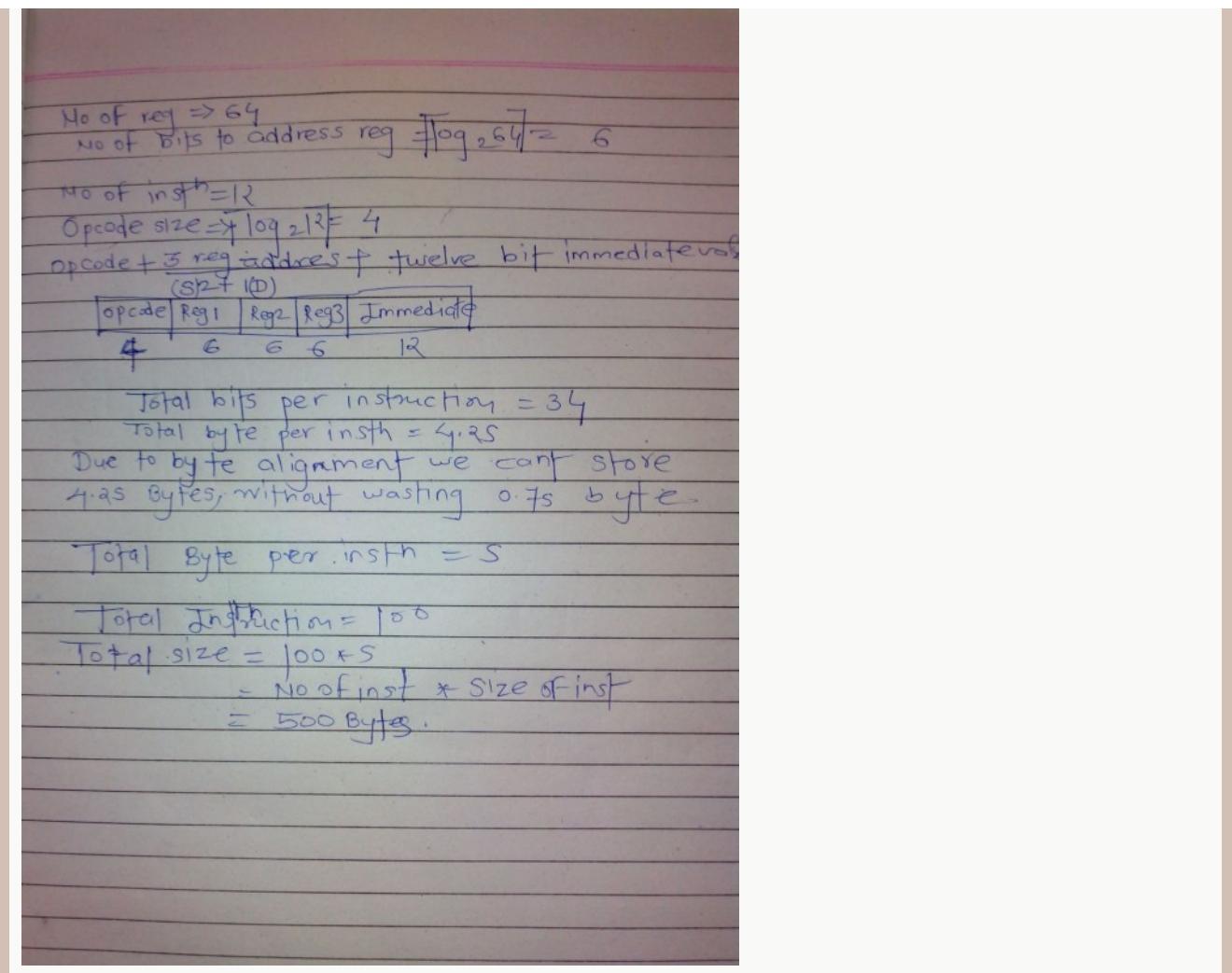
2.8.4 Instruction Format: GATE 2016-2-31 [top](#)

<http://gateoverflow.in/39601>

Selected Answer

Answer => 500 bytes

How =>



10 votes

-- Akash (31.7k points)

2.9

Interrupts top

2.9.1 Interrupts: GATE1998_1.20 top

<http://gateoverflow.in/1657>

Which of the following is true?

- Unless enabled, a CPU will not be able to process interrupts.
- Loop instructions cannot be interrupted till they complete.
- A processor checks for interrupts before executing a new instruction.
- Only level triggered interrupts are possible on microprocessors.

[gate1998](#) [co&architecture](#) [interrupts](#) [normal](#)

Answer

2.9.2 Interrupts: GATE1995_1.3 top

<http://gateoverflow.in/2590>

In a vectored interrupt

- The branch address is assigned to a fixed location in memory

- B. The interrupting source supplies the branch information to the processor through an interrupt vector
 C. The branch address is obtained from a register in the processor
 D. None of the above

[gate1995](#) [co&architecture](#) [interrupts](#) [normal](#)

[Answer](#)

2.9.3 Interrupts: GATE2009-8, UGCNET-June2012-III-58 [top](#)

<http://gateoverflow.in/1300>

A CPU generally handles an interrupt by executing an interrupt service routine

- A. As soon as an interrupt is raised.
 B. By checking the interrupt register at the end of fetch cycle.
 C. By checking the interrupt register after finishing the execution of the current instruction.
 D. By checking the interrupt register at fixed time intervals.

[gate2009](#) [co&architecture](#) [interrupts](#) [normal](#) [ugcnetjune2012iii](#)

[Answer](#)

2.9.4 Interrupts: GATE2007-72 [top](#)

<http://gateoverflow.in/43515>

Consider the following program segment. Here R1, R2 and R3 are the general purpose registers.

| | Instruction | Operation | Instruction size (no. of words) |
|-------|----------------|-------------------------|---------------------------------|
| | MOV R1, (3000) | R1 \leftarrow m[3000] | 2 |
| LOOP: | MOV R2, (R3) | R2 \leftarrow M[R3] | 1 |
| | ADD R2, R1 | R2 \leftarrow R1 + R2 | 1 |
| | MOV (R3), R2 | M[R3] \leftarrow R2 | 1 |
| | INC R3 | R3 \leftarrow R3 +1 | 1 |
| | DEC R1 | R1 \leftarrow R1 - 1 | 1 |
| | BNZ LOOP | Branch on not zero | 2 |
| | HALT | Stop | 1 |

Assume that the content of memory location 3000 is 10 and the content of the register R3 is 2000. The content of each of the memory locations from 2000 to 2010 is 100. The program is loaded from the memory location 1000. All the numbers are in decimal.

Assume that the memory is word addressable. After the execution of this program, the content of memory location 2010 is:

- A. 100
 B. 101
 C. 102
 D. 110

Answer

2.9.5 Interrupts: GATE2007-73 [top](#)

<http://gateoverflow.in/43516>

Consider the following program segment. Here R1, R2 and R3 are the general purpose registers.

| | Instruction | Operation | Instruction size (no. of words) |
|-------|----------------|-------------------------|---------------------------------|
| | MOV R1, (3000) | R1 \leftarrow m[3000] | 2 |
| LOOP: | MOV R2, (R3) | R2 \leftarrow M[R3] | 1 |
| | ADD R2, R1 | R2 \leftarrow R1 + R2 | 1 |
| | MOV (R3), R2 | M[R3] \leftarrow R2 | 1 |
| | INC R3 | R3 \leftarrow R3 + 1 | 1 |
| | DEC R1 | R1 \leftarrow R1 - 1 | 1 |
| | BNZ LOOP | Branch on not zero | 2 |
| | HALT | Stop | 1 |

Assume that the content of memory location 3000 is 10 and the content of the register R3 is 2000. The content of each of the memory locations from 2000 to 2010 is 100. The program is loaded from the memory location 1000. All the numbers are in decimal.

Assume that the memory is byte addressable and the word size is 32 bits. If an interrupt occurs during the execution of the instruction "INC R3", what return address will be pushed on to the stack?

- A. 1005
- B. 1020
- C. 1024
- D. 1040

Answer

2.9.6 Interrupts: GATE2007-71 [top](#)

<http://gateoverflow.in/1269>

Consider the following program segment. Here R1, R2 and R3 are the general purpose registers.

| Instruction | Operation | Instruction size (no. of words) |
|--------------------|-------------------------|---------------------------------|
| MOV R1, (3000) | R1 \leftarrow m[3000] | 2 |
| LOOP: MOV R2, (R3) | R2 \leftarrow M[R3] | 1 |
| ADD R2, R1 | R2 \leftarrow R1 + R2 | 1 |
| MOV (R3), R2 | M[R3] \leftarrow R2 | 1 |
| INC R3 | R3 \leftarrow R3 + 1 | 1 |
| DEC R1 | R1 \leftarrow R1 - 1 | 1 |
| BNZ LOOP | Branch on not zero | 2 |
| HALT | Stop | 1 |

Assume that the content of memory location 3000 is 10 and the content of the register R3 is 2000. The content of each of the memory locations from 2000 to 2010 is 100. The program is loaded from the memory location 1000. All the numbers are

in decimal.

Assume that the memory is word addressable. The number of memory references for accessing the data in executing the program completely is

- A. 10
- B. 11
- C. 20
- D. 21

[gate2007](#) [co&architecture](#) [machine-instructions](#) [interrupts](#) [normal](#)

[Answer](#)

2.9.7 Interrupts: GATE2002_1.9 [top](#)

<http://gateoverflow.in/813>

A device employing INTR line for device interrupt puts the CALL instruction on the data bus while

- A. *INTA* is active
- B. HOLD is active
- C. READY is inactive
- D. None of the above

[gate2002](#) [co&architecture](#) [interrupts](#) [normal](#)

[Answer](#)

Answers: Interrupts

2.9.1 Interrupts: GATE1998_1.20 [top](#)

<http://gateoverflow.in/1657>

Ans is A.

Options B and D is obviously false.

A processor checks for the interrupt before FETCHING an instruction, So Option C is also false.

 3 votes

-- Hardi Shah (167 points)

2.9.2 Interrupts: GATE1995_1.3 [top](#)

<http://gateoverflow.in/2590>



Selected Answer

Answer: B

A vectored interrupt is a processing technique in which the interrupting device directs the processor to the appropriate interrupt service routine. This is in contrast to a polled interrupt system, in which a single interrupt service routine must determine the source of the interrupt by checking all potential interrupt sources, a slow and relatively laborious process.

 4 votes

-- Rajarshi Sarkar (29.7k points)

2.9.3 Interrupts: GATE2009-8, UGCNET-June2012-III-58 [top](#)

<http://gateoverflow.in/1300>



Selected Answer

It will be C.

After finishing the execution of each instruction the CPU reads the interrupt pins to recognize the interrupts.

INTR = 1 = Interrupt is present.(Service the Interrupt)

= 0 = Interrupt is not present.(Goto next Instruction fetch from user program)

5 votes

-- Gate Keeda (17.7k points)

2.9.4 Interrupts: GATE2007-72 [top](#)<http://gateoverflow.in/43515>

Selected Answer

The loop is executed 10 times and it modifies the contents from memory location 2000-2009. Memory location 2010 is untouched - contains 100 as before.

4 votes

-- Vicky Bajoria (3.4k points)

2.9.5 Interrupts: GATE2007-73 [top](#)<http://gateoverflow.in/43516>

Selected Answer

An interrupt is checked for after the execution of the current instruction and the contents of PC (address of next instruction to be executed) is pushed on to stack. Here, address of INC, R3 = $1000 + (2 + 1 + 1 + 1) \times 32/8 = 1020$ and next instruction address = $1020 + 4 = 1024$ which is pushed on to stack.
Ref: http://www.ece.utep.edu/courses/web3376/Notes_files/ee3376-interrupts_stack.pdf

4 votes

-- Vicky Bajoria (3.4k points)

2.9.6 Interrupts: GATE2007-71 [top](#)<http://gateoverflow.in/1269>

Selected Answer

Loop is executed 10 times and there are two memory reference in the loop (each MOV is loading 1 word, so 1 memory reference for each MOV inside the loop). So number of memory reference inside loop is 2 (MOV) * 10 (times iteration) * 1 (1 word access/ MOV) = 20 memory accesses.

One memory access is outside the loop for the first instruction

```
MOV R1, (3000)
```

So, totally $20 + 1 = 21$

6 votes

-- Vicky Bajoria (3.4k points)

2.9.7 Interrupts: GATE2002_1.9 [top](#)<http://gateoverflow.in/813>

INTR is a signal which if enabled then microprocessor has interrupt enabled it receives high INR signal & activates INTA signal, so another request can't be accepted till CPU is busy in servicing interrupt. Hence (A) is correct option.

2 votes

-- Tejas Jaiswal (511 points)

2.10**Io Handling** [top](#)**2.10.1 Io Handling: GATE2008-64, ISRO2009-13** [top](#)<http://gateoverflow.in/487>

Which of the following statements about synchronous and asynchronous I/O is NOT true?

- An ISR is invoked on completion of I/O in synchronous I/O but not in asynchronous I/O
- In both synchronous and asynchronous I/O, an ISR (Interrupt Service Routine) is invoked after completion of the I/O

- C. A process making a synchronous I/O call waits until I/O is complete, but a process making an asynchronous I/O call does not wait for completion of the I/O
- D. In the case of synchronous I/O, the process waiting for the completion of I/O is woken up by the ISR that is invoked after the completion of I/O

gate2008 | operating-system | io-handling | normal | isro2009

[Answer](#)

2.10.2 Io Handling: GATE1996_1.24 [top](#)

<http://gateoverflow.in/2728>

For the daisy chain scheme of connecting I/O devices, which of the following statements is true?

- A. It gives non-uniform priority to various devices
- B. It gives uniform priority to all devices
- C. It is only useful for connecting slow devices to a processor device
- D. It requires a separate interrupt pin on the processor for each device

gate1996 | co&architecture | io-handling | normal

[Answer](#)

2.10.3 Io Handling: GATE1996_25 [top](#)

<http://gateoverflow.in/2777>

A hard disk is connected to a 50 MHz processor through a DMA controller. Assume that the initial set-up of a DMA transfer takes 1000 clock cycles for the processor, and assume that the handling of the interrupt at DMA completion requires 500 clock cycles for the processor. The hard disk has a transfer rate of 2000 Kbytes/sec and average block transferred is 4 K bytes. What fraction of the processor time is consumed by the disk, if the disk is actively transferring 100% of the time?

25. A hard disk is connected to a 50 MHz processor through a DMA controller. Assume that the initial set-up of a DMA transfer takes 1000 clock cycles for the processor, and assume that the handling of the interrupt at DMA completion requires 500 clock cycles for the processor. The hard disk has a transfer rate of 2000 Kbytes/sec and average block size transferred is 4 K bytes. What fraction of the processor time is consumed by the disk, if the disk is actively transferring 100% of the time?

| Level 1 (Cache memory) | | Level 1 (Cache memory) | |
|----------------------------|-----------------------------|----------------------------|-----------------------------|
| Access time = 50 nsec/byte | Access time = 200 nsec/byte | Access time = 50 nsec/byte | Access time = 200 nsec/byte |
| Size | Hit ratio | Size | Hit ratio |
| 8 Kbytes | 0.80 | 4 Kbytes | 0.98 |
| 16 Kbytes | 0.90 | 16 Kbytes | 0.99 |
| 64 Kbytes | 0.95 | 64 Kbytes | 0.995 |
| | | | |
| Size | Hit ratio | | |
| 250 M bytes | 1.0 | | |

gate1996 | computer-organization | io-handling | dma | normal

[Answer](#)

Answers: Io Handling

2.10.1 Io Handling: GATE2008-64, ISRO2009-13 [top](#)

<http://gateoverflow.in/487>



Selected Answer

Answer is (B).

In synchronous I/O process performing I/O operation will be placed in blocked state till the I/O operation is completed. An ISR will be invoked after the completion of I/O operation and it will place process from block state to ready state.

In asynchronous I/O, Handler function will be registered while performing the I/O operation. The process will not be placed

in the block state and process continues to execute the remaining instructions. when the I/O operation completed signal mechanism is used to notify the process that data is available.

13 votes

-- gate_asp (573 points)

2.10.2 Io Handling: GATE1996_1.24 [top](#)

<http://gateoverflow.in/2728>



Selected Answer

daisy chaining approach tell the processor in which order the interrupt should be handled by providing priority to the devices .

In daisy chaining method all the devices are connected in serial. The device with the highest priority is placed in the first position, followed by lower priority devices . interrupt pin is common to all

so answer is a

9 votes

-- Ravi Singh (8.2k points)

2.10.3 Io Handling: GATE1996_25 [top](#)

<http://gateoverflow.in/2777>

30 us for initialisation and termination and 2 ms for data transfer

Cpu time is consumed only for initialisation and termination

% of cpu time consumed = $30\text{us}/(30\text{us}+2\text{ms}) * 100 = 1.5\%$

5 votes

-- Pooja (25.9k points)

2.11

Machine Instructions [top](#)

2.11.1 Machine Instructions: GATE2004-64 [top](#)

<http://gateoverflow.in/43570>

Consider the following program segment for a hypothetical CPU having three user registers R1, R2 and R3.

| Instruction | Operation | Instruction Size (in words) |
|--------------|------------------------------|--------------------------------|
| MOV R1, 5000 | R1 \leftarrow Memory[5000] | 2 |
| MOV R2(R1) | R2 \leftarrow Memory[(R1)] | 1 |
| ADD R2, R3 | R2 \leftarrow R2 + R3 | 1 |
| MOV 6000, R2 | Memory[6000] \leftarrow R2 | 2 |
| HALT | Machine halts | 1 |

Let the clock cycles required for various operations be as follows:

| | |
|------------------------------------|---------------------------|
| Register to/from memory transfer | : 3 clock cycles |
| ADD with both operands in register | : 1 clock cycle |
| Instruction fetch and decode | : 2 clock cycles per word |

The total number of clock cycles required to execute the program is

- A. 29
- B. 24
- C. 23
- D. 20

[gate2004](#) [co&architecture](#) [machine-instructions](#) [normal](#)

[Answer](#)

2.11.2 Machine Instructions: GATE2015-2_42 [top](#)

<http://gateoverflow.in/8215>

Consider a processor with byte-addressable memory. Assume that all registers, including program counter (PC) and Program Status Word (PSW), are size of two bytes. A stack in the main memory is implemented from memory location $(0100)_{16}$ and it grows upward. The stack pointer (SP) points to the top element of the stack. The current value of SP is $(016E)_{16}$. The CALL instruction is of two words, the first word is the op-code and the second word is the starting address of the subroutine (one word = 2 bytes). The CALL instruction is implemented as follows:

- Store the current value of PC in the stack
- Store the value of PSW register in the stack
- Load the starting address of the subroutine in PC

The content of PC just before the fetch of a CALL instruction is $(5FA0)_{16}$. After execution of the CALL instruction, the value of the stack pointer is

- A. $(016A)_{16}$
- B. $(016C)_{16}$
- C. $(0170)_{16}$
- D. $(0172)_{16}$

[gate2015-2](#) [co&architecture](#) [machine-instructions](#) [easy](#)

[Answer](#)

2.11.3 Machine Instructions: GATE2007-IT_41 [top](#)

<http://gateoverflow.in/3476>

Following table indicates the latencies of operations between the instruction producing the result and instruction using the result.

| Instruction producing the result | Instruction using the result | Latency |
|----------------------------------|------------------------------|---------|
| ALU Operation | ALU operation | 2 |
| ALU Operation | Store | 2 |
| Load | ALU Operation | 1 |
| Load | Store | 0 |

Consider the following code segment.

```
Load R1, Loc 1; Load R1 from memory location Loc1
Load R2, Loc 2; Load R2 from memory location Loc 2
Add R1, R2, R1; Add R1 and R2 and save result in R1
Dec R2; Decrement R2
Dec R1; Decrement R1
Mpy R1, R2, R3; Multiply R1 and R2 and save result in R3
Store R3, Loc 3; Store R3 in memory location Loc 3
```

What is the number of cycles needed to execute the above code segment assuming each instruction takes one cycle to execute ?

- | | |
|----|----|
| A) | 7 |
| B) | 10 |

- C) 13
D) 14

gate2007-it co&architecture machine-instructions normal

[Answer](#)

2.11.4 Machine Instructions: GATE2004-IT_46 [top](#)

<http://gateoverflow.in/3689>

If we use internal data forwarding to speed up the performance of a CPU (R1, R2 and R3 are registers and M[100] is a memory reference), then the sequence of operations

$$\begin{aligned} R1 &\rightarrow M[100] \\ M[100] &\rightarrow R2 \\ M[100] &\rightarrow R3 \end{aligned}$$

can be replaced by

- A) $R1 \rightarrow R3$
 $R2 \rightarrow M[100]$
 $M[100] \rightarrow R2$
- B) $R1 \rightarrow R2$
 $R1 \rightarrow R3$
- C) $R1 \rightarrow M[100]$
 $R2 \rightarrow R3$
 $R1 \rightarrow R2$
- D) $R1 \rightarrow R3$
 $R1 \rightarrow M[100]$

gate2004-it co&architecture machine-instructions easy

[Answer](#)

2.11.5 Machine Instructions: GATE2008-34 [top](#)

<http://gateoverflow.in/445>

Which of the following must be true for the RFE (Return From Exception) instruction on a general purpose processor?

- I. It must be a trap instruction
 - II. It must be a privileged instruction
 - III. An exception cannot be allowed to occur during execution of an RFE instruction
- A. I only
 - B. II only
 - C. I and II only
 - D. I, II and III only

gate2008 co&architecture machine-instructions normal

[Answer](#)

2.11.6 Machine Instructions: GATE2003-49 [top](#)

<http://gateoverflow.in/43577>

Consider the following assembly language program for a hypothetical processor A, B, and C are 8 bit registers. The meanings of various instructions are shown as comments.

| | |
|--------------|---|
| MOV B, #0 | $; B \leftarrow 0$ |
| MOV C, #8 | $; C \leftarrow 8$ |
| Z: CMP C, #0 | $; \text{compare } C \text{ with } 0$ |
| JZ X | $; \text{jump to } X \text{ if zero flag is set}$ |

| | | |
|----|-----------|---|
| | SUB C, #1 | ; $C \leftarrow C - 1$ |
| | RRC A, #1 | ; right rotate A through carry by one bit. Thus: |
| | | ; If the initial values of A and the carry flag are $a_7..a_0$ and c_0 respectively, their values after the execution of this |
| | | ; instruction will be $c_0a_7..a_1$ and a_0 respectively. |
| | JC Y | ; jump to Y if carry flag is set |
| | JMP Z | ; jump to Z |
| Y: | ADD B, #1 | ; $B \leftarrow B + 1$ |
| | JMP Z | ; jump to Z |
| X: | | |

Which of the following instructions when inserted at location X will ensure that the value of the register A after program execution is as same as its initial value?

- A. RRC A, #1
- B. NOP ; no operation
- C. LRC A, #1; left rotate A through carry flag by one bit
- D. ADD A, #1

gate2003 co&architecture machine-instructions normal

Answer

2.11.7 Machine Instructions: GATE1999_17 [top](#)

<http://gateoverflow.in/1516>

Consider the following program fragment in the assembly language of a certain hypothetical processor. The processor has three general purpose registers R1, R2 and R3. The meanings of the instructions are shown by comments (starting with ;) after the instructions.

```
X: CMP R1, 0; Compare R1 and 0, set flags appropriately in status register
JZ Z; Jump if zero to target Z
MOV R2, R1; Copy contents of R1 to R2
SHR R1; Shift right R1 by 1 bit
SHL R1; Shift left R1 by 1 bit
CMP R2, R1; Compare R2 and R1 and set flag in status register
JZ Y; Jump if zero to target Y
INC R3; Increment R3 by 1;
Y: SHR R1; Shift right R1 by 1 bit
JMP X; Jump to target X
Z:...
```

- a. Initially R1, R2 and R3 contain the values 5, 0 and 0 respectively, what are the final values of R1 and R3 when control reaches Z?
- b. In general, if R1, R2 and R3 initially contain the values n, 0, and 0 respectively. What is the final value of R3 when control reaches Z?

gate1999 co&architecture machine-instructions normal

Answer

2.11.8 Machine Instructions: GATE2006_09, ISRO2009-35 [top](#)

<http://gateoverflow.in/888>

A CPU has 24-bit instructions. A program starts at address 300 (in decimal). Which one of the following is a legal program counter (all values in decimal)?

- (A) 400
- (B) 500
- (C) 600
- (D) 700

[gate2006](#) [co&architecture](#) [machine-instructions](#) [easy](#) [isro2009](#)

[Answer](#)

2.11.9 Machine Instructions: GATE 2016-2-10 [top](#)

<http://gateoverflow.in/39547>

A processor has 40 distinct instruction and 24 general purpose registers. A 32-bit instruction word has an opcode, two registers operands and an immediate operand. The number of bits available for the immediate operand field is _____.

[gate2016-2](#) [machine-instructions](#) [computer-organization](#) [easy](#) [numerical-answers](#)

[Answer](#)

2.11.10 Machine Instructions: GATE2007_54 [top](#)

<http://gateoverflow.in/1252>

In a simplified computer the instructions are:

- | | |
|---------------|--|
| OP R_j, R_i | -Performs $R_j \text{ OP } R_i$ and stores the result in register R_j . |
| OP m, R_i | -Performs $\text{val OP } R_i$ and stores the result in register R_i . val denotes the content of the memory location m . |
| MOV m, R_i | -Moves the content of memory location m to register R_i |
| MOV R_i, m | -Moves the content of register R_i to memory location m |

The computer has only two registers, and OP is either ADD or SUB. Consider the following basic block:

$$\begin{aligned} t_1 &= a + b \\ t_2 &= c + d \\ t_3 &= e - t_2 \\ t_4 &= t_1 - t_3 \end{aligned}$$

Assume that all operands are initially in memory. The final value of the computation should be in memory. What is the minimum number of MOV instructions in the code generated for this basic block?

- A. 2
- B. 3
- C. 5
- D. 6

[gate2007](#) [co&architecture](#) [machine-instructions](#) [normal](#)

[Answer](#)

2.11.11 Machine Instructions: GATE2004-63 [top](#)

<http://gateoverflow.in/1058>

Consider the following program segment for a hypothetical CPU having three user registers R1, R2 and R3.

Instruction Size

| Instruction | Operation | (in words) |
|--------------|-------------------------------------|------------|
| MOV R1, 5000 | $R1 \leftarrow \text{Memory}[5000]$ | 2 |
| MOV R2(R1) | $R2 \leftarrow \text{Memory}[(R1)]$ | 1 |
| ADD R2, R3 | $R2 \leftarrow R2 + R3$ | 1 |
| MOV 6000, R2 | $\text{Memory}[6000] \leftarrow R2$ | 2 |
| HALT | Machine halts | 1 |

Consider that the memory is byte addressable with size 32 bits, and the program has been loaded starting from memory location 1000 (decimal). If an interrupt occurs while the CPU has been halted after executing the HALT instruction, the return address (in decimal) saved in the stack will be

- A. 1007
- B. 1020
- C. 1024
- D. 1028

gate2004 co&architecture machine-instructions normal

Answer

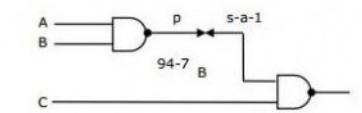
2.11.12 Machine Instructions: GATE1994_12 [top](#)

<http://gateoverflow.in/2508>

- a. Assume that a CPU has only two registers R_1 and R_2 and that only the following instruction is available $XOR R_i, R_j; \{R_j \leftarrow R_i \oplus R_j, \text{ for } i, j = 1, 2\}$

Using this XOR instruction, find an instruction sequence in order to exchange the contents of the registers R_1 and R_2 .

- b. The line p of the circuit shown in figure has stuck at 1 fault. Determine an input test to detect the fault.



gate1994 co&architecture machine-instructions normal

Answer

2.11.13 Machine Instructions: GATE2003-48 [top](#)

<http://gateoverflow.in/938>

Consider the following assembly language program for a hypothetical processor A, B, and C are 8 bit registers. The meanings of various instructions are shown as comments.

```

MOV B, #0      ; B ← 0
MOV C, #8      ; C ← 8
Z: CMP C, #0   ; compare C with 0
    JZ X        ; jump to X if zero flag is set
    C ← C
    ; -1
SUB C, #1     ; C ← C - 1
RRC A, #1     ; right rotate A through carry by one bit. Thus:
    ; If the initial values of A and the carry flag are  $a_7 \dots a_0$  and
    ;  $c_0$  respectively, their values after the execution of this
    ; instruction will be  $c_0 a_7 \dots a_1$  and  $a_0$  respectively.
JC Y          ; jump to Y if carry flag is set
JMP Z          ; jump to Z
Y: ADD B, #1   ; B ← B + 1
JMP Z          ; jump to Z
X:

```

If the initial value of register A is A0 the value of register B after the program execution will be

- A. the number of 0 bits in A_0

- B. the number of 1 bits in A_0
 C. A_0
 D. 8

gate2003 co&architecture machine-instructions normal

Answer

2.11.14 Machine Instructions: GATE2008-IT_38 [top](#)

<http://gateoverflow.in/3348>

Assume that $EA = (X) +$ is the effective address equal to the contents of location X, with X incremented by one word length after the effective address is calculated; $EA = -(X)$ is the effective address equal to the contents of location X, with X decremented by one word length before the effective address is calculated; $EA = (X) -$ is the effective address equal to the contents of location X, with X decremented by one word length after the effective address is calculated. The format of the instruction is (opcode, source, destination), which means (destination \leftarrow source op destination). Using X as a stack pointer, which of the following instructions can pop the top two elements from the stack, perform the addition operation and push the result back to the stack.

- A) ADD $(X) -, (X)$
 B) ADD $(X), (X) -$
 C) ADD $-(X), (X) +$
 D) ADD $-(X), (X)$

gate2008-it co&architecture machine-instructions normal

Answer

Answers: Machine Instructions

2.11.1 Machine Instructions: GATE2004-64 [top](#)

<http://gateoverflow.in/43570>



Selected Answer

64. B. 24 cycles

| Instruction | Size | Fetch and Decode + Execute |
|-------------|-------|----------------------------|
| mov | 2 | $2*2 + 3 = 7$ |
| mov | 1 | $2*1 + 3 = 5$ |
| add | 1 | $2*1 + 1 = 3$ |
| mov | 2 | $2*2 + 3 = 7$ |
| halt | 1 | $2*1 + 0 = 2$ |
| | Total | 24 cycles |

6 votes

-- Vikrant Singh (11k points)

2.11.2 Machine Instructions: GATE2015-2_42 [top](#)

<http://gateoverflow.in/8215>



Selected Answer

first we have to consider here memory is byte-addressable

The CALL instruction is implemented as follows:

- Store the current value of PC in the stack

pc is 2 byte it means when we store pc in stack it will increase by 2
so current value of SP is $(016E)_{16} + 2$

- Store the value of PSW register in the stack
psw is 2 byte it means when we store psw in stack it will increase by 2
so current value of SP is $(016E)_{16} + 2 + 2 = (0172)_{16}$

13 votes

-- Anoop Sonkar (4.5k points)

2.11.3 Machine Instructions: GATE2007-IT_41 [top](#)

<http://gateoverflow.in/3476>



Selected Answer

Answer is (C)

Here each instruction takes 1 cycle but apart from that we have to consider latencies b/w instruction: If there are two ALU operations by I1 and I2 such that I2 uses the value produced by I1 in some register then I2 will be executed ONLY after waiting TWO more cycles after I1 has executed because latency b/w two ALU operations is 2

See here:

| Clock | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
|-------|----|----|---|----|----|---|----|---|---|----|----|----|----|----|
| Inst. | I1 | I2 | - | I3 | I4 | - | I5 | - | - | I6 | - | - | - | I7 |

I3 is ALU operation which uses result of LOAD in I2 , so latency is of 1 cycle.

I5 is ALU operation using result of ALU in I3 therefore has to wait for 2 cycles after I3

I6 is ALU and uses result of ALU in I5 ,therefore waits 2 cycles

8 votes

-- Sandeep_Uniyal (5.5k points)

2.11.4 Machine Instructions: GATE2004-IT_46 [top](#)

<http://gateoverflow.in/3689>



Selected Answer

Data forwarding means if CPU writes to a memory location and subsequently reads from the same memory location, the second instruction can fetch the value directly from the register used to do the write than waiting for the memory. So, this increases the performance.

Here, choices A, B and C doesn't really make any sense as the data was in R1 and it must be moved to R2, R3 and M[100]. So, (D) is the answer.

7 votes

-- Arjun Suresh (150k points)

2.11.5 Machine Instructions: GATE2008-34 [top](#)

<http://gateoverflow.in/445>

RFE (Return From Exception) is a privileged trap instruction that is executed when exception occurs, so an exception is not allowed to execute. (D) is the correct option.

Ref: http://www.cs.rochester.edu/courses/252/spring2014/notes/08_exceptions

4 votes

-- Vikrant Singh (11k points)

2.11.6 Machine Instructions: GATE2003-49 [top](#)

<http://gateoverflow.in/43577>



Selected Answer

49. A. RRC a, #1. As the 8 bit register is rotated via carry 8 times.

a7a6a5a4a3a2a1a0
c0a7a6a5a4a3a2a1, now a0 is the new carry. So, after next rotation,
a0c0a7a6a5a4a3a2

So, after 8 rotations,

a6a5a4a3a2a1a0c0 and carry is a7.

Now, one more rotation will restore the original value of A0.

Upvote 5 votes

-- Arjun Suresh (150k points)

2.11.7 Machine Instructions: GATE1999_17 [top](#)

<http://gateoverflow.in/1516>



Selected Answer

SHR R1 (Lower bit is lost and upper bit becomes 0 and all other bits shift right by 1)
SHL R1 (Upper bit is lost and lower bit becomes 0 and all other bits shift left by 1)

These two operations change the value of R1 if its lower bit is 1. So, the given program checks the lowest bit of R1 in each iteration and if its 1 then only increment R3 and loop terminates when R1 becomes 0. Thus at end, R3 will have the count of the number of bits set to 1 in R1.

- a. R1 = 0, R3 = 2 as 101 has two 1's
- b. R3 = #1 in R1.

Upvote 5 votes

-- Arjun Suresh (150k points)

2.11.8 Machine Instructions: GATE2006_09, ISRO2009-35 [top](#)

<http://gateoverflow.in/888>



Selected Answer

Option c. 24 bit = 3 bytes instructions. So PC will have multiples of 3 in it.

Upvote 5 votes

-- anshu (2.5k points)

2.11.9 Machine Instructions: GATE 2016-2-10 [top](#)

<http://gateoverflow.in/3953>



Selected Answer

Instruction Opcode Size => $\log_2 40 \Rightarrow 6$

Register operand size = $\log_2 24 \Rightarrow 5$

Total bits available => 32

Bits required for opcode + two register operands => $6 + 2 * 5 \Rightarrow 16$

Bits available for immediate operand => $32 - 16 = 16$!

Upvote 6 votes

-- Akash (31.7k points)

2.11.10 Machine Instructions: GATE2007_54 [top](#)

<http://gateoverflow.in/1252>



Selected Answer

```

MOV      a, R1
ADD      b, R1
MOV      c, R2
ADD      d, R2
SUB      e, R2
SUB      R1, R2
MOV      R2, m

```

Total no. of MOV Instruction = 3

10 votes

-- Gate Keeda (17.7k points)

2.11.11 Machine Instructions: GATE2004-63 [top](#)

<http://gateoverflow.in/1058>



Selected Answer

63. Word size is 32 bits (4 bytes). Interrupt occurs after execution of HALT instruction NOT **during**, So address of next instruction will be saved on to the stack which is 1028. (We have 5 instructions starting from address 1000, each of size 2, 1, 1, 2, 1 totaling 7 words = 28 bytes).

After HALT instruction CPU enters a HALT state and if an interrupt happens the return address will be that of the instruction after the HALT. Ref http://x86.renejeschke.de/html/file_module_x86_id_134.html

option D

10 votes

-- Vikrant Singh (11k points)

2.11.12 Machine Instructions: GATE1994_12 [top](#)

<http://gateoverflow.in/2508>



Selected Answer

(a)
 $R2 \leftarrow R1 \oplus R2$
 $R1 \leftarrow R2 \oplus R1$
 $R2 \leftarrow R1 \oplus R2$

(b) A=1, B=1, C=1 should give output as 1 but as p is struck at 1 fault the output comes out to be 0.

5 votes

-- Rajarshi Sarkar (29.7k points)

2.11.13 Machine Instructions: GATE2003-48 [top](#)

<http://gateoverflow.in/938>



Selected Answer

B. The code is counting the number of 1 bits in A0. When a 1 is moved to carry, B is incremented.

9 votes

-- Arjun Suresh (150k points)

2.11.14 Machine Instructions: GATE2008-IT_38 [top](#)<http://gateoverflow.in/3348>

Selected Answer

I think it should be A as $998 < -1000 + 998$. (I am writing only memory locations for sake of brevity). Let's say SP is 1000 initially. Then after it calculates the EA of source (which is 1000 as it decrements after the EA) the destination becomes 998 and that is where we want to store the result as stack is decrementing... In case of C and D it becomes $998 < -998 + 998$

7 votes

-- Shaun Patel (5.8k points)

2.12**Microprogramming** [top](#)**2.12.1 Microprogramming: GATE1996_2.25** [top](#)<http://gateoverflow.in/2754>

A micro program control unit is required to generate a total of 25 control signals. Assume that during any microinstruction, at most two control signals are active. Minimum number of bits required in the control word to generate the required control signals will be

- A. 2
- B. 2.5
- C. 10
- D. 12

[gate1996](#) [co&architecture](#) [microprogramming](#) [normal](#)

Answer

2.12.2 Microprogramming: GATE2013_28 [top](#)<http://gateoverflow.in/1539>

Consider the following sequence of micro-operations.

```
MBR ← PC   MAR ← X   PC ← Y   Memory ← MBR
```

Which one of the following is a possible operation performed by this sequence?

- (A) Instruction fetch
- (B) Operand fetch
- (C) Conditional branch
- (D) Initiation of interrupt service

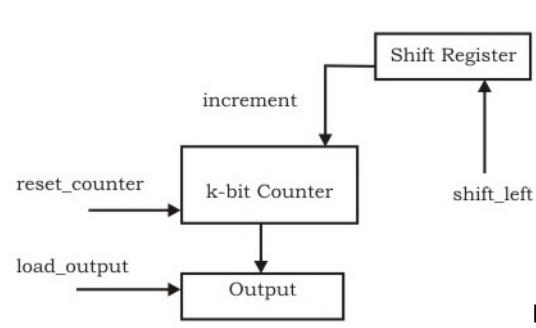
[gate2013](#) [co&architecture](#) [microprogramming](#) [normal](#)

Answer

2.12.3 Microprogramming: GATE2006-IT_41 [top](#)<http://gateoverflow.in/3584>

The data path shown in the figure computes the number of 1s in the 32-bit input word corresponding to an unsigned even integer stored in the shift register.

The unsigned counter, initially zero, is incremented if the most significant bit of the shift register is 1.



The microprogram for the control is shown in the table below with missing control words for microinstructions I_1, I_2, \dots, I_n .

| Microinstruction | reset_counter | shift_left | load_output |
|------------------|---------------|------------|-------------|
| BEGIN | 1 | 0 | 0 |
| I_1 | ? | ? | ? |
| : | : | : | : |
| I_n | ? | ? | ? |
| END | 0 | 0 | 1 |

The counter width (k), the number of missing microinstructions (n), and the control word for microinstructions I_1, I_2, \dots, I_n are, respectively,

- A) 32, 5, 010
- B) 5, 32, 010
- C) 5, 31, 011
- D) 5, 31, 010

gate2006-it | co&architecture | microprogramming | normal

Answer

2.12.4 Microprogramming: GATE2005-IT_45 [top](#)

<http://gateoverflow.in/3806>

A hardwired CPU uses 10 control signals S_1 to S_{10} , in various time steps T_1 to T_5 , to implement 4 instructions I_1 to I_4 as shown below:

| | T1 | T2 | T3 | T4 | T5 |
|-------|-----------------|--------------------|-----------------|------------|------------|
| I_1 | S_1, S_3, S_5 | S_2, S_4, S_6 | S_1, S_7 | S_{10} | S_3, S_8 |
| I_2 | S_1, S_3, S_5 | S_8, S_9, S_{10} | S_5, S_6, S_7 | S_6 | S_{10} |
| I_3 | S_1, S_3, S_5 | S_7, S_8, S_{10} | S_2, S_6, S_9 | S_{10} | S_1, S_3 |
| I_4 | S_1, S_3, S_5 | S_2, S_6, S_7 | S_5, S_{10} | S_6, S_9 | S_{10} |

Which of the following pairs of expressions represent the circuit for generating control signals S_5 and S_{10} respectively?

$((I_j + I_k)T_n)$ indicates that the control signal should be generated in time step T_n if the instruction being executed is I_j or I_k)

$$S_5 \quad \text{and} \\ = T_1 + I_2 \cdot T_3$$

- A) S_{10}
= $(I_1 + I_3) \cdot T_4 + (I_2 + I_4) \cdot T_5$

$$S_5 \quad \text{and} \\ = T_1 + (I_2 + I_4) \cdot T_3$$

- B) S_{10}
 $=$
 $(I_1 + I_3) \cdot T_4 + (I_2 + I_4) \cdot T_5$
- S_5 and
 $= T_1 + (I_2 + I_4) \cdot T_3$
- C) S_{10}
 $=$
 $(I_2 + I_3 + I_4) \cdot T_2 + (I_1 + I_3) \cdot T_4 + (I_2 + I_4) \cdot T_5$
- S_5 and
 $= T_1 + (I_2 + I_4) \cdot T_3$
- D) S_{10}
 $=$
 $(I_2 + I_3) \cdot T_2 + I_4 \cdot T_3 + (I_1 + I_3) \cdot T_4 + (I_2 + I_4) \cdot T_5$

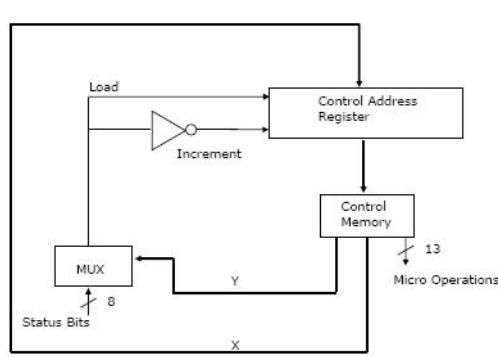
gate2005-it | co&architecture | microporogramming | normal

Answer

2.12.5 Microprogramming: GATE2004_67 [top](#)

<http://gateoverflow.in/1061>

The microinstructions stored in the control memory of a processor have a width of 26 bits. Each microinstruction is divided into three fields: a micro-operation field of 13 bits, a next address field (X), and a MUX select field (Y). There are 8 status bits in the input of the MUX.



How many bits are there in the X and Y fields, and what is the size of the control memory in number of words?

- A. 10, 3, 1024
- B. 8, 5, 256
- C. 5, 8, 2048
- D. 10, 3, 512

gate2004 | co&architecture | microporogramming | normal

Answer

2.12.6 Microprogramming: GATE1997_5.3 [top](#)

<http://gateoverflow.in/2254>

A micro instruction is to be designed to specify

- a. none or one of the three micro operations of one kind and
- b. none or upto six micro operations of another kind

The minimum number of bits in the micro-instruction is

- A. 9
- B. 5
- C. 8
- D. None of the above

[gate1997](#) [co&architecture](#) [microprogramming](#) [normal](#)

[Answer](#)

2.12.7 Microprogramming: GATE1999_2.19 [top](#)

<http://gateoverflow.in/1497>

Arrange the following configuration for CPU in decreasing order of operating speeds:

Hard wired control, Vertical microprogramming, Horizontal microprogramming.

- A. Hard wired control, Vertical microprogramming, Horizontal microprogramming.
- B. Hard wired control, Horizontal microprogramming, Vertical microprogramming.
- C. Horizontal microprogramming, Vertical microprogramming, Hard wired control.
- D. Vertical microprogramming, Horizontal microprogramming, Hard wired control.

[gate1999](#) [co&architecture](#) [microprogramming](#) [normal](#)

[Answer](#)

2.12.8 Microprogramming: GATE2008-IT_39 [top](#)

<http://gateoverflow.in/3349>

Consider a CPU where all the instructions require 7 clock cycles to complete execution. There are 140 instructions in the instruction set. It is found that 125 control signals are needed to be generated by the control unit. While designing the horizontal microprogrammed control unit, single address field format is used for branch control logic. What is the minimum size of the control word and control address register?

- | | |
|----|---------|
| A) | 125, 7 |
| B) | 125, 10 |
| C) | 135, 9 |
| D) | 135, 10 |

[gate2008-it](#) [co&architecture](#) [microprogramming](#) [normal](#)

[Answer](#)

2.12.9 Microprogramming: GATE2005-IT_49 [top](#)

<http://gateoverflow.in/3810>

An instruction set of a processor has 125 signals which can be divided into 5 groups of mutually exclusive signals as follows:

Group 1 : 20 signals, Group 2 : 70 signals, Group 3 : 2 signals, Group 4 : 10 signals, Group 5 : 23 signals.

How many bits of the control words can be saved by using vertical microprogramming over horizontal microprogramming?

- | | |
|----|-----|
| A) | 0 |
| B) | 103 |
| C) | 22 |
| D) | 55 |

[gate2005-it](#) [co&architecture](#) [microprogramming](#) [normal](#)

[Answer](#)

2.12.10 Microprogramming: GATE2002_2.7 [top](#)

<http://gateoverflow.in/837>

Horizontal microprogramming

- A. does not require use of signal decoders
- B. results in larger sized microinstructions than vertical microprogramming
- C. uses one bit for each control signal
- D. all of the above

[gate2002](#) [co&architecture](#) [microprogramming](#)

[Answer](#)

2.12.11 Microprogramming: GATE2004-IT_49 [top](#)

<http://gateoverflow.in/3692>

A CPU has only three instructions I1, I2 and I3, which use the following signals in time steps T1-T5:

I1 : T1 : Ain, Bout, Cin
 T2 : PCout, Bin
 T3 : Zout, Ain
 T4 : Bin, Cout
 T5 : End

I2 : T1 : Cin, Bout, Din
 T2 : Aout, Bin
 T3 : Zout, Ain
 T4 : Bin, Cout
 T5 : End

I3 : T1 : Din, Aout
 T2 : Ain, Bout
 T3 : Zout, Ain
 T4 : Dout, Ain
 T5 : End

Which of the following logic functions will generate the hardwired control for the signal Ain ?

- A) $T1.I1 + T2.I3 + T4.I3 + T3$
- B) $(T1 + T2 + T3).I3 + T1.I1$
- C) $(T1 + T2).I1 + (T2 + T4).I3 + T3$
- D) $(T1 + T2).I2 + (T1 + T3).I1 + T3$

[gate2004-it](#) [co&architecture](#) [microprogramming](#) [normal](#)

[Answer](#)

Answers: Microprogramming

2.12.1 Microprogramming: GATE1996_2.25 [top](#)

<http://gateoverflow.in/274>



Selected Answer

To generate 25 different control signals 5 bits are required....at any time atmost 2 signals are active..so control word length=5+5=10 bits

3 votes

-- aravind90 (609 points)

2.12.2 Microprogramming: GATE2013_28 [top](#)

<http://gateoverflow.in/1539>



Selected Answer

Here PC value is being stored in memory. which is done when either CALL RETURN involved or there is Interrupt. As, we will have to come back to execute current instruction.

so, option (A), (B) are clearly incorrect

option (C) is incorrect coz conditional branch does not require to save PC contents.

option (D) is correct as it matches the generic Interrupt Cycle :

Interrupt Cycle:

| | | |
|-----|--------|-------------------|
| t1: | MBR | ←(PC) |
| t2: | MAR | ← save-address |
| | PC | ← routine-address |
| t3: | memory | ← (MBR) |

8 votes

-- Himanshu Agarwal (9.8k points)

2.12.3 Microprogramming: GATE2006-IT_41 [top](#)

<http://gateoverflow.in/3584>

As there can be maximum 32 ones in number so 5 bit counter is sufficient no of micro instructions required would be 32 we have to load output at end so control word would be 0 1 0 for all micro instructions so ans is b

5 votes

-- Pooja (25.9k points)

2.12.4 Microprogramming: GATE2005-IT_45 [top](#)

<http://gateoverflow.in/3806>



Selected Answer

4. is the option for this question.

If we look at the table, we need to find those time-stamps and instructions which are using these control signals.

For example, $S_5 = T_1$ has used control signal S_5 for all the instructions, or we can say irrespective of the instructions. Also, S_5 is used by instructions I_2 and I_4 for the time stamp T_3 so that comes to:

$$S_5 = T_1 + I_2 \cdot T_3 + I_4 \cdot T_3 = T_1 + (I_2 + I_3) \cdot T_3$$

In the same way, we'll calculate for S_{10} .

It's an example of Hardwired CU Programming used in RISC processors. It gives accurate result, but isn't good for debugging since minor change will cause to restructure the control unit.

8 votes

-- Manu Thakur (5.6k points)

2.12.5 Microprogramming: GATE2004_67 [top](#)

<http://gateoverflow.in/1061>



Selected Answer

$$x + y + 13 = 26 \rightarrow (1)$$

$$y = 3 // y is no of bits used to represent 8 different states of multiplexer \rightarrow (2)$$

x is no of bits required represent size of control memory

x = 10 from (1) and (2)

$$\text{size of control memory} = 2^x = 2^{10} = 1024$$

7 votes

-- Digvijay (35.8k points)

2.12.6 Microprogramming: GATE1997_5.3 [top](#)

<http://gateoverflow.in/2254>



Selected Answer

Answer: C

The first condition (None or any one out of 3 operations) gives 4 variations to consider. This uses 2 bits.
The second condition (Any combination of 6 other operations) gives 64 variations to consider. This uses 6 bits.
In total 8 bits.

5 votes

-- Rajarshi Sarkar (29.7k points)

2.12.7 Microprogramming: GATE1999_2.19 [top](#)

<http://gateoverflow.in/1497>

Hard wired control involves only hardware, whereas microprogramming is software approach. So, hardwire control should be faster than both microprogramming approaches.

Between vertical and horizontal microprogramming. Horizontal is faster because in this control signals are not encoded whereas in vertical microprogramming to save memory signals are encoded. So, it takes less time in horizontal microprogramming because decoding of signals is not required. Therefore, final order is :

hard wired control > horizontal microprogramming > vertical microprogramming

4 votes

-- Shikhar Vashishth (3.7k points)

2.12.8 Microprogramming: GATE2008-IT_39 [top](#)

<http://gateoverflow.in/3349>



Selected Answer

Its ans shuld be D becoz 140 instruction each requiring 7 cycles means...980 cycles which will take 10 bits

since its horizontal so for control word = 125 control signals + 10 bits =135 bits will be required

3 votes

-- nagendra2016 (121 points)

2.12.9 Microprogramming: GATE2005-IT_49 [top](#)

<http://gateoverflow.in/3810>



Selected Answer

In horizontal microprogramming we need 1 bit for every control word, therefore total bits in

$$\text{Horizontal Microprogramming} = 20+70+2+10+23=125$$

Now lets consider vertical microprogramming, In vertical microprogramming we use Decoder (n to 2^n) and output lines are equal to number of control words . A input is given according to what control word we have to select.

Now in this question these 5 groups contains mutually exclusive signals, i.e, they can be activated one at a time for a given group, we can safely use decoder.

group 1= $\lceil \log_2 20 \rceil = 5$ (Number of input bits for decoder, given output is number of control word in given group)

group 2= $\lceil \log_2 70 \rceil = 7$

group 3= $\lceil \log_2 2 \rceil = 1$

group 4= $\lceil \log_2 10 \rceil = 4$

group 5= $\lceil \log_2 23 \rceil = 5$

Total bits required in vertical microprogramming= $5+7+1+4+5=22$

So number of control words saved= $125-22=103$ hence (B) is answer

14 votes

-- Prateeksha Keshari (1.7k points)

2.12.10 Microprogramming: GATE2002_2.7 [top](#)

<http://gateoverflow.in/837>



Selected Answer

option (d). All statements are true.

Ref: <http://www.cs.virginia.edu/~cs333/notes/microprogramming.pdf>

10 votes

-- Suvojit Mondal (433 points)

2.12.11 Microprogramming: GATE2004-IT_49 [top](#)

<http://gateoverflow.in/3692>



Selected Answer

We just have to see which all options give 1 whenever A_{in} is 1 and 0 otherwise.

So, A_{in} is 1 in T3 of I1, I2 and I3. Also during T1 of I1, and T2 and T4 of I3. So, answer will be

$T1.I1 + T2.I3 + T4.I3 + T3.I1 + T3.I2 + T3.I3$

Since CPU is having only 3 instructions, $T3.I1 + T3.I2 + T3.I3$ can be replaced with T3 (we don't need to see which instruction and A_{in} will be activated in time step 3 of all the instructions).

So, $T1.I1 + T2.I3 + T4.I3 + T3$

is the answer. Option A.

9 votes

-- Arjun Suresh (150k points)

2.13

Page Fault [top](#)

2.13.1 Page Fault: GATE1998-2.18, UGCNET-June2012-III-48 [top](#)

<http://gateoverflow.in/1691>

If an instruction takes i microseconds and a page fault takes an additional j microseconds, the effective instruction time if on the average a page fault occurs every k instruction is:

- A. $i + \frac{j}{k}$
- B. $i + j * k$
- C. $\frac{i+j}{k}$
- D. $(i + j) * k$

gate1998 co&architecture page-fault easy ugcnetjune2012iii

Answer

Answers: Page Fault

2.13.1 Page Fault: GATE1998-2.18, UGCNET-June2012-III-48 [top](#)

<http://gateoverflow.in/1691>



Selected Answer

page fault rate=1/k

page hit rate=1-1/k

service time=

page fault service time= $i+j$

now effective memory access time= $1/k*(i+j)+(1-1/k)*i = (i+j)/k + i - i/k = i/k + j/k + i - i/k = i + j/k$

so option A is correct..

3 votes

-- shashi shekhar (387 points)

2.14

Pipeline top

2.14.1 Pipeline: GATE 2016-1-32 top

<http://gateoverflow.in/39691>

The stage delays in a 4-stage pipeline are 800, 500, 400 and 300 picoseconds. The first stage (with delay 800 picoseconds) is replaced with a functionality equivalent design involving two stages with respective delays 600 and 350 picoseconds. The throughput increase of the pipeline is _____ percent.

gate2016-1 co&architecture pipeline normal numerical-answers

Answer

2.14.2 Pipeline: GATE2015-2_44 top

<http://gateoverflow.in/8218>

Consider the sequence of machine instruction given below:

| | |
|-----|------------|
| MUL | R5, R0, R1 |
| DIV | R6, R2, R3 |
| ADD | R7, R5, R6 |
| SUB | R8, R7, R4 |

In the above sequence, R0 to R8 are general purpose registers. In the instructions shown, the first register shows the result of the operation performed on the second and the third registers. This sequence of instructions is to be executed in a pipelined instruction processor with the following 4 stages: (1) Instruction Fetch and Decode (IF), (2) Operand Fetch (OF), (3) Perform Operation (PO) and (4) Write back the result (WB). The IF, OF and WB stages take 1 clock cycle each for any instruction. The PO stage takes 1 clock cycle for ADD and SUB instruction, 3 clock cycles for MUL instruction and 5 clock cycles for DIV instruction. The pipelined processor uses operand forwarding from the PO stage to the OF stage. The number of clock cycles taken for the execution of the above sequence of instruction is _____.

gate2015-2 co&architecture pipeline normal

Answer

2.14.3 Pipeline: GATE2015-1-38 top

<http://gateoverflow.in/8288>

Consider a non-pipelined processor with a clock rate of 2.5 gigahertz and average cycles per instruction of four. The same processor is upgraded to a pipelined processor with five stages; but due to the internal pipeline delay, the clock speed is reduced to 2 gigahertz. Assume that there are no stalls in the pipeline. The speedup achieved in this pipelined processor is _____.

gate2015-1 co&architecture pipeline normal

Answer

2.14.4 Pipeline: GATE2008-77 top

<http://gateoverflow.in/43487>

Delayed branching can help in the handling of control hazards

The following code is to run on a pipelined processor with one branch delay slot:

I1: ADD $R2 \leftarrow R7 + R8$
 I2: Sub $R4 \leftarrow R5 - R6$
 I3: ADD $R1 \leftarrow R2 + R3$
 I4: STORE Memory $[R4] \leftarrow R1$

BRANCH to Label if $R1 == 0$

Which of the instructions I1, I2, I3 or I4 can legitimately occupy the delay slot without any program modification?

- A. I1
- B. I2
- C. I3
- D. I4

[gate2008](#) [co&architecture](#) [pipeline](#) [normal](#)

[Answer](#)

2.14.5 Pipeline: GATE2015-3_51 [top](#)

<http://gateoverflow.in/8560>

Consider the following reservation table for a pipeline having three stages S_1, S_2 and S_3 .

| <i>Time →</i> | | 1 | 2 | 3 | 4 | 5 |
|---------------|---|---|---|---|---|---|
| S_1 | X | | | | | X |
| S_2 | | X | | X | | |
| S_3 | | | X | | | |

The minimum average latency (MAL) is _____

[gate2015-3](#) [co&architecture](#) [pipeline](#) [difficult](#) [numerical-answers](#)

[Answer](#)

2.14.6 Pipeline: GATE2012-20, ISRO2016-23 [top](#)

<http://gateoverflow.in/52>

Register renaming is done in pipelined processors

- A. as an alternative to register allocation at compile time
- B. for efficient access to function parameters and local variables
- C. to handle certain kinds of hazards
- D. as part of address translation

[gate2012](#) [co&architecture](#) [pipeline](#) [easy](#) [isro2016](#)

[Answer](#)

2.14.7 Pipeline: GATE2005-IT_44 [top](#)

<http://gateoverflow.in/3805>

We have two designs D1 and D2 for a synchronous pipeline processor. D1 has 5 pipeline stages with execution times of 3 nsec, 2 nsec, 4 nsec, 2 nsec and 3 nsec while the design D2 has 8 pipeline stages each with 2 nsec execution time. How much time can be saved using design D2 over design D1 for executing 100 instructions?

- | | |
|----|------------|
| A) | 214 nsec |
| B) | 202 nsec |
| C) | 86 nsec |
| D) | - 200 nsec |

[gate2005-it](#) [co&architecture](#) [pipeline](#) [normal](#)

[Answer](#)

2.14.8 Pipeline: GATE2004-IT_47 [top](#)

<http://gateoverflow.in/3690>

Consider a pipeline processor with 4 stages S1 to S4. We want to execute the following loop:

```
for (i = 1; i <= 1000; i++)
    {I1, I2, I3, I4}
```

where the time taken (in ns) by instructions I1 to I4 for stages S1 to S4 are given below:

| | S1 | S2 | S3 | S4 |
|-----|----|----|----|----|
| I1: | 1 | 2 | 1 | 2 |
| I2: | 2 | 1 | 2 | 1 |
| I3: | 1 | 1 | 2 | 1 |
| I4: | 2 | 1 | 2 | 1 |

The output of I1 for i = 2 will be available after

- A) 11 ns
- B) 12 ns
- C) 13 ns
- D) 28 ns

gate2004-it co&architecture pipeline normal

Answer

2.14.9 Pipeline: GATE2013_45 [top](#)

<http://gateoverflow.in/330>

Consider an instruction pipeline with five stages without any branch prediction: Fetch Instruction (FI), Decode Instruction (DI), Fetch Operand (FO), Execute Instruction (EI) and Write Operand (WO). The stage delays for FI, DI, FO, EI and WO are 5 ns, 7 ns, 10 ns, 8 ns and 6 ns, respectively. There are intermediate storage buffers after each stage and the delay of each buffer is 1 ns. A program consisting of 12 instructions I1, I2, I3, ..., I12 is executed in this pipelined processor. Instruction I4 is the only branch instruction and its branch target is I9. If the branch is taken during the execution of this program, the time (in ns) needed to complete the program is

- (A) 132
- (B) 165
- (C) 176
- (D) 328

gate2013 normal co&architecture pipeline

Answer

2.14.10 Pipeline: GATE2008-36 [top](#)

<http://gateoverflow.in/447>

Which of the following are NOT true in a pipelined processor?

- I. Bypassing can handle all RAW hazards
- II. Register renaming can eliminate all register carried WAR hazards
- III. Control hazard penalties can be eliminated by dynamic branch prediction

- A. I and II only
- B. I and III only
- C. II and III only
- D. I, II and III

gate2008 pipeline co&architecture normal

Answer

2.14.11 Pipeline: GATE2008-76 [top](#)

<http://gateoverflow.in/496>

Delayed branching can help in the handling of control hazards

For all delayed conditional branch instructions, irrespective of whether the condition evaluates to true or false,

- A. The instruction following the conditional branch instruction in memory is executed
- B. The first instruction in the fall through path is executed
- C. The first instruction in the taken path is executed
- D. The branch takes longer to execute than any other instruction

gate2008 co&architecture pipeline normal

Answer**2.14.12 Pipeline: GATE2000-1.8** [top](#)<http://gateoverflow.in/631>

Comparing the time T1 taken for a single instruction on a pipelined CPU with time T2 taken on a non-pipelined but identical CPU, we can say that

- A. $T_1 \leq T_2$
- B. $T_1 \geq T_2$
- C. $T_1 < T_2$
- D. T_1 and T_2 plus the time taken for one instruction fetch cycle

[gate2000](#) [pipeline](#) [co&architecture](#) [easy](#)
Answer**2.14.13 Pipeline: GATE2000-12** [top](#)<http://gateoverflow.in/683>

An instruction pipeline has five stages where each stage take 2 nanoseconds and all instruction use all five stages. Branch instructions are not overlapped. i.e., the instruction after the branch is not fetched till the branch instruction is completed. Under ideal conditions,

- a. Calculate the average instruction execution time assuming that 20% of all instructions executed are branch instruction. Ignore the fact that some branch instructions may be conditional.
- b. If a branch instruction is a conditional branch instruction, the branch need not be taken. If the branch is not taken, the following instructions can be overlapped. When 80% of all branch instructions are conditional branch instructions, and 50% of the conditional branch instructions are such that the branch is taken, calculate the average instruction execution time.

[gate2000](#) [co&architecture](#) [pipeline](#) [normal](#)
Answer**2.14.14 Pipeline: GATE2001-12** [top](#)<http://gateoverflow.in/753>

Consider a 5-stage pipeline - IF (Instruction Fetch), ID (Instruction Decode and register read), EX (Execute), MEM (memory), and WB (Write Back). All (memory or register) reads take place in the second phase of a clock cycle and all writes occur in the first phase. Consider the execution of the following instruction sequence:

```
I1: sub r2, r3, r4;      /* r2 ← r3 - r4          */
I2: sub r4, r2, r3;      /* r4 ← r2 - r3          */
I3: sw r2, 100(r1);     /* M[r1 + 100] ← r2      */
I4: sub r3, r4, r2;      /* r3 ← r4 - r2          */
```

- a. Show all data dependencies between the four instructions.
- b. Identify the data hazards.
- c. Can all hazards be avoided by forwarding in this case.

[gate2001](#) [co&architecture](#) [pipeline](#) [normal](#)
Answer**2.14.15 Pipeline: GATE2002-2.6, ISRO2008-19** [top](#)<http://gateoverflow.in/836>

The performance of a pipelined processor suffers if

- A. the pipeline stages have different delays
- B. consecutive instructions are dependent on each other
- C. the pipeline stages share hardware resources
- D. All of the above

[gate2002](#) [co&architecture](#) [pipeline](#) [easy](#) [isro2008](#)
[Answer](#)

2.14.16 Pipeline: GATE2003_10 [top](#)

<http://gateoverflow.in/901>

For a pipelined CPU with a single ALU, consider the following situations

- I. The $j+1$ -st instruction uses the result of the j -th instruction as an operand
- II. The execution of a conditional jump instruction
- III. The j -th and $j+1$ -st instructions require the ALU at the same time.

Which of the above can cause a hazard

- A. I and II only
- B. II and III only
- C. III only
- D. All the three

[gate2003](#) [co&architecture](#) [pipeline](#) [normal](#)
[Answer](#)

2.14.17 Pipeline: GATE2004_69 [top](#)

<http://gateoverflow.in/1063>

A 4-stage pipeline has the stage delays as 150, 120, 160 and 140 nanoseconds respectively. Registers that are used between the stages have a delay of 5 nanoseconds each. Assuming constant clocking rate, the total time taken to process 1000 data items on this pipeline will be

- A. 120.4 microseconds
- B. 160.5 microseconds
- C. 165.5 microseconds
- D. 590.0 microseconds

[gate2004](#) [co&architecture](#) [pipeline](#) [normal](#)
[Answer](#)

2.14.18 Pipeline: GATE2007-37, ISRO2009-37 [top](#)

<http://gateoverflow.in/1235>

Consider a pipelined processor with the following four stages:

- IF: Instruction Fetch
- ID: Instruction Decode and Operand Fetch
- EX: Execute
- WB: Write Back

The IF, ID and WB stages take one clock cycle each to complete the operation. The number of clock cycles for the EX stage depends on the instruction. The ADD and SUB instructions need 1 clock cycle and the MUL instruction needs 3 clock cycles in the EX stage. Operand forwarding is used in the pipelined processor. What is the number of clock cycles taken to complete the following sequence of instructions?

| | | |
|-----|------------|-------------------------|
| ADD | R2, R1, R0 | $R2 \leftarrow R1 + R0$ |
| MUL | R4, R3, R2 | $R4 \leftarrow R3 * R2$ |
| SUB | R6, R5, R4 | $R6 \leftarrow R5 - R4$ |

- A. 7
B. 8
C. 10
D. 14

[gate2007](#) [co&architecture](#) [pipeline](#) [normal](#) [isro2009](#)

[Answer](#)

2.14.19 Pipeline: GATE2009-28 [top](#)

<http://gateoverflow.in/1314>

Consider a 4 stage pipeline processor. The number of cycles needed by the four instructions I1, I2, I3, I4 in stages S1, S2, S3, S4 is shown below:

| | S1 | S2 | S3 | S4 |
|----|----|----|----|----|
| I1 | 2 | 1 | 1 | 1 |
| I2 | 1 | 3 | 2 | 2 |
| I3 | 2 | 1 | 1 | 3 |
| I4 | 1 | 2 | 2 | 2 |

What is the number of cycles needed to execute the following loop?

For (i=1 to 2) {I1; I2; I3; I4;}

- A. 16
B. 23
C. 28
D. 30

[gate2009](#) [co&architecture](#) [pipeline](#) [normal](#)

[Answer](#)

2.14.20 Pipeline: GATE2005_68 [top](#)

<http://gateoverflow.in/1391>

A 5 stage pipelined CPU has the following sequence of stages:

IF – instruction fetch from instruction memory

RD – Instruction decode and register read

EX – Execute: ALU operation for data and address computation

MA – Data memory access – for write access, the register read at RD state is used.

WB – Register write back

Consider the following sequence of instructions:

$I_1: L R0, loc 1; R0 \leq M[loc1]$

$I_2: A R0, R0 1; R0 \leq R0 + R0$

$I_3: S R2, R0 1; R2 \leq R2 - R0$

Let each stage take one clock cycle

What is the number of clock cycles taken to complete the above sequence of instructions starting from the fetch of I_1 ?

- A. 8
B. 10
C. 12
D. 15

[gate2005](#)
[co&architecture](#)
[pipeline](#)
[normal](#)
Answer

2.14.21 Pipeline: GATE1999_13 [top](#)

<http://gateoverflow.in/1512>

An instruction pipeline consists of 4 stages – Fetch (F), Decode field (D), Execute (E) and Result Write (W). The 5 instructions in a certain instruction sequence need these stages for the different number of clock cycles as shown by the table below

| Instruction | No. of cycles needed for | | | |
|--------------------|--------------------------|----------|----------|----------|
| | F | D | E | W |
| 1 | 1 | 2 | 1 | 1 |
| 2 | 1 | 2 | 2 | 1 |
| 3 | 2 | 1 | 3 | 2 |
| 4 | 1 | 3 | 2 | 1 |
| 5 | 1 | 2 | 1 | 2 |

Find the number of clock cycles needed to perform the 5 instructions.

[gate1999](#)
[co&architecture](#)
[pipeline](#)
[normal](#)
Answer

2.14.22 Pipeline: GATE2006_42 [top](#)

<http://gateoverflow.in/1818>

A CPU has a five-stage pipeline and runs at 1 GHz frequency. Instruction fetch happens in the first stage of the pipeline. A conditional branch instruction computes the target address and evaluates the condition in the third stage of the pipeline. The processor stops fetching new instructions following a conditional branch until the branch outcome is known. A program executes 10^9 instructions out of which 20% are conditional branches. If each instruction takes one cycle to complete on average, the total execution time of the program is:

- (A) 1.0 second
- (B) 1.2 seconds
- (C) 1.4 seconds
- (D) 1.6 seconds

[gate2006](#)
[co&architecture](#)
[pipeline](#)
[normal](#)
Answer

2.14.23 Pipeline: GATE2014-1_43 [top](#)

<http://gateoverflow.in/1921>

Consider a 6-stage instruction pipeline, where all stages are perfectly balanced. Assume that there is no cycle-time overhead of pipelining. When an application is executing on this 6-stage pipeline, the speedup achieved with respect to non-pipelined execution if 25% of the instructions incur 2 pipeline stall cycles is _____

[gate2014-1](#)
[co&architecture](#)
[pipeline](#)
[numerical-answers](#)
[normal](#)
Answer

2.14.24 Pipeline: GATE2014-3_9 [top](#)

<http://gateoverflow.in/2043>

Consider the following processors (ns stands for nanoseconds). Assume that the pipeline registers have zero latency.

P1: Four-stage pipeline with stage latencies 1 ns, 2 ns, 2 ns, 1 ns.

P2: Four-stage pipeline with stage latencies 1 ns, 1.5 ns, 1.5 ns, 1.5 ns.

P3: Five-stage pipeline with stage latencies 0.5 ns, 1 ns, 1 ns, 0.6 ns, 1 ns.

P4: Five-stage pipeline with stage latencies 0.5 ns, 0.5 ns, 1 ns, 1 ns, 1.1 ns.

Which processor has the highest peak clock frequency?

- (A) P1
- (B) P2
- (C) P3
- (D) P4

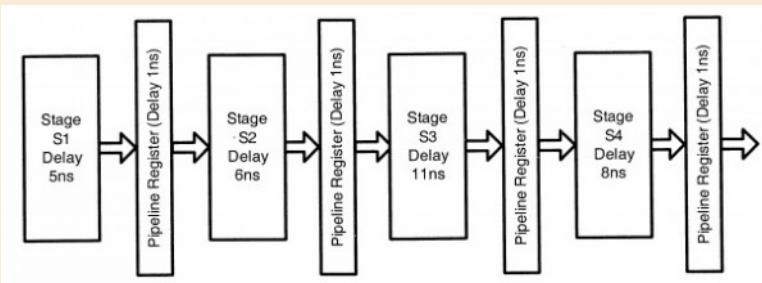
[gate2014-3](#) [co&architecture](#) [pipeline](#) [normal](#)

Answer

2.14.25 Pipeline: GATE2011_41 [top](#)

<http://gateoverflow.in/2143>

Consider an instruction pipeline with four stages (S1, S2, S3 and S4) each with combinational circuit only. The pipeline registers are required between each stage and at the end of the last stage. Delays for the stages and for the pipeline registers are as given in the figure.



What is the approximate speed up of the pipeline in steady state under ideal conditions when compared to the corresponding non-pipeline implementation?

- (A) 4.0
- (B) 2.5
- (C) 1.1
- (D) 3.0

[gate2011](#) [co&architecture](#) [pipeline](#) [normal](#)

Answer

2.14.26 Pipeline: GATE2010-33 [top](#)

<http://gateoverflow.in/2207>

A 5-stage pipelined processor has Instruction Fetch (IF), Instruction Decode (ID), Operand Fetch (OF), Perform Operation (PO) and Write Operand (WO) stages. The IF, ID, OF and WO stages take 1 clock cycle each for any instruction. The PO stage takes 1 clock cycle for ADD and SUB instructions, 3 clock cycles for MUL instruction and 6 clock cycles for DIV instruction respectively. Operand forwarding is used in the pipeline. What is the number of clock cycles needed to execute the following sequence of instructions?

| Instruction | Meaning of instruction |
|-----------------------------------|----------------------------|
| $t_0 : \text{MUL } R_2, R_0, R_1$ | $R_2 \leftarrow R_0 * R_1$ |
| $t_1 : \text{DIV } R_5, R_3, R_4$ | $R_5 \leftarrow R_3 / R_4$ |
| $t_2 : \text{ADD } R_2, R_5, R_2$ | $R_2 \leftarrow R_5 + R_2$ |
| $t_3 : \text{SUB } R_5, R_2, R_6$ | $R_5 \leftarrow R_2 - R_6$ |

- A. 13
- B. 15
- C. 17
- D. 19

[gate2010](#)
[co&architecture](#)
[pipeline](#)
[normal](#)
Answer

2.14.27 Pipeline: GATE2008-IT_40 [top](#)

<http://gateoverflow.in/3350>

A non pipelined single cycle processor operating at 100 MHz is converted into a synchronous pipelined processor with five stages requiring 2.5 nsec, 1.5 nsec, 2 nsec, 1.5 nsec and 2.5 nsec, respectively. The delay of the latches is 0.5 nsec. The speedup of the pipeline processor for a large number of instructions is

- | | |
|----|------|
| A) | 4.5 |
| B) | 4.0 |
| C) | 3.33 |
| D) | 3.0 |

[gate2008-it](#)
[co&architecture](#)
[pipeline](#)
[normal](#)
Answer

2.14.28 Pipeline: GATE2007-IT-6, ISRO2011-25 [top](#)

<http://gateoverflow.in/3437>

A processor takes 12 cycles to complete an instruction I. The corresponding pipelined processor uses 6 stages with the execution times of 3, 2, 5, 4, 6 and 2 cycles respectively. What is the asymptotic speedup assuming that a very large number of instructions are to be executed?

- A. 1.83
- B. 2
- C. 3
- D. 6

[gate2007-it](#)
[co&architecture](#)
[pipeline](#)
[normal](#)
[isro2011](#)
Answer

2.14.29 Pipeline: GATE2006-IT_78 [top](#)

<http://gateoverflow.in/3622>

A pipelined processor uses a 4-stage instruction pipeline with the following stages: Instruction fetch (IF), Instruction decode (ID), Execute (EX) and Writeback (WB). The arithmetic operations as well as the load and store operations are carried out in the EX stage. The sequence of instructions corresponding to the statement $X = (S - R * (P + Q))/T$ is given below. The values of variables P, Q, R, S and T are available in the registers R0, R1, R2, R3 and R4 respectively, before the execution of the instruction sequence.

| | | |
|-------|------------|---------------------------|
| ADD | R5, R0, R1 | $; R5 \leftarrow R0 + R1$ |
| MUL | R6, R2, R5 | $; R6 \leftarrow R2 * R5$ |
| SUB | R5, R3, R6 | $; R5 \leftarrow R3 - R6$ |
| DIV | R6, R5, R4 | $; R6 \leftarrow R5/R4$ |
| STORE | R6, X | $; X \leftarrow R6$ |

The number of Read-After-Write (RAW) dependencies, Write-After-Read (WAR) dependencies, and Write-After-Write (WAW) dependencies in the sequence of instructions are, respectively,

- | | |
|----|---------|
| A) | 2, 2, 4 |
| B) | 3, 2, 3 |
| C) | 4, 2, 2 |
| D) | 3, 3, 2 |

[gate2006-it](#)
[co&architecture](#)
[pipeline](#)
[normal](#)
Answer

2.14.30 Pipeline: GATE2006-IT_79 [top](#)

<http://gateoverflow.in/3623>

A pipelined processor uses a 4-stage instruction pipeline with the following stages: Instruction fetch (IF), Instruction decode

(ID), Execute (EX) and Writeback (WB). The arithmetic operations as well as the load and store operations are carried out in the EX stage. The sequence of instructions corresponding to the statement $X = (S - R * (P + Q))/T$ is given below. The values of variables P, Q, R, S and T are available in the registers R0, R1, R2, R3 and R4 respectively, before the execution of the instruction sequence.

| | | |
|-------|------------|----------------------------|
| ADD | R5, R0, R1 | $; R5 \rightarrow R0 + R1$ |
| MUL | R6, R2, R5 | $; R6 \rightarrow R2 * R5$ |
| SUB | R5, R3, R6 | $; R5 \rightarrow R3 - R6$ |
| DIV | R6, R5, R4 | $; R6 \rightarrow R5/R4$ |
| STORE | R6, X | $; X \leftarrow R6$ |

The IF, ID and WB stages take 1 clock cycle each. The EX stage takes 1 clock cycle each for the ADD, SUB and STORE operations, and 3 clock cycles each for MUL and DIV operations. Operand forwarding from the EX stage to the ID stage is used. The number of clock cycles required to complete the sequence of instructions is

- A. 10
- B. 12
- C. 14
- D. 16

[gate2006-it](#) [co&architecture](#) [pipeline](#) [normal](#)

[Answer](#)

2.14.31 Pipeline: GATE2014-3_43 [top](#)

<http://gateoverflow.in/2077>

An instruction pipeline has five stages, namely, instruction fetch (IF), instruction decode and register fetch (ID/RF), instruction execution (EX), memory access (MEM), and register writeback (WB) with stage latencies 1 ns, 2.2 ns, 2 ns, 1 ns, and 0.75 ns, respectively (ns stands for nanoseconds). To gain in terms of frequency, the designers have decided to split the ID/RF stage into three stages (ID, RF1, RF2) each of latency 2.2/3 ns. Also, the EX stage is split into two stages (EX1, EX2) each of latency 1 ns. The new design has a total of eight pipeline stages. A program has 20% branch instructions which execute in the EX stage and produce the next instruction pointer at the end of the EX stage in the old design and at the end of the EX2 stage in the new design. The IF stage stalls after fetching a branch instruction until the next instruction pointer is computed. All instructions other than the branch instruction have an average CPI of one in both the designs. The execution times of this program on the old and the new design are P and Q nanoseconds, respectively. The value of P/Q is _____.

[gate2014-3](#) [co&architecture](#) [pipeline](#) [numerical-answers](#) [normal](#)

[Answer](#)

Answers: Pipeline

2.14.1 Pipeline: GATE 2016-1-32 [top](#)

<http://gateoverflow.in/39691>



Selected Answer

33.33 % increase

initial through put is 1 instruction for 3200 pico seconds

Reason : $4*800$ (here 800 is maximum stage delay of any stage in an instruction so its selected as synchronous clock cycle time)

in the next design

through put will be 1 instruction for 2400 pico seconds

reason : $4*600$ (here 600 is maximum stage delay of any stage in an instruction so its selected as synchronous clock cycle time)

now increase in throughput is calculated by $((1/2400)-(1/3200))/(1/3200)*100$

now there is an assumption that the pipeline used is synchronous because if asynchronous is used the throughput is dropped but not increased

6 votes

-- Bharani Viswas (733 points)

2.14.2 Pipeline: GATE2015-2_44 [top](#)

<http://gateoverflow.in/8218>

| | t1 | t2 | t3 | t4 | t5 | t6 | t7 | t8 | t9 | t10 | t11 | t12 | t13 | t14 | t15 |
|----|----|----|----|----|----|----|----|----|----|-----|-----|-----|-----|-----|-----|
| I1 | IF | OF | PO | PO | PO | WB | | | | | | | | | |
| I2 | | IF | OF | - | - | PO | PO | PO | PO | PO | WB | | | | |
| I3 | | | IF | - | - | - | - | - | - | OF | PO | WB | | | |
| I4 | | | | - | - | - | - | - | - | IF | - | OF | PO | WB | |

It is mentioned in the question that operand forwarding takes place from PO stage to OF stage and not to PO stage. So, 15 clock cycles.

But since operand forwarding is from PO-OF, we can do like make the PO stage produce the output during the rising edge of the clock and OF stage fetch the output during the falling edge. This would mean the final PO stage and OF stage can be done in one clock cycle making the total number of cycles = 13. And 13 is the answer given in GATE key.

| | t1 | t2 | t3 | t4 | t5 | t6 | t7 | t8 | t9 | t10 | t11 | t12 | t13 |
|----|----|----|----|----|----|----|----|----|----|-----|-----|-----|-----|
| I1 | IF | OF | PO | PO | PO | WB | | | | | | | |
| I2 | | IF | OF | - | - | PO | PO | PO | PO | PO | WB | | |
| I3 | | | IF | - | - | - | - | - | - | OF | PO | WB | |
| I4 | | | | - | - | - | - | - | - | IF | OF | PO | WB |

Ref: <http://www.cs.iastate.edu/~prabhu/Tutorial/PIPELINE/forward.html>

14 votes

-- Arjun Suresh (150k points)

2.14.3 Pipeline: GATE2015-1-38 [top](#)

<http://gateoverflow.in/8288>



Selected Answer

Speed up = Old execution time/New execution time

Old execution time = CPI/2.5 = 4/2.5 = 1.6 ns

With pipelining, each instruction needs old execution time * old frequency/new frequency (without pipelining) = $1.6 * 2.5 / 2 = 2$ ns

There are 5 stages and when there is no pipeline stall, this can give a speed up of up to 5 (happens when all stages take same number of cycles). In our case this time will be $2/5 = 0.4$ ns. But clock frequency being 2 GHz, clock cycle is 1/2 GHz = 0.5 ns and a pipeline stage cannot be faster than this.

So, average instruction execution time after pipelining = $\max(0.4, 0.5) = 0.5$ ns.

So, speed up compared to non-pipelined version = $1.6 / 0.5 = 3.2$.

11 votes

-- Arjun Suresh (150k points)

2.14.4 Pipeline: GATE2008-77 [top](#)

<http://gateoverflow.in/4347>

What is Delayed Branching ?

One way to maximize the use of the pipeline, is to find an instruction that can be safely executed whether the branch is taken or not, and execute that instruction. So, when a branch instruction is encountered, the hardware puts the instruction following the branch into the pipe and begins executing it, just as in predict-not-taken. However, unlike in predict-not-taken, we do not need to worry about whether the branch is taken or not, we do not need to clear the pipe because no matter whether the branch is taken or not, we know the instruction is safe to execute.

More Read : <https://www.cs.umd.edu/class/fall2001/cmsc411/projects/branches/delay.html>

Moving I₁ after branch

- I₁ is updating the value of R2
- R2 which is used to determine branch condition R1
- Value of R2 is available after branch
⇒ **Cannot be moved**

Moving I₃ after branch

- value of R1 is computed in this instruction
- R1 is the branch condition
⇒ **Cannot be moved**

Moving I₄ after branch

- I₄ is simple store instruction used to store R1 in memory
- program execution will have no effect if this is placed after conditional branch
⇒ **Can be moved**

Moving I₂ after branch

- It update the memory location to place the storing of conditional branch instruction R1
- If moved after branch , when compiler reaches I₄ program execution will stop
⇒ **Canot be moved**
- However I₂ I₄ both can be moved after the branch instruction

Apt choice will be I₄ Option D

3 votes

-- Akhil Nadh Pullolikkal Chandran (6.9k points)

2.14.5 Pipeline: GATE2015-3_51 [top](#)

<http://gateoverflow.in/8560>



Selected Answer

Ref: Page 24 <http://www2.cs.siu.edu/~cs401/Textbook/ch3.pdf>

S1 is needed at time 1 and 5, so its forbidden latency is 5-1 = 4.

S2 is needed at time 2 and 4, so its forbidden latency is 4-2 = 2.

So, forbidden latency = (2,4,0) (0 by default is forbidden)

Allowed latency = (1,3,5) (any value more than 5 also).

Collision vector (4,3,2,1,0) = 10101 which is the initial state as well.

From initial state we can have a transition after "1" or "3" cycles and we reach new states with collision vectors (10101 >> 1 + 10101 = 11111) and (10101 >> 3 + 10101 = 10111) respectively. These 2 becomes states 2 and 3 respectively. For "5" cycles we come back to state 1 itself.

From state 2 (11111), the new collision vector is 11111. We can have a transition only when we see first 0 from right. So, here it happens on 5th cycle only which goes to initial state. (Any transition after 5 or more cycles goes to initial state as we have 5 time slices).

From state 3 (10111), the new collision vector is 10111. So, we can have a transition on 3, which will give (10111 >> 3 + 10101 = 10111) third state itself. For 5, we get the initial state. Thus all the transitions are complete.

| State\Time | 1 | 3 | 5 |
|------------------|---|---|---|
| 1 (10101) | 2 | 3 | 1 |
| 2 (11111) | - | - | 1 |
| 3 (10111) | - | 3 | 1 |

So, minimum length cycle is of **length 3** either from 3-3 or from 1-3, 3-1.

Not asked in question, still.

Pipeline throughput is the number of instructions initiated per unit time. So, with $MAL = 3$, we have 2 initiations in $1+3 = 4$ units of time (one at time unit 1 and another at time unit 4). So, throughput = $2/4 = 0.5$.

Pipeline efficiency is the % of time every stage of pipeline is being used. For the given question we can extend the reservation table and taking $MAL = 3$, we can initiate new tasks after every 3 cycles. So, we can consider the time interval from 4-6 in below figure. (The red color shows a stage not being used- affects efficiency).

| Time→ | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|-------|---|---|---|---|---|---|---|---|---|----|----|
| S1 | X | | Y | X | | Z | Y | A | Z | | |
| S2 | X | | X | Y | | Y | Z | Z | A | | |
| S3 | | X | | | Y | | Z | | | | |

Here (during cycles 4-6), stage 1 is used $2/3$, stage 2 is used $2/3$ and stage 3 is used $1/3$. So, total stage utilization = $(2+2+1)/9 = 5/9$ and efficiency = $500/9\% = 55.55\%$.

For simulation, Ref: <http://www.eecs.umass.edu/ece/koren/architecture/ResTable/SimpRes/>

4 votes

-- Arjun Suresh (150k points)

2.14.6 Pipeline: GATE2012-20, ISRO2016-23 [top](#)

<http://gateoverflow.in/52>



Selected Answer

Register renaming is done to eliminate WAR (Write after Read) and WAW (Write after Write) dependency between instructions which could have caused pipeline stalls. Hence (C) is the answer.

Example:

I1: Read A to B
I2: Write C to A

Here, there is a WAR dependency and pipeline would need stalls. In order to avoid it register renaming is done and

Write C to A
will be
Write C to A'

WAR dependency is actually called anti-dependency and there is no real dependency except the fact that both uses same memory location. Register renaming can avoid this. Similarly WAW also.

<http://people.ee.duke.edu/~sorin/ece252/lectures/4.2-tomasulo.pdf>

8 votes

-- Arjun Suresh (150k points)

2.14.7 Pipeline: GATE2005-IT_44 [top](#)

<http://gateoverflow.in/3805>



Selected Answer

(B) is the correct option for this question.

Execution time for Pipeline = $(K+n-1) * \text{execution_time}$ where K = no of stages in pipeline n = no of instructions
execution time = Max(all stages execution time)

$$D1 = (5+100-1)*4 = 416$$

$$D2 = (8+100-1)*2 = 214$$

$$\text{Time saved using D2} = 416 - 214 = 202$$

9 votes

-- Manu Thakur (5.6k points)

2.14.8 Pipeline: GATE2004-IT_47 [top](#)<http://gateoverflow.in/3690>

Selected Answer

| time | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 |
|------|----|----|----|----|----|----|----|----|----|----|----|----|----|
| I1 | s1 | s2 | s2 | s3 | s4 | s4 | | | | | | | |
| I2 | | s1 | s1 | s2 | s3 | s3 | s4 | | | | | | |
| I3 | | | | s1 | s2 | - | s3 | s3 | s4 | | | | |
| I4 | | | | | s1 | s1 | s2 | - | s3 | s3 | s4 | | |
| I1 | | | | | | s1 | - | s2 | s2 | s3 | s4 | s4 | |

so total time would be=13 ns

so option (c).

correct me if i am wrong...

11 votes

-- Suvojit Mondal (433 points)

2.14.9 Pipeline: GATE2013_45 [top](#)<http://gateoverflow.in/330>

Selected Answer

After pipelining we have to adjust the stage delays such that no stage will be waiting for another to ensure smooth pipelining (continuous flow). Since we can not easily decrease the stage delay, we can increase all the stage delays to the maximum delay possible. So, here maximum delay is 10ns. Buffer delay given is 1ns. So, each stage takes 11ns in total.

FI of I9 can start only after the EI of I4. So, the total execution time will be

$$15 \times 11 = 165$$

| | T1 | T2 | T3 | T4 | T5 | T6 | T7 | T8 | T9 | T10 | T11 | T12 | T13 | T14 | T15 |
|-----|----|----|----|----|-------|-------|-------|----|----|-----|-----|-----|-----|-----|-----|
| I1 | FI | DI | FO | EI | WO | | | | | | | | | | |
| I2 | | FI | DI | FO | EI | WO | | | | | | | | | |
| I3 | | | FI | DI | FO | EI | WO | | | | | | | | |
| I4 | | | | FI | DI | FO | EI | WO | | | | | | | |
| | | | | | stall | | | | | | | | | | |
| | | | | | | stall | | | | | | | | | |
| | | | | | | | stall | | | | | | | | |
| I9 | | | | | | | FI | DI | FO | EI | WO | | | | |
| I10 | | | | | | | | FI | DI | FO | EI | WO | | | |
| I11 | | | | | | | | | FI | DI | FO | EI | WO | | |
| I12 | | | | | | | | | | FI | DI | FO | EI | WO | |

24 votes

-- gatecse (10.7k points)

2.14.10 Pipeline: GATE2008-36 [top](#)<http://gateoverflow.in/447>

Selected Answer

(B) I and III

I - False Bypassing can't handle all RAW hazard, consider when any instruction depends on the result of LOAD instruction, now LOAD updates register value at Memory Access Stage (MA), so data will not be available directly on Execute stage.

II - True, register renaming can eliminate all WAR Hazard.

III- False, It cannot completely eliminate, though it can reduce Control Hazard Penalties

14 votes

-- Prateeksha Keshari (1.7k points)

2.14.11 Pipeline: GATE2008-76 top

<http://gateoverflow.in/496>



Selected Answer

76. Answer is A. In order to avoid the pipeline delay due to conditional branch instruction, a suitable instruction is placed below the conditional branch instruction such that the instruction will be executed irrespective of whether branch is taken or not and won't affect the program behaviour.

77. Answer is D) I4. The STORE instruction can be moved below the conditional branch instruction. Whether the branch is taken or not, STORE will be executed as the next instruction after conditional branch instruction, due to delayed branching.

Here, I3 is not the answer because the branch conditional variable R1 is dependent on it. Same for I1. Similarly, I4 has a dependency on I2 and hence I2 must be executed before I4.

18 votes

-- Arjun Suresh (150k points)

2.14.12 Pipeline: GATE2000-1.8 top

<http://gateoverflow.in/631>



Selected Answer

Here we are comparing the execution time of only a single instruction. Pipelining in no way increases the execution time of a single instruction (the time from its start to end). It increases the overall performance by splitting the execution to multiple pipeline stages so that the following instructions can use the finished stages of the previous instructions. But in doing so pipelining causes some problems also as given in the below link, which might slow some instructions. So, (B) is the answer.

<http://www.cs.wvu.edu/~jdm/classes/cs455/notes/tech/instrpipe.html>

12 votes

-- Arjun Suresh (150k points)

2.14.13 Pipeline: GATE2000-12 top

<http://gateoverflow.in/683>



Selected Answer

Each stage is 2ns. So, after 5 time units each of 2ns, the first instruction finishes (i.e., after 10ns), in every 2ns after that a new instruction gets finished. This is assuming no branch instructions. Now, once the pipeline is full, we can assume that the initial fill time doesn't matter our calculations and average execution time for each instruction is 2ns assuming no branch instructions.

(a) Now, we are given that 20% of instructions are branch (like JMP) and when a branch instruction is executed, no further instruction enters the pipeline. So, we can assume every 5th instruction is a branch instruction. So, with this assumption, total time to finish 5 instruction will be $5 * 2 + 8 = 18$ ns (as when a branch instruction enters the pipeline and before it finishes, 4 pipeline stages will be empty totaling $4 * 2 = 8$ ns, as it is mentioned in question that the next instruction fetch starts only when branch instruction completes). And this is the same for every set of 5 instructions, and hence the average instruction execution time = $18/5 = 3.6$ ns

(b) This is just a complex statement. But what we need is to identify the % of branch instructions which cause a branch to be taken as others will have no effect on the pipeline flow.

20% of branch instructions are branch instructions. 80% of branch instructions are conditional. That means $.2 \times .8 = 16\%$ of instructions are conditional branch instructions and it is given that 50% of those result in a branch being taken. So, 8% of instructions are conditional branches being taken and we also have $20\% \text{ of } 20\% = 4\%$ of unconditional branch instructions which are always taken.

So, percentage of instructions where a branch is taken is $8+4 = 12\%$ instead of 20% in (a) part.

So, in 100 instructions there will be 12 branch instructions. We can do a different calculation here as compared to (a) as 12 is not a divisor of 100. Each branch instruction causes a pipeline delay of $4 \times 2 = 8 \text{ ns}$. So, 12 instructions will cause a delay of $12 \times 8 = 96 \text{ ns}$. For 100 instructions, we need $100 \times 2 = 200 \text{ ns}$ without any delay and with delay we require $200 + 96 = 296 \text{ ns}$ for 100 instructions.

So, average instruction execution time = $296/100 = 2.96 \text{ ns}$

(We can also use this method for part (a) which will give $100 \times 2 + 20 \times 8 = 360 \text{ ns}$ for 100 instructions)

14 votes

-- Arjun Suresh (150k points)

2.14.14 Pipeline: GATE2001-12 [top](#)

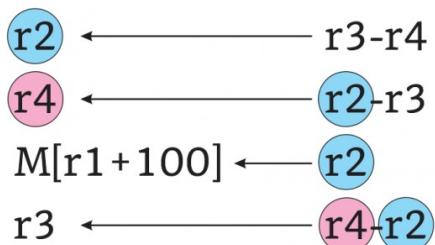
<http://gateoverflow.in/753>



Selected Answer

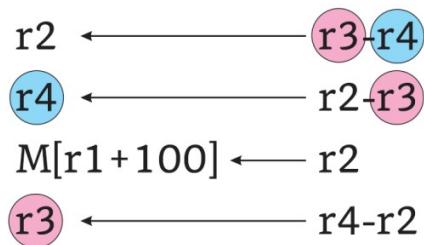
4 RAW

RAW Hazard:



3 WAR

WAR Hazard:



With operand forwarding:

| I ₁ | IF | ID | ³ ₄ EX ₂ | M | WB | | | |
|----------------|----|----|---|---|----|---|----|----|
| I ₂ | | IF | ID | ² ₃ EX ₄ | M | WB | | |
| I ₃ | | | IF | ID | EX | ² M | WB | |
| I ₄ | | | | IF | ID | ² ₄ EX ₃ | M | WB |

R2 is forwarded

R4 is forwarded

Without it:

(both tables represent the same pipeline)

| for r2 | | | | | | | | | | | |
|--------|----|----|-----------|-----------|----|-----------|----|----|----|----|--|
| ① | IF | ID | EX | M | WB | | | | | | |
| ② | | IF | <u>IF</u> | <u>IF</u> | ID | EX | M | WB | | | |
| ③ | | | | | IF | ID | EX | M | WB | | |
| ④ | | | | | IF | <u>IF</u> | ID | EX | M | WB | |

for r4

| | | | | | | | | | | | |
|----|---|---|----------|----------|---|---|----------|---|---|---|---|
| WB | | | | | ① | | | ② | ③ | | ④ |
| M | | | | ① | | | ② | ③ | | ④ | |
| EX | | | ① | | | ② | ③ | | ④ | | |
| ID | | ① | | | ② | ③ | | ④ | | | |
| IF | ① | ② | <u>②</u> | <u>②</u> | ③ | ④ | <u>④</u> | | | | |

7 votes

-- Amar Vashishth (20.7k points)

2.14.15 Pipeline: GATE2002-2.6, ISRO2008-19 [top](#)

<http://gateoverflow.in/836>



Selected Answer

Answer: D

A: Yes. Total delay = Max (All delays) + Register Delay.

B: Yes, if data forwarding is not there.

C: Yes, like ID and EX shares ID/EX register.

9 votes

-- Rajarshi Sarkar (29.7k points)

2.14.16 Pipeline: GATE2003_10 [top](#)

<http://gateoverflow.in/801>



Selected Answer

1. Data hazard
2. Control hazard
3. Structural hazard as only one ALU is there

So, D all of these.

<http://www.cs.iastate.edu/~prabhu/Tutorial/PIPELINE/hazards.html>

10 votes

-- Arjun Suresh (150k points)

2.14.17 Pipeline: GATE2004_69 [top](#)<http://gateoverflow.in/1063>

Selected Answer

Pipelining requires all stages to be synchronized meaning, we have to make the delay of all stages equal to the maximum pipeline stage delay which here is 160.

Time for execution of the first instruction = $(160+5) * 3 + 160 = 655$ ns (5 ns for intermediate registers which is not needed for the final stage).

Now, in every 165 ns, an instruction can be completed. So,

Total time for 1000 instructions = $655 + 999*165 = 165.49$ microseconds

11 votes

-- Arjun Suresh (150k points)

2.14.18 Pipeline: GATE2007-37, ISRO2009-37 [top](#)<http://gateoverflow.in/125>

Selected Answer

Answer: option B

considering EX to EX data forwarding.

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|-----------|----------|----------|----------|----------|----------|----------|----------|----------|
| I1 | IF | ID | EX | WB | | | | |
| I2 | | IF | ID | EX | EX | EX | WB | |
| I3 | | | IF | ID | | | EX | WB |

12 votes

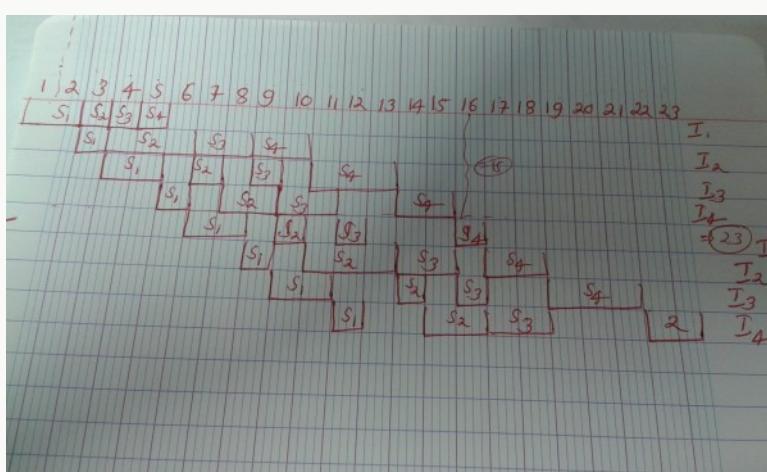
-- Rajarshi Sarkar (29.7k points)

2.14.19 Pipeline: GATE2009-28 [top](#)<http://gateoverflow.in/1314>

Selected Answer

Here bound of the loop are constants, therefore compiler will do the loop unrolling(If compiler won't then prefetcher will do) to increase the instruction level parallelism. And after loop unrolling 23 cycles are required for execution. Therefore correct answer would be (B).

PS: We assume the buffers between the pipeline stages can store multiple results in the form of a queue.



8 votes

-- suraj (3.7k points)

2.14.20 Pipeline: GATE2005_68 top<http://gateoverflow.in/1391>

Selected Answer

answer = **option A**

8 cycles required with operand forwarding.

With operand forwarding

| | |
|----|-------------------|
| I1 | IF RD EX MA WB |
| I2 | IF RD -- EX MA WB |
| I3 | IF -- RD EX MA WB |

Without it

| | |
|----|----------------------|
| I1 | IF RD EX MA WB |
| I2 | IF -- -- RD EX MA WB |
| I3 | IF -- -- RD EX MA WB |

it is not given that RD and WB stage could overlap.

Without it, but RD and WB overlaps.

| | |
|----|----------------------|
| I1 | IF RD EX MA WB |
| I2 | IF -- -- RD EX MA WB |
| I3 | IF -- -- RD EX MA WB |

8 votes

-- Amar Vashishth (20.7k points)

2.14.21 Pipeline: GATE1999_13 top<http://gateoverflow.in/1512>

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
|---|---|---|---|---|---|---|---|---|----|----|----|----|----|----|
| F | D | D | E | W | | | | | | | | | | |
| | F | - | D | D | E | E | W | | | | | | | |
| | | F | - | D | - | E | E | E | W | W | | | | |
| | | | F | - | D | - | - | E | E | W | | | | |
| | | | | F | - | - | - | D | - | E | W | W | | |

therefore 15 clock cycles needed.

6 votes

-- Danish (2.4k points)

2.14.22 Pipeline: GATE2006_42 top<http://gateoverflow.in/1818>

Selected Answer

Delay slots in pipeline caused due to a branch instruction is 2 as after the 3rd stage of current instruction (during 4th stage) IF of next begins. Ideally this should be during 2nd stage.

So, for total no. of instructions = 10^9 and 20% branch, we have $0.2 \times 2 \times 10^9 = 4 \times 10^8$ cycle penalty.

Since, clock speed is 1GHz and each instruction on average takes 1 cycle, total execution time in seconds will be

$$10^9/10^9 + 4 \times 10^8/10^9 = 1.4$$

14 votes

-- Arjun Suresh (150k points)

2.14.23 Pipeline: GATE2014-1_43 [top](#)

<http://gateoverflow.in/1921>



Selected Answer

Time without pipeline = 6 stages=6 cycles

Time with pipeline = 1+stall frequency*stall cycle

$$=1+.25*2$$

$$=1.5$$

Speed up = 6/1.5

$$=4$$

14 votes

-- aravind90 (609 points)

2.14.24 Pipeline: GATE2014-3_9 [top](#)

<http://gateoverflow.in/2043>



Selected Answer

frequency = 1 / max(time in stages)
for P3 it is 1/1 GHz

for P1 it is 1/2 = 0.5 GHz

for P2, it is 1/1.5 = 0.67 GHz

for P4, it is 1/1.1 GHz

13 votes

-- Arpit Dhuriya (2.4k points)

2.14.25 Pipeline: GATE2011_41 [top](#)

<http://gateoverflow.in/2143>



Selected Answer

Answer is (B) 2.5

In pipeline system Time taken is determined by the max delay at any stage i.e., 11ns plus the delay incurred by pipeline stages i.e., 1ns = 12ns. In non-pipeline system Delay = 5ns + 6ns + 11ns + 8ns = 30ns.

∴ The speedup is $\frac{30}{12} = 2.5$ ns.

17 votes

-- Sona Praneeth Akula (3.8k points)

2.14.26 Pipeline: GATE2010-33 [top](#)

<http://gateoverflow.in/2207>



Selected Answer

| | | | | | | | | | | | | | | |
|----|----|----|----|----|----|----|----|----|-----|-----|-----|-----|-----|-----|
| t1 | t2 | t3 | t4 | t5 | t6 | t7 | t8 | t9 | t10 | t11 | t12 | t13 | t14 | t15 |
| | | | | | | | | | | | | | | |

| | | | | | | | | | | | | |
|----|----|----|----|----|----|----|--|----|----|----|--|--|
| IF | IP | RD | OP | PO | PO | WO | | | | | | |
| | IF | ID | | OF | | | | PO | WO | | | |
| | IF | | ID | | | | | OF | PO | WO | | |

Operand forwarding allows an output to be passed for the next instruction. Here from the output of PO stage of DIV instruction operand is forwarded to the PO stage of ADD instruction and similarly between ADD and SUB instructions. Hence, 15cycles required.

<http://www.cs.iastate.edu/~prabhu/Tutorial/PIPELINE/forward.html>

15 votes

-- Arjun Suresh (150k points)

2.14.27 Pipeline: GATE2008-IT_40 [top](#)

<http://gateoverflow.in/3450>



Selected Answer

answer is C..

explanation:

for non pipeline system time required = $2.5 + 1.5 + 2.0 + 1.5 + 2.5 = 10$

for pipelined system = max(stage delay) + max(latch delay) = $2.5 + 0.5 = 3$

speedup = time in non pipeline / time in pipeline = $10/3 = 3.33$

13 votes

-- jayendra (6.6k points)

2.14.28 Pipeline: GATE2007-IT-6, ISRO2011-25 [top](#)

<http://gateoverflow.in/3437>



Selected Answer

For non pipeline processor we have n instruction and each instruction take 12 cycle so total $12n$ instruction.

For pipeline processor we have each stage strict to 6ns so time to complete the n instruction is $6*6 + (n-1)*6$

$\lim_{n \rightarrow \infty} \frac{12n}{36} + (n-1)*6 = 12/6 = 2$

15 votes

-- Arpit Dhuriya (2.4k points)

2.14.29 Pipeline: GATE2006-IT_78 [top](#)

<http://gateoverflow.in/3622>



Selected Answer

(C) is the correct option for this question:

RAW

1. I1 - I2 (R5)
2. I2 - I3 (R6)
3. I3 - I4 (R5)
4. I4 - I5 (R6)

WAR

1. I2 - I3 (R5)
2. I3 - I4 (R6)

WAW

1. I1 - I3 (R5)
2. I2 - I4 (R6)

10 votes

-- Manu Thakur (5.6k points)

2.14.30 Pipeline: GATE2006-IT_79 [top](#)<http://gateoverflow.in/3623>

Selected Answer

answer = **option D** = 16 cycles are required

With Operand Forwarding:

| | | | | | | | | | | | | | | |
|-------|----|----|----|----|----|----|----|----|----|----|----|----|----|----|
| ADD | IF | ID | EX | WB | | | | | | | | | | |
| MUL | | IF | — | ID | EX | EX | EX | WB | | | | | | |
| SUB | | | IF | — | — | — | ID | EX | WB | | | | | |
| DIV | | | | | | | IF | — | ID | EX | EX | EX | WB | |
| STORE | | | | | | | | IF | — | — | — | ID | EX | WB |

4 votes

-- Amar Vashishth (20.7k points)

2.14.31 Pipeline: GATE2014-3_43 [top](#)<http://gateoverflow.in/2077>

Selected Answer

cpi for first case = $2.2(1+2*.2)$ as the stall required is 2 and 2.2 is the maximum stage delay.cpi for second state = $1*(1+5*.2)$ as now stall increase to 5 as there are five stages before the address is calculated and the maximum stage delay now is 1. $\text{cpu_time1}/\text{cpu_time2} = 3.08/2 = 1.54$

17 votes

-- Arpit Dhuriya (2.4k points)

2.15**Virtual Memory** [top](#)**2.15.1 Virtual Memory: GATE2004_47** [top](#)<http://gateoverflow.in/318>

Consider a system with a two-level paging scheme in which a regular memory access takes 150 nanoseconds, and servicing a page fault takes 8 milliseconds. An average instruction takes 100 nanoseconds of CPU time, and two memory accesses. The TLB hit ratio is 90%, and the page fault rate is one in every 10,000 instructions. What is the effective average instruction execution time?

- (A) 645 nanoseconds
- (B) 1050 nanoseconds
- (C) 1215 nanoseconds
- (D) 1230 nanoseconds

[gate2004](#) [co&architecture](#) [virtual-memory](#) [normal](#)**Answer****2.15.2 Virtual Memory: GATE1991_03,iii** [top](#)<http://gateoverflow.in/517>

03. Choose the correct alternatives (more than one may be correct) and write the corresponding letters only:

(iii) The total size of address space in a virtual memory system is limited by

- a. the length of MAR
- b. the available secondary storage
- c. the available main memory
- d. all of the above
- e. none of the above

[gate1991](#) [co&architecture](#) [virtual-memory](#) [normal](#)

[Answer](#)

2.15.3 Virtual Memory: GATE2008-38 [top](#)

<http://gateoverflow.in/449>

In an instruction execution pipeline, the earliest that the data TLB (Translation Lookaside Buffer) can be accessed is

- A. before effective address calculation has started
- B. during effective address calculation
- C. after effective address calculation has completed
- D. after data cache lookup has completed

[gate2008](#) [co&architecture](#) [virtual-memory](#) [normal](#)

[Answer](#)

Answers: Virtual Memory

2.15.1 Virtual Memory: GATE2004_47 [top](#)

<http://gateoverflow.in/318>



Selected Answer

Average Instruction execution time

= Average CPU execution time + Average time for getting data(instruction operands from memory for each instruction)

= Average CPU execution time
+ Average address translation time for each instruction
+ Average memory fetch time for each instruction
+ Average page fault time for each instruction

$$= 100 + 2(0.9(0) + 0.1(2 \times 150)) + 2 \times 150 + \frac{1}{10000} \times 8 \times 10^6$$

(Page Fault Rate per 10,000 instruction is directly given in question.Two memory accesses per instruction and hence we need 2

× address translation time for average instruction execution time)

[TLB access time assumed as 0 and 2 page tables need to be accessed in case of TLB miss as the system uses two-level paging]

$$= 100 + 60 + 300 + 800$$

$$= 1260\text{ns}$$

28 votes

-- Arjun Suresh (150k points)

2.15.2 Virtual Memory: GATE1991_03,iii top<http://gateoverflow.in/517>

Answer is (a) and (b)

Virtual memory concept is independent of size of main memory and depends only on the availability of the secondary storage.

MAR holds the address generated by CPU and this obviously limits the total virtual memory address space.

6 votes

-- Kalpana Bhargav (3k points)

2.15.3 Virtual Memory: GATE2008-38 top<http://gateoverflow.in/449>

Selected Answer

C as only after the calculation of Virtual address you can look up in the TLB

9 votes

-- Shaun Patel (5,8k points)

3 Compiler Design (135) [top](#)

3.0.1 Gate 1990 [top](#)

<http://gateoverflow.in/52986>

Group 1

- a. Lexical analysis
- b. code optimization
- c. code generation
- d. abelian group

Group 2

- p. DAG's
- q. Syntax trees
- r. Push down automata
- s. Finite automata

[compiler-design](#) [gate1990](#)

[Answer](#)

3.0.2 GATE2015-2_14 [top](#)

<http://gateoverflow.in/8084>

In the context of abstract-syntax-tree (AST) and control-flow-graph (CFG), which one of the following is TRUE?

- A. In both AST and CFG, let node N_2 be the successor of node N_1 . In the input program, the code corresponding to N_2 is present after the code corresponding to N_1
- B. For any input program, neither AST nor CFG will contain a cycle
- C. The maximum number of successors of a node in an AST and a CFG depends on the input program
- D. Each node in AST and CFG corresponds to at most one statement in the input program

[gate2015-2](#) [compiler-design](#) [easy](#)

[Answer](#)

3.0.3 GATE2009-17 [top](#)

<http://gateoverflow.in/1309>

Match all items in Group 1 with the correct options from those given in Group 2.

| Group 1 | | Group 2 | |
|---------|---------------------|---------|-------------------|
| P. | Regular Expression | 1. | Syntax analysis |
| Q. | Pushdown automata | 2. | Code generation |
| R. | Dataflow analysis | 3. | Lexical analysis |
| S. | Register allocation | 4. | Code optimization |

- A. P-4, Q-1, R-2, S-3
- B. P-3, Q-1, R-4, S-2
- C. P-3, Q-4, R-1, S-2
- D. P-2, Q-1, R-4, S-3

[gate2009](#) [compiler-design](#) [easy](#)

[Answer](#)

3.0.4 GATE2014-2_18 [top](#)

<http://gateoverflow.in/1975>

Which one of the following is **NOT** performed during compilation?

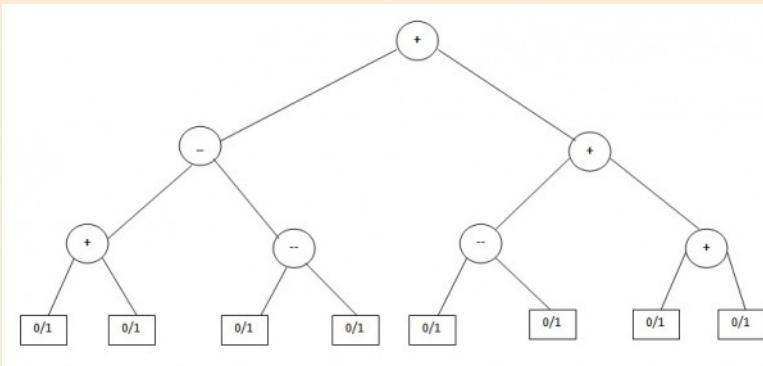
- (A) Dynamic memory allocation
- (B) Type checking
- (C) Symbol table management
- (D) Inline expansion

gate2014-2 compiler-design easy

Answer

3.0.5 GATE2014-2_39 [top](#)<http://gateoverflow.in/1999>

Consider the expression tree shown. Each leaf represents a numerical value, which can either be 0 or 1. Over all possible choices of the values at the leaves, the maximum possible value of the expression represented by the tree is ____.



gate2014-2 compiler-design normal

Answer

3.0.6 GATE2014-3_11 [top](#)<http://gateoverflow.in/2045>

The minimum number of arithmetic operations required to evaluate the polynomial $P(X) = X^5 + 4X^3 + 6X + 5$ for a given value of X , using only one temporary variable is ____.

gate2014-3 compiler-design numerical-answers normal

Answer

3.0.7 GATE2004_9 [top](#)<http://gateoverflow.in/1006>

Consider a program P that consists of two source modules M_1 and M_2 contained in two different files. If M_1 contains a reference to a function defined in M_2 the reference will be resolved at

- A. Edit time
- B. Compile time
- C. Link time
- D. Load time

gate2004 compiler-design easy

Answer

3.0.8 GATE1997_1.7 [top](#)<http://gateoverflow.in/2223>

Which of the following is essential for converting an infix expression to the postfix form efficiently?

- a. An operator stack
- b. An operand stack
- c. An operand stack and an operator stack
- d. A parse tree

[gate1997](#) [compiler-design](#) [normal](#)[Answer](#)**3.0.9 GATE1997_1.8** [top](#)<http://gateoverflow.in/2224>

A language L allows declaration of arrays whose sizes are not known during compilation. It is required to make efficient use of memory. Which one of the following is true?

- a. A compiler using static memory allocation can be written for L
- b. A compiler cannot be written for L ; an interpreter must be used
- c. A compiler using dynamic memory allocation can be written for L
- d. None of the above

[gate1997](#) [compiler-design](#) [easy](#)[Answer](#)**3.0.10 GATE1994_17** [top](#)<http://gateoverflow.in/2513>

State whether the following statements are True or False with reasons for your answer:

- a. Coroutine is just another name for a subroutine.
- b. A two pass assembler uses its machine opcode table in the first pass of assembly.

[gate1994](#) [compiler-design](#) [normal](#)[Answer](#)**3.0.11 GATE1996_1.17** [top](#)<http://gateoverflow.in/2721>

The pass numbers for each of the following activities

- i. object code generation
- ii. literals added to literal table
- iii. listing printed
- iv. address resolution of local symbols that occur in a two pass assembler

respectively are

- A. 1, 2, 1, 2
- B. 2, 1, 2, 1
- C. 2, 1, 1, 2
- D. 1, 2, 2, 2

[gate1996](#) [compiler-design](#) [normal](#)[Answer](#)**3.0.12 GATE1994_18** [top](#)<http://gateoverflow.in/2514>

State whether the following statements are True or False with reasons for your answer

- a. A subroutine cannot always be used to replace a macro in an assembly language program.
- b. A symbol declared as 'external' in an assembly language program is assigned an address outside the program by the assembler itself.

[gate1994](#)
[compiler-design](#)
[normal](#)
Answer**3.0.13 GATE2015-2_19** [top](#)<http://gateoverflow.in/8098>

Match the following:

- | | |
|------------------------|-------------------------|
| P. Lexical analysis | 1. Graph coloring |
| Q. Parsing | 2. DFA minimization |
| R. Register allocation | 3. Post-order traversal |
| S. Express evaluation | 4. Production tree |
- A. P-2, Q-3, R-1, S-4
 B. P-2, Q-1, R-4, S-3
 C. P-2, Q-4, R-1, S-3
 D. P-2, Q-3, R-4, S-1

[gate2015-2](#)
[compiler-design](#)
[normal](#)
Answer**3.0.14 GATE1991_03,ix** [top](#)<http://gateoverflow.in/519>

Choose the correct alternatives (more than one may be correct) and write the corresponding letters only

A "link editor" is a program that:

- (a). matches the parameters of the macro-definition with locations of the parameters of the macro call
- (b). matches external names of one program with their location in other programs
- (c). matches the parameters of subroutine definition with the location of parameters of subroutine call.
- (d). acts as a link between text editor and the user
- (e). acts as a link between compiler and the user program

[gate1991](#)
[compiler-design](#)
[normal](#)
Answer**3.0.15 GATE 2016-2-19** [top](#)<http://gateoverflow.in/39548>

Match the following:

- | | |
|-------------------------|---------------------------|
| (P) Lexical analysis | (i) Leftmost derivation |
| (Q) Top down parsing | (ii) Type checking |
| (R) Semantic analysis | (iii) Regular expressions |
| (S) Runtime environment | (iv) Activation records |

- A. $P \leftrightarrow i, Q \leftrightarrow ii, R \leftrightarrow iv, S \leftrightarrow iii$
 B. $P \leftrightarrow iii, Q \leftrightarrow i, R \leftrightarrow ii, S \leftrightarrow iv$
 C. $P \leftrightarrow ii, Q \leftrightarrow iii, R \leftrightarrow i, S \leftrightarrow iv$
 D. $P \leftrightarrow iv, Q \leftrightarrow i, R \leftrightarrow ii, S \leftrightarrow iii$

gate2016-2 | compiler-design | easy

[Answer](#)

Answers:

3.0.1 Gate 1990 [top](#)

<http://gateoverflow.in/52986>

a) lexical analysis is related to Syntax trees

lexical analysis generates tokens. Tokens are frequently defined by regular expressions, which are understood by a lexical analyzer generator such as lex. ...and regular expressions, are used in syntax analysis for generating..syntax tree.

b) code optimization is related to p)DAG's

<http://web.cecs.pdx.edu/~harry/compilers/slides/Optimize2.pdf>

c) code generation is related to Push down automata

from the run of the push-down automaton, one can construct a derivation and from it a parse tree that can be used for code generation

d) abelian group is related to s) Finite automata

<http://eiche.theoinf.tu-ilmenau.de/kuske/LOGINF/abstractStruengmann.pdf>

1 votes

-- Tauhin Gangwar (5k points)

3.0.2 GATE2015-2_14 [top](#)

<http://gateoverflow.in/8084>



Selected Answer

Option (C) is Correct

(A) is false , In CFG , code of N_2 may be present before N_1 when there is a loop or Goto.

(B) is false , CFG contains cycle when input program has loop.

(C) is true ,successors in AST and CFG depend on Input program.

(D) is false, In CFG a single node may belong to a block of statements.

6 votes

-- Himanshu Agarwal (9.8k points)

3.0.3 GATE2009-17 [top](#)

<http://gateoverflow.in/1309>



Selected Answer

Regular expressions are used in lexical analysis.

Pushdown automata is related to context free grammar which is related to syntax analysis.

Dataflow analysis is done in code optimization.

Register allocation is done in code generation.

Ans B

9 votes

-- Keith Kr (6k points)

3.0.4 GATE2014-2_18 top

<http://gateoverflow.in/1975>



Selected Answer

Dynamic means- at runtime. Dynamic memory allocation happens during the execution time and hence (A) is the answer.

9 votes

-- Arjun Suresh (150k points)

3.0.5 GATE2014-2_39 top

<http://gateoverflow.in/1999>



Selected Answer

ans is 6

at left leafs

$$+ \longrightarrow (1,1)=2 \quad \text{intermediate} + \longrightarrow 2-(-1)=3$$

$$- \longrightarrow (0,1)=-1$$

at right leafs

$$- \text{ minus } \longrightarrow (1,0)=1 \quad \text{intermediate} + \longrightarrow 1+2=3$$

$$+ \longrightarrow (1,1)=2$$

$$\text{at root} + \longrightarrow 3+3=6$$

8 votes

-- GANNA (189 points)

3.0.6 GATE2014-3_11 top

<http://gateoverflow.in/2045>



Selected Answer

$$P(X) = x^5 + 4x^3 + 6x + 5$$

$$= x(x^4 + 4x^2 + 6) + 5$$

$$= x(x(x^3 + 4x) + 6) + 5$$

$$= x(x(x(x^2 + 4)) + 6) + 5$$

$$= x(x(x(x(x + 4))) + 6) + 5$$

mul = pair of brackets 4

add = num of signs 3

total 7

14 votes

-- jayendra (6.6k points)

3.0.7 GATE2004_9 top

<http://gateoverflow.in/1006>



Selected Answer

answer - C. Each module is compiled separately and then linked together to make the executable. The below commands shows how to do this for two modules c1.c and c2.c using gcc.

```
gcc -c c1.c -o c1.o
gcc -c c2.c -o c2.o
gcc c1.o c2.o -o C.exe
```

8 votes

-- ankitrokdeonsns (8.4k points)

3.0.8 GATE1997_1.7 [top](#)<http://gateoverflow.in/2223>

Selected Answer

A.

we use operator stack (only operators are pushed as +, *, (,), /) for converting infix to postfix. And we use operand stack(operands such as 5,4,17 etc) for postfix evaluation.

12 votes

-- Gate Keeda (17.7k points)

3.0.9 GATE1997_1.8 [top](#)<http://gateoverflow.in/2224>

Selected Answer

C.

Using dynamic memory allocation, memory will be allocated to array at runtime.

8 votes

-- Gate Keeda (17.7k points)

3.0.10 GATE1994_17 [top](#)<http://gateoverflow.in/2513>

- a) False
- b) True

1 votes

-- Neha Sisodiya (81 points)

3.0.11 GATE1996_1.17 [top](#)<http://gateoverflow.in/2721>

Ans should be (B)

the functions performed in pass 1 and pass 2 in 2 pass assembler are

Pass 1

1. Assign addresses to all statements in the program.
2. Save the values assigned to all labels for use in pass 2
3. Perform some processing of assembler directives.

Pass 2

1. Assemble instructions.

2. Generate data values defined by BYTE, WORD etc.
3. Perform processing of assembler directives not done during pass 1.
4. Write the program and the assembling listing

5 votes

-- sonam vyas (8.1k points)

3.0.12 GATE1994_18 top

<http://gateoverflow.in/2514>

- A) This is true. We can not replace macro entirely using subroutine. Ex -> Macro constant used for renaming.
 B) This is false. This is job of Linker.

2 votes

-- Akash (31.7k points)

3.0.13 GATE2015-2_19 top

<http://gateoverflow.in/8098>



Selected Answer

Answer: C

11 votes

-- Rajarshi Sarkar (29.7k points)

3.0.14 GATE1991_03,ix top

<http://gateoverflow.in/519>



Selected Answer

Link editor or (linker) performs

1. external symbol resolution
2. relocation.

ANS: B

Matches external names of one program with their location in other programs

3 votes

-- pramod (2.3k points)

3.0.15 GATE 2016-2-19 top

<http://gateoverflow.in/39548>



Selected Answer

Option B.

Lexical Analysis phase uses regular expressions.

LMD is involved in top down parsing.

Type checking is done in semantic analysis phase.

Activation records are related to Run Time Environments

12 votes

-- Sharathkumar Anbu (697 points)

3.1

Assembler top

3.1.1 Assembler: GATE1993-7.6 [top](#)

<http://gateoverflow.in/2294>

A simple two-pass assembler does the following in the first pass:

- A. It allocates space for the literals.
- B. It computes the total length of the program.
- C. It builds the symbol table for the symbols and their values.
- D. It generates code for all the load and store register instructions.
- E. None of the above.

[gate1993](#) [compiler-design](#) [assembler](#) [easy](#)

[Answer](#)

3.1.2 Assembler: GATE1992_03,ii [top](#)

<http://gateoverflow.in/579>

Mention the pass number for each of the following activities that occur in a two pass assembler:

- a. object code generation
- b. literals added to literal table
- c. listing printed
- d. address resolution of local symbols

[gate1992](#) [compiler-design](#) [assembler](#) [easy](#)

[Answer](#)

3.1.3 Assembler: GATE1992-01,viii [top](#)

<http://gateoverflow.in/553>

The purpose of instruction location counter in an assembler is _____

[gate1992](#) [compiler-design](#) [assembler](#) [normal](#)

[Answer](#)

Answers: Assembler

3.1.1 Assembler: GATE1993-7.6 [top](#)

<http://gateoverflow.in/2294>



Selected Answer

a, b, c are TRUE.

http://gateoverflow.in/?qa=blob&qa_blobid=2337905098612945492

11 votes

-- Arjun Suresh (150k points)

3.1.2 Assembler: GATE1992_03,ii [top](#)

<http://gateoverflow.in/579>



Selected Answer

- a) 2
- b) 1

- c) 1
d) 1

P.S. : In first pass, symbol table is created and In second pass, machine code is generated.

Upvote 6 votes

-- Aditya Gaurav (2.1k points)

3.1.3 Assembler: GATE1992-01,viii [top](#)

<http://gateoverflow.in/553>

Each section of an assembler language program has a location counter used to assign storage addresses to your program's statements. As the instructions of a source module are being assembled, the location counter keeps track of the current location in storage.

Upvote 2 votes

-- Rohan Ghosh (1.6k points)

3.2

Code Optimization [top](#)

3.2.1 Code Optimization: GATE2014-1_17 [top](#)

<http://gateoverflow.in/1784>

Which one of the following is **FALSE**?

- A. A basic block is a sequence of instructions where control enters the sequence at the beginning and exits at the end.
- B. Available expression analysis can be used for common subexpression elimination.
- C. Live variable analysis can be used for dead code elimination.
- D. $x = 4 * 5 \Rightarrow x = 20$ is an example of common subexpression elimination.

gate2014-1 compiler-design code-optimization normal

Answer

3.2.2 Code Optimization: GATE2008-12 [top](#)

<http://gateoverflow.in/410>

Some code optimizations are carried out on the intermediate code because

- A. They enhance the portability of the compiler to the target processor
- B. Program analysis is more accurate on intermediate code than on machine code
- C. The information from dataflow analysis cannot otherwise be used for optimization
- D. The information from the front end cannot otherwise be used for optimization

gate2008 normal code-optimization compiler-design

Answer

Answers: Code Optimization

3.2.1 Code Optimization: GATE2014-1_17 [top](#)

<http://gateoverflow.in/1784>

(A) A basic block is a sequence of instructions where control enters the sequence at the beginning and exits at the end is TRUE.

(B) Available expression analysis can be used for common subexpression elimination is TRUE. Available expressions is an analysis algorithm that determines for each point in the program the set of expressions that need not be recomputed. Available expression analysis is used to do global common subexpression elimination (CSE). If an expression is available at a point, there is no need to re-evaluate it.

(C) Live variable analysis can be used for dead code elimination is TRUE.

(D) $x = 4 * 5 \Rightarrow x = 20$ is an example of common subexpression elimination is FALSE. Common subexpression elimination (CSE) refers to compiler optimization replaces identical expressions (i.e., they all evaluate to the same value) with a single variable holding the computed value when it is worthwhile to do so Source: Geeksforgeeks

3 votes

-- Pyuri sahu (1.3k points)

3.2.2 Code Optimization: GATE2008-12 [top](#)

<http://gateoverflow.in/410>



Selected Answer

Ans is (A)

Intermediate codes are machine independent codes. So, intermediate code can be used for code optimization since a given source code can be converted to target machine code.

10 votes

-- Keith Kr (6k points)

3.3

Context Free [top](#)

3.3.1 Context Free: GATE2008-IT_78 [top](#)

<http://gateoverflow.in/3392>

A CFG G is given with the following productions where S is the start symbol, A is a non-terminal and a and b are terminals.

$$S \rightarrow aS \mid AA \rightarrow aAb \mid bAa \mid \epsilon$$

Which of the following strings is generated by the grammar above?

- | | |
|----|---------|
| 1) | aabbaba |
| 2) | aabaaba |
| 3) | abababb |
| 4) | aabbaab |

[gate2008-it](#) [compiler-design](#) [context-free](#) [grammar](#) [normal](#)

Answer

Answers: Context Free

3.3.1 Context Free: GATE2008-IT_78 [top](#)

<http://gateoverflow.in/3392>



Selected Answer

$S \rightarrow aS$
 $S \rightarrow aA$
 $S \rightarrow aaAb$
 $S \rightarrow aabAab$
 $S \rightarrow aabbAaab$
 $S \rightarrow aabbaab$
 hence d is d answer

20 votes

-- Shreyans Dhankhar (2.4k points)

3.4

Dag Representation [top](#)

3.4.1 Dag Representation: GATE2014-3_34 [top](#)

<http://gateoverflow.in/2068>

Consider the basic block given below.

```
a = b + c
c = a + d
d = b + c
e = d - b
a = e + b
```

The minimum number of nodes and edges present in the DAG representation of the above basic block respectively are

- (A) 6 and 6
- (B) 8 and 10
- (C) 9 and 12
- (D) 4 and 4

[gate2014-3](#) | [compiler-design](#) | [dag-representation](#) | [normal](#)

[Answer](#)

Answers: Dag Representation

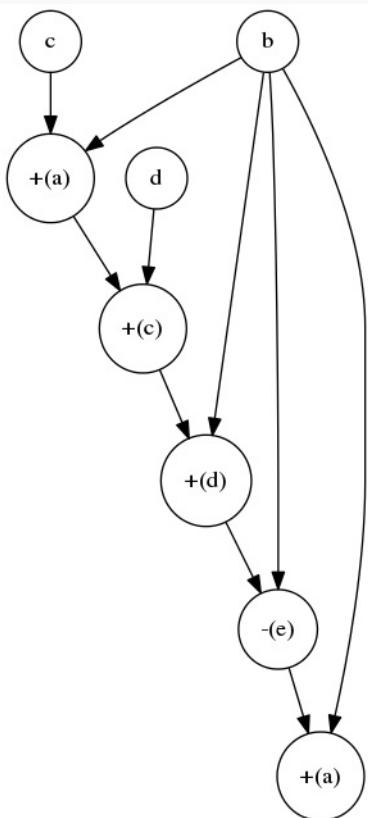
3.4.1 Dag Representation: GATE2014-3_34 [top](#)

<http://gateoverflow.in/2068>



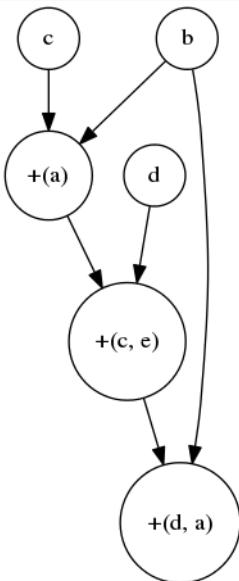
Selected Answer

A normal DAG construction will give 8 nodes and 10 edges as shown below.



Since, this question asks for minimum possible, we can assume algebraic simplification is allowed. So, $d = b + c$, $e = d - b$

b ; can be simplified to $d = b + c$; $e = c$; Similarly, $e = d - b$; $a = e + b$; can be simplified to $a = d$. This gives the following DAG with 6 nodes and 6 edges.



<https://cs.nyu.edu/~gottlieb/courses/2006-07-fall/compilers/lectures/lecture-14.html>

13 votes

-- Arjun Suresh (150k points)

3.5

Grammar

<http://gateoverflow.in/43512>

3.5.1 Grammar: GATE2007-79

Consider the CFG with $\{S, A, B\}$ as the non-terminal alphabet, $\{a, b\}$ as the terminal alphabet, S as the start symbol and the following set of production rules:

$$\begin{array}{ll} S \rightarrow aB & S \rightarrow bA \\ B \rightarrow b & A \rightarrow a \\ B \rightarrow bS & A \rightarrow aS \\ B \rightarrow aBB & S \rightarrow bAA \end{array}$$

For the string $aabbab$, how many derivation trees are there?

- A. 1
- B. 2
- C. 3
- D. 4

gate2007 | compiler-design | grammar | normal

Answer

3.5.2 Grammar: GATE2014-2_17

<http://gateoverflow.in/1973>

Consider the grammar defined by the following production rules, with two operators $*$ and $+$

- $S \rightarrow T * P$
- $T \rightarrow U \mid T * U$
- $P \rightarrow Q + P \mid Q$
- $Q \rightarrow Id$
- $U \rightarrow Id$

Which one of the following is TRUE?

- A. $+$ is left associative, while $*$ is right associative
- B. $+$ is right associative, while $*$ is left associative
- C. Both $+$ and $*$ are right associative
- D. Both $+$ and $*$ are left associative

[gate2014-2](#) [compiler-design](#) [grammar](#) [normal](#)

[Answer](#)

3.5.3 Grammar: GATE1991-10b [top](#)

<http://gateoverflow.in/43604>

Consider the following grammar for arithmetic expressions using binary operators $-$ and $/$ which are not associative

$$E \rightarrow E - T \mid T$$

$$T \rightarrow T/F \mid F$$

$$F \rightarrow (E) \mid id$$

(E is the start symbol)

Does the grammar allow expressions with redundant parentheses as in (id/id) or in $id - (id/id)$? If so, convert the grammar into one which does not generate expressions with redundant parentheses. Do this with minimum number of changes to the given production rules and adding at most one more production rule.

[gate1991](#) [grammar](#) [compiler-design](#) [normal](#) [descriptive](#)

[Answer](#)

3.5.4 Grammar: GATE1991-10c [top](#)

<http://gateoverflow.in/43605>

Consider the following grammar for arithmetic expressions using binary operators $-$ and $/$ which are not associative

$$E \rightarrow E - T \mid T$$

$$T \rightarrow T/F \mid F$$

$$F \rightarrow (E) \mid id$$

(E is the start symbol)

Does the grammar allow expressions with redundant parentheses as in (id/id) or in $id - (id/id)$? If so, convert the grammar into one which does not generate expressions with redundant parentheses. Do this with minimum number of changes to the given production rules and adding at most one more production rule.

Convert the grammar obtained above into one that is not left recursive.

[gate1991](#) [grammar](#) [compiler-design](#) [normal](#) [descriptive](#)

[Answer](#)

3.5.5 Grammar: GATE2006_84,85 [top](#)

<http://gateoverflow.in/1856>

Statement for Linked Answer Questions 84 & 85:

84. Which one of the following grammars generates the language $L = \{a^i b^j \mid i \neq j\}$?

(A)

$$S \rightarrow AC \mid CB$$

$$C \rightarrow aCb \mid a \mid b$$

$$A \rightarrow aA \mid \epsilon$$

$$B \rightarrow Bb \mid \epsilon$$

(B)

$$S \rightarrow aS \mid Sb \mid a \mid b$$

(C)

$$S \rightarrow AC \mid CB$$

$$C \rightarrow aCb \mid \epsilon$$

$$A \rightarrow aA \mid \epsilon$$

$$B \rightarrow Bb \mid \epsilon$$

(D)

$$S \rightarrow AC \mid CB$$

$$C \rightarrow aCb \mid \epsilon$$

$$A \rightarrow aA \mid a$$

$$B \rightarrow Bb \mid b$$

85. In the correct grammar above, what is the length of the derivation (number of steps starting from S) to generate the string $a^l b^m$ with $l \neq m$

- (A) $\max(l, m) + 2$
- (B) $l + m + 2$
- (C) $l + m + 3$
- (D) $\max(l, m) + 3$

[gate2006](#) [compiler-design](#) [grammar](#) [normal](#)
Answer

3.5.6 Grammar: GATE2006_59 [top](#)

<http://gateoverflow.in/1837>

Consider the following translation scheme.

$$S \rightarrow ER$$

$$R \rightarrow^* E \{ \text{print}('*'); \} R \mid \epsilon$$

$$E \rightarrow F + E \{ \text{print}('+'); \} \mid F$$

$$F \rightarrow S \mid id \{ \text{print}(id.value); \}$$

Here id is a token that represents an integer and $id.value$ represents the corresponding integer value. For an input '2 * 3 + 4', this translation scheme prints

- (A) 2 * 3 + 4
- (B) 2 * +3 4
- (C) 2 3 * 4 +
- (D) 2 3 4+*

[gate2006](#) [compiler-design](#) [grammar](#) [normal](#)
Answer

3.5.7 Grammar: GATE1998_14 [top](#)

<http://gateoverflow.in/1728>

- a. Let $G_1 = (N, T, P, S_1)$ be a CFG where, $N = \{S_1 A, B\}$, $T = \{a, b\}$ and P is given by

$$S_1 \rightarrow aS_1b \quad S_1 \rightarrow aBb$$

$S_1 \rightarrow aAb$ $B \rightarrow Bb$ $A \rightarrow aA$ $B \rightarrow b$ $A \rightarrow a$ What is $L(G_1)$?

- b. Use the grammar in Part(a) to give a CFG for $L_2 = \{a^i b^j a^k b^l \mid i, j, k, l \geq 1, i = j \text{ or } k = l\}$ by adding not more than 5 production rules.
- c. Is L_2 inherently ambiguous?

[gate1998](#) [compiler-design](#) [grammar](#) [descriptive](#)
Answer**3.5.8 Grammar: GATE1997_1.6** [top](#)<http://gateoverflow.in/2222>

In the following grammar

$$\begin{aligned} X &::= X \oplus Y \mid Y \\ Y &::= Z * Y \mid Z \\ Z &\quad ::= id \end{aligned}$$

Which of the following is true?

- a. ' \oplus ' is left associative while '*' is right associative
- b. Both ' \oplus ' and '*' are left associative
- c. ' \oplus ' is right associative while '*' is left associative
- d. None of the above

[gate1997](#) [compiler-design](#) [grammar](#) [normal](#)
Answer**3.5.9 Grammar: GATE1997_11** [top](#)<http://gateoverflow.in/2271>

Consider the grammar

$$\begin{aligned} S &\rightarrow bSe \\ S &\rightarrow PQR \\ P &\rightarrow bPc \\ P &\rightarrow \epsilon \\ Q &\rightarrow cQd \\ Q &\rightarrow \epsilon \\ R &\rightarrow dRe \\ R &\rightarrow \epsilon \end{aligned}$$

where S, P, Q, R are non-terminal symbols with S being the start symbol; b, c, d, e are terminal symbols and ' ϵ ' is the empty string. This grammar generates strings of the form b^i, c^j, d^k, e^m for some $i, j, k, m \geq 0$.

- a. What is the condition on the values of i, j, k, m ?
- b. Find the smallest string that has two parse trees.

[gate1997](#) [compiler-design](#) [grammar](#) [normal](#) [theory-of-computation](#)
Answer**3.5.10 Grammar: GATE 2016-2-46** [top](#)<http://gateoverflow.in/39598>

A student wrote two context-free grammars G1 and G2 for generating a single C-like array declaration. The dimension of the array is at least one. For example,

```
int a[10] [3];
```

The grammars use D as the start symbol, and use six terminal symbols **int ; id [] num.**

| Grammar G1 | Grammar G2 |
|-----------------------------------|--------------------------------|
| $D \rightarrow \text{int } L;$ | $D \rightarrow \text{int } L;$ |
| $L \rightarrow \text{id } [E]$ | $L \rightarrow \text{id } E$ |
| $E \rightarrow \text{num }]$ | $E \rightarrow E [\text{num}]$ |
| $E \rightarrow \text{num }] [E]$ | $E \rightarrow [\text{num}]$ |

Which of the grammars correctly generate the declaration mentioned above?

- A. Both **G1** and **G2**
- B. Only **G1**
- C. Only **G2**
- D. Neither **G1** nor **G2**

[gate2016-2](#) [compiler-design](#) [grammar](#) [normal](#)

[Answer](#)

3.5.11 Grammar: GATE2010-38 [top](#)

<http://gateoverflow.in/2339>

The grammar $S \rightarrow aSa \mid bS \mid c$ is

- A. LL(1) but not LR(1)
- B. LR(1) but not LL(1)
- C. Both LL(1) and LR(1)
- D. Neither LL(1) nor LR(1)

[gate2010](#) [compiler-design](#) [grammar](#) [normal](#)

[Answer](#)

3.5.12 Grammar: GATE1994_1.18 [top](#)

<http://gateoverflow.in/2461>

Which of the following features cannot be captured by context-free grammars?

- A. Syntax of if-then-else statements
- B. Syntax of recursive procedures
- C. Whether a variable has been declared before its use
- D. Variable names of arbitrary length

[gate1994](#) [compiler-design](#) [grammar](#) [normal](#)

[Answer](#)

3.5.13 Grammar: GATE1994_3.5 [top](#)

<http://gateoverflow.in/2482>

Match the following items

| | |
|-----------------------|-------------------------|
| (i) Backus-Naur form | (a) Regular expressions |
| (ii) Lexical analysis | (b) LALR(1) grammar |

| | | | | |
|----------------------|----------------------|-----------------------|---------------------|--------------|
| (IV) YACC parsing | Recursive descent | (8) LL(1) grammars | General grammars | context-free |
|----------------------|----------------------|-----------------------|---------------------|--------------|

gate1994 | compiler-design | grammar | normal

Answer

3.5.14 Grammar: GATE 2016-2-45 [top](#)

<http://gateoverflow.in/39594>

Which one of the following grammars is free from left recursion?

(A) $S \rightarrow AB$

$$A \rightarrow Aa|b$$

$$B \rightarrow c$$

(B) $S \rightarrow Ab|Bb|c$

$$A \rightarrow Bd|\epsilon$$

$$B \rightarrow e$$

(C) $S \rightarrow Aa|B$

$$A \rightarrow Bb|Sc|\epsilon$$

$$B \rightarrow d$$

(D) $S \rightarrow Aa|Bb|c$

$$A \rightarrow Bd|\epsilon$$

$$B \rightarrow Ae|\epsilon$$

gate2016-2 | compiler-design | grammar | easy

Answer

3.5.15 Grammar: GATE1999_2.15 [top](#)

<http://gateoverflow.in/1493>

A grammar that is both left and right recursive for a non-terminal, is

- A. Ambiguous
- B. Unambiguous
- C. Information is not sufficient to decide whether it is ambiguous or unambiguous
- D. None of the above

gate1999 | compiler-design | grammar | normal

Answer

3.5.16 Grammar: GATE1994_20 [top](#)

<http://gateoverflow.in/2516>

A grammar G is in Chomsky-Normal Form (CNF) if all its productions are of the form $A \rightarrow BC$ or $A \rightarrow a$, where A, B and C , are non-terminals and a is a terminal. Suppose G is a CFG in CNF and w is a string in $L(G)$ of length n , then how long is

a derivation of w in G ?

gate1994 | compiler-design | grammar | normal

Answer

3.5.17 Grammar: GATE1995_1.10 top

<http://gateoverflow.in/2597>

Consider a grammar with the following productions

$$S \rightarrow aab \mid bac \mid aB$$

$$S \rightarrow \alpha S \mid b$$

$$S \rightarrow abb \mid ab$$

$$S\alpha \rightarrow bdb \mid b$$

The above grammar is:

- A. Context free
- B. Regular
- C. Context sensitive
- D. LR(k)

gate1995 | compiler-design | grammar | normal

Answer

3.5.18 Grammar: GATE1995_9 top

<http://gateoverflow.in/2644>

a. Translate the arithmetic expression $a^* - (b + c)$ into syntax tree.

b. A grammar is said to have cycles if it is the case that

$$A \Rightarrow^+ A$$

Show that no grammar that has cycles can be LL(1).

gate1995 | compiler-design | grammar | normal

Answer

3.5.19 Grammar: GATE1996_2.10 top

<http://gateoverflow.in/2739>

The grammar whose productions are

- > if id then <stmt>
- > if id then <stmt> else <stmt>
- > id := id

is ambiguous because

(a) the sentence

```
if a then if b then c:= d
```

has more than two parse trees

(b) the left most and right most derivations of the sentence

```
if a then if b then c:= d
```

give rise to different parse trees

(c) the sentence

```
if a then if b then c:= d else c:= f
```

has more than two parse trees

(d) the sentence

```
if a then if b then c:= d else c:= f
```

has two parse trees

[gate1996](#) [compiler-design](#) [grammar](#) [normal](#)

[Answer](#)

3.5.20 Grammar: GATE1996_11 [top](#)

<http://gateoverflow.in/2763>

Let G be a context-free grammar where $G = (\{S, A, B, C\}, \{a, b, d\}, P, S)$ with the productions in P given below.

$$S \rightarrow ABAC$$

$$A \rightarrow aA \mid \epsilon$$

$$B \rightarrow bB \mid \epsilon$$

$$C \rightarrow d$$

(ϵ denotes the null string). Transform the grammar G to an equivalent context-free grammar G' that has no ϵ productions and no unit productions. (A unit production is of the form $x \rightarrow y$, and x and y are non terminals).

[gate1996](#) [compiler-design](#) [grammar](#) [normal](#)

[Answer](#)

3.5.21 Grammar: GATE2007-IT_9 [top](#)

<http://gateoverflow.in/3442>

Consider an ambiguous grammar G and its disambiguated version D . Let the language recognized by the two grammars be denoted by $L(G)$ and $L(D)$ respectively. Which one of the following is true ?

- A) $L(D) \subset L(G)$
- B) $L(D) \supset L(G)$
- C) $L(D) = L(G)$
- D) $L(D)$ is empty

[gate2007-it](#) [compiler-design](#) [grammar](#) [normal](#)

[Answer](#)

3.5.22 Grammar: GATE1998_6b [top](#)

<http://gateoverflow.in/1697>

Consider the grammar

- $S \rightarrow Aa \mid b$
- $A \rightarrow Ac \mid Sd \mid \epsilon$

Construct an equivalent grammar with no left recursion and with minimum number of production rules.

[gate1998](#) [compiler-design](#) [grammar](#) [descriptive](#)

[Answer](#)

3.5.23 Grammar: GATE2008-50 [top](#)

<http://gateoverflow.in/395>

Which of the following statements are true?

- I. Every left-recursive grammar can be converted to a right-recursive grammar and vice-versa
 - II. All ϵ -productions can be removed from any context-free grammar by suitable transformations
 - III. The language generated by a context-free grammar all of whose productions are of the form $X \rightarrow w$ or $X \rightarrow wY$ (where, w is a string of terminals and Y is a non-terminal), is always regular
 - IV. The derivation trees of strings generated by a context-free grammar in Chomsky Normal Form are always binary trees
- A. I, II, III and IV
 B. II, III and IV only
 C. I, III and IV only
 D. I, II and IV only

[gate2008](#) [normal](#) [compiler-design](#) [grammar](#)

[Answer](#)

3.5.24 Grammar: GATE2004_45 [top](#)

<http://gateoverflow.in/1042>

Consider the grammar with the following translation rules and E as the start symbol

$$\begin{array}{ll}
 \{E.value = E_1.value * T & \\
 E \rightarrow E_1 \# T & .value\} \\
 |T & \{E.value = T.value\} \\
 T \rightarrow T_1 \& F & \{T.value = T_1.value + F \\
 |F & .value\} \\
 F \rightarrow \text{num} & \{T.value = F.value\} \\
 & \{F.value = \text{num}.value\}
 \end{array}$$

Compute E.value for the root of the parse tree for the expression: 2 # 3 & 5 # 6 & 4

- A. 200
- B. 180
- C. 160
- D. 40

[gate2004](#) [compiler-design](#) [grammar](#) [normal](#)

[Answer](#)

3.5.25 Grammar: GATE2007_52 [top](#)

<http://gateoverflow.in/1250>

Consider the grammar with non-terminals $N = \{S, C, S_1\}$, terminals $T = \{a, b, i, t, e\}$, with S as the start symbol, and the following set of rules:

$$\begin{aligned}
 S &\rightarrow iCtSS_1 \mid a \\
 S_1 &\rightarrow eS \mid \epsilon \\
 C &\rightarrow b
 \end{aligned}$$

The grammar is NOT LL(1) because:

- A. it is left recursive
- B. it is right recursive
- C. it is ambiguous

- D. it is not context-free

[gate2007](#) [compiler-design](#) [grammar](#) [normal](#)

[Answer](#)

3.5.26 Grammar: GATE2007-78 [top](#)

<http://gateoverflow.in/1272>

Consider the CFG with
 $\{S, A, B\}$ as the non-terminal alphabet,
 $\{a, b\}$ as the terminal alphabet, S as the start symbol and the following set of production rules:

$$\begin{array}{ll} S \rightarrow aB & S \rightarrow bA \\ B \rightarrow b & A \rightarrow a \\ B \rightarrow bS & A \rightarrow aS \\ B \rightarrow aBB & S \rightarrow bAA \end{array}$$

Which of the following strings is generated by the grammar?

- A. aaaabb
- B. aabbbb
- C. aabbab
- D. abbbba

[gate2007](#) [compiler-design](#) [grammar](#) [normal](#)

[Answer](#)

3.5.27 Grammar: GATE2004_88 [top](#)

<http://gateoverflow.in/1082>

Consider the following grammar G:

$$S \rightarrow bS \mid aA \mid b$$

$$A \rightarrow bA \mid aB$$

$$B \rightarrow bB \mid aS \mid a$$

Let $N_a(w)$ and $N_b(w)$ denote the number of a's and b's in a string ω respectively.

The language $L(G)$ over $\{a, b\}^+$ generated by G is

- A. $\{w \mid N_a(w) > 3N_b(w)\}$
- B. $\{w \mid N_b(w) > 3N_a(w)\}$
- C. $\{w \mid N_a(w) = 3k, k \in \{0, 1, 2, \dots\}\}$
- D. $\{w \mid N_b(w) = 3k, k \in \{0, 1, 2, \dots\}\}$

[gate2004](#) [compiler-design](#) [grammar](#) [normal](#)

[Answer](#)

3.5.28 Grammar: GATE2001-18 [top](#)

<http://gateoverflow.in/759>

- a. Remove left-recursion from the following grammar: $S \rightarrow Sa \mid Sb \mid a \mid b$
- b. Consider the following grammar: $S \rightarrow aSbS \mid bSaS \mid \epsilon$
- c. Construct all possible parse trees for the string abab. Is the grammar ambiguous?

[gate2001](#)
[compiler-design](#)
[grammar](#)
Answer**3.5.29 Grammar: GATE2004_8** [top](#)<http://gateoverflow.in/1005>

Which of the following grammar rules violate the requirements of an operator grammar? P, Q, R are nonterminals, and r, s, t are terminals.

- I. $P \rightarrow Q R$
- II. $P \rightarrow Q s R$
- III. $P \rightarrow \epsilon$
- IV. $P \rightarrow Q t R r$

- A. (I) only
- B. (I) and (III) only
- C. (II) and (III) only
- D. (III) and (IV) only

[gate2004](#)
[compiler-design](#)
[grammar](#)
[normal](#)
Answer**3.5.30 Grammar: GATE2006-32, ISRO2016-35** [top](#)<http://gateoverflow.in/995>

Consider the following statements about the context free grammar

$$G = \{S \rightarrow SS, S \rightarrow ab, S \rightarrow ba, S \rightarrow \epsilon\}$$

- I. G is ambiguous
- II. G produces all strings with equal number of a 's and b 's
- III. G can be accepted by a deterministic PDA.

Which combination below expresses all the true statements about G ?

- A. I only
- B. I and III only
- C. II and III only
- D. I, II and III

[gate2006](#)
[compiler-design](#)
[grammar](#)
[normal](#)
[isro2016](#)
Answer**3.5.31 Grammar: GATE2005_59** [top](#)<http://gateoverflow.in/1382>

Consider the grammar:

$$E \rightarrow E + n \mid E \times n \mid n$$

For a sentence $n + n \times n$, the handles in the right-sentential form of the reduction are:

- A. $n, E + n$ and $E + n \times n$
- B. $n, E + n$ and $E + E \times n$
- C. $n, n + n$ and $n + n \times n$
- D. $n, E + n$ and $E \times n$

[gate2005](#)
[compiler-design](#)
[grammar](#)
[normal](#)
Answer

3.5.32 Grammar: GATE2003_58 [top](#)

<http://gateoverflow.in/946>

Consider the translation scheme shown below.

$$S \rightarrow T R$$

$$R \rightarrow + T \{print('+');\} R | \epsilon$$

$$T \rightarrow \text{num} \{print(\text{num}.val);\}$$

Here **num** is a token that represents an integer and **num.val** represents the corresponding integer value. For an input string '9 + 5 + 2', this translation scheme will print

- A. 9 + 5 + 2
- B. 9 5 + 2 +
- C. 9 5 2 + +
- D. + + 9 5 2

[gate2003](#)
[compiler-design](#)
[grammar](#)
[normal](#)
Answer

3.5.33 Grammar: GATE1991-10a [top](#)

<http://gateoverflow.in/537>

Consider the following grammar for arithmetic expressions using binary operators — and / which are not associative

$$E \rightarrow E - T \mid T$$

$$T \rightarrow T/F \mid F$$

$$F \rightarrow (E) \mid id$$

(*E* is the start symbol)

Is the grammar unambiguous? Is so, what is the relative precedence between — and /? If not, give an unambiguous grammar that gives / precedence over —.

[gate1991](#)
[grammar](#)
[compiler-design](#)
[normal](#)
[descriptive](#)
Answer

3.5.34 Grammar: GATE2003_56 [top](#)

<http://gateoverflow.in/944>

Consider the grammar shown below

$$S \rightarrow i E t S S' \mid a$$

$$S' \rightarrow e S \mid \epsilon$$

$$E \rightarrow b$$

In the predictive parse table, M, of this grammar, the entries $M[S', e]$ and $M[S', \$]$ respectively are

- A. $\{S' \rightarrow e S\}$ and $\{S' \rightarrow \epsilon\}$
- B. $\{S' \rightarrow e S\}$ and $\{S' \rightarrow \epsilon\}$
- C. $\{S' \rightarrow \epsilon\}$ and $\{S' \rightarrow \epsilon\}$
- D. $\{S' \rightarrow e S, S' \rightarrow \epsilon\}$ and $\{S' \rightarrow \epsilon\}$

[gate2003](#)
[compiler-design](#)
[grammar](#)
[normal](#)

Answer**3.5.35 Grammar: GATE2000-2.21, ISRO2015-24** [top](#)<http://gateoverflow.in/668>

Given the following expression grammar:

$$\begin{aligned} E &\rightarrow E * F \mid F + E \mid F \\ F &\rightarrow F - F \mid id \end{aligned}$$

Which of the following is true?

- A. * has higher precedence than +
- B. — has higher precedence than *
- C. + and — have same precedence
- D. + has higher precedence than *

[gate2000](#) [grammar](#) [normal](#) [compiler-design](#) [isro2015](#)

Answer**3.5.36 Grammar: GATE2001-1.18** [top](#)<http://gateoverflow.in/711>

Which of the following statements is false?

- A. An unambiguous grammar has same leftmost and rightmost derivation
- B. An LL(1) parser is a top-down parser
- C. LALR is more powerful than SLR
- D. An ambiguous grammar can never be LR(k) for any k

[gate2001](#) [compiler-design](#) [grammar](#) [normal](#)

Answer**3.5.37 Grammar: GATE2007-53** [top](#)<http://gateoverflow.in/1251>

Consider the following two statements:

- P: Every regular grammar is LL(1)
- Q: Every regular set has a LR(1) grammar

Which of the following is **TRUE**?

- A. Both P and Q are true
- B. P is true and Q is false
- C. P is false and Q is true
- D. Both P and Q are false

[gate2007](#) [compiler-design](#) [grammar](#) [normal](#)

Answer**Answers: Grammar****3.5.1 Grammar: GATE2007-79** [top](#)<http://gateoverflow.in/43512>

Selected Answer

S → aB
→ aaBB
→ aabB
→ aabbS

-> aabbaB
 -> aabbab

S -> aB
 -> aaBB (till now, only 1 choice possible)
 -> aabSB (last time we took B -> b, now taking B->bS)
 -> aabbAB
 -> aabbaB
 -> aabbab

So, totally 2 possible derivation trees.

Upvote 5 votes

-- Arjun Suresh (150k points)

3.5.2 Grammar: GATE2014-2_17 [top](#)

<http://gateoverflow.in/1973>



Selected Answer

P->Q+P here P is to right of +

so + is right associative

Similarly for T->T *U * is left associative as T is to left of *

so ans is b

Upvote 8 votes

-- Pooja (25.9k points)

3.5.3 Grammar: GATE1991-10b [top](#)

<http://gateoverflow.in/43604>

If the expression with redundant parentheses is (id/id) or id-(id/id) then it can be generated by the given grammar.

To generate expression (id/id) we can go through following steps-

1. E-> T
2. E-> F (T-> F)
3. E-> (E) (F-> (E))
4. E-> (T) (E->T)
5. E-> (T/F) (T-> T/F)
6. E-> (F/F) (T->F)
7. E-> (id/id) (F->id)

Now to generate expression id- (id/id) we can go through following steps-

1. E-> E - T
2. E-> E - F (T-> F)
3. E-> E - (E) (F-> (E))
4. E-> E - (T) (E->T)
5. E-> E - (T/F) (T-> T/F)
6. E-> E - (F/F) (T->F)
7. E-> T - (F/F) (E-> T)
8. E-> F - (F/F) (T->F)
9. E-> id - (id/id) (F->id)

2 votes

-- vijaycs (10.7k points)

3.5.4 Grammar: GATE1991-10c [top](#)<http://gateoverflow.in/43605>

Non left recursive grammar is:

$$\begin{aligned} E &\rightarrow TE' \\ E' &\rightarrow -TE' \mid \epsilon \\ T &\rightarrow FT' \\ T' &\rightarrow /FT' \mid \epsilon \\ F &\rightarrow (E) \mid \text{id} \end{aligned}$$

5 votes

-- Manoj Kumar (23.1k points)

3.5.5 Grammar: GATE2006_84,85 [top](#)<http://gateoverflow.in/1856>

Selected Answer

84, answer = option D 85 answer = option A

Q 84 .**option A** $C \Rightarrow a$ or, $C \Rightarrow b$ or, $C \Rightarrow a\underline{C}b \Rightarrow aa\underline{C}bb \Rightarrow aaa\underline{C}bbb \dots$ soonat last you have to put either $C \rightarrow a$ or $C \rightarrow b$ so production C is used to derive $a^{n+1}b^n$ or a^nb^{n+1} $n >= 0$

$S \rightarrow AC$ [$Aa^n b^{n+1}$] can make $a^{n+1}b^{n+1}$ as single a can be derived from A [$A \Rightarrow aA \Rightarrow a$ as $A \rightarrow \epsilon$] , similarly $S \rightarrow CB$ simple way, ab can be derived from grammar as $S \Rightarrow AC \Rightarrow aAC \Rightarrow aC \Rightarrow ab$

option A is wrong

option B , language is used to drive a^+b^* or a^*b^+ , ab will be derived as $S \Rightarrow aS \Rightarrow ab$

option B is wrong

Option C $C \Rightarrow \epsilon$ or $C \Rightarrow a\underline{C}b \Rightarrow aa\underline{C}bb \Rightarrow aaa\underline{C}bbb \dots$ soon at last need to put $C \rightarrow \epsilon$ Production C will generate a^nb^n $n >= 0$ $S \rightarrow AC$ can generate a^nb^n as A can be ϵ , similarly $S \rightarrow CB$

option C is wrong

Option D .production C is used for generate a^nb^n as in option C $S \rightarrow AC$ will increase no of a's before a^nb^n as A will generate a or aa or aaa... i.e a^+ , so $S \rightarrow AC$ will generate $a^+a^nb^n$ i.e a^ib^j $i > j$ $S \rightarrow CB$ will generate $a^nb^nb^+$ i.e a^ib^j $i < j$

option D is right .

Q 85

$L = a^l b^m$ $l \neq m$ means either $l > m$ or $l < m$

Case I [$l > m$]

if $l > m$, $a^l b^m$ can be written as $a^{l-m} a^m b^m$ [$l-m$ cannot be 0 as l should be $> m$]

$S \rightarrow AC$, one step

a^{l-m} use $l-m$ steps using productions of A

[as $l-m = 1$, one step $A \rightarrow a$

$l-m = 2$, two steps $A \rightarrow aA \rightarrow aa$

$l-m = 3$, three steps, $A \rightarrow aA \rightarrow aaA \rightarrow aaa..$ so on]

$a^m b^m$ will be generated in $m + 1$ steps using production C

[as $m = 0$ one step $C \rightarrow \epsilon$

$m = 1$, two steps $C \rightarrow aCb \rightarrow ab$

$m = 2$, three steps $C \rightarrow aCb \rightarrow aaCbb \rightarrow aabb..$ so on]

so if $l > m$ total steps = $1+l-m+m+1 = l+2$

Case II [$l < m$]

similar if $l < m$, $a^l b^m$ can be written as $a^l b^l b^{m-l}$ [$m-l$ cannot be 0 as m should be $> l$]

$S \rightarrow CB$ one step

$a^l b^l$ will be derived using $l+1$ steps

b^{m-l} will be derived using $m-l$ steps

total = $1+l+1+m-l = m+2$

so $L = a^l b^m$ $l \neq m$ will take $\max(l,m)+2$ steps

拇指图标 13 votes

-- Praveen Saini (38.4k points)

3.5.6 Grammar: GATE2006_59

<http://gateoverflow.in/1837>

It will be D. make a tree and perform post order evaluation.

拇指图标 7 votes

-- Gate Keeda (17.7k points)

3.5.7 Grammar: GATE1998_14

<http://gateoverflow.in/1728>

a) $L(G1) = \{a^i b^j \mid i, j > 1, i > j \text{ or } j > i\}$

b) $S \rightarrow S1S2 \mid S2S1$

$S1 \rightarrow aS1b \mid ab$

$S2 \rightarrow S3S4$

$S3 \rightarrow aS3 \mid a$

$S4 \rightarrow bS4 \mid b$

c) Inherently Ambiguous grammar means there will not be any unambiguity in that grammar

But here we can generate $aabbaaab$, $aabbbaabb.....$ these grammar which are unambiguous in nature

So, it is not inherently ambiguous grammar

0 votes

-- srestha (27.8k points)

3.5.8 Grammar: GATE1997_1.6 [top](#)

<http://gateoverflow.in/2222>



Selected Answer

It will be A. For multiple ' \oplus ', the derivation is possible only via ' X ' which is on left side of ' \oplus ' in the production. Hence it is left associative.

For multiple '*', the derivation is possible only via ' Y ' which is on the right side of '*' in the production. Hence it is right associative.

If both left and right derivations were possible, the grammar would have been ambiguous and we couldn't have given associativity.

13 votes

-- Gate Keeda (17.7k points)

3.5.9 Grammar: GATE1997_11 [top](#)

<http://gateoverflow.in/2271>



Selected Answer

- A) $i+k=j+m$
where $i,j,k,m \geq 0$
- B) bcde

4 votes

-- Danish (2.4k points)

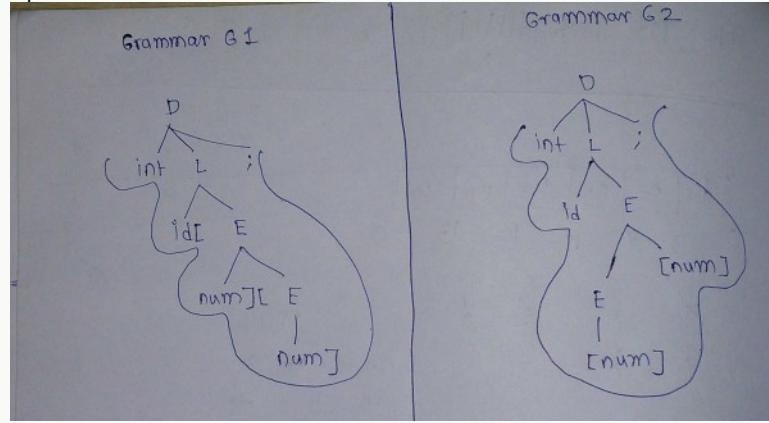
3.5.10 Grammar: GATE 2016-2-46 [top](#)

<http://gateoverflow.in/39598>



Selected Answer

Option A Both G1 and G2



14 votes

-- Shashank Chavan (2.6k points)

3.5.11 Grammar: GATE2010-38 [top](#)

<http://gateoverflow.in/2339>



Selected Answer

It will be C.

For LL(1) take First(S). and do intersection between the result. if intersection is Phi then LL(1) else not.

Making a parsing table and checking if there are two or more entries under any terminal. If yes then neither LL(1) nor LR(1).

12 votes

-- Gate Keeda (17.7k points)

3.5.12 Grammar: GATE1994_1.18 top

<http://gateoverflow.in/2461>



Selected Answer

It will be C.

Since CFG's are used to show syntactic rules while designing compiler, and syntactic rules don't check for meaningful things such as if a variable has been declared before its use or not. Such things are meant to be handled by Semantic Analysis phase (requires power of a context sensitive grammar).

12 votes

-- Gate Keeda (17.7k points)

3.5.13 Grammar: GATE1994_3.5 top

<http://gateoverflow.in/2482>



Selected Answer

answer -

i - d

ii - a

iii - b

iv - c

4 votes

-- ankitrokdeonsns (8.4k points)

3.5.14 Grammar: GATE 2016-2-45 top

<http://gateoverflow.in/39594>



Selected Answer

Option (a) has immediate left recursion. " $A \rightarrow Aa$ "

Option (c) has indirect left recursion " $S \rightarrow Aa \xrightarrow{A \rightarrow Sc} Sca$ "

Option (d) has indirect left recursion " $A \rightarrow Bd \xrightarrow{B \rightarrow Ae} Aed$ "

Option (b) is free from left recursion. No direct left recursion. No indirect left recursion.

option B is correct

11 votes

-- Ashish Deshmukh (1.4k points)

3.5.15 Grammar: GATE1999_2.15 top

<http://gateoverflow.in/1493>



Selected Answer

Let grammar is like this :

$$\begin{aligned} S &\rightarrow a \\ A &\rightarrow AbA \end{aligned}$$

This grammar is left as well as right recursive but still unambiguous.. **A** is useless production but still part of grammar.. A grammar having both left as well as right recursion may or may not be ambiguous ..

12 votes

-- Digvijay (35.8k points)

3.5.16 Grammar: GATE1994_20 [top](#)

<http://gateoverflow.in/2516>



Selected Answer

its answer is $2n-1$ for n length string, because in CNF at every step only 1 terminal can replace a variable, for example

$$\begin{aligned} S &\rightarrow AB \\ A &\rightarrow a \\ B &\rightarrow c \end{aligned}$$

for generating string 'ac' 3 production will be used.

10 votes

-- Manu Thakur (5.6k points)

3.5.17 Grammar: GATE1995_1.10 [top](#)

<http://gateoverflow.in/2597>



Selected Answer

$$S^\infty \rightarrow >$$

This violates the conditions of context-free and hence the grammar becomes context-sensitive.

11 votes

-- Arjun Suresh (150k points)

3.5.18 Grammar: GATE1995_9 [top](#)

<http://gateoverflow.in/2644>



Selected Answer

A grammer having left recursion generates a cycle.

And no left recursive grammar is LL(1) grammar.

4 votes

-- simran (77 points)

3.5.19 Grammar: GATE1996_2.10 [top](#)

<http://gateoverflow.in/2739>



Selected Answer

(d) the sentence

if a then if b then c:= d else c:= f

has two parse trees as follows:

if a then (if b then c:= d) else c:= f
and
if a then (if b then c:=d else c:= f)

10 votes

-- Arjun Suresh (150k points)

3.5.20 Grammar: GATE1996_11 [top](#)

<http://gateoverflow.in/2763>



Selected Answer

final grammar is

$S \rightarrow ABAC / ABC / BAC / BC / AC / AAC / d$

$A \rightarrow aA / a$

$B \rightarrow bB / b$

$C \rightarrow d$

correct me

7 votes

-- Mithlesh Upadhyay (3.6k points)

3.5.21 Grammar: GATE2007-IT_9 [top](#)

<http://gateoverflow.in/3442>



Selected Answer

c) grammar may change but language remain the same.

19 votes

-- Arpit Dhuriya (2.4k points)

3.5.22 Grammar: GATE1998_6b [top](#)

<http://gateoverflow.in/1697>

(b) As it is the case of indirect recursion so let first make it as direct recursion then apply rules of removal of left recursion.

to make it as direct recursion first production remain unchanged while in second production substitute the right hand side of first production wherever it comes. In the question S comes in middle of A so substitute the right hand side of production S. Now after substituting it looks like..

$A \rightarrow Ac | Aad | bd | \epsilon$

Now remove direct recursion from it

For removal of direct recursion rule--

$A \rightarrow A\alpha_1 | \dots | A\alpha_n | \beta_1 | \dots | \beta_m$

Replace these with two sets of productions, one set for A :

$A \rightarrow \beta_1 A' | \dots | \beta_m A'$

and another set for the fresh nonterminal A'

$A' \rightarrow \alpha_1 A' | \dots | \alpha_n A' | \epsilon$

After applying these rule we'll get..

$A \rightarrow bdA' | A'$

$A' \rightarrow cA' | adA' | \epsilon$

Now complete production without left recursion is...

$S \rightarrow Aa | b$

$A \rightarrow bdA' | A'$

$A' \rightarrow cA' | adA' | \epsilon$

1 votes

-- shashi shekhar (387 points)

3.5.23 Grammar: GATE2008-50 [top](#)

<http://gateoverflow.in/395>

Selected Answer

Answer is C:

Statement 1 is **true**: Using GNF we can convert Left recursive grammar to right recursive and by using reversal of CFG and GNF we can convert right recursive to left recursive.

Statement 2 is **false**: because if ϵ is in the language then we can't remove ϵ production from Start symbol. (For example $L = a^*$)

Statement 3 is **true** because right linear grammar generates regular set

Statement 4 is **true**, only two non-terminals are there in each production in CNF. So it always form a binary tree.

16 votes

-- Vikrant Singh (11k points)

3.5.24 Grammar: GATE2004_45 [top](#)

<http://gateoverflow.in/1042>

Selected Answer

we can do in simple manner ...

here # is multiplication and & is addition by semantics rules given in the question ...

and by observation of productions ..

1. here & (+) is higher precedence than #(*). bcoz & is far from starting symbol ...

2. and both &, # are left associative so we can solve the express in this way ...

$((2*(3+5))*(6+4)) = 160$ so ans should be (C).

11 votes

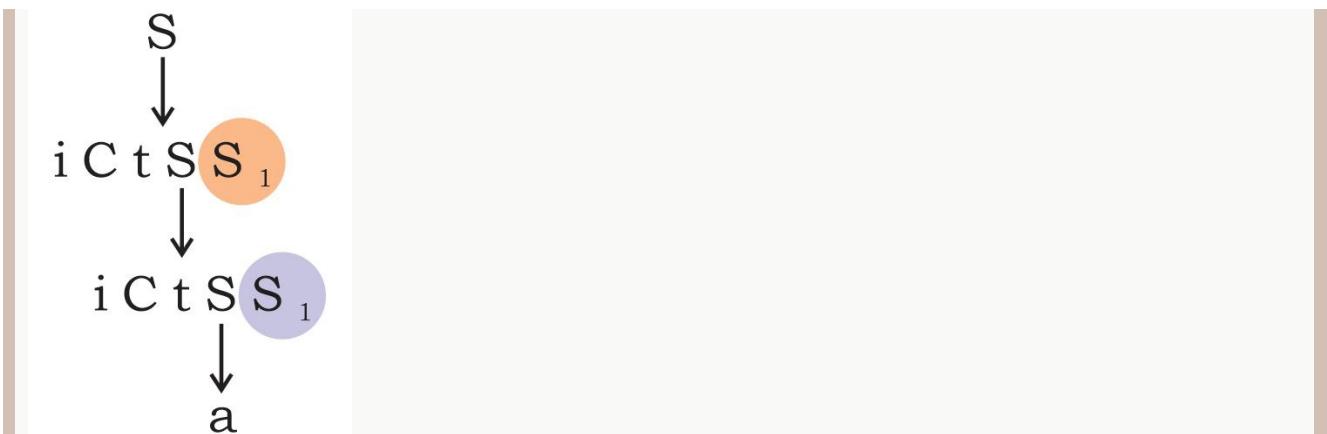
-- sonam vyas (8.1k points)

3.5.25 Grammar: GATE2007_52 [top](#)

<http://gateoverflow.in/1250>

Selected Answer

here, we can expand any one of S_1 to ϵ and other to ea , but which one will it be need not matter, coz in the end we will still get the same string.



this means that the Grammar is Ambiguous. LL(1) cannot be ambiguous. [Here's a Proof for that.](#)

LL(1) Derivations

Left to Right Scan of input

Leftmost Derivation

(1) look ahead 1 token at each step

Alternative characterization of LL(1) Grammars:

Whenever $A \xrightarrow{} \alpha \mid \beta \in G$

1. $FIRST(\alpha) \cap FIRST(\beta) = \{ \}$, and

2. if $\alpha \xrightarrow{*} \epsilon$ then $FIRST(\beta) \cap FOLLOW(A) = \{ \}$.

Corollary: No Ambiguous Grammar is LL(1).

answer = **option C**

10 votes

-- Amar Vashishth (20.7k points)

3.5.26 Grammar: GATE2007-78 [top](#)

<http://gateoverflow.in/1272>



Selected Answer

$S \rightarrow aB$
 $\rightarrow aaBB$
 $\rightarrow aabB$
 $\rightarrow aabbS$
 $\rightarrow aabbaB$
 $\rightarrow aabbab$

10 votes

-- Arjun Suresh (150k points)

3.5.27 Grammar: GATE2004_88 [top](#)

<http://gateoverflow.in/1082>



Selected Answer

above CFG generate string b, aaa..
 b will eliminate options A and D
 aaa eliminate options B.
 C is answer i.e. number of a = 3k, k = 0,1,2....

7 votes

-- Digvijay (35.8k points)

3.5.28 Grammar: GATE2001-18 [top](#)

<http://gateoverflow.in/759>



Selected Answer

a) $S \rightarrow aS'/bS'$
 $S' \rightarrow aS'/bS'/e$
 $b) S \rightarrow aSbS \rightarrow abS \rightarrow abaSbS \rightarrow ababS \rightarrow abab$
 $S \rightarrow aSbS \rightarrow abSaSbS \rightarrow abaSbS \rightarrow ababS \rightarrow abab$
Two derivation so it is ambiguous

8 votes

-- Pooja (25.9k points)

3.5.29 Grammar: GATE2004_8 top<http://gateoverflow.in/1005>

Selected Answer

answer is B .because operator grammar does not contain 1) nullable variable 2) 2 adjacent non-terminal on rhs of production

9 votes

-- koushiksngngh264 (223 points)

3.5.30 Grammar: GATE2006-32, ISRO2016-35 top<http://gateoverflow.in/995>

Selected Answer

I. True. G is ambiguous. E.g. the string ab has multiple derivation trees like $S \rightarrow SS \rightarrow abS \rightarrow ab$, and $S \rightarrow ab$.

II. False. G does not produce all strings with equal no. of a 's and b 's. ($aabb$ cannot be generated).

III. True. The given grammar G generates the language $(ab + ba)^*$, which is Regular and therefore also DCFL. So, a D-PDA can be designed for G .

Hence, the answer is option B.

26 votes

-- Pooja (25.9k points)

3.5.31 Grammar: GATE2005_59 top<http://gateoverflow.in/1382>

Selected Answer

$n+n^*n$
 $E+n^*n$
 E^*n
 E
string in red indicates handle here
so ans is d

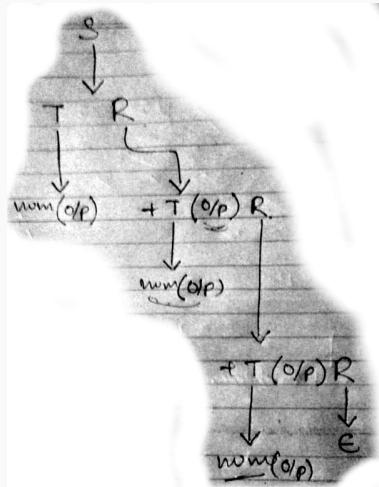
8 votes

-- Pooja (25.9k points)

3.5.32 Grammar: GATE2003_58 [top](#)<http://gateoverflow.in/946>

Selected Answer

answer = option B
 $9 \cdot 5 + 2 +$



11 votes

-- Amar Vashishth (20.7k points)

3.5.33 Grammar: GATE1991-10a [top](#)<http://gateoverflow.in/537>

It is unambiguous grammar and the precedence of / is higher than -.

0 votes

-- shashi shekhar (387 points)

3.5.34 Grammar: GATE2003_56 [top](#)<http://gateoverflow.in/944>

Selected Answer

First (S)={i,a}

First(S')={e, episilon}

First(E)={b}

Follow(S')={e,\$}

Only when first contains episilon we need to consider follow

M[S',e]={S'->eS(first),S'->episilon(considering follow)}

M[S',\$]={S->episilon}

| | a | i | b | e | t | \$ |
|----|------|-----------|---|------------------------|---|--------------|
| S | S->a | S->iεtSS' | | | | |
| S' | | | | S'->eS S'->episilon | | S'->episilon |

| | | | | | | |
|---|--|--|------|--|--|--|
| E | | | E->b | | | |
|---|--|--|------|--|--|--|

answer is d

13 votes

-- Pooja (25.9k points)

3.5.35 Grammar: GATE2000-2.21, ISRO2015-24 [top](#)

<http://gateoverflow.in/668>



Selected Answer

I guess its B.

Operator which is at lower level in the grammar is termed to have higher precedence.

13 votes

-- Gate Keeda (17.7k points)

3.5.36 Grammar: GATE2001-1.18 [top](#)

<http://gateoverflow.in/711>



Selected Answer

(A) is the answer.

(A) We can not have different Left Most Derivation and Right Most Derivation parse trees BUT we can certainly have different LMD and RMD for a given string.(LMD and RMD here refers to the order of various productions used for derivation which could be different.)

(D) is wrong w.r.t. question because IT IS TRUE that any LR(k) IS NEVER AMBIGUOUS and so an ambiguous can never be an LR(K) for any k, no matter how large k becomes.

(B) and (C) can not be the answer because LL(1) is TOP-DOWN parser and LALR is powerful than SLR. So both are TRUE.

12 votes

-- Sandeep_Uniyal (5.5k points)

3.5.37 Grammar: GATE2007-53 [top](#)

<http://gateoverflow.in/1251>



Selected Answer

P:- This is false.

Every regular language is LL(1) meaning we have a LL(1) grammar for it. But we can not say same about every Regular Grammar. For example, every regular language can be represented by Left & Right Linear Grammar, where Left Linear Grammar is not LL(1), Right linear is.

Example aa* we can represent this as S->Sa|a which is not LL(1) ,but S->a|aS is LL(1).

Q:- This is true because of every LL(1) is LR(1).

All regular sets have Right recursive grammar, which is LL(1) & Every LL(1) is LR(1).

We can also say that LR(1) accepts DCFL & Regular languages are subset of DCFL.

So Answer is C.

17 votes

-- Aakash Kanse (325 points)

3.6

Intermediate Code [top](#)

3.6.1 Intermediate Code: GATE2015-1_8 [top](#)

<http://gateoverflow.in/8096>

For computer based on three-address instruction formats, each address field can be used to specify which of the following:

- (S1) A memory operand
 - (S2) A processor register
 - (S3) An implied accumulator register
- A. Either S1 or S2
 - B. Either S2 or S3
 - C. Only S2 and S3
 - D. All of S1, S2 and S3

[gate2015-1](#) | [compiler-design](#) | [intermediate-code](#) | [normal](#)

[Answer](#)

3.6.2 Intermediate Code: GATE1994_1.12 [top](#)

<http://gateoverflow.in/2453>

Generation of intermediate code based on an abstract machine model is useful in compilers because

- A. it makes implementation of lexical analysis and syntax analysis easier
- B. syntax-directed translations can be written for intermediate code generation
- C. it enhances the portability of the front end of the compiler
- D. it is not possible to generate code for real machines directly from high level language programs

[gate1994](#) | [compiler-design](#) | [intermediate-code](#) | [easy](#)

[Answer](#)

3.6.3 Intermediate Code: GATE2015-2_29 [top](#)

<http://gateoverflow.in/8139>

Consider the intermediate code given below.

```
(1) i=1
(2) j=1
(3) t1 = 5 * i
(4) t2 = t1 + j
(5) t3 = 4 * t2
(6) t4 = t3
(7) a[t4] = -1
(8) j = j + 1
(9) if j <= 5 goto (3)
(10) i = i + 1
(11) if i < 5 goto (2)
```

The number of nodes and edges in control-flow-graph constructed for the above code, respectively, are

- A. 5 and 7
- B. 6 and 7
- C. 5 and 5
- D. 7 and 8

[gate2015-2](#) | [compiler-design](#) | [intermediate-code](#) | [normal](#)

[Answer](#)

3.6.4 Intermediate Code: GATE2015-1_55 [top](#)

<http://gateoverflow.in/8365>

The least number of temporary variables required to create a three-address code in static single assignment form for the expression $q + r / 3 + s - t * 5 + u * v/w$ is _____.

[gate2015-1](#) | [compiler-design](#) | [intermediate-code](#) | [normal](#)

[Answer](#)

3.6.5 Intermediate Code: GATE2014-3_17 [top](#)

<http://gateoverflow.in/2051>

One of the purposes of using intermediate code in compilers is to

- make parsing and semantic analysis simpler.
- improve error recovery and error reporting.
- increase the chances of reusing the machine-independent code optimizer in other compilers.
- improve the register allocation.

[gate2014-3](#) [compiler-design](#) [intermediate-code](#) [easy](#)

[Answer](#)

3.6.6 Intermediate Code: GATE2014-2_34 [top](#)

<http://gateoverflow.in/1993>

For a C program accessing **X[i] [j] [k]**, the following intermediate code is generated by a compiler. Assume that the size of an **integer** is 32 bits and the size of a **character** is 8 bits.

```
t0 = i * 1024
t1 = j * 32
t2 = k * 4
t3 = t1 + t0
t4 = t3 + t2
t5 = X[t4]
```

Which one of the following statements about the source code for the C program is CORRECT?

- X** is declared as "**int X[32] [32] [8]**".
- X** is declared as "**int X[4] [1024] [32]**".
- X** is declared as "**char X[4] [32] [8]**".
- X** is declared as "**char X[32] [16] [2]**".

[gate2014-2](#) [compiler-design](#) [intermediate-code](#) [programming-in-c](#) [normal](#)

[Answer](#)

3.6.7 Intermediate Code: GATE1992-11a [top](#)

<http://gateoverflow.in/590>

Write syntax directed definitions (semantic rules) for the following grammar to add the type of each identifier to its entry in the symbol table during semantic analysis. Rewriting the grammar is not permitted and semantic rules are to be added to the ends of productions only.

$$\begin{aligned} D &\rightarrow TL; \\ T &\rightarrow \text{int} \\ T &\rightarrow \text{real} \\ L &\rightarrow L, id \\ L &\rightarrow id \end{aligned}$$

[gate1992](#) [compiler-design](#) [syntax-directed-translation](#) [intermediate-code](#) [normal](#)

[Answer](#)

3.6.8 Intermediate Code: GATE1992-11b [top](#)

<http://gateoverflow.in/43583>

Write 3 address intermediate code (quadruples) for the following boolean expression in the sequence as it would be generated by a compiler. Partial evaluation of boolean expressions is not permitted. Assume the usual rules of precedence of the operators.

$$(a + b) > (c + d) \text{ or } a > c \text{ and } b < d$$

[gate1992](#) [compiler-design](#) [syntax-directed-translation](#) [intermediate-code](#) [descriptive](#)[Answer](#)

Answers: Intermediate Code

3.6.1 Intermediate Code: GATE2015-1_8 [top](#)

<http://gateoverflow.in/8096>

Selected Answer

Three address Instruction

Computer with three addresses instruction format can use each address field to specify either processor register or memory operand.

ADD R1, A, B A1 \oplus M [A] + M [B]
ADD R2, C, D R2 \oplus M [C] + M [B] X = (A + B) * (C + A)
MUL X, R1, R2 M [X] R1 * R2

The advantage of the three address formats is that it results in short program when evaluating arithmetic expression. The disadvantage is that the binary-coded instructions require too many bits to specify three addresses.

- See http://www.laureateiit.com/projects/baci2014/projects/coa_anil/instruction_formate.html#sthash.7y6Hcwvd.dpuf more at:

[12 votes](#)

-- Prasanna Ranganathan (2.5k points)

3.6.2 Intermediate Code: GATE1994_1.12 [top](#)

<http://gateoverflow.in/2453>

Selected Answer

C. stating the actual use of the Intermediate Code.

Also optimizations can be done on intermediate code enhancing the portability of the optimizer.

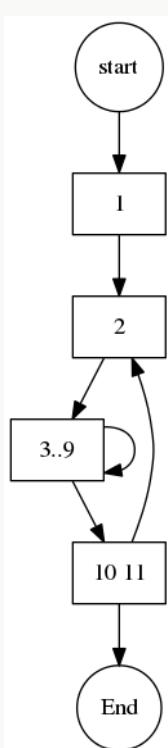
[11 votes](#)

-- Gate Keeda (17.7k points)

3.6.3 Intermediate Code: GATE2015-2_29 [top](#)

<http://gateoverflow.in/8139>

Selected Answer



Answer is 6,7 if we add an explicit start and end nodes. This follows from the definition of CFG in the below IITM link

<http://www.cse.iitm.ac.in/~krishna/cs3300/pm-lecture1.pdf>

But many of the standard books/universities don't follow this definition.

12 votes

-- Arjun Suresh (150k points)

3.6.4 Intermediate Code: GATE2015-1_55 top

<http://gateoverflow.in/8365>



Selected Answer

Answer is 8.

In **compiler** design, **static single assignment form** (often abbreviated as **SSA form** or simply **SSA**) is a property of an **intermediate representation (IR)**, which requires that each variable is assigned exactly once, and every variable is defined before it is used. Existing variables in the original IR are split into **versions**, new variables.

We will need a temporary variable for storing the result of each binary operation **as SSA (Static Single Assignment) implies the variable cannot be repeated on LHS of assignment.**

$q + r / 3 + s - t * 5 + u * v/w$

```
t1 = r/3;
t2 = t*5;
t3 = u*v;
t4 = t3/w;
t5 = q + t1;
t6 = t5 + s;
t7 = t6 - t2;
t8 = t7 + t4
```

<http://web.stanford.edu/class/archive/cs/cs143/cs143.1128/handouts/240%20TAC%20Examples.pdf>

21 votes

-- Arjun Suresh (150k points)

3.6.5 Intermediate Code: GATE2014-3_17 [top](#)<http://gateoverflow.in/2051>

Selected Answer

C.

that is the actual use of intermediate code generator in a compiler.

12 votes

-- Gate Keeda (17.7k points)

3.6.6 Intermediate Code: GATE2014-2_34 [top](#)<http://gateoverflow.in/1993>

Selected Answer

k is multiplied by 4, means sizeof(datatype) is int.

j is multiplied by 32, means the inner most dimension of array is $32/4 = 8$ (we have to divide by the size of the inner dimension- which here is a simple integer)

i is multiplied by 1024, means the second dimension of array is $1024/32 = 32$ ($32 = 8*4$ is the size of the inner dimension here)

So, (A) is correct. The first dimension is not needed for code generation and that is why in C language while passing an array to a function, we can omit the value of the first dimension but not any others.

We can also do as follows:

$X[i][j][k] = *(*(*X + i) + j) + k$

In Integer arithmetic, this equals

$*(*(*X + i * sizeof(*X)) + j * sizeof(**X)) + k * sizeof(***)$

as for every add to a pointer we have to multiply the size of the pointed value (to get a valid address)

So, from the given code we get

$\text{sizeof}(***) = 4, - \text{int}$

$\text{sizeof}(**X) = 32 - \text{int array of size 8}$

$\text{sizeof}(*X) = 1024 - 2 \text{ D int array of size [32] havinf size of inner 1D array 32.}$

So, the inner dimensions must be 32 and 8 and type must be integer. So, only option A matches.

14 votes

-- Arjun Suresh (150k points)

3.6.7 Intermediate Code: GATE1992-11a [top](#)<http://gateoverflow.in/590>

PRODUCTION RULE

SEMANTIC ACTIONS

D->TL

L.in:=T.type

T->int

T.type:=integer

T->real

T.type:=real

L->L,id

L1.in=L.in

Enter_type(id.entry, L.in)

L->id

Enter_type(id.entry, L.in)

2 votes

-- Anupoju Satish Kumar (229 points)

quadruples consists of the 4-section they are operator, operand1, operand2, result

| | | | |
|----------|----------|----------|--------|
| operator | operand1 | operand2 | result |
|----------|----------|----------|--------|

| | | | |
|-----|----|----|----|
| + | a | b | t1 |
| + | c | d | t2 |
| > | t1 | t2 | t3 |
| > | a | c | t4 |
| < | b | d | t5 |
| and | t4 | t5 | t6 |
| or | t3 | t6 | t7 |

2 votes

-- Anupoju Satish Kumar (229 points)

3.6.8 Intermediate Code: GATE1992-11b [top](#)

<http://gateoverflow.in/43583>

Each instruction in quadruples presentation is divided into four fields: operator, arg1, arg2, and result. The above example is represented below in quadruples format:

(a+b)>(c+d)OR a>c AND b<d

(t1>t2)OR a>c AND b<d

t3 OR t4 AND t5

t3 OR t6

t1= a+b

t2= c+d

t3= t1>t2

t4= a>c

t5= b<d

t6= t4 AND t5

t7 =t3 OR t6

| Op | arg1 | arg2 | Result |
|-----|------|------|--------|
| + | a | b | t1 |
| + | c | d | t2 |
| > | t1 | t2 | t3 |
| .> | a | c | t4 |
| < | b | d | t5 |
| AND | t4 | t5 | t6 |
| OR | t3 | t6 | t7 |

7 votes

-- shekhar chauhan (36.4k points)

3.7

Lexical Analysis [top](#)

3.7.1 Lexical Analysis: GATE2000-1.18, ISRO2015-25 [top](#)

<http://gateoverflow.in/641>

The number of tokens in the following C statement is

```
printf("i=%d, &i=%x", i, &i);
```

- A. 3
- B. 26
- C. 10
- D. 21

gate2000 | compiler-design | lexical-analysis | easy | isro2015

Answer

3.7.2 Lexical Analysis: GATE2011_1 [top](#)

<http://gateoverflow.in/2103>

In a compiler, keywords of a language are recognized during

- (A) parsing of the program
- (B) the code generation
- (C) the lexical analysis of the program
- (D) dataflow analysis

gate2011 | compiler-design | lexical-analysis | easy

Answer

3.7.3 Lexical Analysis: GATE2011_19 [top](#)

<http://gateoverflow.in/2121>

The lexical analysis for a modern computer language such as Java needs the power of which one of the following machine models in a necessary and sufficient sense?

- (A) Finite state automata
- (B) Deterministic pushdown automata
- (C) Non-deterministic pushdown automata
- (D) Turing machine

gate2011 | compiler-design | lexical-analysis | easy

Answer

3.7.4 Lexical Analysis: GATE2010-13 [top](#)

<http://gateoverflow.in/2186>

Which data structure in a compiler is used for managing information about variables and their attributes?

- A. Abstract syntax tree
- B. Symbol table
- C. Semantic stack
- D. Parse table

gate2010 | compiler-design | lexical-analysis | easy

Answer

Answers: Lexical Analysis

3.7.1 Lexical Analysis: GATE2000-1.18, ISRO2015-25 [top](#)

<http://gateoverflow.in/641>



Selected Answer

answer - C

Tokens are:

1. printf
2. (
3. "i=%d, &i=%x"
4. ,
5. i
6. ,
7. &
8. i
9.)
10. ;

13 votes

-- ankitrokdeonsns (8.4k points)

3.7.2 Lexical Analysis: GATE2011_1 [top](#)

<http://gateoverflow.in/2103>



Selected Answer

Typically, the lexical analysis phase of compilation breaks the input text up into sequences of lexemes that each belongs to some particular token type that's useful in later analysis. Consequently, keywords are usually first recognized during lexical analysis in order to make parsing easier. Since parsers tend to be implemented by writing context-free grammars of tokens rather than of lexemes (that is, the *category* of the lexeme rather than the *contents* of the lexeme), it is significantly easier to build a parser when keywords are marked during lexing. Any identifier is also a token so it is recognized in lexical Analysis . Hence option C is True.

ref@ <http://stackoverflow.com/questions/5202709/phases-of-a-compiler>

8 votes

-- Mithlesh Upadhyay (3.6k points)

3.7.3 Lexical Analysis: GATE2011_19 [top](#)

<http://gateoverflow.in/2121>

answer - A

lexical analysis can be done via a simple DFA

7 votes

-- ankitrokdeonsns (8.4k points)

3.7.4 Lexical Analysis: GATE2010-13 [top](#)

<http://gateoverflow.in/2186>



Selected Answer

Symbol table is answer . It can be implemented by using array , hash table , tree and eve some time with the help of linked list !

5 votes

-- Dexter (5k points)

3.8

Linking [top](#)

3.8.1 Linking: GATE2003_76 [top](#)

<http://gateoverflow.in/962>

Which of the following is NOT an advantage of using shared, dynamically linked libraries as opposed to using statically linked libraries?

- A. Smaller sizes of executable files
- B. Lesser overall page fault rate in the system

- C. Faster program startup
 D. Existing programs need not be re-linked to take advantage of newer versions of libraries

gate2003 | compiler-design | runtime-environments | linking | easy

[Answer](#)

Answers: Linking

3.8.1 Linking: GATE2003_76 [top](#)

<http://gateoverflow.in/962>



Selected Answer

option c) DLL takes more time in program setup (in loading and linking phase to set up the global offset table and load and link the required libraries)

Since DLLs are separated from executable, the size of executable becomes smaller.

Since DLLs are shared among multiple executables, the total memory usage of the system goes down and hence overall page fault rate decreases.

Dynamic linking takes place during program runtime. So, if a DLL is replaced to a new version, it will automatically get linked during runtime. There is no explicit relinking required as in the case of static linking. (This works by linking the DLL calls to Global Offset Table and the contents of this table is filled during program run. A simple jump in static linking becomes an indirect jump in dynamic linking).

18 votes

-- GateMaster Prime (1.3k points)

3.9

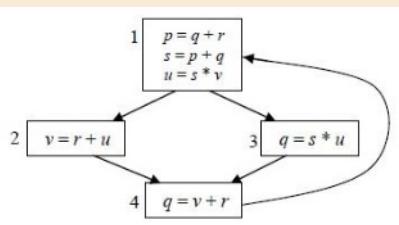
Live Variable [top](#)

3.9.1 Live Variable: GATE2015-1_50 [top](#)

<http://gateoverflow.in/8356>

A variable x is said to be live at a statement s_i in a program if the following three conditions hold simultaneously:

- There exists a statement S_j that uses x
- There is a path from S_i to S_j in the flow graph corresponding to the program
- The path has no intervening assignment to x including at S_i and S_j



The variables which are live both at the statement in basic block 2 and at the statement in basic block 3 of the above control flow graph are

- A. p, s, u
 B. r, s, u
 C. r, u
 D. q, v

gate2015-1 | compiler-design | live-variable | normal

[Answer](#)

Answers: Live Variable

3.9.1 Live Variable: GATE2015-1_50 [top](#)<http://gateoverflow.in/8356>

Selected Answer

r, u.

p, and s are assigned to in 1 and there is no intermediate use of them before that. Hence p, and s are not live in both 2 and 3.

q is assigned to in 4 and hence is not live in both 2 and 3.

v is live at 3 but not at 2.

u is live at 3 and also at 2 if we consider a path of length 0 from 2 - 2.

So, r, u is the answer.

5 votes

-- Arjun Suresh (150k points)

3.10**Macros** [top](#)**3.10.1 Macros: GATE1996_2.16** [top](#)<http://gateoverflow.in/2745>

Which of the following macros can put a macro assembler into an infinite loop?

(i)

```
i. .MACRO M1, X
    .IF EQ, X ;if X=0 then
    M1 X + 1
    .ENDC
    .IF NE, X ;if X ≠ 0 then
    .WORD X ;address (X) is stored here
    .ENDC
    .ENDM
```

(ii)

```
ii. .MACRO M2, X
    .IF EQ, X
    M2 X
    .ENDC
    .IF NE, X
    .WORD X + 1
    .ENDC
    .ENDM
```

- A. (ii) only
- B. (i) only
- C. both (i) and (ii)
- D. None of the above

[gate1996](#) [compiler-design](#) [macros](#) [normal](#)**Answer****3.10.2 Macros: GATE1997_1.9** [top](#)<http://gateoverflow.in/2225>

The conditional expansion facility of macro processor is provided to

- a. test a condition during the execution of the expanded program
- b. to expand certain model statements depending upon the value of a condition during the execution of the expanded program
- c. to implement recursion
- d. to expand certain model statements depending upon the value of a condition during the process of macro expansion

[gate1997](#) [compiler-design](#) [macros](#) [easy](#)

Answer

3.10.3 Macros: GATE1995_1.11 [top](#)<http://gateoverflow.in/2598>

What are x and y in the following macro definition?

```
macro Add x, y
    Load y
    Mul x
    Store y
end macro
```

- A. Variables
- B. Identifiers
- C. Actual parameters
- D. Formal parameters

[gate1995](#) [compiler-design](#) [macros](#) [easy](#)

Answer

Answers: Macros**3.10.1 Macros: GATE1996_2.16** [top](#)<http://gateoverflow.in/2745>

Selected Answer

if M2 macro is called with $x=0$, then it'll go into an infinite loop.
Hence correct option would be A.

thumb up 1 votes

-- suraj (3.7k points)

3.10.2 Macros: GATE1997_1.9 [top](#)<http://gateoverflow.in/2225>

Selected Answer

Macro is expanded during the process of macro expansion. Hence, correct answer would be (d).

thumb up 5 votes

-- suraj (3.7k points)

3.10.3 Macros: GATE1995_1.11 [top](#)<http://gateoverflow.in/2598>

Selected Answer

ans is D

thumb up 4 votes

-- jayendra (6.6k points)

3.11**Parameter Passing** [top](#)**3.11.1 Parameter Passing: GATE1991_03,x** [top](#)<http://gateoverflow.in/524>

Choose the correct alternatives (more than one may be correct) and write the corresponding letters only:

Indicate all the true statements from the following:

- (a). Recursive descent parsing cannot be used for grammar with left recursion.
- (b). The intermediate form for representing expressions which is best suited for code optimization is the postfix form.
- (c). A programming language not supporting either recursion or pointer type does not need the support of dynamic memory allocation.
- (d). Although C does not support call-by-name parameter passing, the effect can be correctly simulated in C
- (e). No feature of Pascal typing violates strong typing in Pascal.

[gate1991](#) [compiler-design](#) [parameter-passing](#) [programming](#) [difficult](#)

[Answer](#)

3.11.2 Parameter Passing: GATE 2016-1-36 [top](#)

<http://gateoverflow.in/39701>

What will be the output of the following pseudo-code when parameters are passed by reference and dynamic scoping is assumed?

```
a = 3;
void n(x) { x = x * a; print (x); }
void m(y) { a = 1 ; a = y - a; n(a); print (a); }
void main () { m(a); }
```

- A. 6,2
- B. 6,6
- C. 4,2
- D. 4,4

[gate2016-1](#) [parameter-passing](#) [normal](#)

[Answer](#)

Answers: Parameter Passing

3.11.1 Parameter Passing: GATE1991_03,x [top](#)

<http://gateoverflow.in/524>

A for sure, not sure about E

3 votes

-- **Shaun Patel** (5.8k points)

3.11.2 Parameter Passing: GATE 2016-1-36 [top](#)

<http://gateoverflow.in/39701>



Selected Answer

It is a bit confusing as variable declaration is not explicit. But we can see that "a=3" and "a=1" are declaring new variables, one in global and other in local space.

Main is calling m(a). Since there is no local 'a', 'a' here is the global one.

In m, we have "a = 1" which declares a local "a" and gives 1 to it. "a = y-a" assigns 3-1 = 2 to 'a'.

Now, in n(x), 'a' is used and as per dynamic scoping this 'a' comes from 'm()' and not the global one. So, "x=x*a" assigns "2*2 = 4" to "x" and 4 is printed. Being passed by reference, "a" in m() also get updated to 4. So, D is the answer here.

20 votes

-- **Arjun Suresh** (150k points)

3.12

Parsing [top](#)

3.12.1 Parsing: GATE2012-53 [top](#)

<http://gateoverflow.in/43312>

For the grammar below, a partial $LL(1)$ parsing table is also presented along with the grammar. Entries that need to be filled are indicated as **E1**, **E2**, and **E3**. ϵ is the empty string, \$ indicates end of input, and, | separates alternate right hand sides of productions.

$$S \rightarrow aAbB \mid bAaB \mid \epsilon$$

$$A \rightarrow S$$

$$B \rightarrow S$$

| | a | b | \$ |
|---|-------------------|-------------------|--------------------------|
| S | E1 | E2 | $S \rightarrow \epsilon$ |
| A | $A \rightarrow S$ | $A \rightarrow S$ | error |
| B | $B \rightarrow S$ | $B \rightarrow S$ | E3 |

The appropriate entries for E1, E2, and E3 are

(A)

$$E1 : S \rightarrow aAbB, A \rightarrow S$$

$$E2 : S \rightarrow bAaB, B \rightarrow S$$

$$E1 : B \rightarrow S$$

(B)

$$E1 : S \rightarrow aAbB, S \rightarrow \epsilon$$

$$E2 : S \rightarrow bAaB, S \rightarrow \epsilon$$

$$E3 : S \rightarrow \epsilon$$

(C)

$$E1 : S \rightarrow aAbB, S \rightarrow \epsilon$$

$$E2 : S \rightarrow bAaB, S \rightarrow \epsilon$$

$$E3 : B \rightarrow S$$

(D)

$$E1 : A \rightarrow S, S \rightarrow \epsilon$$

$$E2 : B \rightarrow S, S \rightarrow \epsilon$$

$$E3 : B \rightarrow S$$

[normal](#) [gate2012](#) [compiler-design](#) [parsing](#)

Answer

3.12.2 Parsing: GATE2001-16 [top](#)

<http://gateoverflow.in/757>

Consider the following grammar with terminal alphabet $\Sigma\{a, (,), +, *\}$ and start symbol E . The production rules of the grammar are:

$$E \rightarrow aA$$

$$E \rightarrow (E)$$

$$A \rightarrow +E$$

$$A \rightarrow * E$$

$$A \rightarrow \epsilon$$

- a. Compute the FIRST and FOLLOW sets for E and A .
- b. Complete the LL(1) parse table for the grammar.

[gate2001](#) [compiler-design](#) [parsing](#) [normal](#)

[Answer](#)

3.12.3 Parsing: GATE2008-55 [top](#)

<http://gateoverflow.in/478>

An LALR(1) parser for a grammar G can have shift-reduce (S-R) conflicts if and only if

- A. The SLR(1) parser for G has S-R conflicts
- B. The LR(1) parser for G has S-R conflicts
- C. The LR(0) parser for G has S-R conflicts
- D. The LALR(1) parser for G has reduce-reduce conflicts

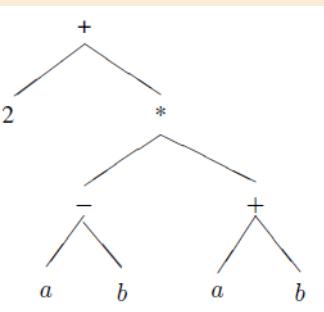
[gate2008](#) [compiler-design](#) [parsing](#) [normal](#)

[Answer](#)

3.12.4 Parsing: TIFR2012-B-8 [top](#)

<http://gateoverflow.in/25108>

Consider the parse tree



Assume that $*$ has higher precedence than $+$, $-$ and operators associate right to left (i.e $(a + b + c = (a + (b + c)))$). Consider

- (i) $2 + a - b$
- (ii) $2 + a - b * a + b$
- (iii) $2 + ((a - b) * (a + b))$
- (iv) $2 + (a - b) * (a + b)$

The parse tree corresponds to

- a. Expression (i)
- b. Expression (ii)
- c. Expression (iv) only
- d. Expression (ii), (iii), and (iv), and (iv)
- e. Expression (iii) and (iv) only

[tifr2012](#)
[compiler-design](#)
[parsing](#)
Answer

3.12.5 Parsing: GATE2008-IT_79 [top](#)

<http://gateoverflow.in/3393>

A CFG G is given with the following productions where S is the start symbol, A is a non-terminal and a and b are terminals.

$$S \rightarrow aS \mid AA \rightarrow aAb \mid bAa \mid \epsilon$$

For the correct answer in above Question http://gateoverflow.in/3392/gate2008-it_78, how many steps are required to derive the string and how many parse trees are there?

- A) 6 and 1
- B) 6 and 2
- C) 7 and 2
- D) 4 and 2

[gate2008-it](#)
[compiler-design](#)
[context-free](#)
[parsing](#)
[normal](#)
Answer

3.12.6 Parsing: GATE2015-3_16 [top](#)

<http://gateoverflow.in/8413>

Among simple LR (SLR), canonical LR, and look-ahead LR (LALR), which of the following pairs identify the method that is very easy to implement and the method that is the most powerful, in that order?

- A. SLR, LALR
- B. Canonical LR, LALR
- C. SLR, canonical LR
- D. LALR, canonical LR

[gate2015-3](#)
[compiler-design](#)
[parsing](#)
[normal](#)
Answer

3.12.7 Parsing: GATE2015-1_13 [top](#)

<http://gateoverflow.in/8187>

Which one of the following is TRUE at any valid state in shift-reduce parsing?

- A. Viable prefixes appear only at the bottom of the stack and not inside
- B. Viable prefixes appear only at the top of the stack and not inside
- C. The stack contains only a set of viable prefixes
- D. The stack never contains viable prefixes

[gate2015-1](#)
[compiler-design](#)
[parsing](#)
[normal](#)
Answer

3.12.8 Parsing: GATE2005-IT_83a [top](#)

<http://gateoverflow.in/3849>

Consider the context-free grammar

$$\begin{aligned} E &\rightarrow E + E \\ E &\rightarrow (E * E) \\ E &\rightarrow id \end{aligned}$$

where E is the starting symbol, the set of terminals is {id, (+, *, *)}, and the set of nonterminals is {E}. Which of the following terminal strings has more than one parse tree when parsed according to the above grammar?

- A) $\text{id} + \text{id} + \text{id} + \text{id}$
 B) $\text{id} + (\text{id}^* (\text{id} * \text{id}))$
 C) $(\text{id}^* (\text{id} * \text{id})) + \text{id}$
 D) $((\text{id} * \text{id} + \text{id}) * \text{id})$

gate2005-it | compiler-design | grammar | parsing | easy

Answer

3.12.9 Parsing: GATE1992_02,xiv [top](#)

<http://gateoverflow.in/571>

Choose the correct alternatives (more than one may be correct) and write the corresponding letters only:

Consider the $SLR(1)$ and $LALR(1)$ parsing tables for a context free grammar. Which of the following statement is/are true?

- (a). The *goto* part of both tables may be different.
- (b). The *shift* entries are identical in both the tables.
- (c). The *reduce* entries in the tables may be different.
- (d). The *error* entries in tables may be different

gate1992 | compiler-design | normal | parsing

Answer

3.12.10 Parsing: GATE2000-1.19, UGCNET-Dec2013-II-30 [top](#)

<http://gateoverflow.in/642>

Which of the following derivations does a top-down parser use while parsing an input string? The input is assumed to be scanned in left to right order.

- A. Leftmost derivation
- B. Leftmost derivation traced out in reverse
- C. Rightmost derivation
- D. Rightmost derivation traced out in reverse

gate2000 | compiler-design | parsing | normal | ugcnetdec2013ii

Answer

3.12.11 Parsing: GATE 2016-1-45 [top](#)

<http://gateoverflow.in/39697>

The attribute of three arithmetic operators in some programming language are given below.

| OPERATOR | PRECEDENCE | ASSOCIATIVITY | ARITY |
|----------|------------|---------------|--------|
| + | high | Left | Binary |
| - | Medium | Right | Binary |
| * | Low | Left | Binary |

The value of the expression $2 - 5 + 1 - 7 * 3$ in this language is _____.

gate2016-1 | compiler-design | parsing | normal | numerical-answers

Answer

3.12.12 Parsing: TIFR2012-B-17 [top](#)

<http://gateoverflow.in/25215>

Which of the following correctly describes $LR(k)$ parsing?

- The input string is alternately scanned left to right and right to left with k reversals.
- Input string is scanned once left to right with rightmost derivation and k symbol look-ahead.
- $LR(k)$ grammars are expressively as powerful as context-free grammars.
- Parser makes k left-to-right passes over input string.
- Input string is scanned from left to right once with k symbol to the right as look-ahead to give left-most derivation.

tiffr2012 | compiler-design | parsing

Answer

3.12.13 Parsing: GATE2015-3_31 [top](#)

<http://gateoverflow.in/8488>

Consider the following grammar G

$$S \rightarrow F \mid H$$

$$F \rightarrow p \mid c$$

$$H \rightarrow d \mid c$$

Where S , F , and H are non-terminal symbols, p , d , and c are terminal symbols. Which of the following statement(s) is/are correct?

S1: LL(1) can parse all strings that are generated using grammar G

S2: LR(1) can parse all strings that are generated using grammar G

- Only S1
- Only S2
- Both S1 and S2
- Neither S1 and S2

gate2015-3 | compiler-design | parsing | normal

Answer

3.12.14 Parsing: TIFR2015-B-15 [top](#)

<http://gateoverflow.in/30079>

Consider the following grammar (the start symbol is E) for generating expressions.

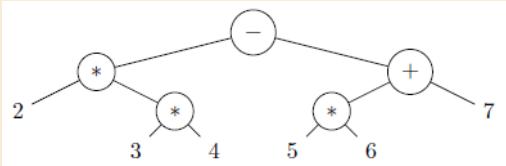
$$E \rightarrow T - E \mid T + E \mid T$$

$$T \rightarrow T * F \mid F$$

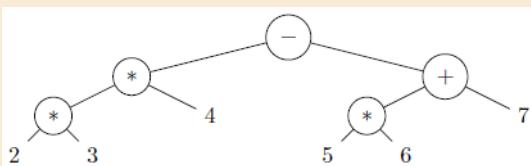
$$F \rightarrow 0 \mid 1 \mid 2 \mid 3 \mid 4 \mid 5 \mid 6 \mid 7 \mid 8 \mid 9$$

With respect to this grammar, which of the following trees is the valid evaluation tree for the expression $2 * 3 * 4 - 5 * 6 + 7$?

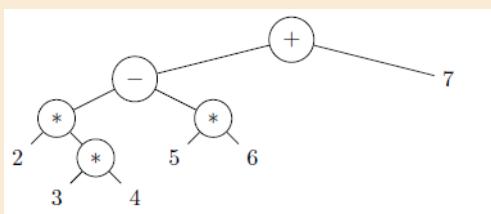
(a)



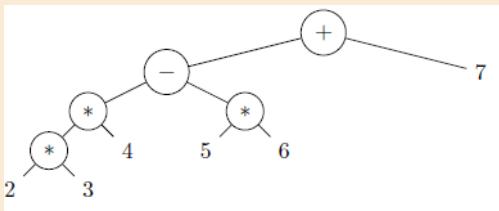
(b)



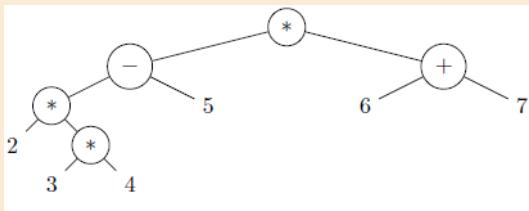
(c)



(d)



(e)



tifr2015 parsing

Answer

3.12.15 Parsing: GATE1992_02,xiii<http://gateoverflow.in/570>

Choose the correct alternatives (more than one may be correct) and write the corresponding letters only:

For a context free grammar, FOLLOW(A) is the set of terminals that can appear immediately to the right of non-terminal A in some "sentential" form. We define two sets LFOLLOW(A) and RFOLLOW(A) by replacing the word "sentential" by "left sentential" and "right most sentential" respectively in the definition of FOLLOW (A).

- (a). FOLLOW(A) and LFOLLOW(A) may be different.
- (b). FOLLOW(A) and RFOLLOW(A) are always the same.
- (c). All the three sets are identical.
- (d). All the three sets are different.

gate1992 parsing compiler-design normal

Answer

3.12.16 Parsing: GATE2005-IT_83b<http://gateoverflow.in/3850>

Consider the context-free grammar

$$\begin{aligned} E &\rightarrow E + E \\ E &\rightarrow (E * E) \\ E &\rightarrow id \end{aligned}$$

where E is the starting symbol, the set of terminals is {id, (+, *, id)}, and the set of non-terminals is {E}.

For the terminal string id + id + id + id, how many parse trees are possible?

A)

5

| | |
|----|---|
| B) | 4 |
| C) | 3 |
| D) | 2 |

gate2005-it | compiler-design | parsing | normal

Answer

3.12.17 Parsing: GATE2013_9 top

<http://gateoverflow.in/1418>

What is the maximum number of reduce moves that can be taken by a bottom-up parser for a grammar with no epsilon and unit-production (i.e., of type $A \rightarrow \epsilon$ and $A \rightarrow a$) to parse a string with n tokens?

- (A) $n/2$
- (B) $n - 1$
- (C) $2n - 1$
- (D) 2^n

gate2013 | compiler-design | parsing | normal

Answer

3.12.18 Parsing: GATE2003-16 top

<http://gateoverflow.in/906>

Which of the following suffices to convert an arbitrary CFG to an LL(1) grammar?

- A. Removing left recursion alone
- B. Factoring the grammar alone
- C. Removing left recursion and factoring the grammar
- D. None of the above

gate2003 | compiler-design | parsing | easy

Answer

3.12.19 Parsing: GATE2007-18 top

<http://gateoverflow.in/1216>

Which one of the following is a top-down parser?

- A. Recursive descent parser.
- B. Operator precedence parser.
- C. An LR(k) parser.
- D. An LALR(k) parser.

gate2007 | compiler-design | parsing | normal

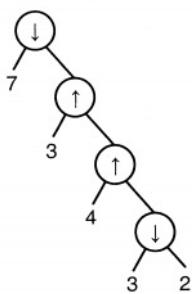
Answer

3.12.20 Parsing: GATE2011_27 top

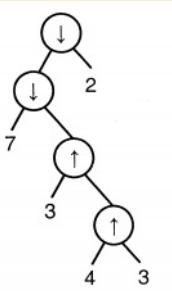
<http://gateoverflow.in/2129>

Consider two binary operators ' \uparrow ' and ' \downarrow ' with the precedence of operator \downarrow being lower than that of the operator \uparrow . Operator \uparrow is right associative while operator \downarrow is left associative. Which one of the following represents the parse tree for expression $(7 \downarrow 3 \uparrow 4 \uparrow 3 \downarrow 2)$

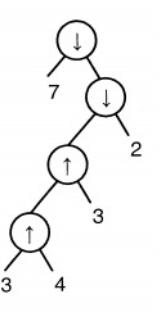
- (A)



(B)



(C)



(D)

[gate2011](#) [compiler-design](#) [parsing](#) [normal](#)
Answer**3.12.21 Parsing: GATE2009-42** top<http://gateoverflow.in/1328>

Which of the following statements are TRUE?

- There exist parsing algorithms for some programming languages whose complexities are less than $\Theta(n^3)$
- A programming language which allows recursion can be implemented with static storage allocation.
- No L-attributed definition can be evaluated in the framework of bottom-up parsing.

IV. Code improving transformations can be performed at both source language and intermediate code level.

- A. I and II
- B. I and IV
- C. III and IV
- D. I, III and IV

[gate2009](#) [compiler-design](#) [parsing](#) [normal](#)

[Answer](#)

3.12.22 Parsing: GATE2012-52 [top](#)

<http://gateoverflow.in/2181>

For the grammar below, a partial

$LL(1)$ parsing table is also presented along with the grammar. Entries that need to be filled are indicated as **E1**, **E2**, and **E3**.

ϵ is the empty string, \$ indicates end of input, and,
| separates alternate right hand sides of productions.

$$S \rightarrow aAbB \mid bAaB \mid \epsilon$$

$$A \rightarrow S$$

$$B \rightarrow S$$

| | a | b | \$ |
|---|-------------------|-------------------|--------------------------|
| S | E1 | E2 | $S \rightarrow \epsilon$ |
| A | $A \rightarrow S$ | $A \rightarrow S$ | error |
| B | $B \rightarrow S$ | $B \rightarrow S$ | E3 |

The FIRST and FOLLOW sets for the non-terminals A and B are

(A)

$$\text{FIRST}(A) = \{a, b, \epsilon\} = \text{FIRST}(B)$$

$$\text{FOLLOW}(A) = \{a, b\}$$

$$\text{FOLLOW}(B) = \{a, b, \$\}$$

(B)

$$\text{FIRST}(A) = \{a, b, \$\}$$

$$\text{FIRST}(B) = \{a, b, \epsilon\}$$

$$\text{FOLLOW}(A) = \{a, b\}$$

$$\text{FOLLOW}(B) = \{\$\}$$

(C)

$$\text{FIRST}(A) = \{a, b, \epsilon\} = \text{FIRST}(B)$$

$$\text{FOLLOW}(A) = \{a, b\}$$

$\text{FOLLOW}(B) = \emptyset$

(D)

$\text{FIRST}(A) = \{a, b\} = \text{FIRST}(B)$

$\text{FOLLOW}(A) = \{a, b\}$

$\text{FOLLOW}(B) = \{a, b\}$

gate2012 | compiler-design | parsing | normal

Answer

3.12.23 Parsing: GATE2006_58 [top](#)

<http://gateoverflow.in/1836>

Consider the following grammar:

$S \rightarrow FR$

$R \rightarrow *S \mid \epsilon$

$F \rightarrow id$

In the predictive parser table, M, of the grammar the entries M[S,id] and M[R,\$] respectively are

- (A) $\{S \rightarrow FR\}$ and $\{R \rightarrow \epsilon\}$
- (B) $\{S \rightarrow FR\}$ and $\{\}$
- (C) $\{S \rightarrow FR\}$ and $\{R \rightarrow *S\}$
- (D) $\{F \rightarrow id\}$ and $\{R \rightarrow \epsilon\}$

gate2006 | compiler-design | parsing | normal

Answer

3.12.24 Parsing: GATE2014-1_34 [top](#)

<http://gateoverflow.in/1807>

A canonical set of items is given below

$S \rightarrow L. > R$

$Q \rightarrow R.$

On input symbol < the set has

- (A) a shift-reduce conflict and a reduce-reduce conflict.
- (B) a shift-reduce conflict but not a reduce-reduce conflict.
- (C) a reduce-reduce conflict but not a shift-reduce conflict.
- (D) neither a shift-reduce nor a reduce-reduce conflict.

gate2014-1 | compiler-design | parsing | normal

Answer

3.12.25 Parsing: GATE2005_14 [top](#)

<http://gateoverflow.in/1350>

The grammar $A \rightarrow AA \mid (A) \mid \epsilon$ is not suitable for predictive-parsing because the grammar is:

- A. ambiguous
- B. left-recursive

- C. right-recursive
D. an operator-grammar

[gate2005](#) [compiler-design](#) [parsing](#) [grammar](#) [easy](#)

[Answer](#)

3.12.26 Parsing: GATE1998_22 [top](#)

<http://gateoverflow.in/1737>

- a. An identifier in a programming language consists of up to six letters and digits of which the first character must be a letter. Derive a regular expression for the identifier.
b. Build an LL(1) parsing table for the language defined by the LL(1) grammar with productions

$\text{Program} \rightarrow \text{begin } d \text{ semi } X \text{ end}$

$X \rightarrow d \text{ semi } X \mid sY$

$Y \rightarrow \text{semi } sY \mid \epsilon$

[gate1998](#) [compiler-design](#) [parsing](#) [descriptive](#)

[Answer](#)

3.12.27 Parsing: GATE2005_60 [top](#)

<http://gateoverflow.in/1383>

Consider the grammar:

$$S \rightarrow (S) \mid a$$

Let the number of states in SLR (1), LR(1) and LALR(1) parsers for the grammar be n_1, n_2 and n_3 respectively. The following relationship holds good:

- A. $n_1 < n_2 < n_3$
B. $n_1 = n_3 < n_2$
C. $n_1 = n_2 = n_3$
D. $n_1 \geq n_3 \geq n_2$

[gate2005](#) [compiler-design](#) [parsing](#) [normal](#)

[Answer](#)

3.12.28 Parsing: GATE2003_57 [top](#)

<http://gateoverflow.in/945>

Consider the grammar shown below.

$S \rightarrow C \ C$

$C \rightarrow c \ C \mid d$

This grammar is

- A. LL(1)
B. SLR(1) but not LL(1)
C. LALR(1) but not SLR(1)
D. LR(I) but not LALR(1)

[gate2003](#) [compiler-design](#) [grammar](#) [parsing](#) [normal](#)
[Answer](#)

3.12.29 Parsing: GATE1998_1.27 [top](#)

<http://gateoverflow.in/1664>

Type checking is normally done during

- (a) lexical analysis
- (b) syntax analysis
- (c) syntax directed translation
- (d) code optimization

[gate1998](#) [compiler-design](#) [parsing](#) [easy](#)
[Answer](#)

3.12.30 Parsing: GATE2003_17 [top](#)

<http://gateoverflow.in/907>

Assume that the SLR parser for a grammar G has n_1 states and the LALR parser for G has n_2 states. The relationship between n_1 and n_2 is

- A. n_1 is necessarily less than n_2
- B. n_1 is necessarily equal to n_2
- C. n_1 is necessarily greater than n_2
- D. None of the above

[gate2003](#) [compiler-design](#) [parsing](#) [easy](#)
[Answer](#)

3.12.31 Parsing: GATE1998_1.26 [top](#)

<http://gateoverflow.in/1663>

Which of the following statements is true?

- A. SLR parser is more powerful than LALR
- B. LALR parser is more powerful than Canonical LR parser
- C. Canonical LR parser is more powerful than LALR parser
- D. The parsers SLR, Canonical CR, and LALR have the same power

[gate1998](#) [compiler-design](#) [parsing](#) [normal](#)
[Answer](#)

3.12.32 Parsing: GATE2013_40 [top](#)

<http://gateoverflow.in/1551>

Consider the following two sets of LR(1) items of an LR(1) grammar.

$$\begin{array}{ll} X \rightarrow c.X, c/d & X \rightarrow c.X, \$ \\ X \rightarrow .cX, c/d & X \rightarrow .cX, \$ \\ X \rightarrow .d, c/d & X \rightarrow .d, \$ \end{array}$$

Which of the following statements related to merging of the two sets in the corresponding LALR parser is/are **FALSE**?

1. Cannot be merged since look aheads are different.

2. Can be merged but will result in S-R conflict.
 3. Can be merged but will result in R-R conflict.
 4. Cannot be merged since goto on c will lead to two different sets.
 (A) 1 only (B) 2 only (C) 1 and 4 only (D) 1, 2, 3 and 4

gate2013 | compiler-design | parsing | normal

[Answer](#)

3.12.33 Parsing: GATE2005_83 [top](#)

<http://gateoverflow.in/1405>

Statement for Linked Answer Questions 83a & 83b:

Consider the following expression grammar. The semantic rules for expression evaluation are stated next to each grammar production.

$$\begin{array}{ll} E \rightarrow number & E.val = \text{number}.val \\ | E '+' E & E^{(1)}.val = E^{(2)}.val + E^{(3)} \\ | E '\times' E & \quad \quad \quad .val \\ & E^{(1)}.val = E^{(2)}.val \times E^{(3)} \\ & \quad \quad \quad .val \end{array}$$

(A) The above grammar and the semantic rules are fed to a *yaac* tool (which is an LALR(1) parser generator) for parsing and evaluating arithmetic expressions. Which one of the following is true about the action of *yaac* for the given grammar?

- A. It detects *recursion* and eliminates recursion
- B. It detects *reduce-reduce* conflict, and resolves
- C. It detects *shift-reduce* conflict, and resolves the conflict in favor of a *shift* over a *reduce* action
- D. It detects *shift-reduce* conflict, and resolves the conflict in favor of a *reduce* over a *shift* action

(B) Assume the conflicts in Part(a) of this question are resolved and an LALR(1) parser is generated for parsing arithmetic expressions as per the given grammar. Consider an expression $3 \times 2 + 1$. What precedence and associativity properties does the generated parser realize?

- A. Equal precedence and left associativity; expression is evaluated to 7
- B. Equal precedence and right associativity; expression is evaluated to 9
- C. Precedence of ' \times ' is higher than that of '+', and both operators are left associative; expression is evaluated to 7
- D. Precedence of '+' is higher than that of ' \times ', and both operators are left associative; expression is evaluated to 9

gate2005 | compiler-design | parsing | normal

[Answer](#)

3.12.34 Parsing: GATE1999_1.17 [top](#)

<http://gateoverflow.in/1470>

Which of the following is the most powerful parsing method?

- A. LL (1)
- B. Canonical LR
- C. SLR
- D. LALR

gate1999 | compiler-design | parsing | easy

[Answer](#)

3.12.35 Parsing: GATE2006_07 [top](#)

<http://gateoverflow.in/886>

Consider the following grammar

$S \rightarrow S * E$
 $S \rightarrow E$
 $E \rightarrow F + E$
 $E \rightarrow F$
 $F \rightarrow id$

Consider the following LR(0) items corresponding to the grammar above

- (i) $S \rightarrow S * .E$
- (ii) $E \rightarrow F. + E$
- (iii) $E \rightarrow F + .E$

Given the items above, which two of them will appear in the same set in the canonical sets-of-items for the grammar?

- (A) (i) and (ii)
- (B) (ii) and (iii)
- (C) (i) and (iii)
- (D) None of the above

gate2006 | compiler-design | parsing | normal

Answer

3.12.36 Parsing: GATE2002_22 top

<http://gateoverflow.in/875>

- a. Construct all the parse trees corresponding to $i + j * k$ for the grammar
 $E \rightarrow E+E$
 $E \rightarrow E*E$
 $E \rightarrow id$
- b. In this grammar, what is the precedence of the two operators * and +?
- c. If only one parse tree is desired for any string in the same language, what changes are to be made so that the resulting LALR(1) grammar is unambiguous?

gate2002 | compiler-design | parsing | normal

Answer

3.12.37 Parsing: GATE2008-11 top

<http://gateoverflow.in/409>

Which of the following describes a handle (as applicable to LR-parsing) appropriately?

- A. It is the position in a sentential form where the next shift or reduce operation will occur
- B. It is non-terminal whose production will be used for reduction in the next step
- C. It is a production that may be used for reduction in a future step along with a position in the sentential form where the next shift or reduce operation will occur
- D. It is the production p that will be used for reduction in the next step along with a position in the sentential form where the right hand side of the production may be found

gate2008 | compiler-design | parsing | normal

Answer

Answers: Parsing

3.12.1 Parsing: GATE2012-53 top

<http://gateoverflow.in/43312>



Selected Answer

Make your own parse table. Firstly calculate First and Follow from the given grammar.

$\text{First}(S) = \{a, b, \epsilon\}$

$\text{First}(A) = \{a, b, \epsilon\}$

$\text{First}(B) = \{a, b, \epsilon\}$

$\text{Follow}(S) = \{a, b, \$\}$

$\text{Follow}(A) = \{a, b\}$

$\text{Follow}(B) = \{a, b, \$\}$

Now make LL(1) parse table

| Non Terminal | a | b | \$ |
|--------------|--|--|--------------------------|
| S | $S \rightarrow aAbB$ $S \rightarrow \epsilon$ | $S \rightarrow bAbB$ $S \rightarrow \epsilon$ | $S \rightarrow \epsilon$ |
| A | $A \rightarrow S$ | $A \rightarrow S$ | |
| B | $B \rightarrow S$ | $B \rightarrow S$ | $B \rightarrow S$ |

Here is the explanation of entries asked in question

1) For E1 and E2 Look into $\text{First}(S) = \{a, b, \epsilon\}$.

a is because of $S \rightarrow aAbB$ and b is because of $B \rightarrow bAaB$

So $M[S, a]$ and $M[S, b]$ will contain $S \rightarrow aAbB$ and $B \rightarrow bAaB$ respectively. For epsilon Look into $\text{Follow}(S) = \{a, b, \$\}$. So $S \rightarrow \epsilon$ will be in $M[S, a]$, $M[S, b]$ and $M[S, \$]$

2) Now for E2 look into $\text{First}(B) = \{a, b, \$\}$. a and b are because of $B \rightarrow S$.

So $M[B, a]$ and $M[B, b]$ will contain $B \rightarrow S$ and for epsilon look into $\text{Follow}(B) = \{a, b, \$\}$. Hence $M[B, \$]$ will contain $B \rightarrow S$

Now we got the answer **E1 is S**

→ **aAbB, S**

→ **epsilon, E2 is S**

→ **bAaB, S**

→ **epsilon and E3 is B**

→ **S.**

Hence **Option (C)** is correct.

3 votes

-- Ashwani Kumar (947 points)

3.12.2 Parsing: GATE2001-16 [top](#)

<http://gateoverflow.in/757>



Selected Answer

$\text{First}(E) = \{a, (, \epsilon\}$

$\text{First}(A) = \{+, *, \epsilon\}$

$\text{Follow}(E) = \text{Follow}(A) = \{\$,)\}$

LL(1) Parsing Table :

| | a | (|) | + | * | \$ |
|---|--------------------|---------------------|--------------------------|--------------------|--------------------|--------------------------|
| E | $E \rightarrow aA$ | $E \rightarrow (E)$ | | | | |
| A | | | $A \rightarrow \epsilon$ | $A \rightarrow +E$ | $A \rightarrow *E$ | $A \rightarrow \epsilon$ |

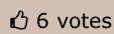
7 votes

-- Aditya Gaurav (2.1k points)

3.12.3 Parsing: GATE2008-55 [top](#)<http://gateoverflow.in/478>

Selected Answer

Answer is B.



6 votes

-- Gate Keeda (17.7k points)

3.12.4 Parsing: TIFR2012-B-8 [top](#)<http://gateoverflow.in/25108>

Selected Answer

e is correct

Because as the expression evaluated right to left , so in (ii) $2+(a-(b*(a+b)))$ this evaluation performed, which is not a correct evaluation as the parse tree



3 votes

-- srestha (27.8k points)

3.12.5 Parsing: GATE2008-IT_79 [top](#)<http://gateoverflow.in/3393>

Selected Answer

- | | |
|--------------|---|
| S → aS | 1 |
| S → aA | 2 |
| S → aaAb | 3 |
| S → aabAab | 4 |
| S → aabbAaab | 5 |
| S → aabbaab | 6 |

Thus 6 steps are needed and only one way to derive the string so only one parse tree.



17 votes

-- Shreyans Dhankhar (2.4k points)

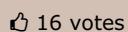
3.12.6 Parsing: GATE2015-3_16 [top](#)<http://gateoverflow.in/8413>

Selected Answer

Answer is C.

SLR is the simplest to implement and Canonical LR is the most powerful.

http://en.wikipedia.org/wiki/LALR_parser_generator



16 votes

-- Arjun Suresh (150k points)

3.12.7 Parsing: GATE2015-1_13 [top](#)<http://gateoverflow.in/8187>

Selected Answer

C) should be the answer

9 votes

-- GateMaster Prime (1.3k points)

3.12.8 Parsing: GATE2005-IT_83a [top](#)<http://gateoverflow.in/3849>

Selected Answer

Answer is A.

10 votes

-- Gate Keeda (17.7k points)

3.12.9 Parsing: GATE1992_02,xiv [top](#)<http://gateoverflow.in/571>

Selected Answer

Goto part & shift entry must be same.
 Reduce entry & error entry may b different due to conflicts.

8 votes

-- Digvijay (35.8k points)

3.12.10 Parsing: GATE2000-1.19, UGCNET-Dec2013-II-30 [top](#)<http://gateoverflow.in/642>

Selected Answer

ans a)

5 votes

-- Aditi Dan (5.4k points)

3.12.11 Parsing: GATE 2016-1-45 [top](#)<http://gateoverflow.in/39697>

Selected Answer

$2 - 5 + 1 - 7 * 3$ will be evaluated according to the precedence and associativity as given in the question as follows:
 $((2 - ((5 + 1) - 7)) * 3) \Rightarrow ((2 - (-1)) * 3) \Rightarrow 9$

28 votes

-- Monanshi Jain (6.5k points)

3.12.12 Parsing: TIFR2012-B-17 [top](#)<http://gateoverflow.in/25215>

Selected Answer

- A) Does not make any sense. false.
- B) This is definition of LR(K) Parser. True
- C) False. LR(K) is subset of CFL.
- D) False.
- E) LR(K) , bottom up parser . We have Right most derivation. This is False.

Answer :- B

5 votes

-- Akash (31.7k points)

3.12.13 Parsing: GATE2015-3_31 [top](#)<http://gateoverflow.in/8488>



Selected Answer

A parser works on the basis of given grammar. It takes the grammar as it is. Parser does not work on the basis of the yield of the grammar. Also, while constructing the LL(1) parser table, that entry for terminal 'c' will contain multiple entries. SO LL(1) parser cannot be constructed for the given grammar.

 $S \rightarrow F \mid H$
 $F \rightarrow p \mid c$
 $H \rightarrow d \mid c$

That {p, d, c} are the strings generated by the grammar is absolutely correct. But LL(1) and LR(1) can parse these strings successfully only if the grammar is unambiguous and like given below...

 $S \rightarrow P \mid D \mid C$
 $P \rightarrow p$
 $D \rightarrow d$
 $C \rightarrow c$

Please note the difference between these two grammars. Both derive the same strings, but in different manner. With the grammar given in the question, both top-down and bottom-up parsers will get confused while deriving "c". Top-down parser will get confused between $F \rightarrow c$ and $H \rightarrow c$. Similarly, bottom-up parser will get confused while reducing "c". This confusion in case of bottom-up parsing is technically termed as "reduce-reduce" conflict.

While top-down parsing, follow(F) and follow(H) are not disjoint, so the grammar cannot be LL(1). Therefore, LL(1) parser cannot parse it.

Hence, the answer should be option (D). Neither S1 nor S2.

19 votes

-- ashishacm (271 points)

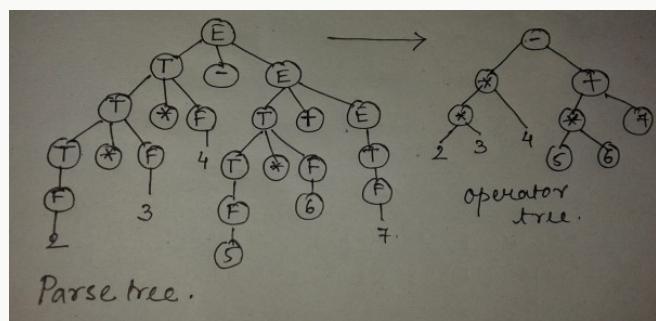
3.12.14 Parsing: TIFR2015-B-15 [top](#)

<http://gateoverflow.in/30079>

Selected Answer

Answer is option B.

The corresponding parse tree is drawn for the given expression according to the given grammar .



7 votes

-- Riya Roy(Arayana) (5.6k points)

3.12.15 Parsing: GATE1992_02,xiii [top](#)

<http://gateoverflow.in/570>



Selected Answer

Ans - a,b, LFollow may be different but RFollow and Follow will be same

Consider a Grammar -

$S \rightarrow AB$

$A \rightarrow a$

$B \rightarrow b$

Now only string derivable is { ab }.

Let's find Follow(A) in all cases :

i) Follow(A) - set of terminals that can appear immediately to the right of non-terminal A in some "sentential" form

$S \rightarrow AB \rightarrow Ab \rightarrow ab$

Here, we notice only 'b' can appear to the right of A.

$\text{Follow}(A) = \{ b \}$

ii) LFollow(A) - set of terminals that can appear immediately to the right of non-terminal A in some "left sentential" form

$S \rightarrow AB \rightarrow aB \rightarrow ab$

Here, we notice no terminal can appear to the right of A.

$\text{LFollow}(A) = \{ \}$

iii) RFollow(A) - set of terminals that can appear immediately to the right of non-terminal A in some "right most sentential" form

$S \rightarrow AB \rightarrow Ab \rightarrow ab$

Here, we notice only 'b' can appear to the right of A.

$\text{RFollow}(A) = \{ b \}$

👍 7 votes

-- Himanshu Agarwal (9.8k points)

3.12.16 Parsing: GATE2005-IT_83b [top](#)

<http://gateoverflow.in/3850>



Selected Answer

5 parse trees are possible.

👍 6 votes

-- ujjwal saini (331 points)

3.12.17 Parsing: GATE2013_9 [top](#)

<http://gateoverflow.in/1418>



Selected Answer

Ans will be B

A->BC
 B->aa
 C->bb
 now suppose string is aabb

then

A->BC(reduction 3)
 ->aaC(reduction 2)
 ->aabb (reduction 1)

n = 4

and number of reductions are 3 so n-1

8 votes

-- rahulkrr (427 points)

3.12.18 Parsing: GATE2003-16 top

<http://gateoverflow.in/906>



Selected Answer

LL(1) parser is top down parser.

For top down parsers, the grammar should be unambiguous, deterministic and should not be left recursive.

All the 3 conditions must be satisfied for LL(1) parsers and not just 2.

So, option D is correct.

9 votes

-- Monanshi Jain (6.5k points)

3.12.19 Parsing: GATE2007-18 top

<http://gateoverflow.in/1216>

answer - A

2 votes

-- ankitrokdeonsns (8.4k points)

3.12.20 Parsing: GATE2011_27 top

<http://gateoverflow.in/2129>



Selected Answer

Answer is B.

To make the parse tree start compiling the identifiers into blocks based on associativity and precedence.

Grouping: $(7 \downarrow (3 \uparrow (4 \uparrow 3))) \downarrow 2$

Tree can be made by opening inner braces and move towards outer braces.

10 votes

-- Sona Praneeth Akula (3.8k points)

3.12.21 Parsing: GATE2009-42 top

<http://gateoverflow.in/1328>



Selected Answer

Answer is B.

A: Yes there does exist parsing algos less than $\Theta(n^3)$.

B: It cannot be implemented with static storage allocation. It needs dynamic memory allocation.

C: If the L-attributed definitions contain synthesized attributes then it can be evaluated.

D: True.

8 votes

-- Gate Keeda (17.7k points)

3.12.22 Parsing: GATE2012-52 [top](#)

<http://gateoverflow.in/2181>



Selected Answer

$\text{First}(S) = \text{First}(A) = \text{First}(B) = \{a, b, \epsilon\}$

$\text{Follow}(A) = \{a, b\}$

$\text{Follow}(B) = \text{Follow}(S) = \{a, b, \$\}$

So, the answer to question 52 is option A.

6 votes

-- Pooja (25.9k points)

3.12.23 Parsing: GATE2006_58 [top](#)

<http://gateoverflow.in/1836>

First S={id}

Follow R={\$}

so M[S,id]=S->FR

M[S,\$]=R->episolon

so ans is a

8 votes

-- Pooja (25.9k points)

3.12.24 Parsing: GATE2014-1_34 [top](#)

<http://gateoverflow.in/1807>



Selected Answer

Ans : The given input symbol no where in the given grammar so with given symbol we have neither a shift-reduce nor a reduce-reduce conflict. So, correct answer is (D) ...

15 votes

-- Jay (1.1k points)

3.12.25 Parsing: GATE2005_14 [top](#)

<http://gateoverflow.in/1350>



Selected Answer

both A and B can be answers but A is a better answer. Because we have standard procedure for removing left-recursion but ambiguity is not easy to remove. - checking if a given CFG is ambiguous is a undecidable problem.

5 votes

-- Vikrant Singh (11k points)

Any Grammar which is Left Recursive will cause any Predictive Parser to fall into an infinite loop. No matter if it is ambiguous or not, it won't be parsable. This is more stronger than saying it is ambiguous so fails.

Hence, answer = **option B**

5 votes

-- Amar Vashishth (20.7k points)

3.12.26 Parsing: GATE1998_22 [top](#)

<http://gateoverflow.in/1737>

- a. $(\text{letter})(\text{letter} + \text{digit} + \text{epsilon})^5$
- b. 1. program ---> begin s end
2. X -----> d semi x
3. | sY
4. Y -----> semi sY
5. | epsilon

| | | | | | | |
|---------|-------|---|------|---|-----|----|
| program | begin | d | semi | s | end | \$ |
| 1 | 2 | 3 | 4 | 5 | | |
| X | | | | | | |
| Y | | | | | | |

2 votes

-- Digvijay (35.8k points)

3.12.27 Parsing: GATE2005_60 [top](#)

<http://gateoverflow.in/1383>



Selected Answer

ans b)

Both in SLR(1) and LALR(1), states are the LR(0) items while in LR(1) the states are LR(1) set of items. Number of LR(0) items can never be greater than number of LR(1) items. So, $n_1 = n_3 \leq n_2$, B choice. If we construct the states for the grammar we can replace \leq with $<$.

6 votes

-- Aditi Dan (5.4k points)

3.12.28 Parsing: GATE2003_57 [top](#)

<http://gateoverflow.in/945>



Selected Answer

ans is a

$\text{First}(S) = \text{First}(C) = \{c, d\}$

there are no multiple in single row of parsing table hence grammar is LL1

note : if we have $A \rightarrow B/C$ for grammar to be LL(1) $\text{First}(B) \cap \text{First}(C)$ should be null otherwise grammar is not LL1. If $\text{First}(B)$ contains epsilon then $\text{Follow}(A) \cap \text{First}(C)$ should be null. Using this we can say grammar is LL(1) or not without constructing parsing table.

An ϵ free LL(1) grammar is also SLR(1) and hence LALR(1) and LR(1) too.

8 votes

-- Pooja (25.9k points)

3.12.29 Parsing: GATE1998_1.27 [top](#)

<http://gateoverflow.in/1664>



Selected Answer

The answer is C .

The use of syntax analyser is used to create parse Tree. But along with Grammar as input to Syntax Analyser we add even semantic rules which form the basis of Syntax Directed Translation That help us in Evaluation of Expression .Remember that

Syntax Directed Translation are used in following cases

1. Conversion of infix to Postfix
- 2.Calculation of infix expression
- 3.For creating a Acyclic graph
- 4.Type Checking
- 5.Conversion of Binary number to Decimal
- 6.Counting the numbers of bits (0 or 1) in a binary number
- 7.Creation of syntax tree
8. To generate Intermediate code
9. Storing the data into Symbol table

12 votes

-- spriti1991 (1.3k points)

3.12.30 Parsing: GATE2003_17 top

<http://gateoverflow.in/907>



Selected Answer

no of states in slr and lalr are equal

and no of states in slr and lalr are less than or equal to lr(1)

8 votes

-- Pooja (25.9k points)

3.12.31 Parsing: GATE1998_1.26 top

<http://gateoverflow.in/1663>

answer - C

6 votes

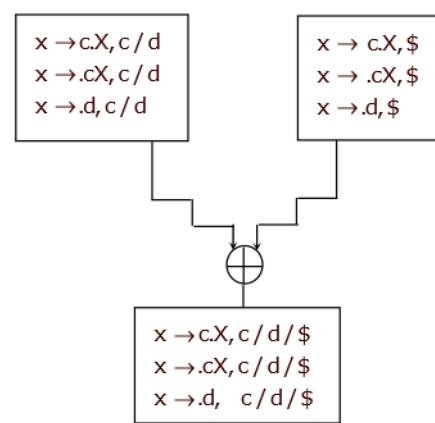
-- ankitrokdeonsns (8.4k points)

3.12.32 Parsing: GATE2013_40 top

<http://gateoverflow.in/1551>



Selected Answer



The TRUE statements are about merging of two states for LALR(1) parser from RR(1) parser.i.e.

1. These can be merged because kernel of these are same, look ahead don't matter in merging
2. Two states are not containing reduces item , so after merging , the merged states can not be contain any S-R conflict.
3. There is no reduction possible so no R-R conflict
4. Merging of states does not depend on further GOTO part on any terminal.

Therefore , ALL given statement in question are FALSE , so option (d) is correct.

10 votes

-- Viral Kapoor (1.8k points)

3.12.33 Parsing: GATE2005_83 top

<http://gateoverflow.in/1405>



Selected Answer

Adding [Nandan Jha](#) answer....

Date :

(A) Here, in LALR(1), we might end up with these productions

$E \rightarrow E + E$. (lookaheads) We have SR conflict
 $E \rightarrow E + E$ (lookaheads)
 $E \rightarrow E * E$ (lookaheads)

YACC favours shift move in case of SR conflict

option (c) ✓

(B) First of all, it is ambiguous grammar.
Hence, equal precedence and associativity
Now, as YACC resolved it with shift move
we will shift until the last operator
and then we will start reducing.

$3 \times 2 + 1$

\ / \ /
 3
 9 → Hence, it gets slight associativity

option (b) ✓

HCI

A

 15 votes

-- Kathleen Bankson (47.9k points)

3.12.34 Parsing: GATE1999_1.17 top<http://gateoverflow.in/1470>

Canonical LR is most powerful method

LR>LALR>SLR

so ans is b

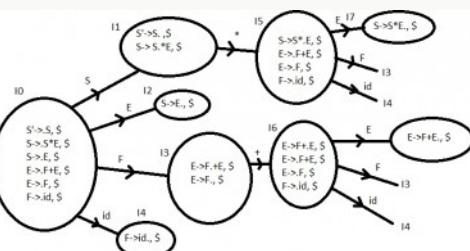
 3 votes

-- Pooja (25.9k points)

3.12.35 Parsing: GATE2006_07 top<http://gateoverflow.in/866>

Selected Answer

ans is D.



6 votes

-- jayendra (6.6k points)

3.12.36 Parsing: GATE2002_22 [top](#)

<http://gateoverflow.in/875>

Selected Answer

- a. two parse tree for $i+j*k$.
 b. + and * having same precedence..
 c. to make grammar LALR compatible give priority to + over * or vice versa.
 following grammar is LALR(1)

$$\begin{aligned} E &\longrightarrow E + T \\ &\quad | \quad T \\ T &\longrightarrow T * F \\ &\quad | \quad F \\ F &\longrightarrow \text{id} \end{aligned}$$

5 votes

-- Digvijay (35.8k points)

3.12.37 Parsing: GATE2008-11 [top](#)

<http://gateoverflow.in/409>

Selected Answer

A *sentential form* is the start symbol S of a grammar or any string in $(V \cup T)^*$ that can be derived from S.

Consider the linear grammar

$(\{S, B\}, \{a, b\}, S, \{S \rightarrow aS, S \rightarrow B, B \rightarrow bB, B \rightarrow \lambda\})$.

A derivation using this grammar might look like this:

$$S \Rightarrow aS \Rightarrow aB \Rightarrow abB \Rightarrow abbB \Rightarrow abb$$

Each of $\{S, aS, aB, abB, abb\}$ is a sentential form.

Because this grammar is linear, each sentential form has at most one variable. Hence there is never any choice about which variable to expand next.

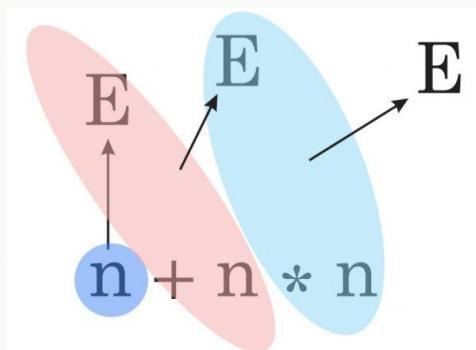
Here, in option D the sentential forms are same but generated differently coz we are using here Bottom Up production.

Handle:

for example the grammar is:

$$\begin{aligned} E &\rightarrow E + n \\ E &\rightarrow E * n \\ E &\rightarrow n \end{aligned}$$

then say to derive string
 $n + n * n$:



these are three different handles shown in 3 different colors =
 $\{n, E + n, E * n\}$

that's what **option D** says

14 votes

-- Amar Vashishth (20.7k points)

3.13

Postfix top

3.13.1 Postfix: GATE1998_19b top

<http://gateoverflow.in/15708>

Compute the post fix equivalent of the following expression $3^* \log(x + 1) - \frac{a}{2}$

gate1998 | compiler-design | postfix

Answer

Answers: Postfix

3.13.1 Postfix: GATE1998_19b top

<http://gateoverflow.in/15708>



Selected Answer

$3x1 + \log *a2/-$

11 votes

-- Happy Mittal (9.5k points)

3.14

Programming In C top

3.14.1 Programming In C: GATE2005_61 top

<http://gateoverflow.in/4066>

Consider line number 3 of the following C-program.

```
int main() { /*Line 1 */
int I, N; /*Line 2 */
fro (I=0, I<N, I++); /*Line 3 */
}
```

Identify the compiler's response about this line while creating the object-module:

- A. No compilation error
- B. Only a lexical error
- C. Only syntactic errors
- D. Both lexical and syntactic errors

gate2005 | compiler-design | programming-in-c | normal

Answer

Answers: Programming In C

3.14.1 Programming In C: GATE2005_61 top

<http://gateoverflow.in/4066>



Selected Answer

C language allows only certain words in it- these are called tokens. If we input any invalid tokens it causes lexical error.

eg:

44a44

causes lexical error as in C as an alphabet cannot come in between digits.

Syntactic error is caused by bad combination of tokens. For example, we cannot have a constant on the left hand side of an assignment statement, a for loop must have two expressions inside () separated by semi colon etc.

In the given question, line 3 won't cause lexical error or syntactic error. The statement will be treated as a function call with three arguments. Function definition being absent will cause link time error, but the question asks only for compile time errors. So, (a) must be the answer.

PS: Implicit function declaration was removed from C99 standard onwards. As per current standard we should not use a function without declaration. Still, we cannot guarantee "compilation error"- just expect compiler warnings in C. In C++ this should produce compilation (semantic) error.

<http://stackoverflow.com/questions/15570553/lexical-and-semantic-errors-in-c>

22 votes

-- Arjun Suresh (150k points)

3.15

Recursion top

3.15.1 Recursion: GATE2014-3_18 top

<http://gateoverflow.in/2052>

Which of the following statements are CORRECT?

1. Static allocation of all data areas by a compiler makes it impossible to implement recursion.
2. Automatic garbage collection is essential to implement recursion.
3. Dynamic allocation of activation records is essential to implement recursion.
4. Both heap and stack are essential to implement recursion.

(A) 1 and 2 only

(B) 2 and 3 only

(C) 3 and 4 only

(D) 1 and 3 only

[gate2014-3](#) [compiler-design](#) [recursion](#) [normal](#)

Answer

Answers: Recursion

3.15.1 Recursion: GATE2014-3_18 top

<http://gateoverflow.in/2052>



Selected Answer

It will be D.

option 2 is wrong because it is not necessary to have automatic garbage collection to implement recursion.

option 4 is wrong because it says that both are required to implement recursion, which is wrong. Either of them will suffice.

9 votes

-- Gate Keeda (17.7k points)

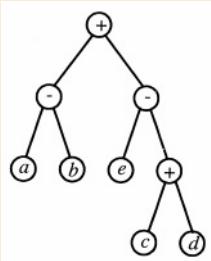
3.16

Register Allocation top

3.16.1 Register Allocation: GATE2011_36 top

<http://gateoverflow.in/2138>

Consider evaluating the following expression tree on a machine with load-store architecture in which memory can be accessed only through load and store instructions. The variables a, b, c, d , and e are initially stored in memory. The binary operators used in this expression tree can be evaluated by the machine only when operands are in registers. The instructions produce result only in a register. If no intermediate results can be stored in memory, what is the minimum number of registers needed to evaluate this expression?



- (A) 2
- (B) 9
- (C) 5
- (D) 3

[gate2011](#) [compiler-design](#) [register-allocation](#) [normal](#)

[Answer](#)

Answers: Register Allocation

3.16.1 Register Allocation: GATE2011_36 [top](#)

<http://gateoverflow.in/2138>



Selected Answer

R1<- -c, R2<- -d, R2<- -R1+R2, R1<- -e, R2<- -R1-R2

To calculate the rest of the expression we must load a and b into the registers but we need the content of $R2$ later. So we must use another register. R1<- -a, R3<- -b, R1<- -R1-R3, R1<- -R1+R2

Ans D

7 votes

-- Keith Kr (6k points)

3.17

Runtime Environments [top](#)

3.17.1 Runtime Environments: GATE1995_1.14 [top](#)

<http://gateoverflow.in/2601>

A linker is given object modules for a set of programs that were compiled separately. What information need to be included in an object module?

- A. Object code
- B. Relocation bits
- C. Names and locations of all external symbols defined in the object module
- D. Absolute addresses of internal symbols

[gate1995](#) [compiler-design](#) [runtime-environments](#) [normal](#)

[Answer](#)

3.17.2 Runtime Environments: GATE1998_1.28 [top](#)

<http://gateoverflow.in/1665>

A linker reads four modules whose lengths are 200, 800, 600 and 500 words, respectively. If they are loaded in that order, what are the relocation constants?

- A. 0, 200, 500, 600
- B. 0, 200, 1000, 1600
- C. 200, 500, 600, 800
- D. 200, 700, 1300, 2100

gate1998 | compiler-design | runtime-environments | normal

Answer

3.17.3 Runtime Environments: GATE2001-1.17 [top](#)

<http://gateoverflow.in/710>

The process of assigning load addresses to the various parts of the program and adjusting the code and the date in the program to reflect the assigned addresses is called

- A. Assembly
- B. parsing
- C. Relocation
- D. Symbol resolution

gate2001 | compiler-design | runtime-environments | easy

Answer

3.17.4 Runtime Environments: GATE1993_7.7 [top](#)

<http://gateoverflow.in/2295>

A part of the system software which under all circumstances must reside in the main memory is:

- a. text editor
- b. assembler
- c. linker
- d. loader
- e. none of the above

gate1993 | compiler-design | runtime-environments | easy

Answer

3.17.5 Runtime Environments: GATE1998-1.25, ISRO2008-41 [top](#)

<http://gateoverflow.in/1662>

In a resident – OS computer, which of the following systems must reside in the main memory under all situations?

- A. Assembler
- B. Linker
- C. Loader
- D. Compiler

gate1998 | compiler-design | runtime-environments | normal | isro2008

Answer

Answers: Runtime Environments

3.17.1 Runtime Environments: GATE1995_1.14 [top](#)

<http://gateoverflow.in/2601>



Selected Answer

(c) is the answer. For linker to link external symbols (for example in C, to link an extern variable in one module to a global variable in another module), it must know the location of all external symbols. In C external symbols includes all global variables and function names.

(a) is trivially there is an object module. (b) must be there if we need to have relocation capability.

(d) is no way needed.

14 votes

-- Arjun Suresh (150k points)

3.17.2 Runtime Environments: GATE1998_1.28 [top](#)

<http://gateoverflow.in/1665>



Selected Answer

answer - B

first module loaded starting at address 0. Size is 200. hence it will occupy first 200 address last address being 199. Second module will be present from 200 and so on.

7 votes

-- ankitrokdeonsns (8.4k points)

3.17.3 Runtime Environments: GATE2001-1.17 [top](#)

<http://gateoverflow.in/710>



Selected Answer

answer - C

8 votes

-- ankitrokdeonsns (8.4k points)

3.17.4 Runtime Environments: GATE1993_7.7 [top](#)

<http://gateoverflow.in/2295>



Selected Answer

Answer: D

The loader is a program that loads the object program from the secondary memory into the main memory for execution of the program. The loader resides in main memory.

8 votes

-- Rajarshi Sarkar (29.7k points)

3.17.5 Runtime Environments: GATE1998-1.25, ISRO2008-41 [top](#)

<http://gateoverflow.in/1662>



Selected Answer

C) is answer ,

In many operating systems the loader is permanently resident in memory, although some operating systems that support [virtual memory](#) may allow the loader to be located in a region of memory that is [pageable](#).
reference @[http://en.wikipedia.org/wiki/Loader_\(computing\)](http://en.wikipedia.org/wiki/Loader_(computing))

4 votes

-- Mithlesh Upadhyay (3.6k points)

answer - C

4 votes

-- ankitrokdeonsns (8.4k points)

3.18**Static Single Assignment** top**3.18.1 Static Single Assignment: GATE 2016-1-19** top<http://gateoverflow.in/39675>

Consider the following code segment.

```
x = u - t;
y = x * v;
x = y + w;
y = t - z;
y = x * y;
```

The minimum number of *total* variables required to convert the above code segment to *static single assignment* form is _____.

[gate2016-1](#) [compiler-design](#) [static-single-assignment](#) [normal](#) [numerical-answers](#)
Answer**Answers: Static Single Assignment****3.18.1 Static Single Assignment: GATE 2016-1-19** top<http://gateoverflow.in/39675>

Selected Answer

I am getting 10. Static single assignment means temporary reg will be assigned only once.

11 votes

-- Shikhar Vashishth (3.7k points)

3.19**Syntax Directed Translation** top**3.19.1 Syntax Directed Translation: GATE1996_20** top<http://gateoverflow.in/2772>

Consider the syntax-directed translation schema (SDTS) shown below:

- $E \rightarrow E + E$ {print "+"}
- $E \rightarrow E * E$ {print "."}
- $E \rightarrow id$ {print id.name}
- $E \rightarrow (E)$

An LR-parser executes the actions associated with the productions immediately after a reduction by the corresponding production. Draw the parse tree and write the translation for the sentence.

$(a + b) * (c + d)$, using SDTS given above.

[gate1996](#) [compiler-design](#) [syntax-directed-translation](#) [normal](#)
Answer**3.19.2 Syntax Directed Translation: GATE2000-19** top<http://gateoverflow.in/690>

Consider the syntax directed translation scheme (SDTS) given in the following. Assume attribute evaluation with bottom-up parsing, i.e., attributes are evaluated immediately after a reduction.

$$E \rightarrow E_1 * T \{E.val = E_1.val * T.val\}$$

$E \rightarrow T \{E.val = T.val\}$
 $T \rightarrow F - T_1 \{T.val = F.val - T_1.val\}$
 $T \rightarrow F \{T.val = F.val\}$
 $F \rightarrow 2 \{F.val = 2\}$
 $F \rightarrow 4 \{F.val = 4\}$

- Using this SDTS, construct a parse tree for the expression $4 - 2 - 4 * 2$ and also compute its $E.val$.
- It is required to compute the total number of reductions performed to parse a given input. Using synthesized attributes only, modify the SDTS given, without changing the grammar, to find $E.red$, the number of reductions performed while reducing an input to E .

gate2000 | compiler-design | syntax-directed-translation | normal

Answer

3.19.3 Syntax Directed Translation: GATE2003_18 [top](#)

<http://gateoverflow.in/908>

In a bottom-up evaluation of a syntax directed definition, inherited attributes can

- always be evaluated
- be evaluated only if the definition is L-attributed
- be evaluated only if the definition has synthesized attributes
- never be evaluated

gate2003 | compiler-design | syntax-directed-translation | normal

Answer

3.19.4 Syntax Directed Translation: GATE1995_2.10 [top](#)

<http://gateoverflow.in/2622>

A shift reduce parser carries out the actions specified within braces immediately after reducing with the corresponding rule of grammar

- $S \rightarrow xxW\{\text{print"}1"\}$
- $S \rightarrow y\{\text{print"}2"\}$
- $W \rightarrow Sz\{\text{print"}3"\}$

What is the translation of $xxxxyzz$ using the syntax directed translation scheme described by the above rules?

- 23131
- 11233
- 11231
- 33211

gate1995 | compiler-design | grammar | syntax-directed-translation | normal

Answer

3.19.5 Syntax Directed Translation: GATE 2016-1-46 [top](#)

<http://gateoverflow.in/39700>

Consider the following Syntax Directed Translation Scheme

(SDTS), with non-terminals

$\{S, A\}$ and terminals

$\{a, b\}$.

$$S \rightarrow aA \quad \{\text{print } 1\}$$

$S \rightarrow a \quad \{\text{print } 2\}$

$A \rightarrow Sb \quad \{\text{print } 3\}$

Using the above

$SDTS$, the output printed by a bottom-up parser, for the input aab is:

- A. 1 3 2
- B. 2 2 3
- C. 2 3 1
- D. syntax error

gate2016-1 compiler-design syntax-directed-translation normal

Answer

3.19.6 Syntax Directed Translation: GATE1998_23 [top](#)

<http://gateoverflow.in/1738>

Let the attribute 'val' give the value of a binary number generated by S in the following grammar:

$S \rightarrow L \cdot L \mid L$

$L \rightarrow LB \mid B$

$B \rightarrow 0 \mid 1$

For example, an input 101.101 gives $S.val = 5.625$

Construct a syntax directed translation scheme using only synthesized attributes, to determine $S.val$.

gate1998 compiler-design syntax-directed-translation normal

Answer

Answers: Syntax Directed Translation

3.19.1 Syntax Directed Translation: GATE1996_20 [top](#)

<http://gateoverflow.in/2772>

ab+cd+. its a basic SDT, used to find the postfix expression.

1 6 votes

-- abhishek1317 (269 points)

3.19.2 Syntax Directed Translation: GATE2000-19 [top](#)

<http://gateoverflow.in/690>



Selected Answer

A. Given Expression is $4 - 2 - 4 * 2$, which can be rewritten as $((4 - (2 - 4)) * 2)$ which is equal to 12.

1 7 votes

-- Aditya Gaurav (2.1k points)

3.19.3 Syntax Directed Translation: GATE2003_18 [top](#)

<http://gateoverflow.in/908>

Ans D

Why ?

A) inherited attributes can have cyclic dependencies. Due to which we can not be sure whether they can be evaluated in First Place.

So A is wrong.

B) This is wrong because even definition is L-attributed, we need to go top down, left to right. We can not do standard bottom up Traversal.

example :-

$T' \rightarrow *FT_1' \mid T_1'.inh = T'.inh * F.val \rightarrow$ This move is allowed in L attributed, which can not be computed using bottom up traversal. We need to go from left to right, top down. So B is out of question.

reference :- https://en.wikipedia.org/wiki/L-attributed_grammar

L-attributed grammars are a special type of [attribute grammars](#). They allow the attributes to be evaluated in one depth-first left-to-right traversal of the [abstract syntax tree](#). As a result, attribute evaluation in L-attributed grammars can be incorporated conveniently in [top-down parsing](#).

A syntax-directed definition is L-attributed if each inherited attribute of X_j on the right side of

$A \rightarrow X_1 X_2 \dots X_n$

depends only on

1. the attributes of the symbols X_1, X_2, \dots, X_{j-1}

2. the inherited attributes of A // This is why B is false.

C) This is wrong because it says " definition has synthesized attributes". So along with Synthesized attributes, I can even have cycles. Which makes this wrong..

So answer is One and only D. Never !

4 votes

-- Akash (31.7k points)

Answer : B

Explanation: A Syntax Directed Definition (SDD) is called S Attributed if it has only synthesized attributes.

L-Attributed Definitions contain both synthesized and inherited attributes but do not need to build a dependency graph to evaluate them.

References:

<http://cse.iitkgp.ac.in/~bivasm/notes/SDD.pdf>

4 votes

-- shekhar chauhan (36.4k points)

3.19.4 Syntax Directed Translation: GATE1995_2.10 [top](#)

<http://gateoverflow.in/2622>



Selected Answer

A.

Making a tree and performing post order traversal will yield answer as A.

$S \rightarrow x \ x \ W \ (Pf'1')$

$W \rightarrow S \ z \ (Pf'3')$

$S \rightarrow x \ x \ W \ (Pf'1')$

$W \rightarrow S \ z \ (Pf'3')$

$S \rightarrow y \ (Pf'2').$

13 votes

-- Gate Keeda (17.7k points)

3.19.5 Syntax Directed Translation: GATE 2016-1-46 [top](#)

<http://gateoverflow.in/39700>



Selected Answer

aab could be derived as follows by the bottom up parser:

S->aA prints 1
A->aSb prints 3
A->aab prints 2

Now since bottom up parser will work in reverse of right most derivation, so it will print in bottom up fashion i.e., 231 which is option C.

Note that this could also be visualized easily by drawing the derivation tree.

Upvote 21 votes

-- Monanshi Jain (6.5k points)

3.19.6 Syntax Directed Translation: GATE1998_23 [top](#)

<http://gateoverflow.in/1738>



Selected Answer

S-- > L.L { S.dv = L₁.dv + L₂.dv/2^{L₂.nb} }

| L { S.dv = L.dv }

L-- > LB { L.dv = 2 * L₁.dv + B.dv

L.nb = L₁.nb + B.nb }}

| B { L.dv = B.dv

L.nb = B.nb }

B-- > 0 { B.dv = 0

B.nb = 1 }

| 1 { B.dv = 1

B.nb = 1 }

here dv = decimal value

nb = number of bits.

Upvote 6 votes

-- Gate Keeda (17.7k points)

3.20

Target Code Generation [top](#)

3.20.1 Target Code Generation: GATE2004_10 [top](#)

<http://gateoverflow.in/4069>

Consider the grammar rule E → E₁ – E₂ for arithmetic expressions. The code generated is targeted to a CPU having a single user register. The subtraction operation requires the first operand to be in the register. If E₁ and E₂ do not have any common sub expression, in order to get the shortest possible code

- (A) E₁ should be evaluated first
- (B) E₂ should be evaluated first

- (C) Evaluation of E1 and E2 should necessarily be interleaved
(D) Order of evaluation of E1 and E2 is of no consequence

gate2004 | compiler-design | target-code-generation | normal

Answer

3.20.2 Target Code Generation: GATE2003_59 [top](#)

<http://gateoverflow.in/947>

Consider the syntax directed definition shown below.

```
S → id := E      {gen(id.place = E.place);}
E → E1 + E2 {t = newtemp();
                    gen(t = E1.place + E2.place);
                    E.place = t;}
E → id          {E.place = id.place;}
```

Here, *gen* is a function that generates the output code, and *newtemp* is a function that returns the name of a new temporary variable on every call. Assume that *t*'s are the temporary variable names generated by *newtemp*. For the statement 'X := Y + Z', the 3-address code sequence generated by this definition is

- A. X = Y + Z
- B. t₁ = Y + Z; X = t₁
- C. t₁ = Y; t₂ = t₁ + Z; X = t₂
- D. t₁ = Y; t₂ = Z; t₃ = t₁ + t₂; X = t₃

gate2003 | compiler-design | target-code-generation | normal

Answer

3.20.3 Target Code Generation: GATE1997_4.9 [top](#)

<http://gateoverflow.in/2250>

The expression $(a * b) * c \text{ op} \dots$

where 'op' is one of '+', '*' and ' \uparrow ' (exponentiation) can be evaluated on a CPU with single register without storing the value of $(a * b)$ if

- A. 'op' is '+' or '*'
- B. 'op' is ' \uparrow ' or '*'
- C. 'op' is ' \uparrow ' or '+'
- D. not possible to evaluate without storing

gate1997 | compiler-design | target-code-generation | register-allocation | normal

Answer

3.20.4 Target Code Generation: GATE2010-37 [top](#)

<http://gateoverflow.in/2338>

The program below uses six temporary variables *a, b, c, d, e, f*.

```
a = 1
b = 10
c = 20
d = a + b
e = c + d
f = c + e
b = c + e
e = b + f
d = 5 + e
return d + f
```

Assuming that all operations take their operands from registers, what is the minimum number of registers needed to execute

this program without spilling?

- A. 2
- B. 3
- C. 4
- D. 6

[gate2010](#) [compiler-design](#) [target-code-generation](#) [register-allocation](#) [normal](#)

[Answer](#)

Answers: Target Code Generation

3.20.1 Target Code Generation: GATE2004_10 [top](#)

<http://gateoverflow.in/4069>



Selected Answer

E2 should be evaluated first

After evaluating E2 first and then E1, we will have E1 in the register and thus we can simply do SUB operation with E2 which will be in memory (as we have only a single register). If we do E1 first and then E2, we must move E2 to memory and E1 back to register before doing SUB, which will increase the code size.

16 votes

-- Arjun Suresh (150k points)

3.20.2 Target Code Generation: GATE2003_59 [top](#)

<http://gateoverflow.in/947>

answer - B

7 votes

-- ankitrokdeonsns (8.4k points)

3.20.3 Target Code Generation: GATE1997_4.9 [top](#)

<http://gateoverflow.in/2250>

A)

\uparrow has higher precedence than $\{*, +, -, /\}$

So, if $op = \uparrow$ implies, we need to evaluate the right hand side of \uparrow first and then do the lhs part, which would definitely require us to store the value of lhs

but if its a '+' or '*' , we dont need to store the values evaluated, and on the go can do the operation directly on one register.

1 votes

-- confused_luck (329 points)

3.20.4 Target Code Generation: GATE2010-37 [top](#)

<http://gateoverflow.in/2338>



Selected Answer

After making the interference graph it can be colored with 3 different colors. Therefore minimum number of color needed to execute the program without spilling would be 3 (B).

8 votes

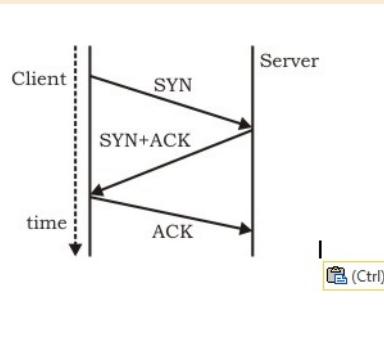
-- suraj (3.7k points)

4 Computer Networks (177) [top](#)

4.0.1 GATE2008-IT_69 [top](#)

<http://gateoverflow.in/3383>

The three way handshake for TCP connection establishment is shown below.



Which of the following statements are TRUE?

- (S1) Loss of SYN + ACK from the server will not establish a connection
- (S2) Loss of ACK from the client cannot establish the connection
- (S3) The server moves LISTEN → SYN_RECV → SYN_SENT → ESTABLISHED in the state machine on no packet loss
- (S4) The server moves LISTEN → SYN_RECV → ESTABLISHED in the state machine on no packet loss.

- A) S2 and S3 only
- B) S1 and S4 only
- C) S1 and S3 only
- D) S2 and S4 only

[gate2008-it](#) [computer-networks](#) [normal](#)

[Answer](#)

4.0.2 GATE1992_03,v [top](#)

<http://gateoverflow.in/582>

Start and stop bits do not contain any "information" but are used in serial communication for

- (a). Error detection
- (b). Error correction
- (c). Synchronization
- (d). Slowing down the communications.

[gate1992](#) [computer-networks](#) [easy](#)

[Answer](#)

4.0.3 GATE2008-IT_20 [top](#)

<http://gateoverflow.in/3280>

Provide the best matching between the entries in the two columns given in the table below:

| | | | |
|------|--------------|----|----------|
| I. | Proxy Server | a. | Firewall |
| II. | Kazaa, DC++ | b. | Caching |
| III. | Slip | c. | P2P |
| IV. | DNS | d. | PPP |

- A) I-a, II-d, III-c, IV-b

- B) I-b, II-d, III-c, IV-a
 C) I-a, II-c, III-d, IV-b
 D) I-b, II-c, III-d, IV-a

[gate2008-it](#) [computer-networks](#) [normal](#)

Answer

4.0.4 GATE2008-IT_66 [top](#)

<http://gateoverflow.in/3380>

Data transmitted on a link uses the following 2D parity scheme for error detection:
 Each sequence of 28 bits is arranged in a 4×7 matrix (rows r_0 through r_3 , and columns d_7 through d_0) and is padded with a column d_0 and row r_4 of parity bits computed using the Even parity scheme. Each bit of column d_0 (respectively, row r_4) gives the parity of the corresponding row (respectively, column). These 40 bits are transmitted over the data link.

| | d₇ | d₆ | d₅ | d₄ | d₃ | d₂ | d₁ | d₀ |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| r₀ | 0 | 1 | 0 | 1 | 0 | 0 | 1 | 1 |
| r₁ | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 0 |
| r₂ | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 |
| r₃ | 0 | 1 | 1 | 0 | 1 | 0 | 1 | 0 |
| r₄ | 1 | 1 | 0 | 0 | 0 | 1 | 1 | 0 |

 A yellow button labeled '(Ctrl)' is visible at the bottom right of the grid."/>

The table shows data received by a receiver and has n corrupted bits. What is the minimum possible value of n?

- A) 1
 B) 2
 C) 3
 D) 4

[gate2008-it](#) [computer-networks](#) [normal](#)

Answer

4.0.5 GATE2007-IT-18 [top](#)

<http://gateoverflow.in/3451>

A firewall is to be configured to allow hosts in a private network to freely open TCP connections and send packets on open connections. However, it will only allow external hosts to send packets on existing open TCP connections or connections that are being opened (by internal hosts) but not allow them to open TCP connections to hosts in the private network. To achieve this the minimum capability of the firewall should be that of

- A. A combinational circuit
 B. A finite automaton
 C. A pushdown automaton with one stack
 D. A pushdown automaton with two stacks

[gate2007-it](#) [computer-networks](#) [theory-of-computation](#) [normal](#)

Answer

4.0.6 GATE2006-IT_19 [top](#)

<http://gateoverflow.in/3558>

Which of the following statements is TRUE?

- A) Both Ethernet frame and IP packet include checksum fields
 B) Ethernet frame includes a checksum field and IP packet includes a CRC field
 C) Ethernet frame includes a CRC field and IP packet includes a checksum field
 D) Both Ethernet frame and IP packet include CRC fields

[gate2006-it](#) [computer-networks](#) [normal](#)
[Answer](#)**4.0.7 GATE2005-IT_77** [top](#)<http://gateoverflow.in/3840>

Assume that "host1.mydomain.dom" has an IP address of 145.128.16.8. Which of the following options would be most appropriate as a subsequence of steps in performing the reverse lookup of 145.128.16.8? In the following options "NS" is an abbreviation of "nameserver".

- A) Query a NS for the root domain and then NS for the "dom" domains
- B) Directly query a NS for "dom" and then a NS for "mydomain.dom" domains
- C) Query a NS for in-addr.arpa and then a NS for 128.145.in-addr.arpa domains
- D) Directly query a NS for 145.in-addr.arpa and then a NS for 128.145.in-addr.arpa domains

[gate2005-it](#) [computer-networks](#) [normal](#)
[Answer](#)**4.0.8 GATE2015-2_34** [top](#)<http://gateoverflow.in/8154>

Assume that the bandwidth for a TCP connection is 1048560 bits/sec. Let α be the value of RTT in milliseconds (rounded off to the nearest integer) after which the TCP window scale option is needed. Let β be the maximum possible window size with window scale option. Then the values of α and β are

- A. 63 milliseconds, 65535×2^{14}
- B. 63 milliseconds, 65535×2^{16}
- C. 500 milliseconds, 65535×2^{14}
- D. 500 milliseconds, 65535×2^{16}

[gate2015-2](#) [computer-networks](#) [difficult](#)
[Answer](#)**4.0.9 GATE2015-3_36** [top](#)<http://gateoverflow.in/8495>

Two hosts are connected via a packet switch with 10^7 bits per second links. Each link has a propagation delay of 20 microseconds. The switch begins forwarding a packet 35 microseconds after it receives the same. If 10000 bits of data are to be transmitted between the two hosts using a packet size of 5000 bits, the time elapsed between the transmission of the first bit of data and the reception of the last bit of the data in microseconds is _____.

[gate2015-3](#) [computer-networks](#) [normal](#) [numerical-answers](#)
[Answer](#)**4.0.10 GATE 2016-2-25** [top](#)<http://gateoverflow.in/39572>

Identify the correct sequence in which the following packets are transmitted on the network by a host when a browser requests a webpage from a remote server, assuming that the host has just been restarted.

- A. HTTP GET request, DNS query, TCP SYN
- B. DNS query, HTTP GET request, TCP SYN
- C. DNS query, TCP SYN, HTTP GET request.
- D. TCP SYN, DNS query, HTTP GET request.

[gate2016-2](#) [computer-networks](#) [normal](#)
[Answer](#)**4.0.11 GATE2005_24** [top](#)<http://gateoverflow.in/1360>

The address resolution protocol (ARP) is used for:

- (a) Finding the IP address from the DNS
 - (b) Finding the IP address of the default gateway
 - (c) Finding the IP address that corresponds to a MAC address
 - (d) Finding the MAC address that corresponds to an IP address

gate2005 computer-networks normal

Answer

Answers:

4.0.1 GATE2008-IT 69 top

<http://gateoverflow.in/3383>



Selected Answer

(S1) Loss of SYN + ACK from the server will not establish a connection => True.
(S2) Loss of ACK from the client cannot establish the connection => No this is not true. Detail reasoning -> <http://stackoverflow.com/questions/16259774/what-if-a-tcp-handshake-segment-is-lost>

If after ACK client immediately sends data then everything goes on without worry. (Though if along with ACK, first data packet is dropped, connection is reset)

(S3) The server moves LISTEN → SYN_RCVD → SYN_SENT → ESTABLISHED in the state machine on no packet loss =>False .

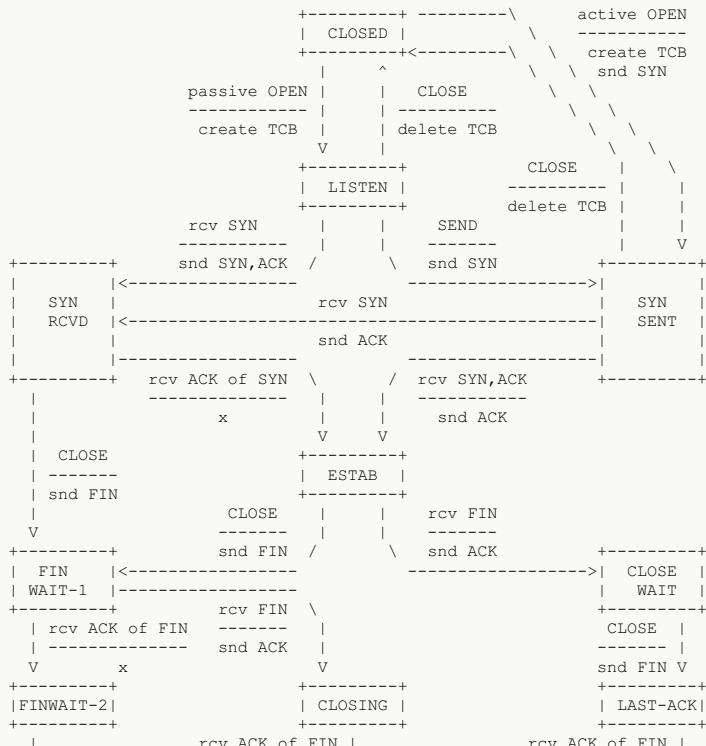
(S4) The server moves LISTEN → SYN_RCVD → ESTABLISHED in the state machine on no packet loss. => True

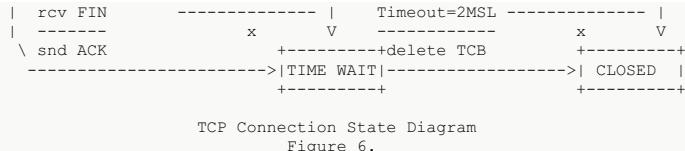
ANSWER => S1 and S4 are true.

Reference for S4 => <https://www.rfc-editor.org/rfc/rfc793.txt>

September 1981

Transmission Control Protocol Functional Specification





1 upvotes

-- Akash (31.7k points)

4.0.2 GATE1992_03,v [top](#)

<http://gateoverflow.in/582>



Selected Answer

Answer is C

1 upvotes

-- saurabhrk (1.3k points)

4.0.3 GATE2008-IT_20 [top](#)

<http://gateoverflow.in/3280>

Ans is C) I-a, II-c, III-d, IV-b

- I. Proxy Server ==> Proxy Server and Firewall can be combined => a. Firewall
- II. Kazaa, DC++ => These are P2P application. c. P2P
- III. Slip => . P2P Slip is predecessor of PPP. => d. PPP
- IV. DNS => DNS responses are often catedh => b. Caching

1 upvotes

-- Akash (31.7k points)

4.0.4 GATE2008-IT_66 [top](#)

<http://gateoverflow.in/3380>



Selected Answer

| | d ₇ | d ₆ | d ₅ | d ₄ | d ₃ | d ₂ | d ₁ | d ₀ |
|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|
| r ₀ | 0 | 1 | 0 | 1 | 0 | 0 | 1 | 1 |
| r ₁ | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 0 |
| r ₂ | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 |
| r ₃ | 0 | 1 | 1 | 0 | 1 | 0 | 1 | 0 |
| r ₄ | 1 | 1 | 0 | 0 | 0 | 0 | 1 | 1 |

Here we need to change minimum 3 bits, so by doing it correct we get correct parity column wise and row wise (Correction marked by dark number).

C is answer

1 upvotes

-- Anirudh Pratap Singh (17.7k points)

4.0.5 GATE2007-IT-18 [top](#)

<http://gateoverflow.in/3451>



Selected Answer

- A) A combinational circuit => Not possible, because we need memory in Firewall, Combinational ckt has none.
 B) A finite automaton => We need infinite memory, there is no upper limit on Number of TCP ckt so Not this.
 A pushdown automaton with one stack => Stack is infinite. Suppose we have 2 connections , we have pushed details
 C) of those on stack we can not access the details of connection which was pushed first, without popping it off. So Big
 NO.
 D) A pushdown automaton with two stacks => This is TM. It can do everything our normal computer can do so Yes.
 Firewall can be created out of TM.

13 votes

-- Akash (31.7k points)

4.0.6 GATE2006-IT_19 top

<http://gateoverflow.in/3558>

Selected Answer

Answer: C

Ref:

http://en.wikipedia.org/wiki/Ethernet_frame#Structurehttp://en.wikipedia.org/wiki/IPv4_header_checksum#Example:_calculating_an_IPv4_header_checksum

2 votes

-- Rajarshi Sarkar (29.7k points)

4.0.7 GATE2005-IT_77 top

<http://gateoverflow.in/3840>

answer - C

we are performing reverse lookup of IP address to its hostname

first we need to locate in-addr.apra

then perform reverse lookup of 8.16.128.145.in-addr.arpa which will point to host1.mydomain.com

5 votes

-- ankitrokdeonsns (8.4k points)

4.0.8 GATE2015-2_34 top

<http://gateoverflow.in/8154>

Selected Answer

In TCP when the **bandwidth delay product** increases beyond 64K receiver window scaling is needed.

The bandwidth delay product is the maximum amount of data on the network circuit at any time and is measured as RTT * Bandwidth. This is not the time for sending data rather just the time for sending data without acknowledgement.

So, here, we have bandwidth delay product = $(1048560 / 8) B * a = 64 K$
 $a = (64 K * 8) / 1048560 = 0.5 \text{ s} = 500 \text{ milliseconds.}$ When window scaling happens, a 14 bit shift count is used in TCP header. So, the maximum possible window size gets increased from $2^{16}-1$ to $(2^{16}-1) * 2^{14}$ or from 65535 to $65535 * 2^{14}$ http://en.wikipedia.org/wiki/TCP_window_scale_option

14 votes

-- Arjun Suresh (150k points)

4.0.9 GATE2015-3_36 top

<http://gateoverflow.in/8495>



Selected Answer

No. of packets sent = $10000/5000 = 2$.

Time for the first packet to reach switch = Transmission time + Propagation delay
 $= (5000/10^7) * 10^6 \mu s + 20 \mu s$
 $= 520 \mu s$.

(Another 520 μs is required for the same packet to reach the destination from the switch and in between there is a forwarding delay of 35 μs . So, first packet is received at destination at $2 * 520 + 35 = 1075 \mu s$.)

After 520 μs , the switch can start receiving the second packet and at $520 + 500 = 1020 \mu s$, second frame is completely received by the switch (we don't need to add propagation time here as packet 2 can just follow packet 1). So, at 1055 μs from the start the switch starts sending the second packet and this will be received at destination after another 520 $\mu s = 1575 \mu s$. Since we added transmission time, this ensures that the last bit of data is received at the sender.

24 votes

-- Arjun Suresh (150k points)

4.0.10 GATE 2016-2-25 [top](#)

<http://gateoverflow.in/39572>

Selected Answer

Here

C) Seems correct answer.

Say you type www.google.com

First you send DNS request to get IP address. Then you establish connection with IP of google using TCP. Finally you start talking in HTTP !

9 votes

-- Akash (31.7k points)

4.0.11 GATE2005_24 [top](#)

<http://gateoverflow.in/1360>

Selected Answer

ans d)

5 votes

-- Aditi Dan (5.4k points)

4.1

Application Layer Protocols [top](#)

4.1.1 Application Layer Protocols: GATE2005-IT_25 [top](#)

<http://gateoverflow.in/3770>

Consider the three commands : PROMPT, HEAD and RCPT.

Which of the following options indicate a correct association of these commands with protocols where these are used?

- A) HTTP, SMTP, FTP
- B) FTP, HTTP, SMTP
- C) HTTP, FTP, SMTP
- D) SMTP, HTTP, FTP

[gate2005-it](#) [computer-networks](#) [application-layer-protocols](#) [normal](#)

Answer

4.1.2 Application Layer Protocols: GATE2007-20 [top](#)

<http://gateoverflow.in/1218>

Which one of the following uses UDP as the transport protocol?

- A. HTTP
- B. Telnet
- C. DNS
- D. SMTP

[gate2007](#) [computer-networks](#) [network-protocols](#) [application-layer-protocols](#) [easy](#)

[Answer](#)

4.1.3 Application Layer Protocols: GATE2006-IT_18 [top](#)

<http://gateoverflow.in/3557>

HELO and PORT, respectively, are commands from the protocols

- A) FTP and HTTP
- B) TELNET and POP3
- C) HTTP and TELNET
- D) SMTP and FTP

[gate2006-it](#) [computer-networks](#) [application-layer-protocols](#) [normal](#)

[Answer](#)

4.1.4 Application Layer Protocols: GATE2008-14, ISRO2016-74 [top](#)

<http://gateoverflow.in/412>

What is the maximum size of data that the application layer can pass on to the TCP layer below?

- A. Any size
- B. 2^{16} bytes - size of TCP header
- C. 2^{16} bytes
- D. 1500 bytes

[gate2008](#) [easy](#) [computer-networks](#) [application-layer-protocols](#) [isro2016](#)

[Answer](#)

4.1.5 Application Layer Protocols: GATE 2016-1-25 [top](#)

<http://gateoverflow.in/39628>

Which of the following is/are example(s) of stateful application layer protocol?

- i. HTTP
 - ii. FTP
 - iii. TCP
 - iv. POP3
-
- A. (i) and (ii) only
 - B. (ii) and (iii) only
 - C. (ii) and (iv) only
 - D. (iv) only

[gate2016-1](#) [computer-networks](#) [application-layer-protocols](#) [normal](#)

[Answer](#)

4.1.6 Application Layer Protocols: GATE2011_4 [top](#)

<http://gateoverflow.in/2106>

Consider the different activities related to email.

- m1: Send an email from mail client to mail server
- m2: Download an email from mailbox server to a mail client
- m3: Checking email in a web browser

Which is the application level protocol used in each activity?

- A. m1: HTTP m2: SMTP m3: POP
 B. m1: SMTP m2: FTP m3: HTTP
 C. m1: SMTP m2: POP m3: HTTP
 D. m1: POP m2: SMTP m3: IMAP

[gate2011](#) [computer-networks](#) [application-layer-protocols](#) [easy](#)

[Answer](#)

4.1.7 Application Layer Protocols: GATE2012_10 [top](#)

<http://gateoverflow.in/42>

The protocol data unit (PDU) for the application layer in the Internet stack is

- (A) Segment
 (B) Datagram
 (C) Message
 (D) Frame

[gate2012](#) [computer-networks](#) [application-layer-protocols](#) [easy](#)

[Answer](#)

Answers: Application Layer Protocols

4.1.1 Application Layer Protocols: GATE2005-IT_25 [top](#)

<http://gateoverflow.in/3770>



Selected Answer

RCPT->Recipient to, As the name suggest it is used in SMTP(Simple Mail Transfer protocol)

HEAD->this is used in HTTP to get the meta-information,to decide the category of packet.

Prompt->turns off prompting for individual files when using the mget or mput commands

6 votes

-- nagalla pruthvi (689 points)

4.1.2 Application Layer Protocols: GATE2007-20 [top](#)

<http://gateoverflow.in/1218>



Selected Answer

The answer is C.

Where quick response is needed, there UDP is preferred.

8 votes

-- Gate Keeda (17.7k points)

4.1.3 Application Layer Protocols: GATE2006-IT_18 [top](#)

<http://gateoverflow.in/3557>



Selected Answer

Answer: D

Ref:

http://en.wikipedia.org/wiki/Simple_Mail_Transfer_Protocol#SMTP_transport_example

http://en.wikipedia.org/wiki/File_Transfer_Protocol#Protocol_overview

1 2 votes

-- Rajarshi Sarkar (29.7k points)

ans d)

1 2 votes

-- Aditi Dan (5.4k points)

4.1.4 Application Layer Protocols: GATE2008-14, ISRO2016-74 [top](#)

<http://gateoverflow.in/412>



Selected Answer

ans a)

1 3 votes

-- Aditi Dan (5.4k points)

4.1.5 Application Layer Protocols: GATE 2016-1-25 [top](#)

<http://gateoverflow.in/39628>



Selected Answer

HTTP - stateless

FTP - stateful

TCP - not application layer protocol

POP3 - Stateful

And according to options answer would be C)

1 20 votes

-- Abhilash Panicker (7k points)

4.1.6 Application Layer Protocols: GATE2011_4 [top](#)

<http://gateoverflow.in/2106>



Selected Answer

ans c)

1 5 votes

-- Aditi Dan (5.4k points)

4.1.7 Application Layer Protocols: GATE2012_10 [top](#)

<http://gateoverflow.in/42>



Selected Answer

(C) Message is answer.

For Application, Presentation and Session layers, the PDU is message

For Transport layer, PDU is segment for TCP and datagram for UDP

For Network layer, PDU is packet

For Datalink layer, PDU is frames

For physical layer, PDU is stream of bits

14 votes

-- gatecse (10.7k points)

4.2

Bit Stuffing [top](#)4.2.1 Bit Stuffing: GATE2014-3_24 [top](#)<http://gateoverflow.in/2058>

A bit-stuffing based framing protocol uses an 8-bit delimiter pattern of 01111110. If the output bit-string after stuffing is 01111100101, then the input bit-string is

- (A) 0111110100
- (B) 0111110101
- (C) 0111111101
- (D) 0111111111

[gate2014-3](#) [computer-networks](#) [bit-stuffing](#)

Answer

Answers: Bit Stuffing

4.2.1 Bit Stuffing: GATE2014-3_24 [top](#)<http://gateoverflow.in/2058>

Selected Answer

```
011111 *one zero emitted here* 0101
```

6 votes

-- abhishek1317 (269 points)

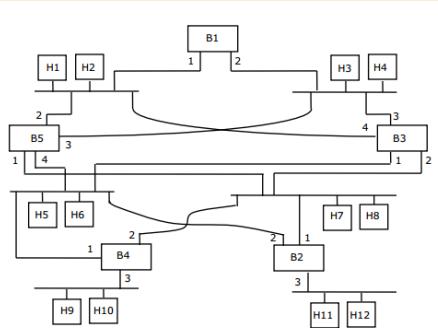
4.3

Bridges [top](#)4.3.1 Bridges: GATE2006_82,83 [top](#)<http://gateoverflow.in/1855>

Statement for Linked Answer Questions 82 & 83:

Consider the diagram shown below where a number of LANs are connected by (transparent) bridges. In order to avoid packets looping through circuits in the graph, the bridges organize themselves in a spanning tree. First, the root bridge is identified as the bridge with the least serial number. Next, the root sends out (one or more) data units to enable the setting up of the spanning tree of shortest paths from the root bridge to each bridge.

Each bridge identifies a port (the root port) through which it will forward frames to the root bridge. Port conflicts are always resolved in favour of the port with the lower index value. When there is a possibility of multiple bridges forwarding to the same LAN (but not through the root port), ties are broken as follows: bridges closest to the root get preference and between such bridges, the one with the lowest serial number is preferred.



82. For the given connection of LANs by bridges, which one of the following choices represents the depth first traversal of the spanning tree of bridges?

- (A) B1, B5, B3, B4, B2
(B) B1, B3, B5, B2, B4
(C) B1, B5, B2, B3, B4
(D) B1, B3, B4, B5, B2

83. Consider the correct spanning tree for the previous question. Let host H1 send out a broadcast ping packet. Which of the following options represents the correct forwarding table on B3?

(A)

| Hosts | Port |
|-----------------|------|
| H1, H2, H3, H4 | 3 |
| H5, H6, H9, H10 | 1 |

| | |
|------------------|---|
| H7, H8, H11, H12 | 2 |
|------------------|---|

(B)

| Hosts | Port |
|---------------------------|------|
| H1, H2 | 4 |
| H3, H4 | 3 |
| H5, H6 | 1 |
| H7, H8, H9, H10, H11, H12 | 2 |

(C)

| Hosts | Port |
|------------------|------|
| H3, H4 | 3 |
| H5, H6, H9, H10 | 1 |
| H1, H2 | 4 |
| H7, H8, H11, H12 | 2 |

(D)

| Hosts | Port |
|------------------|------|
| H1, H2, H3, H4 | 3 |
| H5, H7, H9, H10 | 1 |
| H7, H8, H11, H12 | 4 |

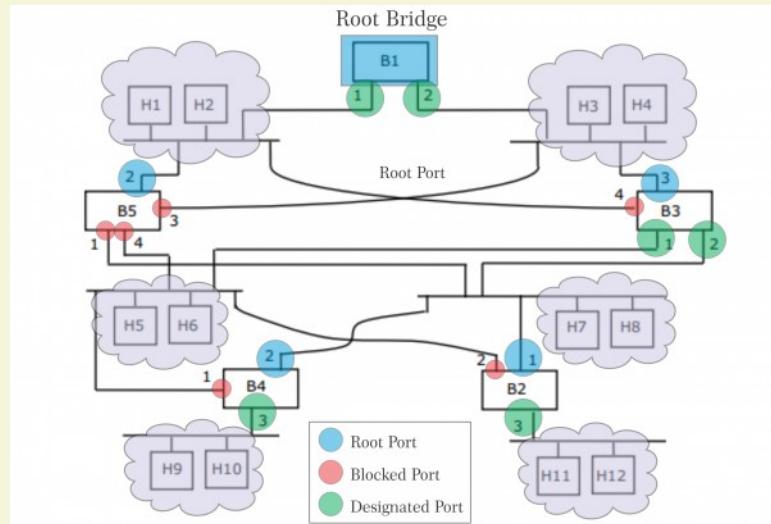
gate2006 computer-networks bridges normal

Answer

Answers: Bridges

4.3.1 Bridges: GATE2006_82,83 top

<http://gateoverflow.in/1855>



This makes it clear that:

Q.82 answer = **option A**

Q.83 answer = **option A**

7 votes

-- Amar Vashishth (20.7k points)

4.4

Communication top

4.4.1 Communication: GATE2004-IT_45 top

<http://gateoverflow.in/3688>

A serial transmission T1 uses 8 information bits, 2 start bits, 1 stop bit and 1 parity bit for each character. A synchronous transmission T2 uses 3 eight-bit sync characters followed by 30 eight-bit information characters. If the bit rate is 1200 bits/second in both cases, what are the transfer rates of T1 and T2?

- A) 100 characters/sec, 153 characters/sec
- B) 80 characters/sec, 136 characters/sec
- C) 100 characters/sec, 136 characters/sec
- D) 80 characters/sec, 153 characters/sec

[gate2004-it](#) [computer-networks](#) [communication](#) [normal](#)

Answer

4.4.2 Communication: GATE1997_2.3 top

<http://gateoverflow.in/2229>

Purpose of a start bit in RS 232 serial communication protocol is

- A. to synchronize receiver for receiving every byte
- B. to synchronize receiver for receiving a sequence of bytes
- C. a parity bit
- D. to synchronize receiver for receiving the last byte

[gate1997](#) [computer-networks](#) [communication](#) [normal](#)

Answer

4.4.3 Communication: GATE2007-IT-62 top

<http://gateoverflow.in/3506>

Let us consider a statistical time division multiplexing of packets. The number of sources is 10. In a time unit, a source transmits a packet of 1000 bits. The number of sources sending data for the first 20 time units is 6, 9, 3, 7, 2, 2, 2, 3, 4, 6, 1, 10, 7, 5, 8, 3, 6, 2, 9, 5 respectively. The output capacity of multiplexer is 5000 bits per time unit. Then the average number of backlogged of packets per time unit during the given period is

- A. 5
- B. 4.45
- C. 3.45
- D. 0

gate2007-it computer-networks communication normal

Answer

4.4.4 Communication: GATE2004_22 [top](#)

<http://gateoverflow.in/1019>

How many 8-bit characters can be transmitted per second over a 9600 baud serial communication link using asynchronous mode of transmission with one start bit, eight data bits, two stop bits and one parity bit?

- A. 600
- B. 800
- C. 876
- D. 1200

gate2004 computer-networks communication normal

Answer

4.4.5 Communication: GATE2002_1.11 [top](#)

<http://gateoverflow.in/815>

In serial data transmission, every byte of data is padded with a '0' in the beginning and one or two '1's at the end of byte because

- A. receiver is to be synchronized for byte reception
- B. receiver recovers lost '0's and '1's from these padded bits
- C. padded bits are useful in parity computation
- D. none of the above

gate2002 computer-networks communication easy

Answer

4.4.6 Communication: GATE1993-6.4, ISRO2008-14 [top](#)

<http://gateoverflow.in/2287>

Assume that each character code consists of 8 bits. The number of characters that can be transmitted per second through an asynchronous serial line at 2400 baud rate, and with two stop bits is

- A. 109
- B. 216
- C. 218
- D. 219
- E. 240

gate1993 computer-networks communication normal isro2008

Answer

4.4.7 Communication: GATE2012_44 [top](#)

<http://gateoverflow.in/2153>

Consider a source computer (S) transmitting a file of size 10^6 bits to a destination computer (D) over a network of two routers (R_1 and R_2) and three links (L_1 , L_2 , and L_3). L_1 connects S to R_1 ; L_2 connects R_1 to R_2 ; and L_3 connects R_2 to D . Let each link be of length 100 km. Assume signals travel over each link at a speed of 10^8 meters per second. Assume that the link bandwidth on each link is 1 Mbps. Let the file be broken down into 1000 packets each of size 1000 bits. Find the total sum of transmission and propagation delays in transmitting the file from S to D ?

- (A) 1005 ms
- (B) 1010 ms
- (C) 3000 ms
- (D) 3003 ms

[gate2012](#) [computer-networks](#) [communication](#) [normal](#)

[Answer](#)

4.4.8 Communication: GATE2007-IT_64 [top](#)

<http://gateoverflow.in/3509>

A broadcast channel has 10 nodes and total capacity of 10 Mbps. It uses polling for medium access. Once a node finishes transmission, there is a polling delay of 80 μ s to poll the next node. Whenever a node is polled, it is allowed to transmit a maximum of 1000 bytes. The maximum throughput of the broadcast channel is

- | | |
|----|-------------|
| A) | 1 Mbps |
| B) | 100/11 Mbps |
| C) | 10 Mbps |
| D) | 100 Mbps |

[gate2007-it](#) [computer-networks](#) [communication](#) [normal](#)

[Answer](#)

Answers: Communication

4.4.1 Communication: GATE2004-IT_45 [top](#)

<http://gateoverflow.in/3688>



Selected Answer

1. T_1 : 1 char. = $(8 + 2 + 1 + 1) = 12$ bit
 Transfer Rate = $1200/12 = 100$ char/sec.
 T_2 : Transfer character in bits = $24 + 240 = 264$ bits
 In $264 = 30$ character
 Then $1200 = ?$
 $264/30 = 1200/X$
 $X = 136.3$ character / sec.
 so correct option is (C)

7 votes

-- Shreyans Dhankhar (2.4k points)

4.4.2 Communication: GATE1997_2.3 [top](#)

<http://gateoverflow.in/2229>

- A) Because RS 232 requires a start before each byte transmission for synchronization..

1 votes

-- Hunain (441 points)

4.4.3 Communication: GATE2007-IT-62 [top](#)

<http://gateoverflow.in/3506>

Answer: C

In statistical TDM, the bandwidth is divided into slots each for a source if the source requires. There is no dedicated slot for each source in the bandwidth.

STDM does not reserve a time slot for each terminal, rather it assigns a slot when the terminal is requiring data to be sent or received.

Multiplexer bandwidth = 5000bits = 5 packets can be send in a time unit.

If x number of source want to transmit in a particular time unit then MBW will be divided among x sources. Therefore,

```
if [x <= 5] {
    all x sources can successfully transmit their 1000bits because [x*1000]<=[5000]
} else {
    all sources cannot transmit their complete 1000 bits and there will be backlog of x (incompletely transmitted) packets.
}
```

So,

6 [Backlog], 9 [-], 7 [Backlog], 3 [-], 7 [Backlog], 2 [-], 2 [-], 3 [-], 4 [-], 6 [Backlog], 1 [-], 10 [Backlog], 7 [Backlog], 5 [-], 8 [Backlog], 3 [-], 6 [Backlog], 2 [-], 9 [Backlog], 5 [-]

Average number of backlogged packets per time unit during the given period is = $[6+9+7+6+10+7+8+6+9]/20 = 3.4$

4 votes

-- Rajarshi Sarkar (29.7k points)

Answer is C

Here we can spent at max 5 packets per Time unit 5000 /1000. So

Whatever which is not sent is backlog.

So

First Time Unit => 6 ,

Backlog in First time unit => 6-5 => 1 This one gets added to next Time units load

Second time unit => 9 + 1 (One from Previous Time Unit)

Backlog in Second time Unit = 10-5 => 5 (This one gets added to next Time Units load).

Total Backlog this way = > 89/20 => 4.45

4 votes

-- Akash (31.7k points)

4.4.4 Communication: GATE2004_22 [top](#)

<http://gateoverflow.in/1019>

Selected Answer

The baud rate is the rate at which information is transferred in a communication channel. Serial ports use two-level (binary) signaling, so the data rate in bits per second is equal to the symbol rate in bauds. Ref: https://en.wikipedia.org/wiki/Serial_port#Speed.

"9600 baud" means that the serial port is capable of transferring a maximum of 9600 bits per second."

So, transmission rate here = 9600 bps

An eight bit data (which is a char) requires 1 start bit, 2 stop bits and 1 parity bit = 12 bits.

So, number of characters transmitted per second = $9600 / 12 = 800$

8 votes

-- Arjun Suresh (150k points)

4.4.5 Communication: GATE2002_1.11 [top](#)<http://gateoverflow.in/815>

Option a

1 votes

-- anshu (2.5k points)

In serial communication in beginning '0' is padded as start bit and one or two '1's are padded as stop bit.

and those bits are for synchronize receiver

http://www.powerbasic.com/support/help/pbcc/start_and_stop_bits.htm

<http://esd.cs.ucr.edu/labs/serial/serial.html>

1 votes

-- srestha (27.8k points)

4.4.6 Communication: GATE1993-6.4, ISRO2008-14 [top](#)<http://gateoverflow.in/2287>

Selected Answer

Total bit per character = 8 bit data + 2 stop bit + 1 start bit (#) = 11 bits
no of characters = $2400/11 = 218.18$

Since it is asked for transmitted characters we take floor and answer is 218.

4 votes

-- Digvijay (35.8k points)

4.4.7 Communication: GATE2012_44 [top](#)<http://gateoverflow.in/2153>

Selected Answer

routers are store and forward devices.
Propagation time = $100\text{km}/10^8\text{m/s} = 1 \text{ millisecond}$
Transmission time for a packet = $1000/10^6 = 1 \text{ millisecond}$

Packets will be forwarded in pipelined manner, after the first packet reaches the receiver, in every 1 ms a new one arrives.

now Time taken by packet no 1 to reach destination is :
1 ms (TT at sender) + 1 ms (PT from sender to R1) + 1ms (TT at R1) + 1ms(PT from R1 to R2) + 1ms (TT at R2) + 1ms (PT from R2 to destination)
= 6ms

So, time for packet 1000 = 6ms + 999ms
= 1005ms

20 votes

-- Digvijay (35.8k points)

4.4.8 Communication: GATE2007-IT_64 [top](#)<http://gateoverflow.in/3509>

Selected Answer

Propagation time is not given so that's negligible here.
efficiency = transmission time/(transmission time + polling time)
 $Tx=1000 \text{ bytes}/10\text{Mbps} = 800\mu\text{s}$.
Delay because of polling is = $80 \mu\text{s}$
Efficiency of channel , e =transmission delay/ (total delay) = $800/(800+80)= 10/11$
Maximum throughput is =(10/11) * 10 Mbps= $100/11 \text{ Mbps}$

13 votes

-- Manu Thakur (5.6k points)

4.5**Congestion Control** [top](#)**4.5.1 Congestion Control: GATE2008-56** [top](#)<http://gateoverflow.in/479>

In the slow start phase of the TCP congestion algorithm, the size of the congestion window

- A. does not increase
- B. increase linearly
- C. increases quadratically
- D. increases exponentially

[gate2008](#) [computer-networks](#) [congestion-control](#) [normal](#)
Answer**4.5.2 Congestion Control: GATE2014-1_27** [top](#)<http://gateoverflow.in/1794>

Let the size of congestion window of a TCP connection be 32 KB when a timeout occurs. The round trip time of the connection is 100 msec and the maximum segment size used is 2 KB. The time taken (**in msec**) by the TCP connection to get back to 32 KB congestion window is _____.

[gate2014-1](#) [computer-networks](#) [tcp](#) [congestion-control](#) [numerical-answers](#) [normal](#)
Answer**4.5.3 Congestion Control: GATE2005-IT_73** [top](#)<http://gateoverflow.in/3836>

On a TCP connection, current congestion window size is Congestion Window = 4 KB. The window size advertised by the receiver is Advertise Window = 6 KB. The last byte sent by the sender is LastByteSent = 10240 and the last byte acknowledged by the receiver is LastByteAcked = 8192. The current window size at the sender is

- A) 2048 bytes
- B) 4096 bytes
- C) 6144 bytes
- D) 8192 bytes

[gate2005-it](#) [computer-networks](#) [congestion-control](#) [normal](#)
Answer**4.5.4 Congestion Control: GATE2012_45** [top](#)<http://gateoverflow.in/2156>

Consider an instance of TCP's Additive Increase Multiplicative Decrease (AIMD) algorithm where the window size at the start of the slow start phase is 2 MSS and the threshold at the start of the first transmission is 8 MSS. Assume that a timeout occurs during the fifth transmission. Find the congestion window size at the end of the tenth transmission.

- (A) 8 MSS
- (B) 14 MSS
- (C) 7 MSS
- (D) 12 MSS

[gate2012](#) [computer-networks](#) [congestion-control](#) [normal](#)
Answer**Answers: Congestion Control**

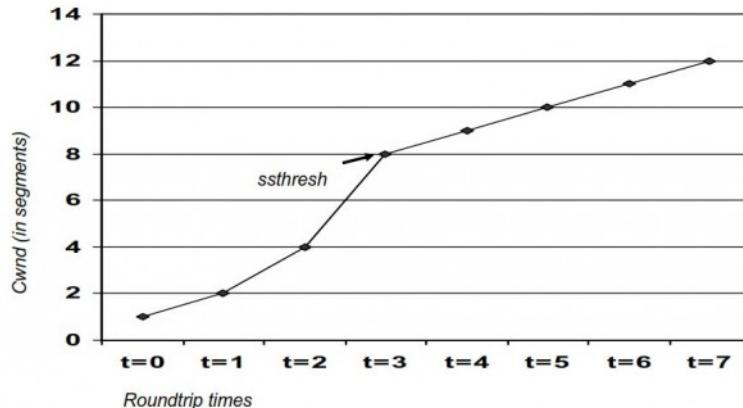
4.5.1 Congestion Control: GATE2008-56 [top](#)

<http://gateoverflow.in/479>



Selected Answer

Assume that $ssthresh = 8$



increase is exponential in the Slow Start Phase.

answer = **option D**

7 votes

-- Amar Vashishth (20.7k points)

ans d)

Ref: <http://www.ece.virginia.edu/~mv/edu/ee136/Lectures/congestion-control/tcp-congestion-control.pdf>

7 votes

-- Aditi Dan (5.4k points)

4.5.2 Congestion Control: GATE2014-1_27 [top](#)

<http://gateoverflow.in/1794>



Selected Answer

Ans: Given that at the time of **Time Out**, Congestion Window Size is $32KB$ and $RTT = 100ms$,

When Time Out occurs, for the next round of Slow Start,

$$\text{Threshold} = \frac{\text{size of congestion window}}{2},$$

Threshold = $16KB$

Suppose we have a **slow start** ==> $2KB | 4KB | 8KB | 16KB$ (As the threshold is reached, Additive increase starts) $| 18KB | 20KB | 22KB | 24KB | 26KB | 28KB | 30KB | 32KB$

Here | (vertical line) is representing **RTT** so the total number of vertical lines is $11 * 100ms ==> 1100msec$ and so this is the answer...

33 votes

-- Jay (1.1k points)

4.5.3 Congestion Control: GATE2005-IT_73 [top](#)

<http://gateoverflow.in/3836>



Selected Answer

Answer is (A)**Current Sender window = min (Congestion Window, Advertised Window)= min(4KB, 6KB)= 4KB****Unacknowledged Bytes= 10240 - 8192 = 2048 Bytes =2 KB****Since 2KB data is unacknowledged it can send only (Current window- Unacknowledged Bytes)= 4KB- 2KB =2KB = 2048 Bytes**

10 votes

-- Sandeep_Uniyal (5.5k points)

4.5.4 Congestion Control: GATE2012_45 [top](#)

<http://gateoverflow.in/2156>

Selected Answer

At

t=1, =>2mss

t=2, =>4mss

t=3, =>8mss

t=4, =>9mss (after threshold additive increase)

t=5, =>10mss (fails)

Threshold will be reduced by n/2 i.e. 10/2 = 5.

t=6, =>2mss

t=7 =>4mss

t=8, =>5mss

t=9, =>6mss

t=10, =>7mss.

So at the end of 10th transmission 7 segments will be transmitted.

Hence the congestion window size will be 7mss.

20 votes

-- Gate Keeda (17.7k points)

4.6

Crc Polynomial [top](#)

4.6.1 Crc Polynomial: GATE2007-68, ISRO2016-73 [top](#)

<http://gateoverflow.in/1266>

The message 11001001 is to be transmitted using the CRC polynomial $x^3 + 1$ to protect it from errors. The message that should be transmitted is:

- A. 11001001000
- B. 11001001011
- C. 11001010
- D. 110010010011

[gate2007](#) [computer-networks](#) [error-detection](#) [crc-polynomial](#) [normal](#) [isro2016](#)
Answer

4.6.2 Crc Polynomial: GATE2005-IT_78 [top](#)

<http://gateoverflow.in/3842>

Consider the following message $M = 1010001101$. The cyclic redundancy check (CRC) for this message using the divisor polynomial $x^5 + x^4 + x^2 + 1$ is :

- A) 01110
- B) 01011
- C) 10101
- D) 10110

[gate2005-it](#) [computer-networks](#) [crc-polynomial](#) [normal](#)
Answer

Answers: Crc Polynomial

4.6.1 Crc Polynomial: GATE2007-68, ISRO2016-73 [top](#)

<http://gateoverflow.in/1266>

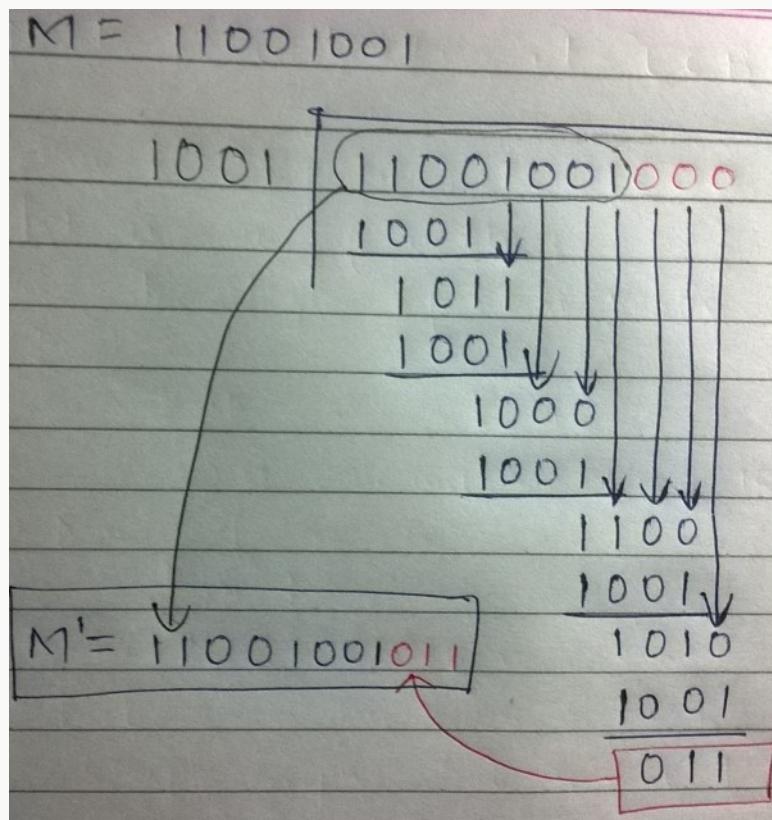
Selected Answer

answer - B

degree of generator polynomial is 3 hence 3 bits are appended before performing division

after performing division using 2's complement arithmetic remainder is 011

the remainder is appended to original data bits



By **Anurag Pandey**

6 votes

-- ankitrokdeonsns (8.4k points)

4.6.2 Crc Polynomial: GATE2005-IT_78 [top](#)

<http://gateoverflow.in/3842>



Selected Answer

Answer: A

Divide 101000110100000 by 110101 to get 01110 as remainder. And as we know, remainder is the CRC.

6 votes

-- Rajarshi Sarkar (29.7k points)

4.7

Cryptography [top](#)

4.7.1 Cryptography: GATE 2016-2-23 [top](#)

<http://gateoverflow.in/39555>

Anarkali digitally signs a message and sends it to Salim. Verification of the signature by Salim requires.

- A. Anarkali's public key.
- B. Salim's public key.
- C. Salim's private key.
- D. Anarkali's private key.

[gate2016-2](#) | [computer-networks](#) | [network-security](#) | [cryptography](#) | [easy](#)

Answer

Answers: Cryptography

4.7.1 Cryptography: GATE 2016-2-23 [top](#)

<http://gateoverflow.in/39555>



Selected Answer

In digital signature,
Alice/Anarkali/sender :P

First encrypts with **own private key** then again encrypts with Receivers/Bob/Salim's **Public key**.

Thus to decrypt, receiver will need **sender's/Anarkali's public key** after decrypting it with own/receiver's private key.

So answer is A !

13 votes

-- Shashank Chavan (2.6k points)

4.8

Csma Cd [top](#)

4.8.1 Csma Cd: GATE2015-3_6 [top](#)

<http://gateoverflow.in/8400>

Consider a CSMA/CD network that transmits data at a rate of 100 Mbps (10^8 bits per second) over a 1 km (kilometer) cable with no repeaters. If the minimum frame size required for this network is 1250 bytes, what is the signal speed (km/sec) in the cable?

- A. 8000
- B. 10000
- C. 16000
- D. 20000

gate2015-3 computer-networks congestion-control csma-cd normal

Answer

4.8.2 Csma Cd: GATE 2016-2-53 [top](#)

<http://gateoverflow.in/39589>

A network has a data transmission bandwidth of 20×10^6 bits per second. It uses **CSMA/CD** in the **MAC** layer. The maximum signal propagation time from one node to another node is 40 microseconds. The minimum size of a frame in the network is _____ bytes.

gate2016-2 computer-networks csma-cd numerical-answers normal

Answer

4.8.3 Csma Cd: GATE2008-IT_65 [top](#)

<http://gateoverflow.in/3376>

The minimum frame size required for a CSMA/CD based computer network running at 1 Gbps on a 200m cable with a link speed of 2×10^8 m/s is

- A) 125 bytes
- B) 250 bytes
- C) 500 bytes
- D) None of the above

gate2008-it computer-networks csma-cd normal

Answer

4.8.4 Csma Cd: GATE2005-IT_71 [top](#)

<http://gateoverflow.in/3834>

A network with CSMA/CD protocol in the MAC layer is running at 1 Gbps over a 1 km cable with no repeaters. The signal speed in the cable is 2×10^8 m/sec. The minimum frame size for this network should be

- A) 10000 bits
- B) 10000 bytes
- C) 5000 bits
- D) 5000 bytes

gate2005-it computer-networks congestion-control csma-cd normal

Answer

4.8.5 Csma Cd: GATE2005-IT_27 [top](#)

<http://gateoverflow.in/3773>

Which of the following statements is TRUE about CSMA/CD

- A) IEEE 802.11 wireless LAN runs CSMA/CD protocol
- B) Ethernet is not based on CSMA/CD protocol
- C) CSMA/CD is not suitable for a high propagation delay network like satellite network
- D) There is no contention in a CSMA/CD network

[gate2005-it](#) [computer-networks](#) [congestion-control](#) [csma-cd](#) [normal](#)
[Answer](#)

Answers: Csma Cd

4.8.1 Csma Cd: GATE2015-3_6 [top](#)

<http://gateoverflow.in/8400>


Selected Answer

For collision to be detected, the frame size should be such that the transmission time of the frame should be greater than twice the propagation delay (So, before the frame is completely sent, any possible collision will be discovered).

$$\text{So, } 1250 * 8 / (10^8) \geq 2 * 1 / x$$

$$x = 2 * 10^4 = 20000$$

12 votes
-- Arjun Suresh (150k points)

4.8.2 Csma Cd: GATE 2016-2-53 [top](#)

<http://gateoverflow.in/39589>


Selected Answer

Since CSMA/CD

Transmission Delay = RTT
hence,

$$\begin{aligned} L &= B \times \text{RTT} \\ L &= B \times 2 \times \text{Tpropagation delay} \end{aligned}$$

$$\begin{aligned} L &= (20 \times 10^6) \times 2 \times 40 \times 10^{-6} \\ &= 20 \times 2 \times 40 \\ &= 1600 \text{ bits} \\ &= 200 \text{ bytes} \end{aligned}$$

Hence **200Bytes** is the answer.

10 votes
-- Shashank Chavan (2.6k points)

4.8.3 Csma Cd: GATE2008-IT_65 [top](#)

<http://gateoverflow.in/3376>


Selected Answer

Minimum frame size is needed to ensure that collisions are detected properly. The minimum frame size ensures that before a frame is completely send, it would be notified of any possible collision and hence collision detection works perfectly.

In CSMA/CD a sender won't send a packet if it senses that another sender is using it. So, assume a sender A and a receiver B. When sender sends a packet, receiver might use the cable until it is notified that a packet is being send to it. The receiver will be notified as soon as the first bit arrives that a packet is coming and it won't send any packet after this until that packet is finished. So, in the worst case for collision, receiver will transmit a packet back to the sender just before the first bit of the packet reaches it. (If t_d is the propagation delay of the channel, this time would be just t_d). In this case, surely there will be collision. But for the sender to detect it, it should be notified of B's packet before the sending of the first packet finishes. i.e., when B's packet arrives at A (takes another t_d time), A shouldn't have finished transmission of the first packet for it to detect a collision. i.e., A should be still continuing the sending of the packet in this time interval of $2 \times t_d$. Thus,

The amount of bits that can be transmitted by A in $2 \times t_d$ time should be less than the frame size (S) (sending of the frame shouldn't finish in this time)

Amount of bits transmitted in time t is bandwidth $\times t$ and propagation delay- t_d is $\frac{\text{distance}}{\text{link speed}}$

$$\text{So, } S \geq 2 \times \text{bandwidth} \times t_d$$

$$\geq 2 \times 10^9 \times \frac{200}{2 \times 10^8}$$

$$\geq 2000 \text{ bits}$$

$$\geq 250 \text{ bytes}$$

10 votes

-- Arjun Suresh (150k points)

4.8.4 Csma Cd: GATE2005-IT_71 [top](#)

<http://gateoverflow.in/3834>



Selected Answer

Minimum frame size is needed to ensure that collisions are detected properly. The minimum frame size ensures that before a frame is completely send, it would be notified of any possible collision and hence collision detection works perfectly.

In CSMA/CD a sender won't send a packet if it senses that another sender is using it. So, assume a sender A and a receiver B. When sender sends a packet, receiver might use the cable until it is notified that a packet is being sent to it. The receiver will be notified as soon as the first bit arrives that a packet is coming and it won't send any packet after this until that packet is finished. So, in the worst case for collision, receiver will transmit a packet back to the sender just before the first bit of the packet reaches it. (If t_d is the propagation delay of the channel, this time would be just t_d). In this case, surely there will be collision. But for the sender to detect it, it should be notified of B's packet before the sending of the first packet finishes. i.e., when B's packet arrives at A (takes another t_d time), A shouldn't have finished transmission of the first packet for it to detect a collision. i.e., A should be still continuing the sending of the packet in this time interval of $2 \times t_d$. Thus,

The amount of bits that can be transmitted by A in $2 \times t_d$ time should be less than the frame size (S) (sending of the frame shouldn't finish in this time)

Amount of bits transmitted in time t is bandwidth $\times t$ and propagation delay- t_d is $\frac{\text{distance}}{\text{link speed}}$

$$\text{So, } S \geq 2 \times \text{bandwidth} \times t_d$$

$$\geq 2 \times 10^9 \times \frac{1000}{2 \times 10^8}$$

$$\geq 10000 \text{ bits}$$

9 votes

-- Arjun Suresh (150k points)

4.8.5 Csma Cd: GATE2005-IT_27 [top](#)

<http://gateoverflow.in/3773>



Selected Answer

Answer->C

CSMA/CD was used in early days, 802.3 not in 802.11

There will be contention in this protocol.

Ethernet is based on csma/cd early in 1980s,

6 votes

-- nagalla pruthvi (689 points)

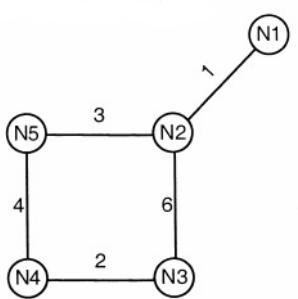
4.9

Distance Vector Routing [top](#)

4.9.1 Distance Vector Routing: GATE2011-52 [top](#)

<http://gateoverflow.in/2160>

Consider a network with five nodes, N1 to N5, as shown below.



The network uses a Distance Vector Routing protocol. Once the routes have been stabilized, the distance vectors at different nodes are as following.

N1: (0, 1, 7, 8, 4)

N2: (1, 0, 6, 7, 3)

N3: (7, 6, 0, 2, 6)

N4: (8, 7, 2, 0, 4)

N5: (4, 3, 6, 4, 0)

Each distance vector is the distance of the best known path at that instance to nodes, N1 to N5, where the distance to itself is 0. Also all links are symmetric and the cost is identical in both directions. In each round, all nodes exchange their distance vectors with their respective neighbors. Then all nodes update their distance vectors. In between two rounds, any change in cost of a link will cause the two incident nodes to change only that entry in their distance vectors.

The cost of link N2-N3 reduces to 2 (in both directions). After the next round of updates, what will be the new distance vector at node, N3?

- A. (3, 2, 0, 2, 5)
- B. (3, 2, 0, 2, 6)
- C. (7, 2, 0, 2, 5)
- D. (7, 2, 0, 2, 6)

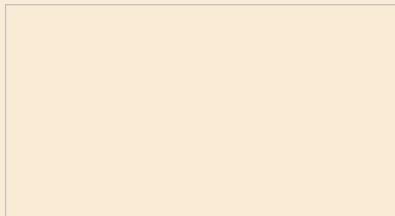
[gate2011](#) [computer-networks](#) [routing](#) [distance-vector-routing](#) [normal](#)

Answer

4.9.2 Distance Vector Routing: GATE2010-54 [top](#)

<http://gateoverflow.in/2362>

Consider a network with 6 routers R1 to R6 connected with links having weights as shown in the following diagram.



All the routers use the distance vector based routing algorithm to update their routing tables. Each router starts with its routing table initialized to contain an entry for each neighbour with the weight of the respective connecting link. After all the routing tables stabilize, how many links in the network will never be used for carrying any data?

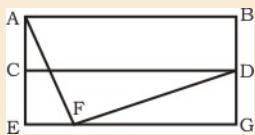
- A. 4
- B. 3
- C. 2
- D. 1

Answer

4.9.3 Distance Vector Routing: GATE2007-IT_60 [top](#)

<http://gateoverflow.in/3504>

For the network given in the figure below, the routing tables of the four nodes A, E, D and G are shown. Suppose that F has estimated its delay to its neighbors, A, E, D and G as 8, 10, 12 and 6 msec respectively and updates its routing table using distance vector routing technique.



Routing Table of A

| | |
|---|----|
| A | 0 |
| B | 40 |
| C | 14 |
| D | 17 |
| E | 21 |
| F | 9 |
| G | 24 |

Routing Table of D

| | |
|---|----|
| A | 20 |
| B | 8 |
| C | 30 |
| D | 0 |
| E | 14 |
| F | 7 |
| G | 22 |

Routing Table of E

| | |
|---|----|
| A | 24 |
| B | 27 |
| C | 7 |
| D | 20 |
| E | 0 |
| F | 11 |
| G | 22 |

Routing Table of G

| | |
|---|----|
| A | 21 |
| B | 24 |
| C | 22 |
| D | 19 |
| E | 22 |
| F | 10 |
| G | 0 |

A)

| | |
|---|----|
| A | 8 |
| B | 20 |
| C | 17 |
| D | 12 |
| E | 10 |
| F | 0 |
| G | 6 |

B)

| | |
|---|----|
| A | 21 |
| B | 8 |
| C | 7 |
| D | 19 |
| E | 14 |
| F | 0 |
| G | 22 |

C)

| | |
|---|----|
| A | 8 |
| B | 20 |
| C | 17 |
| D | 12 |
| E | 10 |
| F | 16 |
| G | 6 |

D)

| | |
|---|----|
| A | 8 |
| B | 8 |
| C | 7 |
| D | 12 |

| | |
|---|----|
| E | 10 |
| F | 0 |
| G | 6 |

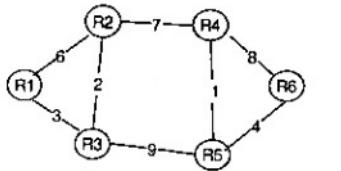
gate2007-it | computer-networks | distance-vector-routing | normal

Answer

4.9.4 Distance Vector Routing: GATE2010-55 [top](#)

<http://gateoverflow.in/43326>

Consider a network with 6 routers R1 to R6 connected with links having weights as shown in the following diagram.



Suppose the weights of all unused links are changed to 2 and the distance vector algorithm is used again until all routing tables stabilize. How many links will now remain unused?

- A. 0
- B. 1
- C. 2
- D. 3

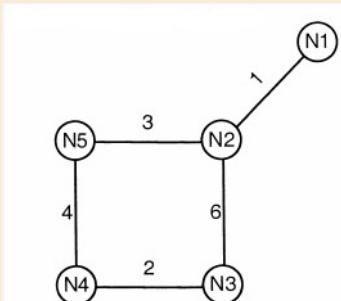
gate2010 | computer-networks | routing | distance-vector-routing | normal

Answer

4.9.5 Distance Vector Routing: GATE2011-53 [top](#)

<http://gateoverflow.in/43317>

Consider a network with five nodes, N1 to N5, as shown as below.



The network uses a Distance Vector Routing protocol. Once the routes have been stabilized, the distance vectors at different nodes are as following.

- N1:** (0, 1, 7, 8, 4)
- N2:** (1, 0, 6, 7, 3)
- N3:** (7, 6, 0, 2, 6)
- N4:** (8, 7, 2, 0, 4)
- N5:** (4, 3, 6, 4, 0)

Each distance vector is the distance of the best known path at that instance to nodes, N1 to N5, where the distance to itself is 0. Also all links are symmetric and the cost is identical in both directions. In each round, all nodes exchange their distance vectors with their respective neighbors. Then all nodes update their distance vectors. In between two rounds, any change in cost of a link will cause the two incident nodes to change only that entry in their distance vectors.

The cost of link N2-N3 reduces to 2 (in both directions). After the next round of updates, the link N1-N2 goes down. N2 will reflect this change immediately in its distance vector as cost,

∞ . After the **NEXT ROUND** of update, what will be the cost to N1 in the distance vector of N3?

- A. 3
- B. 9
- C. 10
- D. ∞

gate2011 computer-networks routing distance-vector-routing normal

[Answer](#)

4.9.6 Distance Vector Routing: GATE2005-IT_29 [top](#)

<http://gateoverflow.in/3775>

Count to infinity is a problem associated with

- A) link state routing protocol.
- B) distance vector routing protocol.
- C) DNS while resolving host name.
- D) TCP for congestion control.

gate2005-it computer-networks routing distance-vector-routing normal

[Answer](#)

Answers: Distance Vector Routing

4.9.1 Distance Vector Routing: GATE2011-52 [top](#)

<http://gateoverflow.in/2160>



Selected Answer

Q:52 Answer is (A)

1. As soon as N2-N3 reduces to 2, both N2 and N3 instantly updates their distance to N3 and N2 to 2 respectively. So N2: (1, 0, 2, 7, 3), N3: (7, 2, 0, 2, 6) becomes this.

After this starts first round of update in which each node shares its table with their respective neighbors ONLY. BUT KEEP IN MIND THAT ONLY OLD TABLES WILL BE SHARED. What I mean is tables that will be used for updation at this moment contain the values as N1: (0, 1, 7, 8, 4), N2: (1, 0, 2, 7, 3), N3: (7, 2, 0, 2, 6), N4: (8, 7, 2, 0, 4), N5: (4, 3, 6, 4, 0).

SEE at this time all the entries are old EXCEPT in N2 and N3 where value changes to 2 instead of 6.

Question asks for N3. So focus on that.

N3 receives tables from N2: (1, 0, 2, 7, 3) and N4: (8, 7, 2, 0, 4). Using THIS ONLY original N3: (7, 2, 0, 2, 6) updates to N3(3,2,0,2,5) .(For updation and forming the tables for this refer FOROUZAN.)

So answer is (A).

14 votes

-- Sandeep_Uniyal (5.5k points)

4.9.2 Distance Vector Routing: GATE2010-54 [top](#)

<http://gateoverflow.in/2362>



Selected Answer

Answer (C)

Following will be distance vectors of all nodes.

Shortest Distances from R1 to R2, R3, R4, R5 and R6
 R1 (5, 3, 12, 12, 16)
 Links used: R1-R3, R3-R2, R2-R4, R3-R5, R5-R6

Shortest Distances from R2 to R3, R4, R5 and R6

R2 (2, 7, 8, 12)

Links used: R2-R3, R2-R4, R4-R5, R5-R6

Shortest Distances from R3 to R4, R5 and R6

R3 (9, 9, 13)

Links used: R3-R2, R2-R4, R3-R5, R5-R6

Shortest Distances from R4 to R5 and R6

R4 (1, 5)

Links used: R4-R5, R5-R6

Shortest Distance from R5 to R6

R5 (4)

Links Used: R5-R6

If we mark, all the used links one by one, we can see that following links are never used.

R1-R2

R4-R6

1 2 votes

-- Akhil Nadh Pullolikkal Chandran (6.9k points)

4.9.3 Distance Vector Routing: GATE2007-IT_60 [top](#)

<http://gateoverflow.in/3504>



Selected Answer

Answer: A

Distance from F to F is 0 which eliminates option C.

Using distance vector routing protocol, F -> D -> B yields distance as 20 which eliminates option B and D.

1 9 votes

-- Rajarshi Sarkar (29.7k points)

4.9.4 Distance Vector Routing: GATE2010-55 [top](#)

<http://gateoverflow.in/43326>



Selected Answer

B) All entries are set to ∞ .
 $R_1 - R_2$ and $R_4 - R_6$ remain unused.

Distance from R_1 : $(\infty, \infty, \infty, \infty, \infty, \infty)$
 $(2, 3, 9, 10, 11)$

R_2 : $(\infty, \infty, \infty, \infty, \infty, \infty)$
 $(3, 7, 8, 9)$

R_3 : $(\infty, \infty, \infty, \infty, \infty, \infty)$
 $(9, 1, 12)$

R_4 : $(\infty, \infty, \infty, \infty, \infty, \infty)$
 $(1, 2)$

R_5 : $(\infty, \infty, \infty, \infty, \infty, \infty)$
 (3)

Link $R_5 - R_6$ Not used

Only one link is not used

2 votes

-- Akhil Nadh Pulolikkal Chandran (6.9k points)

4.9.5 Distance Vector Routing: GATE2011-53 [top](#)

<http://gateoverflow.in/43317>



Selected Answer

First, as soon as N1-N2 goes down, N2 and N1 both update that entry in their tables as infinity. So N2 at this moment will be $N2(\infty, 0, 2, _, _)$. I have left blank coz that details are not important.

Now for N3 to get updated in the subsequent round it will get tables from N2 and N4 only. But first we need to find the N4 calculated in previous update. So in previous question N4 received updates from N3 and N5 which are N3: $(7, 6, 0, 2, 6)$, N5: $(4, 3, 6, 4, 0)$.

NOW THIS IS VERY IMPORTANT AS WHY N4 DID NOT GET UPDATED TABLES FROM N3. SO ANSWER IS THAT these tables were shared at the same moment and so in a particular round of update old values of all the tables are used and not the updated values.

N3 was updates AFTER IT PASSED ITS OLD table to its neighbors AS WHY WOULD N4 WAIT FOR N3 TO GET UPDATED first !!! **So N4 will update its table (in prev question) to N4(8,7,2,0,4).**

See here path to N1 exists via N5 and not via N3 bcoz when table was shared by N3 it contained path to N1 as 7 and N1 via N3 sums to $7+2=9$. Now when N3 receives tables from $N2(\infty, 0, _, _, _)$ and $N4(8, 7, 2, 0, 4)$.

At first it will see its distance to N1 as "Inf" and NOT 3 because "inf" is the new distance with the same Next hop N2 (**If next hop is same, new entry is updated even though it is larger than previous entry for the same NEXT HOP**).

But at the same time it sees distance to N1 from N4 as 8 and so updates with the value $(N3-N4 + N4-N1) = (2+8)=10$. So N3-N1 distance in N3($10, _, 0, _, _)$ is 10.

So answer is (C)

Ref: <http://www.cs.princeton.edu/courses/archive/spr11/cos461/docs/lec14-distvector.pdf>

4 votes

-- Sandeep_Uniyal (5.5k points)

4.9.6 Distance Vector Routing: GATE2005-IT_29 [top](#)<http://gateoverflow.in/3775>

Selected Answer

Answer->B

Distance vector routing

3 votes

-- nagalla pruthvi (689 points)

4.10**Encoding** [top](#)**4.10.1 Encoding: GATE2006-IT_65** [top](#)<http://gateoverflow.in/3609>

In the 4B/5B encoding scheme, every 4 bits of data are encoded in a 5-bit codeword. It is required that the codewords have at most 1 leading and at most 1 trailing zero. How many such codewords are possible?

- A) 14
- B) 16
- C) 18
- D) 20

[gate2006-it](#) [computer-networks](#) [encoding](#) [permutation](#) [normal](#)

Answer

Answers: Encoding**4.10.1 Encoding: GATE2006-IT_65** [top](#)<http://gateoverflow.in/3609>

Selected Answer

Answer is (C)

It says we have 5 bit codeword such that "it can't have two consecutive zeros in first and second bit" and also "can't have two consecutive zeros in last two bits".

Code word with first two bits zero = 0|0|x|x|x| =8

Code word with last two bits zero = |x|x|x|0|0| =8

Code word with first and last two bits zero = 0|0|x|0|0| =2

Code word with first OR last two bits zero = 8+8-2=14

Therefore possible codewords =32-14 =18

7 votes

-- Sandeep_Uniyal (5.5k points)

4.11**Error Detection** [top](#)**4.11.1 Error Detection: GATE2007-IT-43** [top](#)<http://gateoverflow.in/3478>

An error correcting code has the following code words: 00000000, 00001111, 01010101, 10101010, 11110000. What is the maximum number of bit errors that can be corrected?

- A. 0
- B. 1
- C. 2
- D. 3

[gate2007-it](#) [computer-networks](#) [error-detection](#) [normal](#)

[Answer](#)

4.11.2 Error Detection: GATE2009-48 [top](#)

<http://gateoverflow.in/1334>

Let $G(x)$ be the generator polynomial used for CRC checking. What is the condition that should be satisfied by $G(x)$ to detect odd number of bits in error?

- A. $G(x)$ contains more than two terms
- B. $G(x)$ does not divide $1 + x^k$, for any k not exceeding the frame length
- C. $1 + x$ is a factor of $G(x)$
- D. $G(x)$ has an odd number of terms.

[gate2009](#) [computer-networks](#) [error-detection](#) [normal](#)

[Answer](#)

4.11.3 Error Detection: GATE2005-IT_74 [top](#)

<http://gateoverflow.in/3837>

In a communication network, a packet of length L bits takes link L_1 with a probability of p_1 or link L_2 with a probability of p_2 . Link L_1 and L_2 have bit error probability of b_1 and b_2 respectively. The probability that the packet will be received without error via either L_1 or L_2 is

- A. $(1 - b_1)^L p_1 + (1 - b_2)^L p_2$
- B. $[1 - (b_1 + b_2)]^L p_1 p_2$
- C. $(1 - b_1)^L (1 - b_2)^L p_1 p_2$
- D. $1 - (b_1^L p_1 + b_2^L p_2)$

[gate2005-it](#) [computer-networks](#) [error-detection](#) [probability](#) [normal](#)

[Answer](#)

4.11.4 Error Detection: GATE1992_01,ii [top](#)

<http://gateoverflow.in/546>

Consider a 3-bit error detection and 1-bit error correction hamming code for 4-bit datq. The extra parity bits required would be ____ and the 3-bit error detection is possible because the code has a minimum distance of ____

[gate1992](#) [computer-networks](#) [error-detection](#) [normal](#)

[Answer](#)

4.11.5 Error Detection: GATE1995_1.12 [top](#)

<http://gateoverflow.in/2599>

What is the distance of the following code 000000, 010101, 000111, 011001, 111111?

- A. 2
- B. 3
- C. 4
- D. 1

[gate1995](#) [computer-networks](#) [error-detection](#) [normal](#)

Answer

Answers: Error Detection

4.11.1 Error Detection: GATE2007-IT-43 [top](#)

<http://gateoverflow.in/3478>


Selected Answer

Answer: B

For correction: Floor of $[(\text{Hamming Distance} - 1)/2] = \text{Floor of } [1.5] = 1$ bit error.

For detection: Hamming Distance - 1 = 3 bit error.

up 6 votes

-- Rajarshi Sarkar (29.7k points)

4.11.2 Error Detection: GATE2009-48 [top](#)

<http://gateoverflow.in/1334>

ans c)

up 3 votes

-- Aditi Dan (5.4k points)

In this case polynomial generator should satisfy (A) Polynomial generated shouldn't be divisible by x (B) It should be divisible by $1 + x$ i.e $1 + x$ is a factor of polynomial.

up 3 votes

-- Registered user (41 points)

4.11.3 Error Detection: GATE2005-IT_74 [top](#)

<http://gateoverflow.in/3837>


Selected Answer

Probability of choosing link $L_1 = p_1$

Probability for no bit error (for any single bit) = $(1 - b_1)$

Similarly for link L_2

Probability of no bit error = $(1 - b_2)$

Packet can go either through link L_1 or L_2 they are mutually exclusive events (means one event happens other won't be happening and so we can simply add their respective probabilities for the favorable case).

Probability packet will be received without any error = Probability of L_1 being chosen and no error in any of the L bits + Probability of L_2 being chosen and no error in any of the L bits

$$= (1 - b_1)^L p_1 + (1 - b_2)^L p_2.$$

Option D here is giving the probability of a frame being arrived with at least one bit correctly - i.e., all the bits are not errors.

up 11 votes

-- Pooja (25.9k points)

4.11.4 Error Detection: GATE1992_01,ii [top](#)

<http://gateoverflow.in/546>

let minimum Hamming distance is t .

so with this hamming distance $t-1$ bit error detection as well as $(t-1)/2$ bit error correction is possible..

for 3 bit error detection minimum Hamming distance = $3+1 = 4$
 for 1 bit error correction minimum Hamming distance = $2*1+1 = 4$
 no of parity bits = p
 $p + t + 1 \leq 2^p$
 $p + 4 + 1 \leq 2^p$
 $p=3$

5 votes

-- Digvijay (35.8k points)

4.11.5 Error Detection: GATE1995_1.12 [top](#)



Selected Answer

Distance (also called min-distance) of a block code is the minimum number of positions in which any two distinct codes differ. Here, min-distance occurs for the codes 2 and 3 and they differ only in 2 positions. So, $d = 2$.

https://en.wikipedia.org/wiki/Block_code

9 votes

-- Arjun Suresh (150k points)

4.12

Ethernet [top](#)

4.12.1 Ethernet: GATE2013_36 [top](#)

<http://gateoverflow.in/1547>

Determine the maximum length of the cable (in km) for transmitting data at a rate of 500 Mbps in an Ethernet LAN with frames of size 10,000 bits. Assume the signal speed in the cable to be 2,00,000 km/s.

- (A) 1 (B) 2 (C) 2.5 (D) 5

[gate2013](#) [computer-networks](#) [ethernet](#) [normal](#)

Answer

4.12.2 Ethernet: GATE2004_54 [top](#)

<http://gateoverflow.in/1050>

A and B are the only two stations on an Ethernet. Each has a steady queue of frames to send. Both A and B attempt to transmit a frame, collide, and A wins the first backoff race. At the end of this successful transmission by A, both A and B attempt to transmit and collide. The probability that A wins the second backoff race is

- A. 0.5
 B. 0.625
 C. 0.75
 D. 1.0

[gate2004](#) [computer-networks](#) [ethernet](#) [probability](#) [normal](#)

Answer

4.12.3 Ethernet: GATE 2016-2-24 [top](#)

<http://gateoverflow.in/39543>

In an Ethernet local area network, which one of the following statements is **TRUE**?

- A. A station stops to sense the channel once it starts transmitting a frame.
 B. The purpose of the jamming signal is to pad the frames that are smaller than the minimum frame size.
 C. A station continues to transmit the packet even after the collision is detected.
 D. The exponential back off mechanism reduces the probability of collision on retransmissions.

[gate2016-2](#) [computer-networks](#) [ethernet](#) [normal](#)
Answer**Answers: Ethernet****4.12.1 Ethernet: GATE2013_36** [top](#)<http://gateoverflow.in/1547>

Selected Answer

transmission time \geq round trip time of 1 bittransmission time $\geq 2 \times$ propagation time

$$\frac{10,000 \text{ bits}}{500 \text{ Mbps}} \geq 2 \times \frac{d}{2 \times 10^5 \text{ km per sec}}$$

$$\frac{2 \text{ km}}{2 \text{ km}} \geq d$$

option B is correct

8 votes

-- Amar Vashishth (20.7k points)

4.12.2 Ethernet: GATE2004_54 [top](#)<http://gateoverflow.in/1050>

Selected Answer

Find this solution.

In Ethernet networks, the Exponential back-off algorithm is commonly used to schedule re-transmissions after collisions. This algorithm gives waiting time for the stations that are involved in collision.

Waiting time for station = $k \times 51\text{ms}$ K is randomly chosen from 0 to $2^n - 1$ where n= no of collisions a station is involved.

51ms is a generic RTT for a standard Ethernet.

Station A and Station B both try to access a link at the same time. Since they detect a collision, A waits for a random time between 0 and 1 time units and so does B. It's given that A wins the first back-off race. Hence A has no need to wait and begins to use the link and B waits for $1 \times 51\text{ms}$ ($k=1$ is the number selected by B according to the algorithm). At the end of this successful transmission by A, both A and B attempts to transmit, and collide. A will once again choose a random back-off time between 0 and 1, but B will choose a back-off time between 0 and 3 - because this is his second time colliding in a row.

| Value of K selected by A | Value of K selected by B | Winner |
|--------------------------|--------------------------|--------|
| 0 | 0 | X |
| 0 | 1 | A |
| 0 | 2 | A |
| 0 | 3 | A |
| 1 | 0 | B |
| 1 | 1 | X |
| 1 | 2 | A |
| 1 | 3 | A |

Hence A has 5 chances to win out of 8 combinations.

Therefore that A wins the second backoff race = $5/8 = 0.625$

14 votes

-- Bijendra Behera (171 points)

4.12.3 Ethernet: GATE 2016-2-24 [top](#)<http://gateoverflow.in/39543>

Selected Answer

On Ethernet

- A) This is false because station need not stop to listen to stuff !
 B) No, this is not purpose of jamming singal.
 C) No, stations sends jamming signal if collision is detected. This is reason why B is false.
 So answer is D)

5 votes

-- Akash (31.7k points)

4.13**Firewall** [top](#)**4.13.1 Firewall: GATE2011_2** [top](#)<http://gateoverflow.in/2104>

A layer-4 firewall (a device that can look at all protocol headers up to the transport layer) **CANNOT**

- A. block entire HTTP traffic during 9:00PM and 5:00AM
- B. block all ICMP traffic
- C. stop incoming traffic from specific IP address but allow outgoing traffic to the same IP address
- D. block TCP traffic from a specific user on a multi-user system during 9:00PM to 5:00AM

[gate2011](#) [computer-networks](#) [network-security](#) [firewall](#) [normal](#)

Answer

Answers: Firewall**4.13.1 Firewall: GATE2011_2** [top](#)<http://gateoverflow.in/2104>

Selected Answer

Answer is (D).

(A) It is POSSIBLE to block "entire" HTTP traffic by blocking all the traffic on port number 80 Since here we DON'T need to check anything that is application layer specific. We only need to block port no 80 for required time span.

(B) & (C) are fairly possible to achieve.

(D) However (D) is not possible to achieve although the service uses TCP at transport layer. But see the question. We dont need to block entire TCP traffic so we cant block any specific PORT number. Also it is given that IT IS MULTI- USER System and so many user may be using same port for communication. Therefore blocking that port would block all the users WHILE we want a specific user. So how to do that. To do so we need Application layer specific information of the user like user_id type of things which cant be checked as it is 4-layer firewall.

So it is not possible to allow other users and block some specific at the same time using a 4-layer firewall (unless they all be using different port numbers which we actually cant predict).

10 votes

-- Sandeep_Uniyal (5.5k points)

4.14**Hamming Code** [top](#)

4.14.1 Hamming Code: GATE1994_9 [top](#)

<http://gateoverflow.in/2505>

Following 7 bit single error correcting hamming coded message is received.

| 7 | 6 | 5 | 4 | 3 | 2 | 1 | bit No. |
|---|---|---|---|---|---|---|---------|
| 1 | 0 | 0 | 0 | 1 | 1 | 0 | |

Determine if the message is correct (assuming that at most 1 bit could be corrupted). If the message contains an error find the bit which is erroneous and gives correct message.

[gate1994](#) [computer-networks](#) [error-detection](#) [hamming-code](#) [normal](#)

[Answer](#)

Answers: Hamming Code

4.14.1 Hamming Code: GATE1994_9 [top](#)

<http://gateoverflow.in/2505>



Selected Answer

Here Answer is yes. There is error in This message. Error is in bit 6.

How to calculate it ? First of all reverse given input to get it in correct position from 1 to 7.

0110001

Bit 1, Bit 2 & Bit 4 are parity bits.

Calculating position of error =>

c3 c2 c1

1 1 0

Here $c_1 = \text{bit}4 \oplus \text{bit}5 \oplus \text{bit}6 \oplus \text{bit}7 = 0 \oplus 0 \oplus 0 \oplus 1 = 1$ (Taking Even parity)

$c_2 = \text{bit}2 \oplus \text{bit}3 \oplus \text{bit}6 \oplus \text{bit}7 = 1 \oplus 1 \oplus 0 \oplus 1 = 1$

$c_3 = \text{bit}1 \oplus \text{bit}3 \oplus \text{bit}5 \oplus \text{bit}7 = 0 \oplus 1 \oplus 0 \oplus 1 = 0$

Ref -> <https://en.wikipedia.org/wiki/Hamming%287,4%29>

When you correct bit 6 .

You get message as 0110011.

IF you calculate C1,c2,c3 all will be 0 now !

3 votes

-- Akash (31.7k points)

4.15

Icmp [top](#)

4.15.1 Icmp: GATE2005-IT_26 [top](#)

<http://gateoverflow.in/3772>

Traceroute reports a possible route that is taken by packets moving from some host A to some other host B. Which of the following options represents the technique used by traceroute to identify these hosts

By progressively querying routers about the next router on the path to B using ICMP packets, starting with the first

- A) router
 B) By requiring each router to append the address to the ICMP packet as it is forwarded to B. The list of all routers en-route to B is returned by B in an ICMP reply packet
 C) By ensuring that an ICMP reply packet is returned to A by each router en-route to B, in the ascending order of their hop distance from A
 D) By locally computing the shortest path from A to B

gate2005-it computer-networks icmp application-layer-protocols normal

[Answer](#)

Answers: Icmp

4.15.1 Icmp: GATE2005-IT_26 [top](#)

<http://gateoverflow.in/3772>



Selected Answer

A) Traceroute works by sending packets with gradually increasing TTL value, starting with TTL value of 1. The first router receives the packet, decrements the TTL value and drops the packet because it then has TTL value zero. The router sends an ICMP Time Exceeded message back to the source. The next set of packets are given a TTL value of 2, so the first router forwards the packets, but the second router drops them and replies with ICMP Time Exceeded. Proceeding in this way, traceroute uses the returned ICMP Time Exceeded messages to build a list of routers that packets traverse, until the destination is reached and returns an ICMP Echo Reply message

8 votes

-- Shaun Patel (5.8k points)

4.16

Ip Packet [top](#)

4.16.1 Ip Packet: GATE2015-1_22 [top](#)

<http://gateoverflow.in/8220>

Which of the following fields of an IP header is NOT modified by a typical IP router?

- A. Check sum
- B. Source address
- C. Time to Live (TTL)
- D. Length

gate2015-1 computer-networks ip-packet easy

[Answer](#)

4.16.2 Ip Packet: GATE2015-2_52 [top](#)

<http://gateoverflow.in/8255>

Host A sends a UDP datagram containing 8880 bytes of user data to host B over an Ethernet LAN. Ethernet frames may carry data up to 1500 bytes (i.e. MTU = 1500 bytes). Size of UDP header is 8 bytes and size of IP header is 20 bytes. There is no option field in IP header. How many total number of IP fragments will be transmitted and what will be the contents of offset field in the last fragment?

- A. 6 and 925
- B. 6 and 7400
- C. 7 and 1110
- D. 7 and 8880

gate2015-2 computer-networks ip-packet normal

[Answer](#)

4.16.3 Ip Packet: GATE2010-15 [top](#)

<http://gateoverflow.in/2188>

One of the header fields in an IP datagram is the Time-to-Live (TTL) field. Which of the following statements best explains the need for this field?

- A. It can be used to prioritize packets.
- B. It can be used to reduce delays.
- C. It can be used to optimize throughput.
- D. It can be used to prevent packet looping.

[gate2010](#) [computer-networks](#) [ip-packet](#) [easy](#)

[Answer](#)

4.16.4 Ip Packet: GATE 2016-1-53 [top](#)

<http://gateoverflow.in/3972>

An IP datagram of size 1000 bytes arrives at a router. The router has to forward this packet on a link whose MTU (maximum transmission unit) is 100 bytes. Assume that the size of the IP header is 20 bytes.

The number of fragments that the IP datagram will be divided into for transmission is_____.

[gate2016-1](#) [computer-networks](#) [ip-packet](#) [normal](#) [numerical-answers](#)

[Answer](#)

4.16.5 Ip Packet: GATE2004-IT_86 [top](#)

<http://gateoverflow.in/3730>

In the TCP/IP protocol suite, which one of the following is NOT part of the IP header?

- A) Fragment Offset
- B) Source IP address
- C) Destination IP address
- D) Destination port number

[gate2004-it](#) [computer-networks](#) [ip-packet](#) [normal](#)

[Answer](#)

4.16.6 Ip Packet: GATE2014-3_28 [top](#)

<http://gateoverflow.in/2062>

An IP router with a Maximum Transmission Unit (MTU) of 1500 bytes has received an IP packet of size 4404 bytes with an IP header of length 20 bytes. The values of the relevant fields in the header of the third IP fragment generated by the router for this packet are

- (A) MF bit: 0, Datagram Length: 1444; Offset: 370
- (B) MF bit: 1, Datagram Length: 1424; Offset: 185
- (C) MF bit: 1, Datagram Length: 1500; Offset: 370
- (D) MF bit: 0, Datagram Length: 1424; Offset: 2960

[gate2014-3](#) [computer-networks](#) [ip-packet](#) [normal](#)

[Answer](#)

4.16.7 Ip Packet: GATE2014-3_25 [top](#)

<http://gateoverflow.in/2059>

Host A (on TCP/IP v4 network A) sends an IP datagram D to host B (also on TCP/IP v4 network B). Assume that no error occurred during the transmission of D. When D reaches B, which of the following IP header field(s) may be different from that of the original datagram D?

- (i) TTL (ii) Checksum (iii) Fragment Offset
- (A) (i) only
 (B) (i) and (ii) only
 (C) (ii) and (iii) only

(D) (i), (ii) and (iii)

gate2014-3 computer-networks ip-packet normal

Answer

Answers: Ip Packet**4.16.1 Ip Packet: GATE2015-1_22** [top](#)<http://gateoverflow.in/8220>

Selected Answer

Source Address.

9 votes

-- Arjun Suresh (150k points)

4.16.2 Ip Packet: GATE2015-2_52 [top](#)<http://gateoverflow.in/8255>

Selected Answer

Ans C

number of fragments = ceil(8888/1480) = 7
 offset of last fragment = (1500 - 20) * 6 / 8 = 1110 (scaling factor of 8 is used in offset field).

TCP or UDP header will be added to the DataUnit received from Transport Layer to Network Layer. And fragmentation happens at Network Layer. So no need to add TCP or UDP header into each fragment.

21 votes

-- Vikrant Singh (11k points)

4.16.3 Ip Packet: GATE2010-15 [top](#)<http://gateoverflow.in/2188>

Selected Answer

It can be used to prevent packet looping.

11 votes

-- Sankaranarayanan P.N (9.8k points)

4.16.4 Ip Packet: GATE 2016-1-53 [top](#)<http://gateoverflow.in/39712>

Selected Answer

IP Datagram size = 1000B
 MTU = 100B
 IP header size = 20B
 So, each packet will have 20B header + 80B payload.
 Therefore, $80 * 12 = 960$
 now remaining 40B data could be sent in next fragment. So, total 12 + 1 = 13 fragments.

23 votes

-- Monanshi Jain (6.5k points)

4.16.5 Ip Packet: GATE2004-IT_86 [top](#)<http://gateoverflow.in/3730>

 Selected Answer

D.) Destination Port number.

Why? Because the IP header has nothing to do with the port number.

Port numbers are used by the transport layer to ensure process to process delivery.

Upvote: 8 votes -- Gate Keeda (17.7k points)

4.16.6 Ip Packet: GATE2014-3_28 [top](#)

<http://gateoverflow.in/2062>

 Selected Answer

ip packet length is given 4404 which includes ip header of length 20
so data is 4384
now router divide this data in 3 parts
1480 1480 1424
after adding ip header in last packet packet size is 1444 and since its the last packet therefore MF =0
and offset is 2960/8=370

Upvote: 10 votes -- anmolgate (273 points)

4.16.7 Ip Packet: GATE2014-3_25 [top](#)

<http://gateoverflow.in/2059>

 Selected Answer

The Answer is OPTION D.

Whenever an IP packet is transmitted, the value in Time to Live (TTL) field will be decremented on every single hop. Hence, TTL is changed on every hop.

Now, since TTL changes, hence the Checksum of the packet will also change.

For the Fragmentation offset, A packet will be fragmented if the packet has a size greater than the Maximum Transmission Unit (MTU) of the network. Hence, Fragmentation offset can also be changed.

Upvote: 18 votes -- saurabhrk (1.3k points)

4.17

Ipv4 [top](#)

4.17.1 Ipv4: GATE2003_27 [top](#)

<http://gateoverflow.in/917>

Which of the following assertions is FALSE about the Internet Protocol (IP)?

- A. It is possible for a computer to have multiple IP addresses
- B. IP packets from the same source to the same destination can take different routes in the network
- C. IP ensures that a packet is discarded if it is unable to reach its destination within a given number of hops
- D. The packet source cannot set the route of an outgoing packets; the route is determined only by the routing tables in the routers on the way

[gate2003](#) [computer-networks](#) [ipv4](#) [normal](#)
Answer

4.17.2 Ipv4: GATE2006_05 [top](#)

<http://gateoverflow.in/884>

For which one of the following reasons does internet protocol(IP) use the time-to-live(TTL) field in IP datagram header?

- A. Ensure packets reach destination within that time
- B. Discard packets that reach later than that time
- C. Prevent packets from looping indefinitely
- D. Limit the time for which a packet gets queued in intermediate routers

[gate2006](#) [computer-networks](#) [ipv4](#) [ip-packet](#) [easy](#)
Answer

4.17.3 Ipv4: GATE2004-57 [top](#)

<http://gateoverflow.in/43572>

Consider three IP networks A , B and C . Host H_A in network A sends messages each containing 180 bytes of application data to a host H_C in network C . The TCP layer prefixes 20 byte header to the message. This passes through an intermediate network B . The maximum packet size, including 20 byte IP header, in each network is:

- A: 1000 bytes
- B: 100 bytes
- C: 1000 bytes

The network A and B are connected through a 1 Mbps link, while B and C are connected by a 512 Kbps link (bps = bits per second).



What is the rate at which application data is transferred to host H_C ? Ignore errors, acknowledgements, and other overheads.

- A. 325.5 Kbps
- B. 354.5 Kbps
- C. 409.6 Kbps
- D. 512.0 Kbps

[gate2004](#) [computer-networks](#) [ipv4](#) [tcp](#) [normal](#)
Answer

4.17.4 Ipv4: GATE2014-3_27 [top](#)

<http://gateoverflow.in/2061>

Every host in an IPv4 network has a 1-second resolution real-time clock with battery backup. Each host needs to generate up to 1000 unique identifiers per second. Assume that each host has a globally unique IPv4 address. Design a 50-bit globally unique ID for this purpose. After what period (in seconds) will the identifiers generated by a host wrap around?

[gate2014-3](#) [computer-networks](#) [ipv4](#) [numerical-answers](#) [normal](#)
Answer

4.17.5 Ipv4: GATE2004-56 [top](#)

<http://gateoverflow.in/1052>

Consider three IP networks A , B and C . Host H_A in network A sends messages each containing 180 bytes of application data to a host H_C in network C . The TCP layer prefixes 20 byte header to the message. This passes through an intermediate network B . The maximum packet size, including 20 byte IP header, in each network is:

- A: 1000 bytes
- B: 100 bytes
- C: 1000 bytes

The network A and B are connected through a 1 Mbps link, while B and C are connected by a 512 Kbps link (bps = bits per second).



Assuming that the packets are correctly delivered, how many bytes, including headers, are delivered to the IP layer at the destination for one application message, in the best case? Consider only data packets.

- A. 200
- B. 220
- C. 240
- D. 260

[gate2004](#) [computer-networks](#) [ipv4](#) [tcp](#) [normal](#)

[Answer](#)

4.17.6 Ipv4: GATE2013_37 [top](#)

<http://gateoverflow.in/1548>

In an IPv4 datagram, the M bit is 0, the value of HLEN is 10, the value of total length is 400 and the fragment offset value is 300. The position of the datagram, the sequence numbers of the first and the last bytes of the payload, respectively are

- (A) Last fragment, 2400 and 2789
- (B) First fragment, 2400 and 2759
- (C) Last fragment, 2400 and 2759
- (D) Middle fragment, 300 and 689

[gate2013](#) [computer-networks](#) [ipv4](#) [normal](#)

[Answer](#)

4.17.7 Ipv4: GATE2012_23 [top](#)

<http://gateoverflow.in/1606>

In the IPv4 addressing format, the number of networks allowed under Class C addresses is

- (A) 2^{14}
- (B) 2^7
- (C) 2^{21}
- (D) 2^{24}

[gate2012](#) [computer-networks](#) [ipv4](#) [easy](#)

[Answer](#)

Answers: Ipv4

4.17.1 Ipv4: GATE2003_27 [top](#)

<http://gateoverflow.in/917>



Selected Answer

In computer networking, **source routing**, also called **path addressing**, allows a sender of a packet to partially or completely specify the route of the packet takes through the network. In contrast, in non-source routing protocols, routers in the network determine the path based on the packet's destination.

http://en.wikipedia.org/wiki/Source_routing

Answer-D

9 votes

-- Priya_das (663 points)

4.17.2 Ipv4: GATE2006_05 [top](#)<http://gateoverflow.in/884>

Selected Answer

ans c)

1 upvote

-- Aditi Dan (5.4k points)

4.17.3 Ipv4: GATE2004-57 [top](#)<http://gateoverflow.in/43572>

Selected Answer

Packet A sends an IP packet of 180 bytes of data + 20 bytes of TCP header + 20 bytes of IP header to B.

IP layer of B now removes 20 bytes of IP header and has 200 bytes of data. So, it makes 3 IP packets - [80 + 20, 80 + 20 + 40 + 20] and sends to C as the Ip packet size of B is 100. So, C receives 260 bytes of data which includes 60 bytes of IP headers and 20 bytes of TCP header.

For data rate, we need to consider only the slowest part of the network as data will be getting accumulated at that sender (data rate till that slowest part, we need to add time if a faster part follows a slower part).

So, here 180 bytes of application data are transferred from A to C and this causes 260 bytes to be transferred from B to C.

Time to transfer 260 bytes from B-C = $260 * 8 / (512 * 1000) = 65/16000 = 13/3200$

So, data rate = $180 * 3200 / 13 = 44.3 \text{ kBps} = 354.46 \text{ kbps}$

1 upvote

-- Arjun Suresh (150k points)

4.17.4 Ipv4: GATE2014-3_27 [top](#)<http://gateoverflow.in/2061>

Worst case scenario can be that all 2^{32} host are present on the network each generating 1000 packets simultaneously in 1 second

so total packet produced in 1 second = $2^{32} * 2^{10}$ (assuming 1024 = 1000) = 2^{42}

now we can distinguish 2^{50} packets, after that wrap around (SO wrap around time will be when 2^{50} identifiers are used)

2^{42} takes 1 second

2^{50} will take = $(2^{50}/2^{42}) = 2^8 = 256$ seconds

1 upvote

-- Igau0522 (129 points)

4.17.5 Ipv4: GATE2004-56 [top](#)<http://gateoverflow.in/1052>

Selected Answer

Packet A sends an IP packet of 180 bytes of data + 20 bytes of TCP header + 20 bytes of IP header to B.

IP layer of B now removes 20 bytes of IP header and has 200 bytes of data. So, it makes 3 IP packets - [80 + 20, 80 + 20 + 40 + 20] and sends to C as the Ip packet size of B is 100. So, C receives 260 bytes of data which includes 60 bytes of IP headers and 20 bytes of TCP header.

For data rate, we need to consider only the slowest part of the network as data will be getting accumulated at that sender (data rate till that slowest part, we need to add time if a faster part follows a slower part).

So, here 180 bytes of application data are transferred from A to C and this causes 260 bytes to be transferred from B to C.

18 votes

-- Arjun Suresh (150k points)

4.17.6 Ipv4: GATE2013_37 <http://gateoverflow.in/1548>

Selected Answer

payload = total length - header
 $= 400 - 40$
 $= 360$

M bit is 0 so it is last fragment

offset is 300

so packet's first bit $300 * 8 = 2400$

last bit $= 2400 + 359 = 2759$

so ans is c

11 votes

-- Pooja (25.9k points)

4.17.7 Ipv4: GATE2012_23 <http://gateoverflow.in/1606>

Selected Answer

Answer is (c)

| Class | Leading bits | Size of network number bit field | Size of rest bit field | Number of networks | Addresses per network | Total addresses in class | Start address | End address |
|---------------------|--------------|----------------------------------|------------------------|----------------------|-----------------------|--------------------------|---------------|-----------------|
| Class A | 0 | 8 | 24 | $128 (2^7)$ | $16,777,216 (2^{24})$ | $2,147,483,648 (2^{31})$ | 0.0.0.0 | 127.255.255.255 |
| Class B | 10 | 16 | 16 | $16,384 (2^{14})$ | $65,536 (2^{16})$ | $1,073,741,824 (2^{30})$ | 128.0.0.0 | 191.255.255.255 |
| Class C | 110 | 24 | 8 | $2,097,152 (2^{21})$ | $256 (2^8)$ | $536,870,912 (2^{29})$ | 192.0.0.0 | 223.255.255.255 |
| Class D (multicast) | D | 1110 | not defined | not defined | not defined | $268,435,456 (2^{28})$ | 224.0.0.0 | 239.255.255.255 |
| Class (reserved) | E | 1111 | not defined | not defined | not defined | $268,435,456 (2^{28})$ | 240.0.0.0 | 255.255.255.255 |

We have 32 bits in the IPV4 network

Class A = 8 network bits + 24 Host bits

Class B = 16 network bits + 16 Host bits

Class C = 24 network bits + 8 host bits.

Now for class C we have 3 bits reserved for the network id... Hence remaining bits are 21. Therefore total number of networks possible are 2^{21} .

Similarly in Class B we have 2 bits reserved... Hence total number of networks in class B are 2^{14} .

And we have 1 bit reserved in Class A, therefore there are 2^7 networks.

And a better reasoning for the bit reservation is given here. have a look.

https://en.wikipedia.org/wiki/Classful_network

9 votes

-- Gate Keeda (17.7k points)

4.18

Lan Technologies [top](#)

4.18.1 Lan Technologies: GATE2006-IT_66 [top](#)

<http://gateoverflow.in/3610>

A router has two full-duplex Ethernet interfaces each operating at 100 Mb/s. Ethernet frames are at least 84 bytes long (including the Preamble and the Inter-Packet-Gap). The maximum packet processing time at the router for wirespeed forwarding to be possible is (in microseconds)

- A) 0.01
- B) 3.36
- C) 6.72
- D) 8

[gate2006-it](#) [computer-networks](#) [lan-technologies](#) [ethernet](#) [normal](#)

[Answer](#)

4.18.2 Lan Technologies: GATE2005-IT_28 [top](#)

<http://gateoverflow.in/3774>

Which of the following statements is FALSE regarding a bridge?

- A) Bridge is a layer 2 device
- B) Bridge reduces collision domain
- C) Bridge is used to connect two or more LAN segments
- D) Bridge reduces broadcast domain

[gate2005-it](#) [computer-networks](#) [lan-technologies](#) [normal](#)

[Answer](#)

4.18.3 Lan Technologies: GATE2007-65 [top](#)

<http://gateoverflow.in/1263>

There are n stations in slotted LAN. Each station attempts to transmit with a probability p in each time slot. What is the probability that **ONLY** one station transmits in a given time slot?

- A. $np(1-p)^{n-1}$
- B. $(1-p)^{n-1}$
- C. $p(1-p)^{n-1}$
- D. $1 - (1-p)^{n-1}$

[gate2007](#) [computer-networks](#) [lan-technologies](#) [probability](#) [normal](#)

[Answer](#)

4.18.4 Lan Technologies: GATE2004-IT_27 [top](#)

<http://gateoverflow.in/3668>

A host is connected to a Department network which is part of a University network. The University network, in turn, is part of the Internet. The largest network in which the Ethernet address of the host is unique is

- A) the subnet to which the host belongs
 B) the Department network
 C) the University network
 D) the Internet

[gate2004-it](#) [computer-networks](#) [lan-technologies](#) [ethernet](#) [normal](#)

[Answer](#)

4.18.5 Lan Technologies: GATE2003_83 [top](#)

<http://gateoverflow.in/966>

A 2km long broadcast LAN has 10^7 bps bandwidth and uses CSMA/CD. The signal travels along the wire at 2×10^8 m/s. What is the minimum packet size that can be used on this network?

- A. 50 bytes
 B. 100 bytes
 C. 200 bytes
 D. None of the above

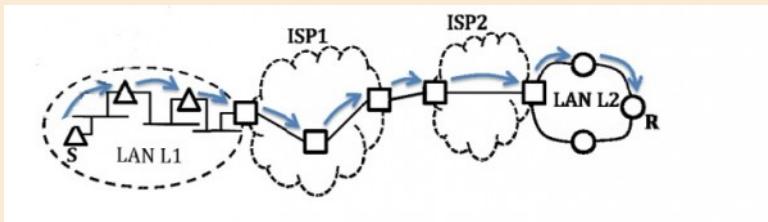
[gate2003](#) [computer-networks](#) [lan-technologies](#) [normal](#)

[Answer](#)

4.18.6 Lan Technologies: GATE2014-2_25 [top](#)

<http://gateoverflow.in/1983>

In the diagram shown below, L1 is an Ethernet LAN and L2 is a Token-Ring LAN. An IP packet originates from sender S and traverses to R, as shown. The links within each ISP and across the two ISPs, are all point-to-point optical links. The initial value of the TTL field is 32. The maximum possible value of the TTL field when R receives the datagram is _____.



[gate2014-2](#) [computer-networks](#) [numerical-answers](#) [lan-technologies](#) [ethernet](#) [token-ring](#) [normal](#)

[Answer](#)

Answers: Lan Technologies

4.18.1 Lan Technologies: GATE2006-IT_66 [top](#)

<http://gateoverflow.in/3610>



Selected Answer

Here we need at least enough speed that we are able to transmit packets in a speed we get them !

We have got 2 Full duplex ports, each operating at 100 Mb/s. So we require incoming packets with 200 Mbps so that we can send out data at 200 Mbps over the two interfaces.

For each packet to come In router, you will need transmission TIme, in case of single 84 byte packet you will get it as 6.72 microsecond.

Now D is simply wrong. You take 8 Microsecond to process, soon you will have pile of packets waiting (Processing > Transmission), and we are getting 2 packets per 6.72 micro seconds as input.

C is wrong, here we can get 2 6.72 micro seconds packets & we are barely able to process 1 packet in that time. So every processing time our Queue will increase size by 1 & get full and overflow.

B & A are okay.

A is best though as we are asked to give Maximum, **B is answer !**

Assume that in B you got 2 packet at time 0, by time 3.36 you can start sending packet 1, by 6.72 packet 2. By 6.72 you got 2 more packet. By time you finish processing Packet no 3, first port where you started processing with 3.36 is free, so you can start sending Packet 3 and so on !

Ref: https://en.wikipedia.org/wiki/Wire_speed

8 votes

-- Akash (31.7k points)

4.18.2 Lan Technologies: GATE2005-IT_28 [top](#)

<http://gateoverflow.in/3774>



Selected Answer

Bridges are DataLink layer devices used to connect LANs.. Briges are collision domain separator but unable to separate Broadcast domain..

5 votes

-- Digvijay (35.8k points)

4.18.3 Lan Technologies: GATE2007-65 [top](#)

<http://gateoverflow.in/1263>



Selected Answer

Probability that only one station transmits in a given slot = $\binom{n}{1} p^1 (1-p)^{n-1}$

answer = **option A**

p for 1 transmitting and $(1-p)$ for $n-1$ non transmitting and n ways to choose 1 from n .

7 votes

-- Aditi Dan (5.4k points)

4.18.4 Lan Technologies: GATE2004-IT_27 [top](#)

<http://gateoverflow.in/3668>

Ans is D, Ethernet address is nothing but MAC Address which is present on NIC and it is unique for every system.

6 votes

-- Pradyumna Paralikar (327 points)

4.18.5 Lan Technologies: GATE2003_83 [top](#)

<http://gateoverflow.in/966>



Selected Answer

In CSMA/CD, to detect a collision the transmission time (which depends on the packet size) must be greater than twice the propagation delay.

Propagation delay here = $\frac{2km}{2 \times 10^8 m/s}$
= 10 microseconds

Now, transmission time for x bytes = $\frac{x \times 8}{10^7}$ = $0.8x$ microseconds

So, $0.8x > 2 \times 10 \implies x > 25$ bytes

So, None of these.

10 votes

-- Arjun Suresh (150k points)

4.18.6 Lan Technologies: GATE2014-2_25 [top](#)<http://gateoverflow.in/1983>

Selected Answer

TTL field reduced at each router, there are total 5 routers and finally at receiver.

$$=32 - (5+1) = 26$$

7 votes

-- Keith Kr (6k points)

4.19**Link State Routing** [top](#)**4.19.1 Link State Routing: GATE2014-1_23** [top](#)<http://gateoverflow.in/1790>

Consider the following three statements about link state and distance vector routing protocols, for a large network with 500 network nodes and 4000 links.

- [S1] The computational overhead in link state protocols is higher than in distance vector protocols.
- [S2] A distance vector protocol (with split horizon) avoids persistent routing loops, but not a link state protocol.
- [S3] After a topology change, a link state protocol will converge faster than a distance vector protocol.

Which one of the following is correct about S1, S2, and S3 ?

- (A) S1, S2, and S3 are all true.
- (B) S1, S2, and S3 are all false.
- (C) S1 and S2 are true, but S3 is false.
- (D) S1 and S3 are true, but S2 is false.

[gate2014-1](#) [computer-networks](#) [routing](#) [distance-vector-routing](#) [link-state-routing](#) [normal](#)
Answer**Answers: Link State Routing****4.19.1 Link State Routing: GATE2014-1_23** [top](#)<http://gateoverflow.in/1790>

Selected Answer

S1 : because of flooding at each router computational overhead in link state routing is more.
 S2 : Persistent loop i.e. count to infinity problem takes place in Distance vector routing not in link state routing.
 Persistent loop from Distance Vector Routing protocol can be avoided with the help of Split Horizon technique. i.e.
 Persistent loop can be avoided from both Distance and Link state routing protocol.
 S3 : Link state routing protocol converges faster when topology changes.

6 votes

-- Digvijay (35.8k points)

4.20**Mac Protocol** [top](#)**4.20.1 Mac Protocol: GATE2005-IT-75** [top](#)<http://gateoverflow.in/3838>

In a TDM medium access control bus LAN, each station is assigned one time slot per cycle for transmission. Assume that the length of each time slot is the time to transmit 100 bits plus the end-to-end propagation delay. Assume a propagation speed of 2×10^8 m/sec. The length of the LAN is 1 km with a bandwidth of 10 Mbps. The maximum number of stations that can be allowed in the LAN so that the throughput of each station can be 2/3 Mbps is

- A. 3
B. 5
C. 10
D. 20

[gate2005-it](#) [computer-networks](#) [mac-protocol](#) [normal](#)

[Answer](#)

4.20.2 Mac Protocol: GATE2015-2_8 [top](#)

<http://gateoverflow.in/8056>

A link has transmission speed of 10^6 bits/sec. It uses data packets of size 1000 bytes each. Assume that the acknowledgement has negligible transmission delay, and that its propagation delay is the same as the data propagation delay. Also assume that the processing delays at nodes are negligible. The efficiency of the stop-and-wait protocol in this setup is exactly 25%. The value of the one way propagation delay (in milliseconds) is_____.

[gate2015-2](#) [computer-networks](#) [mac-protocol](#) [stop-and-wait](#) [normal](#)

[Answer](#)

4.20.3 Mac Protocol: GATE2004-IT_85 [top](#)

<http://gateoverflow.in/3729>

Consider a simplified time slotted MAC protocol, where each host always has data to send and transmits with probability $p = 0.2$ in every slot. There is no backoff and one frame can be transmitted in one slot. If more than one host transmits in the same slot, then the transmissions are unsuccessful due to collision. What is the maximum number of hosts which this protocol can support, if each host has to be provided a minimum throughput of 0.16 frames per time slot?

- | | |
|----|---|
| A) | 1 |
| B) | 2 |
| C) | 3 |
| D) | 4 |

[gate2004-it](#) [computer-networks](#) [congestion-control](#) [mac-protocol](#) [normal](#)

[Answer](#)

4.20.4 Mac Protocol: GATE2005_74 [top](#)

<http://gateoverflow.in/1397>

Suppose the round trip propagation delay for a 10 Mbps Ethernet having 48-bit jamming signal is 46.4 μ s. The minimum frame size is:

- A. 94
B. 416
C. 464
D. 512

[gate2005](#) [computer-networks](#) [mac-protocol](#) [normal](#) [debated](#)

[Answer](#)

Answers: Mac Protocol

4.20.1 Mac Protocol: GATE2005-IT-75 [top](#)

<http://gateoverflow.in/3838>



Selected Answer

$T_t = 10$ micro secs

$T_p = 5$ micro secs

Efficiency of the network = $T_t / (T_t + T_p) = 10 / 15 = 2/3$

Total throughput available for the entire network = Efficiency * Bandwidth = $(2/3) * 10 \text{ Mbps} = 20/3 \text{ Mbps}$

Let, No. of stations = N (each wants a Throughput of $2/3 \text{ Mbps}$),

$$N * (2/3 \text{ Mbps}) = 20/3 \text{ Mbps} \Rightarrow N = 10$$

$\Rightarrow 10$ stations can be connected in the channel at max.

Upvote 7 votes

-- Ravi Ranjan (1.2k points)

4.20.2 Mac Protocol: GATE2015-2_8 [top](#)

<http://gateoverflow.in/8056>



Selected Answer

In stop and wait, a frame is sent and next frame will be sent only after ACK is received.

$$\text{Efficiency} = \frac{\text{Amount of data sent}}{\text{Amount of data that could be sent}}$$

$$= \frac{\text{Amount of data sent}}{RTT \times 10^6}$$

$$= \frac{\text{Amount of data sent}}{(\text{Prop. delay for data} + \text{Prop. delay for ACK} + \text{Transmission time for data} + \text{Transmission time for ACK}) \times 10^6}$$

$$= \frac{1000 \times 8}{(p + p + 1000 \times 8 / 10^6 + 0) \times 10^6}$$

$$= \frac{8}{2p + 8ms} \text{ (where } p \text{ is the prop. delay in milli seconds)}$$

$$= \frac{4}{p+4} = 0.25 \text{ (given in question)}$$

$$\text{So, } p + 4 = 16, p = 12ms.$$

Upvote 14 votes

-- Arjun Suresh (150k points)

4.20.3 Mac Protocol: GATE2004-IT_85 [top](#)

<http://gateoverflow.in/3729>



Selected Answer

Let there be N such hosts.

Then when one host is transmitting then others must be silent for successful transmission.
So the throughput per host

$$0.16 = 0.2 \times 0.8^{N-1}$$

$$\Rightarrow 0.8 = 0.8^{N-1}$$

on comparing the exponents, since base are identical
 $N - 1 = 1, N = 2$.

Upvote 18 votes

-- Shreyans Dhankhar (2.4k points)

4.20.4 Mac Protocol: GATE2005_74 [top](#)

<http://gateoverflow.in/1397>

The sender must be able to detect a collision before completely sending a frame. So, the minimum frame length must be such that, before the frame completely leaves the sender any collision must be detected.

Now, the worst case for collision detection is when the start of the frame is about to reach the receiver and the receiver starts sending. Collision happens and a jam signal is produced and this signal must travel to the sender. So, the time for this will be the time for the start of the frame to reach near the receiver + time for the jam signal to reach the sender + transmission time for the jam signal. (We don't need to include transmission time for the frame as soon as the first bit of the frame arrives, the receiver will have detected it). Time for the start of the frame to reach near the receiver + Time for the jam signal to reach the sender = Round trip propagation delay = 46.4 μ s. So,

$$46.4 + 48/10 \text{ (48 bits at 10 Mbps takes 4.8 micro sec.)} = 51.2 \mu\text{s.}$$

Now, the frame length must be such that its transmission time must be more than 51.2 μ s. So, minimum frame length
 $= 51.2 * 10^{-6} * 10 * 10^6 = 512$ bits.

<http://gatecse.in/w/images/3/32/3-MACSublayer.ppt>

20 votes

-- Arjun Suresh (150k points)

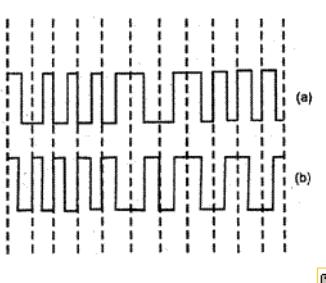
4.21

Manchester Encoding top

4.21.1 Manchester Encoding: GATE2007-IT-61 top

<http://gateoverflow.in/3505>

In the waveform (a) given below, a bit stream is encoded by Manchester encoding scheme. The same bit stream is encoded in a different coding scheme in wave form (b). The bit stream and the coding scheme are



- A. 1000010111 and Differential Manchester respectively
- B. 0111101000 and Differential Manchester respectively
- C. 1000010111 and Integral Manchester respectively
- D. 0111101000 and Integral Manchester respectively

[gate2007-it](#) [computer-networks](#) [communication](#) [manchester-encoding](#) [normal](#)

Answer

4.21.2 Manchester Encoding: GATE2007_19 top

<http://gateoverflow.in/1217>

In Ethernet when Manchester encoding is used, the bit rate is:

- A. Half the baud rate
- B. Twice the baud rate
- C. Same as the baud rate
- D. None of the above

[gate2007](#) [computer-networks](#) [ethernet](#) [manchester-encoding](#) [normal](#)

Answer

Answers: Manchester Encoding

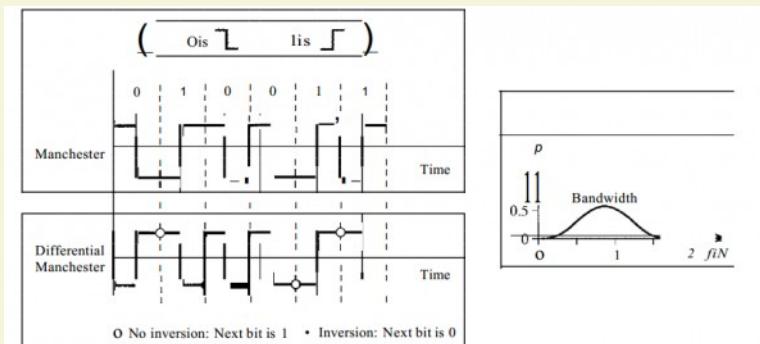
4.21.1 Manchester Encoding: GATE2007-IT-61 [top](#)

<http://gateoverflow.in/3505>

Here Ans is A)

Here code is 1000010111 .

Along with that, Rule for differential Manchester is, Let me post snap From Data Communication book ,Forouzen ->



In Manchester and differential Manchester encoding, the transition at the middle of the bit is used for synchronization.

Looking at this image, It is clear this same rule is applied here And so this is differential Manchester.

AFAIK, there is no term as Integral Manchester, It was just put there for more confusion.

1 votes

-- Akash (31.7k points)

4.21.2 Manchester Encoding: GATE2007_19 [top](#)

<http://gateoverflow.in/1217>



Selected Answer

Bit rate is half the baud rate in Manchester encoding as bits are transferred only during a positive transition of the clock.

<http://stackoverflow.com/questions/25834577/why-in-manchester-encoding-the-bit-rate-is-half-of-the-baud-rate>

4 votes

-- Arjun Suresh (150k points)

4.22

Network Flow [top](#)

4.22.1 Network Flow: GATE1992_01,v [top](#)

<http://gateoverflow.in/550>

(v) A simple and reliable data transfer can be accomplished by using the 'handshake protocol'. It accomplishes reliable data transfer because for every data item sent by the transmitter _____.

gate1992 computer-networks network-flow easy

Answer

4.22.2 Network Flow: GATE2006-IT_67 [top](#)

<http://gateoverflow.in/3611>

A link of capacity 100 Mbps is carrying traffic from a number of sources. Each source generates an on-off traffic stream; when the source is on, the rate of traffic is 10 Mbps, and when the source is off, the rate of traffic is zero. The duty cycle, which is the ratio of on-time to off-time, is 1 : 2. When there is no buffer at the link, the minimum number of sources that can be multiplexed on the link so that link capacity is not wasted and no data loss occurs is S1. Assuming that all sources are synchronized and that the link is provided with a large buffer, the maximum number of sources that can be multiplexed so

that no data loss occurs is S2. The values of S1 and S2 are, respectively,

- (A) 10 and 30
- (B) 12 and 25
- (C) 5 and 33
- (D) 15 and 22

[gate2006-it](#) [computer-networks](#) [network-flow](#) [normal](#)

[Answer](#)

4.22.3 Network Flow: GATE1992_02,v [top](#)

<http://gateoverflow.in/560>

02. Choose the correct alternatives (more than one may be correct) and write the corresponding letters only:

- (v). Start and stop bits do not contain an 'information' but are used in serial communication
- (a). Error detection
- (b). Error correction
- (c). Synchronization
- (d). Slowing down the communications

[gate1992](#) [easy](#) [computer-networks](#) [network-flow](#)

[Answer](#)

4.22.4 Network Flow: GATE2004-IT_87 [top](#)

<http://gateoverflow.in/3731>

A TCP message consisting of 2100 bytes is passed to IP for delivery across two networks. The first network can carry a maximum payload of 1200 bytes per frame and the second network can carry a maximum payload of 400 bytes per frame, excluding network overhead. Assume that IP overhead per packet is 20 bytes. What is the total IP overhead in the second network for this transmission?

- | | |
|----|-----------|
| A) | 40 bytes |
| B) | 80 bytes |
| C) | 120 bytes |
| D) | 160 bytes |

[gate2004-it](#) [computer-networks](#) [network-flow](#) [normal](#)

[Answer](#)

4.22.5 Network Flow: GATE2005-IT_72 [top](#)

<http://gateoverflow.in/3835>

A channel has a bit rate of 4 kbps and one-way propagation delay of 20 ms. The channel uses stop and wait protocol. The transmission time of the acknowledgement frame is negligible. To get a channel efficiency of at least 50%, the minimum frame size should be

- | | |
|----|-----------|
| A) | 80 bytes |
| B) | 80 bits |
| C) | 160 bytes |
| D) | 160 bits |

[gate2005-it](#) [computer-networks](#) [network-flow](#) [stop-and-wait](#) [normal](#)

[Answer](#)

4.22.6 Network Flow: GATE2004-IT_80 [top](#)

<http://gateoverflow.in/3724>

In a data link protocol, the frame delimiter flag is given by 0111. Assuming that bit stuffing is employed, the transmitter sends the data sequence 01110110 as

- A) 01101011
- B) 011010110
- C) 011101100
- D) 0110101100

[gate2004-it](#) [computer-networks](#) [network-flow](#) [normal](#)

[Answer](#)

Answers: Network Flow

4.22.1 Network Flow: GATE1992_01,v [top](#)

<http://gateoverflow.in/550>



Selected Answer

the receiver responds that it is ready to receive the data item.

Ref: http://www.sqa.org.uk/e-learning/NetInf101CD/page_28.htm

1 votes

-- Rajarshi Sarkar (29.7k points)

4.22.2 Network Flow: GATE2006-IT_67 [top](#)

<http://gateoverflow.in/3611>

Since there is no buffer.. and constraint given is there should not be any data lost, and no wastage of capacity as well..

Since data should not be lost, we calculate for the extreme case when all sources are on-time (that is transmitting)..

$$10 \text{ Mbps} * n\text{-station} \leq 100 \text{ Mbps}$$

$$n\text{-station} = 10..$$

In the next part of the question it is given that the link is provided with large buffer and we are asked to find out large no. of stations..

for that we'll calculate expected value of bandwidth usage (if more data comes we store in buffer and due to expectation, the buffer will be emptied soon):

$$E = 1/3 * 10 + 1/3 * 10 + \dots n\text{-station times} \leq 100 \text{ Mbps} \quad [\text{total time is } (1+2) = 3 \text{ then on time is 1 so } 1/3 \text{ of BW}]$$

$$\Rightarrow 1/3 * 10 * n\text{-station} \leq 100 \text{ Mbps}$$

$$\Rightarrow n\text{-station} = 30$$

so, option (A)

9 votes

-- Vicky Bajoria (3.4k points)

4.22.3 Network Flow: GATE1992_02,v [top](#)

<http://gateoverflow.in/560>



Selected Answer

Answer: C

The start and stop bits are used to synchronize the serial receivers.

Ref: <http://esd.cs.ucr.edu/labs/serial/serial.html>

2 votes

-- Rajarshi Sarkar (29.7k points)

4.22.4 Network Flow: GATE2004-IT_87 [top](#)

<http://gateoverflow.in/3731>



Selected Answer

answer is C

since in the question they have directly given the payload so 2100 will be divided in 1200 and 904 (y 904 coz 900 is not a multiple of 8 so we have to pad 4 bits in order to make it a multiple of 8)

now in second network payload is 400B

so 1200 packet will be divided in 400,400,400 with each having 20B header

and 900 will be divided in 400 400 104 (y 104 is same reason mentioned above) each having 20 B header
so total overhead is $20 \times 6 = 120$ B

13 votes

-- Shreyans Dhankhar (2.4k points)

4.22.5 Network Flow: GATE2005-IT_72 [top](#)

<http://gateoverflow.in/3835>



Selected Answer

for 50% utilization

$$tt/(tt+2tp) \geq 1/2$$

$$2tt \geq tt + 2tp$$

$$tt \geq 2tp$$

$$L/B \geq 2 * tp$$

$$L \geq 2 * tp * B$$

$$\text{so here } L = 2 * 20 * 10^{-3} * 4 * 10^3$$

$$= 160 \text{ bits}$$

so ans is d

7 votes

-- Pooja (25.9k points)

4.22.6 Network Flow: GATE2004-IT_80 [top](#)

<http://gateoverflow.in/3724>



Selected Answer

Answer will be option D.)

The bit stuffing is done after every two '11' (as flag is 0111) to differentiate the data part from the flag- there must not be "111" in the data so after every 11 a '0' is added. The receiver also knows this and so it decodes every "110" as "11". Therefore option D. is the answer.

http://web.nchu.edu.tw/~pcwang/computer_networks/data_link_layer.pdf

https://en.wikipedia.org/wiki/High-Level_Data_Link_Control

9 votes

-- Gate Keeda (17.7k points)

4.23

Network Layering [top](#)**4.23.1 Network Layering: GATE2013_14** [top](#)<http://gateoverflow.in/1436>

Assume that source S and destination D are connected through two intermediate routers labeled R. Determine how many times each packet has to visit the network layer and the data link layer during a transmission from S to D.

- (A) Network layer – 4 times and Data link layer – 4 times
- (B) Network layer – 4 times and Data link layer – 3 times
- (C) Network layer – 4 times and Data link layer – 6 times
- (D) Network layer – 2 times and Data link layer – 6 times

[gate2013](#) [computer-networks](#) [network-layering](#) [normal](#)

Answer**4.23.2 Network Layering: GATE2004_15** [top](#)<http://gateoverflow.in/1012>

Choose the best matching between Group 1 and Group 2

Group - 1

- P. Data link layer
- Q. Network layer
- R. Transport layer

Group - 2

- 1. Ensures reliable transport of data over a physical point-to-point link
- 2. Encodes/decodes data for physical transmission
- 3. Allows end-to-end communication between two processes
- 4. Routes data from one network node to the next

- A. P-1, Q-4, R-3
- B. P-2, Q-4, R-1
- C. P-2, Q-3, R-1
- D. P-1, Q-3, R-2

[gate2004](#) [computer-networks](#) [network-layering](#) [normal](#)

Answer**4.23.3 Network Layering: GATE2007-70** [top](#)<http://gateoverflow.in/1268>

Match the following:

- | | | | |
|-----|------|-----|-------------------|
| (P) | SMTP | (1) | Application layer |
| (Q) | BGP | (2) | Transport layer |
| (R) | TCP | (3) | Data link layer |
| (S) | PPP | (4) | Network layer |
| | | (5) | Physical layer |

- A. P - 2, Q - 1, R - 3, S - 5
- B. P - 1, Q - 4, R - 2, S - 3
- C. P - 1, Q - 4, R - 2, S - 5
- D. P - 2, Q - 4, R - 1, S - 3

[gate2007](#) [computer-networks](#) [network-layering](#) [network-protocols](#) [easy](#)

Answer**4.23.4 Network Layering: GATE2003_28** [top](#)<http://gateoverflow.in/918>

Which of the following functionality *must* be implemented by a transport protocol over and above the network protocol?

- A. Recovery from packet losses
- B. Detection of duplicate packets
- C. Packet delivery in the correct order
- D. End to end connectivity

gate2003 | computer-networks | network-layering | easy

[Answer](#)

Answers: Network Layering

4.23.1 Network Layering: GATE2013_14 [top](#)

<http://gateoverflow.in/1036>

Selected Answer

C is the answer .

7 votes -- Mithlesh Upadhyay (3.6k points)

4.23.2 Network Layering: GATE2004_15 [top](#)

<http://gateoverflow.in/1012>

Selected Answer

ans a)

6 votes -- Aditi Dan (5.4k points)

4.23.3 Network Layering: GATE2007-70 [top](#)

<http://gateoverflow.in/1268>

Selected Answer

Answer is B

SMTP is an application layer protocol used for e-mail transmission.

TCP is a core transport layer protocol.

BGP is a network layer protocol backing the core routing decisions on the Internet

PPP is a data link layer protocol commonly used in establishing a direct connection between two networking

3 votes -- naga praveen (2.9k points)

4.23.4 Network Layering: GATE2003_28 [top](#)

<http://gateoverflow.in/918>

End to end connectivity is the required functionality provided by Transport protocol. UDP of transport layer protocol that doesn't implement other three functionalities, they are implemented only in TCP.

1 upvotes

-- Anurag Semwal (5.5k points)

4.24

Network Protocols top

4.24.1 Network Protocols: GATE 2016-1-24 top

<http://gateoverflow.in/39639>

Which one of the following protocols is **NOT** used to resolve one form of address to another one?

- A. DNS
- B. ARP
- C. DHCP
- D. RARP

[gate2016-1](#) | [computer-networks](#) | [network-protocols](#) | [normal](#)

[Answer](#)

4.24.2 Network Protocols: GATE2007-IT-69 top

<http://gateoverflow.in/3514>

Consider the following clauses:

- i. Not inherently suitable for client authentication.
- ii. Not a state sensitive protocol.
- iii. Must be operated with more than one server.
- iv. Suitable for structured message organization.
- v. May need two ports on the serve side for proper operation.

The option that has the maximum number of correct matches is

- A. IMAP-i; FTP-ii; HTTP-iii; DNS-iv; POP3-v
- B. FTP-i; POP3-ii; SMTP-iii; HTTP-iv; IMAP-v
- C. POP3-i; SMTP-ii; DNS-iii; IMAP-iv; HTTP-v
- D. SMTP-i; HTTP-ii; IMAP-iii; DNS-iv; FTP-v

[gate2007-it](#) | [computer-networks](#) | [network-protocols](#) | [normal](#)

[Answer](#)

4.24.3 Network Protocols: GATE2008-IT_68 top

<http://gateoverflow.in/3382>

Which of the following statements are TRUE?

- (S1) TCP handles both congestion and flow control
- (S2) UDP handles congestion but not flow control
- (S3) Fast retransmit deals with congestion but not flow control
- (S4) Slow start mechanism deals with both congestion and flow control

- 1) S1, S2 and S3 only
- 2) S1 and S3 only
- 3) S3 and S4 only
- 4) S1, S3 and S4 only

[gate2008-it](#) | [computer-networks](#) | [network-protocols](#) | [normal](#)

[Answer](#)

4.24.4 Network Protocols: GATE2015-1_17 top

<http://gateoverflow.in/8214>

In one of the pairs of protocols given below , both the protocols can use multiple TCP connections between the same client and the server. Which one is that?

- A. HTTP, FTP
- B. HTTP, TELNET
- C. FTP, SMTP
- D. HTTP, SMTP

gate2015-1 computer-networks network-protocols normal

[Answer](#)

Answers: Network Protocols

4.24.1 Network Protocols: GATE 2016-1-24 [top](#)

<http://gateoverflow.in/39639>



Selected Answer

- A) DNS - host name to IP address
- B) ARP - IP to MAC
- C) RARP - MAC to IP

So ANSWER C

9 votes

-- Abhilash Panicker (7k points)

4.24.2 Network Protocols: GATE2007-IT-69 [top](#)

<http://gateoverflow.in/3514>

They are asking for maximum correct matches so

1. Should be HTTP thus we use HTTPS
2. HTTP as it does not depend on state of device or operating system.
3. IMAP or DNS *Not sure but they may involve multiple servers
4. POP3 is suitable for structuring or arranging the folders.
5. FTP needs two ports, 20 for data and 21 for control.

Thus, Option D, As it's matching with HTTP-2,IMAP-3,FTP-5

2 votes

-- Shashank Chavan (2.6k points)

4.24.3 Network Protocols: GATE2008-IT_68 [top](#)

<http://gateoverflow.in/3382>



Selected Answer

- (S1)** TCP handles both congestion and flow control => True. IT uses congestion window for congestion control & Advertisement window for flow control
- (S2)** UDP handles congestion but not flow control => UDP does not handle congestion but also not handle flow control.
- (S3)** Fast retransmit deals with congestion but not flow control => Yes. Fast Retransmit is technique for detecting out of Order Datagram & Sending it. It is congestion control technique and has no relation with Flow control
- (S4)** Slow start mechanism deals with both congestion and flow control => False. It has nothing to do with Flow control. Flow control is taken care by Advertisement window. Slow start is way Sender tries to gauge network capacity !

Ans -> **S1** and **S3** only

7 votes

-- Akash (31.7k points)

4.24.4 Network Protocols: GATE2015-1_17 [top](#)

<http://gateoverflow.in/8214>



Selected Answer

SMTP: only one TCP connection

Ref: <https://tools.ietf.org/html/rfc821>

Telnet: only one TCP connection

Ref: <https://tools.ietf.org/html/rfc854>

HTTP: Multiple connections can be used for each resource

Ref: <http://www.w3.org/Protocols/rfc2616/rfc2616-sec1.html#sec1>

FTP: FTP uses Telnet protocol for Control info on a TCP connection and another TCP connection for data exchange

Ref: <https://tools.ietf.org/html/rfc959> (See page 8)

So, answer is A.

15 votes

-- Arjun Suresh (150k points)

4.25

Network Security [top](#)

4.25.1 Network Security: GATE2004-IT_84 [top](#)

<http://gateoverflow.in/3728>

Consider a parity check code with three data bits and four parity check bits. Three of the code words are 0101011, 1001101 and 1110001. Which of the following are also code words?

I. 0010111 II. 0110110 III. 1011010 IV. 0111010

- A) I and III
- B) I, II and III
- C) II and IV
- D) I, II, III and IV

[gate2004-it](#) [computer-networks](#) [network-security](#) [normal](#)

[Answer](#)

4.25.2 Network Security: GATE2013_13 [top](#)

<http://gateoverflow.in/1435>

Using public key cryptography, X adds a digital signature σ to message M , encrypts $\langle M, \sigma \rangle$, and sends it to Y , where it is decrypted. Which one of the following sequences of keys is used for the operations?

- (A) Encryption: X 's private key followed by Y 's private key; Decryption: X 's public key followed by Y 's public key
- (B) Encryption: X 's private key followed by Y 's public key; Decryption: X 's public key followed by Y 's private key
- (C) Encryption: X 's public key followed by Y 's private key; Decryption: Y 's public key followed by X 's private key
- (D) Encryption: X 's private key followed by Y 's public key; Decryption: Y 's private key followed by X 's public key

[gate2013](#) [computer-networks](#) [network-security](#) [normal](#)

[Answer](#)

4.25.3 Network Security: GATE2007-IT-70 [top](#)

<http://gateoverflow.in/3515>

Your are given the following four bytes :

10100011|00110111|11101001|10101011

Which of the following are substrings of the base 64 encoding of the above four bytes ?

- A. zdp
- B. fpq
- C. qwA
- D. oze

[gate2007-it](#)
[computer-networks](#)
[network-security](#)
[normal](#)
Answer

4.25.4 Network Security: TIFR2011-B-36 [top](#)

<http://gateoverflow.in/20918>

Consider malware programs. Which of the following is true?

- A worm is a parasite.
- A virus cannot affect a linux operating system.
- A trojan can be in the payload of only a worm.
- A worm and virus are self replicating programs.
- There is no difference between a virus and a worm.

[tifr2011](#)
[computer-networks](#)
[network-security](#)
Answer

4.25.5 Network Security: GATE2014-2_27 [top](#)

<http://gateoverflow.in/1986>

An IP machine Q has a path to another IP machine H via three IP routers R1, R2, and R3.

$Q - R1 - R2 - R3 - H$

H acts as an HTTP server, and Q connects to H via HTTP and downloads a file. Session layer encryption is used, with DES as the shared key encryption protocol. Consider the following four pieces of information:

- [I1] The URL of the file downloaded by Q
- [I2] The TCP port numbers at Q and H
- [I3] The IP addresses of Q and H
- [I4] The link layer addresses of Q and H

Which of I1, I2, I3, and I4 can an intruder learn through sniffing at R2 alone?

- (A) Only I1 and I2
- (B) Only I1
- (C) Only I2 and I3
- (D) Only I3 and I4

[gate2014-2](#)
[computer-networks](#)
[network-security](#)
[normal](#)
Answer

4.25.6 Network Security: GATE 2016-1-52 [top](#)

<http://gateoverflow.in/39694>

Consider that B wants to send a message m that is digitally signed to A . Let the pair of private and public keys for A and B be denoted by K_x^- and K_x^+ for $x = A, B$, respectively. Let $K_x(m)$ represent the operation of encrypting m with a key K_x and $H(m)$ represent the message digest. Which one of the following indicates the **CORRECT** way of sending the message m along with the digital signature to A ?

- $\{m, K_B^+(H(m))\}$
- $\{m, K_B^-(H(m))\}$
- $\{m, K_A^-(H(m))\}$
- $\{m, K_A^+(m)\}$

[gate2016-1](#)
[computer-networks](#)
[network-security](#)
[easy](#)
Answer

4.25.7 Network Security: GATE2009-46 [top](#)

<http://gateoverflow.in/1343>

In the RSA public key cryptosystem, the private and public keys are (e, n) and (d, n) respectively, where $n = p \times q$ and p and q are large primes. Besides, n is public and p and q are private. Let M be an integer such that $0 < M < n$ and $\phi(n) = (p-1)(q-1)$. Now consider the following equations.

I. $M' = M^e \pmod{n}$
 $M = (M')^d \pmod{n}$

II. $ed \equiv 1 \pmod{n}$

III. $ed \equiv 1 \pmod{\phi(n)}$

IV. $M' = M^e \pmod{\phi(n)}$
 $M = (M')^d \pmod{\phi(n)}$

Which of the above equations correctly represents RSA cryptosystem?

- A. I and II
- B. I and III
- C. II and IV
- D. III and IV

[gate2009](#) [computer-networks](#) [network-security](#) [normal](#)

[Answer](#)

4.25.8 Network Security: GATE2007-IT_15 [top](#)

<http://gateoverflow.in/3448>

Consider the following two statements:

- i. A hash function (these are often used for computing digital signatures) is an injective function.
- ii. A encryption technique such as DES performs a permutation on the elements of its input alphabet.

Which one of the following options is valid for the above two statements?

- A) Both are false
- B) Statement (i) is true and the other is false
- C) Statement (ii) is true and the other is false
- D) Both are true

[gate2007-it](#) [computer-networks](#) [network-security](#) [normal](#)

[Answer](#)

4.25.9 Network Security: GATE2004-IT_25 [top](#)

<http://gateoverflow.in/3666>

A sender is employing public key cryptography to send a secret message to a receiver. Which one of the following statements is TRUE?

- A) Sender encrypts using receiver's public key
- B) Sender encrypts using his own public key
- C) Receiver decrypts using sender's public key
- D) Receiver decrypts using his own public key

[gate2004-it](#) [computer-networks](#) [network-security](#) [normal](#)

[Answer](#)

4.25.10 Network Security: GATE2005-IT_79 [top](#)

<http://gateoverflow.in/3843>

Suppose that two parties A and B wish to setup a common secret key (D-H key) between themselves using the Diffie-Hellman key exchange technique. They agree on 7 as the modulus and 3 as the primitive root. Party A chooses 2 and party B chooses 5 as their respective secrets. Their D-H key is

- | | |
|----|---|
| A) | 3 |
| B) | 4 |
| C) | 5 |
| D) | 6 |

gate2005-it | computer-networks | network-security | normal

[Answer](#)

4.25.11 Network Security: GATE2015-1_21 [top](#)

<http://gateoverflow.in/8244>

Suppose that everyone in a group of N people wants to communicate secretly with the $N - 1$ others using symmetric key cryptographic system. The communication between any two persons should not be decodable by the others in the group. The numbers of keys required in the system as a whole to satisfy the confidentiality requirement is

- A. $2N$
- B. $N(N - 1)$
- C. $N(N - 1)/2$
- D. $(N - 1)^2$

gate2015-1 | computer-networks | network-security | normal

[Answer](#)

4.25.12 Network Security: GATE2008-IT_70 [top](#)

<http://gateoverflow.in/3384>

The total number of keys required for a set of n individuals to be able to communicate with each other using secret key and public key cryptosystems, respectively are:

- | | |
|----|---------------------------|
| A) | $n(n-1)$ and $2n$ |
| B) | $2n$ and $((n(n - 1))/2)$ |
| C) | $((n(n - 1))/2)$ and $2n$ |
| D) | $((n(n - 1))/2)$ and n |

gate2008-it | computer-networks | network-security | normal

[Answer](#)

4.25.13 Network Security: GATE2014-1_24 [top](#)

<http://gateoverflow.in/1791>

Which of the following are used to generate a message digest by the network security protocols?

- (P) RSA (Q) SHA-1 (R) DES (S) MD5
- (A) P and R only
- (B) Q and R only
- (C) Q and S only
- (D) R and S only

gate2014-1 | computer-networks | network-security | normal

[Answer](#)

Answers: Network Security

4.25.1 Network Security: GATE2004-IT_84 [top](#)

<http://gateoverflow.in/3728>



Selected Answer

The simplest way to solve this is to use XOR property of codewords which says that XOR of two codewords is itself a codeword.

Upon XORing 1st and 3rd codeword we get another codeword **1011010**, which is III .

And on XORing this new generated codeword with 2nd codeword given we get **0010111**, which is I.

Hence Answer = **A**

8 votes

-- learncp (877 points)

4.25.2 Network Security: GATE2013_13 [top](#)

<http://gateoverflow.in/1435>



Selected Answer

X adds his digital signature: In order to identify the authentic user, X uses his **Private Key** to encrypt his signature.

X then encrypts the whole message with the digital signature: X uses Y's **Public Key** to encrypt the message so that Y can decipher it when it reaches to him using his private key.

Message then reaches Y.

Y then uses his **Private key** to decrypt the message, and extracts the message and along with the signature.

But as the signature has been encrypted using X's private key so:

Y uses X's **Public Key** to see the signature if it matches X's actual signature (this step ensures that no one can fake as X and sends a message to Y).

Nobody can tamper the message as in order to do that he/she has to first know Y's private key to decipher the message extract the signature and then change the signature and then recreate that using X's private key which is not with him.

So sequence of operations:

X's Private Key -> Y's public key -> Y's Private key -> X's public Key which is **(D)**.

8 votes

-- Santanu Naskar (177 points)

4.25.3 Network Security: GATE2007-IT-70 [top](#)

<http://gateoverflow.in/3515>

Your are given the following four bytes :

10100011 00110111 11101001 10101011 =32 + ADD 4 0's = 36
accoding to wikipedia, make pair of 6 should be made. <https://en.wikipedia.org/wiki/Base64>

101000 110011 011111 101001 101010 11**0000**
40 51 31 41 42 48

o z f p q w from base 64 table.
now the longest substring will be from option checking is '**fpq**'

1 votes

-- Jayesh10 (21 points)

4.25.4 Network Security: TIFR2011-B-36 [top](#)

<http://gateoverflow.in/20918>

Ans D reference:

<http://www.cisco.com/web/about/security/intelligence/virus-worm-diffs.html>

2 votes

-- Saurav Shrivastava (719 points)

4.25.5 Network Security: GATE2014-2_27 [top](#)

<http://gateoverflow.in/1986>



Selected Answer

intruder cant see URL because it is well encrypted by DES at presentation layer..
 TCP PORT number available to intruder because TCP header contains source as well as destination address..
 Link address unavailable because sniffing at R2 which is basically a router intruder can see link address of R1, R3 , but at R2 link address of Q and H unavailable..

7 votes

-- Digvijay (35.8k points)

4.25.6 Network Security: GATE 2016-1-52 [top](#)

<http://gateoverflow.in/39694>

Selected Answer

B wants to send message 'm' to A.
 Private keys are denoted by $K^-(x)$ and public keys by $K^+(x)$.
 In digital signature, the private key of sender is used to encrypt the message and its public key is used to decrypt.
 So, $\{m, K^-(B)(H(m))\}$ must be the correct way of sending the message.
 Option B.

17 votes

-- Monanshi Jain (6.5k points)

4.25.7 Network Security: GATE2009-46 [top](#)

<http://gateoverflow.in/132>

Selected Answer

ans b)

6 votes

-- Aditi Dan (5.4k points)

4.25.8 Network Security: GATE2007-IT_15 [top](#)

<http://gateoverflow.in/3448>

Selected Answer

Answer: C

- i. Hash function is not one one or injective. It is many to one.
- ii. True. Uses P-Box permutation.

7 votes

-- Rajarshi Sarkar (29.7k points)

4.25.9 Network Security: GATE2004-IT_25 [top](#)

<http://gateoverflow.in/3666>

Selected Answer

A) Sender encrypts using receiver's public key

8 votes

-- Omesh Pandita (2.3k points)

4.25.10 Network Security: GATE2005-IT_79 [top](#)

<http://gateoverflow.in/3843>



Selected Answer

For Diffie-Hellman the secret is $[g^a \cdot b] \text{ mod } p$, where g is the prime root (or generator) and p is the modulus.

So the answer should be $(3^{10}) \text{ mod } 7$ which is B) 4.

8 votes

-- Omesh Pandita (2.3k points)

4.25.11 Network Security: GATE2015-1_21 [top](#)

<http://gateoverflow.in/6244>

Selected Answer

In symmetric key cryptographic system, both parties have access to key. So, the first person has $N-1$ keys with other $N-1$ people, second one has another $N-2$ with $N-2$ people (1 we already considered) and so on till 1. So, total number of keys required

$$= N-1 + N-2 + \dots + 1$$

$$= N(N-1)/2$$

C choice.

Had we been using Public key cryptography we needed just $2N$ keys in the system.

Ref: https://en.wikipedia.org/wiki/Symmetric-key_algorithm

12 votes

-- Arjun Suresh (150k points)

4.25.12 Network Security: GATE2008-IT_70 [top](#)

<http://gateoverflow.in/3384>

Selected Answer

For private key crypto for communication between each pair of individuals on secret key will be required, so if an individual wants to communicate with other $n-1$ individuals he should have $n-1$ secret keys, so the total number of secret keys for private encryption is $n*(n-1)$ (If we include copies) or $n*(n-1)/2$ (distinct keys).

For public key encryption each individual needs to have a public and private key, so the total keys required in $2*n$

From the tone of the question the answer seems to be C) $n(n-1)/2$ and $2n$

11 votes

-- Omesh Pandita (2.3k points)

4.25.13 Network Security: GATE2014-1_24 [top](#)

<http://gateoverflow.in/1791>

Selected Answer

RSA and DES are used for Encryption where MD5 and SHA 1 are used to generate Message Digest.

9 votes

-- Shiva Chaitanya Gajula (473 points)

4.26

Network Switching [top](#)

4.26.1 Network Switching: GATE2005_73 [top](#)

<http://gateoverflow.in/1396>

In a packet switching network, packets are routed from source to destination along a single path having two intermediate nodes. If the message size is 24 bytes and each packet contains a header of 3 bytes, then the optimum packet size is:

- A. 4
- B. 6
- C. 7
- D. 9

[gate2005](#) [computer-networks](#) [network-switching](#) [normal](#)

[Answer](#)

4.26.2 Network Switching: GATE2004-IT_22 [top](#)

<http://gateoverflow.in/3663>

Which one of the following statements is FALSE?

- A) Packet switching leads to better utilization of bandwidth resources than circuit switching
- B) Packet switching results in less variation in delay than circuit switching
- C) Packet switching requires more per-packet processing than circuit switching
- D) Packet switching can lead to reordering unlike in circuit switching

[gate2004-it](#) [computer-networks](#) [network-switching](#) [normal](#)

[Answer](#)

4.26.3 Network Switching: GATE2014-2_26 [top](#)

<http://gateoverflow.in/1985>

Consider the store and forward packet switched network given below. Assume that the bandwidth of each link is 10^6 bytes / sec. A user on host A sends a file of size

10^3 bytes to host B through routers R1 and R2 in three different ways. In the first case a single packet containing the complete file is transmitted from A to B. In the second case, the file is split into 10 equal parts, and these packets are transmitted from A to B. In the third case, the file is split into 20 equal parts and these packets are sent from A to B. Each packet contains 100 bytes of header information along with the user data. Consider only transmission time and ignore processing, queuing and propagation delays. Also assume that there are no errors during transmission. Let T1, T2 and T3 be the times taken to transmit the file in the first, second and third case respectively. Which one of the following is CORRECT?



- (A)
 $T < T2 < T3$
- (B)
 $T1 > T2 > T3$
- (C)
 $T2 = T3, T3 < T1$
- (D)
 $T1 = T3, T3 > T2$

[gate2014-2](#) [computer-networks](#) [network-switching](#) [normal](#)

[Answer](#)

Answers: Network Switching

4.26.1 Network Switching: GATE2005_73 [top](#)

<http://gateoverflow.in/1396>



Selected Answer

correct answer should be option (d)

As we know in packet switching dividing message into packets decrease the transmission time due to pipelined transmission.

but if there are many packets beyond some threshold then transmission time may increase .. so we can do by option checking

1. packet size =4 = packet data + header size = 1+3 ...so no of packets will be = message / packet data = $24B/1B = 24$ packets ...

so time to reach at receiver for 1st packet will be = $3(\text{source} + \text{two intermediate node}) * \text{transmission time}$

$\text{TT} = L/\text{BW}$... here L will be changed according to option and BW will remain same ..

so time to reach at receiver for 1st packet will be= $3*4/\text{BW} = 12/\text{BW}$

and for remaining 23 packets will take time = $23 * \text{TT} = 23 * 4/\text{BW} = 92/\text{BW}$

TOTAL TIME = $104/\text{BW}$

2. packet size = 6 = $3+3$ (packet data + header size) so no of packets will be 8.

time to reach at receiver for 1st packet will be= $3*6/\text{BW} = 18/\text{BW}$

and for remaining 7 packet will take time = $7*6/\text{BW} = 42/\text{BW}$

total time = $60/\text{BW}$

3. packet size = 7 = $4+3$,so no of packets = $24/4=6$ packets

for 1st packet time will be = $3*7/\text{BW} = 21/\text{BW}$

for remaining 5 packet will take time= $5*7/\text{BW} = 35/\text{BW}$

total time= $56/\text{BW}$

4 . packet size =9. $6+3=$ so no of packet will be 4 .

for 1st packet time will be = $3*9/\text{BW}=27/\text{BW}$

for remaining 3 packets will take time= $3*9/\text{BW} = 27/\text{BW}$

TOTAL time= $54/\text{BW}$

SO optimal packet size will be 9 byte due to less total transmission time.

7 votes

-- sonam vyas (8.1k points)

4.26.2 Network Switching: GATE2004-IT_22 [top](#)

<http://gateoverflow.in/3663>



Selected Answer

Answer B

In circuit switching, a fix bandwidth is allocated to each connection, e.g. 64 Kb/s allocated to each each phone call.

In circuit switching each connection has a dedicated circuit or channel all the way along the path and the circuit is not shared with anyone else.

Thus in circuit switching each call has its own private, guaranteed, isolated data rate from end to end.So we can say that every connection or flow is independent of others.

In the case of packet switching, all flows share the full channel capacity by statistical multiplexing.

So the bandwidth allocated to each flow depends upon the number of concurrent flows & network traffic.

In packet switching if we know the type of link we are using, the bandwidth allocated, the packet size for any flow then we can calculate the Propagation Delay & Transmission Delays.

But **Queueing Delay is a random variable that depends upon the number of packets arriving at the same time at any switch.**

It is the only random variable in our end to end delay expression. All other delays can be calculated precisely if we have enough information about the flows.

So queueing adds unpredictable & variable delays in the packet switching.

There are delays like propagation delay etc. in circuit switching but they have a very small variance because of independence, privacy & bandwidth guarantees.

7 votes

-- Anurag Pandey (9.7k points)

4.26.3 Network Switching: GATE2014-2_26 [top](#)

<http://gateoverflow.in/1985>



Selected Answer

In this question we have used the concept of pipelining.

In second and Third case, First packet will take $3*T_t$ time and all subsequent packets will be delivered in one T_t time.

$$T1 = 3 * T_t = 3 * (1000 + 100) / B$$

$$T_t = (\text{data} + \text{header}) / \text{Bandwidth}$$

$$\text{data} = 1000 \text{ Bytes}; \text{header} = 100 \text{ Bytes}$$

$$T1 = 3300/B \text{ seconds}$$

$$T2 = 3 * T_t' + 9 * T_t' = 12 * T_t'$$

$$T_t' = (\text{data} + \text{header}) / \text{Bandwidth}$$

$$T2 = 12 * (100 + 100) / B = 2400 / B \text{ seconds}$$

$$T3 = 3 * T_t'' + 19 * T_t'' = 22 * T_t''$$

$$T_t'' = (50 + 100) / B$$

$$T3 = 22 * 150 / B = 3300 / B$$

So $T1 = T3$ and $T3 > T2$;

option D

27 votes

-- Vikrant Singh (11k points)

4.27

Osi Protocol [top](#)

4.27.1 Osi Protocol: GATE2014-3_23 [top](#)

<http://gateoverflow.in/2057>

In the following pairs of OSI protocol layer/sub-layer and its functionality, the **INCORRECT** pair is

- (A) Network layer and Routing
- (B) Data Link Layer and Bit synchronization
- (C) Transport layer and End-to-end process communication
- (D) Medium Access Control sub-layer and Channel sharing

[gate2014-3](#)
[computer-networks](#)
[network-layering](#)
[osi-protocol](#)
[easy](#)
Answer

Answers: Osi Protocol

4.27.1 Osi Protocol: GATE2014-3_23 [top](#)

<http://gateoverflow.in/2057>


Selected Answer

Answer is B) Data Link Layer & Bit Synchronization.

Because, Data Link Layer is associated with Frame Synchronization, and not Bit Synchronization.

thumb-up 12 votes

-- saurabhrk (1.3k points)

4.28

Routers Bridge Hubs Switches [top](#)

4.28.1 Routers Bridge Hubs Switches: GATE2004_16 [top](#)

<http://gateoverflow.in/1013>

Which of the following is NOT true with respect to a transparent bridge and a router?

- A. Both bridge and router selectively forward data packets
- B. A bridge uses IP addresses while a router uses MAC addresses
- C. A bridge builds up its routing table by inspecting incoming packets
- D. A router can connect between a LAN and a WAN

[gate2004](#)
[computer-networks](#)
[routers-bridge-hubs-switches](#)
[normal](#)
Answer

Answers: Routers Bridge Hubs Switches

4.28.1 Routers Bridge Hubs Switches: GATE2004_16 [top](#)

<http://gateoverflow.in/1013>


Selected Answer

- A. Both bridge and router selectively forward data packets => True. Bridge can drop packets not meant for other side, so can router.
- B. A bridge uses IP addresses while a router uses MAC addresses => False . A bridge operate at layer 2 (data link layer) so it uses MAC address, while router at layer 3 (network layer) so it using IP address
- C. A bridge builds up its routing table by inspecting incoming packets => True. Self Learning Bridges
- D. A router can connect between a LAN and a WAN => True. Router connecting home LAN To internet !

thumb-up 6 votes

-- Akash (31.7k points)

4.29

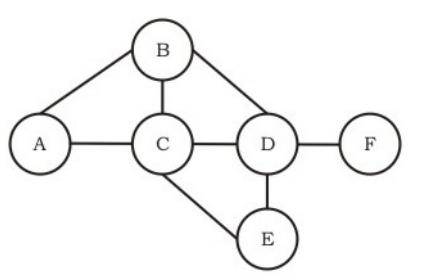
Routing [top](#)

4.29.1 Routing: GATE2005-IT_85a [top](#)

<http://gateoverflow.in/3858>

Consider a simple graph with unit edge costs. Each node in the graph represents a router. Each node maintains a routing table indicating the next hop router to be used to relay a packet to its destination and the cost of the path to the destination through that router. Initially, the routing table is empty. The routing table is synchronously updated as follows. In each updation interval, three tasks are performed.

- A node determines whether its neighbours in the graph are accessible. If so, it sets the tentative cost to each accessible neighbour as 1. Otherwise, the cost is set to ∞ .
- From each accessible neighbour, it gets the costs to relay to other nodes via that neighbour (as the next hop).
- Each node updates its routing table based on the information received in the previous two steps by choosing the minimum cost.



For the graph given above, possible routing tables for various nodes after they have stabilized, are shown in the following options. Identify the correct table.

Table for node A

| | | |
|---|---|---|
| A | - | - |
| B | B | 1 |
| C | C | 1 |
| D | B | 3 |
| E | C | 3 |
| F | C | 4 |

Table for node C

| | | |
|---|---|---|
| A | A | 1 |
| B | B | 1 |
| C | - | - |
| D | D | 1 |
| E | E | 1 |
| F | E | 3 |

Table for node B

| | | |
|---|---|---|
| A | A | 1 |
| B | - | - |
| C | C | 1 |
| D | D | 1 |
| E | C | 2 |
| F | D | 2 |

Table for node D

| | | |
|---|---|---|
| A | B | 3 |
| B | B | 1 |
| C | C | 1 |
| D | - | - |
| E | E | 1 |
| F | F | 1 |

[gate2005-it](#) [computer-networks](#) [routing](#) [normal](#)

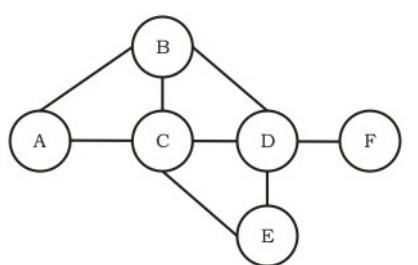
Answer

4.29.2 Routing: GATE2005-IT_85b [top](#)

<http://gateoverflow.in/3859>

Consider a simple graph with unit edge costs. Each node in the graph represents a router. Each node maintains a routing table indicating the next hop router to be used to relay a packet to its destination and the cost of the path to the destination through that router. Initially, the routing table is empty. The routing table is synchronously updated as follows. In each updation interval, three tasks are performed.

- A node determines whether its neighbours in the graph are accessible. If so, it sets the tentative cost to each accessible neighbour as 1. Otherwise, the cost is set to ∞ .
- From each accessible neighbour, it gets the costs to relay to other nodes via that neighbour (as the next hop).
- Each node updates its routing table based on the information received in the previous two steps by choosing the minimum cost.



Continuing from the earlier problem, suppose at some time t , when the costs have stabilized, node A goes down. The cost from node F to node A at time $(t + 100)$ is :

- A. > 100 but finite
- B. ∞
- C. 3
- D. > 3 and ≤ 100

[gate2005-it](#) [computer-networks](#) [routing](#) [normal](#)

[Answer](#)

4.29.3 Routing: GATE2008-IT_67 [top](#)

<http://gateoverflow.in/3381>

Two popular routing algorithms are Distance Vector(DV) and Link State (LS) routing. Which of the following are true?

- (S1) Count to infinity is a problem only with DV and not LS routing
- (S2) In LS, the shortest path algorithm is run only at one node
- (S3) In DV, the shortest path algorithm is run only at one node
- (S4) DV requires lesser number of network messages than LS

- A) S1, S2 and S4 only
- B) S1, S3 and S4 only
- C) S2 and S3 only
- D) S1 and S4 only

[gate2008-it](#) [computer-networks](#) [routing](#) [normal](#)

[Answer](#)

4.29.4 Routing: GATE2005_26 [top](#)

<http://gateoverflow.in/1362>

In a network of LANs connected by bridges, packets are sent from one LAN to another through intermediate bridges. Since more than one path may exist between two LANs, packets may have to be routed through multiple bridges. Why is the *spanning tree algorithm* used for bridge-routing?

- A. For shortest path routing between LANs
- B. For avoiding loops in the routing paths
- C. For fault tolerance
- D. For minimizing collisions

[gate2005](#) [computer-networks](#) [routing](#) [normal](#)
[Answer](#)

4.29.5 Routing: GATE2007-IT-63 [top](#)

<http://gateoverflow.in/3508>

A group of 15 routers are interconnected in a centralized complete binary tree with a router at each tree node. Router i communicates with router j by sending a message to the root of the tree. The root then sends the message back down to router j. The mean number of hops per message, assuming all possible router pairs are equally likely is

- A. 3
- B. 4.26
- C. 4.53
- D. 5.26

[gate2007-it](#) [computer-networks](#) [routing](#) [binary-tree](#) [normal](#)
[Answer](#)

4.29.6 Routing: GATE2014-3_26 [top](#)

<http://gateoverflow.in/2060>

An IP router implementing Classless Inter-domain Routing (CIDR) receives a packet with address 131.23.151.76. The router's routing table has the following entries:

| Prefix | Output Interface Identifier |
|----------------|-----------------------------|
| 131.16.0.0/ 12 | 3 |
| 131.28.0.0/ 14 | 5 |
| 131.19.0.0/ 16 | 2 |
| 131.22.0.0/ 15 | 1 |

The identifier of the output interface on which this packet will be forwarded is _____.

[gate2014-3](#) [computer-networks](#) [routing](#) [normal](#)
[Answer](#)

4.29.7 Routing: GATE2014-2_23 [top](#)

<http://gateoverflow.in/1981>

Which of the following is TRUE about the interior gateway routing protocols
 — Routing Information Protocol
(RIP) and Open Shortest Path First
(OSPF)

- (A) RIP uses distance vector routing and OSPF uses link state routing
- (B) OSPF uses distance vector routing and RIP uses link state routing
- (C) Both RIP and OSPF use link state routing
- (D) Both RIP and OSPF use distance vector routing

[gate2014-2](#) [computer-networks](#) [routing](#) [normal](#)
[Answer](#)

Answers: Routing

4.29.1 Routing: GATE2005-IT_85a [top](#)

<http://gateoverflow.in/3858>

Selected Answer

| Table for node A | Table for node D | Table for node C | Table for node B |
|------------------|------------------|------------------|------------------|
| A - - | A B 2 | A A 1 | A A 1 |
| B B 1 | B B 1 | B B 1 | B - - |
| C C 1 | C C 1 | C - - | C C 1 |
| D B 2 | D - - | D D 1 | D D 1 |
| E C 2 | E E 1 | E E 1 | E C 2 |
| F C 3 | F F 1 | F E 3 | F D 2 |

correct table are updated

only option C is matching here with given tables

1 votes

-- Anirudh Pratap Singh (17.7k points)

4.29.2 Routing: GATE2005-IT_85b top

<http://gateoverflow.in/3859>



Selected Answer

We consider A B D F at t they are

The distance between A and the nodes B,D,F respectively are:
t: 1 2 3

t+1: 3 2 3

t+2 :3 4 3

t+3: 5 4 5

t+4: 5 6 5

t+5: 7 6 7

t+6: 7 8 7

t+7: 9 8 9

t+8: 9 10 9
and this continues

so in every two steps they get incremented by 2

so at t+99 F is $3+(99-2)=100$

at t+100 F is 102

So count to infinity problem
so option A

2 votes

-- Shreya Roy (773 points)

4.29.3 Routing: GATE2008-IT_67 top

<http://gateoverflow.in/3381>



Selected Answer

S1 is true, S2 and S3 are false and S4 is true.

Link State: <https://cseweb.ucsd.edu/classes/fa10/cse123/lectures/123-fa10-l12.pdf>

Distance Vector: <http://cseweb.ucsd.edu/classes/fa10/cse123/lectures/123-fa10-l13.pdf>

8 votes

-- Arjun Suresh (150k points)

4.29.4 Routing: GATE2005_26 top

<http://gateoverflow.in/1362>

Selected Answer

The answer is B.

Since, in a spanning tree, there is a unique path from a source to the destination, which avoids loops, since it is a tree, and contains all the nodes, since it is a spanning tree.

6 votes

-- saurabhrk (1.3k points)

4.29.5 Routing: GATE2007-IT-63 top

<http://gateoverflow.in/3508>

Selected Answer

OPTION C

Here, we have to count average hops per message.

Steps -

- 1) Message goes up from sender to root
 - 2) Message comes down from root to destination
-

1) Average hops message goes to root -
$$\frac{(3*8)+(2*4)+(1*2)+(0*1)}{15} = 2.267$$

Here 3 * 8 represents 3 hops & 8 routers for Bottommost level & So on..

2) Similarly average hops when message comes down -
$$\frac{(3*8)+(2*4)+(1*2)+(0*1)}{15} \quad \text{{Same as above}}$$

So, Total Hops = 2 * 2.267 = **4.53 (Ans)**

17 votes

-- Himanshu Agarwal (9.8k points)

4.29.6 Routing: GATE2014-3_26 top

<http://gateoverflow.in/2060>

Selected Answer

Answer: (1)

Exp: Given address 131.23.151.76 coming to the first field of given routing table

$$\Rightarrow 131.16.0.0/12$$

131.0001 0111.151.76

131.0001 0000.0.0 (\because given mask bits = 12)

$$\Rightarrow 131.16.0.0 \quad \text{Matched}$$

Coming to the 2nd field of given Routing table

$$\Rightarrow 131.28.0.0/14$$

131.0001 0111.151.76

131.0001 0100.0.0 (\because given mask bits = 14)

$$\Rightarrow 131.20.0.0 \quad \text{Not matched.}$$

Coming to the 3rd field of given Routing table

Error! Not a valid link. 131.19.0.0/16

$$131.0001 0111.151.76$$

131.0001 0111.0.0 (\because given mask bits = 16)

$$\Rightarrow 131.23.0.0 \quad \text{Not matched}$$

Coming to the 4th field of given Routing table

$$\Rightarrow 131.22.0.0/15$$

131.0001 0111.151.76

131.0001 0110.0.0 (\because given mask bits = 15)

$$\Rightarrow 131.22.0.0 \quad \text{Matched}$$

We are getting 1st and 4th entries are matched so among them we have to pick up the longest mask bit, so output interface identifier is 1.

Hence Answer is Interface 1

9 votes

-- saurabhrk (1.3k points)

4.29.7 Routing: GATE2014-2_23 [top](#)

<http://gateoverflow.in/1981>



Selected Answer

ans a)

5 votes

-- Aditi Dan (5.4k points)

4.30

Selective Repeat [top](#)

4.30.1 Selective Repeat: GATE 2016-2-55 [top](#)

<http://gateoverflow.in/39577>

Consider a 128×10^3 bits/second satellite communication link with one way propagation delay of 150 milliseconds. Selective retransmission (repeat) protocol is used on this link to send data with a frame size of 1 kilobyte. Neglect the transmission time of acknowledgement. The minimum number of bits required for the sequence number field to achieve 100% utilization is _____.

[gate2016-2](#) [computer-networks](#) [selective-repeat](#) [normal](#) [numerical-answers](#)

Answer

Answers: Selective Repeat

4.30.1 Selective Repeat: GATE 2016-2-55 [top](#)

<http://gateoverflow.in/39577>



Selected Answer

Answer is 4 bits.

As we want 100 percent efficiency, $ws=1+2a$

$$a = \frac{\text{propagation time}}{\text{transmission time}} = \frac{150}{1024 \times 8 / 128} = \frac{150}{64} = 2.34, \Rightarrow ws = 1 + 2a = 5.6875 \approx 6$$

Available seq numbers $\geq ws + wr$

In Selective Repeat,
 $ws=wr$ (let it be n)
 $2*n=2*6=12$
avail seq numbers ≥ 12
so minimum seq numbers are 12
number of bits for that is ceil of $\lceil \log_2 12 \rceil = 4$.

14 votes

-- Sreyas S (1.6k points)

4.31**Serial Communication** top**4.31.1 Serial Communication: GATE1998_1.16** top<http://gateoverflow.in/1653>

In serial communication employing 8 data bits, a parity bit and 2 stop bits, the minimum band rate required to sustain a transfer rate of 300 characters per second is

- A. 2400 band
- B. 19200 band
- C. 4800 band
- D. 1200 band

[gate1998](#) [computer-networks](#) [communication](#) [serial-communication](#) [normal](#)
Answer**4.31.2 Serial Communication: GATE2008-IT_18** top<http://gateoverflow.in/3278>

How many bytes of data can be sent in 15 seconds over a serial link with baud rate of 9600 in asynchronous mode with odd parity and two stop bits in the frame?

- A) 10,000 bytes
- B) 12,000 bytes
- C) 15,000 bytes
- D) 27,000 bytes

[gate2008-it](#) [computer-networks](#) [communication](#) [serial-communication](#) [normal](#)
Answer**Answers: Serial Communication****4.31.1 Serial Communication: GATE1998_1.16** top<http://gateoverflow.in/1653>

Selected Answer

Since stop bit is given it is asynchronous communication and 1 start bit is implied. So,

$$(8 + 2 + 1 + 1) * 300 = 3600 \text{ bps}$$

Minimum [band rate](#) required would be 4800 here.

2 votes

-- Arjun Suresh (150k points)

4.31.2 Serial Communication: GATE2008-IT_18 [top](#)<http://gateoverflow.in/3278>

Selected Answer

Answer: B

Given that it is asynchronous mode of transmission, then along with per byte, you have to send some extra bit like start, stop bit and parity bits, etc (start and stop bit are compulsory).

1 bit for start bit, 8 bits for data, 1 bit for parity, 2 bits for stop bits.

$9600 * 15 / (1+8+1+2)$ Byte = 12000 Byte.

6 votes

-- Rajarshi Sarkar (29.7k points)

4.32**Sliding Window** [top](#)**4.32.1 Sliding Window: GATE2004-IT_81** [top](#)<http://gateoverflow.in/3725>

In a sliding window ARQ scheme, the transmitter's window size is N and the receiver's window size is M. The minimum number of distinct sequence numbers required to ensure correct operation of the ARQ scheme is

- A) min (M, N)
- B) max (M, N)
- C) M + N
- D) MN

[gate2004-it](#) [computer-networks](#) [sliding-window](#) [normal](#)

Answer

4.32.2 Sliding Window: GATE2005_25 [top](#)<http://gateoverflow.in/1361>

The maximum window size for data transmission using the selective reject protocol with $n - \text{bit}$ frame sequence numbers is:

- (a) 2^n
- (b) 2^{n-1}
- (c) $2^n - 1$
- (d) 2^{n-2}

[gate2005](#) [computer-networks](#) [sliding-window](#) [easy](#)

Answer

4.32.3 Sliding Window: GATE2009-57, ISRO2016-75 [top](#)<http://gateoverflow.in/1340>

Frames of 1000 bits are sent over a 10^6 bps duplex link between two hosts. The propagation time is 25ms. Frames are to be transmitted into this link to maximally pack them in transit (within the link).

What is the minimum number of bits (I) that will be required to represent the sequence numbers distinctly? Assume that no time gap needs to be given between transmission of two frames.

- A. I=2
- B. I=3
- C. I=4
- D. I=5

[gate2009](#) [computer-networks](#) [sliding-window](#) [normal](#) [isro2016](#)

Answer

4.32.4 Sliding Window: GATE2009-58 [top](#)<http://gateoverflow.in/43470>

Frames of 1000 bits are sent over a 10^6 bps duplex link between two hosts. The propagation time is 25ms. Frames are to be transmitted into this link to maximally pack them in transit (within the link).

Let I be the minimum number of bits (I) that will be required to represent the sequence numbers distinctly assuming that no time gap needs to be given between transmission of two frames.

Suppose that the sliding window protocol is used with the sender window size of 2^I , where

I is the numbers of bits as mentioned earlier and acknowledgements are always piggy backed. After sending 2^I frames, what is the minimum time the sender will have to wait before starting transmission of the next frame? (Identify the closest choice ignoring the frame processing time.)

- A. 16ms
- B. 18ms
- C. 20ms
- D. 22ms

[gate2009](#) [computer-networks](#) [sliding-window](#) [normal](#)

[Answer](#)

4.32.5 Sliding Window: GATE2014-1_28 [top](#)

<http://gateoverflow.in/1795>

Consider a selective repeat sliding window protocol that uses a frame size of 1 KB to send data on a 1.5 Mbps link with a one-way latency of 50 msec. To achieve a link utilization of 60%, the minimum number of bits required to represent the sequence number field is _____.

[gate2014-1](#) [computer-networks](#) [sliding-window](#) [numerical-answers](#) [normal](#)

[Answer](#)

4.32.6 Sliding Window: GATE2008-IT_64 [top](#)

<http://gateoverflow.in/3375>

A 1Mbps satellite link connects two ground stations. The altitude of the satellite is 36,504 km and speed of the signal is 3×10^8 m/s. What should be the packet size for a channel utilization of 25% for a satellite link using go-back-127 sliding window protocol? Assume that the acknowledgment packets are negligible in size and that there are no errors during communication.

- | | |
|----|-----------|
| A) | 120 bytes |
| B) | 60 bytes |
| C) | 240 bytes |
| D) | 90 bytes |

[gate2008-it](#) [computer-networks](#) [sliding-window](#) [normal](#)

[Answer](#)

4.32.7 Sliding Window: GATE2003_84 [top](#)

<http://gateoverflow.in/967>

Host A is sending data to host B over a full duplex link. A and B are using the sliding window protocol for flow control. The send and receive window sizes are 5 packets each. Data packets (sent only from A to B) are all 1000 bytes long and the transmission time for such a packet is 50 μ s. Acknowledgement packets (sent only from B to A) are very small and require negligible transmission time. The propagation delay over the link is 200 μ s. What is the maximum achievable throughput in this communication?

- A. 7.69×10^6 bps
- B. 11.11×10^6 bps
- C. 12.33×10^6 bps
- D. 15.00×10^6 bps

[gate2003](#) [computer-networks](#) [sliding-window](#) [normal](#)

Answer**4.32.8 Sliding Window: GATE2015-3_28** [top](#)<http://gateoverflow.in/8481>

Consider a network connecting two systems located 8000 kilometers apart. The bandwidth of the network is 500×10^6 bits per second. The propagation speed of the media is 4×10^6 meters per second. It is need to design a Go-Back- N sliding window protocol for this network. The average packet size is 10^7 bits. The network is to be used to its full capacity. Assume that processing delays at nodes are negligible. Then, the minimum size in bits of the sequence number field has to be _____.

[gate2015-3](#) [computer-networks](#) [sliding-window](#) [normal](#) [numerical-answers](#)

Answer**4.32.9 Sliding Window: GATE2004-IT_88** [top](#)<http://gateoverflow.in/3732>

Suppose that the maximum transmit window size for a TCP connection is 12000 bytes. Each packet consists of 2000 bytes. At some point of time, the connection is in slow-start phase with a current transmit window of 4000 bytes. Subsequently, the transmitter receives two acknowledgements. Assume that no packets are lost and there are no time-outs. What is the maximum possible value of the current transmit window?

- A) 4000 bytes
- B) 8000 bytes
- C) 10000 bytes
- D) 12000 bytes

[gate2004-it](#) [computer-networks](#) [sliding-window](#) [normal](#)

Answer**4.32.10 Sliding Window: GATE2004-IT_83** [top](#)<http://gateoverflow.in/3727>

A 20 Kbps satellite link has a propagation delay of 400 ms. The transmitter employs the "go back n ARQ" scheme with n set to 10. Assuming that each frame is 100 bytes long, what is the maximum data rate possible?

- 1) 5 Kbps
- 2) 10 Kbps
- 3) 15 Kbps
- 4) 20 Kbps

[gate2004-it](#) [computer-networks](#) [sliding-window](#) [normal](#)

Answer**4.32.11 Sliding Window: GATE2007_69** [top](#)<http://gateoverflow.in/1267>

The distance between two stations M and N is L kilometers. All frames are K bits long. The propagation delay per kilometer is t seconds. Let R bits/second be the channel capacity. Assuming that the processing delay is negligible, the minimum number of bits for the sequence number field in a frame for maximum utilization, when the sliding window protocol is used, is:

- A. $\lceil \log_2 \frac{2LtR+2K}{K} \rceil$
- B. $\lceil \log_2 \frac{2LtR}{K} \rceil$
- C. $\lceil \log_2 \frac{2LtR+K}{K} \rceil$
- D. $\lceil \log_2 \frac{2LtR+2K}{2K} \rceil$

[gate2007](#) [computer-networks](#) [sliding-window](#) [normal](#)
Answer**4.32.12 Sliding Window: GATE2006_46** [top](#)<http://gateoverflow.in/1822>

Station A needs to send a message consisting of 9 packets to Station B using a sliding window (window size 3) and go-back-n error control strategy. All packets are ready and immediately available for transmission. If every 5th packet that A transmits gets lost (but no acks from B ever get lost), then what is the number of packets that A will transmit for sending the message to B?

- (A) 12
- (B) 14
- (C) 16
- (D) 18

[gate2006](#) [computer-networks](#) [sliding-window](#) [normal](#)
Answer**4.32.13 Sliding Window: GATE2006-IT_64** [top](#)<http://gateoverflow.in/3608>

Suppose that it takes 1 unit of time to transmit a packet (of fixed size) on a communication link. The link layer uses a window flow control protocol with a window size of N packets. Each packet causes an ack or a nak to be generated by the receiver, and ack/nak transmission times are negligible. Further, the round trip time on the link is equal to N units. Consider time $i > N$. If only acks have been received till time i (no naks), then the goodput evaluated at the transmitter at time i (in packets per unit time) is

- | | |
|----|-----------------|
| A) | $1 - N/i$ |
| B) | $i/(N + i)$ |
| C) | 1 |
| D) | $1 - e^{(i/N)}$ |

[gate2006-it](#) [computer-networks](#) [sliding-window](#) [normal](#)
Answer**4.32.14 Sliding Window: GATE2006_44** [top](#)<http://gateoverflow.in/1820>

Station A uses 32 byte packets to transmit messages to Station B using a sliding window protocol. The round trip delay between A and B is 80 milliseconds and the bottleneck bandwidth on the path between A and B is 128 kbps. What is the optimal window size that A should use?

- (A) 20
- (B) 40
- (C) 160
- (D) 320

[gate2006](#) [computer-networks](#) [sliding-window](#) [normal](#)
Answer**Answers: Sliding Window****4.32.1 Sliding Window: GATE2004-IT_81** [top](#)<http://gateoverflow.in/3725>

Selected Answer

C) M+N

Because $W_s + W_r \leq$ Sequence numbers (as the maximum number of unacknowledged packets at sender will be W_s and at the receiver it will be W_r , similar to the sequence numbering in Selective Repeat)

where W_s is size of sender window and W_r is receiver window's size.

12 votes

-- Parul Agarwal (783 points)

4.32.2 Sliding Window: GATE2005_25 [top](#)

<http://gateoverflow.in/1361>

Selected Answer

ans b)

In selective reject protocol, the maximum window size must be half the sequence number space = $2^n/2 = 2^{n-1}$.

For Go-back n, the maximum window size can be $2^n - 1$.

<http://webmuseum.mi.fh-offenburg.de/index.php?view=exh&src=73>

10 votes

-- Aditi Dan (5.4k points)

4.32.3 Sliding Window: GATE2009-57, ISRO2016-75 [top](#)

<http://gateoverflow.in/1340>

Selected Answer

Bandwidth won't be halved in full duplex. <http://superuser.com/questions/335979/does-1-gbit-s-port-in-full-duplex-mean-1-gbit-s-send-and-1-gbit-s-receive>

Propagation time is given as 25 ms.

Bandwidth = 10^6 bps.

So, to fully utilize the channel, we must send 10^6 bits into the channel in a second, which will be 1000 frames per second as each frame is 1000 bits. Now, since the propagation time is 25 ms, to fully pack the link we need to send at least $1000 * 25 * 10^{-3} = 25$ frames. So, we need $\lceil \log_2 25 \rceil = 5$ bits.

26 votes

-- Arjun Suresh (150k points)

4.32.4 Sliding Window: GATE2009-58 [top](#)

<http://gateoverflow.in/4370>

Bandwidth won't be halved in full duplex. <http://superuser.com/questions/335979/does-1-gbit-s-port-in-full-duplex-mean-1-gbit-s-send-and-1-gbit-s-receive>

Propagation time is given as 25 ms.

Bandwidth = 10^6 bps.

So, to fully utilize the channel, we must send 10^6 bits into the channel in a second, which will be 1000 frames per second as each frame is 1000 bits. Now, since the propagation time is 25 ms, to fully pack the link we need to send at least $1000 * 25 * 10^{-3} = 25$ frames. So, we need $\lceil \log_2 25 \rceil = 5$ bits.

$I = 5$, so $2^I = 32$ frames are sent.

Now, we need to get RTT (which is the time between which a frame is sent and its ACK is received), to determine the waiting time.

Transmission time (for a frame of size 1000 bits) = $1000/10^6 = 1 \text{ ms}$.
So, transmission time for 32 frames = 32 ms.

RTT = Propagation time for frame + Transmission time for frame + Propagation time for ACK + Transmission time for ACK
 $= 25 \text{ ms} + 1 \text{ ms} + 25 \text{ ms} + 1 \text{ ms}$ (ACK is piggy backed and assuming frame size for piggy backing is also 1000 bits)
 $= 52 \text{ ms}$

So, waiting time = $52 - 32 = 20 \text{ ms}$. (For the 32 ms, the sender was transmitting and not waiting)

8 votes

-- Arjun Suresh (150k points)

4.32.5 Sliding Window: GATE2014-1_28 [top](#)

<http://gateoverflow.in/1795>

The image shows a handwritten solution for a sliding window problem. It includes the following equations and steps:

$$\eta_{SR} = \frac{N}{1+2a}$$

$$B = 1.5 \text{ Mbps}$$

$$T_p = 50 \text{ ms}$$

$$L = 1 \text{ KB} = 1024 \times 8 \text{ bits}$$

$$\eta_{SR} = 60\%$$

$$W_S + W_R \leq ASN$$

$$2N \leq ASN$$

$$[2 \times 11.58] \leq ASN$$

$$ASN \geq [23.172]$$

$$\geq 24$$

$$\text{bits of seq\#} = \lceil \log_2 24 \rceil = 5 \text{ bits}$$

$$0.6 = \frac{N}{1+2a}$$

$$N = 0.6(1+2a)$$

$$a = \frac{T_p}{T_t} = \frac{T_p}{L} \cdot B$$

$$= \frac{50 \times 10^{-3} \times 1.5 \times 10^6}{1024 \times 8}$$

$$= 9.155$$

$$N = 0.6(1+2 \times 9.155)$$

$$N = 11.58$$

Is it the correct solution for this problem?

20 votes

-- Vikrant Singh (11k points)

4.32.6 Sliding Window: GATE2008-IT_64 [top](#)

<http://gateoverflow.in/3375>

The image shows a handwritten solution for a sliding window problem involving a satellite. It includes the following equations and steps:

$$\text{Distance from Station A to Satellite} = 36504 \times 10^3 \text{ m}$$

$$\text{Time to reach satellite} = \frac{36504000}{300000000} = 0.12168 \text{ s}$$

$$\text{RTT for a bit} = 4 \times \text{Time to reach satellite}(A \rightarrow S, S \rightarrow B, B \rightarrow S, S \rightarrow A)$$

Efficiency is the ratio of the amount of data sent to the maximum amount of data that could be sent. Let X be the packet

size.

In Go-Back-N, within RTT we can sent n packets. So, useful data is $n \times X$, where X is the packet size. Now, before we can sent another packet ACK must reach back. Time for this is transmission time for a packet (other packets are pipelined and we care only for first ACK), and RTT for a bit (propagation times for the packet + propagation time for ACK + transmission time for ACK - neglected as per question)

$$\text{Efficiency} = \frac{\text{Transmitted Data Size}}{\text{PacketSize} + \text{RTT}_{\text{bit}} \times \text{Bandwidth}}$$

$$0.25 = \frac{127 \times X}{X + 4 \times 0.12168 \times B}$$

$$0.25X + 0.25 \times 4 \times 0.12168 \times B = 127X$$

$$0.25 \times X + 0.12168 \times 10^6 = 127X$$

$$121680 = 126.75X$$

$$X = 9.6 \times 10^{-4} \times 10^6 = 960$$

Packet Size = 960 bits = 120 Bytes

so option (A)

18 votes

-- Danish (2.4k points)

4.32.7 Sliding Window: GATE2003_84 [top](#)

<http://gateoverflow.in/967>



Selected Answer

I think options are given in bytes per sec instead of bits per sec.

Transmission time = 50 micro sec

Propagation time = 200 micro sec

RTT = $50 + 2 \times 200 = 450$ microsec (Receiver can send an ACK as soon as the first packet is received)

total number of bits transmitted before first ACK is received = $1000 \times 5 \times 8$ bits = 40000 bits

After first ACK is received, same cycle of action repeats. So,

Throughput = $(40000/450) \times 10^6$ bits = 88.88×10^6 bits ps = 11.11×10^6 bytes per sec

21 votes

-- Parul Agarwal (783 points)

4.32.8 Sliding Window: GATE2015-3_28 [top](#)

<http://gateoverflow.in/8481>



Selected Answer

Answer = 8 bits

In order to achieve full utilization, sender has to keep on sending frames till the acknowledgement arrives for the first frame.

Time taken for acknowledgement to arrive is 2 times propagation delay + transmission time for a frame.

One way propagation time = $8000 \times 10^3 / (4 \times 10^6)$

= 2 secs

Time taken to transmit one frame = $10^7 / (500 \times 10^6)$

= 0.02 secs

So, RTT = $2 * 2 = 4$

No of frames that can be transmitted in 4 secs = $4 / 0.02$

= 200

Hence minimum number of bits required for sequence numbers till 200 is 8 (as $2^8 = 256$)

16 votes

-- overtomanu (1.1k points)

4.32.9 Sliding Window: GATE2004-IT_88 [top](#)

<http://gateoverflow.in/3732>



Selected Answer

In slow-start phase, for each ACK, the sender increases the current transmit window by Maximum Segment Size (MSS). In the question it is given a packet consists of 2000 bytes and that can be taken as MSS. So, after two ACKs, current transmit window
 $= 4000 + 2000 + 2000$
 $= 8000$

<http://www.ece.virginia.edu/~mv/edu/ee136/Lectures/congestion-control/tcp-congestion-control.pdf>

11 votes

-- Arjun Suresh (150k points)

4.32.10 Sliding Window: GATE2004-IT_83 [top](#)

<http://gateoverflow.in/3727>



Selected Answer

Answer: B
Transmission Time = $100*8 \text{ bits}/20 \text{ Kbps} = 40 \text{ ms}$
Propagation Time = 400 ms
Efficiency = $\text{Window Size} * \text{Transmission Time} / (\text{Transmission Time} + 2 * \text{Propagation Time}) = 10 * 40 / (40 + 2 * 400) = .476$
Maximum Data Rate = $.476 * 20 \text{ Kbps} = 9.52 \text{ Kbps}$ which is close to option B.

12 votes

-- Rajarshi Sarkar (29.7k points)

4.32.11 Sliding Window: GATE2007_69 [top](#)

<http://gateoverflow.in/1267>



Selected Answer

Answer: C

We can send $\frac{\text{RTT}}{\text{Transmission Time}}$ number of packets for maximum utilisation of the channel, as in this time we get the first ACK back and till that time, we can continue sending packets.

So, $\frac{\text{Transmission Time} + 2 * \text{Propagation Time}}{\text{Transmission Time}}$ number of packets should be sent.

Therefore, bits required for the sequence number field:

$$\left\lceil \log_2 \left(\frac{\frac{K}{R} + 2Lt}{\frac{K}{R}} \right) \right\rceil = \left\lceil \log_2 \left(\frac{K + 2LtR}{K} \right) \right\rceil$$

16 votes

-- Rajarshi Sarkar (29.7k points)

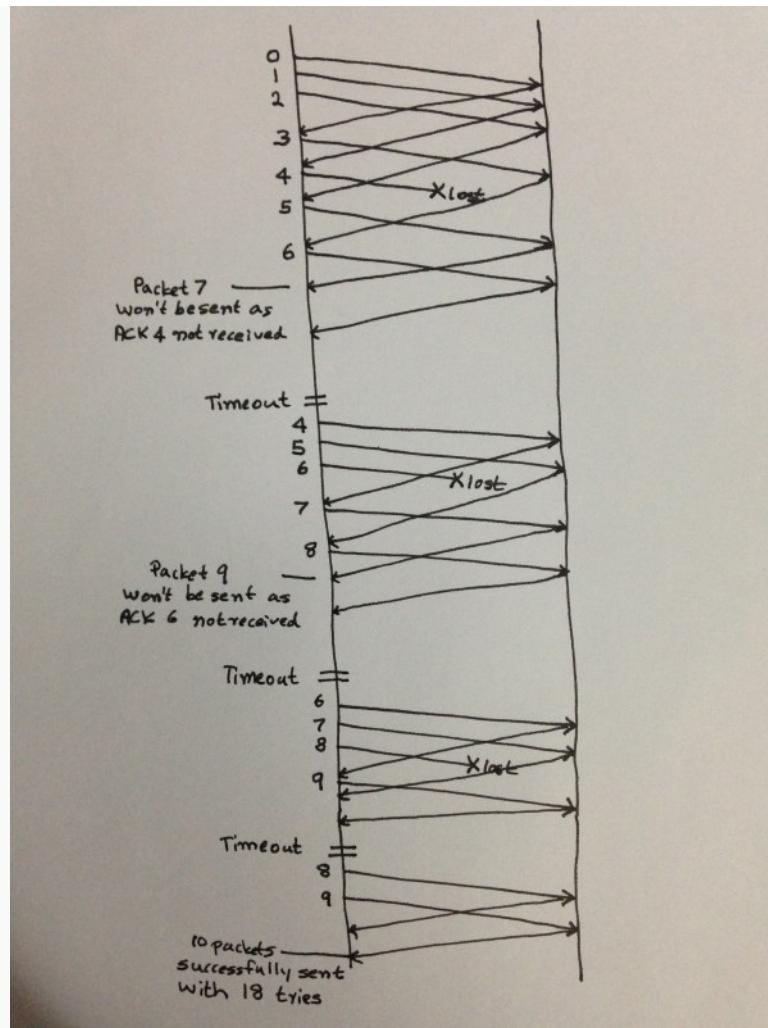
4.32.12 Sliding Window: GATE2006_46 [top](#)

<http://gateoverflow.in/1822>



Selected Answer

Since all packets are ready initially itself, we can assume a timeout is detected after all possible packets are sent. So, the sending happens as shown in figure (I draw the figure assuming 10 packets. For 9 packets answer will be 16).



✓ 21 votes

-- Arjun Suresh (150k points)

4.32.13 Sliding Window: GATE2006-IT_64 top

<http://gateoverflow.in/3608>



Selected Answer

In [computer networks](#), **goodput** is the application level [throughput](#), i.e. the number of useful information [bits](#) delivered by the network to a certain destination per unit of time. (From wikipedia).

So, successful delivery of packet can be assured if ACK has been received for it.

So till time ' i ' we would have transmitted ' i ' packets but only $(i-N)$ can be acknowledged as minimum time for a packet to get Acknowledged is N (since RTT is N which is equal to the window size, there is no waiting time for the sender).

So successfully delivered packets = $(i-N)$

Time for transmission =

Goodput = Successfully delivered data/ Time = $(i-N)/i = 1 - N/i$

Therefore (A)

✓ 15 votes

-- Sandeep_Uniyal (5.5k points)

4.32.14 Sliding Window: GATE2006_44 top

<http://gateoverflow.in/1820>



Selected Answer

Round trip delay = 80 ms.

Quoting from [Wikipedia](#)

the **round-trip delay** time (RTD) or **round-trip** time (RTT) is the length of time it takes for a signal to be sent plus the length of time it takes for an acknowledgment of that signal to be received.

Now, in many books including standard ones, they have used RTT to mean just the 2-way propagation delay by considering the signal/packet as of the smallest possible quantity so that its transmission time is negligible. The given question is following the first definition as given by Wikipedia which is clear from the choice.

During this time the first ACK arrives and so sender can continue sending frames. So, for maximum utilization sender should have used the full bandwidth during this time. i.e., it should have sent $128 \text{ kbps} * 80 \text{ ms}$ amount of data and a packet being of size 32 byte we get no. of packets

$$= \frac{128 \times 80}{32 \times 8} = 40.$$

9 votes

-- Arjun Suresh (150k points)

4.33

Sockets

4.33.1 Sockets: GATE2014-2_24 [top](#)

<http://gateoverflow.in/1982>

Which of the following socket API functions converts an unconnected active TCP socket into a passive socket?

- (A) connect
- (B) bind
- (C) listen
- (D) accept

[gate2014-2](#) [computer-networks](#) [sockets](#) [easy](#)

[Answer](#)

4.33.2 Sockets: GATE2015-2_20 [top](#)

<http://gateoverflow.in/8108>

Identify the correct order in which a server process must invoke the function calls accept, bind, listen, and recv according to UNIX socket API.

- A. listen, accept, bind, recv
- B. bind, listen, accept, recv
- C. bind, accept, listen, recv
- D. accept, listen, bind, recv

[gate2015-2](#) [computer-networks](#) [sockets](#) [easy](#)

[Answer](#)

4.33.3 Sockets: GATE2008-17 [top](#)

<http://gateoverflow.in/415>

Which of the following system calls results in the sending of SYN packets?

- A. socket
- B. bind

- C. listen
- D. connect

[gate2008](#) [normal](#) [computer-networks](#) [sockets](#)

[Answer](#)

4.33.4 Sockets: GATE2008-59 [top](#)

<http://gateoverflow.in/482>

A client process P needs to make a TCP connection to a server process S. Consider the following situation: the server process S executes a socket(), a bind() and a listen() system call in that order, following which it is preempted. Subsequently, the client process P executes a socket() system call followed by connect() system call to connect to the server process S. The server process has not executed any accept() system call. Which one of the following events could take place?

- A. connect() system call returns successfully
- B. connect() system call blocks
- C. connect() system call returns an error
- D. connect() system call results in a core dump

[gate2008](#) [computer-networks](#) [sockets](#) [normal](#)

[Answer](#)

Answers: Sockets

4.33.1 Sockets: GATE2014-2_24 [top](#)

<http://gateoverflow.in/1982>



Selected Answer

C is ans listen converts unconnected socket into passive connect i.e it is waiting for request from client

6 votes

-- Pooja (25.9k points)

4.33.2 Sockets: GATE2015-2_20 [top](#)

<http://gateoverflow.in/8108>



Selected Answer

Answer: B

Bind: Binds the socket to an address

Listen: Waits for connections to the socket

Accept: Accepts a connection to the socket

Recv: Receives data from connection

From Man page of accept:

It extracts the first connection request on the queue of pending connections for the listening socket, creates a new connected socket, and returns a new file descriptor referring to that socket. The newly created socket is not in the listening state. The original socket is unaffected by this call

10 votes

-- Rajarshi Sarkar (29.7k points)

4.33.3 Sockets: GATE2008-17 [top](#)

<http://gateoverflow.in/415>



Selected Answer

answer (D)

socket() creates a new socket of a certain socket type, identified by an integer number, and allocates system resources to it.

bind() is typically used on the server side, and associates a socket with a socket address structure, i.e. a specified local port number and IP address.

listen() is used on the server side, and causes a bound TCP socket to enter listening state.

connect() is used on the client side, and assigns a free local port number to a socket. In case of a TCP socket, it causes an attempt to establish a new TCP connection.

When **connect()** is called by client, following three way handshake happens to establish the connection in TCP.

- 1) The client requests a connection by sending a SYN (synchronize) message to the server.
- 2) The server acknowledges this request by sending SYN-ACK back to the client.
- 3) The client responds with an ACK, and the connection is established.

10 votes

-- sonam vyas (8.1k points)

4.33.4 Sockets: GATE2008-59 [top](#)

<http://gateoverflow.in/482>



Selected Answer

First thing to note: All the sockets are by default in BLOCKING mode. What do we mean by blocking ??

Blocking mode means that when we make a system call, it blocks the caller for the time "when call() is made till the job is done OR an error returns ". We can set each socket to Non-blocking explicitly. Setting to Non-Blocking means we are telling the kernel that "If the system call cant be completed without putting process to sleep then DON'T put the process to sleep . Instead return with an ERROR immediately and continue the process" which can be checked for the completion by the caller in between the execution of other tasks.

Now coming to this question:

Suppose connect() is in default blocking mode then calling connect() sends SYN packet to the server. Since server has not executed any accept() call it can not acknowledge the SYN packet. Connect() in blocking mode keep sending SYN packets at fixed intervals(first after 6 sec, second after 24 sec typically until 75 sec latest). This is done until an error ETIMEDOUT is returned by the TCP.(in this case,else there are several other type of errors returned in case No port exists for that connection or server id not listening etc.)

here option (B) saying that connect() blocks is not entirely wrong but since we know that accept() call is not made by server, connect() WILL NOT WAIT FOREVER and SO IT CAN NOT BLOCK. It will **ultimately return** with an ERROR message.

So option (c) is CORRECT.

Core dump thing I don't know about !!

But once connect() returns error that socket can not be reused and must be CLOSED.

And a non-blocking connect() is never blocked and immediately returns with an error if connection is not successful although IT CONTINUES WITH TRYING TO CONNECT .Error here just means that it returns a message saying "I could not connect immediately BUT i am trying AND you can check it in between."

Hope it clears a bit.

22 votes

-- Sandeep_Uniyal (5.5k points)

4.34

Stop And Wait [top](#)

4.34.1 Stop And Wait: GATE2006-IT_68 [top](#)

<http://gateoverflow.in/3612>

On a wireless link, the probability of packet error is 0.2. A stop-and-wait protocol is used to transfer data across the link. The channel condition is assumed to be independent from transmission to transmission. What is the average number of transmission attempts required to transfer 100 packets?

- A) 100
- B) 125
- C) 150
- D) 200

[gate2006-it](#) [computer-networks](#) [sliding-window](#) [stop-and-wait](#) [normal](#)

[Answer](#)

4.34.2 Stop And Wait: GATE 2016-1-55 [top](#)

<http://gateoverflow.in/39696>

A sender uses the Stop-and-Wait ARQ protocol for reliable transmission of frames. Frames are of size 1000 bytes and the transmission rate at the sender is 80 Kbps (1 Kbps = 1000 bits/second). Size of an acknowledgement is 100 bytes and the transmission rate at the receiver is 8 Kbps. The one-way propagation delay is 100 milliseconds.

Assuming no frame is lost, the sender throughput is _____ bytes/ second.

[gate2016-1](#) [computer-networks](#) [stop-and-wait](#) [normal](#) [numerical-answers](#)

[Answer](#)

4.34.3 Stop And Wait: GATE2015-1_53 [top](#)

<http://gateoverflow.in/8363>

Suppose that the stop-and-wait protocol is used on a link with a bit rate of 64 kilobits per second and 20 milliseconds propagation delay. Assume that the transmission time for the acknowledgement and the processing time at nodes are negligible. Then the minimum frame size in bytes to achieve a link utilization of at least 50% is_____.

[gate2015-1](#) [computer-networks](#) [stop-and-wait](#) [normal](#)

[Answer](#)

Answers: Stop And Wait

4.34.1 Stop And Wait: GATE2006-IT_68 [top](#)

<http://gateoverflow.in/3612>



Selected Answer

total number of retransmissions for one frame in general is $1/(1-p)$ where p is the probability of error
so here it would be
for one frame $1/(1-0.2)$
so for 100 frames $100/(0.8)=125$

7 votes

-- Shreyans Dhankhar (2.4k points)

4.34.2 Stop And Wait: GATE 2016-1-55 [top](#)

<http://gateoverflow.in/39696>



Selected Answer

Answer is 2500 bytes per second.

Throughput is number of bytes we are able to send per second.

Calculate the transmission time of sender T_{t_Send}, calculate one way propagation delay T_p, Calculate the transmission time of receiver T_{t_Recv}. We get T_{t_Send} here as 1/10 seconds, T_p as 1/10 seconds(given in qstn as 100 ms), T_{t_Recv} as 1/10 seconds.

So , total time taken to send a frame from sender to destination = $T_{t_Send} + 2*T_p + T_{t_Recv}$

=4/10 seconds

So, we can send 1000 bytes (frame size) in 4/10 seconds. So in 1 second, we can send 2500 bytes. So throughput is 2500 bytes per second.

18 votes

-- Sreyas S (1.6k points)

4.34.3 Stop And Wait: GATE2015-1_53 [top](#)

<http://gateoverflow.in/8363>



Selected Answer

Link Utilization = Amount of data sent/Max. amount of data that could be sent.

Let x be the frame size in bits.

In stop-and-wait protocol, once a frame is sent, next frame won't be sent until ACK is received. Time for this,
 $RTT = \text{Propagation delay for frame} + \text{Transmission time for frame} + \text{Propagation delay for ACK} + \text{Transmission time for ACK}$
 $= 20 \text{ ms} + x/64 \text{ ms} + 20 \text{ ms} + 0$ (as given in question)
 $= (40 + x/64) \text{ ms.}$

Amount of data sent during RTT = x

Max. amount of data that could be sent = $(40 + x/64) * 64 = 2560 + x$ bits.

So, link utilization, $0.5 = x/(2560 + x)$

$x = 2560 \text{ bits} = 320 \text{ bytes.}$

alternative approach ,

link utilization or efficiency of stop and wait protocol is ,

$\text{efficiency} = Tx / (Tx + 2Tp) = 1 / (1 + 2(Tp / Tx)) = 1 / (1 + 2a)$,

where , Transmission time = $Tx = \text{packet size} / \text{bandwidth} = L / B$

Propagation time = $T_p = \text{distance} / \text{speed} = d / v$,
and , $a = \text{Propagation time} / \text{Transmission time} = (Tp / Tx)$,
now for 50% efficiency ,
 $\text{efficiency} = 1 / (1 + 2a)$
 $50\% = 1 / (1 + 2a)$

$$1/2 = 1/(1+2a) ,$$

$$2 = (1+2a)$$

$$2 - 1 = 2a$$

$$1 = 2.(Tp / Tx)$$

$$Tx = 2.T_p$$

$$L / B = 2 * 20 \text{ ms}$$

$$L = 2 * 20 \text{ ms} * B = 2 * 20 * 10^{-3} * 64 \text{ k bits} = 2 * 20 * 10^{-3} * 64 * 10^3 \text{ bits}$$

$$L = 40 * 64 \text{ bits} = 40 * 64 / 8 \text{ bytes} = 40 * 8 \text{ bytes} = 320 \text{ bytes (answer)}$$

24 votes

-- Arjun Suresh (150k points)

4.35

Subnetting [top](#)

4.35.1 Subnetting: GATE2008-IT_84 [top](#)

<http://gateoverflow.in/3408>

Host X has IP address 192.168.1.97 and is connected through two routers R1 and R2 to another host Y with IP address 192.168.1.80. Router R1 has IP addresses 192.168.1.135 and 192.168.1.110. R2 has IP addresses 192.168.1.67 and 192.168.1.155. The netmask used in the network is 255.255.255.224.

Given the information above, how many distinct subnets are guaranteed to already exist in the network?

- | | |
|----|---|
| A) | 1 |
| B) | 2 |
| C) | 3 |
| D) | 6 |

gate2008-it computer-networks subnetting normal

[Answer](#)

4.35.2 Subnetting: GATE2015-3_38 [top](#)

<http://gateoverflow.in/8497>

In the network 200.10.11.144/27, the fourth octet (in decimal) of the last IP address of the network which can be assigned to a host is _____.

gate2015-3 computer-networks subnetting normal

[Answer](#)

4.35.3 Subnetting: GATE2004_55 [top](#)

<http://gateoverflow.in/1051>

The routing table of a router is shown below:

| Destination | Subnet Mask | Interface |
|-------------|-----------------|-----------|
| 128.75.43.0 | 255.255.255.0 | Eth0 |
| 128.75.43.0 | 255.255.255.128 | Eth1 |
| 192.12.17.5 | 255.255.255.255 | Eth3 |
| Default | | Eth2 |

On which interface will the router forward packets addressed to destinations 128.75.43.16 and 192.12.17.10 respectively?

- A. Eth1 and Eth2
- B. Eth0 and Eth2
- C. Eth0 and Eth3
- D. Eth1 and Eth3

gate2004 computer-networks subnetting normal

[Answer](#)

4.35.4 Subnetting: GATE2006-IT_70 [top](#)

<http://gateoverflow.in/3614>

A subnetted Class B network has the following broadcast address : 144.16.95.255. Its subnet mask

- A) is necessarily 255.255.224.0
- B) is necessarily 255.255.240.0
- C) is necessarily 255.255.248.0.
- D) could be any one of 255.255.224.0, 255.255.240.0, 255.255.248.0

gate2006-it computer-networks subnetting normal

[Answer](#)

4.35.5 Subnetting: GATE2010-47 [top](#)

<http://gateoverflow.in/2349>

Suppose computers A and B have IP addresses 10.105.1.113 and 10.105.1.91 respectively and they both use same netmask N. Which of the values of N given below should not be used if A and B should belong to the same network?

- A. 255.255.255.0
- B. 255.255.255.128
- C. 255.255.255.192

D. 255.255.255.224

gate2010 computer-networks subnetting easy

Answer

4.35.6 Subnetting: GATE2006_45 [top](#)

<http://gateoverflow.in/1821>

Two computers C1 and C2 are configured as follows. C1 has IP address 203.197.2.53 and netmask 255.255.128.0. C2 has IP address 203.197.75.201 and netmask 255.255.192.0. Which one of the following statements is true?

- (A) C1 and C2 both assume they are on the same network
- (B) C2 assumes C1 is on same network, but C1 assumes C2 is on a different network
- (C) C1 assumes C2 is on same network, but C2 assumes C1 is on a different network
- (D) C1 and C2 both assume they are on different networks.

gate2006 computer-networks subnetting normal

Answer

4.35.7 Subnetting: GATE2006-IT-63, ISRO2015-57 [top](#)

<http://gateoverflow.in/3607>

A router uses the following routing table:

| Destination | Mask | Interface |
|--------------|-----------------|-----------|
| 144.16.0.0 | 255.255.0.0 | eth0 |
| 144.16.64.0 | 255.255.224.0 | eth1 |
| 144.16.68.0 | 255.255.255.0 | eth2 |
| 144.16.68.64 | 255.255.255.224 | eth3 |

packet bearing a destination address 144.16.68.117 arrives at the router. On which interface will it be forwarded?

- A. eth0
- B. eth1
- C. eth2
- D. eth3

gate2006-it computer-networks subnetting normal isro2015

Answer

4.35.8 Subnetting: GATE2007-67, ISRO2016-72 [top](#)

<http://gateoverflow.in/1265>

The address of a class B host is to be split into subnets with a 6-bit subnet number. What is the maximum number of subnets and the maximum number of hosts in each subnet?

- A. 62 subnets and 262142 hosts.
- B. 64 subnets and 262142 hosts.
- C. 62 subnets and 1022 hosts.
- D. 64 subnets and 1024 hosts.

gate2007 computer-networks subnetting easy isro2016

Answer

4.35.9 Subnetting: GATE2008-IT_85 [top](#)

<http://gateoverflow.in/3409>

Host X has IP address 192.168.1.97 and is connected through two routers R1 and R2 to another host Y with IP address 192.168.1.80. Router R1 has IP addresses 192.168.1.135 and 192.168.1.110. R2 has IP addresses 192.168.1.67 and 192.168.1.155. The netmask used in the network is 255.255.255.224.

Which IP address should X configure its gateway as?

- A) 192.168.1.67
- B) 192.168.1.110
- C) 192.168.1.135
- D) 192.168.1.155

[gate2008-it](#) [computer-networks](#) [subnetting](#) [normal](#)

[Answer](#)

4.35.10 Subnetting: GATE2005_27 [top](#)

<http://gateoverflow.in/1363>

An organization has a class B network and wishes to form subnets for 64 departments. The subnet mask would be:

- A. 255.255.0.0
- B. 255.255.64.0
- C. 255.255.128.0
- D. 255.255.252.0

[gate2005](#) [computer-networks](#) [subnetting](#) [normal](#)

[Answer](#)

4.35.11 Subnetting: GATE2012_34 [top](#)

<http://gateoverflow.in/1752>

An Internet Service Provider (ISP) has the following chunk of CIDR-based IP addresses available with it: 245.248.128.0/20. The ISP wants to give half of this chunk of addresses to Organization A, and a quarter to Organization B, while retaining the remaining with itself. Which of the following is a valid allocation of addresses to A and B?

- (A) 245.248.136.0/21 and 245.248.128.0/22
- (B) 245.248.128.0/21 and 245.248.128.0/22
- (C) 245.248.132.0/22 and 245.248.132.0/21
- (D) 245.248.136.0/24 and 245.248.132.0/21

[gate2012](#) [computer-networks](#) [subnetting](#) [normal](#)

[Answer](#)

4.35.12 Subnetting: GATE2008-57 [top](#)

<http://gateoverflow.in/480>

If a class B network on the Internet has a subnet mask of 255.255.248.0, what is the maximum number of hosts per subnet?

- A. 1022
- B. 1023
- C. 2046
- D. 2047

[gate2008](#) [computer-networks](#) [subnetting](#) [easy](#)

[Answer](#)

4.35.13 Subnetting: GATE2005-IT_76 [top](#)

<http://gateoverflow.in/3839>

A company has a class C network address of 204.204.204.0. It wishes to have three subnets, one with 100 hosts and two with 50 hosts each. Which one of the following options represents a feasible set of subnet address/subnet mask pairs?

- 1) 204.204.204.128/255.255.255.192
 204.204.204.0/255.255.255.128
 204.204.204.64/255.255.255.128
- 2) 204.204.204.0/255.255.255.192
 204.204.204.192/255.255.255.128
 204.204.204.64/255.255.255.128
- 3) 204.204.204.192/255.255.255.192
 204.204.204.224/255.255.255.192
 204.204.204.128/255.255.255.128
- 4) 204.204.204.64/255.255.255.192
 204.204.204.0/255.255.255.192

gate2005-it computer-networks subnetting normal

Answer

4.35.14 Subnetting: GATE2015-2_41 [top](#)

<http://gateoverflow.in/8213>

Consider the following routing table at an IP router:

| Network No | Net Mask | Next Hop |
|--------------|---------------|-------------|
| 128.96.170.0 | 255.255.254.0 | Interface 0 |
| 128.96.168.0 | 255.255.254.0 | Interface 1 |
| 128.96.166.0 | 255.255.254.0 | R2 |
| 128.96.164.0 | 255.255.252.0 | R3 |
| 0.0.0.0 | Default | R4 |

For each IP address in Group I Identify the correct choice of the next hop from Group II using the entries from the routing table above.

- | Group I | Group II |
|---------------------|-----------------|
| i) 128.96.171.92 | a) Interface 0 |
| ii) 128.96.167.151 | b) Interface 1 |
| iii) 128.96.163.151 | c) R2 |
| iv) 128.96.164.121 | d) R3 |
| | e) R4 |

- A. i-a, ii-c, iii-e, iv-d
- B. i-a, ii-d, iii-b, iv-e
- C. i-b, ii-c, iii-d, iv-e
- D. i-b, ii-c, iii-e, iv-d

gate2015-2 computer-networks subnetting easy

Answer

4.35.15 Subnetting: GATE2004-IT_26 [top](#)

<http://gateoverflow.in/3667>

A subnet has been assigned a subnet mask of 255.255.255.192. What is the maximum number of hosts that can belong to this subnet?

- | | |
|----|-----|
| A) | 14 |
| B) | 30 |
| C) | 62 |
| D) | 126 |

gate2004-it computer-networks subnetting normal

Answer

4.35.16 Subnetting: GATE2003-82, ISRO2009-1 [top](#)

<http://gateoverflow.in/965>

The subnet mask for a particular network is 255.255.31.0. Which of the following pairs of IP addresses could belong to this network?

- A. 172.57.88.62 and 172.56.87.23
 B. 10.35.28.2 and 10.35.29.4
 C. 191.203.31.87 and 191.234.31.88
 D. 128.8.129.43 and 128.8.161.55

gate2003 computer-networks subnetting normal isro2009

[Answer](#)

Answers: Subnetting

4.35.1 Subnetting: GATE2008-IT_84 [top](#)

<http://gateoverflow.in/3408>



Selected Answer

Option C, Just perform bit wise and of given IP addresses and subnet mask, we get 3 distinct subnet mask
 1) 011
 2) 010
 3) 100

10 votes

-- Pradyumna Paralikar (327 points)

4.35.2 Subnetting: GATE2015-3_38 [top](#)

<http://gateoverflow.in/8497>



Selected Answer

Answer=158

144 in binary = 100 10000

out of this 3 bits in left are subnet bits. (27 bits are used for subnet, which means top 3 bytes and leftmost 3 bits from the last byte)

so the 4th octet in the last ip address of the network which can be assigned to a host is 100 11110. (its not 100 11111 because its network broadcast address)

so 10011110 is 158 in decimal.

24 votes

-- overtomanu (1.1k points)

4.35.3 Subnetting: GATE2004_55 [top](#)

<http://gateoverflow.in/1051>



Selected Answer

The Answer must be A.

For 1st packet,

$(128.75.43.16) \&& (255.255.255.0) = (128.75.43.0)$ since $\{16 \&& 0 = 0\}$, as well as

$(128.75.43.16) \&& (255.255.255.128) = (128.75.43.0)$ since $\{16 \&& 128 = 0\}$.

Now, since both these subnet masks are producing the same Network ID, hence The one with greater number of ones will be selected, and the packet will be forwarded there. Hence packet 1 will be forwarded to Eth1.

For 2nd packet,

$(192.12.17.10)$ when anded with each of the subnet masks does not match with any of the network ID, since:

(192.12.17.10) && (255.255.255.0) = (192.12.17.0) {Does not match with any of the network addresses}
 (192.12.17.10) && (255.255.255.128) = (192.12.17.0) {Does not match with any of the network addresses}
 (192.12.17.10) && (255.255.255.255) = (192.12.17.10) {Does not match with any of the network addresses}
 Hence, Default interface must be selected for packet 2, i.e Interface Eth2.

15 votes

-- saurabhrk (1.3k points)

4.35.4 Subnetting: GATE2006-IT_70 [top](#)

<http://gateoverflow.in/3614>



Selected Answer

option (D) is correct. In the broadcast address for a subnet, all the host bits are set to 1. So as long as all the bits to the right are 1, bits left to it can be taken as possible subnet.

broadcast address for subnet is .95.255 .0101 1111. 1111 1111 (as in Class B, 16 bits each are used for network and host)

So we can take minimum 3 bits (from left) as subnet and make rest as host bits(as they are 1).

- .224.0 1110 0000. 0000 0000 (leftmost 3 bits for subnet)
- .240.0 1111 0000. 0000 0000 (leftmost 4 bits for subnet)
- .248.0 1111 1000. 0000 0000 (... 5 bits for subnet)

9 votes

-- Sandeep_Uniyal (5.5k points)

4.35.5 Subnetting: GATE2010-47 [top](#)

<http://gateoverflow.in/2349>



Selected Answer

D is correct answer because

when we perform AND operation between ip address **10.105.1.113** and **255.255.255.224** result is **10.105.1.96**

when we perform AND operation between ip address **10.105.1.91** and **255.255.255.224** result is **10.105.1.64**

10.105.1.96 and 10.105.1.64 are different network so D is correct answer

14 votes

-- R.B. Tiwari (353 points)

4.35.6 Subnetting: GATE2006_45 [top](#)

<http://gateoverflow.in/1821>



Selected Answer

Subnetmask for C1 is 255.255.128.0. So, it finds the network ID as

$$\begin{aligned} 203.197.2.53 \text{ AND } 255.255.128.0 &= 203.197.0.0 \\ 203.197.75.201 \text{ AND } 255.255.128.0 &= 203.197.0.0 \end{aligned}$$

Both same.

Bow subnetmask for C2 is 255.255.192.0. So, the respective network IDs are

$$\begin{aligned} 203.197.2.53 \text{ AND } 255.255.192.0 &= 203.197.0.0 \\ 203.197.75.201 \text{ AND } 255.255.192.0 &= 203.197.64.0 \end{aligned}$$

Both not same. So, option C.

14 votes

-- Arjun Suresh (150k points)

4.35.7 Subnetting: GATE2006-IT-63, ISRO2015-57 [top](#)

<http://gateoverflow.in/3607>



Selected Answer

Firstly start with **Longest mask**

$$144.16.68.117 = 144.16.68.01110101 \text{ AND}$$

$$255.255.255.224 = 255.255.255.11100000$$

$$= 144.16.68.96 \text{ (**Not matching with Destination**)}$$

Now, take 255.255.255.0

$$144.16.68.117 \text{ AND } 255.255.255.0 = 144.16.68.0 \text{ (**matched**)}$$

So, interface chosen is **eth2 OPTION (C)**.

13 votes

-- Himanshu Agarwal (9.8k points)

4.35.8 Subnetting: GATE2007-67, ISRO2016-72 [top](#)

<http://gateoverflow.in/1265>



Selected Answer

In class B .. first 2 octet are reserved for NID and remaining for HID .. so first 6 bits of 3rd octet are used for subnet and remaining 10 bits for hosts ..

$$\text{Maximum number of subnets} = 2^6 - 2 = 62$$

Note that 2 is subtracted because subnet values consisting of all zeros and all ones (broadcast), reducing the number of available subnets by two in classic subnetting. In modern networks, we can have 64 as well. See here: <http://www.weird.com/~woods/classb.html>

$$\text{and no of hosts} = 2^{10} - 2 = 1022.$$

2 is subtracted for Number of hosts is also. The address with all bits as 1 is reserved as broadcast address and address with all host id bits as 0 is used as network address of subnet.

So option (C) is correct..

18 votes

-- sonam vyas (8.1k points)

4.35.9 Subnetting: GATE2008-IT_85 [top](#)

<http://gateoverflow.in/3409>



Selected Answer

X must be able to reach the gateway using the net mask.

$$\text{Subnet number of host X} = 192.168.1.97 \& 255.255.255.224 = 192.168.1.96$$

Now, the gateway must also have the same subnet number. Lets take IP 192.168.1.110 of R1. 192.168.1.110 & 255.255.255.224 = 192.168.1.96 and hence this can be used by X.

(To quickly identify the matching mask divide the last part of mask (224 here) into powers of 2. So, $224 = 128 + 64 +$

32. Now, our host X has 97 as the last part of IP = $64 + 32 + 1$. So, the last part of subnet number becomes $64 + 32 = 96$. Now, we need to consider only those IPs whose last part will contain 64 as well as 32)

http://courses.washington.edu/css432/joemcc/slides/03_cidr.ppt

18 votes

-- Arjun Suresh (150k points)

4.35.10 Subnetting: GATE2005_27 [top](#)

<http://gateoverflow.in/1363>



Selected Answer

D is correct answer.

to form subnet for 64 departments we need 6 continuous bit and the value of $11111100 = 252$.

organization has class B network so subnet mask would be **255.255.252.0**

9 votes

-- R.B. Tiwari (353 points)

4.35.11 Subnetting: GATE2012_34 [top](#)

<http://gateoverflow.in/1782>

ans should be a) , the mask are /21 and /22 respectively, acc. to the half and quarter chunks requirement... and option b) can creat problem as address can get clashed between the two..

7 votes

-- Sneha Goel (1k points)

4.35.12 Subnetting: GATE2008-57 [top](#)

<http://gateoverflow.in/480>



Selected Answer

number of zeros are to be counted for calculating the total number of possible hosts per subnet.

$255-248 = 7$ can be represented using 3 bits

these 3bits + 8bits more = 11 bits

so possible subnets = 2^{11} out of these 2 are reserved as Subnet ID and DBA

therefore we have maximum possible usable hosts = $2^{11} - 2 = 2046$

10 votes

-- Amar Vashishth (20.7k points)

4.35.13 Subnetting: GATE2005-IT_76 [top](#)

<http://gateoverflow.in/3839>

Answer->D

MSB in last 8 bits helps us to get two subnets

10000000--->subnet1

00000000--->subnet2

subnet2 is divided into 2 more subnets using 7th bit

00000000--->subnet2(0)

01000000--->subnet2(1)

10 votes

-- nagalla pruthvi (689 points)

4.35.14 Subnetting: GATE2015-2_41 [top](#)<http://gateoverflow.in/8213>

option A is correct .. do the AND operation of group1 with net mask you will get the answer

8 votes

-- Anoop Sonkar (4.5k points)

4.35.15 Subnetting: GATE2004-IT_26 [top](#)<http://gateoverflow.in/3667>

Selected Answer

C is answer since you have 6 zeroes so u can make 64-2 hosts

8 votes

-- Shreyans Dhankhar (2.4k points)

4.35.16 Subnetting: GATE2003-82, ISRO2009-1 [top](#)<http://gateoverflow.in/965>

Selected Answer

A and C are not the answers as the second byte of IP differs and subnet mask has 255 for second byte.

Consider B, (& for bitwise AND)

$$10.35.28.2 \& 255.255.31.0 = 10.35.28.0 \quad (28 = 11100_2)$$

$$10.35.29.4 \& 255.255.31.0 = 10.35.29.0 \quad (29 = 11111_2)$$

So, we get different subnet numbers

Consider D.

$$128.8.129.43 \& 255.255.31.0 = 128.8.1.0 \quad (129 = 10000001_2)$$

$$128.8.161.55 \& 255.255.31.0 = 128.8.1.0 \quad (161 = 10100001_2)$$

The subnet number matches. So, D is the answer.

24 votes

-- Arjun Suresh (150k points)

4.36**Tcp** [top](#)**4.36.1 Tcp: GATE2012_22** [top](#)<http://gateoverflow.in/1605>

Which of the following transport layer protocols is used to support electronic mail?

- (A) SMTP
- (B) IP
- (C) TCP
- (D) UDP

[gate2012](#) [computer-networks](#) [tcp](#) [easy](#)

Answer

4.36.2 Tcp: GATE2007-IT-13 [top](#)<http://gateoverflow.in/3446>

Consider the following statements about the timeout value used in TCP.

- i. The timeout value is set to the RTT (Round Trip Time) measured during TCP connection establishment for the entire duration of the connection.
- ii. Appropriate RTT estimation algorithm is used to set the timeout value of a TCP connection.
- iii. Timeout value is set to twice the propagation delay from the sender to the receiver.

Which of the following choices hold?

- A. (i) is false, but (ii) and (iii) are true
 B. (i) and (iii) are false, but (ii) is true
 C. (i) and (ii) are false, but (iii) is true
 D. (i), (ii) and (iii) are false

gate2007-it | computer-networks | tcp | normal

[Answer](#)

4.36.3 Tcp: GATE2007-IT_14 [top](#)

<http://gateoverflow.in/3447>

Consider a TCP connection in a state where there are no outstanding ACKs. The sender sends two segments back to back. The sequence numbers of the first and second segments are 230 and 290 respectively. The first segment was lost, but the second segment was received correctly by the receiver. Let X be the amount of data carried in the first segment (in bytes), and Y be the ACK number sent by the receiver. The values of X and Y (in that order) are

- A) 60 and 290
 B) 230 and 291
 C) 60 and 231
 D) 60 and 230

gate2007-it | computer-networks | tcp | normal

[Answer](#)

4.36.4 Tcp: GATE2015-1_19 [top](#)

<http://gateoverflow.in/8217>

Suppose two hosts use a TCP connection to transfer a large file . Which of the following statements is/are FALSE with respect to the TCP connection?

- I. If the sequence number of a segment is m, then the sequence number of the subsequent segment is always m+1.
 II. If the estimated round trip time at any given point of time is t sec, the value of the retransmission timeout is always set to greater than or equal to t sec.
 III. The size of the advertised window never changes during the course of the TCP connection.
 IV. The number of unacknowledged bytes at the sender is always less than or equal to the advertised window.

- A. III only
 B. I and III only
 C. I and IV only
 D. II and IV only

gate2015-1 | computer-networks | tcp | normal

[Answer](#)

4.36.5 Tcp: GATE2015-3_22 [top](#)

<http://gateoverflow.in/8425>

Consider the following statements.

- I. TCP connections are full duplex
 II. TCP has no option for selective acknowledgement
 III. TCP connections are message streams
- A. Only I is correct
 B. Only I and III are correct
 C. Only II and III are correct
 D. All of I, II and III are correct

gate2015-3 | computer-networks | tcp | normal

[Answer](#)

4.36.6 Tcp: GATE2004-IT_23 [top](#)

<http://gateoverflow.in/3664>

Which one of the following statements is FALSE?

- A) TCP guarantees a minimum communication rate
- B) TCP ensures in-order delivery
- C) TCP reacts to congestion by reducing sender window size
- D) TCP employs retransmission to compensate for packet loss

[gate2004-it](#) [computer-networks](#) [tcp](#) [normal](#)

[Answer](#)

4.36.7 Tcp: GATE2004-IT_28 [top](#)

<http://gateoverflow.in/3669>

In TCP, a unique sequence number is assigned to each

- A) byte
- B) word
- C) segment
- D) message

[gate2004-it](#) [computer-networks](#) [tcp](#) [normal](#)

[Answer](#)

4.36.8 Tcp: GATE2009-47 [top](#)

<http://gateoverflow.in/1333>

While opening a TCP connection, the initial sequence number is to be derived using a time-of-day (ToD) clock that keeps running even when the host is down. The low order 32 bits of the counter of the ToD clock is to be used for the initial sequence numbers. The clock counter increments once per milliseconds. The maximum packet lifetime is given to be 64s.

Which one of the choices given below is closest to the minimum permissible rate at which sequence numbers used for packets of a connection can increase?

- A. 0.015/s
- B. 0.064/s
- C. 0.135/s
- D. 0.327/s

[gate2009](#) [computer-networks](#) [tcp](#) [difficult](#)

[Answer](#)

Answers: Tcp

4.36.1 Tcp: GATE2012_22 [top](#)

<http://gateoverflow.in/1605>



Selected Answer

answer = option C : TCP

There are three primary TCP/IP protocols for E-Mail management:

- Post Office Protocol (POP)
- Simple Mail Transfer Protocol (SMTP)
- Internet Message Access Protocol (IMAP)

They all are Application Layer Protocols

Once a client connects to the E-mail Server, there may be 0(zero) or more SMTP transactions. If the client has no mail to send, then there are no SMTP transactions. Every e-mail message sent is an SMTP transfer.

SMTP is only used to send (push) messages to the server. POP and IMAP are used to receive messages as well as manage the mailbox contents(which includes tasks such as deleting, moving messages etc.).

6 votes

-- Amar Vashishth (20.7k points)

ans c)

SMTP is used in Application Layer.

6 votes

-- Aditi Dan (5.4k points)

4.36.2 Tcp: GATE2007-IT-13 [top](#)

<http://gateoverflow.in/3446>



Selected Answer

Answer: B

Jacobson's algorithm is used.

6 votes

-- Rajarshi Sarkar (29.7k points)

4.36.3 Tcp: GATE2007-IT_14 [top](#)

<http://gateoverflow.in/3447>



Selected Answer

ans d)

11 votes

-- Aditi Dan (5.4k points)

4.36.4 Tcp: GATE2015-1_19 [top](#)

<http://gateoverflow.in/8217>



Selected Answer

Option B

III. False. It is the size of the receiver's buffer that's never changed. RcvWindow is the part of the receiver's buffer that's changing all the time depending on the processing capability at the receiver's side and the network traffic.

http://web.eecs.utk.edu/~qi/teaching/ece453f06/hw/hw7_sol.htm

11 votes

-- GATERush (1.1k points)

4.36.5 Tcp: GATE2015-3_22 [top](#)

<http://gateoverflow.in/8425>



Selected Answer

answer is (A) since TCP has options for selective ACK and TCP uses byte streams that is every byte that is send using TCP is numbered.

http://repo.hackerzvoice.net/depot_madchat/ebooks/TCP-IP_Illustrated/tcp_tran.htm

14 votes

-- Tamojit Chatterjee (1.9k points)

4.36.6 Tcp: GATE2004-IT_23 [top](#)<http://gateoverflow.in/3664>

Selected Answer

Option B: "Sequence numbers allow receivers to discard duplicate packets and properly sequence reordered packets."
 Option C: "When congestion is detected, the transmitter decreases the transmission rate by a multiplicative factor; for example, cut the congestion window in half after loss." (Additive Increase/multiplicative decrease)
 Option D: "Acknowledgments allow senders to determine when to retransmit lost packets."

So, A is answer.

http://en.wikipedia.org/wiki/Transmission_Control_Protocol#Error_detection

http://en.wikipedia.org/wiki/Additive_increase/multiplicative_decrease

5 votes

-- Arjun Suresh (150k points)

4.36.7 Tcp: GATE2004-IT_28 [top](#)<http://gateoverflow.in/3669>

Selected Answer

a) it should be byte

http://www.industrialethernetu.com/courses/202_2.htm

10 votes

-- Parul Agarwal (783 points)

4.36.8 Tcp: GATE2009-47 [top](#)<http://gateoverflow.in/133>

Ans) 3 information present in the question. (1)The low order 32 bits of the counter of the ToD clock is to be used for the initial sequence numbers - That means only 32 bits are used to represent a sequence number. So we have 2^{32} different sequence number. (2)The maximum packet lifetime is 64s. So by 1 & 2 we can calculate maximum data rate possible(bandwidth) to avoid the wraparound= $2^{32}/64=2^{26}$ Byte/sec (3)The clock counter increments once per milliseconds -That means when then counter increments next possible sequence number is generated. Suppose we make a TCP connection by picking initial sequence number that is derived by clock.If the connection terminate after sending few bytes of data then to avoid the ambiguity of sequence number we don't reestablish the connection immediately because of counter increment happen after 1 msec. Suppose the sender sends 2^{24} Byte data. Time required to sent 2^{24} Byte data is $2^{24}/2^{26}=250$ ms. So 2^{24} Byte takes 2^{24} sequence number . ($2^{24} * 1$)ms required to increment the counter . So the permissible rate of sequence number used for packets is in 64 sec we use only sequence number .So $1/64=0.015$ (approx)

11 votes

-- Abhishek Verma (167 points)

4.37**Token Bucket** [top](#)**4.37.1 Token Bucket: GATE 2016-1-54** [top](#)<http://gateoverflow.in/39720>

For a host machine that uses the token bucket algorithm for congestion control, the token bucket has a capacity of 1 mega byte and the maximum output rate is 20 mega bytes per second. Tokens arrive at a rate to sustain output at a rate of 10 mega bytes per second. The token bucket is currently full and the machine needs to send 12 mega bytes of data. The minimum time required to transmit the data is _____ seconds.

gate2016-1 computer-networks token-bucket normal numerical-answers

Answer

Answers: Token Bucket

4.37.1 Token Bucket: GATE 2016-1-54 [top](#)<http://gateoverflow.in/39720>

Selected Answer

Initially token bucket is full. the rate at which it is emptying is (20-10) Mbps. time take to empty token bucket of 1 mb is $1/10$ i.e. 0.1 sec. Data send in this time is $0.1 \times 20 = 2$ mb (rate at which bucket is emptying is different from rate at which data is send). Data left to send is $12 - 2 = 10$ mb. Now bucket is empty and rate of token arriving is less than that of going out so effective data speed will be 10Mbps. Time to send remaining 10 mb will be 1 sec. So total time is $1 + 0.1 = 1.1$ sec

16 votes

-- Vaibhav Singh (521 points)

4.38**Udp** [top](#)**4.38.1 Udp: GATE2013_12** [top](#)<http://gateoverflow.in/1421>

The transport layer protocols used for real time multimedia, file transfer, DNS and email, respectively are

- (A) TCP, UDP, UDP and TCP
- (B) UDP, TCP, TCP and UDP
- (C) UDP, TCP, UDP and TCP
- (D) TCP, UDP, TCP and UDP

[gate2013](#) [computer-networks](#) [tcp](#) [udp](#) [easy](#)

Answer

4.38.2 Udp: GATE2005_23 [top](#)<http://gateoverflow.in/1359>

Packets of the same session may be routed through different paths in:

- A. TCP, but not UDP
- B. TCP and UDP
- C. UDP, but not TCP
- D. Neither TCP nor UDP

[gate2005](#) [computer-networks](#) [tcp](#) [udp](#) [easy](#)

Answer

4.38.3 Udp: GATE2006-IT_69 [top](#)<http://gateoverflow.in/3613>

A program on machine X attempts to open a UDP connection to port 5376 on a machine Y, and a TCP connection to port 8632 on machine Z. However, there are no applications listening at the corresponding ports on Y and Z. An ICMP Port Unreachable error will be generated by

- A) Y but not Z
- B) Z but not Y
- C) Neither Y nor Z
- D) Both Y and Z

[gate2006-it](#) [computer-networks](#) [tcp](#) [udp](#) [normal](#)

Answer

Answers: Udp**4.38.1 Udp: GATE2013_12** [top](#)<http://gateoverflow.in/1421>



Selected Answer

Real Time Multimedia: Data packets should be delivered faster. Also it can be unreliable. Therefore UDP.

File Transfer: For example downloading a file. It should be secure and reliable. Therefore TCP.

DNS: uses both UDP and TCP for its transport. But to achieve efficiency DNS uses UDP. To start a TCP connection a minimum of three packets are required (SYN out, SYN+ACK back, ACK out). UDP uses a simple transmission model with a minimum of protocol mechanism. UDP has no handshaking dialogues.

Email: uses SMTP protocol which uses TCP protocol.

14 votes

-- Pyuri sahu (1.3k points)

4.38.2 Udp: GATE2005_23 [top](#)

<http://gateoverflow.in/1359>

Selected Answer

b) TCP and UDP.

Routing happens in Network layer and hence has no dependency with the transport layer protocols TCP and UDP. The transport layer protocol- whether TCP or UDP is hidden to the router and the routing path is determined based on the network configuration at the time and hence can change even during a session.

Ref: <http://stackoverflow.com/questions/15601389/if-tcp-is-connection-oriented-why-do-packets-follow-different-paths>

19 votes

-- Arjun Suresh (150k points)

4.38.3 Udp: GATE2006-IT_69 [top](#)

<http://gateoverflow.in/3613>

According to rfc, the standard there's no where mentioned that ICMP messages depend upon transport layer protocol. Link <https://tools.ietf.org/html/rfc792> So (d)

5 votes

-- nishant.oli (61 points)

4.39

Wifi [top](#)

4.39.1 Wifi: GATE 2016-2-54 [top](#)

<http://gateoverflow.in/39593>

For the IEEE 802.11 MAC protocol for wireless communication, which of the following statements is/are **TRUE?**

- (I) At least three non-overlapping channels are available for transmissions.
 - (II) The RTS-CTS mechanism is used for collision detection.
 - (III) Unicast frames are ACKed.
- A. All I, II, and III
 - B. I and III only
 - C. II and III only
 - D. II only

[gate2016-2](#) [computer-networks](#) [wifi](#) [normal](#)

Answer

Answers: Wifi

4.39.1 Wifi: GATE 2016-2-54 top<http://gateoverflow.in/39593>

Selected Answer

802.11 MAC = Wifi

I) This is true, maximum 3 overlapping channels are possible in Wifi !

II) This is false. Collision detection is not really possible in Wireless, because signal strength of sending & receiving signal need not be same ! So Wifi uses **collision Avoidance** instead ! In this RTS-CTS are used to announce to all nodes, that for which node wireless channel is reserved for communication. So this is collision avoidance, not detection

III) This is true. Every frame in Wifi is acked, because Wifi station do not use collision detection, in Ethernet we use collision detection, in which it is possible for us to listen channel for collision & use exponential back off in case of collision detection. As in case of wifi, due to more error rate and not using collision detection strategy , we instead use ACK frame, in case of not getting ACK Host will retransmit after Random back off period

Ans => B

Source => Kurose & Ross Top down approach to internet

9 votes

-- Akash (31.7k points)

5

Databases (188)

[top](#)

5.0.1 GATE2012_2 [top](#)

<http://gateoverflow.in/34>

Which of the following is **TRUE**?

- (A) Every relation in 3NF is also in BCNF
- (B) A relation R is in 3NF if every non-prime attribute of R is fully functionally dependent on every key of R
- (C) Every relation in BCNF is also in 3NF
- (D) No relation can be in both BCNF and 3NF

[gate2012](#) [databases](#) [easy](#)

[Answer](#)

5.0.2 GATE2014-1_22 [top](#)

<http://gateoverflow.in/1789>

Given the following statements:

S1: A foreign key declaration can always be replaced by an equivalent check assertion in SQL.

S2: Given the table $R(a, b, c)$ where a and b together form the primary key, the following is a valid table definition.

```
CREATE TABLE S (
    a INTEGER,
    d INTEGER,
    e INTEGER,
    PRIMARY KEY (d),
    FOREIGN KEY (a) REFERENCES R)
```

Which one of the following statements is **CORRECT**?

- (A) S1 is TRUE and S2 is FALSE
- (B) Both S1 and S2 are TRUE
- (C) S1 is FALSE and S2 is TRUE
- (D) Both S1 and S2 are FALSE

[gate2014-1](#) [databases](#) [normal](#)

[Answer](#)

5.0.3 GATE2005-IT_82a [top](#)

<http://gateoverflow.in/3847>

A database table T1 has 2000 records and occupies 80 disk blocks. Another table T2 has 400 records and occupies 20 disk blocks. These two tables have to be joined as per a specified join condition that needs to be evaluated for every pair of records from these two tables. The memory buffer space available can hold exactly one block of records for T1 and one block of records for T2 simultaneously at any point in time. No index is available on either table.

If Nested-loop join algorithm is employed to perform the join, with the most appropriate choice of table to be used in outer loop, the number of block accesses required for reading the data are

- | | |
|----|--------|
| A) | 800000 |
| B) | 40080 |
| C) | 32020 |
| D) | 100 |

[gate2005-it](#) [databases](#) [normal](#)

[Answer](#)

5.0.4 GATE2004-IT_21 [top](#)<http://gateoverflow.in/3662>

Which level of locking provides the highest degree of concurrency in a relational database ?

- A) Page
- B) Table
- C) Row
- D) Page, table and row level locking allow the same degree of concurrency

[gate2004-it](#) [databases](#) [normal](#)**Answer****5.0.5 GATE2015-2_32** [top](#)<http://gateoverflow.in/8151>

Consider two relations $R_1(A, B)$ with the tuples $(1, 5), (3, 7)$ and $R_2(A, C) = (1, 7), (4, 9)$. Assume that $R(A, B, C)$ is the full natural outer join of R_1 and R_2 . Consider the following tuples of the form (A, B, C) :

$a = (1, 5, \text{null}), b = (1, \text{null}, 7), c = (3, \text{null}, 9), d = (4, 7, \text{null}), e = (1, 5, 7), f = (3, 7, \text{null}), g = (4, \text{null}, 9)$.

Which one of the following statements is correct?

- A. R contains a, b, e, f, g but not c, d .
- B. R contains all a, b, c, d, e, f, g .
- C. R contains e, f, g but not a, b .
- D. R contains e but not f, g .

[gate2015-2](#) [databases](#) [normal](#)**Answer****5.0.6 GATE2011_12** [top](#)<http://gateoverflow.in/2114>

Consider a relational table with a single record for each registered student with the following attributes:

1. Registration_Num: Unique registration number for each registered student
2. UID: Unique identity number, unique at the national level for each citizen
3. BankAccount_Num: Unique account number at the bank. A student can have multiple accounts or joint accounts. This attribute stores the primary account number.
4. Name: Name of the student
5. Hostel_Room: Room number of the hostel

Which of the following options is **INCORRECT**?

- (A) BankAccount_Num is a candidate key
- (B) Registration_Num can be a primary key
- (C) UID is a candidate key if all students are from the same country
- (D) If S is a super key such that $S \cap \text{UID}$ is NULL then $S \cup \text{UID}$ is also a superkey

[gate2011](#) [databases](#) [normal](#)**Answer****5.0.7 GATE2009-49** [top](#)<http://gateoverflow.in/1335>

Which of the following statements are TRUE?

- I. The context diagram should depict the system as a single bubble.
- II. External entities should be identified clearly at all levels of DFDs.

- III. Control information should not be represented in a DFD.
 IV. A data store can be connected wither to another data store or to an external entity.

- A. II and III
 B. II and III
 C. I and III
 D. I, II and III

gate2009 databases normal

[Answer](#)

5.0.8 GATE1999-1.18, ISRO2016-53 [top](#)

<http://gateoverflow.in/1471>

Consider the join of a relation R with a relation S . If R has m tuples and S has n tuples then the maximum and minimum sizes of the join respectively are

- A. $m + n$ and 0
 B. mn and 0
 C. $m + n$ and $|m - n|$
 D. mn and $m + n$

gate1999 databases easy isro2016

[Answer](#)

5.0.9 GATE1994_3.11 [top](#)

<http://gateoverflow.in/2497>

State True or False with reason

Logical data independence is easier to achieve than physical data independence

gate1994 databases normal

[Answer](#)

5.0.10 GATE1994_3.7 [top](#)

<http://gateoverflow.in/2493>

An instance of a relational scheme $R(A, B, C)$ has distinct values for attribute A . Can you conclude that A is a candidate key for R ?

gate1994 databases easy

[Answer](#)

5.0.11 GATE2005-IT_82b [top](#)

<http://gateoverflow.in/3848>

A database table T1 has 2000 records and occupies 80 disk blocks. Another table T2 has 400 records and occupies 20 disk blocks. These two tables have to be joined as per a specified join condition that needs to be evaluated for every pair of records from these two tables. The memory buffer space available can hold exactly one block of records for T1 and one block of records for T2 simultaneously at any point in time. No index is available on either table.

If, instead of Nested-loop join, Block nested-loop join is used, again with the most appropriate choice of table in the outer loop, the reduction in number of block accesses required for reading the data will be

- A) 0
 B) 30400
 C) 38400
 D) 798400

[gate2005-it](#)
[databases](#)
[normal](#)
Answer**5.0.12 GATE2010-43** [top](#)<http://gateoverflow.in/2344>

The following functional dependencies hold for relations $R(A, B, C)$ and $S(B, D, E)$.

 $B \rightarrow A$
 $A \rightarrow C$

The relation R contains 200 tuples and the relation S contains 100 tuples. What is the maximum number of tuples possible in the natural join $R \bowtie S$?

- A. 100
- B. 200
- C. 300
- D. 2000

[gate2010](#)
[databases](#)
[normal](#)
Answer**5.0.13 GATE2012_14** [top](#)<http://gateoverflow.in/46>

Given the basic ER and relational models, which of the following is **INCORRECT**?

- (A) An attribute of an entity can have more than one value
- (B) An attribute of an entity can be composite
- (C) In a row of a relational table, an attribute can have more than one value
- (D) In a row of a relational table, an attribute can have exactly one value or a NULL value

[gate2012](#)
[databases](#)
[normal](#)
Answer**5.0.14 GATE2014-2_21** [top](#)<http://gateoverflow.in/1978>

The maximum number of superkeys for the relation schema $R(E, F, G, H)$ with E as the key is _____.

[gate2014-2](#)
[databases](#)
[numerical-answers](#)
[easy](#)
Answer**5.0.15 GATE2012_15** [top](#)<http://gateoverflow.in/47>

Which of the following statements are **TRUE** about an SQL query?

- P : An SQL query can contain a HAVING clause even if it does not have a GROUP BY clause
- Q : An SQL query can contain a HAVING clause only if it has a GROUP BY clause
- R : All attributes used in the GROUP BY clause must appear in the SELECT clause
- S : Not all attributes used in the GROUP BY clause need to appear in the SELECT clause

- (A) P and R
- (B) P and S
- (C) Q and R
- (D) Q and S

[gate2012](#)
[databases](#)
[easy](#)
Answer**5.0.16 GATE2014-2_22** [top](#)<http://gateoverflow.in/1980>

Given an instance of the STUDENTS relation as shown as below

| StudentID | StudentName | StudentEmail | StudentAge | CPI |
|-----------|-------------|--------------|------------|-----|
| 2345 | Shankar | Shankar@math | X | 9.4 |
| 1287 | Swati | swati@ee | 19 | 9.5 |
| 7853 | Shankar | Shankar@cse | 19 | 9.4 |
| 9876 | Swati | swati@mech | 18 | 9.3 |
| 8765 | Ganesh | ganesh@civil | 19 | 8.7 |

For
 $(StudentName, StudentAge)$ to be a key for this instance, the value X should NOT be equal to _____.

gate2014-2 | databases | numerical-answers | easy

Answer

5.0.17 GATE2014-2_30 top

<http://gateoverflow.in/1989>

Consider a join (relation algebra) between relations $r(R)$ and $s(S)$

using the nested loop method. There are 3 buffers each of size equal to disk block size, out of which one buffer is reserved for intermediate results. Assuming $\text{size}(r(R)) < \text{size}(s(S))$, the join will have fewer number of disk block accesses if

- (A) relation $r(R)$ is in the outer loop.
- (B) relation $s(S)$ is in the outer loop.
- (C) join selection factor between $r(R)$ and $s(S)$ is more than 0.5.
- (D) join selection factor between $r(R)$ and $s(S)$ is less than 0.5.

gate2014-2 | databases | normal

Answer

5.0.18 GATE2014-3_22 top

<http://gateoverflow.in/2056>

A prime attribute of a relation scheme R is an attribute that appears

- (A) in all candidate keys of R
- (B) in some candidate key of R
- (C) in a foreign key of R
- (D) only in the primary key of R

gate2014-3 | databases | easy

Answer

Answers:

5.0.1 GATE2012_2 top

<http://gateoverflow.in/34>



Selected Answer

(C) Every relation in BCNF is also in 3NF. Straight from definition of BCNF.

8 votes

-- Arjun Suresh (150k points)

5.0.2 GATE2014-1_22 top

<http://gateoverflow.in/1789>



Selected Answer

(D) both are false

S1: foreign key constraint means a lot of constraints it has to be a primary key(which intrun has few constraints)
we cannot replace it with a single check

S2:

if a and b forms a primary key in R, a alone cannot form a foreign key.

foreign key defn: it should be a candidate key in some other table(in our case it is only a prime attribute)

please add points if i had missed any

11 votes

-- Aravind (3k points)

5.0.3 GATE2005-IT_82a top

<http://gateoverflow.in/3647>



Selected Answer

Refer : http://en.wikipedia.org/wiki/Nested_loop_join

as per this reference This algorithm will involve $n_r * b_s + b_r$ block transfers
either T1 can be R or T2

if R is T1 then total number of block access is $2000 * 20 + 80 = 40080$

if R is T2 then total number of block access is $400 * 80 + 20 = 32020$

so better is the second case (32020) Hence i go for option C

10 votes

-- Sankaranarayanan P.N (9.8k points)

5.0.4 GATE2004-IT_21 top

<http://gateoverflow.in/3662>



Selected Answer

row level locking provides more concurrency. because different transactions can access different rows in a table / page at same time

3 votes

-- Sankaranarayanan P.N (9.8k points)

5.0.5 GATE2015-2_32 top

<http://gateoverflow.in/8151>



Selected Answer

$R_1(A, B)$

| A | B |
|---|---|
| 1 | 5 |
| 3 | 7 |

$R_2(A, C)$:

| A | C |
|---|---|
| 1 | 7 |
| 4 | 9 |

Now, if we do full natural outer join :

| A | B | C |
|---|------|------|
| 1 | 5 | 7 |
| 3 | 7 | NULL |
| 4 | NULL | 9 |

So, option (c) is correct.

6 votes

-- Shounak Kundu (4.1k points)

5.0.6 GATE2011_12 top

<http://gateoverflow.in/2114>



Selected Answer

A relation is given (**Registration_Num, UID, BankAccount_Num, Name, Hostel_Room**).

Now, **Registration_Num** is unique for each student. So with this, we can identify each student. Hence, this can be the primary key.

UID: It's an identification number for a person in a country. (Say you're in India and your **UID** is 0243. Someone in Pakistan may also have the same **UID** as 0243). So, if all students are from India (that is, the same country) then their **UID** will be different and then **UID** will be a Candidate key.

If **S** is a super key then **S ∪ UID** will be a Super key. e.g. **R(A, B, C, D)**, If **AB** is a superkey then **ABC**, **ABCD** are also superkey.

BankAccount_Num is not a candidate key, because a student can have multiple accounts or joint accounts. We can not identify each student uniquely with **BankAccount_Num**.

7 votes

-- Pranay Datta (6.8k points)

5.0.7 GATE2009-49 top

<http://gateoverflow.in/1335>



Selected Answer

234

Function-Oriented Software Design

business world. It is therefore useful to understand the different types of mistakes that beginners usually make while constructing the DFD model of systems, so that you can consciously try to avoid them. The errors are as follows:

- Many beginners commit the mistake of drawing more than one bubble in the context diagram. Context diagram should depict the system as a single bubble.
- Many beginners create DFD models in which external entities appearing at all levels of DFDs. All external entities interacting with the system should be represented only in the context diagram. The external entities should not appear in the DFDs at any other level.
- It is a common oversight to have either too few or too many bubbles in a DFD. Only three to seven bubbles per diagram should be allowed. This also means that each bubble in a DFD should be decomposed three to seven bubbles in the next level.
- Many beginners leave the DFDs at the different levels of a DFD model unbalanced.
- A common mistake committed by many beginners while developing a DFD model is attempting to represent control information in a DFD.

It is important to realise that a DFD represents only data flow, and it does not represent any control information.

Answer is clearly c) i and iii

1 votes

-- resilientknight (1.2k points)

5.0.8 GATE1999-1.18, ISRO2016-53 [top](#)

<http://gateoverflow.in/1471>



Selected Answer

B

mn if every row of r matches with each row of s - i.e., the join attribute has the same value in all rows of both r and s ,
0 if nothing matches- the join attribute in r and s have no common value.

7 votes

-- Anurag Semwal (5.5k points)

5.0.9 GATE1994_3.11 [top](#)

<http://gateoverflow.in/2497>



Selected Answer

This is False.

Generally, physical data independence exists in most databases and file environments where physical details such as the exact location of data on disk, and hardware details of storage encoding, placement, compression, splitting, merging of records, and so on are hidden from the user. Applications remain unaware of these details. On the other hand, logical data independence is harder to achieve because it allows structural and constraint changes without affecting application programs—a much stricter requirement. This paragraph is taken from Navathe book of DBMS, Page no 36, Chapter 2.

4 votes

-- Akash (31.7k points)

5.0.10 GATE1994_3.7 [top](#)

<http://gateoverflow.in/2493>



Selected Answer

No.

| | | |
|---|---|---|
| A | B | C |
| 1 | 5 | 6 |

| | | |
|---|---|---|
| 2 | 4 | 7 |
| 3 | 5 | |

Suppose this is the relational instance at any point of time.

Now we may see that $A \rightarrow BC$ holds for this instance ,hence $A^+ = \{ABC\}$.

But FD's are defined on the schema itself not the instance, so based on the state of the instance we cannot say what holds for schema (there can be many instances for R).

Up 5 votes

-- Sourav Roy (2.7k points)

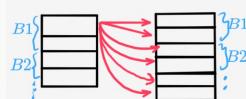
5.0.11 GATE2005-IT_82b top

<http://gateoverflow.in/3848>



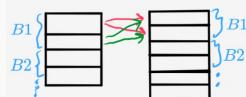
Selected Answer

In Nested loop join for each tuple in first table we scan through all the tuples in second table.



Here we will take table T2 as the outer table in nested loop join algorithm. The number of block accesses then will be $20 + (400 \times 80) = 32020$

In block nested loop join we keep 1 block of T1 in memory and 1 block of T2 in memory and do join on tuples.



For every block in T1 we need to load all blocks of T2. So number of block accesses is $80 * 20 + 20 = 1620$

So the difference is $32020 - 1620 = 30400$

(B) 30400

Up 12 votes

-- Omesh Pandita (2.3k points)

5.0.12 GATE2010-43 top

<http://gateoverflow.in/2344>



Selected Answer

(A) 100

natural join will combine tuples with same value of the common rows(if there are two common rows then both values must be equal to get into the resultant set). So by this defn: we can get at the max only 100 common values :P

Up 14 votes

-- Aravind (3k points)

5.0.13 GATE2012_14 top

<http://gateoverflow.in/46>



Selected Answer

(C) is incorrect as a relational table requires that, in a row, an attribute can have exactly one value or NULL value.

Up 8 votes

-- Arjun Suresh (150k points)

5.0.14 GATE2014-2_21 [top](#)<http://gateoverflow.in/1978>

Selected Answer

Super Key is any set of attributes that uniquely determines a tuple in a relation.

Since E is **the only key**, E should be present in any super key.

Excluding E , there are three attributes in the relation, namely F, G, H . Hence, if we add E to any subset of those three attributes, then the resulting set is a super key. Number of subsets of $\{F, G, H\}$ is 8. **Hence the answer is 8.**

The following are Super Keys:

$$\left\{ \begin{array}{l} E \\ EF \\ EG \\ EH \\ EFG \\ EFH \\ EGH \\ EFGH \end{array} \right\}$$

9 votes

-- Sankaranarayanan P.N (9.8k points)

5.0.15 GATE2012_15 [top](#)<http://gateoverflow.in/47>

Selected Answer

GATE 2012 Answer key is (C) Q and R are true.

But correct answer should be B.

- When group by is not present, having is applied to the whole table

"A grouped table is a set of groups derived during the evaluation of a <group by clause> or a <having clause>. A group is a multiset of rows in which all values of the grouping column or columns are equal if a <group by clause> is specified, or the group is the entire table if no <group by clause> is specified. A grouped table may be considered as a collection of tables. Set functions may operate on the individual tables within the grouped table."

This shows that P is indeed correct.

Also see "having clause section"

<http://www.contrib.andrew.cmu.edu/~shadow/sql/sql1992.txt>

<http://searchsqlserver.techtarget.com/answer/ISO-ANSI-SQL-and-the-GROUP-BY-clause>

The above link says that all columns used in group by must be present in select clause as per SQL-92 standard but later standards doesn't enforce it. I tried this on MySQL and it works. It is allowed in MSSQL also- see below link.

From Microsoft (obviously applicable only to MS-SQL)

<http://msdn.microsoft.com/en-us/library/ms177673.aspx>

Expressions in the GROUP BY clause can contain columns of the tables, derived tables or views in the FROM clause. The columns are not required to appear in the SELECT clause <select> list.

Each table or view column in any nonaggregate expression in the <select> list must be included in the GROUP BY list:

So, as per standard it is not allowed, but in most current DBMS it is allowed. And there is no reason why this shouldn't be allowed. So, ideally 'S' is more correct than 'R' or both are debatable and marks should have been given to all.

7 votes

-- Arjun Suresh (150k points)

5.0.16 GATE2014-2_22 [top](#)<http://gateoverflow.in/1980>



Selected Answer

should not equal to 19.

Since if it is equal the same key will have two different values which cannot be true by the definition of candidate/primary/super key.

6 votes

-- Aravind (3k points)

5.0.17 GATE2014-2_30 top

<http://gateoverflow.in/1989>



Selected Answer

Nested loop join is one of the methods to implement database in memory. A nested loop join is an algorithm that joins two sets by using two nested loops.

According to nested join,given relation R and S

For each tuple r in R do

For each tuple s in S do

If r and s satisfy the join condition

Then output the tuple <r,s>

Cost estimations for the above loop:

- $b(R)$ and $b(S)$ number of blocks in R and in S
- Each block of outer relation is read once
- Inner relation is read once for each block of outer relation

Summing up : $IO = b(R) + b(R)*b(S)$ total IO operations

Lets assume $|R| > |S|$ i.e $b(R) = 10$ and $b(s) = 4$

Now, if R is outer relation then, $IO = 10 + 10 * 4 = 50$

if S is outer relation then $IO = 4 + 4 * 10 = 44$

As it can be observed , that total IO is lesser if the value of outer variable is less and as it is already given that $|R| < |S|$.Therefore, Relation r(R) should be in the outer loop to have fewer number of disk block accesses.

So, option (a) is correct.

5 votes

-- Lubna Khan (249 points)

In joining A and B using nested loop method, with A in outer loop two factors are involved

i>No. of blocks containing all rows in A should be fetched

ii> No. Of Rows A times no of Blocks containing all Rows of B

(in worst case all rows of B are matched with all rows of A)

in above ques, $|R| < |S|$

i> will be less when number of rows in outer table is less since less no of rows will take less no. of Blocks

ii> if we keep R in outer loop, no of rows in R are less and no. of blocks in S are more

if we keep S in outer loop , no of rows in S are more and no. of blocks in R are less

in ii> block accesses will be multiplication and will come same in both cases

so i> will determine no of block accesses

so ans is A

5 votes

-- Anurag Semwal (5.5k points)

5.0.18 GATE2014-3_22 [top](#)<http://gateoverflow.in/2056>

Selected Answer

prime attribute is a constituent of a candidate key. it need not present in all candidate keys. hence option B is correct
correct me if i went wrong

8 votes

-- Sankaranarayanan P.N (9.8k points)

5.1**B Tree** [top](#)**5.1.1 B Tree: GATE2005-IT_23** [top](#)<http://gateoverflow.in/3768>

A B-Tree used as an index for a large database table has four levels including the root node. If a new key is inserted in this index, then the maximum number of nodes that could be newly created in the process are

- | | |
|----|---|
| A) | 5 |
| B) | 4 |
| C) | 3 |
| D) | 2 |

[gate2005-it](#) [databases](#) [b-tree](#) [normal](#)

Answer

5.1.2 B Tree: GATE2004-IT_79 [top](#)<http://gateoverflow.in/3723>

Consider a table T in a relational database with a key field K. A B-tree of order p is used as an access structure on K, where p denotes the maximum number of tree pointers in a B-tree index node. Assume that K is 10 bytes long; disk block size is 512 bytes; each data pointer P_D is 8 bytes long and each block pointer P_B is 5 bytes long. In order for each B-tree node to fit in a single disk block, the maximum value of p is

- | | |
|----|----|
| 1) | 20 |
| 2) | 22 |
| 3) | 23 |
| 4) | 32 |

[gate2004-it](#) [databases](#) [b-tree](#) [normal](#)

Answer

5.1.3 B Tree: GATE2004_52 [top](#)<http://gateoverflow.in/1048>

The order of an internal node in a B+ tree index is the maximum number of children it can have. Suppose that a child pointer takes 6 bytes, the search field value takes 14 bytes, and the block size is 512 bytes. What is the order of the internal node?

- A. 24
- B. 25
- C. 26
- D. 27

[gate2004](#) [databases](#) [b-tree](#) [normal](#)

Answer

5.1.4 B Tree: GATE2010-18 [top](#)

<http://gateoverflow.in/2191>

Consider a B^+ -tree in which the maximum number of keys in a node is 5. What is the minimum number of keys in any non-root node?

- A. 1
- B. 2
- C. 3
- D. 4

[gate2010](#) [databases](#) [b-tree](#) [easy](#)

[Answer](#)

5.1.5 B Tree: GATE2007-63, ISRO2016-59 [top](#)

<http://gateoverflow.in/1261>

The order of a leaf node in a B^+ -tree is the maximum number of (value, data record pointer) pairs it can hold. Given that the block size is 1K bytes, data record pointer is 7 bytes long, the value field is 9 bytes long and a block pointer is 6 bytes long, what is the order of the leaf node?

- A. 63
- B. 64
- C. 67
- D. 68

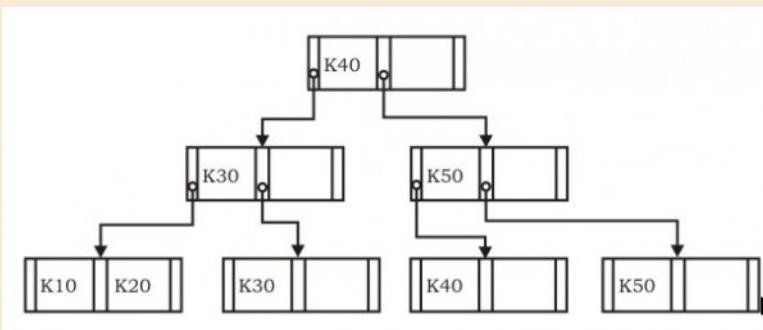
[gate2007](#) [databases](#) [b-tree](#) [normal](#) [isro2016](#)

[Answer](#)

5.1.6 B Tree: GATE2007-IT-85 [top](#)

<http://gateoverflow.in/3537>

Consider the B tree in the adjoining figure, where each node has at most two keys and three links.



Now the key K 50 is deleted from the B^+ tree resulting after the two insertions made earlier. Consider the following statements about the B^+ tree resulting after this deletion.

- The height of the tree remains the same.
- The node

| | | |
|-----|--|--|
| k20 | | |
|-----|--|--|

 (disregarding the links) is present in the tree.
- The root node remains unchanged (disregarding the links)

Which one of the following options is true ?

- A. Statements (i) and (ii) are true
- B. Statements (ii) and (iii) are true
- C. Statements (iii) and (i) are true
- D. All the statements are false

[gate2007-it](#)
[databases](#)
[b-tree](#)
[normal](#)
Answer

5.1.7 B Tree: GATE2009-44 [top](#)

<http://gateoverflow.in/1330>

The following key values are inserted into a B+ - tree in which order of the internal nodes is 3, and that of the leaf nodes is 2, in the sequence given below. The order of internal nodes is the maximum number of tree pointers in each node, and the order of leaf nodes is the maximum number of data items that can be stored in it. The B+ - tree is initially empty

10, 3, 6, 8, 4, 2, 1

The maximum number of times leaf nodes would get split up as a result of these insertions is

- A. 2
- B. 3
- C. 4
- D. 5

[gate2009](#)
[databases](#)
[b-tree](#)
[normal](#)
Answer

5.1.8 B Tree: GATE1997_19 [top](#)

<http://gateoverflow.in/2279>

A B^+ - tree of order d is a tree in which each internal node has between d and $2d$ key values. An internal node with M key values has $M + 1$ children. The root (if it is an internal node) has between 1 and $2d$ key values. The distance of a node from the root is the length of the path from the root to the node. All leaves are at the same distance from the root. The height of the tree is the distance of a leaf from the root.

- a. What is the total number of key values in the internal nodes of a B^+ -tree with l leaves ($l \geq 2$)?
- b. What is the maximum number of internal nodes in a B^+ - tree of order 4 with 52 leaves?
- c. What is the minimum number of leaves in a B^+ -tree of order d and height h ($h \geq 1$)?

[gate1997](#)
[databases](#)
[b-tree](#)
[normal](#)
Answer

5.1.9 B Tree: GATE2005_28 [top](#)

<http://gateoverflow.in/1364>

Which of the following is a key factor for preferring B^+ -trees to binary search trees for indexing database relations?

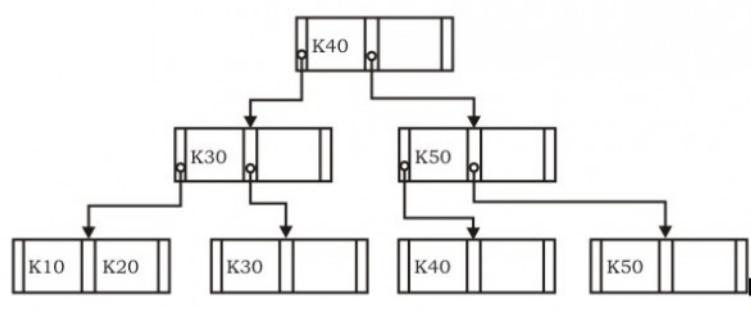
- A. Database relations have a large number of records
- B. Database relations are sorted on the primary key
- C. B^+ -trees require less memory than binary search trees
- D. Data transfer from disks is in blocks

[gate2005](#)
[databases](#)
[b-tree](#)
[normal](#)
Answer

5.1.10 B Tree: GATE2007-IT-84 [top](#)

<http://gateoverflow.in/3536>

Consider the B^+ tree in the adjoining figure, where each node has at most two keys and three links.



Keys K 15 and then K 25 are inserted into this tree in that order. Exactly how many of the following nodes (disregarding the links) will be present in the tree after the two insertions?



- A. 1
- B. 2
- C. 3
- D. 4

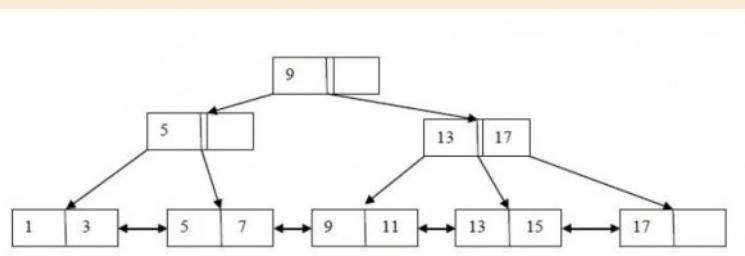
[gate2007-it](#) [databases](#) [b-tree](#) [normal](#)

[Answer](#)

5.1.11 B Tree: GATE2015-2_6 [top](#)

<http://gateoverflow.in/8052>

With reference to the B+ tree index of order 1 shown below, the minimum number of nodes (including the Root node) that must be fetched in order to satisfy the following query. "Get all records with a search key greater than or equal to 7 and less than 15" is _____.



[gate2015-2](#) [databases](#) [b-tree](#) [normal](#)

[Answer](#)

5.1.12 B Tree: GATE1999_21 [top](#)

<http://gateoverflow.in/1520>

Consider a B-tree with degree m , that is, the number of children, c , of any internal note (except the root) is such that $m \leq c \leq 2m - 1$. Derive the maximum and minimum number of records in the leaf nodes for such a B-tree with height h , $h \geq 1$. (Assume that the root of a tree is at height 0).

[gate1999](#) [databases](#) [b-tree](#) [normal](#)

[Answer](#)

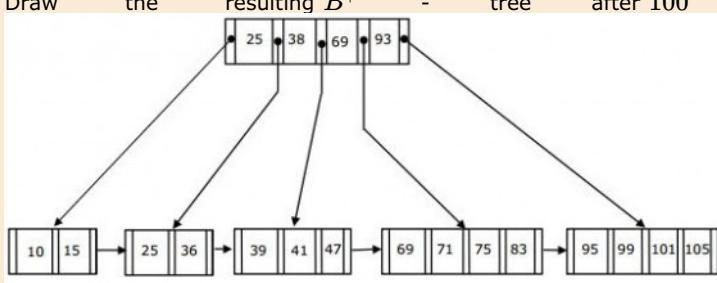
5.1.13 B Tree: GATE1994_14 [top](#)

<http://gateoverflow.in/2510>

Consider B^+ - tree of order d shown in figure. (A B^+ - tree of order d contains between

d and
2d keys in each node)

- a. Draw the resulting B^+ - tree after 100 is inserted in the figure below.



- b. For a B^+ - tree of order d with n leaf nodes, the number of nodes accessed during a search is $O(-)$.

gate1994 databases b-tree normal

Answer

5.1.14 B Tree: GATE1999_1.25 [top](#)

<http://gateoverflow.in/1478>

Which of the following is correct?

- A. B-trees are for storing data on disk and B^+ trees are for main memory.
- B. Range queries are faster on B^+ trees.
- C. B-trees are for primary indexes and B^+ trees are for secondary indexes.
- D. The height of a B^+ tree is independent of the number of records.

gate1999 databases b-tree normal

Answer

5.1.15 B Tree: GATE2006-IT_61 [top](#)

<http://gateoverflow.in/3605>

In a database file structure, the search key field is 9 bytes long, the block size is 512 bytes, a record pointer is 7 bytes and a block pointer is 6 bytes. The largest possible order of a non-leaf node in a B^+ tree implementing this file structure is

- | | |
|----|----|
| A) | 23 |
| B) | 24 |
| C) | 34 |
| D) | 44 |

gate2006-it databases b-tree normal

Answer

5.1.16 B Tree: GATE2002_17 [top](#)

<http://gateoverflow.in/870>

- a. The following table refers to search items for a key in B -trees and B^+ trees.

| B -tree | | B^+ -tree | |
|-------------------|---------------------|-------------------|---------------------|
| Successful search | Unsuccessful search | Successful search | Unsuccessful search |
| X1 | X2 | X3 | X4 |

A successful search means that the key exists in the database and unsuccessful means that it is not present in the

database. Each of the entries X_1, X_2, X_3 and X_4 can have a value of either Constant or Variable. Constant means that the search time is the same, independent of the specific key value, where variable means that it is dependent on the specific key value chosen for the search.

Give the correct values for the entries X_1, X_2, X_3 and X_4 (for example $X_1 = \text{Constant}, X_2 = \text{Constant}, X_3 = \text{Constant}, X_4 = \text{Constant}$).

- b. Relation R(A,B) has the following view defined on it:

```
CREATE VIEW V AS
(SELECT R1.A,R2.B
FROM R AS R1, R AS R2
WHERE R1.B=R2.A)
```

- i. The current contents of relation R are shown below. What are the contents of the view V?

| A | B |
|---|----|
| 1 | 2 |
| 2 | 3 |
| 2 | 4 |
| 4 | 5 |
| 6 | 7 |
| 6 | 8 |
| 9 | 10 |

- ii. The tuples (2,11) and (11,6) are now inserted into R. What are the additional tuples that are inserted in V?

gate2002 databases b-tree normal

Answer

5.1.17 B Tree: GATE2000-1.22, UGCNET-June2012-II-11 [top](#)

<http://gateoverflow.in/646>

B^+ -trees are preferred to binary trees in databases because

- A. Disk capacities are greater than memory capacities
- B. Disk access is much slower than memory access
- C. Disk data transfer rates are much less than memory data transfer rates
- D. Disks are more reliable than memory

gate2000 databases b-tree normal ugcnetjune2012ii

Answer

5.1.18 B Tree: GATE2008-41 [top](#)

<http://gateoverflow.in/453>

A B-tree of order 4 is built from scratch by 10 successive insertions. What is the maximum number of node splitting operations that may take place?

- A. 3
- B. 4
- C. 5
- D. 6

gate2008 databases b-tree normal

Answer

5.1.19 B Tree: GATE 2016-2-21 [top](#)

<http://gateoverflow.in/39569>

B+ Trees are considered BALANCED because.

- A. The lengths of the paths from the root to all leaf nodes are all equal.
- B. The lengths of the paths from the root to all leaf nodes differ from each other by at most 1.
- C. The number of children of any two non-leaf sibling nodes differ by at most 1.
- D. The number of records in any two leaf nodes differ by at most 1.

[gate2016-2](#) [databases](#) [b-tree](#) [normal](#)

[Answer](#)

5.1.20 B Tree: GATE2002-2.23, UGCNET-June2012-II-26 [top](#)

<http://gateoverflow.in/853>

A B^+ - tree index is to be built on the *Name* attribute of the relation *STUDENT*. Assume that all the student names are of length 8 bytes, disk blocks are of size 512 bytes, and index pointers are of size 4 bytes. Given the scenario, what would be the best choice of the degree (i.e. number of pointers per node) of the B^+ - tree?

- A. 16
- B. 42
- C. 43
- D. 44

[gate2002](#) [databases](#) [b-tree](#) [normal](#) [ugcnetjune2012ii](#)

[Answer](#)

5.1.21 B Tree: GATE2015-3_46 [top](#)

<http://gateoverflow.in/855>

Consider a B^+ tree in which the search key is 12 bytes long, block size is 1024 bytes, recorder pointer is 10 bytes long and the block pointer is 8 byte long. The maximum number of keys that can be accommodated in each non-leaf node of the tree is _____.

[gate2015-3](#) [databases](#) [b-tree](#) [normal](#)

[Answer](#)

Answers: B Tree

5.1.1 B Tree: GATE2005-IT_23 [top](#)

<http://gateoverflow.in/3768>



Selected Answer

suppose all nodes are completely full means every node has $n-1$ keys. tree has 4 levels if a new key is inserted then at every level there will be created a new node. and in worst case root node will also be broken into two parts. and we have 4 levels so answer should be 5 because tree will be increased with one more level

8 votes

-- Manu Thakur (5.6k points)

5.1.2 B Tree: GATE2004-IT_79 [top](#)

<http://gateoverflow.in/3723>



Selected Answer

It's 23

$(p-1)(key_ptr_size + record_ptr_size) + p \cdot (block_ptr_size) \leq 512$

we get , p=23

12 votes

-- Sandeep_Uniyal (5.5k points)

5.1.3 B Tree: GATE2004_52 [top](#)

<http://gateoverflow.in/1048>



Selected Answer

Answer: C

$$14(p-1) + 6p \leq 512$$

$$20p - 14 \leq 512$$

$$20p \leq 526$$

Therefore, $p = 26$.

4 votes

-- Rajarshi Sarkar (29.7k points)

5.1.4 B Tree: GATE2010-18 [top](#)

<http://gateoverflow.in/2191>



Selected Answer

Answer: B

$$\text{Order} = 5+1 = 6$$

$$\text{Minimum children in a non root node} = \lceil \frac{\text{Order}}{2} \rceil = \lceil \frac{6}{2} \rceil = 3$$

$$\text{Keys} = \text{Minimum children in a non root node} - 1 = 2$$

8 votes

-- Rajarshi Sarkar (29.7k points)

5.1.5 B Tree: GATE2007-63, ISRO2016-59 [top](#)

<http://gateoverflow.in/1261>



Selected Answer

The answer = **option A**

$$B_{-p} + P(R_p + \text{Key}) \leq \text{BlockSize}$$

$$1 \times 6 + n(7 + 9) \leq 1024$$

$$n \leq 63.625.$$

17 votes

-- Gate Keeda (17.7k points)

5.1.6 B Tree: GATE2007-IT-85 [top](#)

<http://gateoverflow.in/3537>

Answer is (A)

Only (i) and (ii) are correct .

After deleting 50 from the tree we are left with node (20,40) with 40 having no right subtree except 40 itself. Nodes can't be combined because that would overflow the node as they are already half -full or full .So key 40 can be out in node containing 30 .height remains same with 20 at root

5 votes

-- Sandeep_Uniyal (5.5k points)

5.1.7 B Tree: GATE2009-44 [top](#)<http://gateoverflow.in/1330>

Selected Answer

In this question they have asked only to count leaf node splits.

So after discussing with my friends on fb, I found that you will get two different answers depending on which convention you follow.

Convention 1: put the middle element in the left node, if you follow this you will get 4 as answer.

Convention 2: put the middle element in the right node, if you follow this you will get 3 as answer.

4 splits

1. after inserting 6
2. after inserting 4
3. after inserting 2 (there will be an internal node split and a leaf node split)
4. after inserting 1

12 votes

-- **Vikrant Singh** (11k points)**5.1.8 B Tree: GATE1997_19** [top](#)<http://gateoverflow.in/2279>

for part a)

assuming max nodes at each level

| height | nodes | keys |
|--------|-------------------|-----------------------------|
| 0 | 1 | 2d |
| 1 | 2d+1 | 2d (2d +1) |
| ... | | ... |
| h-1 | $(2d +1)^ (h-1)$ | $.2d [(2d +1) ^{(h-1)}]$ |

$(2d +1) ^h = L$ thus $\Rightarrow h = \log L / \log (2d+1)$

using GP

total keys in **internal nodes** $(2d + 1) ^{h -1}$ ie $L-1$

2 votes

-- **Vertika Srivastava** (283 points)**5.1.9 B Tree: GATE2005_28** [top](#)<http://gateoverflow.in/1364>

Selected Answer

Answer: D

- A: Cannot compare both the trees solely on basis of this.
- B: Both trees are BST.
- C: False. High fanout in B+ ensures that it takes more memory than BST.
- D: True. Records are stored in disk blocks.

5 votes

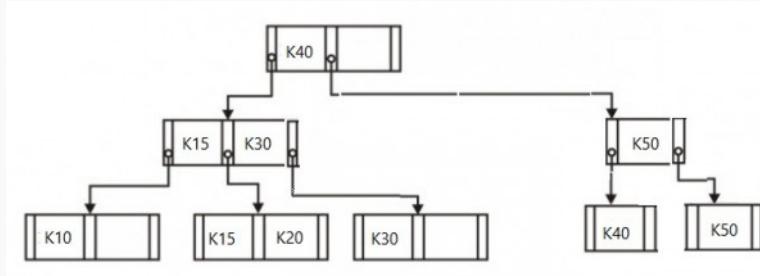
-- **Rajarshi Sarkar** (29.7k points)**5.1.10 B Tree: GATE2007-IT-84** [top](#)<http://gateoverflow.in/3536>

Selected Answer

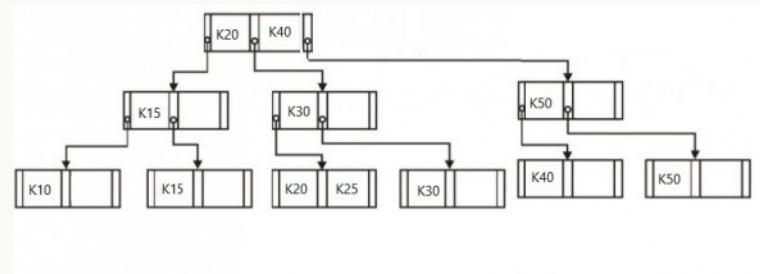
Option A is correct.

It is a B⁺ Tree.

After inserting K15 we get -



Now, we insert K25 , which gives -



so, we see in the final tree only (K20,K25) is present. Hence, **1 (Ans)**.

5 votes

-- Himanshu Agarwal (9.8k points)

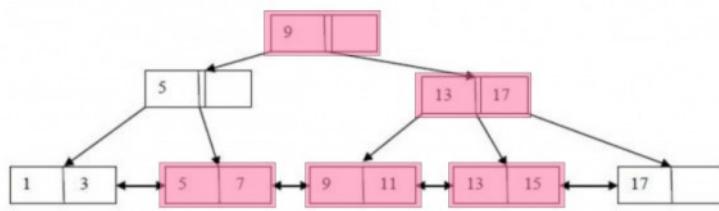
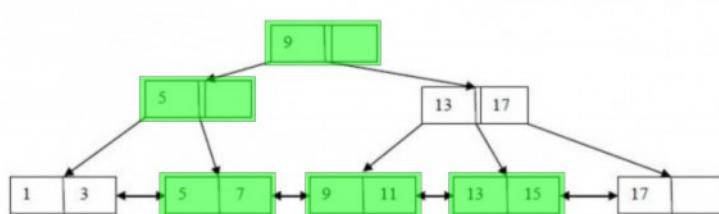
5.1.11 B Tree: GATE2015-2_6 top

<http://gateoverflow.in/8052>



Selected Answer

whichever way you go from the root to leaves, you'll always end up counting 5 nodes.



8 votes

-- Amar Vashishth (20.7k points)

5.1.12 B Tree: GATE1999_21 [top](#)<http://gateoverflow.in/1520>

Selected Answer

Given a B tree :

$$\text{max children at a node : } 2m - 1 \Rightarrow \text{max keys : } 2m - 2$$

$$\text{min children at a node : } m \Rightarrow \text{min keys : } m - 1$$

At Root node : min keys : 1 min children : 2

Here , leaf level is at level h (becz root is at level 0)

Now, we have to find

1) Minimum keys at leaf level(complete bottommost level , not just a node) -**For this we have to consider minimum everywhere.****Firstly we will count minimum possible nodes at leaf level.****At Root Node (level 0) :** It can have minimum 2 child (mean 2 nodes
minimum for next level)**At level 1 :** It has 2 nodes , each can have minimum m child (so , this
gives $2 * m$ minimum possible nodes at next level)**At level 2 :** min $2 * m^2$ Child and so on.**At level (h-1) :** $2 * (m)^{h-1}$ child (these are min number of leaf nodes possible)**At level h (leaf level) :** $2 * (m)^{h-1}$ nodes each having minimum $(m-1)$ keys.So, this gives the answer as **$2 * (m)^{h-1} * (m-1)$** minimum keys
possible at leaf level.2) Maximum keys at leaf level(complete bottommost level , not just a node) -**For this we have to count max everywhere.****At root (level 0) :** max child possible $2m-1$ (nodes for next level)**At level 1 :** $2m-1$ nodes give $(2m-1)^2$ child**At level (h-1) :** $(2m-1)^h$ child (these are maximum possible nodes at leaf level)**At level h (leaf level) :** $(2m-1)^h$ nodes each having a maximum of $(2m-2)$ keys ,Giving a total of - **$(2m-1)^h * (2m-2)$** maximum keys at leaf level.

7 votes

-- Himanshu Agarwal (9.8k points)

5.1.13 B Tree: GATE1994_14 [top](#)<http://gateoverflow.in/2510>

if u think i am wrong at some point plz comment.

i think the first part. they have given their own definition of b+ tree.

no considering their definition . if $d=1$

then minimum no of nodes should be 1 and maximum should be 2 . which we can see is not the case as 4 keys are their in one node.

$d=2$

minimum =2 max =4

satisfy the condition .

$d=3$

one underflow case exists which means the value of d is 2. now insert it according order 5 tree.

now the second part. number of access will be order of level . as i have to access every level once till the leafs . as the record pointer is always present in leafs.

so to find worst case complexity the tree should be of maximum height so that the number of levels can be full.

to get maximum height the tree should contain least data which can be attained by putting least number of children of every node.

so as we know the least number of data the root can have is 1.

so level zero which is root will have 1 node.

if root has one node then 2 nodes will be there at level 1. as children = data +1.

now from level 2 every node can have $(d+1)$ children. minimum data is d

so it will be like this

| level | nodes |
|----------|-----------------|
| 0 (root) | 1 |
| 1 | 2 |
| 2 | $2*(d+1)$ |
| 3 | $2*(d+1)(d+1)$ |
| k level | $2*(d+1)^(k-1)$ |

now we are given at last level it is n nodes

$$n=2*(d+1)^(k-1)$$

$$n/2= (d+1)^(k-1)$$

taking log on both sides

$$\log(n/2)=(k-1)*\log(d+1)$$

$$\log(n/2) \text{ base } (d+1)=k-1$$

$$k= 1+\log(n/2) \text{ base } (d+1)$$

so it will be $O(\log(n/2) \text{ base } (d+1))$.

3 votes

-- Ravi Singh (8.2k points)

5.1.14 B Tree: GATE1999_1.25 [top](#)

<http://gateoverflow.in/1478>

A) False. Both r stored in disk

B) True. By searching leaf level linearly in B+ tree, we can say a node is present or not in B+ tree. But for B tree we have to traverse the whole tree

C) False. B tree and B+ tree uses dynamic multilevel indexes <http://home.iitj.ac.in/~ramana/ch10-storage-2.pdf>

D) False. Height depends on number of records and also max no of keys in each node (order of tree)

3 votes

-- srestha (27.8k points)

5.1.15 B Tree: GATE2006-IT_61 [top](#)<http://gateoverflow.in/3605>

Selected Answer

ans is (C)

from the structure of B+ tree we can get this equation:

$$n*p + (n-1)*k \leq B \text{ (for non leaf node)}$$

here, n=order, p=tree/block/index pointer, B=size of block

i non leaf node no record pointer is there in B+ tree.

so $n*p + (n-1)*k \leq B$

$$n*6 + (n-1)*9 \leq 512$$

$$n \leq 34.77$$

largest possible is 34

10 votes

-- jayendra (6.6k points)

5.1.16 B Tree: GATE2002_17 [top](#)<http://gateoverflow.in/870>

Selected Answer

For A)

X1 = Variable (Key can be found @ Internal nodes at various levels)

X2 = Constant

X3 = Variable , We need to just check where key is present/absent, not to access Data. (A successful search means that the key exists in the database and unsuccessful means that it is not present in the database.) So Variable

X4 = Constant

For Part B) i) Write down two copies of same table for comparison side by side. Just map B of first to A of second copy. Those matching tuples take A of first table & B of second.

Content of View A

A B

1 3

1 4

2 5

For Part B) ii)

Additional tuples getting inserted ->

A B

11 7

11 8

2 6

1 11

5 votes

-- Akash (31.7k points)

5.1.17 B Tree: GATE2000-1.22, UGCNET-June2012-II-11 [top](#)<http://gateoverflow.in/646>

Selected Answer

Answer is B. The major advantage of B+ tree is in reducing the number of last level access which would be from disk in case of large data size.

<http://stackoverflow.com/questions/15485220/advantage-of-b-trees-over-bsts>

5 votes

-- Arjun Suresh (150k points)

5.1.18 B Tree: GATE2008-41 [top](#)<http://gateoverflow.in/453>

Selected Answer

Let 1 to 10 be inserted

Insertion of 123 does not cause any split

When we insert 4 split occurs

We use right bias

2

1 3456

Again on insertion of 6 split occurs

2 4

1 3 56

7 does not cause split

2 4

1 3 5678

8 cause split

2 4 6

1 3 5 7 8

Inserting 9 wont cause any split

2 4 6

1 3 5 7 8 9

Inserting 10 causes split at leaf and non leaf node

4

2 6 8

1 3 5 7 9 10

So total 5 splits

9 votes

-- Pooja (25.9k points)

5.1.19 B Tree: GATE 2016-2-21 [top](#)<http://gateoverflow.in/39569>

Selected Answer

A: In B+ Tree all leaves are at same level.

11 votes

-- Anurag Semwal (5.5k points)

5.1.20 B Tree: GATE2002-2.23, UGCNET-June2012-II-26 [top](#)<http://gateoverflow.in/853>

Selected Answer

Answer: C

In a B^+ tree we want entire node content to be in a disk block. A node can contain up to p pointers to child nodes and up to $p - 1$ key values for a B^+ tree of order p . Here, key size is 8 bytes and pointer size is 4 bytes. Thus we can write

$$8(p - 1) + 4p \leq 512 \implies 12p \leq 520 \implies p = 43.$$

<http://www.cburch.com/cs/340/reading/btree/index.html>

12 votes

-- Rajarshi Sarkar (29.7k points)

5.1.21 B Tree: GATE2015-3_46 [top](#)<http://gateoverflow.in/8555>

Selected Answer

$$(n-1)12 + n*8 \leq 1024$$

$$n \leq 51$$

in non leaf node number of keys = $n-1$

$$= 51-1 = 50$$

15 votes

-- ppm (559 points)

5.2**Concurrency** [top](#)**5.2.1 Concurrency: GATE 2016-2-51** [top](#)<http://gateoverflow.in/3950>

Consider the following database schedule with two transactions T_1 and T_2 .

$$S = r_2(X); r_1(X); r_2(Y); w_1(X); r_1(Y); w_2(X); a_1; a_2$$

Where $r_i(Z)$ denotes a read operation by transaction T_i on a variable Z , $w_i(Z)$ denotes a write operation by T_i on a variable Z and a_i denotes an abort by transaction T_i .

Which one of the following statements about the above schedule is **TRUE**?

- A. S is non-recoverable.
- B. S is recoverable, but has a cascading abort.
- C. S does not have a cascading abort.
- D. S is strict.

[gate2016-2](#) [databases](#) [concurrency](#) [transactions](#) [normal](#)
Answer

Answers: Concurrency

5.2.1 Concurrency: GATE 2016-2-51 [top](#)

<http://gateoverflow.in/39590>


Selected Answer

Answer is C

| | | |
|----------------|------|--|
| T ₁ | TR | ③ No dirty read. ④ X |
| R(X) | R(Y) | ② No Dirty Read ③ X |
| W(Z) | W(Z) | ① Not strict because X after T1 write X. |
| R(Y) | 92 | T2 also writes X before T1 commit abort so not ④ X |
| a1 | | |
| | | Ans \Rightarrow C. |

(A) => This is not possible, because we have no dirty read ! No dirty read => Recoverable

(B) => This is not possible, because of no Dirty read ! No dirty read => No cascading aborts !

(D) => This is not true, because we can see clearly in image that after W1(X) before T1 commit or aborts T2 does W2(x) !

C is only option remaining !

6 votes

-- Akash (31.7k points)

5.3

Database Normalization [top](#)

5.3.1 Database Normalization: GATE2002_16 [top](#)

<http://gateoverflow.in/869>

For relation $R = (L, M, N, O, P)$, the following dependencies hold:

$$M \rightarrow O, NO \rightarrow P, P \rightarrow L \text{ and } L \rightarrow MN$$

R is decomposed into $R_1 = (L, M, N, P)$ and $R_2 = (M, O)$.

- Is the above decomposition a lossless-join decomposition? Explain.
- Is the above decomposition dependency-preserving? If not, list all the dependencies that are not preserved.
- What is the highest normal form satisfied by the above decomposition?

[gate2002](#) [databases](#) [database-normalization](#) [normal](#)

Answer**5.3.2 Database Normalization: GATE2014-1_30** [top](#)<http://gateoverflow.in/1797>

Given the following two statements:

S1: Every table with two single-valued attributes is in 1NF, 2NF, 3NF and BCNF.

S2: $AB \rightarrow C$. $D \rightarrow E$, $E \rightarrow C$ is a minimal cover for the set of functional dependencies $AB \rightarrow C$, $D \rightarrow E$, $AB \rightarrow E$, $E \rightarrow C$.

Which one of the following is **CORRECT**?

- (A) S1 is TRUE and S2 is FALSE.
- (B) Both S1 and S2 are TRUE.
- (C) S1 is FALSE and S2 is TRUE.
- (D) Both S1 and S2 are FALSE.

[gate2014-1](#) [databases](#) [database-normalization](#) [normal](#)

Answer**5.3.3 Database Normalization: GATE2005_78** [top](#)<http://gateoverflow.in/1401>

Consider a relation scheme $R = (A, B, C, D, E, H)$ on which the following functional dependencies hold: $\{A \rightarrow B, BC \rightarrow D, E \rightarrow C, D \rightarrow A\}$. What are the candidate keys R?

- A. AE, BE
- B. AE, BE, DE
- C. AEH, BEH, BCH
- D. AEH, BEH, DEH

[gate2005](#) [databases](#) [database-normalization](#) [easy](#)

Answer**5.3.4 Database Normalization: GATE2001-1.23, UGCNET-June2012-III-18** [top](#)<http://gateoverflow.in/716>

Consider a schema $R(A, B, C, D)$ and functional dependencies $A \rightarrow B$ and $C \rightarrow D$. Then the decomposition of R into $R_1(A, B)$ and $R_2(C, D)$ is

- A. dependency preserving and lossless join
- B. lossless join but not dependency preserving
- C. dependency preserving but not lossless join
- D. not dependency preserving and not lossless join

[gate2001](#) [databases](#) [database-normalization](#) [normal](#) [ugcnetjune2012iii](#)

Answer**5.3.5 Database Normalization: GATE2008-IT_62** [top](#)<http://gateoverflow.in/3372>

Let R (A, B, C, D, E, P, G) be a relational schema in which the following functional dependencies are known to hold: $AB \rightarrow CD$, $DE \rightarrow P$, $C \rightarrow E$, $P \rightarrow C$ and $B \rightarrow G$. The relational schema R is

- 1) in BCNF
- 2) in 3NF, but not in BCNF
- 3) in 2NF, but not in 3NF
- 4) not in 2NF

[gate2008-it](#) [databases](#) [database-normalization](#) [normal](#)
Answer

5.3.6 Database Normalization: GATE1999_1.24 [top](#)

<http://gateoverflow.in/1477>

Let $R = (A, B, C, D, E, F)$ be a relation scheme with the following dependencies $C \rightarrow F, E \rightarrow A, EC \rightarrow D, A \rightarrow B$. Which one of the following is a key for R ?

- A. CD
- B. EC
- C. AE
- D. AC

[gate1999](#) [databases](#) [database-normalization](#) [easy](#)
Answer

5.3.7 Database Normalization: GATE2008-69 [top](#)

<http://gateoverflow.in/492>

Consider the following relational schemes for a library database:

`Book (Title, Author, Catalog_no, Publisher, Year, Price)`
`Collection (Title, Author, Catalog_no)`

with the following functional dependencies:

- I. Title Author \rightarrow Catalog_no
- II. Catalog_no \rightarrow Title Author Publisher Year
- III. Publisher Title Year \rightarrow Price

Assume { Author, Title } is the key for both schemes. Which of the following statements is true?

- A. Both Book and Collection are in BCNF
- B. Both Book and Collection are in 3NF only
- C. Book is in 2NF and Collection in 3NF
- D. Both Book and Collection are in 2NF only

[gate2008](#) [databases](#) [database-normalization](#) [normal](#)
Answer

5.3.8 Database Normalization: GATE2008-IT-61 [top](#)

<http://gateoverflow.in/3371>

Let $R (A, B, C, D)$ be a relational schema with the following functional dependencies : $A \rightarrow B, B \rightarrow C, C \rightarrow D$ and $D \rightarrow B$. The decomposition of R into $(A, B), (B, C), (B, D)$

- A. gives a lossless join, and is dependency preserving
- B. gives a lossless join, but is not dependency preserving
- C. does not give a lossless join, but is dependency preserving
- D. does not give a lossless join and is not dependency preserving

[gate2008-it](#) [databases](#) [database-normalization](#) [normal](#)
Answer

5.3.9 Database Normalization: GATE1999_2.7, UGCNET-June2014-III-25 [top](#)

<http://gateoverflow.in/1485>

Consider the schema $R = (S, T, U, V)$ and the dependencies $S \rightarrow T, T \rightarrow U, U \rightarrow V$ and $V \rightarrow S$. Let

$R = (R1 \text{ and } R2)$ be a decomposition such that $R1 \cap R2 \neq \emptyset$. The decomposition is

- A. not in 2NF
- B. in 2NF but not 3NF
- C. in 3NF but not in 2 NF
- D. in both 2NF and 3NF

gate1999 | databases | database-normalization | normal | ugcnetjune2014iii

Answer

5.3.10 Database Normalization: GATE1995_26 [top](#)

<http://gateoverflow.in/2665>

Consider the relation scheme $R(A, B, C)$ with the following functional dependencies:

- $A, B \rightarrow C$,
 - $C \rightarrow A$
- Show that the scheme R is in 3NF but not in BCNF.
 - Determine the minimal keys of relation R .

gate1995 | databases | database-normalization | normal

Answer

5.3.11 Database Normalization: GATE1998_1.34 [top](#)

<http://gateoverflow.in/1671>

Which normal form is considered adequate for normal relational database design?

- A. 2 NF
- B. 5 NF
- C. 4 NF
- D. 3 NF

gate1998 | databases | database-normalization | easy

Answer

5.3.12 Database Normalization: GATE 2016-1-23 [top](#)

<http://gateoverflow.in/39646>

A database of research articles in a journal uses the following schema.

$(VOLUME, NUMBER, STARTPAGE, ENDPAGE, TITLE, YEAR, PRICE)$

The primary key is ' $(VOLUME, NUMBER, STARTPAGE, ENDPAGE)$ '

and the following functional dependencies exist in the schema.

- | | | |
|--|---------------|---------|
| $(VOLUME, NUMBER, STARTPAGE, ENDPAGE)$ | \rightarrow | $TITLE$ |
| $(VOLUME, NUMBER)$ | \rightarrow | $YEAR$ |
| $(VOLUME, NUMBER, STARTPAGE, ENDPAGE)$ | \rightarrow | $PRICE$ |

The database is redesigned to use the following schemas

$(VOLUME, NUMBER, STARTPAGE, ENDPAGE, TITLE, PRICE)$ $(VOLUME, NUMBER, YEAR)$

Which is the weakest normal form that the new database satisfies, but the old one does not?

- A. 1NF

- B. 2NF
C. 3NF
D. BCNF

[gate2016-1](#) | [databases](#) | [database-normalization](#) | [normal](#)

[Answer](#)

5.3.13 Database Normalization: GATE1998_26 [top](#)

<http://gateoverflow.in/1741>

Consider the following database relations containing the attributes

- Book_id
- Subject_Category_of_book
- Name_of_Author
- Nationality_of_Author

With Book_id as the primary key.

- a. What is the highest normal form satisfied by this relation?
- b. Suppose the attributes Book_title and Author_address are added to the relation, and the primary key is changed to {Name_of_Author, Book_title}, what will be the highest normal form satisfied by the relation?

[gate1998](#) | [databases](#) | [database-normalization](#) | [normal](#)

[Answer](#)

5.3.14 Database Normalization: GATE 2016-1-21 [top](#)

<http://gateoverflow.in/39637>

Which of the following is NOT a superkey in a relational schema with attributes V, W, X, Y, Z and primary key XY ?

- A. $VXYZ$
B. $VWXZ$
C. $VWXY$
D. $VWXYZ$

[gate2016-1](#) | [databases](#) | [database-normalization](#) | [easy](#)

[Answer](#)

5.3.15 Database Normalization: GATE2009-56 [top](#)

<http://gateoverflow.in/43474>

Consider the following relational schema:

Suppliers(sid:integer, sname:string, city:string, street:string)

Parts(pid:integer, pname:string, color:string)

Catalog(sid:integer, pid:integer, cost:real)

Assume that, in the suppliers relation above, each supplier and each street within a city has unique name, and (sname, city) forms a candidate key. No other functional dependencies are implied other than those implied by primary and candidate keys. Which one of the following is TRUE about the above schema?

- A. The schema is in BCNF
B. The schema is in 3NF but not in BCNF
C. The schema is in 2 NF but not in 3NF
D. The schema is not in 2NF

[gate2009](#) [databases](#) [sql](#) [database-normalization](#) [normal](#)
Answer

5.3.16 Database Normalization: GATE1994_3.6 [top](#)

<http://gateoverflow.in/2492>

State True or False with reason

There is always a decomposition into Boyce-Codd normal form (BCNF) that is lossless and dependency preserving.

[gate1994](#) [databases](#) [database-normalization](#) [easy](#)
Answer

5.3.17 Database Normalization: GATE2005-29, UGCNET-June2015-III-9 [top](#)

<http://gateoverflow.in/1365>

Which one of the following statements about normal forms is FALSE?

- A. BCNF is stricter than 3NF
- B. Lossless, dependency-preserving decomposition into 3NF is always possible
- C. Lossless, dependency-preserving decomposition into BCNF is always possible
- D. Any relation with two attributes is in BCNF

[gate2005](#) [databases](#) [database-normalization](#) [easy](#) [ugcnetjune2015iii](#)
Answer

5.3.18 Database Normalization: GATE2007-62, UGCNET-June2014-II-47 [top](#)

<http://gateoverflow.in/1260>

Which one of the following statements is **FALSE**?

- A. Any relation with two attributes is in BCNF
- B. A relation in which every key has only one attribute is in 2NF
- C. A prime attribute can be transitively dependent on a key in a 3 NF relation
- D. A prime attribute can be transitively dependent on a key in a BCNF relation

[gate2007](#) [databases](#) [database-normalization](#) [normal](#) [ugcnetjune2014ii](#)
Answer

5.3.19 Database Normalization: GATE2003_85 [top](#)

<http://gateoverflow.in/968>

Consider the following functional dependencies in a database.

| | |
|--|--|
| Date_of_Birth \rightarrow Age | Age \rightarrow Eligibility |
| Name \rightarrow Roll_number | Roll_number \rightarrow Name |
| Course_number \rightarrow Course_name | Course_number \rightarrow Instructor |
| (Roll_number, Course_number) \rightarrow Grade | |

The relation (Roll_number, Name, Date_of_birth, Age) is

- A. in second normal form but not in third normal form
 B. in third normal form but not in BCNF
 C. in BCNF
 D. in none of the above

[gate2003](#) [databases](#) [database-normalization](#) [normal](#)

[Answer](#)

5.3.20 Database Normalization: GATE2005-IT_22 [top](#)

<http://gateoverflow.in/3767>

A table has fields F1, F2, F3, F4, F5 with the following functional dependencies
 $F1 \rightarrow F3$ $F2 \rightarrow F4$ $(F1 . F2) \rightarrow F5$
 In terms of Normalization, this table is in

- 1) 1 NF
 2) 2 NF
 3) 3 NF
 4) None of these

[gate2005-it](#) [databases](#) [database-normalization](#) [easy](#)

[Answer](#)

5.3.21 Database Normalization: GATE2004_50 [top](#)

<http://gateoverflow.in/1046>

The relation scheme Student Performance (name, courseNo, rollNo, grade) has the following functional dependencies:

- name, courseNo, \rightarrow grade
- rollNo, courseNo \rightarrow grade
- name \rightarrow rollNo
- rollNo \rightarrow name

The highest normal form of this relation scheme is

- A. 2 NF
 B. 3 NF
 C. BCNF
 D. 4 NF

[gate2004](#) [databases](#) [database-normalization](#) [normal](#)

[Answer](#)

5.3.22 Database Normalization: GATE2009-55 [top](#)

<http://gateoverflow.in/1339>

Consider the following relational schema:

Suppliers(sid:integer, sname:string, city:string, street:string)

Parts(pid:integer, pname:string, color:string)

Catalog(sid:integer, pid:integer, cost:real)

Consider the following relational query on the above database:

SELECT S.sname

```

FROM   Suppliers S
WHERE S.sid NOT IN (SELECT C.sid
                      FROM Catalog C
                      WHERE C.pid NOT IN (SELECT P.pid
                                           FROM Parts P
                                           WHERE P.color<>'blue'))

```

Assume that relations corresponding to the above schema are not empty. Which one of the following is the correct interpretation of the above query?

- A. Find the names of all suppliers who have supplied a non-blue part.
- B. Find the names of all suppliers who have not supplied a non-blue part.
- C. Find the names of all suppliers who have supplied only non-blue part.
- D. Find the names of all suppliers who have not supplied only blue parts.

[gate2009](#) [databases](#) [sql](#) [database-normalization](#) [normal](#)

[Answer](#)

5.3.23 Database Normalization: GATE2004-IT_75 [top](#)

<http://gateoverflow.in/3719>

A relation Empdtl is defined with attributes empcode (unique), name, street, city, state and pincode. For any pincode, there is only one city and state. Also, for any given street, city and state, there is just one pincode. In normalization terms, Empdtl is a relation in

- A. 1NF only
- B. 2NF and hence also in 1NF
- C. 3NF and hence also in 2NF and 1NF
- D. BCNF and hence also in 3NF, 2NF and 1NF

[gate2004-it](#) [databases](#) [database-normalization](#) [normal](#)

[Answer](#)

5.3.24 Database Normalization: GATE2002_2.24 [top](#)

<http://gateoverflow.in/854>

Relation R is decomposed using a set of functional dependencies, F, and relation S is decomposed using another set of functional dependencies, G. One decomposition is definitely BCNF, the other is definitely 3NF, but it is not known which is which. To make a guaranteed identification, which one of the following tests should be used on the decompositions? (Assume that the closures of F and G are available).

- A. Dependency-preservation
- B. Lossless-join
- C. BCNF definition
- D. 3NF definition

[gate2002](#) [databases](#) [database-normalization](#) [easy](#)

[Answer](#)

5.3.25 Database Normalization: GATE1997_6.9 [top](#)

<http://gateoverflow.in/2265>

For a database relation $R(a, b, c, d)$, where the domains a, b, c, d include only atomic values, only the following functional dependencies and those that can be inferred from them hold

- $a \rightarrow c$
- $b \rightarrow d$

This relation is

- A. in first normal form but not in second normal form
- B. in second normal form but not in first normal form
- C. in third normal form
- D. none of the above

[gate1997](#) [databases](#) [database-normalization](#) [normal](#)
Answer**5.3.26 Database Normalization: GATE2001-2.23** [top](#)<http://gateoverflow.in/741>

$R(A,B,C,D)$ is a relation. Which of the following does not have a lossless join, dependency preserving BCNF decomposition?

- A. $A \rightarrow B, B \rightarrow CD$
- B. $A \rightarrow B, B \rightarrow C, C \rightarrow D$
- C. $AB \rightarrow C, C \rightarrow AD$
- D. $A \rightarrow BCD$

[gate2001](#) [databases](#) [database-normalization](#) [normal](#)
Answer**Answers: Database Normalization****5.3.1 Database Normalization: GATE2002_16** [top](#)<http://gateoverflow.in/869>

Selected Answer

a) Yes as $R1 \cap R2 = M$ and $M \rightarrow O$

b) NO

From the Dependencies obtained from R1 and R2, we CANNOT infer $NO \rightarrow P$

Mistake That CAN be made: Here we CANNOT apply Pseudo Transitivity Rule using $M \rightarrow O$ & $MN \rightarrow P$ to obtain $NO \rightarrow P$ because the rule says :

if $M \rightarrow O$ and $NO \rightarrow P$ then $NM \rightarrow P$ or $MN \rightarrow P$

But here we have $M \rightarrow O$ and $MN \rightarrow P$... SO we CANNOT apply the rule here to obtain $NO \rightarrow P$ from it.

c) BCNF

$R1$ keys : P, L, MN hence BCNF

$R2$ key : M hence BCNF

Upvote 8 votes

-- Danish (2.4k points)

5.3.2 Database Normalization: GATE2014-1_30 [top](#)<http://gateoverflow.in/1797>

Selected Answer

(A) $S1$ is TRUE and $S2$ is FALSE.

a relation with 2 attributes is always in bcnf

the two sets of functional dependency are not the same, could not derive $ab \rightarrow E$ from the 1 st set

Upvote 9 votes

-- Aravind (3k points)

5.3.3 Database Normalization: GATE2005_78 [top](#)<http://gateoverflow.in/1401>



Selected Answer

(d) AEH, BEH, DEH

using the given functional dependencies and looking at the dependent attributes, E and H are not dependent on any. So, they must be part of any candidate key. So, only option is D. If we see the FD's, adding A, B or D to EH do form candidate keys.

9 votes

-- Aravind (3k points)

5.3.4 Database Normalization: GATE2001-1.23, UGCNET-June2012-III-18 [top](#)



Selected Answer

ans is C.

here no common attribute in R1 and R2, therefore lossy join will be there.

and both the dependencies are preserved in composed relations so dependency preserving.

6 votes

-- jayendra (6.6k points)

5.3.5 Database Normalization: GATE2008-IT_62 [top](#)

<http://gateoverflow.in/716>



Selected Answer

Answer: D

Here AB is the candidate key and B->G is a partial dependency. So, R is not in 2 NF.

10 votes

-- Rajarshi Sarkar (29.7k points)

5.3.6 Database Normalization: GATE1999_1.24 [top](#)

<http://gateoverflow.in/1477>



Selected Answer

Answer: B

EC is the key for R. Both E and C are not coming on the right hand side of any functional dependency. So, both of them must be present in any key. Now, with EC and the given FDs, we can derive all other attributes making EC a key.

6 votes

-- Rajarshi Sarkar (29.7k points)

5.3.7 Database Normalization: GATE2008-69 [top](#)

<http://gateoverflow.in/492>



Selected Answer

Answer: C

It is given that {Author , Title} is the key for both schemas.

The given dependencies are :

- {Title, Author} --> {Catalog_no}
- Catalog_no --> {Title , Author , Publisher , Year }
- {Publisher , Title , Year} --> {Price}

First , let's take schema Collection (Title , Author , Catalog_no) :

$\{Title, Author\} \rightarrow Catalog_no$

$\{Title, Author\}$ is a candidate key and hence super key also and by definition of BCNF this is in BCNF.

Now , let's see Book ($Title, Author, Catalog_no, Publisher, Year, Price$) :

$\{Title, Author\}^+ \rightarrow \{Title, Author, Catalog_no, Publisher, Year, Price\}$

$\{Catalog_no\}^{++} \rightarrow \{Title, Author, Publisher, Year, Price, Catalog_no\}$

So candidate keys are : $Catalog_no$, $\{Title, Author\}$

But in the given dependencies , $\{Publisher, Title, Year\} \rightarrow Price$, which has Transitive Dependency. **So , Book is in 2NF.**

10 votes

-- Shounak Kundu (4.1k points)

5.3.8 Database Normalization: GATE2008-IT-61 [top](#)

<http://gateoverflow.in/3371>



Selected Answer

Option A.

$(A, B) (B, C) \rightarrow$ common attribute is B and due to $B \rightarrow C$, B is a key for (B, C) and hence ABC can be losslessly decomposed into (A, B) and (B, C) .

$(A, B, C) (B, D)$, common attribute is B and $B \rightarrow D$ is a FD (via $B \rightarrow C$, $C \rightarrow D$), and hence B is a key for (B, D) . So, decomposition of (A, B, C, D) into (A, B, C) (B, D) is lossless.

Thus the given decomposition is lossless.

The given decomposition is also dependency preserving as the dependencies $A \rightarrow B$ is present in (A, B) , $B \rightarrow C$ is present in (B, C) , $D \rightarrow B$ is present in (B, D) and $C \rightarrow D$ is indirectly present via $C \rightarrow B$ in (B, C) and $B \rightarrow D$ in (B, D) .

<http://www.sztaki.hu/~fodoroczi/dbs/dep-pres-own.pdf>

16 votes

-- Arjun Suresh (150k points)

5.3.9 Database Normalization: GATE1999_2.7, UGCNET-June2014-III-25 [top](#)

<http://gateoverflow.in/1485>



Selected Answer

$R_1 \cap R_2 \neq \emptyset$. This makes the decomposition lossless join, as all the attributes are keys, $R_1 \cap R_2$ will be a key of the decomposed relations (lossless condition says the common attribute must be a key in at least one of the decomposed relation). Now, even the original relation

R is in 3NF (even BCNF) as all the attributes are prime attributes (in fact each attribute is a candidate key). Hence, any decomposition will also be in 3NF (even BCNF). Option D.

PS: Decomposition in 3NF means decomposed relations are in 3NF.

13 votes

-- Arjun Suresh (150k points)

5.3.10 Database Normalization: GATE1995_26 [top](#)

<http://gateoverflow.in/2665>



Selected Answer

The Candidate Keys are AB and BC.

None of the given functional dependencies are partial. So, the scheme qualifies for 2 NF.

There is no transitive dependency. So, the scheme qualifies for 3 NF.

All determinants are not Candidate Keys. So, the scheme do not qualify for BCNF.

10 votes

-- Rajarshi Sarkar (29.7k points)

5.3.11 Database Normalization: GATE1998_1.34 [top](#)

<http://gateoverflow.in/1671>



Selected Answer

3 NF,
because we can always have a 3NF decomposition which is dependency preserving and lossless (not possible for any higher forms).

7 votes

-- Digvijay (35.8k points)

5.3.12 Database Normalization: GATE 2016-1-23 [top](#)

<http://gateoverflow.in/39646>



Selected Answer

the actual design is in 1NF coz there are partial dependencies in the given FD set so the original db design is in 1 NF but not 2NF

now the new design is removing all the partial dependencies so its in 2NF

so the weakest form that the new schema satisfies that the old one couldnt is 2NF answer is B

6 votes

-- Bharani Viswas (733 points)

5.3.13 Database Normalization: GATE1998_26 [top](#)

<http://gateoverflow.in/1741>

- Book_id ----- i
- Subject_Category_of_book ----- c
- Name_of_Author ----- a
- Nationality_of_Author ----- n
- Book_title ----- t
- Author_address ----- d

first part) $i \rightarrow\!> c a n$
which satisfies **BCNF**

second part)

$i \rightarrow\!> c a n$

$a t \rightarrow\!> i c n d$

CKs = { {a t} , {i t} }

first FD satisfies BCNF

second FD violates 2NF

Hence, in **1NF**

9 votes

-- Amar Vashishth (20.7k points)

5.3.14 Database Normalization: GATE 2016-1-21 [top](#)

<http://gateoverflow.in/39637>



Selected Answer

Any superset of a key is also a superkey from definition of a superkey.
So Answer B.

a superkey can be defined as a set of attributes of a [relation schema](#) upon which all attributes of the schema are [functionally dependent](#)

11 votes

-- Abhilash Panicker (7k points)

5.3.15 Database Normalization: GATE2009-56 [top](#)

<http://gateoverflow.in/43474>

56. The non-trivial FDs are
 $(\text{lname}, \text{city}) \rightarrow \text{street}$
 $\text{sid} \rightarrow \text{street}$
 $(\text{lname}, \text{city}) \rightarrow \text{sid}$
 $\text{sid} \rightarrow \text{lname}$
 $\text{sid} \rightarrow \text{city}$

For all these, LHS is a super key and hence BCNF condition satisfied. But we have some more dependencies here:

"each supplier and each street within a city has unique name"

This basically means each supplier in a city has unique name making $(\text{lname}, \text{city})$ determine sid and hence making it a candidate key. Each street within a city also has a unique name and so $(\text{street}, \text{city})$ is also a candidate key. Even then with all 3 candidate keys (for Suppliers schema), for any FD, the LHS is a super key here, and hence the relation schema (for other two relations it is straight forward) is in BCNF.

<http://db.grussell.org/section009.html>

6 votes

-- Arjun Suresh (150k points)

5.3.16 Database Normalization: GATE1994_3.6 [top](#)

<http://gateoverflow.in/2492>



Selected Answer

False

BCNF decomposition can always be lossless, but it may not be always possible to get a dependency preserving BCNF decomposition.

6 votes

-- Sourav Roy (2.7k points)

5.3.17 Database Normalization: GATE2005-29, UGCNET-June2015-III-9 [top](#)

<http://gateoverflow.in/1365>



Selected Answer

option c

8 votes

-- Sankaranarayanan P.N (9.8k points)

5.3.18 Database Normalization: GATE2007-62, UGCNET-June2014-II-47 [top](#)

<http://gateoverflow.in/1260>



Selected Answer

1. Any relation with two attributes is in BCNF => This is true. It is trivial
2. A relation in which every key has only one attribute is in 2NF => This is true. As it is not possible to have Partial Functional Dependency !
3. A prime attribute can be transitively dependent on a key in a 3 NF relation => This is true. As For 3NF to be violated we have something like Key => Non Key, Non Key => Non key

. 3NF definition say $x \rightarrow y$, either x should be key or y should be prime attribute. Then we can have something like
 Key \Rightarrow Non Key, Non key \Rightarrow Prime Attribute, resulting in Transitive FD on Prime Attribute, still in 3NF.
 4. LHS must be always key, so No Transitive dependency is allowed. So answer \Rightarrow D

7 votes

-- Akash (31.7k points)

(d)

Defn from wiki:

The 3NF version of the definition is weaker than Date's BCNF variation, as the former is concerned only with ensuring that *non-key* attributes are dependent on keys. Prime attributes (which are keys or parts of keys) must not be functionally dependent at all; they each represent a fact about the key in the sense of providing part or all of the key itself. (It should be noted here that this rule applies only to functionally dependent attributes, as applying it to all attributes would implicitly prohibit composite candidate keys, since each part of any such key would violate the "whole key" clause.)

7 votes

-- Aravind (3k points)

5.3.19 Database Normalization: GATE2003_85 [top](#)

<http://gateoverflow.in/988>



Selected Answer

There are three FDs that are valid from the above set of FDs for the given relation :

Date_of_Birth \rightarrow Age

Name \rightarrow Roll_number

Roll_number \rightarrow Name

candidate keys for the above are : (Date_of_Birth,Name) and (Date_of_Birth,Roll_number)

clearly there is partial dependency here (Date_of_Birth \rightarrow Age) and Age is not a prime attribute. So it is only in 1NF.

Option (D).

13 votes

-- Danish (2.4k points)

5.3.20 Database Normalization: GATE2005-IT_22 [top](#)

<http://gateoverflow.in/3767>



Selected Answer

ans : 1

key is f1f2

f1 \rightarrow f3, f2 \rightarrow f4 are partial dependencies

9 votes

-- rajsh3kar (831 points)

5.3.21 Database Normalization: GATE2004_50 [top](#)

<http://gateoverflow.in/1046>



Selected Answer

option B is correct, because

Here candidate keys are,

Name+course

roll_no+course

that makes name, roll_no and course_no prime attribute(or part of key)

functional dependencies 3 and 4 are not partial FDs

rule of FD not belonging to 2NF is,

for FD $x \rightarrow y$, x should be prime attribute and y should be non prime attribute, here y is also a partial key

so this is 2NF, because y is also prime attribute

but for BCNF, for every FD, of $x \rightarrow y$, x should be super key, so this is not BCNF, because x is not super key

in 3NF, for every FD, $x \rightarrow y$, condition is x can be super key or y can be prime attribute, x is not super key, but y is prime attribute

thats why this condition holds ans relation is in 3NF

3 votes

-- rameshbabu (2.1k points)

5.3.22 Database Normalization: GATE2009-55 [top](#)

<http://gateoverflow.in/1339>



Selected Answer

```
SELECT P.pid FROM Parts P WHERE P.color<>'blue'
```

Select all non blue parts

```
SELECT C.sid FROM Catalog C WHERE C.pid NOT IN
```

Selects all suppliers who have supplied a blue part

```
SELECT S.sname
FROM Suppliers S
WHERE S.sid NOT IN
```

Selects suppliers who have not supplied any blue parts.

So, **none** of the options matches. (Option C is wrong because the given query also selects suppliers who have not supplied any parts).

12 votes

-- Arjun Suresh (150k points)

5.3.23 Database Normalization: GATE2004-IT_75 [top](#)

<http://gateoverflow.in/3719>



Selected Answer

It is in 2nf - for 2NF all non prime attribute should be fully functionally dependent on key. Here key is empcode and contains only one attribute hence no partial dependency. But there is transitive dependency in this (pincode -> city, state). So it is not in 3 NF.

answer: B

12 votes

-- Sankaranarayanan P.N (9.8k points)

5.3.24 Database Normalization: GATE2002_2.24 [top](#)

<http://gateoverflow.in/854>



Selected Answer

- A) False. BCNF may or may not satisfy Dependency preservation, 3NF always does. But we can't make any guaranteed decision, regarding BCNF if it satisfies Dependency preservation
- B) False. Both are lossless.
- C) True. Using this we can always decide between BCNF & 3NF.
- D) False. Every BCNF relation is also 3NF trivially.

ANSWER -> C (& Only C)

10 votes

-- Akash (31.7k points)

5.3.25 Database Normalization: GATE1997_6.9 [top](#)

<http://gateoverflow.in/2265>



Selected Answer

Ck is ab.

Since all a,b,c,d are atomic so the relation is in 1 NF.

Now check the FD s.

$a \rightarrow c(P \rightarrow NP)$

$b \rightarrow d(P \rightarrow NP)$

Since there are partial dependencies, so it is not 2 NF.

a} Ans 1NF but not 2NF

6 votes

-- Sourav Roy (2.7k points)

5.3.26 Database Normalization: GATE2001-2.23 [top](#)

<http://gateoverflow.in/741>



Selected Answer

taking up option A first :

We have, R(A, B, C, D) and the Functional Dependency set = {A→B, B→CD}.

Now we will try to decompose it such that the decomposition is a Lossless Join, Dependency Preserving and new relations thus formed are in BCNF.

We decomposed it to R₁(A, B) and R₂(B, C, D). This decomposition satisfies all three properties we mentioned prior.

taking up option B :

we have, R(A, B, C, D) and the Functional Dependency set = {A→B, B→C, C→D}.

we decomposed it as R₁(A, B), R₂(B, C) and R₃(C, D). This decomposition too satisfies all properties as decomposition in option A.

taking up option D :

we have, R(A, B, C, D) and the Functional Dependency set = {A→BCD}.

This set of FDs is equivalent to set = {A→B, A→C, A→D} on applying decomposition rule which is derived from Armstrong's Axioms.

we decomposed it as R₁(A, B), R₂(A, C) and R₃(A, D). This decomposition also satisfies all properties as required.

taking up option C :

we have, R(A, B, C, D) and the Functional Dependency set = {AB→C, C→AD}.

we decompose it as R₁(A, B, C) and R₂(C, D). This preserves all dependencies and the join is lossless too, but the relation R₁ is not in BCNF. In R₁ we keep ABC together otherwise preserving {AB→C} will fail, but doing so also causes {C→A} to appear in R₁. {C→A} violates the condition for R₁ to be in BCNF as C is not a superkey. Condition that all relations formed after decomposition should be in BCNF is not satisfied here.

We need to identify the INCORRECT, Hence mark option C.

18 votes

-- Amar Vashishth (20.7k points)

5.4

Er Diagram [top](#)5.4.1 Er Diagram: GATE2005_75 [top](#)<http://gateoverflow.in/1398>

Let E_1 and E_2 be two entities in an E/R diagram with simple-valued attributes. R_1 and R_2 are two relationships between E_1 and E_2 , where R_1 is one-to-many and R_2 is many-to-many. R_1 and R_2 do not have any attributes of their own. What is the minimum number of tables required to represent this situation in the relational model?

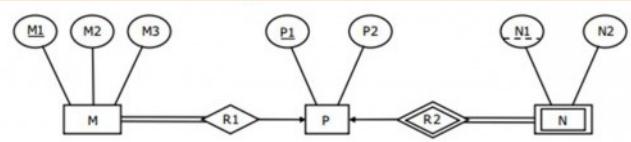
- A. 2
- B. 3
- C. 4
- D. 5

[gate2005](#) [databases](#) [er-diagram](#) [normal](#)

Answer

5.4.2 Er Diagram: GATE2008-82-83 [top](#)<http://gateoverflow.in/390>

82. Consider the following ER diagram



The minimum number of tables needed to represent M, N, P, R1, R2 is

- A. 2
- B. 3
- C. 4
- D. 5

83. Which of the following is a correct attribute set for one of the tables for the correct answer to the above question?

- A. {M1, M2, M3, P1}
- B. {M1, P1, N1, N2}
- C. {M1, P1, N1}
- D. {M1, P1}

[gate2008](#) [databases](#) [er-diagram](#) [normal](#)

Answer

Answers: Er Diagram

5.4.1 Er Diagram: GATE2005_75 [top](#)<http://gateoverflow.in/1398>

Selected Answer

We need a separate table for many-to-many relation.
one-to-many relation doesn't need a separate table and can be handled using a foreign key.
So, answer is B. 3 tables.

Ref: <http://web.cse.ohio-state.edu/~gurari/course/cse670/cse670Ch9.xht>

10 votes

-- Arjun Suresh (150k points)

5.4.2 Er Diagram: GATE2008-82-83 [top](#)<http://gateoverflow.in/390>



Selected Answer

First strong entity types are made to tables. So, we get two tables M and P.

I assume R1 is 1:1 or 1:n as that would minimize the number of tables as asked in question.

Now participation of M in R1 is total (indicated by double arrow) meaning every entity of M participate in R1. Since R1 is not having an attribute, we can simply add the primary key of P to the table M and add a foreign key reference to M. This handles R1 and we don't need an extra table. So, M becomes {M1, M2, M3, P1}.

N here is a weak entity weakly related to P. So, we form a new table N, and includes the primary key of P (P1) as foreign key reference. Now (P1, N1) becomes the primary key of N.

Thus we get 3 tables.

M: {M1, M2, M3, P1} - M1 primary key, P1 references P

P: {P1, P2} - P1 primary key

N: {P1, N1, N2} - (P1, N1) primary key, P1 references P.

So, answers are 82: B and 83: A.

18 votes

-- Arjun Suresh (150k points)

5.5

Er Model top

5.5.1 Er Model: GATE2004-IT_73 top

<http://gateoverflow.in/3717>

Consider the following entity relationship diagram (ERD), where two entities E1 and E2 have a relation R of cardinality 1 : m.



The attributes of E1 are A11, A12 and A13 where A11 is the key attribute. The attributes of E2 are A21, A22 and A23 where A21 is the key attribute and A23 is a multi-valued attribute. Relation R does not have any attribute. A relational database containing minimum number of tables with each table satisfying the requirements of the third normal form (3NF) is designed from the above ERD. The number of tables in the database is

- | | |
|----|---|
| A) | 2 |
| B) | 3 |
| C) | 5 |
| D) | 4 |

[gate2004-it](#) [databases](#) [er-model](#) [normal](#)

Answer

5.5.2 Er Model: GATE2005-IT_21 top

<http://gateoverflow.in/3766>

Consider the entities 'hotel room', and 'person' with a many to many relationship 'lodging' as shown below:



If we wish to store information about the rent payment to be made by person (s) occupying different hotel rooms, then this information should appear as an attribute of

- | | |
|----|---------------|
| A) | Person |
| B) | Hotel Room |
| C) | Lodging |
| D) | None of these |

[gate2005-it](#) [databases](#) [er-model](#) [easy](#)
[Answer](#)

5.5.3 Er Model: GATE2015-1_41 [top](#)

<http://gateoverflow.in/8309>

Consider an Entity-Relationship (ER) model in which entity sets E_1 and E_2 are connected by an m:n relationship R_{12} . E_1 and E_3 are connected by a 1 : n (1 on the side of E_1 and n on the side of E_3) relationship R_{13} .

E_1 has two-singled attributes a_{11} and a_{12} of which a_{11} is the key attribute. E_2 has two singled-valued attributes a_{21} and a_{22} of which a_{21} is the key attribute. E_3 has two single-valued attributes a_{31} and a_{32} of which a_{31} is the key attribute. The relationships do not have any attributes.

If a relational model is derived from the above ER model, then the minimum number of relations that would be generated if all relation are in 3NF is _____.

[gate2015-1](#) [databases](#) [er-model](#) [normal](#)
[Answer](#)

Answers: Er Model

5.5.1 Er Model: GATE2004-IT_73 [top](#)

<http://gateoverflow.in/3717>

Selected Answer

We need just two tables for 1NF.

T1: {A11, A12, A13}

T2: {A21, A22, A23, A11}

A23 being multi-valued, {A21, A23} becomes the key for T2 as we need to repeat multiple values corresponding to the multi-valued attribute to make it 1NF. But, this causes partial FD $A_{21} \rightarrow A_{22}$ and makes the table not in 2NF. In order to make the table in 2NF, we have to create a separate table for multi-valued attribute. Then we get

T1: {A11, A12, A13} - key is A11

T2: {A21, A22, A11} - key is A21

T3: {A21, A23} - key is {A21, A23}

Here, all determinants of all FDs are keys and hence the relation is in BCNF and so 3NF also. So, we need minimum 3 tables.

thumb up 12 votes

-- Arjun Suresh (150k points)

5.5.2 Er Model: GATE2005-IT_21 [top](#)

<http://gateoverflow.in/3766>

Selected Answer

since it is many to many. rent cannot be an attribute of room or person entities alone. if depending on number of persons sharing a room the rent for each person for the room will be different. otherwise rent can be attribute of room. hence i go for attribute of Lodging

thumb up 11 votes

-- Sankaranarayanan P.N (9.8k points)

5.5.3 Er Model: GATE2015-1_41 [top](#)

<http://gateoverflow.in/8309>

Selected Answer

Answer is 4. The relations are as shown:

< a_{11}, a_{12} > for E_1

<a21, a22> for E2

<a31, a32, a11> for E3 and E1-E3 relationship

<a11, a21> for m:n relationship E1-E2

We cannot combine any relation here as it will give rise to partial functional dependency and thus violate 3NF.

<http://cisnet.baruch.cuny.edu/holowczak/classes/9440/entityrelationship/>

14 votes

-- Arjun Suresh (150k points)

5.6

Functional Dependencies [top](#)

5.6.1 Functional Dependencies: GATE2006_70 [top](#)

<http://gateoverflow.in/1848>

The following functional dependencies are given:

$AB \rightarrow CD, AF \rightarrow D, DE \rightarrow F, C \rightarrow G, F \rightarrow E, G \rightarrow A$

Which one of the following options is false?

- (A) $\{CF\}^* = \{ACDEFG\}$
- (B) $\{BG\}^* = \{ABCDG\}$
- (C) $\{AF\}^* = \{ACDEFG\}$
- (D) $\{AB\}^* = \{ABCDG\}$

[gate2006](#) [databases](#) [functional-dependencies](#) [normal](#)

[Answer](#)

5.6.2 Functional Dependencies: GATE2015-3_20 [top](#)

<http://gateoverflow.in/8420>

Consider the relation $X(P, Q, R, S, T, U)$ with the following set of functional dependencies

$F = \{ \{P, R\} \rightarrow \{S, T\}, \{P, S, U\} \rightarrow \{Q, R\} \}$

Which of the following is the trivial functional dependency in F^+ , where F^+ is closure to F?

- A. $\{P, R\} \rightarrow \{S, T\}$
- B. $\{P, R\} \rightarrow \{R, T\}$
- C. $\{P, S\} \rightarrow \{S\}$
- D. $\{P, S, U\} \rightarrow \{Q\}$

[gate2015-3](#) [databases](#) [functional-dependencies](#) [easy](#)

[Answer](#)

5.6.3 Functional Dependencies: GATE2013-54 [top](#)

<http://gateoverflow.in/1558>

Relation R has eight attributes ABCDEFGH. Fields of R contain only atomic values. $F = \{CH \rightarrow G, A \rightarrow BC, B \rightarrow CFH, E \rightarrow A, F \rightarrow EG\}$ is a set of functional dependencies (FDs) so that F^+ is exactly the set of FDs that hold for R.

Q.54 How many candidate keys does the relation R have?

- (A) 3 (B) 4 (C) 5 (D) 6

[gate2013](#) [databases](#) [functional-dependencies](#) [database-normalization](#) [normal](#)

[Answer](#)

5.6.4 Functional Dependencies: GATE2002_1.19 [top](#)

<http://gateoverflow.in/824>

Relation R with an associated set of functional dependencies, F, is decomposed into BCNF. The redundancy (arising out of functional dependencies) in the resulting set of relations is

- A. Zero
- B. More than zero but less than that of an equivalent 3NF decomposition
- C. Proportional to the size of F^+
- D. Indeterminate

[gate2002](#) [databases](#) [functional-dependencies](#) [database-normalization](#) [normal](#)

[Answer](#)

5.6.5 Functional Dependencies: GATE2013-55 [top](#)

<http://gateoverflow.in/43290>

Relation R has eight attributes ABCDEFGH. Fields of R contain only atomic values. $F = \{CH \rightarrow G, A \rightarrow BC, B \rightarrow CFH, E \rightarrow A, F \rightarrow EG\}$ is a set of functional dependencies (FDs) so that F^+ is exactly the set of FDs that hold for R.

The relation R is

- A. in 1NF, but not in 2NF.
- B. in 2NF, but not in 3NF.
- C. in 3NF, but not in BCNF.
- D. in BCNF.

[gate2013](#) [databases](#) [functional-dependencies](#) [database-normalization](#) [normal](#)

[Answer](#)

5.6.6 Functional Dependencies: GATE2002_2.25 [top](#)

<http://gateoverflow.in/855>

Form the following instance of a relation schema R(A,B,C), we can conclude that:

| A | B | C |
|---|---|---|
| 1 | 1 | 1 |
| 1 | 1 | 0 |
| 2 | 3 | 2 |
| 2 | 3 | 2 |

- A. A functionally determines B and B functionally determines C
- B. A functionally determines B and B does not functionally determine C
- C. B does not functionally determine C
- D. A does not functionally determine B and B does not functionally determine C

[gate2002](#) [databases](#) [functional-dependencies](#)

[Answer](#)

5.6.7 Functional Dependencies: GATE2005-IT_70 [top](#)

<http://gateoverflow.in/3833>

In a schema with attributes A, B, C, D and E following set of functional dependencies are given

$A \rightarrow B$
 $A \rightarrow C$
 $CD \rightarrow E$
 $B \rightarrow D$
 $E \rightarrow A$

Which of the following functional dependencies is NOT implied by the above set?

- | | |
|----|---------------------|
| A) | $CD \rightarrow AC$ |
| B) | $BD \rightarrow CD$ |
| C) | $BC \rightarrow CD$ |
| D) | $AC \rightarrow BC$ |

[gate2005-it](#)
[databases](#)
[functional-dependencies](#)
[normal](#)
Answer

5.6.8 Functional Dependencies: GATE2014-1_21 [top](#)

<http://gateoverflow.in/1788>

Consider the relation scheme

$R = (E, F, G, H, I, J, K, L, M, N)$ and the set of functional dependencies

$$\{\{E, F\} \rightarrow \{G\}, \{F\} \rightarrow \{I, J\}, \{E, H\} \rightarrow \{K, L\}, \{K\} \rightarrow \{M\}, \{L\} \rightarrow \{N\}\}$$

on

R . What is the key for R ?

- (A) $\{E, F\}$
- (B) $\{E, F, H\}$
- (C) $\{E, F, H, K, L\}$
- (D) $\{E\}$

[gate2014-1](#)
[databases](#)
[functional-dependencies](#)
[normal](#)
Answer

5.6.9 Functional Dependencies: GATE2006-IT_60 [top](#)

<http://gateoverflow.in/3604>

Consider a relation R with five attributes V, W, X, Y, and Z. The following functional dependencies hold:

$$VY \rightarrow W, WX \rightarrow Z, \text{ and } ZY \rightarrow V.$$

Which of the following is a candidate key for R?

- | | |
|----|-------|
| A) | VXZ |
| B) | VXY |
| C) | VWXY |
| D) | VWXYZ |

[gate2006-it](#)
[databases](#)
[functional-dependencies](#)
[normal](#)
Answer

5.6.10 Functional Dependencies: GATE2000-2.24 [top](#)

<http://gateoverflow.in/671>

Given the following relation instance.

| X | Y | Z |
|---|---|---|
| 1 | 4 | 2 |
| 1 | 5 | 3 |
| 1 | 6 | 3 |
| 3 | 2 | 2 |

Which of the following functional dependencies are satisfied by the instance?

- A. $XY \rightarrow Z$ and $Z \rightarrow Y$
- B. $YZ \rightarrow X$ and $Y \rightarrow Z$
- C. $YZ \rightarrow X$ and $X \rightarrow Z$
- D. $XZ \rightarrow Y$ and $Y \rightarrow X$

[gate2000](#)
[databases](#)
[functional-dependencies](#)
[easy](#)
Answer

Answers: Functional Dependencies

5.6.1 Functional Dependencies: GATE2006_70 [top](#)

<http://gateoverflow.in/1848>



Selected Answer

$\{AF\}^* = \{AFDE\}$. Hence option C is wrong

13 votes

-- Sankaranarayanan P.N (9.8k points)

5.6.2 Functional Dependencies: GATE2015-3_20 [top](#)

<http://gateoverflow.in/8420>



Selected Answer

option C is correct because $\{P, S\} \rightarrow \{S\}$

for trivial FD, if $X \rightarrow Y$ then Y must be a subset of X and for non trivial FD $X \cap Y = \emptyset$. and here $\{S\}$ is subset of $\{P, S\}$.

PS: Trivial means something which is always there. An attribute set always determines any of the component attributes and this is always true irrespective of the relation instance. Hence this FD becomes trivial.

13 votes

-- Anoop Sonkar (4.5k points)

5.6.3 Functional Dependencies: GATE2013-54 [top](#)

<http://gateoverflow.in/1558>



Selected Answer

54) B.

4 candidate keys namely DA,DB,DE,DF.

11 votes

-- kalpashri (295 points)

5.6.4 Functional Dependencies: GATE2002_1.19 [top](#)

<http://gateoverflow.in/824>



Selected Answer

Answer: A

If a relation schema is in BCNF then all redundancy based on functional dependency has been removed, although other types of redundancy may still exist. A relational schema R is in Boyce-Codd normal form if and only if for every one of its dependencies $X \rightarrow Y$, at least one of the following conditions hold:

- $X \rightarrow Y$ is a trivial functional dependency ($Y \subseteq X$)
- X is a super key for schema R
- http://en.wikipedia.org/wiki/Boyce%20Codd_normal_form

11 votes

-- Priya_das (663 points)

5.6.5 Functional Dependencies: GATE2013-55 [top](#)

<http://gateoverflow.in/43290>



Selected Answer

Here Candidate keys are AD, BD, ED and FD .

Partial dependency like $A \rightarrow BC$, $E \rightarrow A$ etc exists in the given relation.

So given relation is in 1NF, but not in 2NF.

1 votes

-- Manoj Kumar (23.1k points)

5.6.6 Functional Dependencies: GATE2002_2.25 [top](#)

<http://gateoverflow.in/855>



Selected Answer

Ans. C

Generally Normalization is done on the schema itself.

From the relational instance given, we may strike out FD's that do not hold.

e.g. B does not functionally determine C (This is true).

But we cannot say that A functionally determines B for the entire relation itself. This is because that $A \rightarrow B$ holds for this instance, but in future there might be some tuples added to the instance that may violate $A \rightarrow B$.

So overall on the relation we cannot conclude that $A \rightarrow B$, from the relational instance which is just a subset of an entire relation.

12 votes

-- Sourav Roy (2.7k points)

5.6.7 Functional Dependencies: GATE2005-IT_70 [top](#)

<http://gateoverflow.in/383>



Selected Answer

Answer is B.

Apply membership test for all the given Functional Dependencies.

1.) $CD \rightarrow AC$

$CD^+ = CDEAB$

2.) $BD \rightarrow CD$

$BD^+ = BD$

i.e. BD cannot derive CD and hence is not implied.

Similarly do for rest two.

10 votes

-- Gate Keeda (17.7k points)

5.6.8 Functional Dependencies: GATE2014-1_21 [top](#)

<http://gateoverflow.in/1788>



Selected Answer

since H cannot be derived from anything else H should be there in key

using Find {EFH}+ it contains all the attributes of the relation

hence it is key

8 votes

-- Sankaranarayanan P.N (9.8k points)

5.6.9 Functional Dependencies: GATE2006-IT_60 [top](#)

<http://gateoverflow.in/3604>



Selected Answer

As we can see attr X Y do not appear in rhs of any fd they need to be part of key
Candidate keys are VXY,WXY,ZXY.

Ans is b

6 votes

-- Pooja (25.9k points)

5.6.10 Functional Dependencies: GATE2000-2.24 [top](#)

<http://gateoverflow.in/671>



Selected Answer

(b)

if $a \rightarrow b$ then for each same value of a , b should be same,
we have to get the opposite of the defn i.e if no values of a are same then b need be same

9 votes

-- Aravind (3k points)

5.7

Indexing [top](#)

5.7.1 Indexing: GATE1993_14 [top](#)

<http://gateoverflow.in/2311>

An ISAM (indexed sequential) file consists of records of size 64 bytes each, including key field of size 14 bytes. An address of a disk block takes 2 bytes. If the disk block size is 512 bytes and there are 16 K records, compute the size of the data and index areas in terms of number blocks. How many levels of tree do you have for the index?

[gate1993](#) [databases](#) [indexing](#) [normal](#)

[Answer](#)

5.7.2 Indexing: GATE2008-16, ISRO2016-60 [top](#)

<http://gateoverflow.in/414>

A clustering index is defined on the fields which are of type

- A. non-key and ordering
- B. non-key and non-ordering
- C. key and ordering
- D. key and non-ordering

[gate2008](#) [easy](#) [databases](#) [indexing](#) [isro2016](#)

[Answer](#)

5.7.3 Indexing: GATE2008-70 [top](#)

<http://gateoverflow.in/259>

Consider a file of 16384 records. Each record is 32 bytes long and its key field is of size 6 bytes. The file is ordered on a non-key field, and the file organization is unspanned. The file is stored in a file system with block size 1024 bytes, and the size of a block pointer is 10 bytes. If the secondary index is built on the key field of the file, and a multi-level index scheme is used to store the secondary index, the number of first-level and second-level blocks in the multi-level index are respectively

- A. 8 and 0
- B. 128 and 6
- C. 256 and 4
- D. 512 and 5

[gate2008](#) [databases](#) [indexing](#) [normal](#)

[Answer](#)

5.7.4 Indexing: GATE2011_39 [top](#)

<http://gateoverflow.in/2141>

Consider a relational table r with sufficient number of records, having attributes A_1, A_2, \dots, A_n and let $1 \leq p \leq n$. Two queries $Q1$ and $Q2$ are given below.

- $Q1 : \pi_{A_1, \dots, A_p} (\sigma_{A_p=c}(r))$ where c is a constant
- $Q2 : \pi_{A_1, \dots, A_p} (\sigma_{c_1 \leq A_p \leq c_2}(r))$ where c_1 and c_2 are constants.

The database can be configured to do ordered indexing on A_p or hashing on A_p . Which of the following statements is **TRUE**?

- (A) Ordered indexing will always outperform hashing for both queries
- (B) Hashing will always outperform ordered indexing for both queries
- (C) Hashing will outperform ordered indexing on $Q1$, but not on $Q2$
- (D) Hashing will outperform ordered indexing on $Q2$, but not on $Q1$

[gate2011](#) [databases](#) [indexing](#) [normal](#)

[Answer](#)

5.7.5 Indexing: GATE1998_1.35 [top](#)

<http://gateoverflow.in/1672>

There are five records in a database.

| Name | Age | Occupation | Category |
|----------|-----|------------|----------|
| Rama | 27 | CON | A |
| Abdul | 22 | ENG | A |
| Jennifer | 28 | DOC | B |
| Maya | 32 | SER | D |
| Dev | 24 | MUS | C |

There is an index file associated with this and it contains the values 1, 3, 2, 5 and 4. Which one of the fields is the index built from?

- A. Age
 B. Name
 C. Occupation
 D. Category

[gate1998](#) [databases](#) [indexing](#) [normal](#)

[Answer](#)

5.7.6 Indexing: GATE2013_15 [top](#)

<http://gateoverflow.in/1437>

An index is clustered, if

- (A) it is on a set of fields that form a candidate key.
 (B) it is on a set of fields that include the primary key.
 (C) the data records of the file are organized in the same order as the data entries of the index.
 (D) the data records of the file are organized not in the same order as the data entries of the index.

[gate2013](#) [databases](#) [indexing](#) [normal](#)

[Answer](#)

5.7.7 Indexing: GATE2015-1_24 [top](#)

<http://gateoverflow.in/8222>

A file is organized so that the ordering of the data records is the same as or close to the ordering of data entries in some index. Than that index is called

- A. Dense
- B. Sparse
- C. Clustered
- D. Unclustered

[gate2015-1](#) [databases](#) [indexing](#) [easy](#)

[Answer](#)

5.7.8 Indexing: GATE2002_2.22 [top](#)

<http://gateoverflow.in/852>

In the index allocation scheme of blocks to a file, the maximum possible size of the file depends on

- A. the size of the blocks, and the size of the address of the blocks.
- B. the number of blocks used for the index, and the size of the blocks.
- C. the size of the blocks, the number of blocks used for the index, and the size of the address of the blocks.
- D. None of the above

[gate2002](#) [databases](#) [indexing](#) [normal](#)

[Answer](#)

Answers: Indexing

5.7.1 Indexing: GATE1993_14 [top](#)

<http://gateoverflow.in/2311>



Selected Answer

Answer: 3

Size of each index entry = $14 + 2 = 16 \text{ B}$

Blocking factor of record file = $\frac{\text{Block size}}{\text{Record size}} = 512 \text{ B}/64 \text{ B} = 8$

Blocking factor of index file = $\frac{\text{Block size}}{\text{Index entry size}} = 512 \text{ B}/16 \text{ B} = 32$

No. of Blocks needed for data file = $\frac{\text{No. of Records}}{\text{Blocking factor of record file}} = 16 \text{ K}/8 = 2 \text{ K}$

No. of first level index entries = No. of Data Blocks needed for data file = 2 K

No. of first level index blocks = $\lceil \frac{\text{No. of first level index entries}}{\text{Blocking factor of index file}} \rceil = \lceil \frac{2K}{32} \rceil = 64$

No. of second level index entries = No. of first level index blocks = 64

No. of second level index blocks = $\lceil \frac{\text{No. of second level index entries}}{\text{Blocking factor of index file}} \rceil = \lceil \frac{64}{32} \rceil = 2$

No. of third level index entries = No. of second level index blocks = 2

No. of third level index blocks = $\lceil \frac{\text{No. of third level index entries}}{\text{Blocking factor of index file}} \rceil = \lceil \frac{2}{32} \rceil = 1$

7 votes

-- Rajarshi Sarkar (29.7k points)

5.7.2 Indexing: GATE2008-16, ISRO2016-60 [top](#)

<http://gateoverflow.in/414>

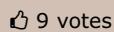


Selected Answer

There are several types of ordered indexes. A **primary index** is specified on the *ordering key field* of an **ordered file** of records. Recall from Section 17.7 that an ordering key field is used to *physically order* the file records on disk, and every record has a *unique value* for that field. If the ordering field is not a key field—that is, if numerous records in the file can have the same value for the ordering field—another type of index, called a **clustering index**, can be used. The data file is called a **clustered file** in this latter case. Notice that a file can have at most one physical ordering field, so it can have at most one primary index or one clustering index, *but not both*.

Ref -> Database Systems book BY Navathe, 6th Edition , 18.1 Types of Single-Level Ordered Indexes Page no 632

Answer should be A.



9 votes

-- Akash (31.7k points)

5.7.3 Indexing: GATE2008-70 [top](#)

<http://gateoverflow.in/259>

Selected Answer

Content of an index will be <key, block pointer> and so will have size $6 + 10 = 16$.

In the first level, there will be an entry for each record of the file. So, total size of first-level index

$$= 16384 * 16$$

No. of blocks in the first-level = Size of first-level index / block size

$$= 16384 * 16 / 1024$$

$$= 16 * 16 = 256$$

In the second-level there will be an entry for each block in the first level. So, total number of entries = 256 and total size of second-level index

$$= \text{No. of entries} * \text{size of an entry}$$

$$= 256 * 16$$

No. of blocks in second-level index = Size of second-level index / block size

$$= 256 * 16 / 1024$$

$$= 4$$



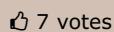
15 votes -- gatecse (10.7k points)

5.7.4 Indexing: GATE2011_39 [top](#)

<http://gateoverflow.in/2141>

Selected Answer

(c) Hashing works well on the 'equal' queries, while ordered indexing works well better on range queries too. For ex consider B+ Tree, once you have searched a key in B+ tree , you can find range of values via the block pointers pointing to another block of values on the leaf node level.



7 votes -- Prateeksha Keshari (1.7k points)

5.7.5 Indexing: GATE1998_1.35 [top](#)

<http://gateoverflow.in/1672>

Selected Answer

Indexing will be on Occupation field because Occupation field lexicographically sorted will give the sequence 1,3,2,5,4.

14 votes

-- Digvijay (35.8k points)

5.7.6 Indexing: GATE2013_15 [top](#)<http://gateoverflow.in/1437>

Ans C)

Index can be created using any column or combination of column which need not be unique. So A,B are not the ans.

Indexed column is used to sort rows of table. Whole data record of file is sorted using index so C is correct option.
<https://www.youtube.com/watch?v=NGsIt99VOCw>(Simple video explains this).

4 votes

-- prashant singh (299 points)

5.7.7 Indexing: GATE2015-1_24 [top](#)<http://gateoverflow.in/8222>

Selected Answer

Clustered- this is the definition of clustered indexing and for the same reason a table can have only one clustered index.

<http://www.ece.rutgers.edu/~yyzhang/spring03/notes/7-B+tree.ppt>

7 votes

-- Arjun Suresh (150k points)

5.7.8 Indexing: GATE2002_2.22 [top](#)<http://gateoverflow.in/852>

Selected Answer

In Index allocation size of maximum file can be derived like following :-

No of addressable blocks using one Index block (A) = Size of block / Size of block address

No of block addresses available for addressing one file (B) = No of Maximum blocks we can use for the Index * No of addressable blocks using one Index block (A)

Size of File = B * Size of Block

So it is clear that ->

Answer is (C).

A & B are incomplete.

8 votes

-- Akash (31.7k points)

5.8**Multivalued Dependency 4nf** [top](#)**5.8.1 Multivalued Dependency 4nf: GATE2007-IT_67** [top](#)<http://gateoverflow.in/3512>

Consider the following implications relating to functional and multivalued dependencies given below, which may or may not be correct.

- If $A \rightarrow\rightarrow B$ and $A \rightarrow C$ then $A \rightarrow BC$
- If $A \rightarrow B$ and $A \rightarrow C$ then $A \rightarrow\rightarrow BC$
- If $A \rightarrow BC$ and $A \rightarrow B$ then $A \rightarrow C$
- If $A \rightarrow BC$ and $A \rightarrow B$ then $A \rightarrow\rightarrow C$

Exactly how many of the above implications are valid?

(A) 0

(B) 1

(C) 2

(D) 3

[gate2007-it](#) [databases](#) [functional-dependencies](#) [multivalued-dependency-4nf](#) [normal](#)
[Answer](#)

Answers: Multivalued Dependency 4nf

5.8.1 Multivalued Dependency 4nf: GATE2007-IT_67 [top](#)



Selected Answer

- a. If $A \rightarrow\!\!\rightarrow B$ and $A \rightarrow\!\!\rightarrow C$ then $A \rightarrow BC$. So FALSE
 - b. If $A \rightarrow B$ and $A \rightarrow C$ then $A \rightarrow BC$. So $A \rightarrow\!\!\rightarrow BC$ TRUE..
 - c. If $A \rightarrow\!\!\rightarrow BC$ and $A \rightarrow B$ here B is Subset of AB and (A intersection BC) is phi so $A \rightarrow B$ but not $A \rightarrow C$ so FALSE (Coalescence rule)
 - d. If $A \rightarrow BC$ then $A \rightarrow C$ so $A \rightarrow\!\!\rightarrow C$ TRUE
- if $A \rightarrow B$ then $A \rightarrow\!\!\rightarrow B$ holds but reverse not true.

[Upvote](#) 4 votes

-- Digvijay (35.8k points)

5.9

Referential Integrity [top](#)

5.9.1 Referential Integrity: GATE1997-6.10, ISRO2016-54 [top](#)

[http://gateoverflow.in/2266](#)

Let $R(a, b, c)$ and $S(d, e, f)$ be two relations in which d is the foreign key of S that refers to the primary key of R . Consider the following four operations R and S

- I. Insert into R
- II. Insert into S
- III. Delete from R
- IV. Delete from S

Which of the following can cause violation of the referential integrity constraint above?

- A. Both I and IV
- B. Both II and III
- C. All of these
- D. None of these

[gate1997](#) [databases](#) [referential-integrity](#) [easy](#) [isro2016](#)
[Answer](#)

5.9.2 Referential Integrity: GATE2005_76 [top](#)

[http://gateoverflow.in/1399](#)

The following table has two attributes A and C where A is the primary key and C is the foreign key referencing A with on-delete cascade.

| A | C |
|---|---|
| 2 | 4 |
| 3 | 4 |
| 4 | 3 |
| | |

| | |
|---|---|
| A | C |
| 7 | 5 |
| 6 | 4 |

The set of all tuples that must be additionally deleted to preserve referential integrity when the tuple (2, 4) is deleted is:

- A. (3, 4) and (6, 4)
- B. (5, 2) and (7, 2)
- C. (5, 2), (7, 2) and (9, 5)
- D. (3, 4), (4, 3) and (6, 4)

gate2005 databases referential-integrity normal

Answer

Answers: Referential Integrity

5.9.1 Referential Integrity: GATE1997-6.10, ISRO2016-54 [top](#)

<http://gateoverflow.in/2266>

Selected Answer

| R | | |
|-----------|---|---|
| a Let(PK) | b | c |
| 1 | | |
| 2 | | |

| S | | |
|----------------------------|---|---|
| d(FK referring to PK of R) | e | f |
| 2 | | |
| 1 | | |

Insert into R cannot cause any violation.

Insert into S can cause violation if any value is inserted into d of S, which value is not in a of R.

Delete from S would cause no violation.

Delete from R would cause violation if any tuple is deleted, and as a result a value in a gets deleted which is referred to by d in S.

10 votes

-- Sourav Roy (2.7k points)

5.9.2 Referential Integrity: GATE2005_76 [top](#)

<http://gateoverflow.in/139>

Selected Answer

| |
|-----|
| (c) |
|-----|

since deleting (2,4), since 2 is a primary key, you have to delete its foreign key occurrence i.e (5,2) and (7,2)

since we are deleting 5, and 7 we have to delete its foreign key occurrence i.e (9,5)

there is no foreign key occurrence for 9

9 votes

-- Aravind (3k points)

5.10

Relational Algebra [top](#)

5.10.1 Relational Algebra: GATE2007-59 [top](#)

<http://gateoverflow.in/2428>

Information about a collection of students is given by the relation `studInfo(studId, name, sex)`. The relation `enroll(studId, courseId)` gives which student has enrolled for (or taken) what course(s). Assume that every course is taken by at least one male and at least one female student. What does the following relational algebra expression represent?

$$\pi_{courseId} ((\pi_{studId} (\sigma_{sex="female"}(studInfo)) \times \pi_{courseId} (enroll)) - enroll)$$

- A. Courses in which all the female students are enrolled.
- B. Courses in which a proper subset of female students are enrolled.
- C. Courses in which only male students are enrolled.
- D. None of the above

[gate2007](#) [databases](#) [relational-algebra](#) [normal](#)

[Answer](#)

5.10.2 Relational Algebra: GATE1994_13 [top](#)

<http://gateoverflow.in/2509>

Consider the following relational schema:

- COURSES (cno, cname)
- STUDENTS (rollno, sname, age, year)
- REGISTERED FOR (cno, rollno)

The underlined attributes indicate the primary keys for the relations. The 'year' attribute for the STUDENTS relation indicates the year in which the student is currently studying (First year, Second year etc.)

- a. Write a relational algebra query to print the roll number of students who have registered for cno 322.
- b. Write a SQL query to print the age and year of the youngest student in each year.

[gate1994](#) [databases](#) [relational-algebra](#) [sql](#) [normal](#)

[Answer](#)

5.10.3 Relational Algebra: GATE1995_27 [top](#)

<http://gateoverflow.in/2666>

Consider the relation scheme.

AUTHOR (ANAME, INSTITUTION, ACITY, AGE)
PUBLISHER (PNAME, PCITY)
BOOK (TITLE, ANAME, PNAME)

Express the following queries using (one or more of) SELECT, PROJECT, JOIN and DIVIDE operations.

- a. Get the names of all publishers.
- b. Get values of all attributes of all authors who have published a book for the publisher with PNAME='TECHNICAL PUBLISHERS'.
- c. Get the names of all authors who have published a book for any publisher located in Madras

[gate1995](#) [databases](#) [relational-algebra](#) [normal](#)

[Answer](#)

5.10.4 Relational Algebra: GATE1996_27 [top](#)

<http://gateoverflow.in/2779>

A library relational database system uses the following schema

- USERS (User#, User Name, Home Town)
- BOOKS (Book#, Book Title, Author Name)
- ISSUED (Book#, User#, Date)

Explain in one English sentence, what each of the following relational algebra queries is designed to determine

- $\sigma_{User\#=6}(\pi_{User\#, Book\ Title}((USERS \bowtie ISSUED) \bowtie BOOKS))$
- $\pi_{Author\ Name}(BOOKS \bowtie \sigma_{Home\ Town=Delhi}(USERS \bowtie ISSUED))$

gate1996 databases relational-algebra normal

Answer

5.10.5 Relational Algebra: TIFR2010-B-33 [top](#)

<http://gateoverflow.in/19246>

In a relational database there are three relations:

- Customers = C (C Name)
- Shops = S (S Name)
- Buys = B (C Name, S Name)

Then the Relational Algebra expression (Π is the projection operator).

$$C - \Pi_{CName}((C \times S) - B)$$

returns the names of

- Customers who buy from at least one shop.
- Customers who buy from at least two shops.
- Customers who buy from all shops.
- Customers who do not buy anything at all.
- None of the above.

tifr2010 databases relational-algebra

Answer

5.10.6 Relational Algebra: GATE2015-1_7 [top](#)

<http://gateoverflow.in/8094>

SELECT operation in SQL is equivalent to

- The selection operation in relational algebra
- The selection operation in relational algebra, except that SELECT in SQL retains duplicates
- The projection operation in relational algebra
- The projection operation in relational algebra, except that SELECT in SQL retains duplicates

gate2015-1 databases sql relational-algebra easy

Answer

5.10.7 Relational Algebra: TIFR2013-B-19 [top](#)

<http://gateoverflow.in/25872>

In a relational database there are three relations:

- Customers = C(CName),
- Shops = S(SName),
- Buys = B(CName, SName).

Which of the following relational algebra expressions returns the names of shops that have no customers at all? [Here Π is the projection operator.]

- $\Pi_{SName} B$
- $S - B$
- $S - \Pi_{SName} B$
- $S - \Pi_{SName} ((C \times S) - B)$
- None of the above

[tifr2013](#)
[databases](#)
[relational-algebra](#)
[Answer](#)

5.10.8 Relational Algebra: GATE1992-13b [top](#)

<http://gateoverflow.in/43581>

Suppose we have a database consisting of the following three relations:

| | |
|-----------|--------------------|
| FREQUENTS | (CUSTOMER, HOTEL) |
| SERVES | (HOTEL, SNACKS) |
| LIKES | (CUSTOMER, SNACKS) |

The first indicates the hotels each customer visits, the second tells which snacks each hotel serves and last indicates which snacks are liked by each customer. Express the following query in relational algebra:

Print the hotels the serve the snack that customer Rama likes.

[gate1992](#)
[databases](#)
[relational-algebra](#)
[normal](#)
[Answer](#)

5.10.9 Relational Algebra: GATE2001-1.25 [top](#)

<http://gateoverflow.in/718>

Let r and s be two relations over the relation schemes R and S respectively, and let A be an attribute in R . The relational algebra expression $\sigma_{A=a}(r \bowtie s)$ is always equal to

- A. $\sigma_{A=a}(r)$
- B. r
- C. $\sigma_{A=a}(r) \bowtie s$
- D. None of the above

[gate2001](#)
[databases](#)
[relational-algebra](#)
[difficult](#)
[Answer](#)

5.10.10 Relational Algebra: GATE2008-68 [top](#)

<http://gateoverflow.in/491>

Let R and S be two relations with the following schema

 $R(\underline{P}, \underline{Q}, R1, R2, R3)$
 $S(\underline{P}, \underline{Q}, S1, S2)$

where $\{\underline{P}, \underline{Q}\}$ is the key for both schemas. Which of the following queries are equivalent?

- I. $\Pi_P(R \bowtie S)$
 - II. $\Pi_P(R) \bowtie \Pi_P(S)$
 - III. $\Pi_P(\Pi_{P,Q}(R) \cap \Pi_{P,Q}(S))$
 - IV. $\Pi_P(\Pi_{P,Q}(R) - (\Pi_{P,Q}(R) - \Pi_{P,Q}(S)))$
- A. Only I and II
 - B. Only I and III
 - C. Only I, II and III
 - D. Only I, III and IV

[gate2008](#)
[databases](#)
[relational-algebra](#)
[normal](#)
[Answer](#)

5.10.11 Relational Algebra: GATE2001-1.24 [top](#)

<http://gateoverflow.in/711>

Suppose the adjacency relation of vertices in a graph is represented in a table Adj (X,Y). Which of the following queries cannot be expressed by a relational algebra expression of constant length?

- A. List all vertices adjacent to a given vertex
- B. List all vertices which have self loops
- C. List all vertices which belong to cycles of less than three vertices
- D. List all vertices reachable from a given vertex

[gate2001](#) [databases](#) [relational-algebra](#) [normal](#)

[Answer](#)

5.10.12 Relational Algebra: GATE1998_27 [top](#)

<http://gateoverflow.in/1742>

Consider the following relational database schemes:

- COURSES (Cno.name)
- PRE-REQ(Cno, pre-Cno)
- COMPLETED (student_no, Cno)

COURSES gives the number and name of all the available courses.

PRE-REQ gives the information about which courses are pre-requisites for a given course.

COMPLETED indicates what courses have been completed by students

Express the following using relational algebra:

List all the courses for which a student with student_no 2310 has completed all the pre-requisites.

[gate1998](#) [databases](#) [relational-algebra](#) [normal](#)

[Answer](#)

5.10.13 Relational Algebra: GATE2000-1.23, ISRO2016-57 [top](#)

<http://gateoverflow.in/647>

Given the relations

- employee (name, salary, dept-no), and
- department (dept-no, dept-name, address),

Which of the following queries cannot be expressed using the basic relational algebra operations ($\sigma, \pi, \times, \bowtie, \cup, \cap, -$)?

- A. Department address of every employee
- B. Employees whose name is the same as their department name
- C. The sum of all employees' salaries
- D. All employees of a given department

[gate2000](#) [databases](#) [relational-algebra](#) [easy](#) [isro2016](#)

[Answer](#)

5.10.14 Relational Algebra: GATE1992-13a [top](#)

<http://gateoverflow.in/592>

How is redundancy reduced in the following models?

1. Hierarchical
2. Network
3. Relational

[gate1992](#) [databases](#) [relational-algebra](#) [descriptive](#)

[Answer](#)

Answers: Relational Algebra

5.10.1 Relational Algebra: GATE2007-59 [top](#)

<http://gateoverflow.in/2428>



Selected Answer

Ans is b,

First it does a cross join between female students id and all course ids, then subtract the entries which are already present in enroll table.

Remaining are the courseids which are **NOT** done by **at least one** female student

10 votes

-- Anurag Semwal (5.5k points)

5.10.2 Relational Algebra: GATE1994_13 [top](#)

<http://gateoverflow.in/2509>



Selected Answer

(a) $\pi_{roll_no.}(\sigma_{cno.=322}(\text{registered for}))$

(b) SELECT year,min(age)

FROM students

GROUP BY year

in second question we hav to find year nd youngest student from that year so, we have to applied minn aggregate function on group of year

5 votes

-- SAKET NANDAN (2.2k points)

5.10.3 Relational Algebra: GATE1995_27 [top](#)

<http://gateoverflow.in/2666>

a. select pname

from publisher;

2. select author.*

from author, book

where author.aname = book.name and book.pname = 'TECHNICAL PUBLISHERS';

3. select author.aname

from author, book, publisher

where author.aname = book.aname and book.pname = publisher.pname and publisher.pcity='Madras';

6 votes

-- Manu Thakur (5.6k points)

5.10.4 Relational Algebra: GATE1996_27 [top](#)<http://gateoverflow.in/2779>

Selected Answer

- (a) Select the (user# and) titles of the books issued to User# 6
 (b) Select author names of the books issued to users whose home town is Delhi

11 votes

-- Arjun Suresh (150k points)

5.10.5 Relational Algebra: TIFR2010-B-33 [top](#)<http://gateoverflow.in/19246>

Selected Answer

It is division in relational algebra
 Division = >
 $\Pi_{AB}(R)/\Pi_B(S)$ Results in 'A' values for which here should be 'B' in R for every 'B' of S.

$\Pi_{AB}(R)/\Pi_B(S) = \Pi_A(R) - \Pi_A(\Pi_A(R) \times S - R)$ Retrieve all A's who are related to every B

$C - \Pi_{CName}((C \times S) - B)$

$C \times S$ gives the complete relation of each customer to every shop

$(C \times S) - B$: gives the relation of the customer which is not related to every shop.

$\Pi_{CName}((C \times S) - B)$: gives the customer name who is not related to every shop.

$C - \Pi_{CName}((C \times S) - B)$: gives the customer who is related to every shop.

Option C) Customers who buy from all shops.

6 votes

-- Umang Raman (11.3k points)

5.10.6 Relational Algebra: GATE2015-1_7 [top](#)<http://gateoverflow.in/8094>

Selected Answer

option D is correct because SELECT operation in SQL is equivalent to The projection operation in relational algebra, except that SELECT in SQL retains duplicates but projection gives only distinct

13 votes

-- Anoop Sonkar (4.5k points)

5.10.7 Relational Algebra: TIFR2013-B-19 [top](#)<http://gateoverflow.in/25872>

Selected Answer

Answer will be (c)

It subtract shopnames to those shop which sells something

So as a result we are getting shops which have no customer

5 votes

-- srestha (27.8k points)

5.10.8 Relational Algebra: GATE1992-13b top<http://gateoverflow.in/43581>

$\Pi_{\text{Hotel}}(\sigma_{\text{customer} = \text{"RAMA"}}(\text{LIKES} (\text{Natural Join}) \text{Serves}))$

1 2 votes

-- Archies09 (327 points)

5.10.9 Relational Algebra: GATE2001-1.25 top<http://gateoverflow.in/718>

Selected Answer

ans is C.

C is just the better form of query, more execution friendly because requires less memory while joining. query, given in question takes more time and memory while joining.

1 6 votes

-- jayendra (6.6k points)

5.10.10 Relational Algebra: GATE2008-68 top<http://gateoverflow.in/491>

Selected Answer

(d) i, iii, iv

iv) is expansion for natural join represented with other operators.

Why ii is not equivalent? Consider the following instances of R and S

$R : \{\langle "1", "abc", "p1", "p2", "p3" \rangle, \langle "2", "xyz", "p1", "p2", "p3" \rangle\}$

$S : \{\langle "1", "abc", "q1", "q2", "q3" \rangle, \langle "2", "def", "q1", "q2", "q3" \rangle\}$

Now, consider the given queries:

i. $R \bowtie S$ gives

$\{\langle "1", "abc", "p1", "p2", "p3", "q1", "q2", "q3" \rangle\}$

Projecting P gives $\{\langle "1" \rangle\}$

ii. $\pi_P(R) \bowtie \pi_P(S)$ gives

$\{\langle "1" \rangle \langle "2" \rangle\} \bowtie \{\langle "1" \rangle \langle "2" \rangle\}$

$= \{\langle "1", "2" \rangle\}$

iii. $\Pi_P(\Pi_{P,Q}(R) \cap \Pi_{P,Q}(S))$ gives

$\{\langle "1", "abc" \rangle, \langle "2", "xyz" \rangle\} \cap \{\langle "1", "abc" \rangle, \langle "2", "def" \rangle\} = \{\langle "1", "abc" \rangle\}$

Projecting P gives $\{\langle "1" \rangle\}$

iv. $\Pi_P(\Pi_{P,Q}(R) - (\Pi_{P,Q}(R) - \Pi_{P,Q}(S)))$ gives

$\{\langle "1", "abc" \rangle, \langle "2", "xyz" \rangle\} - (\{\langle "1", "abc" \rangle, \langle "2", "xyz" \rangle\} - \{\langle "1", "abc" \rangle, \langle "2", "def" \rangle\})$

$= \{\langle "1", "abc" \rangle, \langle "2", "xyz" \rangle\} - \{\langle "2", "xyz" \rangle\} = \{\langle "1", "abc" \rangle\}$

Projecting P gives $\{\langle "1" \rangle\}$

1 16 votes

-- Aravind (3k points)

5.10.11 Relational Algebra: GATE2001-1.24 [top](#)

<http://gateoverflow.in/711>



Selected Answer

Answer :- D

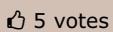
(A) :-> This is simple select query query.

(B) -> This is simple query we need to check $X=Y$ in where clause.

(C) :-> Cycle < 3 . Means cycle of length 1 & 2. Cycle of length 1 is easy., Same as self loop. Cycle of length 2 is also not too hard to compute. Though it'll be little complex, will need to do like (X,Y) & (Y, X) both present & $X \neq Y$. We can do this with constant RA query.

(D) :-> This is most hard part. Here we need to find closure of vertices. This will need kind of loop. If the graph is like skewed tree, our query must loop for $O(N)$ Times. We can't do with constant length query here.

Answer :-> D



5 votes

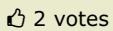
-- Akash (31.7k points)

5.10.12 Relational Algebra: GATE1998_27 [top](#)

<http://gateoverflow.in/1742>

SQL query will be

```
SELECT cno
FROM Completed, Pre-Req
WHERE student_no = '2310'
GROUP BY cno
HAVING pre-Cno IN (
    SELECT C.cno
    FROM Completed AS C
    WHERE C.student_no = '2310';
)
```



2 votes

-- Amar Vashishth (20.7k points)

5.10.13 Relational Algebra: GATE2000-1.23, ISRO2016-57 [top](#)

<http://gateoverflow.in/647>



Selected Answer

possible solutions , relational algebra

(a) join relation using attribute dpart_no.

$\Pi_{address}(\text{emp} \bowtie \text{depart})$

or

$\Pi_{address}(\sigma_{\text{emp.dpart_no.}=\text{depart.dpart_no.}}(\text{emp} \times \text{depart}))$

(b) $\Pi_{name}(\sigma_{\text{emp.dpart_no.}=\text{depart.dpart_no.} \wedge \text{emp.name} = \text{depart.dpart_name}}(\text{emp} \times \text{depart}))$

or

$\Pi_{name}(\text{emp} \bowtie_{\text{emp.name} = \text{depart.dpart_name}} \text{depart})$

(d) Let given department number is = 'x'

$\Pi_{name}(\sigma_{\text{emp.dpart_no.}=\text{depart.dpart_no.} \wedge \text{depart.no.} = 'x'}(\text{emp} \times \text{depart}))$

or

$\Pi_{name}(\text{emp} \bowtie_{\text{depart.no.}='x'} \text{depart})$

(c) but we can't generate relational algebra of aggregate function using basic operation , so we need extended operation here , option (c) is false .

8 votes

-- Mithlesh Upadhyay (3.6k points)

5.10.14 Relational Algebra: GATE1992-13a [top](#)

<http://gateoverflow.in/592>

13(b)

Select s.hotel

From serves s,likes l

Where s.snacks =l.snacks

And l.customer = "Rama"

1 votes

-- ravineesh (55 points)

5.11

Relational Calculus [top](#)

5.11.1 Relational Calculus: GATE2003_30 [top](#)

<http://gateoverflow.in/920>

Consider the following SQL query

```
Select distinct a1, a2, ..., an
from r1, r2, ..., rm
where P
```

For an arbitrary predicate P, this query is equivalent to which of the following relational algebra expressions?

- A. $\Pi_{a_1, a_2, \dots, a_n} \sigma_p (r_1 \times r_2 \times \dots \times r_m)$
- B. $\Pi_{a_1, a_2, \dots, a_n} \sigma_p (r_1 \bowtie r_2 \bowtie \dots \bowtie r_m)$
- C. $\Pi_{a_1, a_2, \dots, a_n} \sigma_p (r_1 \cup r_2 \cup \dots \cup r_m)$
- D. $\Pi_{a_1, a_2, \dots, a_n} \sigma_p (r_1 \cap r_2 \cap \dots \cap r_m)$

[gate2003](#) [databases](#) [relational-calculus](#) [normal](#)

Answer

5.11.2 Relational Calculus: GATE2005-IT_68 [top](#)

<http://gateoverflow.in/3831>

A table 'student' with schema (roll, name, hostel, marks), and another table 'hobby' with schema (roll, hobbyname) contains records as shown below:

Table: Student

| Roll | Name | Hostel | Marks |
|------|-----------------|--------|-------|
| 1798 | Manoj Rathod | 7 | 95 |
| 2154 | Soumic Banerjee | 5 | 68 |
| 2369 | Gumma Reddy | 7 | 86 |
| 2581 | Pradeep Pendse | 6 | 92 |
| 2643 | Suhas Kulkarni | 5 | 78 |

| Roll | Name | Hostel | Marks |
|------|------------------|--------|-------|
| 2926 | Nitin Kadam | 5 | 94 |
| 2959 | Manoj Kunkalikar | 7 | 88 |
| 3125 | Hemant Karkhanis | 5 | 82 |

Table: hobby

| Roll | Hobbyname |
|------|-------------|
| 1798 | chess |
| 1798 | music |
| 2154 | music |
| 2369 | swimming |
| 2581 | cricket |
| 2643 | chess |
| 2643 | hockey |
| 2711 | volleyball |
| 2872 | football |
| 2926 | cricket |
| 2959 | photography |
| 3125 | music |
| 3125 | chess |

The following SQL query is executed on the above tables:

```
select hostel
from student natural join hobby
where marks >= 75 and roll between 2000 and 3000;
```

Relations S and H with the same schema as those of these two tables respectively contain the same information as tuples. A new relation S' is obtained by the following relational algebra operation:

$$S' = \Pi_{\text{hostel}} ((\sigma_{S.\text{roll} = H.\text{roll}} (\sigma_{\text{marks} > 75} \text{ and } \text{roll} > 2000 \text{ and } \text{roll} < 3000) (S)) \times (H))$$

The difference between the number of rows output by the SQL statement and the number of tuples in S' is

- | | |
|----|---|
| A) | 6 |
| B) | 4 |
| C) | 2 |
| D) | 0 |

gate2005-it databases sql relational-calculus normal

Answer

5.11.3 Relational Calculus: GATE2006-IT_15 [top](#)

<http://gateoverflow.in/3554>

Which of the following relational query languages have the same expressive power?

- I. Relational algebra
- II. Tuple relational calculus restricted to safe expressions
- III. Domain relational calculus restricted to safe expressions

- A) II and III only
- B) I and II only
- C) I and III only
- D) I, II and III

gate2006-it databases relational-algebra relational-calculus easy

Answer

5.11.4 Relational Calculus: GATE2006-IT_14 [top](#)

<http://gateoverflow.in/3553>

Consider the relations $r_1(P, Q, R)$ and $r_2(R, S, T)$ with primary keys P and R respectively. The relation r_1 contains 2000 tuples and r_2 contains 2500 tuples. The maximum size of the join $r_1 \bowtie r_2$ is :

- A) 2000
- B) 2500
- C) 4500
- D) 5000

[gate2006-it](#) [databases](#) [relational-calculus](#) [normal](#)

[Answer](#)

5.11.5 Relational Calculus: GATE2009-45 [top](#)

<http://gateoverflow.in/1331>

Let R and S be relational schemes such that $R=\{a,b,c\}$ and $S=\{c\}$. Now consider the following queries on the database:

1. $\pi_{R-S}(r) - \pi_{R-S}(\pi_{R-S}(r) \times s - \pi_{R-S,S}(r))$
2. $\{t \mid t \in \pi_{R-S}(r) \wedge \forall u \in s (\exists v \in r (u = v[S] \wedge t = v[R - S]))\}$
3. $\{t \mid t \in \pi_{R-S}(r) \wedge \forall v \in r (\exists u \in s (u = v[S] \wedge t = v[R - S]))\}$
- 4.

```
Select R.a,R.b
  From R,S
 Where R.c = S.c
```

Which of the above queries are equivalent?

- A. 1 and 2
- B. 1 and 3
- C. 2 and 4
- D. 3 and 4

[gate2009](#) [databases](#) [relational-calculus](#) [difficult](#)

[Answer](#)

5.11.6 Relational Calculus: GATE1999_1.19 [top](#)

<http://gateoverflow.in/1472>

The relational algebra expression equivalent to the following tuple calculus expression:

$\{t \mid t \in r \wedge (t[A] = 10 \wedge t[B] = 20)\}$ is

- A. $\sigma_{(A=10 \vee B=20)}(r)$
- B. $\sigma_{(A=10)}(r) \cup \sigma_{(B=20)}(r)$
- C. $\sigma_{(A=10)}(r) \cap \sigma_{(B=20)}(r)$
- D. $\sigma_{(A=10)}(r) - \sigma_{(B=20)}(r)$

[gate1999](#) [databases](#) [relational-calculus](#) [normal](#)

[Answer](#)

5.11.7 Relational Calculus: GATE2005_30 [top](#)

<http://gateoverflow.in/1366>

Let r be a relation instance with schema $R = (A, B, C, D)$. We define $r_1 = \pi_{A,B,C}(R)$ and $r_2 = \pi_{A,D}(r)$. Let $s = r_1 * r_2$ where $*$ denotes natural join. Given that the decomposition of r into r_1 and r_2 is lossy, which one of the following is TRUE?

- A. $s \subset r$
- B. $r \cup s = r$
- C. $r \subset s$
- D. $r^*s = s$

[gate2005](#) [databases](#) [relational-calculus](#) [normal](#)

[Answer](#)

5.11.8 Relational Calculus: GATE2007-IT-68 [top](#)

<http://gateoverflow.in/3513>

Consider the following relation schemas :

- b-Schema = (b-name, b-city, assets)
- a-Schema = (a-num, b-name, bal)
- d-Schema = (c-name, a-number)

Let branch, account and depositor be respectively instances of the above schemas. Assume that account and depositor relations are much bigger than the branch relation.

Consider the following query:

$\Pi_{c\text{-name}} (\sigma_{b\text{-city} = "Agra"} \wedge \text{bal} < 0) (\text{branch} \bowtie (\text{account} \bowtie \text{depositor}))$

Which one of the following queries is the most efficient version of the above query ?

- A. $\Pi_{c\text{-name}} (\sigma_{\text{bal} < 0} (\sigma_{b\text{-city} = "Agra"} \text{branch} \bowtie \text{account}) \bowtie \text{depositor})$
- B. $\Pi_{c\text{-name}} (\sigma_{b\text{-city} = "Agra"} \text{branch} \bowtie (\sigma_{\text{bal} < 0} \text{account} \bowtie \text{depositor}))$
- C. $\Pi_{c\text{-name}} ((\sigma_{b\text{-city} = "Agra"} \text{branch} \bowtie \sigma_{b\text{-city} = "Agra"} \wedge \text{bal} < 0 \text{account}) \bowtie \text{depositor})$
- D. $\Pi_{c\text{-name}} (\sigma_{b\text{-city} = "Agra"} \text{branch} \bowtie (\sigma_{b\text{-city} = "Agra"} \wedge \text{bal} < 0 \text{account} \bowtie \text{depositor}))$

[gate2007-it](#) [databases](#) [relational-calculus](#) [normal](#)

[Answer](#)

5.11.9 Relational Calculus: GATE2004_13 [top](#)

<http://gateoverflow.in/1010>

Let $R_1(\underline{A}, B, C)$ and $R_2(\underline{D}, E)$ be two relation schema, where the primary keys are shown underlined, and let C be a foreign key in R_1 referring to R_2 . Suppose there is no violation of the above referential integrity constraint in the corresponding relation instances r_1 and r_2 . Which of the following relational algebra expressions would necessarily produce an empty relation?

- A. $\Pi_D(r_2) - \Pi_C(r_1)$
- B. $\Pi_C(r_1) - \Pi_D(r_2)$
- C. $\Pi_D(r_1 \bowtie_{C \neq D} r_2)$
- D. $\Pi_C(r_1 \bowtie_{C=D} r_2)$

[gate2004](#) [databases](#) [relational-calculus](#) [easy](#)

[Answer](#)

5.11.10 Relational Calculus: GATE2002_15 [top](#)

<http://gateoverflow.in/868>

A university placement center maintains a relational database of companies that interview students on campus and make job offers to those successful in the interview. The schema of the database is given below:

```
COMPANY(cname, clocation) STUDENT (srollno, sname,
                                     sdegree)
INTERVIEW (cname, srollno) OFFER(cname, srollno, osalary
                                 odate)
```

The COMPANY relation gives the name and location of the company. The STUDENT relation gives the student's roll number, name and the degree program for which the student is registered in the university. The INTERVIEW relation gives the date on which a student is interviewed by a company. The OFFER relation gives the salary offered to a student who is successful in a company's interview. The key for each relation is indicated by the underlined attributes

(a) Write a **relational algebra** expressions (using only the operator $\sigma, \pi, \cup, -$) for the following queries.

- List the rollnumbers and names of students who attended at least one interview but did not receive *any* job offer.
 - List the rollnumbers and names of students who went for interviews and received job offers from *every* company with which they interviewed.
- b. Write an SQL query to list, for each degree program in which more than five students were offered jobs, the name of the degree and the average offered salary of students in this degree program.

[gate2002](#) [databases](#) [relational-calculus](#) [normal](#)

[Answer](#)

5.11.11 Relational Calculus: GATE2002_1.20 [top](#)

<http://gateoverflow.in/825>

With regards to the expressive power of the formal relational query languages, which of the following statements is true?

- A. Relational algebra is more powerful than relational calculus
- B. Relational algebra has the same power as relational calculus
- C. Relational algebra has the same power as safe relational calculus
- D. None of the above

[gate2002](#) [databases](#) [relational-calculus](#) [normal](#)

[Answer](#)

5.11.12 Relational Calculus: GATE2007-IT_65 [top](#)

<http://gateoverflow.in/3510>

Consider a selection of the form $\sigma_{A \leq 100}(r)$, where r is a relation with 1000 tuples. Assume that the attribute values for A among the tuples are uniformly distributed in the interval [0, 500]. Which one of the following options is the best estimate of the number of tuples returned by the given selection query ?

- | | |
|----|-----|
| 1) | 50 |
| 2) | 100 |
| 3) | 150 |
| 4) | 200 |

[gate2007-it](#) [databases](#) [relational-calculus](#) [normal](#)

[Answer](#)

5.11.13 Relational Calculus: GATE2007_60 [top](#)

<http://gateoverflow.in/1258>

Consider the relation **employee**(name, sex, supervisorName) with *name* as the key, *supervisorName* gives the name of the supervisor of the employee under consideration. What does the following Tuple Relational Calculus query produce?

$\{e.name \mid employee(e) \wedge (\forall x)[\neg employee(x) \vee x.supervisorName \neq e.name \vee x.sex = "male"]\}$

- A. Names of employees with a male supervisor.
- B. Names of employees with no immediate male subordinates.
- C. Names of employees with no immediate female subordinates.
- D. Names of employees with a female supervisor.

gate2007 databases relational-calculus normal

Answer

5.11.14 Relational Calculus: GATE2004_14 [top](#)

<http://gateoverflow.in/1011>

Consider the following relation schema pertaining to a students database:

- Students(rollno, name, address)
- Enroll(rollno, courseno, coursename)

where the primary keys are shown underlined. The number of tuples in the student and Enroll tables are 120 and 8 respectively. What are the maximum and minimum number of tuples that can be present in (Student * Enroll), where '*' denotes natural join?

- A. 8, 8
- B. 120, 8
- C. 960, 8
- D. 960, 120

gate2004 databases relational-calculus easy

Answer

5.11.15 Relational Calculus: GATE2008-IT_75 [top](#)

<http://gateoverflow.in/3389>

Student (school-id, sch-roll-no, sname, saddress)
 School (school-id, sch-name, sch-address, sch-phone)
 Enrolment(school-id sch-roll-no, erollno, examname)
 ExamResult(erollno, examname, marks)

Consider the following tuple relational calculus query.

$\{t \mid \exists E \in \text{Enrolment} \ t = E.\text{school-id} \wedge$
 $\quad | \{x \mid x \in \text{Enrolment} \wedge x.\text{school-id} = t \wedge$
 $\quad \quad (\exists B \in \text{ExamResult} \ B.erollno = x.erollno \wedge B.\text{examname} = x.\text{examname} \wedge B.\text{marks} > 35)\} | /$
 $\quad | \{x \mid x \in \text{Enrolment} \wedge x.\text{school-id} = t\} | * 100 > 35\}$

If a student needs to score more than 35 marks to pass an exam, what does the query return?

- A) The empty set
- B) schools with more than 35% of its students enrolled in some exam or the other
- C) schools with a pass percentage above 35% over all exams taken together
- D) schools with a pass percentage above 35% over each exam

gate2008-it databases relational-calculus normal

Answer

5.11.16 Relational Calculus: GATE2004_51 [top](#)

<http://gateoverflow.in/1047>

Consider the relation Student (name, sex, marks), where the primary key is shown underlined, pertaining to students in a class that has at least one boy and one girl. What does the following relational algebra expression produce? (Note: ρ is the

rename operator).

$$\pi_{\text{name}} \left[\sigma_{\text{sex} = \text{Female}} (\text{student}) \right] = \pi_{\text{name}} \left[\text{student} \begin{array}{c} M \\ \text{sex} = \text{Female} \\ \wedge \\ \text{sex} = \text{Male} \\ \wedge \\ \text{marks} \leq m \end{array} \sigma_{\text{marks} \leq m} (\text{student}) \right]$$

- a) names of girl students with the highest marks
- b) names of girl students with more marks than some boy student
- c) names of girl students with marks not less than some boy students
- d) names of girl students with more marks than all the boy students

[gate2004](#) [databases](#) [relational-calculus](#) [normal](#)

Answer

5.11.17 Relational Calculus: GATE2001-2.24 [top](#)

<http://gateoverflow.in/742>

Which of the relational calculus expression is not safe?

- A. $\{t \mid \exists u \in R_1 (t[A] = u[A]) \wedge \neg \exists s \in R_2 (t[A] = s[A])\}$
- B. $\{t \mid \forall u \in R_1 (u[A] = "x") \Rightarrow \exists s \in R_2 (t[A] = s[A] \wedge s[A] = u[A])\}$
- C. $\{t \mid \neg(t \in R_1)\}$
- D. $\{t \mid \exists u \in R_1 (t[A] = u[A]) \wedge \exists s \in R_2 (t[A] = s[A])\}$

[gate2001](#) [relational-calculus](#) [normal](#) [databases](#)

Answer

5.11.18 Relational Calculus: GATE2014-3_21 [top](#)

<http://gateoverflow.in/2055>

What is the optimized version of the relation algebra expression

$\pi_{A1}(\pi_{A2}(\sigma_{F1}(\sigma_{F2}(r))))$, where

$A1, A2$ are sets of attributes in

r with

$A1 \subset A2$ and

$F1, F2$ are Boolean expressions based on the attributes in r ?

- (A) $\pi_{A1}(\sigma_{(F1 \wedge F2)}(r))$
- (B) $\pi_{A1}(\sigma_{(F1 \vee F2)}(r))$
- (C) $\pi_{A2}(\sigma_{(F1 \wedge F2)}(r))$
- (D) $\pi_{A2}(\sigma_{(F1 \vee F2)}(r))$

[gate2014-3](#) [databases](#) [relational-calculus](#) [easy](#)

Answer

5.11.19 Relational Calculus: GATE2014-3_30 [top](#)

<http://gateoverflow.in/2064>

Consider the relational schema given below, where **eId** of the relation **dependent** is a foreign key referring to **empId** of the relation **employee**. Assume that every employee has at least one associated dependent in the **dependent** relation.

employee (empId, empName, empAge)
dependent(depId, eId, depName, depAge)

Consider the following relational algebra query:

$$\Pi_{empId} (employee) - \Pi_{empId} (employee \bowtie_{(empId=eID) \wedge (empAge \leq depAge)} dependent)$$

The above query evaluates to the set of **empIds** of employees whose age is greater than that of

- (A) some dependents.
- (B) all dependents.
- (C) some of his/her dependents.
- (D) all of his/her dependents.

[gate2014-3](#) [databases](#) [relational-calculus](#) [normal](#)

Answer

5.11.20 Relational Calculus: GATE2013_35 [top](#)

<http://gateoverflow.in/1546>

Consider the following relational schema.

- Students(rollno: integer, sname: string)
- Courses(courseno: integer, cname: string)
- Registration(rollno: integer, courseno: integer, percent: real)

Which of the following queries are equivalent to this query in English?

"Find the distinct names of all students who score more than 90% in the course numbered 107"

(I)

```
SELECT DISTINCT S.sname
FROM Students as S, Registration as R
WHERE R.rollno=S.rollno AND R.courseno=107 AND R.percent >90
```

(II) $\prod_{sname} (\sigma_{courseno=107 \wedge percent>90} (Registration \bowtie Students))$

(III) $\{T \mid \exists S \in Students, \exists R \in Registration (S.rollno = R.rollno \wedge R.courseno = 107 \wedge R.percent > 90 \wedge T.sname = S.sname)\}$

(IV) $\{\langle S_N \rangle \mid \exists S_R \exists R_P (\langle S_R, S_N \rangle \in Students \wedge \langle S_R, 107, R_P \rangle \in Registration \wedge R_P > 90)\}$

(A) I, II, III and IV

(B) I, II and III only

(C) I, II and IV only

(D) II, III and IV only

[gate2013](#) [databases](#) [sql](#) [relational-calculus](#) [normal](#)

Answer

5.11.21 Relational Calculus: GATE2008-15 [top](#)

<http://gateoverflow.in/413>

Which of the following tuple relational calculus expression(s) is/are equivalent to $\forall t \in r (P(t))$?

- I. $\neg \exists t \in r (P(t))$
- II. $\exists t \notin r (P(t))$
- III. $\neg \exists t \in r (\neg P(t))$
- IV. $\exists t \notin r (\neg P(t))$
 - A. I only
 - B. II only
 - C. III only
 - D. III and IV only

[gate2008](#) [databases](#) [relational-calculus](#) [normal](#)
[Answer](#)

5.11.22 Relational Calculus: GATE2012_43 [top](#)

<http://gateoverflow.in/2151>

Suppose $R_1(\underline{A}, B)$ and $R_2(C, D)$ are two relation schemas. Let r_1 and r_2 be the corresponding relation instances. B is a foreign key that refers to C in R_2 . If data in r_1 and r_2 satisfy referential integrity constraints, which of the following is **ALWAYS TRUE?**

- (A) $\prod_B(r_1) - \prod_C(r_2) = \emptyset$
- (B) $\prod_C(r_2) - \prod_B(r_1) = \emptyset$
- (C) $\prod_B(r_1) = \prod_C(r_2)$
- (D) $\prod_B(r_1) - \prod_C(r_2) \neq \emptyset$

[gate2012](#) [databases](#) [relational-calculus](#) [normal](#)
[Answer](#)

5.11.23 Relational Calculus: GATE1998_2.19 [top](#)

<http://gateoverflow.in/1692>

Which of the following query transformations (i.e., replacing the l.h.s. expression by the r.h.s expression) is incorrect? R_1 and R_2 are relations, C_1 and C_2 are selection conditions and A_1 and A_2 are attributes of R_1 .

- A. $\sigma_{C_1}(\sigma_{C_2}(R_1)) \rightarrow \sigma_{C_1}(\sigma_{C_1}(R_1))$
- B. $\sigma_{C_1}(\pi_{A_1}(R_1)) \rightarrow \pi_{A_1}(\sigma_{C_1}(R_1))$
- C. $\sigma_{C_1}(R_1 \cup R_2) \rightarrow \sigma_{C_1}(R_1) \cup \sigma_{C_1}(R_2)$
- D. $\pi_{A_1}(\sigma_{C_1}(R_1)) \rightarrow \sigma_{C_1}(\pi_{A_1}(R_1))$

[gate1998](#) [databases](#) [relational-calculus](#) [normal](#)
[Answer](#)

5.11.24 Relational Calculus: GATE2012-50 [top](#)

<http://gateoverflow.in/2180>

Consider the following relations A, B and C:

| A | | |
|-----------|-------------|------------|
| Id | Name | Age |
| 12 | Arun | 60 |
| 15 | Shreya | 24 |
| 99 | Rohit | 11 |

| B | | |
|-----------|-------------|------------|
| Id | Name | Age |
| 15 | Shreya | 24 |
| 25 | Hari | 40 |

| | | |
|----|-------|----|
| 98 | Rohit | 20 |
| 99 | Rohit | 11 |

| C | | |
|-----------|--------------|-------------|
| Id | Phone | Area |
| 10 | 2200 | 02 |
| 99 | 2100 | 01 |

How many tuples does the result of the following relational algebra expression contain? Assume that the schema of $A \cup B$ is the same as that of A .

$$(A \cup B) \bowtie_{A.Id > 40 \vee C.Id < 15} C$$

- A. 7
- B. 4
- C. 5
- D. 9

gate2012 databases sql relational-calculus normal

Answer

5.11.25 Relational Calculus: GATE1993_23,24 [top](#)

<http://gateoverflow.in/2320>

For questions 1 and 2:

The following relations are used to store data about students, courses, enrollment of students in courses and teachers of courses. Attributes for primary key in each relation are marked by '*'.

```
Students (rollno*, sname, saddr)
courses (cno*, cname)
enroll(rollno*, cno*, grade)
teach(tno*, tname, cao*)
```

(cno is course number cname is course name, tno is teacher number, tname is teacher name, sname is student name, etc.)

1. Write a SQL query for retrieving roll number and name of students who got A grade in at least one course taught by teacher names Ramesh for the above relational database.
2. For the relational database given above, the following functional dependencies hold:

$\text{rollno} \rightarrow \text{sname}, \text{saddr}$ $\text{cno} \rightarrow \text{cname}$

$\text{tno} \rightarrow \text{tname}$ $\text{rollno}, \text{cno} \rightarrow \text{grade}$

- a. Is the database in 3rd normal form (3NF)?
- b. If yes, prove that it is in 3 NF. If not normalize, the relations so that they are in 3NF (without proving)?

gate1993 databases sql relational-calculus normal

Answer

5.11.26 Relational Calculus: GATE2012-51 [top](#)<http://gateoverflow.in/43313>

Consider the following relations A, B and C:

| A | | |
|-----------|-------------|------------|
| Id | Name | Age |
| 12 | Arun | 60 |
| 15 | Shreya | 24 |
| 99 | Rohit | 11 |
| | | |
| | | |

| B | | |
|-----------|-------------|------------|
| Id | Name | Age |
| 15 | Shreya | 24 |
| 25 | Hari | 40 |
| 98 | Rohit | 20 |
| 99 | Rohit | 11 |
| | | |
| | | |

| C | | |
|-----------|--------------|-------------|
| Id | Phone | Area |
| 10 | 2200 | 02 |
| 99 | 2100 | 01 |

How many tuples does the result of the following SQL query contain?

```
SELECT A.Id
FROM A
WHERE A.Age > ALL (SELECT B.Age
                     FROM B
                     WHERE B.Name = 'Arun')
```

- A. 4
- B. 3
- C. 0
- D. 1

[gate2012](#) [databases](#) [sql](#) [relational-calculus](#) [normal](#)
Answer

Answers: Relational Calculus

5.11.1 Relational Calculus: GATE2003_30 [top](#)

<http://gateoverflow.in/920>


Selected Answer

select distinct in SQL is equivalent to project and by default relation 1, relation 2 in SQL corresponds to cross-product. So, option A.

thumb-up 8 votes

-- Arjun Suresh (150k points)

5.11.2 Relational Calculus: GATE2005-IT_68 [top](#)

<http://gateoverflow.in/3831>


Selected Answer

Sql query will return

| Roll | Hostel |
|------|--|
| 2369 | 7 |
| 2581 | 6 |
| 2643 | 5 |
| 2643 | 5 Duplicate Row is present in Hobby table |
| 2872 | 5 |
| 2926 | 5 |
| 2959 | 7 |

Total 7 rows are selected.

In RA only distinct values of hostels are selected i.e. 5,6,7

SQL row count - RA row count = 7 - 3 = 4

Answer is **B**

thumb-up 12 votes

-- Vikrant Singh (11k points)

5.11.3 Relational Calculus: GATE2006-IT_15 [top](#)

<http://gateoverflow.in/3554>


Selected Answer

Answer: D

All are equivalent in expressive power.

thumb-up 5 votes

-- Rajarshi Sarkar (29.7k points)

5.11.4 Relational Calculus: GATE2006-IT_14 [top](#)

<http://gateoverflow.in/3553>



Selected Answer

the common attribute is R and it is primary key in the second relation. hence the R value is distinct for 2500 rows. hence when we join max possible number of tuples is 2000

option A

8 votes

-- Sankaranarayanan P.N (9.8k points)

5.11.5 Relational Calculus: GATE2009-45 [top](#)

<http://gateoverflow.in/1331>



Selected Answer

$$1. \pi_{R-S}(r) = \pi_{R-S}(\pi_{R-S}(r) \times s - \pi_{R-S,S}(r))$$

$$= \pi_{a,b}(r) - \pi_{a,b}(\pi_{a,b}(r) \times s - \pi_R(r)) \\ = (r/s)$$

2. Expanding logically the statement means to select t (a,b) from r such that for all tuples u in s, there is a tuple v in r, such that u = v[S] and t = v[R-S]. This is just equivalent to

(r) / (s)

3. Expanding logically the statement means that select t (a,b) from r such that for all tuples v in r, there is a tuple u in s, such that u = v[S] and t = v[R-S]. This is equivalent to saying to select (a,b) values from r, where the c value is in some type of s.

4. This selects (a,b) from all tuples from r which has an equivalent c value in s.

So, 1 and 2 are equivalent

| r | | |
|------|----|----|
| a | b | c |
| Arj | TY | 12 |
| Arj | TY | 14 |
| Cell | TR | 13 |
| Tom | TW | 12 |
| Ben | TE | 14 |

| s | |
|----|--|
| c | |
| 12 | |
| 14 | |

1. will give <Arj, TY>
2. will give <Arj, TY>
3. will not return any tuple as the c value 13, is not in s.
4. will give <Arj, TY>, <Arj, TY>, Tom, TW>, <Ben, TE>

<http://pages.cs.wisc.edu/~dbbook/openAccess/firstEdition/slides/pdfsides/mod3l1.pdf>

12 votes

-- Arjun Suresh (150k points)

5.11.6 Relational Calculus: GATE1999_1.19 [top](#)

<http://gateoverflow.in/1472>



Selected Answer

Answer: C

Tuple t should have two attributes A and B such that $t.A = 10$ and $t.B = 20$.

So, $(\text{Tuples having } A = 10) \cap (\text{Tuples having } B = 20) = (\text{Tuples having } A = 10 \text{ and } B = 20)$.

5 votes

-- Rajarshi Sarkar (29.7k points)

5.11.7 Relational Calculus: GATE2005_30 [top](#)

<http://gateoverflow.in/1366>



Selected Answer

Answer is C. $r \subset s$

| | | R | | |
|---|---|---|---|--|
| A | B | C | D | |
| 1 | 2 | 3 | 3 | |
| 1 | 5 | 3 | 4 | |

| | | R1 | | |
|---|---|----|---|--|
| A | B | C | D | |
| 1 | 2 | 3 | | |
| 1 | 5 | 3 | | |
| | | R2 | | |
| A | D | | | |
| 1 | | 3 | | |
| 1 | | 4 | | |

$S = R1 * R2$

| A | B | C | D |
|---|---|---|---|
| 1 | 2 | 3 | 3 |
| 1 | 5 | 3 | 3 |
| 1 | 5 | 3 | 4 |
| 1 | 5 | 3 | 4 |

Red color rows of S are present in R so $R \subset S$

and one more result $R * S = R$.

10 votes

-- Vikrant Singh (11k points)

5.11.8 Relational Calculus: GATE2007-IT-68 [top](#)

<http://gateoverflow.in/3513>



Selected Answer

It should be A. As in B we are doing a join between two massive table whereas in A we are doing join between relatively smaller table and larger one and the output that this inner table gives (which is smaller in comparison to joins that we are doing in B) is used for join with depositor table with the selection condition.

Options C and D are invalid as there is no b-city column in a-Schema.

Lets see in detail. Let there be 100 different branches. Say about 10% of accounts are below 0. Also, let there be 10,000 accounts in a branch amounting to 1,000,000 total accounts. A customer can have multiple accounts, so let there be on average 2 accounts per customer. So, this amounts to 2,000,000 total entries in depositor table. Lets assume these assumptions are true for all the branches. So, now lets evaluate options A and B.

1. All the accounts in Agra branch, filter by positive balance, and then depositor details of them. So,

- Get branch name from branch table after processing 100 records
- Filter 10,000 accounts after processing 1,000,000 accounts belonging to Agra
- Filter 1000 accounts after processing 10,000 accounts for positive balance
- Get 500 depositor details after processing 2,000,000 entries for the given 1000 accounts (assuming 1 customer having 2 accounts). So, totally this amounts to 2,000,000,000 record processing.
- So totally ≈ 2 billion records needs processing.

2. All the positive balance accounts are found first, and then those in Agra are found.

- Filter 100,000 accounts after processing 1,000,000 accounts having positive balance
- Find the deposito details of these accounts. So, 100,000 * 2,000,000 records need processing and this is a much larger value than for query A. Even if we reduce the percentage of positive balance (10 we assumed) the record processing of query A will also get reduced by same rate. So, overall query A is much better than query B.

14 votes

-- Shaun Patel (5.8k points)

5.11.9 Relational Calculus: GATE2004_13 [top](#)

<http://gateoverflow.in/1010>



Selected Answer

ans (B)

C in R1 is a foreign key referring to the primary key D in R2. So, every element of C must come from some D element.

9 votes

-- Vicky Bajoria (3.4k points)

5.11.10 Relational Calculus: GATE2002_15 [top](#)

<http://gateoverflow.in/868>

Answer a) part i)

$$\prod_{srollno,sname} (\sigma_{student.srollno=interview.srollno} (\text{Student} \bowtie \text{Interview})) - \prod_{srollno,sname} (\sigma_{srollno=offer.srollno} (\text{Offer} \bowtie \text{Student}))$$

Answer part ii)

$$\text{Temp} = \prod_{srollno,cname} (\text{Interview}) - \prod_{srollno,cname} (\text{Offer})$$

Temp will store those students roll no who where interviewed but still did not get the job atleast in some companies.

$$\text{Temp1} = \prod_{srollno} \{\sigma_{student.srollno=Interview.srollno \wedge student.srollno=offer.srollno \wedge offer cname=Interview cname} (\text{Student} \bowtie \text{Interview} \bowtie \text{Offer})\}$$

Temp1 will contain all those students who appeared for interview into different companies and their interview turned into offer letters .

$$\text{Answer : Temp1} - \prod_{srollno} (\text{Temp})$$

This will result in students who got the job in all the companies they sat for interview .

Answer part b)

Select sdegree , avg(salary) from student , Offer where Student.srollno = Offer.srollno group by sdegree having count(distinct student.srollno) > 5

3 votes

-- Riya Roy(Arayana) (5.6k points)

5.11.11 Relational Calculus: GATE2002_1.20 [top](#)

<http://gateoverflow.in/825>



Selected Answer

Answer: C

Relational algebra has the same power as safe relational calculus as:

- A query can be formulated in safe Tuple Relational Calculus if and only if it can be formulated in Relational Algebra.
- A query can be formulated in Relational Algebra if and only if it can be formulated in safe Tuple Relational Calculus.

7 votes

-- Rajarshi Sarkar (29.7k points)

5.11.12 Relational Calculus: GATE2007-IT_65 [top](#)<http://gateoverflow.in/3510>

Selected Answer

 $\sigma_{A \leq 100}(r)$

r=1000 tuples

values for A among the tuples are uniformly distributed in the interval [0, 500]

best estimate of the number of tuples returned by the given selection query

it value of 0-500 are uniformly distributed among 1000 tuples so there should be 2 entires Same i.e 11,2,2,3,3,4,4,..... so $\sigma_{A \leq 100}(r)$ selects all values smaller than equal to 100 SO there should be 200.

Correct If Wrong.

10 votes

-- Abhinav Rana (529 points)

5.11.13 Relational Calculus: GATE2007_60 [top](#)<http://gateoverflow.in/1258>

Selected Answer

Query is selecting e such that e is an employee and for all x, either x is not an employee or x's supervisor's name is not e.name or x is male.

So, this is equivalent to saying, select all employees who don't have an immediate female subordinate. (Assuming there is no transgender). (C) option.

13 votes

-- Arjun Suresh (150k points)

5.11.14 Relational Calculus: GATE2004_14 [top](#)<http://gateoverflow.in/1011>

Selected Answer

Rollno in students is key, ans students table has 120 tuples, In Enroll table rollno is FK referencing to Students table. in natural join it'll return the records where the rollno value of enroll matches with the rollno of students so in both conditions min and max records will be resulted (8,8). hence A is the answer.

Hint: table which has non-key, no of records of that will be resulted.

9 votes

-- Manu Thakur (5.6k points)

5.11.15 Relational Calculus: GATE2008-IT_75 [top](#)<http://gateoverflow.in/3389>query having division with $\{x \mid x \in \text{Enrolment} \wedge x.\text{school-id} = t\} \mid * 100 > 35\}$. school with enrollment % is 35 or above ..

2 votes

-- Digvijay (35.8k points)

5.11.16 Relational Calculus: GATE2004_51 [top](#)<http://gateoverflow.in/1047>

Selected Answer

Answer is D

because 1st query result = all Female candidate

2nd Query = All the Female Student Whose Marks Less than from Male Student

and Ques = 1st Query - 2nd Query = Girl Student with more marks than all the male Student

2 votes

-- Raj Mike (843 points)

OPTION : (d)

The following query states the following conditions:-

| |
|-------------------------------|
| sex=Female \wedge |
| $\alpha = \text{Male} \wedge$ |
| Marks $\leq m$ |

Let the relation student (Name, Sex, Marks)

| Name | Sex | Marks |
|------|--------|-------|
| S1 | Female | 30 |
| S2 | Female | 10 |
| S3 | Male | 20 |

Student (Name, Sex, Marks) Relation is renamed as
student (m, α, m).

Taking cross product of the relations

| Name | Sex | Marks | m | α | m |
|------|--------|-------|-----|----------|-----|
| S1 | Female | 30 | S1 | female | 30 |
| S1 | Female | 30 | S2 | Female | 10 |
| S1 | Female | 30 | S3 | Male | 20 |
| S2 | Female | 10 | S1 | female | 30 |
| S2 | Female | 10 | S2 | female | 10 |
| S2 | Female | 10 | S3 | Male | 20 |
| S3 | Male | 20 | S1 | female | 30 |
| S3 | Male | 20 | S2 | Female | 10 |
| S3 | Male | 20 | S3 | Male | 20 |

selecting the tuple
which satisfy the
condition i.e
 $\boxed{\begin{array}{l} \text{sex=Female} \wedge \\ \alpha = \text{Male} \wedge \\ \text{Marks} \leq m \end{array}}$

PROJECTING : $\pi_{\text{Name}} = \boxed{S2}$

$$\pi_{\text{Name}} \left[\sigma_{\text{sex=female}} (\text{student}) \right] = \boxed{S1}$$

Hence the query:

$$\pi_{\text{Name}} \left[\sigma_{\text{sex=female}} (\text{student}) \right] - \pi_{\text{Name}} \left[\text{student} \bowtie_{\substack{\text{student} \bowtie_{m, \alpha, m} (\text{student}) \\ \text{sex=female} \wedge \\ \alpha = \text{male} \wedge \\ \text{marks} \leq m}} \right]$$

$$\boxed{S1} - \boxed{S2} = \boxed{S1}$$

Let us take another relation data of student (Name, sex, marks)

| Name | Sex | Marks |
|------|-----|-------|
| S1 | M | 100 |
| S2 | F | 50 |
| S3 | M | 40 |
| S4 | F | 30 |

→ highest marks of Male students
→ highest mark of female students.

Taking cross product :

| Name | Sex | Marks | m | \times | m |
|------|-----|-------|----|----------|-----|
| S1 | M | 100 | S1 | M | 100 |
| S1 | M | 100 | S2 | F | 50 |
| S1 | M | 100 | S3 | M | 40 |
| S1 | M | 100 | S4 | F | 30 |
| S2 | F | 50 | S1 | M | 100 |
| S2 | F | 50 | S2 | F | 50 |
| S2 | F | 50 | S3 | M | 40 |
| S2 | F | 50 | S4 | F | 30 |
| S3 | M | 40 | S1 | M | 100 |
| S3 | M | 40 | S2 | F | 50 |
| S3 | M | 40 | S3 | M | 40 |
| S3 | M | 40 | S4 | F | 30 |
| S4 | F | 30 | S1 | M | 100 |
| S4 | F | 30 | S2 | F | 50 |
| S4 | F | 30 | S3 | M | 40 |
| S4 | F | 30 | S4 | F | 30 |

⇒ $\boxed{S2}$
 $\boxed{S4}$
↓
female students
who scored less
than equal to some
male students

$$\pi_{\text{marks}} [\sigma_{\text{sex} = \text{female}} (\text{student})] = \boxed{S2} - \boxed{S4}$$

Hence, the result of the query will be :

$$\boxed{S2} - \boxed{S4} = \text{empty relation}$$

From the above relational data of table
student (Name, Sex, Marks)

(d) is the correct option

In short,

$$\begin{aligned}\{ &\geq \text{All} \} &= |\text{universal}| - |\text{< some male}| \\ \{ &\geq \text{All} \} &= |\text{universal}| - |\text{<= some male}| \\ \{ &\geq \text{some} \} &= |\text{universal}| - |\text{< all male}|\end{aligned}$$

2 votes

-- Akhil Nadh Pullolikkal Chandran (6.9k points)

5.11.17 Relational Calculus: GATE2001-2.24 top

<http://gateoverflow.in/742>



Selected Answer

Answer: C

It returns tuples not belonging to R1 (which is infinitely many). So, it is not safe.

Ref: http://nptel.ac.in/courses/IIT-MADRAS/Intro_to_Database_Systems_Design/pdf/3.1_Tuple_Relational_Calculus.pdf

6 votes

-- Rajarshi Sarkar (29.7k points)

5.11.18 Relational Calculus: GATE2014-3_21 top

<http://gateoverflow.in/2055>



Selected Answer

(A) $\pi_{A1}(\sigma_{(F1 \wedge F2)}(r))$

since A1 is subset of A2 will get only A1 attributes as it is in the outside, so we can remove project A2.

Two Selects with boolean expression can be combined into one select with And of two boolean expressions.

11 votes

-- Aravind (3k points)

5.11.19 Relational Calculus: GATE2014-3_30 [top](#)



Selected Answer

(D) all of his/her dependents.

The inner query selects the employees whose age is less than or equal to at least one of his dependents. So, subtracting from the set of employees, gives employees whose age is greater than all of his dependents.

16 votes

-- Arjun Suresh (150k points)

5.11.20 Relational Calculus: GATE2013_35 [top](#)



Selected Answer

Answer: A

Four queries given in SQL, RA, TRC and DRC in four statements respectively retrieve the required information.

8 votes

-- Rajarshi Sarkar (29.7k points)

5.11.21 Relational Calculus: GATE2008-15 [top](#)



Selected Answer

Only III is correct.

The given statement means for all tuples from r, P is true. III means there does not exist a tuple in r where P is not true. Both are equivalent.

IV is not correct as it is saying that there exist a tuple, not in r for which P is not true, which is not what the given expression means.

13 votes

-- Arjun Suresh (150k points)

5.11.22 Relational Calculus: GATE2012_43 [top](#)



Selected Answer

(a)

Referential integrity means, all the values in foreign key should be present in primary key

$r2(c)$ is the super set of $r1(b)$

so $\{\text{subset} - \text{superset}\}$ is always empty set

11 votes

-- Aravind (3k points)

5.11.23 Relational Calculus: GATE1998_2.19 [top](#)

<http://gateoverflow.in/1692>



Selected Answer

D) if the selection condition is on attribute A₂, then we cannot replace it by RHS as there will not be any attribute A₂ due to projection of A₁ only.

14 votes

-- Shaun Patel (5.8k points)

5.11.24 Relational Calculus: GATE2012-50 [top](#)

<http://gateoverflow.in/2180>

Selected Answer

50. For C.ID = 10, all tuples from A ∪ B satisfies the join condition, hence 5 tuples (union of A and B has only 5 tuples are 2 of them are repeating for Shreya and Rohit) will be returned. Now, for C.ID = 99, A.ID = 99 and A.ID = 98 (for A.ID = 98, we need to assume A ∪ B, has the same schema as A as told in the question) satisfies the condition A.ID > 40, and hence two tuples are returned. So, number of tuples = 5 + 2 = 7.

The output will be:

| Id | Name | Age | Id | Phone | Area |
|----|--------|-----|----|-------|------|
| 12 | Arun | 60 | 10 | 2200 | 02 |
| 15 | Shreya | 24 | 10 | 2200 | 02 |
| 99 | Rohit | 11 | 10 | 2200 | 02 |
| 25 | Hari | 40 | 10 | 2200 | 02 |
| 98 | Rohit | 20 | 10 | 2200 | 02 |
| 99 | Rohit | 11 | 99 | 2100 | 01 |
| 98 | Rohit | 20 | 99 | 2100 | 01 |

9 votes

-- Arjun Suresh (150k points)

5.11.25 Relational Calculus: GATE1993_23,24 [top](#)

<http://gateoverflow.in/2320>

23) select student.rollno,student.sname

from student natural join enroll on student.rollno=enroll.rollno

where enroll.grade='A' AND enroll.cno in (select cno from teach where tname='Ramesh')

24) In teach relation cno(non prime attribute) does not depend upon any super key

so split them like

teach1(tno,tname)

teach2(tno,cno)

4 votes

-- Aravind (3k points)

5.11.26 Relational Calculus: GATE2012-51 [top](#)

<http://gateoverflow.in/43313>

Selected Answer

51. <cond> ALL evaluates to TRUE if inner query returns no tuples. So, Number of tuples returned will be number of tuples in A = 3.

Ref: <http://dcx.sap.com/1200/en/dbusage/all-test-quantified-subquery.html>

4 votes

-- Arjun Suresh (150k points)

Ans 3 table

All condition with empty return true

Also the result of subquery is empty So all id of A will be selected.

4 votes

-- Manoj Kumar (23.1k points)

5.12**Sql** top**5.12.1 Sql: GATE2004-IT_78** top<http://gateoverflow.in/3722>

Consider two tables in a relational database with columns and rows as follows:

Table: Student

| Roll_no | Name | Dept_id |
|---------|------|---------|
| 1 | ABC | 1 |
| 2 | DEF | 1 |
| 3 | GHI | 2 |
| 4 | JKL | 3 |

Table: Department

| Dept_id | Dept_name |
|---------|-----------|
| 1 | A |
| 2 | B |
| 3 | C |

Roll_no is the primary key of the Student table, Dept_id is the primary key of the Department table and Student.Dept_id is a foreign key from Department.Dept_id

What will happen if we try to execute the following two SQL statements?

- update Student set Dept_id = Null where Roll_no = 1
- update Department set Dept_id = Null where Dept_id = 1

- A) Both (i) and (ii) will fail
 B) (i) will fail but (ii) will succeed
 C) (i) will succeed but (ii) will fail
 D) Both (i) and (ii) will succeed

[gate2004-it](#) [databases](#) [sql](#) [normal](#)**Answer****5.12.2 Sql: GATE2005-IT_69** top<http://gateoverflow.in/3832>

In an inventory management system implemented at a trading corporation, there are several tables designed to hold all the information. Amongst these, the following two tables hold information on which items are supplied by which suppliers, and which warehouse keeps which items along with the stock-level of these items.

Supply = (supplierid, itemcode)

Inventory = (itemcode, warehouse, stocklevel)

For a specific information required by the management, following SQL query has been written

```
Select distinct STMP.supplierid
From Supply as STMP
Where not unique (Select ITMP.supplierid
                  From Inventory, Supply as ITMP
```

```
Where STMP.supplierid = ITMP.supplierid
And ITMP.itemcode = Inventory.itemcode
And Inventory.warehouse = 'Nagpur');
```

For the warehouse at Nagpur, this query will find all suppliers who

- A) do not supply any item
- B) supply exactly one item
- C) supply one or more items
- D) supply two or more items

[gate2005-it](#) [databases](#) [sql](#) [normal](#)

[Answer](#)

5.12.3 Sql: GATE2003_86 [top](#)

<http://gateoverflow.in/699>

Consider the set of relations shown below and the SQL query that follows.

Students: (Roll_number, Name, Date_of_birth)

Courses: (Course_number, Course_name, Instructor)

Grades: (Roll_number, Course_number, Grade)

```
Select distinct Name
from Students, Courses, Grades
where Students.Roll_number=Grades.Roll_number
and Courses.Instructor = 'Korth'
and Courses.Course_number = Grades.Course_number
and Grades.Grade = 'A'
```

Which of the following sets is computed by the above query?

- A. Names of students who have got an A grade in all courses taught by Korth
- B. Names of students who have got an A grade in all courses
- C. Names of students who have got an A grade in at least one of the courses taught by Korth
- D. None of the above

[gate2003](#) [databases](#) [sql](#) [easy](#)

[Answer](#)

5.12.4 Sql: GATE1991_12,b [top](#)

<http://gateoverflow.in/42998>

Suppose a database consist of the following relations:

```
SUPPLIER (SCODE, SNAME, CITY).
PART (PCODE, PNAME, PDESC, CITY).
PROJECTS (PRCODE, PRNAME, PRCITY).
SPPR (SCODE, PCODE, PRCODE, QTY).
```

Write algebraic solution to the following :

Get SCODE values for suppliers who supply to both projects PR1 and PR2.

Get PRCODE values for projects supplied by at least one supplier not in the same city.

[sql](#) [gate1991](#) [normal](#) [databases](#)

[Answer](#)

5.12.5 Sql: GATE 2016-2-52 [top](#)

<http://gateoverflow.in/39604>

Consider the following database table named water_schemes:

| Water_schemes | | |
|---------------|---------------|----------|
| scheme_no | district_name | capacity |
| 1 | Ajmer | 20 |
| 1 | Bikaner | 10 |
| 2 | Bikaner | 10 |
| 3 | Bikaner | 20 |
| 1 | Churu | 10 |
| 2 | Churu | 20 |
| 1 | Dungargarh | 10 |

The number of tuples returned by the following SQL query is _____.

```
with total (name, capacity) as
    select district_name, sum (capacity)
    from water_schemes
    group by district_name
with total_avg (capacity) as
    select avg (capacity)
    from total
select name
    from total, total_avg
    where total.capacity >= total_avg.capacity
```

gate2016-2 | databases | sql | normal | numerical-answers

Answer

5.12.6 Sql: GATE1991_12,a [top](#)

<http://gateoverflow.in/539>

Suppose a database consist of the following relations:

```
SUPPLIER (SCODE, SNAME, CITY).
PART (PCODE, PNAME, PDESC, CITY).
PROJECTS (PRCODE, PRNAME, PRCITY).
SPPR (SCODE, PCODE, PRCODE, QTY).
```

- a. Write SQL programs corresponding to the following queries:
 - i. Print PCODE values for parts supplied to any project in DELHI by a supplier in DELHI.
 - ii. Print all triples <CITY, PCODE, CITY> such that a supplier in first city supplies the specified part to a project in the second city, but do not print the triples in which the two CITY values are same.

gate1991 | databases | sql | normal

Answer

5.12.7 Sql: GATE2015-3_3 [top](#)

<http://gateoverflow.in/8396>

Consider the following relation

Cinema(theater, address, capacity)

Which of the following options will be needed at the end of the SQL query

```
SELECT P1.address
FROM Cinema P1
```

such that it always finds the addresses of theaters with maximum capacity?

- A. WHERE P1.capacity >= All (select P2.capacity from Cinema P2)
- B. WHERE P1.capacity >= Any (select P2.capacity from Cinema P2)
- C. WHERE P1.capacity > All (select max(P2.capacity) from Cinema P2)
- D. WHERE P1.capacity > Any (select max(P2.capacity) from Cinema P2)

[gate2015-3](#)
[databases](#)
[sql](#)
[normal](#)
Answer**5.12.8 Sql: GATE2000-2.25** [top](#)<http://gateoverflow.in/672>

Given relations $r(w, x)$ and $s(y, z)$ the result of

```
select distinct w, x
from r, s
```

is guaranteed to be same as r , provided.

- A. r has no duplicates and s is non-empty
- B. r and s have no duplicates
- C. s has no duplicates and r is non-empty
- D. r and s have the same number of tuples

[gate2000](#)
[databases](#)
[sql](#)
Answer**5.12.9 Sql: GATE2000-2.26** [top](#)<http://gateoverflow.in/673>

In SQL, relations can contain null values, and comparisons with null values are treated as unknown. Suppose all comparisons with a null value are treated as false. Which of the following pairs is not equivalent?

- A. $x = 5 \quad \text{not}(\text{not}(x = 5))$
- B. $x = 5 \quad x > 4 \text{ and } x < 6$, where x is an integer
- C. $x \neq 5 \quad \text{not}(x = 5)$
- D. none of the above

[gate2000](#)
[databases](#)
[sql](#)
[normal](#)
Answer**5.12.10 Sql: GATE1997_76** [top](#)<http://gateoverflow.in/19838>

Consider the following relational database schema:

EMP (eno name, age)

PROJ (pno name)

INVOLVED (eno, pno)

EMP contains information about employees. PROJ about projects and involved about which employees involved in which projects. The underlined attributes are the primary keys for the respective relations.

- a. What is the relational algebra expression containing one or more of $\{\sigma, \pi, x, u, -\}$ which is equivalent to SQL query.

```
select eno from EMP | INVOLVED where EMP.eno=INVOLVED.eno and INVOLVED.pno=3
```

- b. State in English (in not more than 15 words)

What the following relational algebra expressions are designed to determine

- i. $\pi_{eno}(\text{INVOLVED}) - \pi_{eno}((\pi_{eno}(\text{INVOLVED}) \times \pi_{pno}(\text{PROJ})) - \text{INVOLVED})$
- ii. $\pi_{age}(\text{EMP}) - \pi_{Eage} < \text{EMP}.age(\rho E(\text{EMP}) \times \text{EMP})$

(Note: $\rho E(\text{EMP})$ conceptually makes a copy of EMP and names it K (ρ is called the rename operator))

[gate1997](#)
[databases](#)
[sql](#)
Answer**5.12.11 Sql: GATE2001-21** [top](#)<http://gateoverflow.in/762>

Consider a relation examinee (regno, name, score), where regno is the primary key to score is a real number.

- Write a relational algebra using $(\Pi, \sigma, \rho, \times)$ to find the list of names which appear more than once in examinee.
- Write an SQL query to list the *regno* of examinees who have a score greater than the average score.
- Suppose the relation *appears* (regno, centr_code) specifies the center where an examinee appears. Write an SQL query to list the *centr_code* having an examinee of score greater than 80.

[gate2001](#)
[databases](#)
[sql](#)
[normal](#)
Answer**5.12.12 Sql: GATE2015-1_27** [top](#)<http://gateoverflow.in/8225>

Consider the following relation:

Student

| Roll-No | Student name |
|---------|--------------|
| 1 | Raj |
| 2 | Rohit |
| 3 | Raj |

Performance

| Roll-No | Course | Marks |
|---------|---------|-------|
| 1 | Math | 80 |
| 1 | English | 70 |
| 2 | Math | 75 |
| 3 | English | 80 |
| 2 | Physics | 65 |
| 3 | Math | 80 |

Consider the following SQL query.

```
SELECT S. student_Name, Sum(p. Marks)
FROM student S, performance P
WHERE S.Roll_No= P.Roll_No
GROUP BY S.STUDENT_Name
```

The numbers of rows that will be returned by the SQL query is_____.

[gate2015-1](#)
[databases](#)
[sql](#)
[normal](#)
Answer**5.12.13 Sql: GATE2001-2.25** [top](#)<http://gateoverflow.in/743>

Consider a relation geq which represents "greater than or equal to", that is, $(x, y) \in \text{geq}$ only if $y \geq x$.

```
create table geq
(
    ib integer not null,
    ub integer not null,
    primary key ib,
    foreign key (ub) references geq on delete cascade
);
```

Which of the following is possible if tuple (x,y) is deleted?

- A tuple (z,w) with $z > y$ is deleted

- B. A tuple (z,w) with $z > x$ is deleted
 C. A tuple (z,w) with $w < x$ is deleted
 D. The deletion of (x,y) is prohibited

gate2001 | databases | sql | normal

[Answer](#)

5.12.14 Sql: GATE2014-3_54 [top](#)

<http://gateoverflow.in/2089>

Consider the following relational schema:

employee(empId,empName,empDept)

customer(custId,custName,salesRepId,rating)

salesRepId is a foreign key referring to **empId** of the employee relation. Assume that each employee makes a sale to at least one customer. What does the following query return?

```
SELECT empName FROM employee E
WHERE NOT EXISTS (SELECT custId
                   FROM customer C
                   WHERE C.salesRepId = E.empId
                   AND C.rating <> 'GOOD');
```

- (A) Names of all the employees with at least one of their customers having a 'GOOD' rating.
 (B) Names of all the employees with at most one of their customers having a 'GOOD' rating.
 (C) Names of all the employees with none of their customers having a 'GOOD' rating.
 (D) Names of all the employees with all their customers having a 'GOOD' rating.

gate2014-3 | databases | sql | easy

[Answer](#)

5.12.15 Sql: GATE2004-IT_74 [top](#)

<http://gateoverflow.in/3778>

A relational database contains two tables student and department in which student table has columns roll_no, name and dept_id and department table has columns dept_id and dept_name. The following insert statements were executed successfully to populate the empty tables:

```
Insert into department values (1, 'Mathematics')
Insert into department values (2, 'Physics')
Insert into student values (1, 'Navin', 1)
Insert into student values (2, 'Mukesh', 2)
Insert into student values (3, 'Gita', 1)
```

How many rows and columns will be retrieved by the following SQL statement?

```
Select * from student, department
```

- A. 0 row and 4 columns
 B. 3 rows and 4 columns
 C. 3 rows and 5 columns
 D. 6 rows and 5 columns

gate2004-it | databases | sql | normal

[Answer](#)

5.12.16 Sql: GATE2014-2_54 [top](#)

<http://gateoverflow.in/2021>

SQL allows duplicate tuples in relations, and correspondingly defines the multiplicity of tuples in the result of joins. Which one of the following queries always gives the same answer as the nested query shown below:

```
select * from R where a in (select S.a from S)
```

(A)

```
select R.* from R, S where R.a=S.a
```

(B)

```
select distinct R.* from R,S where R.a=S.a
```

(C)

```
select R.* from R, (select distinct a from S) as S1 where R.a=S1.a
```

(D)

```
select R.* from R,S where R.a=S.a and is unique R
```

[gate2014-2](#) [databases](#) [sql](#) [normal](#)

Answer

5.12.17 Sql: GATE2006-IT_84 [top](#)

<http://gateoverflow.in/3640>

Consider a database with three relation instances shown below. The primary keys for the Drivers and Cars relation are *did* and *cid* respectively and the records are stored in ascending order of these primary keys as given in the tables. No indexing is available in the database.

D: Drivers relation

| did | dname | rating | age |
|-----|-------------|--------|-----|
| 22 | Karthikeyan | 7 | 25 |
| 29 | Salman | 1 | 33 |
| 31 | Boris | 8 | 55 |
| 32 | Amoldt | 8 | 25 |
| 58 | Schumacher | 10 | 35 |
| 64 | Sachin | 7 | 35 |
| 71 | Senna | 10 | 16 |
| 74 | Sachin | 9 | 35 |
| 85 | Rahul | 3 | 25 |
| 95 | Ralph | 3 | 53 |

R: Reserves relation

| did | cid | day |
|-----|-----|----------|
| 22 | 101 | 10/10/06 |
| 22 | 102 | 10/10/06 |
| 22 | 103 | 08/10/06 |
| 22 | 104 | 07/10/06 |
| 31 | 102 | 10/11/06 |
| 31 | 103 | 06/11/06 |
| 31 | 104 | 12/11/06 |
| 64 | 101 | 05/09/06 |
| 64 | 102 | 08/09/06 |
| 74 | 103 | 08/09/06 |

C: cars relation

| cid | cname | colour |
|-----|---------|--------|
| 101 | Renault | blue |
| 102 | Renault | red |
| 103 | Ferrari | green |
| 104 | Jaguar | red |

What is the output of the following SQL query?

```
select D.dname
from Drivers D
where D.did in (
    select R.did
    from Cars C, Reserves R
    where R.cid = C.cid and C.colour = 'red'
    intersect
    select R.did
    from Cars C, Reserves R
    where R.cid = C.cid and C.colour = 'green'
)
```

- A) Karthikeyan, Boris
- B) Sachin, Salman
- C) Karthikeyan, Boris, Sachin
- D) Schumacher, Senna

[gate2006-it](#) [databases](#) [sql](#) [normal](#)

[Answer](#)

5.12.18 Sql: GATE2005-77, ISRO2016-55 [top](#)

<http://gateoverflow.in/1400>

The relation **book** (title,price) contains the titles and prices of different books. Assuming that no two books have the same price, what does the following SQL query list?

```
select title
from book as B
where (select count(*)
      from book as T
      where T.price>B.price) < 5
```

- A. Titles of the four most expensive books
- B. Title of the fifth most inexpensive book
- C. Title of the fifth most expensive book
- D. Titles of the five most expensive books

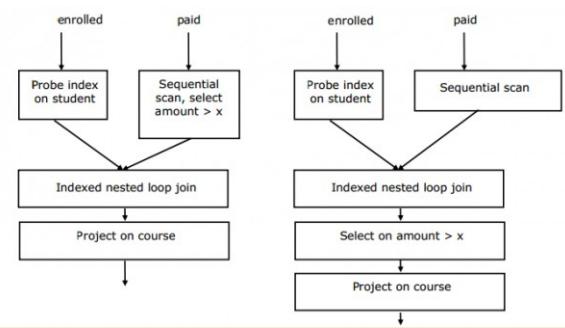
[gate2005](#) [databases](#) [sql](#) [easy](#) [isro2016](#)

[Answer](#)

5.12.19 Sql: GATE2006_69 [top](#)

<http://gateoverflow.in/1847>

Consider the relation **enrolled** (**student, course**) in which (**student, course**) is the primary key, and the relation **paid** (**student, amount**) where **student** is the primary key. Assume no null values and no foreign keys or integrity constraints. Assume that amounts 6000, 7000, 8000, 9000 and 10000 were each paid by 20% of the students. Consider these query plans (Plan 1 on left, Plan 2 on right) to "list all courses taken by students who have paid more than x"



A disk seek takes 4ms, disk data transfer bandwidth is 300 MB/s and checking a tuple to see if amount is greater than x takes 10 μ s. Which of the following statements is correct?

- (A) Plan 1 and Plan 2 will not output identical row sets for all databases
- (B) A course may be listed more than once in the output of Plan 1 for some databases
- (C) For x = 5000, Plan 1 executes faster than Plan 2 for all databases
- (D) For x = 9000, Plan 1 executes slower than Plan 2 for all databases.

[gate2006](#) [databases](#) [sql](#) [normal](#)

Answer

5.12.20 Sql: GATE2014-1_54 [top](#)

<http://gateoverflow.in/1934>

Given the following schema:

employees(emp-id, first-name, last-name, hire-date, dept-id, salary)
departments(dept-id, dept-name, manager-id, location-id)

You want to display the last names and hire dates of all latest hires in their respective departments in the location ID 1700. You issue the following query:

```
SQL>SELECT last-name, hire-date
   FROM employees
 WHERE (dept-id, hire-date) IN
 (SELECT dept-id, MAX(hire-date)
    FROM employees JOIN departments USING(dept-id)
 WHERE location-id =1700
 GROUP BY dept-id);
```

What is the outcome?

- (A) It executes but does not give the correct result
- (B) It executes and gives the correct result.
- (C) It generates an error because of pairwise comparison.
- (D) It generates an error because of the GROUP BY clause cannot be used with table joins in a sub-query.

[gate2014-1](#) [databases](#) [sql](#) [normal](#)

Answer

5.12.21 Sql: GATE2004-IT_76 [top](#)

<http://gateoverflow.in/3720>

A table T1 in a relational database has the following rows and columns:

| roll no. | marks |
|----------|-------|
| 1 | 10 |
| 2 | 20 |
| 3 | 30 |
| 4 | Null |

The following sequence of SQL statements was successfully executed on table T1.

```
Update T1 set marks = marks + 5
Select avg(marks) from T1
```

What is the output of the select statement?

- A. 18.75
- B. 20
- C. 25
- D. Null

[gate2004-it](#) [databases](#) [sql](#) [normal](#)

[Answer](#)

5.12.22 Sql: GATE1998_7a [top](#)

<http://gateoverflow.in/1721>

Suppose we have a database consisting of the following three relations.

- FREQUENTS (student, parlor) giving the parlors each student visits.
- SERVES (parlor, ice-cream) indicating what kind of ice-creams each parlor serves.
- LIKES (student, ice-cream) indicating what ice-creams each student likes.

(Assume that each student likes at least one ice-cream and frequents at least one parlor)

Express the following in SQL:

Print the students that frequent at least one parlor that serves some ice-cream that they like.

[gate1998](#) [databases](#) [sql](#) [descriptive](#)

[Answer](#)

5.12.23 Sql: GATE2006_67 [top](#)

<http://gateoverflow.in/1845>

Consider the relation account (customer, balance) where customer is a primary key and there are no null values. We would like to rank customers according to decreasing balance. The customer with the largest balance gets rank 1. Ties are not broke but ranks are skipped: if exactly two customers have the largest balance they each get rank 1 and rank 2 is not assigned.

| | |
|---------|---|
| Query1: | select A.customer, count(B.customer) from account A, account B where A.balance <= B.balance group by A.customer |
| Query2: | select A.customer, 1+count(B.customer) from account A, account B where A.balance < B.balance group by A.customer |

Consider these statements about Query1 and Query2.

1. Query1 will produce the same row set as Query2 for some but not all databases.
2. Both Query1 and Query2 are correct implementation of the specification
3. Query1 is a correct implementation of the specification but Query2 is not
4. Neither Query1 nor Query2 is a correct implementation of the specification
5. Assigning rank with a pure relational query takes less time than scanning in decreasing balance order assigning ranks using ODBC.

Which two of the above statements are correct?

- (A) 2 and 5
- (B) 1 and 3
- (C) 1 and 4
- (D) 3 and 5

[gate2006](#)
[databases](#)
[sql](#)
[normal](#)

Answer

5.12.24 Sql: GATE2006-IT_85 [top](#)

<http://gateoverflow.in/3641>

Consider a database with three relation instances shown below. The primary keys for the Drivers and Cars relation are *did* and *cid* respectively and the records are stored in ascending order of these primary keys as given in the tables. No indexing is available in the database.

D: Drivers relation

| did | dname | rating | age |
|-----|-------------|--------|-----|
| 22 | Karthikeyan | 7 | 25 |
| 29 | Salman | 1 | 33 |
| 31 | Boris | 8 | 55 |
| 32 | Amoldt | 8 | 25 |
| 58 | Schumacher | 10 | 35 |
| 64 | Sachin | 7 | 35 |
| 71 | Senna | 10 | 16 |
| 74 | Sachin | 9 | 35 |
| 85 | Rahul | 3 | 25 |
| 95 | Ralph | 3 | 53 |

R: Reserves relation

| did | cid | day |
|-----|-----|----------|
| 22 | 101 | 10/10/06 |
| 22 | 102 | 10/10/06 |
| 22 | 103 | 08/10/06 |
| 22 | 104 | 07/10/06 |
| 31 | 102 | 10/11/06 |
| 31 | 103 | 06/11/06 |
| 31 | 104 | 12/11/06 |
| 64 | 101 | 05/09/06 |
| 64 | 102 | 08/09/06 |
| 74 | 103 | 08/09/06 |

C: cars relation

| cid | cname | colour |
|-----|---------|--------|
| 101 | Renault | blue |
| 102 | Renault | red |
| 103 | Ferrari | green |
| 104 | Jaguar | red |

```

select D.dname
from Drivers D
where D.did in (
    select R.did
    from Cars C, Reserves R
    where R.cid = C.cid and C.colour = 'red'
    intersect
    select R.did
    from Cars C, Reserves R
    where R.cid = C.cid and C.colour = 'green'
)

```

Let n be the number of comparisons performed when the above SQL query is optimally executed. If linear search is used to

locate a tuple in a relation using primary key, then n lies in the range

- A) 36 - 40
- B) 44 - 48
- C) 60 - 64
- D) 100 - 104

[gate2006-it](#) [databases](#) [sql](#) [normal](#)

[Answer](#)

5.12.25 Sql: GATE2008-IT_74 [top](#)

<http://gateoverflow.in/3388>

Student (school-id, sch-roll-no, sname, saddress)
 School (school-id, sch-name, sch-address, sch-phone)
 Enrolment(school-id sch-roll-no, erollno, examname)
 ExamResult(erollno, examname, marks)

What does the following SQL query output?

```
SELECT sch-name, COUNT (*)
FROM School C, Enrolment E, ExamResult R
WHERE E.school-id = C.school-id
AND
E.examname = R.examname AND E.erollno = R.erollno
AND
R.marks = 100 AND S.school-id IN (SELECT school-id
                                    FROM student
                                    GROUP BY school-id
                                    HAVING COUNT (*) > 200)
GROUP BY school-id
```

- A) for each school with more than 200 students appearing in exams, the name of the school and the number of 100s scored by its students
- B) for each school with more than 200 students in it, the name of the school and the number of 100s scored by its students
- C) for each school with more than 200 students in it, the name of the school and the number of its students scoring 100 in at least one exam
- D) nothing; the query has a syntax error

[gate2008-it](#) [databases](#) [sql](#) [normal](#)

[Answer](#)

5.12.26 Sql: GATE1999_2.25 [top](#)

<http://gateoverflow.in/1502>

Which of the following is/are correct?

- A. An SQL query automatically eliminates duplicates
- B. An SQL query will not work if there are no indexes on the relations
- C. SQL permits attribute names to be repeated in the same relation
- D. None of the above

[gate1999](#) [databases](#) [sql](#) [easy](#)

[Answer](#)

5.12.27 Sql: GATE2010-19 [top](#)

<http://gateoverflow.in/2194>

A relational schema for a train reservation database is given below.

passenger(pid, pname, age)

reservation(pid, class, tid)

Table: Passenger

| pid | pname | Age |
|-----|----------|-----|
| 0 | 'Sachin' | 65 |

| pid | Name | Age |
|-----|----------|-----|
| 2 | 'Sourav' | 67 |
| 3 | 'Anil' | 69 |

Table: Reservation

| pid | class | tid |
|-----|-------|------|
| 0 | 'AC' | 8200 |
| 1 | 'AC' | 8201 |
| 2 | 'SC' | 8201 |
| 5 | 'AC' | 8203 |
| 1 | 'SC' | 8204 |
| 3 | 'AC' | 8202 |

What **pids** are returned by the following SQL query for the above instance of the tables?

```
SELECT pid
FROM Reservation
WHERE class='AC' AND
      EXISTS (SELECT *
              FROM Passenger
              WHERE age>65 AND
              Passenger.pid=Reservation.pid)
```

- A. 1, 0
- B. 1, 2
- C. 1, 3
- D. 1, 5

gate2010 databases sql normal

Answer

5.12.28 Sql: GATE1999_22 top

<http://gateoverflow.in/1521>

Consider the set of relations

- EMP (Employee-no, Dept-no, Employee-name, Salary)
- DEPT (Dept-no, Dept-name, Location)

Write an SQL query to:

- Find all employees names who work in departments located at 'Calcutta' and whose salary is greater than Rs.50,000.
- Calculate, for each department number, the number of employees with a salary greater than Rs. 1,00,000

gate1999 databases sql easy

Answer

5.12.29 Sql: GATE2011_46 top

<http://gateoverflow.in/2148>

Database table by name
Loan_Records is given below.

| Borrower | Bank_Manager | Loan_Amount |
|----------|--------------|-------------|
| Ramesh | Sunderajan | 10000.00 |
| Suresh | Ramgopal | 5000.00 |
| Mahesh | Sunderajan | 7000.00 |

What is the output of the following SQL query?

```
SELECT count(*)
FROM (
```

```
SELECT Borrower, Bank_Manager FROM Loan_Records) AS S
NATURAL JOIN
(SELECT Bank_Manager, Loan_Amount FROM Loan_Records) AS T
);
```

- (A) 3
- (B) 9
- (C) 5
- (D) 6

gate2011 databases sql normal

[Answer](#)

5.12.30 Sql: GATE2007_61 [top](#)

<http://gateoverflow.in/1259>

Consider the table **employee**(empId, name, department, salary) and the two queries Q_1, Q_2 below. Assuming that department 5 has more than one employee, and we want to find the employees who get higher salary than anyone in the department 5, which one of the statements is **TRUE** for any arbitrary employee table?

Q_1 :

```
Select e.empId
From employee e
Where not exists
(Select * From employee s Where s.department = "5" and s.salary >= e.salary)
```

Q_2 :

```
Select e.empId
From employee e
Where e.salary > Any
(Select distinct salary From employee s Where s.department = "5")
```

- A. Q_1 is the correct query
- B. Q_2 is the correct query
- C. Both Q_1 and Q_2 produce the same answer
- D. Neither Q_1 nor Q_2 is the correct query

gate2007 databases sql normal verbal-ability

[Answer](#)

5.12.31 Sql: GATE2011_32 [top](#)

<http://gateoverflow.in/2134>

Consider a database table T containing two columns X and Y each of type integer. After the creation of the table, one record ($X=1, Y=1$) is inserted in the table.

Let MX and MY denote the respective maximum values of X and Y among all records in the table at any point in time. Using MX and MY, new records are inserted in the table 128 times with X and Y values being $MX+1, 2*MY+1$ respectively. It may be noted that each time after the insertion, values of MX and MY change.

What will be the output of the following SQL query after the steps mentioned above are carried out?

```
SELECT Y FROM T WHERE X=7;
```

- (A) 127
- (B) 255
- (C) 129
- (D) 257

gate2011 databases sql normal

[Answer](#)

5.12.32 Sql: GATE2004_53 [top](#)<http://gateoverflow.in/1049>

The employee information in a company is stored in the relation

- Employee (name, sex, salary, deptName)

Consider the following SQL query

```
Select deptName
  From Employee
 Where sex = 'M'
 Group by deptName
 Having avg(salary) >
        (select avg (salary) from Employee)
```

It returns the names of the department in which

- the average salary is more than the average salary in the company
- the average salary of male employees is more than the average salary of all male employees in the company
- the average salary of male male employees is more than the average salary of employees in same the department
- the average salary of male employees is more than the average salary in the company

[gate2004](#) [databases](#) [sql](#) [normal](#)

Answer

5.12.33 Sql: GATE2006_68 [top](#)<http://gateoverflow.in/1846>

Consider the relation enrolled (student, course) in which (student, course) is the primary key, and the relation paid (student, amount) where student is the primary key. Assume no null values and no foreign keys or integrity constraints.
Given the following four queries:

Query1:

```
select student from enrolled where student in (select student from paid)
```

Query2:

```
select student from paid where student in (select student from enrolled)
```

Query3:

```
select E.student from enrolled E, paid P where E.student = P.student
```

Query4:

```
select student from paid where exists
      (select * from enrolled where enrolled.student = paid.student)
```

Which one of the following statements is correct?

- All queries return identical row sets for any database
- Query2 and Query4 return identical row sets for all databases but there exist databases for which Query1 and Query2 return different row sets.
- There exist databases for which Query3 returns strictly fewer rows than Query2
- There exist databases for which Query4 will encounter an integrity violation at runtime.

[gate2006](#) [databases](#) [sql](#) [normal](#)

Answer

Answers: Sql**5.12.1 Sql: GATE2004-IT_78** [top](#)<http://gateoverflow.in/3722>



Selected Answer

ans is C

here in (i) when we update in STUDENT table dept id =NULL then it will not cause any problem to referenced table

but in (II) if we set in DEPARTMENT table dept id =NULL then it will produce inconsistency because in STUDENT table we still have the tuples containing the dept id =1

1 6 votes

-- neha pawar (3.8k points)

5.12.2 Sql: GATE2005-IT_69 [top](#)

<http://gateoverflow.in/3832>

Ans D) supply two or more items

The whole query returns the distinct list of suppliers who supply two or more items.

1 10 votes

-- Bran Stark (339 points)

5.12.3 Sql: GATE2003_86 [top](#)

<http://gateoverflow.in/969>

Selected Answer

C. Names of the students who have got an A grade in at least one of the courses taught by Korth.

1 6 votes

-- Arjun Suresh (150k points)

5.12.4 Sql: GATE1991_12,b [top](#)

<http://gateoverflow.in/42998>

Ans of these two questions are below

$$\textcircled{1} \quad \pi_{\text{SCODE}} (\sigma_{\text{SUPPLIER}. \text{SCODE} = \text{SPPR}. \text{SCODE} \wedge \text{PROJECTS}. \text{PRCODE} = \text{SPPR}. \text{PRCODE} \wedge \text{PRNAME} = \text{PR1} \wedge \text{PRNAME} = \text{PR2}} (\text{SUPPLIER} \bowtie \text{SPPR} \bowtie \text{PROJECTS})$$

$$\textcircled{2} \quad T \leftarrow \pi_{\text{SCODE}} (\sigma_{m_1. \text{SCODE} = m_2. \text{SCODE} \wedge m_1. \text{city} = m_2. \text{city}} (\int_{m_1} (\text{SUPPLIER}) \times \int_{m_2} (\text{SUPPLIER})) \text{ (T} \bowtie \text{SPPR} \bowtie \text{PROJECTS)})$$

$$\pi_{\text{PRCODE}} (\sigma_{T. \text{SCODE} = \text{SPPR}. \text{SCODE} \wedge \text{SPPR}. \text{PRCODE} = \text{PROJECTS}. \text{PRCODE}} \text{ (T} \bowtie \text{SPPR} \bowtie \text{PROJECTS}))$$

1 1 votes

-- srestha (27.8k points)

5.12.5 Sql: GATE 2016-2-52 [top](#)

<http://gateoverflow.in/39604>



Selected Answer

1st query will return following,

Total(name,capacity)

Ajmer 20
Bikaner 40
Churu 30
Dungargarh 10

2nd Query will return,

Total_avg(capacity)

25

Since sum of capacity = $100/4=25$

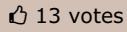
3rd query will be final and it's tuples will be considered as output,

where name of district and its total capacity should be more than or equal to 25

name

Bikaner
Churu

Hence, **2 tuples** returned.



13 votes

-- Shashank Chavan (2.6k points)

5.12.6 Sql: GATE1991_12,a [top](#)

<http://gateoverflow.in/539>

a)i) select pcode from sprr where pcode IN (select pcode from project where city="delhi") AND scode IN (select scode from supplier where city="delhi")

ii) select s.city,p.pcode,pr.city from supplier s, project pr, parts p, sprr sp where s.city != pr.city AND sp.scode=s.scode AND p.pcode=sp.pcode AND sp.prcode=pr.prcode



1 votes

-- Aravind (3k points)

5.12.7 Sql: GATE2015-3_3 [top](#)

<http://gateoverflow.in/8396>

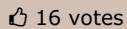
Selected Answer

A is the answer

B - Returns the addresses of all theaters.

C - Returns null set. max() returns a single value and there won't be any value > max.

D - Returns null set. Same reason as C. All and ANY works the same here as max returns a single value.



16 votes

-- Arjun Suresh (150k points)

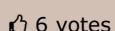
5.12.8 Sql: GATE2000-2.25 [top](#)

<http://gateoverflow.in/672>

Selected Answer

(a)

if s is empty r x s will give empty set, so s can't be empty



6 votes

-- Aravind (3k points)

5.12.9 Sql: GATE2000-2.26 [top](#)

<http://gateoverflow.in/673>

 Selected Answer

answer = **option C**

| Value at hand | Option A | Option B | Option C |
|---------------|----------|----------|----------|
| 6 | ✗ | ✗ | ✗ |
| 5 | ✓ | ✓ | ✓ |
| null | ✗ | ✗ | ✗ |

10 votes -- Amar Vashishth (20.7k points)

Answer: C

As (null) != 5 gives false.
But, not((null) = 5) gives not(false) gives true.

10 votes

-- Aravind (3k points)

5.12.10 Sql: GATE1997_76 top

<http://gateoverflow.in/19838>

- A) $\sigma_{pno=3}(emp \sqcap involved)$
 B)i)it returns eno of employees involved in all project
 ii)it returns max age (ie age of senior most employee)

0 votes

-- Pooja (25.9k points)

i) $\pi_{eno}(EMP \bowtie_{EMP.eno=INVOLVED.eno \text{ and } INVOLVED.pno=3} INVOLVED)$

↓
projects employee involved on some project

ii) $\pi_{eno}(INVOLVED) - \pi_{eno}((\pi_{eno}(INVOLVED) \times \pi_{pno}(PROJ)) - INVOLVED)$

↑
All employee involved in the projects

Projects All employee involved in the projects)-(projects employee involved on some project)=
Projects employee involved on the all project

↓
Employee except max age

iii) $\pi_{age}(EMP) - \pi_{age}(\sigma_{Eage < EMP.age}(\rho_E(EMP) \times EMP))$

↑
All employee

(All employee) - (Employee except max age) = **Employee with maximum age**

0 votes

-- Umang Raman (11.3k points)

5.12.11 Sql: GATE2001-21 top

<http://gateoverflow.in/762>

1) $\rho(\text{exm1}, \text{examinee}), \rho(\text{exm2}, \text{examinee})$
 $\Pi_{\text{exm1.name}}(\text{exm1} \times \text{exm2})$
 $\sigma((\text{emp1.regno} \neq \text{emp2.regno}) \text{ and } (\text{emp1.name} = \text{emp2.name}))$

2) select reg no
from examinee where score IN (select score
from examinee
where score < select avg(score) from examinee)
3)select centre_code from appears
where regno IN (SELECT regno from examinee where score>80)

1 upvote

-- Tauhin Gangwar (5k points)

5.12.12 Sql: GATE2015-1_27 [top](#)

<http://gateoverflow.in/8225>



Selected Answer

answer is 2 as there are only 2 distinct student names.

1 upvote

-- naresh1845 (1.3k points)

5.12.13 Sql: GATE2001-2.25 [top](#)

<http://gateoverflow.in/743>



Selected Answer

Answer: C

The table can be depicted as:

| ib (PK) | ub (FK) |
|---------|---------|
| z | w=u |
| u | v=x |
| x | y |

If (x,y) is deleted then from the above table:

- $v \leq y$ (as $v=x$)
- $u < v \leq y$, $u \neq v$ (as $v=x$ and ib is the Primary Key)
- $w < v \leq y$ (as $w=u$)
- $z < w < v \leq y$, $z \neq w$ (as $w=u$ and ib is the Primary Key)

As, it can be seen that $w < v$ or $w < x$ (as $v=x$) so C is the answer.

1 upvote

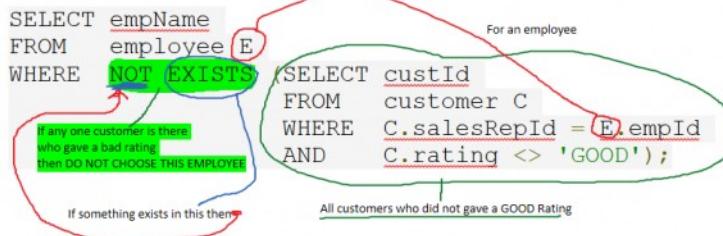
-- Rajarshi Sarkar (29.7k points)

5.12.14 Sql: GATE2014-3_54 [top](#)

<http://gateoverflow.in/2089>



Selected Answer



So, an employee whose *ALL* customers gives him GOOD rating is chosen;

All such employees are chosen.
ans = option D

7 votes

-- Amar Vashishth (20.7k points)

5.12.15 Sql: GATE2004-IT_74 [top](#)

<http://gateoverflow.in/3718>



Selected Answer

since there is no specific joining condition specified it will retrieve cartesian product of the table

number of rows = product of number of rows in each relation = $3 \times 2 = 6$

number of columns = sum of number of columns = $3 + 2 = 5$

answer: D

16 votes

-- Sankaranarayanan P.N (9.8k points)

5.12.16 Sql: GATE2014-2_54 [top](#)

<http://gateoverflow.in/2021>



Selected Answer

c)

Consider the following instances of R & S

Let R

| A | B | C |
|---|---|---|
| 1 | 2 | 3 |
| 1 | 2 | 3 |
| 7 | 8 | 9 |
| 7 | 8 | 9 |

Let S:-

| A | X | Z |
|---|---|---|
| 1 | 2 | 3 |
| 3 | 5 | 7 |
| 7 | 6 | 5 |
| 7 | 5 | 4 |

Now output of given Query

```
select * from R where a in (select S.a from S)
```

| A | B | C |
|---|---|---|
| 1 | 2 | 3 |
| 1 | 2 | 3 |
| 7 | 8 | 9 |
| 7 | 8 | 9 |

For Option,

A) since multiplicity of tuples is disturbed

```
select R.* from R, S where R.a=S.a
```

∴ Output will be

| A | B | C |
|---|---|---|
| 1 | 2 | 3 |
| 1 | 2 | 3 |
| 7 | 8 | 9 |
| 7 | 8 | 9 |
| 7 | 8 | 9 |
| 7 | 8 | 9 |

B)

```
select distinct R.* from R,S where R.a=S.a
```

∴ only Distinct R will be chosen in the end so , Output will look like

| A | B | C |
|---|---|---|
| 1 | 2 | 3 |
| 7 | 8 | 9 |

C) ANSWER

```
select R.* from R, (select distinct a from S) as S1 where R.a=S1.a
```

Multiplicity of tuples is maintained. ∴ Multiplicity of duplicate tuples will be distributed when there is a match between R.a and S.a and for that match S.a's value is repeated.

So, Output will be

| A | B | C |
|---|---|---|
| 1 | 2 | 3 |
| 1 | 2 | 3 |
| 7 | 8 | 9 |
| 7 | 8 | 9 |

18 votes

-- Kalpish Singhal (1.7k points)

5.12.17 Sql: GATE2006-IT_84 [top](#)

<http://gateoverflow.in/3640>



Selected Answer

For color = "Red"

did = {22, 22, 31, 64}

For color = "Green"

did = {22, 31, 74}

intersection of Red and Green will give = {22, 31}

which is Karthikeyan and Boris

Ans: A

10 votes

-- Vikrant Singh (11k points)

5.12.18 Sql: GATE2005-77, ISRO2016-55 [top](#)

<http://gateoverflow.in/1400>



Selected Answer

Answer: D

The outer query selects all titles from book table. For every selected book, the subquery returns count of those books which are more expensive than the selected book. The where clause of outer query will be true for 5 most expensive book. For example count (*) will be 0 for the most expensive book and count(*) will be 1 for second most expensive book.

15 votes

-- Rajarshi Sarkar (29.7k points)

5.12.19 Sql: GATE2006_69 [top](#)

<http://gateoverflow.in/1847>

I think it should be C)

in all cases plan 1 is faster than plan 2 cause in plan 1 we are reducing the load by doing select amount >x and then the loop

but in case of plan 2 its in the nested loop so it need to check every time and will take more time to execute .

6 votes

-- Pranay Datta (6.8k points)

5.12.20 Sql: GATE2014-1_54 [top](#)

<http://gateoverflow.in/1934>



Selected Answer

```
SELECT dept_id, MAX(hire_date)
FROM employees JOIN departments USING(dept_id)
WHERE location_id =1700
GROUP BY dept_id
```

this inner query will give the max hire date of each department whose location_id =1700

and outer query will give the last name and hire-date of all those employees who joined on max hire date.
answer should come to (B) no errors

And we can use group by and where together, who said we can not :(

Example: create table departments(dept_id number, dept_name varchar2(25), location_id number);
Query: select d1.dept_name,max(d1.location_id)
from departments d1, departments d2
where d1.dept_name = d2.dept_name
and d1.dept_name='AA'
group by d1.dept_name;

will give output

12 votes

-- Manu Thakur (5.6k points)

5.12.21 Sql: GATE2004-IT_76 [top](#)

<http://gateoverflow.in/3720>



Selected Answer

Update on null gives null. Now, avg function ignores null values. So, here avg will be $(15 + 25 + 35) / 3 = 25$.

<http://msdn.microsoft.com/en-us/library/ms177677.aspx>

8 votes

-- Arjun Suresh (150k points)

5.12.22 Sql: GATE1998_7a [top](#)

<http://gateoverflow.in/1721>

Selected Answer

```
SELECT DISTINCT A.student FROM
FREQUENTS A, SERVES B, LIKES C
WHERE
    A.parlor=B.parlor
    AND
    B.ice-cream=C.ice-cream
    AND
    A.student=C.student;
```

OR

```
SELECT DISTINCT A.student FROM FREQUENTS A
WHERE
    parlor IN
        (SELECT parlor FROM SERVES B
        WHERE B.ice-cream IN
            (SELECT ice-cream
            FROM LIKES C
            WHERE C.student = A.student));
```

3 votes

-- Arjun Suresh (150k points)

5.12.23 Sql: GATE2006_67 [top](#)

<http://gateoverflow.in/1845>

Selected Answer

I think only statement 4 is correct.
[need @arjun Sir to verify it]

page 1

Relation Account with distinct balance account values.

| customer | balance |
|----------|---------|
| a | 1000 |
| b | 900 |
| c | 700 |
| d | 500 |
| e | 800 |
| f | 600 |

Query1:

| customer | rank |
|----------|------|
| a | 1 |
| b | 2 |
| c | 4 |
| d | 6 |
| e | 3 |
| f | 5 |

| customer | balance |
|----------|---------|
| a | 1000 |
| b | 900 |
| c | 700 |
| d | 500 |
| e | 800 |
| f | 600 |

Query2:

| customer | rank |
|----------|------|
| b | 2 |
| c | 4 |
| d | 6 |
| e | 3 |
| f | 5 |

So In this case, Query1 is correct implementation of query2 is not correct implementation.

(Since the condition $a.balance < b.balance$ will never hold true for customer having maxbalance, so we cannot assign rank 1 to any customer.)

page2

relation Account with duplicate balances

| Customer | Balance |
|----------|---------|
| a | 1000 |
| b | 900 |
| c | 1000 |
| d | 800 |
| e | 600 |
| f | 500 |
| g | 700 |

| Customer | Balance |
|----------|---------|
| a | 1000 |
| b | 900 |
| c | 1000 |
| d | 800 |
| e | 600 |
| f | 500 |
| g | 700 |

olp of query 1:

| Customer | rank |
|----------|------|
| a | 2 |
| b | |
| c | |
| d | |
| e | |
| f | |
| g | |

→ Here 'a' should get rank 1 but it is giving '2', so, query 1 is not correct implementation, if they there are duplicates in 'balance' values.

olp of query 2:

| Customer | rank |
|----------|------|
| a | |
| b | |

→ Here 'a' row will never be displayed in output since $a.balance < b.balance$ i.e $1000 < 1000$ will be never evaluated to true.

So, query 1 & query 2 are not correct implementations of the given specification.

⇒ option (d) is correct. So, only statement (4) is correct.

2 votes

-- Akhil Nadh Pullolikkal Chandran (6.9k points)

5.12.24 Sql: GATE2006-IT_85 top<http://gateoverflow.in/3641>

4 for finding red cars with 20 for Did & 4 for finding green cars with 10 for Did

red Did : 22 31 64

green Did : 22 31 74

6 for intersection

1 for searching 22 in driver relation

& 3 for 31

total $38+6+4=48$

therefore **B is the answer**

4 votes

-- paras17jain (65 points)

5.12.25 Sql: GATE2008-IT_74 top<http://gateoverflow.in/3388>



Selected Answer

D:

If Select clause consist aggregate and non - aggregate columns.All non aggregate columns in the Select clause must appear in Group By clause. But in this query Group by clause consists school-id instead of school-name

<http://weblogs.sqlteam.com/jeffs/archive/2007/07/20/but-why-must-that-column-be-contained-in-an-aggregate.aspx>

14 votes

-- erravi90 (171 points)

5.12.26 Sql: GATE1999_2.25 [top](#)

<http://gateoverflow.in/1502>



Selected Answer

(d)

SQL wont remove duplicates like relational algebra projection, we have to remove it explicitly by distinct.

If there are no indexes on the relation SQL will either chose one/more on its own or simply work without any index. No index would just slow the query but it will surely work.

SQL does not permit 2 attributes to have same name in a relation.

9 votes

-- Aravind (3k points)

5.12.27 Sql: GATE2010-19 [top](#)

<http://gateoverflow.in/2194>



Selected Answer

(c)1,3

the inner query gives passenger_id with age above 65 i.e. 1,2,3

the outer query chooses the class as AC, which are 1 and 3

9 votes

-- Aravind (3k points)

5.12.28 Sql: GATE1999_22 [top](#)

<http://gateoverflow.in/1521>



Selected Answer

(a)

```
select Employee-name
from EMP, DEPT
where Salary>50000 and EMP.Dept-no=DEPT.Dept-no and Location="Calcutta"
```

(b)

```
select Dept-no, count(*)
from EMP where salary > 100000
group by Dept-no
```

5 votes

-- Aravind (3k points)

5.12.29 Sql: GATE2011_46 [top](#)

<http://gateoverflow.in/2148>



Selected Answer

i think ans is (c)

when we perform natural join on S and T then result will be like this

| Borrower | Bank Manager | Loan Amount |
|----------|--------------|-------------|
| Ramesh | Sunderajan | 10,000 |
| Ramesh | Sunderajan | 7000 |
| Suresh | Ramgopala | 5000 |
| Mahesh | Sunderajan | 10,000 |
| Mahesh | Sunderajan | 7000 |

after that count (*) will count total tuples present in this table so here it is 5

9 votes

-- neha pawar (3.8k points)

5.12.30 Sql: GATE2007_61 top

<http://gateoverflow.in/1259>



Selected Answer

Answer: A

Create a table like this:

```
create table employee(empId int(50), name varchar(50), department int(50), salary int(50));
insert into employee values (1, 'a', 4, 90);
insert into employee values (2, 'b', 5, 30);
insert into employee values (3, 'c', 5, 50);
insert into employee values (4, 'd', 5, 80);
insert into employee values (8, 'f', 7, 10);
```

Q1 returns 1 for the above table. See here: <http://sqlfiddle.com/#!9/9acce/1>

Q2 returns empId of those employees who get salary more than the minimum salary offered in department 5. It returns 1,3,4 for the above table. See here: <http://sqlfiddle.com/#!9/9acce/2>

According to the question the answer should be 1 for the above table.

PS: The question implies that the required employee must not be from department 5.

12 votes

-- Rajarshi Sarkar (29.7k points)

5.12.31 Sql: GATE2011_32 top

<http://gateoverflow.in/2134>



Selected Answer

X = 1, Y = 1

X = 2, Y = 2*1 + 1 = 3

X = 3, Y = 2*3 + 1 = 7

X = 4, Y = 2*7 + 1 = 15

X = 5, Y = 2*15 + 1 = 31

X = 6, Y = 2*31+1 = 63

X = 7, Y = 2*63 + 1 = 127

9 votes

-- Arjun Suresh (150k points)

5.12.32 Sql: GATE2004_53 [top](#)<http://gateoverflow.in/1049>

Selected Answer

D is the answer.

The inner query is over all department and over both male and female employees while the outer query is only for male employees.

6 votes

-- Arjun Suresh (150k points)

5.12.33 Sql: GATE2006_68 [top](#)<http://gateoverflow.in/1846>

Selected Answer

Query 1 and Query 3: output will be same

and Query 2 and 4, output will be same

I have run these queries on online compiler, this what I get

```

BEGIN TRANSACTION;

-- /* Create a table called NAMES */
-- CREATE TABLE E(Id integer);
-- CREATE TABLE P(Id integer);
-- 
-- /* Create few records in this table */
-- INSERT INTO E VALUES(1);
-- INSERT INTO E VALUES(1);
-- INSERT INTO E VALUES(3);
-- INSERT INTO E VALUES(3);
-- 
-- INSERT INTO P VALUES(1);
-- INSERT INTO P VALUES(2);
-- INSERT INTO P VALUES(3);
-- INSERT INTO P VALUES(4);

COMMIT;

/* Display all the records from the table */
-- SELECT * FROM E;
-- select "-----";
-- SELECT * FROM P;
-- select "-----";
select "Query 1:";
select E.id from E
where E.id in (select P.id from P);

select "Query 2:";
select id from P
where id in (select id from E);

select "Query 3:";

select E.id from E e, P p
where e.id = p.id;

select "Query 4:";
select id from P
where exists (select * from E where E.id = P.id);

/* output */
Query 1:
1
1
3
3
Query 2:
1
3
Query 3:
1
Query 4:
1
3

```

```

1
3
3
Query 4:
1
3

```

So according to me answer should be **B**.

10 votes

-- Vikrant Singh (11k points)

5.13

Transactions top

5.13.1 Transactions: GATE2014-2_29 top

<http://gateoverflow.in/1988>

Consider the following schedule **S** of transactions T1, T2, T3, T4:

| T1 | T2 | T3 | T4 |
|---------------------|---------------------------------|---------------------|--------------------------------|
| Writes(X) Commit | Reads(X) | Writes(X) Commit | |
| | Writes(Y) Reads(Z) Commit | | Reads(X) Reads(Y) Commit |

Which one of the following statements is CORRECT?

- (A) **S** is conflict-serializable but not recoverable
- (B) **S** is not conflict-serializable but is recoverable
- (C) **S** is both conflict-serializable and recoverable
- (D) **S** is neither conflict-serializable nor is it recoverable

[gate2014-2](#) [databases](#) [transactions](#) [normal](#)

Answer

5.13.2 Transactions: GATE2010-42 top

<http://gateoverflow.in/2343>

Consider the following schedule for transactions T1, T2 and T3:

| T1 | T2 | T3 |
|----------|----------|----------|
| Read(X) | Read(Y) | Read(Y) |
| Write(X) | Write(Y) | Write(X) |

Read(X)

T1 **W₂ite(X)** **T3**

Which one of the schedules below is the correct serialization of the above?

- A. $T_1 \rightarrow T_3 \rightarrow T_2$
- B. $T_2 \rightarrow T_1 \rightarrow T_3$
- C. $T_2 \rightarrow T_3 \rightarrow T_1$
- D. $T_3 \rightarrow T_1 \rightarrow T_2$

[gate2010](#) [databases](#) [transactions](#) [normal](#)

[Answer](#)

5.13.3 Transactions: GATE 2016-1-22 [top](#)

<http://gateoverflow.in/39644>

Which one of the following is NOT a part of the ACID properties of database transactions?

- A. Atomicity
- B. Consistency
- C. Isolation
- D. Deadlock-freedom

[gate2016-1](#) [databases](#) [transactions](#) [easy](#)

[Answer](#)

5.13.4 Transactions: GATE 2016-1-51 [top](#)

<http://gateoverflow.in/39703>

Consider the following two phase locking protocol. Suppose a transaction T accesses (for read or write operations), a certain set of objects $\{O_1, \dots, O_k\}$. This is done in the following manner:

Step 1 . T acquires exclusive locks to O_1, \dots, O_k in increasing order of their addresses.

Step 2 . The required operations are performed .

Step 3 . All locks are released

This protocol will

- A. guarantee serializability and deadlock-freedom
- B. guarantee neither serializability nor deadlock-freedom
- C. guarantee serializability but not deadlock-freedom
- D. guarantee deadlock-freedom but not serializability.

[gate2016-1](#) [databases](#) [transactions](#) [normal](#)

[Answer](#)

5.13.5 Transactions: GATE2010-20 [top](#)

<http://gateoverflow.in/2196>

Which of the following concurrency control protocols ensure both conflict serializability and freedom from deadlock?

- I. 2-phase locking
- II. Time-stamp ordering
 - A. I only
 - B. II only
 - C. Both I and II
 - D. Neither I nor II

[gate2010](#) [databases](#) [transactions](#) [normal](#)

[Answer](#)

5.13.6 Transactions: GATE2014-3_29 [top](#)

<http://gateoverflow.in/2063>

Consider the transactions T_1, T_2 , and T_3 and the schedules S_1 and S_2 given below.

$T_1 : r_1(X); r_1(Z); w_1(X); w_1(Z)$

$T_2 : r_2(Y); r_2(Z); w_2(Z)$

$T_3 : r_3(Y); r_3(X); w_3(Y)$

$S_1 : r_1(X); r_3(Y); r_3(X); r_2(Y); r_2(Z); w_3(Y); w_2(Z); r_1(Z); w_1(X); w_1(Z)$

$S_2 : r_1(X); r_3(Y); r_2(Y); r_3(X); r_1(Z); r_2(Z); w_3(Y); w_1(X); w_2(Z); w_1(Z)$

Which one of the following statements about the schedules is **TRUE**?

(A) Only
 S_1 is conflict-serializable.

(B) Only
 S_2 is conflict-serializable.

(C) Both
 S_1 and
 S_2 are conflict-serializable.

(D) Neither
 S_1 nor
 S_2 is conflict-serializable.

[gate2014-3](#) | [databases](#) | [transactions](#) | [normal](#)

Answer

5.13.7 Transactions: GATE2014-1_29 [top](#)

<http://gateoverflow.in/1796>

Consider the following four schedules due to three transactions (indicated by the subscript) using *read* and *write* on a data item x , denoted by $r(x)$ and $w(x)$ respectively. Which one of them is conflict serializable?

(A)
 $r_1(x);$
 $r_2(x);$
 $w_1(x);$
 $r_3(x);$
 $w_2(x);$

(B)
 $r_2(x);$
 $r_1(x);$
 $w_2(x);$
 $r_3(x);$
 $w_1(x);$

(C)
 $r_3(x);$
 $r_2(x);$
 $r_1(x);$
 $w_2(x);$
 $w_1(x);$

(D)
 $r_2(x);$
 $w_2(x);$
 $r_3(x);$
 $r_1(x);$
 $w_1(x);$

Answer**5.13.8 Transactions: GATE2004-IT_77** [top](#)<http://gateoverflow.in/3721>

Consider the following schedule S of transactions T1 and T2:

| T1 | T2 |
|---|---|
| Read(A) A = A - 10 | Read (A) Temp = 0.2*A Write(A) Read(B) |
| Write(A) Read(B) B = B + 10 Write(B) | B = B + Temp Write(B) |

Which of the following is TRUE about the schedule S ?

- A. S is serializable only as T1, T2
- B. S is serializable only as T2, T1
- C. S is serializable both as T1, T2 and T2, T1
- D. S is serializable either as T1 or as T2

Answer**5.13.9 Transactions: GATE2012_27** [top](#)<http://gateoverflow.in/1612>

Consider the following transactions with data items P and Q initialized to zero:

| | |
|-------|--|
| T_1 | <pre>read (P); read (Q); if P = 0 then Q := Q + 1 ; write (Q).</pre> |
| T_2 | <pre>read (Q); read (P); if Q = 0 then P := P + 1 ; write (P)</pre> |

Any non-serial interleaving of T_1 and T_2 for concurrent execution leads to

- (A) a serializable schedule
- (B) a schedule that is not conflict serializable
- (C) a conflict serializable schedule
- (D) a schedule for which a precedence graph cannot be drawn

Answer**5.13.10 Transactions: GATE2015-3_29** [top](#)<http://gateoverflow.in/8482>

Consider the partial Schedule S involving two transactions $T1$ and $T2$. Only the read and the write operations have been shown. The read operation on data item P is denoted by $\text{read}(P)$ and write operation on data item P is denoted by $\text{write}(P)$.

Schedule S

| Time Instance | Transaction id | |
|---------------|-------------------|-------------------|
| | $T1$ | $T2$ |
| 1 | $\text{read}(A)$ | |
| 2 | $\text{write}(A)$ | |
| 3 | | $\text{read}(C)$ |
| 4 | | $\text{write}(C)$ |
| 5 | | $\text{read}(B)$ |
| 6 | | $\text{write}(B)$ |
| 7 | | $\text{read}(A)$ |
| 8 | | commit |
| 9 | $\text{read}(B)$ | |

Suppose that the transaction $T1$ fails immediately after time instance 9. Which of the following statements is correct?

- A. $T2$ must be aborted and then both $T1$ and $T2$ must be re-started to ensure transaction atomicity
- B. Schedule S is non-recoverable and cannot ensure transaction atomicity
- C. Only $T2$ must be aborted and then re-started to ensure transaction atomicity
- D. Schedule S is recoverable and can ensure transaction atomicity and nothing else needs to be done

gate2015-3 databases transactions normal

Answer

5.13.11 Transactions: GATE1999_2.6 [top](#)

<http://gateoverflow.in/1484>

For the schedule given below, which of the following is correct:

- | | | |
|---|---------|---------|
| 1 | Read A | |
| 2 | | Read B |
| 3 | Write A | |
| 4 | | Read A |
| 5 | | Write A |
| 6 | | Write B |
| 7 | Read B | |
| 8 | Write B | |

- A. This schedule is serializable and can occur in a scheme using 2PL protocol
- B. This schedule is serializable but cannot occur in a scheme using 2PL protocol
- C. This schedule is not serializable but can occur in a scheme using 2PL protocol
- D. This schedule is not serializable and cannot occur in a scheme using 2PL protocol

gate1999 databases transactions normal

Answer

5.13.12 Transactions: GATE2008-IT_63 [top](#)

<http://gateoverflow.in/3374>

Consider the following three schedules of transactions $T1$, $T2$ and $T3$. [Notation: In the following NYO represents the action Y (R for read, W for write) performed by transaction N on object O.]

(S1) 2RA 2WA 3RC 2WB 3WA 3WC 1RA 1RB 1WA 1WB
 (S2) 3RC 2RA 2WA 2WB 3WA 1RA 1RB 1WA 1WB 3WC
 (S3) 2RZ 3RC 3WA 2WA 2WB 3WC 1RA 1RB 1WA 1WB

Which of the following statements is TRUE?

- 1) S1, S2 and S3 are all conflict equivalent to each other
- 2) No two of S1, S2 and S3 are conflict equivalent to each other
- 3) S2 is conflict equivalent to S3, but not to S1
- 4) S1 is conflict equivalent to S2, but not to S3

gate2008-it databases transactions normal

Answer

5.13.13 Transactions: GATE2007-IT-66 [top](#)

<http://gateoverflow.in/3511>

Consider the following two transactions : T₁ and T₂.

| | |
|---------------------|-----------------------|
| T_1 | T_2 |
| : read (A); | : read (B); |
| read (B); | read (A); |
| if A = 0 then B ← B | if B ≠ 0 then A ← A - |
| + 1; | 1; |
| write (B); | write (A); |

Which of the following schemes, using shared and exclusive locks, satisfy the requirements for strict two phase locking for the above transactions?

A.

| | |
|------------------|------------------|
| S_1 lock S(A); | S_2 lock S(B); |
| : read (A); | : read (B); |
| lock S(B); | lock S(A); |
| read (B); | read (A); |
| if A = 0 | if B ≠ 0 |
| then B ← B | then A ← A |
| + 1; | - 1; |
| write (B); | write (A); |
| commit; | commit; |
| unlock (A); | unlock (B); |
| unlock (B); | unlock (A); |

B.

| | |
|------------------|------------------|
| S_1 lock X(A); | S_2 lock X(B); |
| : read (A); | : read (B); |
| lock X(B); | lock X(A); |
| read (B); | read (A); |
| if A = 0 | if B ≠ 0 |
| then B ← B | then A ← A |
| + 1; | - 1; |
| write (B); | write (A); |
| unlock (A); | unlock (A); |
| commit; | commit; |
| unlock (B); | unlock (A); |

C.

| | |
|------------------|------------------|
| S_1 lock S(A); | S_2 lock S(B); |
| : read (A); | : read (B); |
| lock X(B); | lock X(A); |
| read (B); | read (A); |
| if A = 0 | if B ≠ 0 |
| then B ← B | then A ← A |
| + 1; | - 1; |
| write (B); | write (A); |
| unlock (A); | unlock (B); |
| commit; | commit; |
| unlock (B); | unlock (A); |

D.

| | |
|-------|-------|
| S_1 | S_2 |
|-------|-------|

```

: lock S(A);    : lock S(B);
read (A);       read (B);
lock X(B);     lock X(A);
read (B);       read (A);
if A = 0        if B ≠ 0
then B ← B     then A ← A
+ 1;           - 1;
write (B);     write (A);
unlock (A);   unlock (A);
unlock (B);   unlock (B);
commit;        commit;

```

gate2007-it | databases | transactions | normal

Answer

5.13.14 Transactions: GATE2003-29, ISRO2009-73 [top](#)

<http://gateoverflow.in/919>

Which of the following scenarios may lead to an irrecoverable error in a database system?

- A. A transaction writes a data item after it is read by an uncommitted transaction
- B. A transaction reads a data item after it is read by an uncommitted transaction
- C. A transaction reads a data item after it is written by a committed transaction
- D. A transaction reads a data item after it is written by an uncommitted transaction

gate2003 | databases | transactions | easy | isro2009

Answer

5.13.15 Transactions: GATE2015-2_1 [top](#)

<http://gateoverflow.in/8047>

Consider the following transaction involving two bank accounts x and y .

```
read(x); x:=x-50; write(x); read(y); y:=y+50; write(y)
```

The constraint that the sum of the accounts x and y should remain constant is that of

- A. Atomicity
- B. Consistency
- C. Isolation
- D. Durability

gate2015-2 | databases | transactions | easy

Answer

5.13.16 Transactions: GATE2009-43 [top](#)

<http://gateoverflow.in/1329>

Consider two transactions T_1 and T_2 , and four schedules S_1, S_2, S_3, S_4 , of T_1 and T_2 as given below:

$T_1 : R_1[x]W_1[x]W_1[y]$

$T_2 : R_2[x]R_2[y]W_2[y]$

$S_1 : R_1[x]R_2[x]R_2[y]W_1[x]W_1[y]W_2[y]$

$S_2 : R_1[x]R_2[x]R_2[y]W_1[x]W_2[y]W_1[y]$

$S_3 : R_1[x]W_1[x]R_2[x]W_1[y]R_2[y]W_2[y]$

$S_4 : R_2[x]R_2[y]R_1[x]W_1[x]W_1[y]W_2[y]$

Which of the above schedules are conflict-serializable?

- A. S_1 and S_2
- B. S_2 and S_3
- C. S_3 only

D. S_4 only

gate2009 databases transactions normal

Answer

5.13.17 Transactions: GATE2007-64 [top](#)

<http://gateoverflow.in/1262>

Consider the following schedules involving two transactions. Which one of the following statements is **TRUE**?

- $S_1 : r_1(X); r_1(Y); r_2(X); r_2(Y); w_2(Y); w_1(X)$
- $S_2 : r_1(X); r_2(X); r_2(Y); w_2(Y); r_1(Y); w_1(X)$

- A. Both S_1 and S_2 are conflict serializable.
- B. S_1 is conflict serializable and S_2 is not conflict serializable.
- C. S_1 is not conflict serializable and S_2 is conflict serializable.
- D. Both S_1 and S_2 are not conflict serializable.

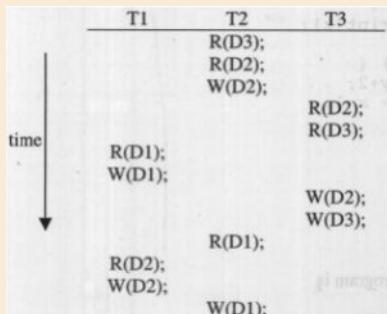
gate2007 databases transactions normal

Answer

5.13.18 Transactions: GATE2003_87 [top](#)

<http://gateoverflow.in/970>

Consider three data items D1, D2, and D3, and the following execution schedule of transactions T1, T2, and T3. In the diagram, R(D) and W(D) denote the actions reading and writing the data item D respectively.



Which of the following statements is correct?

- A. The schedule is serializable as T2; T3; T1
- B. The schedule is serializable as T2; T1; T3
- C. The schedule is serializable as T3; T2; T1
- D. The schedule is not serializable

gate2003 databases transactions normal

Answer

5.13.19 Transactions: GATE2005-IT_67 [top](#)

<http://gateoverflow.in/3830>

A company maintains records of sales made by its salespersons and pays them commission based on each individual's total sales made in a year. This data is maintained in a table with following schema:

`salesinfo = (salespersonid, totalsales, commission)`

In a certain year, due to better business results, the company decides to further reward its salespersons by enhancing the commission paid to them as per the following formula:

If commission ≤ 50000 , enhance it by 2%
 If $50000 < \text{commission} \leq 100000$, enhance it by 4%
 If $\text{commission} > 100000$, enhance it by 6%

The IT staff has written three different SQL scripts to calculate enhancement for each slab, each of these scripts is to run as a separate transaction as follows:

T1
`Update salesinfo
Set commission = commission * 1.02
Where commission <= 50000;`

T2
`Update salesinfo
Set commission = commission * 1.04
Where commission > 50000 and commission is <= 100000;`

T3
`Update salesinfo
Set commission = commission * 1.06
Where commission > 100000;`

Which of the following options of running these transactions will update the commission of all salespersons correctly

- 1) Execute T1 followed by T2 followed by T3
- 2) Execute T2, followed by T3; T1 running concurrently throughout
- 3) Execute T3 followed by T2; T1 running concurrently throughout
- 4) Execute T3 followed by T2 followed by T1

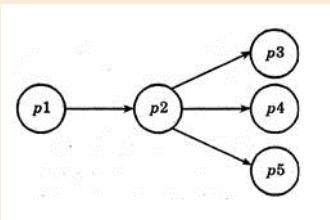
[gate2005-it](#) [databases](#) [transactions](#) [normal](#)

[Answer](#)

5.13.20 Transactions: GATE2005-IT_66 [top](#)

<http://gateoverflow.in/3828>

In a data flow diagram, the segment shown below is identified as having transaction flow characteristics, with p2 identified as the transaction center



A first level architectural design of this segment will result in a set of process modules with an associated invocation sequence. The most appropriate architecture is

- A) p1 invokes p2, p2 invokes either p3, or p4, or p5
- B) p2 invokes p1, and then invokes p3, or p4, or p5
- C) A new module Tc is defined to control the transaction flow. This module Tc first invokes p1 and then invokes p2. p2 in turn invokes p3, or p4, or p5
- D) A new module Tc is defined to control the transaction flow. This module Tc invokes p2. p2 invokes p1, and then invokes p3, or p4, or p5

[gate2005-it](#) [databases](#) [transactions](#) [normal](#)

[Answer](#)

5.13.21 Transactions: GATE2005-IT_24 [top](#)

<http://gateoverflow.in/3769>

Amongst the ACID properties of a transaction, the 'Durability' property requires that the changes made to the database by a successful transaction persist

- 1) Except in case of an Operating System crash
- 2) Except in case of a Disk crash
- 3) Except in case of a power failure
- 4) Always, even if there is a failure of any kind

[gate2005-it](#) [databases](#) [transactions](#) [easy](#)

[Answer](#)

5.13.22 Transactions: GATE2006-20, ISRO2015-17 [top](#)

<http://gateoverflow.in/981>

Consider the following log sequence of two transactions on a bank account, with initial balance 12000, that transfer 2000 to a mortgage payment and then apply a 5% interest.

1. T1 start
2. T1 B old=1200 new=10000
3. T1 M old=0 new=2000
4. T1 commit
5. T2 start
6. T2 B old=10000 new=10500
7. T2 commit

Suppose the database system crashes just before log record 7 is written. When the system is restarted, which one statement is true of the recovery procedure?

- (A) We must redo log record 6 to set B to 10500
- (B) We must undo log record 6 to set B to 10000 and then redo log records 2 and 3
- (C) We need not redo log records 2 and 3 because transaction T1 has committed
- (D) We can apply redo and undo operations in arbitrary order because they are idempotent.

[gate2006](#) [databases](#) [transactions](#) [normal](#) [isro2015](#)

[Answer](#)

5.13.23 Transactions: GATE2015-2_46 [top](#)

<http://gateoverflow.in/8246>

Consider a simple checkpointing protocol and the following set of operations in the log.

```
(start, T4); (write, T4, y, 2, 3); (start, T1); (commit, T4); (write, T1, z, 5, 7);
(checkpoint);

(start, T2); (write, T2, x, 1, 9); (commit, T2); (start, T3); (write, T3, z, 7, 2);
```

If a crash happens now and the system tries to recover using both undo and redo operations, what are the contents of the undo list and the redo list?

- A. Undo: T3, T1; Redo: T2
- B. Undo: T3, T1; Redo: T2, T4
- C. Undo: none; Redo: T2, T4, T3, T1
- D. Undo: T3, T1, T4; Redo: T2

[gate2015-2](#) [databases](#) [transactions](#) [normal](#)

[Answer](#)

Answers: Transactions

5.13.1 Transactions: GATE2014-2_29 [top](#)

<http://gateoverflow.in/1988>



Selected Answer

Answer: S is both conflict serializable and recoverable.

Recoverable? Look if there are any dirty reads? Since there are no dirty read, it simply implies schedule is recoverable(if there were dirty read, then we would have taken into consideration the order in which transactions commit)

Conflict serializable? Draw the precedence graph(make edges if there is a conflict instruction among T_i and T_j . But for the given schedule, no cycle exists in precedence graph, thus it's conflict serializable.

Hope this helps.

Upvote 8 votes

-- Ramandeep Singh (175 points)

5.13.2 Transactions: GATE2010-42 [top](#)

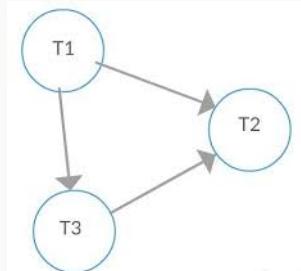
<http://gateoverflow.in/2343>



Selected Answer

answer = **option A**

create precedence graph and apply [Topological sort](#) on it to obtain
 $T1 \rightarrow T3 \rightarrow T2$



Upvote 9 votes

-- Amar Vashishth (20.7k points)

5.13.3 Transactions: GATE 2016-1-22 [top](#)

<http://gateoverflow.in/39644>



Selected Answer

- A- Atomicity
 - C- Consistency
 - I-Isolation
 - D-Durability..
- Answer D

Upvote 15 votes

-- Abhilash Panicker (7k points)

5.13.4 Transactions: GATE 2016-1-51 [top](#)

<http://gateoverflow.in/39703>



Selected Answer

Two Phase Locking protocol is conflict serializable.. so this is a modified version of the basic 2PL protocol, so serializability should be guaranteed.. and we can get a serializable scheduling by ordering based on Lock points(same as in basic 2PL).. Now in Step 1, exclusive locks are acquired to O1,O2,O3.... in increasing order of addresses..since it is mentioned as exclusive lock, only one transaction can lock the object.. Due to acquiring of locks based on ordering of addresses.. and locks aren't released until the transaction completes its operation.. we can prevent the circular wait condition, and hence making it deadlock free.

So, the answer should be A)guarantees serializability and deadlock freedom

13 votes

-- Abhilash Panicker (7k points)

5.13.5 Transactions: GATE2010-20 [top](#)

<http://gateoverflow.in/2196>



Selected Answer

in basic two phase locking there is a chance for deadlock

conservative 2pl is deadlock free

i go with B

10 votes

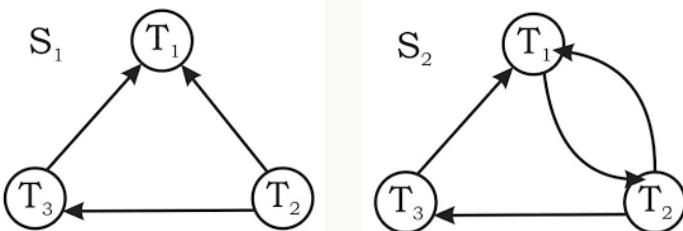
-- Sankaranarayanan P.N (9.8k points)

5.13.6 Transactions: GATE2014-3_29 [top](#)

<http://gateoverflow.in/2063>



Selected Answer



S_1 has no cycle hence, **Conflict-S Serializable**

S_2 has cycle hence **NOT Conflict-S Serializable**

answer = **option A**

8 votes

-- Amar Vashishth (20.7k points)

5.13.7 Transactions: GATE2014-1_29 [top](#)

<http://gateoverflow.in/1796>



Selected Answer

(D) make precedence graph for all the options, for option D only graph will be acyclic, hence D is CSS.

4 votes

-- Manu Thakur (5.6k points)

5.13.8 Transactions: GATE2004-IT_77 [top](#)

<http://gateoverflow.in/3721>



Selected Answer

This schedule is not serializable(not even view serializable). So none of the first 3 options match. Option (d), even I don't understand.

According to me there should have been an option saying that schedule is not serializable; neither as T1,T2 nor as T2,T1.

9 votes

-- Sandeep_Uniyal (5.5k points)

5.13.9 Transactions: GATE2012_27 [top](#)

<http://gateoverflow.in/1612>



Selected Answer

Ans is (B): explanation: T1:r(P),r(Q),w(Q) T2:r(Q),r(P),w(P) now consider any non serial schedule for example, S:r1(P),r2(Q),r1(Q),r2(P),w1(Q),w2(P) now draw a precedence graph for this schedule. here there is a conflict from T1->T2 and there is a conflict from T2->T1 therefore, the graph will contain a cycle. so we can say that the schedule is not conflict serializable.

22 votes

-- jayendra (6.6k points)

5.13.10 Transactions: GATE2015-3_29 [top](#)

<http://gateoverflow.in/8482>



Selected Answer

I think the correct option is B.

Why A is not correct because it says abort transaction T2 and then redo all the operations .

But is there a gaurantee that it will succeed this time ??(no maybe again T1 will fail)..

now as to why b is correct because as the other answer points out it is by definition an irrecoverable schedule now even if we start to undo the actions on by one(after t1 fails) in order to ensure transaction atomicity. Still we cannot undo a committed transaction. hence this schedule is unrecoverable by definition and also not atomic since it leaves the data base in an inconsistent state.

12 votes

-- Tamojit Chatterjee (1.9k points)

5.13.11 Transactions: GATE1999_2.6 [top](#)

<http://gateoverflow.in/1484>



Selected Answer

If we draw the precedence graph we get a loop, and hence the schedule is not conflict serializable.

There is no blind write too so ,there is no chance that view serializability can occur.

Now 2pl ensures CS.

Since possibility of CS is ruled out at the onset, so schedule cannot occur in 2PL.

Ans d)

4 votes

-- Sourav Roy (2.7k points)

5.13.12 Transactions: GATE2008-IT_63 [top](#)

<http://gateoverflow.in/3374>



Selected Answer

Answer: D

Two schedules are conflict equivalent when the precedence graphs are isomorphic.

For S1, edges in precedence graph are: 2->3, 3->1, 2->1.

For S2, edges in precedence graph are: 2->1, 3->1, 2->3.

For S3, edges in precedence graph are: 3->1, 3->2, 2->1.

Hence, S1 is conflict equivalent to S2, but not to S3.

2 votes

-- Rajarshi Sarkar (29.7k points)

5.13.13 Transactions: GATE2007-IT-66 [top](#)

<http://gateoverflow.in/3511>



Selected Answer

Answer is (C)

Many of you would point a DEADLOCK and I won't deny But see Question just asks for requirement to follow Strict 2PL . Requirement is that

1. Exclusive locks should be released after the commit . and

2. No Locking can be done after the first Unlock and vice versa.

In 2PL deadlock may occur BUT it may be that it doesn't occur at all.

Consider that in option (C) if both execute in serial order without concurrency.Then that is perfectly valid and YES it follows Strict 2PL.

10 votes

-- Sandeep_Uniyal (5.5k points)

5.13.14 Transactions: GATE2003-29, ISRO2009-73 [top](#)

<http://gateoverflow.in/919>



Selected Answer

D) This is dirty read. In case if transaction reading uncommitted data commits, irrecoverable error occurs of uncommitted transaction fails. So D is answer

B) This is non issue.Both transaction reading data.

C) This is non issue.

A) Here if transaction writing data commits , then transaction which read the data might get phantom tuple/ Unrepeatable error. Though there is no irrecoverable error possible even in this option.

8 votes

-- Akash (31.7k points)

5.13.15 Transactions: GATE2015-2_1 [top](#)

<http://gateoverflow.in/8047>



Selected Answer

B. Consistency

In the given transaction Atomicity guarantees that the said constraint is satisfied. But this constraint is not part of Atomicity property. It is just that Atomicity implies Consistency here.

5 votes

-- Arjun Suresh (150k points)

Kindly check out PPT for Transaction chapter in below link.(Part 5: Transaction Management Ch. 15)

<http://www.cse.iitb.ac.in/~sudarsha/db-book/slide-dir/>

Question is directly taken from Korth. And wording almost completely matches to Consistency requirement.

1 5 votes

-- kshirsagar1992 (63 points)

5.13.16 Transactions: GATE2009-43 [top](#)

<http://gateoverflow.in/1329>



Selected Answer

The answer is B.

S1 has a cycle from T1-->T2 and T2-->T1.

S2-- . It is uni-directional and has only T2-->T1.

S3-- It is uni-directional and has only T1-->T2.

S4-- same as S1.

A schedule is conflict serializable if there is no cycle in the directed graph made by the schedules.

In the schedules we check for RW, WR, WW conflicts between the schedules. and these conflicts only contribute in the edges of the graph.

1 4 votes

-- Gate Keeda (17.7k points)

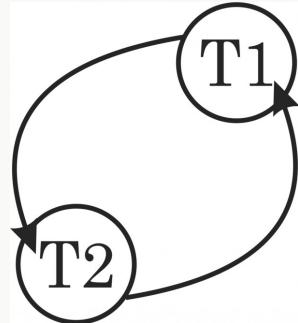
5.13.17 Transactions: GATE2007-64 [top](#)

<http://gateoverflow.in/1262>

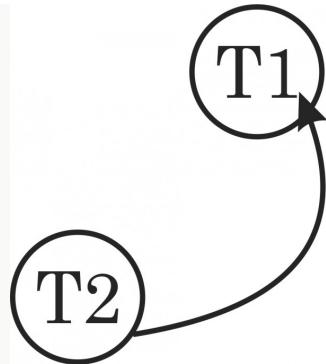


Selected Answer

For S1 : it is **not conflict serializable**



for S2 : it is **conflict serializable**



answer = **option C**

4 votes

-- Amar Vashishth (20.7k points)

5.13.18 Transactions: GATE2003_87 [top](#)

<http://gateoverflow.in/970>



Selected Answer

der is cycle in precedence graph so schedule is not conflict serialisable.
check View Serialization.
checking View Serialization is NPC problem so proving by contradiction..

1. Initial Read
T2 read D2 value from initial database and T1 modify D2 so T2 should execute before T1.
i.e. T2 -----> T1
2. final write.
final write of D1 in given schedule done by T2 and T1 modify D1 i.e. W(D1)..
that means T2 should execute after T1..
i.e. T1 -----> T2

clearly schedule not even view Serializable.
Not Serializable..

7 votes

-- Digvijay (35.8k points)

5.13.19 Transactions: GATE2005-IT_67 [top](#)

<http://gateoverflow.in/3830>



Selected Answer

T3 followed by T2 followed by T1 will be correct execution sequence

other cases some people will get two times increment

eg if we have T1 followed by T2

if initial commision is 49500

then he is belonging to < 50000

hence $49500 \times 1.02 = 50490$

now he is eligible in second category

then $50490 \times 1.04 = 52509.6$

so he wil get increment two times. but he is eligible for only one slab of commision

9 votes

-- Sankaranarayanan P.N (9.8k points)

5.13.20 Transactions: GATE2005-IT_66 [top](#)

<http://gateoverflow.in/3828>

Answer: C

A new module T_c is defined to invoke p_1 as p_1 isn't being invoked in the diagram. Later, p_1 invokes p_2 which then invokes p_3 , p_4 or p_5 .

1 votes

-- Rajarshi Sarkar (29.7k points)

5.13.21 Transactions: GATE2005-IT_24 [top](#)

<http://gateoverflow.in/3769>



Selected Answer

answer d. irrespective of any failure the successful result of transaction should persist.

suppose we book ticket 2 months in advance in irctc and transaction success

then when we are going to board the train on that time they tells because of system/disk/power crash they dont have your seat information and you are not allowed in the seat

it is a serious problem. hence result should persist irrespective of all crashes

12 votes

-- Sankaranarayanan P.N (9.8k points)

5.13.22 Transactions: GATE2006-20, ISRO2015-17 [top](#)

<http://gateoverflow.in/981>



Selected Answer

ans should be B here we arent using checkpoints so redo log records 2 and 3 and undo log record 6. Consider the following screenshot taken from the book 'Navathe':

PROCEDURE RIU_M

1. Use two lists of transactions maintained by the system: the committed transactions since the last checkpoint and the active transactions.
2. Undo all the write_tem operations of the active (uncommitted) transactions using the UNDO procedure. The operations should be undone in the reverse of the order in which they were written into the log.
3. Redo all the write_tem operations of the committed transactions from the log in the order in which they were written into the log.

13 votes

-- Pooja (25.9k points)

5.13.23 Transactions: GATE2015-2_46 [top](#)

<http://gateoverflow.in/8246>



Selected Answer

| T1 | T2 | T3 | T4 |
|------------|------------|------------|------------|
| | | | start |
| | | | W(y,2,3) |
| start | | | commit |
| W(z,5,7) | | | |
| Checkpoint | Checkpoint | Checkpoint | Checkpoint |
| | start | | |
| | W(x,1,9) | | |
| | commit | | |
| | | start | |
| | | W(z,7,2) | |



Now from the table we can find , T1 and T3 has uncommitted write operation , so they must be undone. and even though T2 has committed after writing , but it is after checkpoint. So , it needs to be redone. So answer is A.

11 votes

-- Shounak Kundu (4.1k points)

6**Digital Logic (209)**[top](#)**6.0.1 GATE2012_6** [top](#)<http://gateoverflow.in/38>

The truth table

| X | Y | (X,Y) |
|---|---|-------|
| 0 | 0 | 0 |
| 0 | 1 | 0 |
| 1 | 0 | 1 |
| 1 | 1 | 1 |

represents the Boolean function

- (A) X
 (B) $X + Y$
 (C) $X \oplus Y$
 (D) Y

[gate2012](#) [digital-logic](#) [easy](#)[Answer](#)**6.0.2 GATE2007-34** [top](#)<http://gateoverflow.in/1232>

Suppose only one multiplexer and one inverter are allowed to be used to implement any Boolean function of n variables. What is the minimum size of the multiplexer needed?

- A. 2^n line to 1 line
 B. 2^{n+1} line to 1 line
 C. 2^{n-1} line to 1 line
 D. 2^{n-2} line to 1 line

[gate2007](#) [digital-logic](#) [normal](#)[Answer](#)**6.0.3 GATE1994_4** [top](#)<http://gateoverflow.in/2500>

- a. Let $*$ be a Boolean operation defined as $A * B = AB + \bar{A} \bar{B}$. If $C = A * B$ then evaluate and fill in the blanks:
 i. $A * A = \underline{\hspace{2cm}}$
 ii. $C * A = \underline{\hspace{2cm}}$
- b. Solve the following boolean equations for the values of A, B and C :
 $AB + \bar{A}C = 1$
 $AC + B = 0$

[gate1994](#) [digital-logic](#) [normal](#)
Answer**6.0.4 GATE2005_18** [top](#)<http://gateoverflow.in/1354>

The switching expression corresponding to $f(A, B, C, D) = \Sigma(1, 4, 5, 9, 11, 12)$ is:

- A. $BC'D' + A'C'D + AB'D$
- B. $ABC' + ACD + B'C'D$
- C. $ACD' + A'BC' + AC'D'$
- D. $A'BD + ACD' + BCD'$

[gate2005](#) [digital-logic](#) [normal](#)
Answer**6.0.5 GATE1996_1.21** [top](#)<http://gateoverflow.in/2725>

A ROM is used to store the table for multiplication of two 8-bit unsigned integers. The size of ROM required is

1. 256×16
2. $64 K \times 8$
3. $4 K \times 16$
4. $64 K \times 16$

[gate1996](#) [digital-logic](#) [normal](#)
Answer**6.0.6 GATE1996_5** [top](#)<http://gateoverflow.in/2757>

A logic network has two data inputs A and B , and two control inputs C_0 and C_1 . It implements the function F according to the following table.

| C_1 | C_2 | F |
|-------|-------|--------------|
| 0 | 0 | $A + B$ |
| 0 | 1 | $A + B$ |
| 1 | 0 | $A \oplus B$ |

Implement the circuit using one 4 to 1 Multiplexer, one 2-input Exclusive OR gate, one 2-input AND gate, one 2-input OR gate and one Inverter.

[gate1996](#) [digital-logic](#) [normal](#)
Answer**6.0.7 GATE2006_36** [top](#)<http://gateoverflow.in/1294>

Given two three bit numbers $a_2a_1a_0$ and $b_2b_1b_0$ and c the carry in, the function that represents the carry generate function when these two numbers are added is:

- (A) $a_2b_2 + a_2a_1b_1 + a_2a_1a_0b_0 + a_2a_0b_1b_0 + a_1b_2b_1 + a_1a_0b_2b_0 + a_0b_2b_1b_0$
- (B) $a_2b_2 + a_2b_1b_0 + a_2a_1b_1b_0 + a_1a_0b_2b_1 + a_1a_0b_2 + a_1a_0b_2b_0 + a_2a_0b_1b_0$

- (C) $a_2 + b_2 + (a_2 \oplus b_2)(a_1 + b_1 + (a_1 \oplus b_1) + (a_0 + b_0))$
 (D) $a_2 b_2 + \bar{a}_2 a_1 b_1 + \bar{a}_2 \bar{a}_1 a_0 b_0 + \bar{a}_2 a_0 \bar{b}_1 b_0 + a_1 \bar{b}_2 b_1 + \bar{a}_1 a_0 \bar{b}_2 b_0 + a_0 \bar{b}_2 \bar{b}_1 b_0$

gate2006 | digital-logic | normal

Answer

6.0.8 GATE2007_48 top

<http://gateoverflow.in/1246>

Which of the following is TRUE about formulae in Conjunctive Normal Form?

- A. For any formula, there is a truth assignment for which at least half the clauses evaluate to true.
- B. For any formula, there is a truth assignment for which all the clauses evaluate to true.
- C. There is a formula such that for each truth assignment, at most one-fourth of the clauses evaluate to true.
- D. None of the above.

gate2007 | digital-logic | normal

Answer

6.0.9 GATE2008-IT_1 top

<http://gateoverflow.in/3222>

A set of Boolean connectives is functionally complete if all Boolean functions can be synthesized using those. Which of the following sets of connectives is NOT functionally complete?

- A) EX-NOR
- B) implication, negation
- C) OR, negation
- D) NAND

gate2008-it | digital-logic | easy

Answer

6.0.10 GATE2007_35 top

<http://gateoverflow.in/1233>

In a look-ahead carry generator, the carry generate function G_i and the carry propagate function P_i for inputs A_i and B_i are given by:

$$P_i = A_i \oplus B_i \text{ and } G_i = A_i B_i$$

The expressions for the sum bit S_i and the carry bit C_{i+1} of the look ahead carry adder are given by:

$$S_i = P_i \oplus C_i \text{ and } C_{i+1} = G_i + P_i C_i, \text{ where } C_0 \text{ is the input carry.}$$

Consider a two-level logic implementation of the look-ahead carry generator. Assume that all P_i and G_i are available for the carry generator circuit and that the AND and OR gates can have any number of inputs. The number of AND gates and OR gates needed to implement the look-ahead carry generator for a 4-bit adder with S_3, S_2, S_1, S_0 and C_4 as its outputs are respectively:

- A. 6, 3
- B. 10, 4
- C. 6, 4
- D. 10, 5

gate2007 | digital-logic | normal

Answer

6.0.11 GATE2007_33 [top](#)<http://gateoverflow.in/1231>

Define the connective $*$ for the Boolean variables X and Y as:

$$X * Y = XY + X'Y'.$$

Let $Z = X * Y$. Consider the following expressions P , Q and R .

$$P : X = Y * Z, Q : Y = X * Z, R : X * Y * Z = 1$$

Which of the following is **TRUE**?

- (A) Only P and Q are valid. (B) Only Q and R are valid.
 (C) Only P and R are valid. (D) All P , Q , R are valid.

[gate2007](#) [digital-logic](#) [normal](#)

[Answer](#)

6.0.12 GATE2013_5 [top](#)<http://gateoverflow.in/1414>

In the following truth table, $V = 1$ if and only if the input is valid.

| Inputs | | | | Outputs | | |
|--------|-------|-------|-------|---------|-------|-----|
| D_0 | D_1 | D_2 | D_3 | X_0 | X_1 | V |
| 0 | 0 | 0 | 0 | x | x | 0 |
| 1 | 0 | 0 | 0 | 0 | 0 | 1 |
| x | 1 | 0 | 0 | 0 | 1 | 1 |
| x | x | 1 | 0 | 1 | 0 | 1 |
| x | x | x | 1 | 1 | 1 | 1 |

What function does the truth table represent?

- (A) Priority encoder (B) Decoder (C) Multiplexer (D) Demultiplexer

[gate2013](#) [digital-logic](#) [normal](#)

[Answer](#)

6.0.13 GATE2007-32 [top](#)<http://gateoverflow.in/1230>

Let $f(w, x, y, z) = \sum(0, 4, 5, 7, 8, 9, 13, 15)$. Which of the following expressions are NOT equivalent to f ?

P: $x'y'z' + w'xy' + wy'z + xz$

Q: $w'y'z' + wx'y' + xz$

R: $w'y'z' + wx'y' + xyz + xy'z$

S: (S) $x'y'z' + wx'y' + w'y$

- A. P only
- B. Q and S
- C. R and S
- D. S only

[gate2007](#)
[digital-logic](#)
[normal](#)
Answer**6.0.14 GATE2007_9** [top](#)<http://gateoverflow.in/1207>

Consider the following Boolean function of four variables:

$$f(w, x, y, z) = \Sigma(1, 3, 4, 6, 9, 11, 12, 14)$$

The function is

- A. independent of one variables.
- B. independent of two variables.
- C. independent of three variables.
- D. dependent on all variables

[gate2007](#)
[digital-logic](#)
[normal](#)
Answer**6.0.15 GATE2007-8, ISRO2011-31** [top](#)<http://gateoverflow.in/1206>

How many 3-to-8 line decoders with an enable input are needed to construct a 6-to-64 line decoder without using any other logic gates?

- A. 7
- B. 8
- C. 9
- D. 10

[gate2007](#)
[digital-logic](#)
[normal](#)
[isro2011](#)
Answer**6.0.16 GATE2008-IT_8** [top](#)<http://gateoverflow.in/3268>

Consider the following Boolean function of four variables

$$f(A, B, C, D) = \Sigma(2, 3, 6, 7, 8, 9, 10, 11, 12, 13)$$

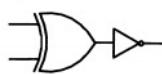
The function is

- A) independent of one variable
- B) independent of two variables
- C) independent of three variable
- D) dependent on all the variables

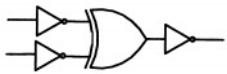
[gate2008-it](#)
[digital-logic](#)
[normal](#)
Answer**6.0.17 GATE2011_13** [top](#)<http://gateoverflow.in/2115>

Which one of the following circuits is **NOT** equivalent to a 2-input XNOR (exclusive NOR) gate?

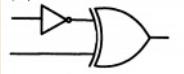
(A)



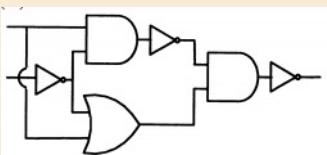
(B)



(C)



(D)



gate2011 digital-logic normal

Answer

6.0.18 GATE2004_60 top<http://gateoverflow.in/1055>

60. Consider a multiplexer with X and Y as data inputs and Z as control input. Z = 0 selects input X, and Z = 1 selects input Y. What are the connections required to realize the 2-variable Boolean function $f = T + R$, without using any additional hardware?

- (a) R to X, 1 to Y, T to Z
- (b) T to X, R to Y, T to Z
- (c) T to X, R to Y, 0 to Z
- (d) R to X, 0 to Y, T to Z

gate2004 digital-logic normal

Answer

6.0.19 GATE2004_59 top<http://gateoverflow.in/1054>

Which are the essential prime implicants of the following Boolean function?

$$f(a, b, c) = a\bar{b}c + a\bar{c}\bar{b} + b\bar{c}\bar{b}$$

- a. $a\bar{b}c$ and $a\bar{c}\bar{b}$
- b. $a\bar{b}c$ and $b\bar{c}\bar{b}$
- c. $a\bar{b}c$ only.
- d. $a\bar{c}\bar{b}$ and $b\bar{c}\bar{b}$

59. Which are the essential prime implicants of the following Boolean function?

$$f(a, b, c) = a\bar{c} + a\bar{c}\bar{b} + b\bar{c}$$

- (a) $a\bar{c}$ and $a\bar{c}\bar{b}$
- (b) $a\bar{c}$ and $b\bar{c}$
- (c) $a\bar{c}$ only
- (d) $a\bar{c}\bar{b}$ and $b\bar{c}$

gate2004 digital-logic normal

Answer

6.0.20 GATE2007-IT_7 top<http://gateoverflow.in/3440>

Which of the following input sequences for a cross-coupled R-S flip-flop realized with two NAND gates may lead to an oscillation ?

- A) 11, 00
- B) 01, 10
- C) 10, 01
- D) 00, 11

[gate2007-it](#) [digital-logic](#) [normal](#)

[Answer](#)

6.0.21 GATE1994_2.1 [top](#)

<http://gateoverflow.in/2468>

The number of flip-flops required to construct a binary modulo N counter is _____

[gate1994](#) [digital-logic](#) [easy](#)

[Answer](#)

6.0.22 GATE1999_1.7 [top](#)

<http://gateoverflow.in/1460>

Which of the following expressions is not equivalent to \bar{x} ?

- A. x NAND x
- B. x NOR x
- C. x NAND 1
- D. x NOR 1

[gate1999](#) [digital-logic](#) [easy](#)

[Answer](#)

6.0.23 GATE2004_17 [top](#)

<http://gateoverflow.in/1014>

A Boolean function $x'y' + xy + x'y$ is equivalent to

- A. $x' + y'$
- B. $x + y$
- C. $x + y'$
- D. $x' + y$

[gate2004](#) [digital-logic](#) [easy](#)

[Answer](#)

6.0.24 GATE1998_16 [top](#)

<http://gateoverflow.in/1730>

Design a synchronous counter to go through the following states:

1, 4, 2, 3, 1, 4, 2, 3, 1, 4

[gate1998](#) [digital-logic](#) [normal](#) [descriptive](#)

[Answer](#)

6.0.25 GATE2011_14 [top](#)

<http://gateoverflow.in/2116>

The simplified SOP (Sum of Product) from the Boolean expression

$$(P + \bar{Q} + \bar{R}) \cdot (P + \bar{Q} + R) \cdot (P + Q + \bar{R})$$

is

(A) $(\bar{P} \cdot Q + \bar{R})$ (B) $(P + \bar{Q} \cdot \bar{R})$ (C) $(\bar{P} \cdot Q + R)$ (D) $(P \cdot Q + R)$

gate2011 | digital-logic | normal

Answer

6.0.26 GATE2014-3_8 top<http://gateoverflow.in/2042>

Consider the following combinational function block involving four Boolean variables x, y, a, b where x, a, b are inputs and y is the output.

```
f(x, a, b, y)
{
    if(x is 1) y = a;
    else y = b;
}
```

Which one of the following digital logic blocks is the most suitable for implementing this function?

(A) Full adder

(B) Priority encoder

(C) Multiplexor

(D) Flip-flop

gate2014-3 | digital-logic | easy

Answer

6.0.27 GATE2011_15 top<http://gateoverflow.in/2117>

The minimum number of D flip-flops needed to design a mod-258 counter is

(A) 9

(B) 8

(C) 512

(D) 258

gate2011 | digital-logic | normal

Answer

6.0.28 GATE2012_7 top<http://gateoverflow.in/39>

The decimal value 0.5 in IEEE single precision floating point representation has

- (A) fraction bits of 000...000 and exponent value of 0
- (B) fraction bits of 000...000 and exponent value of -1
- (C) fraction bits of 100...000 and exponent value of 0
- (D) no exact representation

gate2012 | digital-logic | normal

Answer

6.0.29 GATE2014-2_7 [top](#)<http://gateoverflow.in/1959>

Let $k = 2^n$. A circuit is built by giving the output of an n -bit binary counter as input to an n -to- 2^n bit decoder. This circuit is equivalent to a

- (A) k -bit binary up counter.
- (B) k -bit binary down counter.
- (C) k -bit ring counter.
- (D) k -bit Johnson counter.

[gate2014-2](#) | [digital-logic](#) | [normal](#)

Answer

6.0.30 GATE2014-2_6 [top](#)<http://gateoverflow.in/1958>

The dual of a Boolean function $F(x_1, x_2, \dots, x_n, +, \cdot, ',)$, written as F^D is the same expression as that of F with $+$ and \cdot swapped. F is said to be self-dual if $F = F^D$. The number of self-dual functions with n Boolean variables is

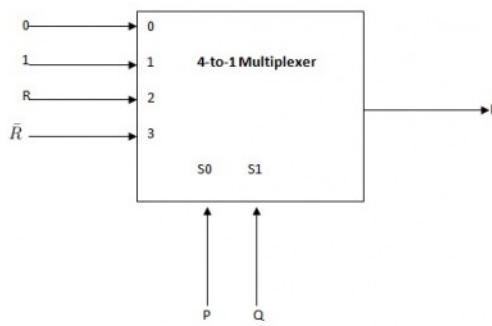
- (A) 2^n
- (B) 2^{n-1}
- (C) 2^{2^n}
- (D) $2^{2^{n-1}}$

[gate2014-2](#) | [digital-logic](#) | [normal](#)

Answer

6.0.31 GATE2014-1_45 [top](#)<http://gateoverflow.in/1923>

Consider the 4-to-1 multiplexer with two select lines S_1 and S_0 given below



The minimal sum-of-products form of the Boolean expression for the output F of the multiplexer is

- (A) $\bar{P}Q + Q\bar{R} + P\bar{Q}R$
- (B) $\bar{P}Q + \bar{P}QR + PQ\bar{R} + P\bar{Q}R$
- (C) $\bar{P}QR + \bar{P}Q\bar{R} + Q\bar{R} + P\bar{Q}R$
- (D) $PQ\bar{R}$

gate2014-1 | digital-logic | normal

Answer

6.0.32 GATE2014-1_7 [top](#)

<http://gateoverflow.in/1764>

Consider the following Boolean expression for F:

$$F(P, Q, R, S) = PQ + \bar{P}QR + \bar{P}QS$$

The minimal sum-of-products form of F is

- (A) $\bar{P}Q + QR + QS$
- (B) $P + Q + R + S$
- (C) $\bar{P} + \bar{Q} + \bar{R} + \bar{S}$
- (D) $\bar{P}R + \bar{R}\bar{P}S + P$

gate2014-1 | digital-logic | normal

Answer

6.0.33 GATE1997_2.1 [top](#)

<http://gateoverflow.in/2227>

Let * be defined as $x * y = \bar{x} + y$. Let $z = x * y$. Value of $z * x$ is

- A. $\bar{x} + y$
 B. x
 C. 0
 D. 1

gate1997 | digital-logic | normal

Answer

6.0.34 GATE1999_1.21 top

<http://gateoverflow.in/1474>

The maximum gate delay for any output to appear in an array multiplier for multiplying two n bit numbers is

- A. $O(n^2)$
 B. $O(n)$
 C. $O(\log n)$
 D. $O(1)$

gate1999 | digital-logic | normal

Answer

6.0.35 GATE1997_2.5 top

<http://gateoverflow.in/2231>

An N-bit carry lookahead adder, where N is a multiple of 4, employs ICs 74181 (4 bit ALU) and 74182 (4 bit carry lookahead generator).

The minimum addition time using the best architecture for this adder is

- A. proportional to N
 B. proportional to $\log N$
 C. a constant
 D. None of the above

gate1997 | digital-logic | normal

Answer

6.0.36 GATE1998_2.8 top

<http://gateoverflow.in/1680>

Which of the following operations is commutative but not associative?

- A. AND
 B. OR
 C. NAND
 D. EXOR

gate1998 | digital-logic | easy

Answer

6.0.37 GATE1997_5.1 top

<http://gateoverflow.in/2252>

Let $f(x, y, z) = \bar{x} + \bar{y}x + xz$ be a switching function. Which one of the following is valid?

- A. $\bar{y}x$ is a prime implicant of f

- B. xz is a minterm of f
- C. xz is an implicant of f
- D. y is a prime implicant of f

[gate1997](#) [digital-logic](#) [normal](#)

[Answer](#)

6.0.38 GATE1993_6.6 [top](#)

<http://gateoverflow.in/2285>

A ROM is used to store the Truth table for a binary multiple unit that will multiply two 4-bit numbers. The size of the ROM (number of words \times number of bits) that is required to accommodate the Truth table is M words $\times N$ bits. Write the values of M and N .

[gate1993](#) [digital-logic](#) [normal](#)

[Answer](#)

6.0.39 GATE1998_1.13 [top](#)

<http://gateoverflow.in/1650>

What happens when a bit-string is XORed with itself n -times as shown:

$$[B \oplus (B \oplus (B \oplus (B \dots n \text{ times})))]$$

- A. complements when n is even
- B. complements when n is odd
- C. divides by 2^n always
- D. remains unchanged when n is even

[gate1998](#) [digital-logic](#) [normal](#)

[Answer](#)

6.0.40 GATE2013_21 [top](#)

<http://gateoverflow.in/1532>

Which one of the following expressions does **NOT** represent exclusive NOR of x and y ?

- (A) $xy + x'y'$ (B) $x \oplus y'$ (C) $x' \oplus y$ (D) $x' \oplus y'$

[gate2013](#) [digital-logic](#) [easy](#)

[Answer](#)

6.0.41 GATE1993_9 [top](#)

<http://gateoverflow.in/2306>

Assume that only half adders are available in your laboratory. Show that any binary function can be implemented using half adders only.

[gate1993](#) [digital-logic](#)

[Answer](#)

6.0.42 GATE1999_2.16 [top](#)

<http://gateoverflow.in/1494>

The number of full and half-adders required to add 16-bit numbers is

- A. 8 half-adders, 8 full-adders
- B. 1 half-adder, 15 full-adders

- C. 16 half-adders, 0 full-adders
- D. 4 half-adders, 12 full-adders

[gate1999](#) [digital-logic](#) [normal](#)

[Answer](#)

6.0.43 GATE1999_2.9 [top](#)

<http://gateoverflow.in/1487>

Which of the following sets of component(s) is/are sufficient to implement any arbitrary Boolean function?

- A. XOR gates, NOT gates
- B. 2 to 1 multiplexers
- C. AND gates, XOR gates
- D. Three-input gates that output $(A \cdot B) + C$ for the inputs A, B and C.

[gate1999](#) [digital-logic](#) [normal](#)

[Answer](#)

6.0.44 GATE2004_18, ISRO2007-31 [top](#)

<http://gateoverflow.in/1051>

In an SR latch made by cross-coupling two NAND gates, if both S and R inputs are set to 0, then it will result in

- A. $Q = 0, Q' = 1$
- B. $Q = 1, Q' = 0$
- C. $Q = 1, Q' = 1$
- D. Indeterminate states

[gate2004](#) [digital-logic](#) [easy](#) [isro2007](#)

[Answer](#)

6.0.45 GATE2004_62 [top](#)

<http://gateoverflow.in/1057>

A 4-bit carry look ahead adder, which adds two 4-bit numbers, is designed using AND, OR, NOT, NAND, NOR gates only. Assuming that all the inputs are available in both complemented and uncomplemented forms and the delay of each gate is one time unit, what is the overall propagation delay of the adder? Assume that the carry network has been implemented using two-level AND-OR logic.

- A. 4 time units
- B. 6 time units
- C. 10 time units
- D. 12 time units

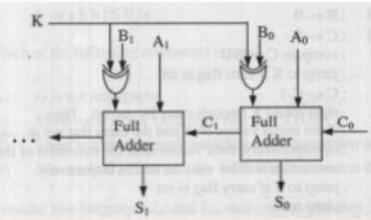
[gate2004](#) [digital-logic](#) [normal](#)

[Answer](#)

6.0.46 GATE2003_46 [top](#)

<http://gateoverflow.in/937>

Consider the ALU shown below.



If the operands are in 2's complement representation, which of the following operations can be performed by suitably setting the control lines K and C_0 only (+ and - denote addition and subtraction respectively)?

- A. $A + B$, and $A - B$, but not $A + 1$
- B. $A + B$, and $A + 1$, but not $A - B$
- C. $A + B$, but not $A - B$ or $A + 1$
- D. $A + B$, and $A - B$, and $A + 1$

[gate2003](#) [digital-logic](#) [normal](#)

Answer

6.0.47 GATE2001-11 [top](#)

<http://gateoverflow.in/752>

A sequential circuit takes an input stream of 0's and 1's and produces an output stream of 0's and 1's. Initially it replicates the input on its output until two consecutive 0's are encountered on the input. From then onward, it produces an output stream, which is the bit-wise complement of input stream until it encounters two consecutive 1's, whereupon the process repeats. An example input and output stream is shown below.

The input stream: $101100|01001011 \quad 0|11$
 The desired output $101100|10110100 \quad 0|11$

J-K master-slave flip-flops are to be used to design the circuit.

- a. Give the state transition diagram
- b. Give the minimized sum-of-product expression for J and K inputs of one of its state flip-flops

[gate2001](#) [digital-logic](#) [normal](#)

Answer

6.0.48 GATE2012_19 [top](#)

<http://gateoverflow.in/51>

The amount of ROM needed to implement a 4 bit multiplier is

- (A) 64 bits
- (B) 128 bits
- (C) 1 Kbits
- (D) 2 Kbits

[gate2012](#) [digital-logic](#) [normal](#)

Answer

6.0.49 GATE2008-26 [top](#)

<http://gateoverflow.in/424>

If P, Q, R are Boolean variables, then

$$(P + \bar{Q})(P \cdot \bar{Q} + P \cdot R)(\bar{P} \cdot \bar{R} + \bar{Q}) \text{ simplifies to}$$

- A. $P \cdot \bar{Q}$
- B. $P \cdot \bar{R}$
- C. $P \cdot \bar{Q} + R$
- D. $P \cdot \bar{R} + Q$

gate2008 | easy | digital-logic

Answer

6.0.50 GATE1991_01,v top<http://gateoverflow.in/503>

When two $4-bit$ numbers $A = a_3a_2a_1a_0$ and $B = b_3b_2b_1b_0$ are multiplied, the bit c_1 of the product C is given by _____

gate1991 | digital-logic | normal

Answer

6.0.51 GATE1991-03,ii top<http://gateoverflow.in/516>

Choose the correct alternatives (more than one may be correct) and write the corresponding letters only:

(ii). Advantage of synchronous sequential circuits over asynchronous ones is:

- a. faster operation
- b. ease of avoiding problems due to hazards
- c. lower hardware requirement
- d. better noise immunity
- e. none of the above

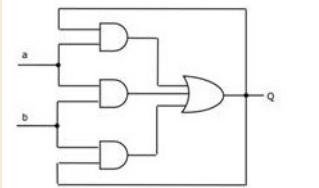
gate1991 | digital-logic | normal

Answer

6.0.52 GATE1991-5,a top<http://gateoverflow.in/531>

Analyse the circuit in Fig below and complete the following table

| a | b | Q_n |
|----------|----------|-------|
| 0 | 0 | |
| 0 | 1 | |
| 1 | 0 | |
| 1 | 1 | |



gate1991 | digital-logic | normal

Answer

6.0.53 TIFR2015-A-4 top<http://gateoverflow.in/29162>

The Boolean function obtained by adding an inverter to each and every input of an AND gate is:

- a. OR
- b. XOR
- c. $NAND$
- d. NOR
- e. None of the above.

tifr2015 | digital-logic

Answer

6.0.54 GATE1992_02,i top<http://gateoverflow.in/555>

Choose the correct alternatives (more than one may be correct) and write the corresponding letters only:

The operation which is communicative but not associative is:

- A. AND
- B. OR
- C. EX-OR
- D. NAND

[gate1992](#) [easy](#) [digital-logic](#)

[Answer](#)

6.0.55 GATE1992_02,ii top<http://gateoverflow.in/556>

02. Choose the correct alternatives (more than one may be correct) and write the corresponding letters only:

(ii) All digital circuits can be realized using only

- a. Ex-OR gates
- b. Multiplexers
- c. Half adders
- d. OR gates

[gate1992](#) [normal](#) [digital-logic](#)

[Answer](#)

6.0.56 GATE1992_04a top<http://gateoverflow.in/553>

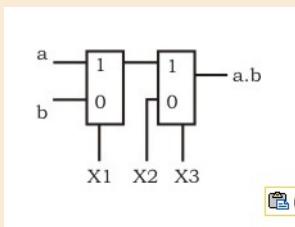
Consider addition in two's complement arithmetic. A carry from the most significant bit does not always correspond to an overflow. Explain what is the condition for overflow in two's complement arithmetic.

[gate1992](#) [digital-logic](#) [normal](#)

[Answer](#)

6.0.57 GATE2007-IT_8 top<http://gateoverflow.in/3441>

The following circuit implements a two-input AND gate using two 2-1 multiplexers.



What are the values of X1, X2, X3?

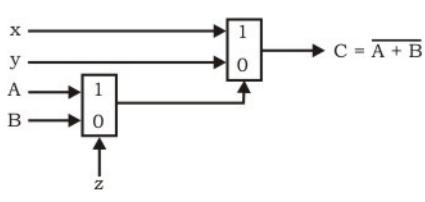
- A) X1 = b, X2 = 0, X3 = a
- B) X1 = b, X2 = 1, X3 = b
- C) X1 = a, X2 = b, X3 = 1
- D) X1 = a, X2 = 0, X3 = b

gate2007-it digital-logic normal

Answer

6.0.58 GATE2005-IT_48 [top](#)<http://gateoverflow.in/3809>

The circuit shown below implements a 2-input NOR gate using two 2-4 MUX (control signal 1 selects the upper input). What are the values of signals x, y and z?



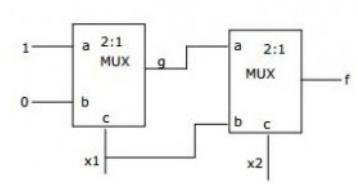
- | | |
|----|---------|
| A) | 1, 0, B |
| B) | 1, 0, A |
| C) | 0, 1, B |
| D) | 0, 1, A |

gate2005-it digital-logic normal

Answer

6.0.59 GATE2001-2.11 [top](#)<http://gateoverflow.in/729>

Consider the circuit shown below. The output of a 2:1 Mux is given by the function $(ac' + bc)$.



Which of the following is true?

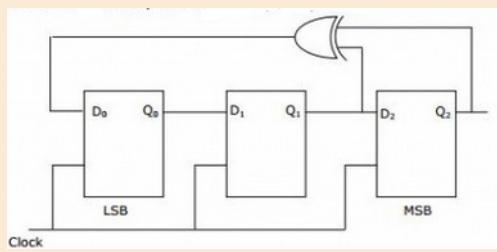
- A. $f = X1' + X2$
- B. $f = X1'X2 + X1X2'$
- C. $f = X1X2 + X1'X2'$
- D. $f = X1 + X2'$

gate2001 digital-logic normal

Answer

6.0.60 GATE2001-2.12 [top](#)<http://gateoverflow.in/730>

Consider the circuit given below with initial state $Q_0 = 1, Q_1 = Q_2 = 0$. The state of the circuit is given by the value $4Q_2 + 2Q_1 + Q_0$



Which one of the following is correct state sequence of the circuit?

- A. 1, 3, 4, 6, 7, 5, 2
- B. 1, 2, 5, 3, 7, 6, 4
- C. 1, 2, 7, 3, 5, 6, 4
- D. 1, 6, 5, 7, 2, 3, 4

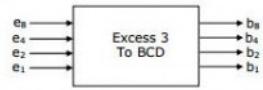
[gate2001](#) [digital-logic](#) [normal](#)

[Answer](#)

6.0.61 GATE2001-10 [top](#)

<http://gateoverflow.in/751>

- a. Is the 3-variable function $f = \Sigma(0, 1, 2, 4)$ its self-dual? Justify your answer.
- b. Give a minimal product-of-sum form of the b output of the following excess-3 to BCD converter.



[gate2001](#) [digital-logic](#) [normal](#)

[Answer](#)

6.0.62 GATE2014-3_55 [top](#)

<http://gateoverflow.in/2090>

Let \oplus denote the exclusive OR (XOR) operation. Let '1' and '0' denote the binary constants. Consider the following Boolean expression for F over two variables P and Q :

$$F(P, Q) = ((1 \oplus P) \oplus (P \oplus Q)) \oplus ((P \oplus Q) \oplus (Q \oplus 0))$$

The equivalent expression for F is

(A)
 $P + Q$

(B)
 $\overline{P + Q}$

(C)
 $P \oplus Q$

(D)
 $\overline{P \oplus Q}$

[gate2014-3](#) [digital-logic](#) [normal](#)

[Answer](#)

6.0.63 GATE2005-IT_7 [top](#)

<http://gateoverflow.in/3752>

Which of the following expressions is equivalent to $(A \oplus B) \oplus C$

- A. $(A + B + C)(\bar{A} + \bar{B} + \bar{C})$
- B. $(A + B + C)(\bar{A} + \bar{B} + C)$
- C. $ABC + \bar{A}(B \oplus C) + \bar{B}(A \oplus C)$
- D. None of these

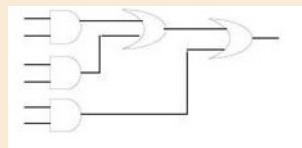
[gate2005-it](#) [digital-logic](#) [normal](#)

[Answer](#)

6.0.64 GATE2002_7 [top](#)

<http://gateoverflow.in/860>

- a. Express the function $f(x, y, z) = xy' + yz'$ with only one complement operation and one or more AND/OR operations. Draw the logic circuit implementing the expression obtained, using a single NOT gate and one or more AND/OR gates.
- b. Transform the following logic circuit (without expressing its switching function) into an equivalent logic circuit that employs only 6 NAND gates each with 2-inputs.



gate2002 | digital-logic | normal

[Answer](#)

6.0.65 GATE2004-IT_10 [top](#)

<http://gateoverflow.in/3651>

What is the minimum size of ROM required to store the complete truth table of an 8-bit x 8-bit multiplier?

- A) 32 K x 16 bits
- B) 64 K x 16 bits
- C) 16 K x 32 bits
- D) 64 K x 32 bits

gate2004-it | digital-logic | normal

[Answer](#)

6.0.66 GATE2003_11 [top](#)

<http://gateoverflow.in/902>

Consider an array multiplier for multiplying two n bit numbers. If each gate in the circuit has a unit delay, the total delay of the multiplier is

- A. $\Theta(1)$
- B. $\Theta(\log n)$
- C. $\Theta(n)$
- D. $\Theta(n^2)$

gate2003 | digital-logic | normal

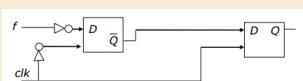
[Answer](#)

6.0.67 GATE2006_08 [top](#)

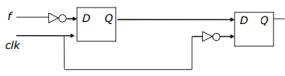
<http://gateoverflow.in/887>

You are given a free running clock with a duty cycle of 50% and a digital waveform f which changes only at the negative edge of the clock. Which one of the following circuits (using clocked D flip-flops) will delay the phase of f by 180° ?

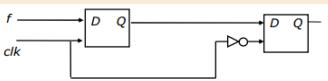
(A)



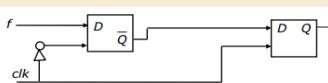
(B)



(C)



(D)



gate2006 digital-logic normal

Answer

Answers:**6.0.1 GATE2012_6** top<http://gateoverflow.in/38>

Selected Answer

Whenever X is true (X, Y) is true and whenever X is false (X, Y) is false, so the answer is (A) X .

13 votes

-- Omesh Pandita (2.3k points)

6.0.2 GATE2007-34 top<http://gateoverflow.in/122>

Selected Answer

 2^{n-1} to 1

We will map $(n - 1)$ variables to select lines and 1 variable to input line

8 votes

-- Anurag Semwal (5.5k points)

6.0.3 GATE1994_4 top<http://gateoverflow.in/2500>

Selected Answer

$$\text{a) i) } A * A = AA + A'A' = A + A' = 1$$

$$\begin{aligned} \text{ii) } C * A &= (A * B) * A = (AB + A'B') * A = (AB + A'B')A + (AB + A'B')A' \\ &= (AB + A'B')A + (A'B + AB')A' = AB + 0 + A'B + 0 = B. \end{aligned}$$

$$\text{b) } AB + A'C = 1, AC + B = 0$$

$$AC + B = 0, \text{ means both } B = 0 \text{ and } AC = 0$$

$$AB + A'C = 1$$

$$A'C = 1 \quad [\text{bcz } B = 0 \text{ so } AB = 0]$$

$$\text{So } C = 1 \text{ and } A = 0$$

so A = 0 , B = 0 and C = 1

1 6 votes

-- Praveen Saini (38.4k points)

6.0.4 GATE2005_18 top

<http://gateoverflow.in/1354>

answer - A

Use K map

1 4 votes

-- ankitrokdeonsns (8.4k points)

6.0.5 GATE1996_1.21 top

<http://gateoverflow.in/2725>



Selected Answer

When we multiply two 8 bit numbers result can go up to 16 bits. So, we need 16 bits for each of the multiplication result. Number of results possible = $2^8 \times 2^8 = 2^{16} = 64$ K as we need to store all possible results of multiplying two 8 bit numbers. So, 64 K \times 16 is the answer.

1 16 votes

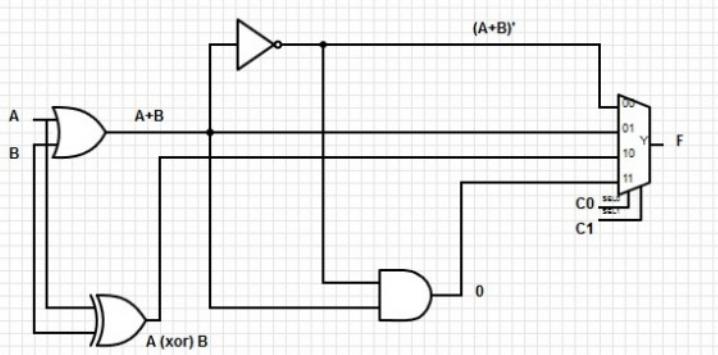
-- Arjun Suresh (150k points)

6.0.6 GATE1996_5 top

<http://gateoverflow.in/2757>



Selected Answer



This is the implementation asked in question

C0 = 0 , C1 = 0 line 00 will be selected and F will give $(A+B)'$

C0 = 0 , C1 = 1 line 01 will be selected and F will give $(A+B)$

C0 = 1 , C1 = 0 line 10 will be selected and F will give $(A \oplus B)$

C0 = 1 , C1 = 1 line 11 will be selected and F will give $(A+B)' \cdot (A+B) = 0$

1 2 votes

-- Praveen Saini (38.4k points)

6.0.7 GATE2006_36 top

<http://gateoverflow.in/1294>



Selected Answer

$$c_1 = a_0 b_0$$

$$c_2 = a_1 b_1 + a_1 c_1 + b_1 c_1$$

$$c_3 = a_2 b_2 + a_2 c_2 + b_2 c_2 = a_2 b_2 + a_2 a_1 b_1 + a_2 a_1 c_1 + a_2 b_1 c_1 + b_2 a_1 b_1 + b_2 a_1 c_1 + b_2 b_1 c_1 = a_2 b_2 + a_2 a_1 b_1 + a_2 a_1 a_0 b_0 + a_2 b_1 a_0 c_1$$

Option A.

Considering the carry in function c , $c_1 = a_0 b_0 + a_0 c + b_0 c$, but c is missing in all options and hence ignored.

15 votes

-- Arjun Suresh (150k points)

6.0.8 GATE2007_48 top

<http://gateoverflow.in/1246>



Selected Answer

answer = **option A**

To Prove: For any formula, there is a truth assignment for which at least half the clauses evaluate to true

Proof:

Consider an arbitrary truth assignment. For each of its clause i , introduce a random variable.

$$X_i = \begin{cases} 1 & \text{if clause } i \text{ is satisfied;} \\ 0 & \text{otherwise.} \end{cases}$$

Then, $X = \sum_i X_i$ is the number of satisfied clauses.

Given any clause c , it is unsatisfied only if all of its k constituent literals evaluates to false; as they are joined by OR operator coz the formula is in CNF.

Now, because each literal within a clause has a $\frac{1}{2}$ chance of evaluating to true independently of any of the truth value of any of the other literals, the probability that they are all false is $(\frac{1}{2})^k = \frac{1}{2^k}$.

Thus, the probability that c is satisfied(true) is $1 - \frac{1}{2^k}$

$$\text{So, } E(X_i) = 1 \times \left(1 - \frac{1}{2^k}\right) = 1 - \frac{1}{2^k}$$

This means that

$$E(X_i) \geq \frac{1}{2}$$

(try putting arbitrary valid values of k to see that)

Summation on both sides to get $E(X)$,

Therefore, we have $E(X) = \sum_i E(X_i) \geq \frac{m}{2}$; where m is the number of clauses.

$E(X)$ represents expected number of satisfied(to true) clauses.

So, there must exist an assignment that satisfies(to true) at least half of the clauses.

8 votes

-- Amar Vashishth (20.7k points)

6.0.9 GATE2008-IT_1 top

<http://gateoverflow.in/3222>



Selected Answer

EX-NOR is not functionally complete. NOR and NAND are functionally complete logic gates, OR , AND, NOT any logic gate can be generated using them.

And (Implication, Negation) also

$p \rightarrow q = p' + q = \text{apply negation } (p+q)' = pq + p'q' = \text{apply again negation } = (pq)' + p'q' = (p'+q') + p'q' = p'+q' + p'q' = p'+q' = \text{again apply negation } = (p'+q')' = pq$
that's how we got AND logic gate.

8 votes

-- Manu Thakur (5.6k points)

6.0.10 GATE2007_35 top

<http://gateoverflow.in/123>



Selected Answer

$$C_1 = G_0 + C_0.P_0$$

$$C_2 = G_1 + G_1.P_0 + C_0.P_0.P_1$$

$$C_3 = G_2 + G_1.P_2 + G_0.P_1.P_2 + C_0.P_0.P_1.P_2$$

$C_4 = G_3 + G_2.P_3 + G_1.P_2.P_3 + G_0.P_1.P_2.P_3 + C_0.P_0.P_1.P_2.P_3$ // read this as carry is generated in 3rd stage OR carry is generated in 2nd stage AND propagated to 3rd stage OR carry is generated in 1st stage AND carry is propagated through 2nd AND 3rd stage OR carry is generated in 0th stage AND propagated through 1st,2nd AND 3rd stage OR initial carry is propagated through 0th, 1st ,2nd AND 3rd stage.

4 OR gates are required for C_1, C_2, C_3, C_4

1 AND gate for C_1

2 AND gate for C_2

3 AND gate for C_3

4 AND gate for C_4

AND = 10

OR = 4

7 votes

-- Vikrant Singh (11k points)

6.0.11 GATE2007_33 top

<http://gateoverflow.in/123>



Selected Answer

P:

$$\begin{aligned} Y * Z &= Y * (X * Y) \\ &= Y * (XY + X'Y') \\ &= Y(XY + X'Y') + Y'(XY + X'Y')' \\ &= XY + Y'((X' + Y')(X + Y)) \\ &= XY + Y'(X'Y + XY') \\ &= XY + XY' \\ &= X(Y + Y') \\ &= X \end{aligned}$$

So, P is valid.

Q:

$$\begin{aligned} X * Z &= X * (X * Y) \\ &= X * (XY + X'Y') \\ &= X(XY + X'Y') + X'(XY + X'Y')' \\ &= XY + X'((X' + Y')(X + Y)) \\ &= XY + X'(X'Y + XY') \\ &= XY + X'Y \\ &= Y(X + X') \\ &= Y \end{aligned}$$

So, Q is also valid.

R:

$$X * Y * Z = (X * Y) * (X * Y)$$

$$\begin{aligned}
 &= (XY + X'Y') * (XY + X'Y') \\
 &= (XY + X'Y') (XY + XY') + (XY + X'Y')' (XY + X'Y')' \\
 &= (XY + X'Y') + (XY + X'Y')' \text{ (Since, } AA = A) \\
 &= 1 \text{ (Since } A + A' = 1)
 \end{aligned}$$

So, R is also valid.

Hence, D choice.

8 votes

-- Arjun Suresh (150k points)

6.0.12 GATE2013_5 top

<http://gateoverflow.in/1414>



Selected Answer

Answer is **A**.

For 2^n inputs we are having n outputs. Here $n=2$.

http://en.wikipedia.org/wiki/Priority_encoder

6 votes

-- Sona Praneeth Akula (3.8k points)

6.0.13 GATE2007-32 top

<http://gateoverflow.in/1230>



Selected Answer

K-map

| | $w'x'$ | $w'x$ | wx | wx' |
|--------|--------|-------|------|-------|
| $y'z'$ | 1 | 1 | | 1 |
| $y'z$ | | 1 | 1 | 1 |
| yz | | 1 | 1 | |
| yz' | | | | |

So, minimized expression will be

$xz + w'y'z' + wx'y'$ which is Q. From the K-map, we can also get P and R. So, only S is NOT equivalent to f .

http://www.eecs.berkeley.edu/~newton/Classes/CS150sp98/lectures/week4_2/sld011.htm

4 votes

-- Arjun Suresh (150k points)

Let me show u a very simple method

Let $w = 1, x = 1, y = 1, z = 1$ then the value of f is 1

consider each statement

$$x'y'z' + w'x'y' + w'y'z + xz = 0.0.0 + 0.1.0 + 1.0.1 + 1.1 = 1$$

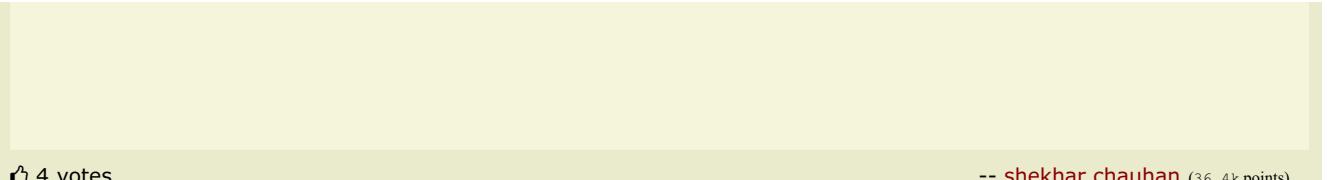
$$w'y'z' + w'x'z' + y' + xz = 0.0.0 + 1.0.0 + 1.1 = 1$$

$$w'y'z' + w'x'y' + xz + y'z = 0.0.0 + 1.0.0 + 1.1.1 + 1.0.1 = 1$$

$$x'y'z' + w'x'y' + w'y = 0.0.0 + 1.0.0 + 0.1 = 0$$

So statement (d) is false because $w=1 x=1 y=1 z=1$ the value of f is 0 .

(d) does not contain the essential Minterms .



4 votes

-- shekhar chauhan (36.4k points)

6.0.14 GATE2007_9 top

<http://gateoverflow.in/1207>

Selected Answer

The K-map would be

| | $w'x'$ | $w'x$ | wx | wx' |
|--------|--------|-------|------|-------|
| $y'z'$ | | 1 | 1 | |
| $y'z$ | 1 | | | 1 |
| yz | 1 | | | 1 |
| yz' | | 1 | 1 | |

So, the minimized expression would be
 $x'z + xz'$.
So, option B.

3 votes

-- Arjun Suresh (150k points)

6.0.15 GATE2007-8, ISRO2011-31 top

<http://gateoverflow.in/1206>

Selected Answer

ans is C:
to get 6:64 we need 64 o/p
we have 3:8 decode with 8 o/p. so we need $64/8=8$ decoders
now to select any of this 8 decoder we need one more decoder.
total= $8+1= 9$ decoders

9 votes

-- jayendra (6.6k points)

6.0.16 GATE2008-IT_8 top

<http://gateoverflow.in/3268>

Selected Answer

Option A

Map

| | $\bar{C} \cdot \bar{D}$ | $\bar{C} \cdot D$ | $C \cdot D$ | $C \cdot \bar{D}$ | |
|-------------------------|-------------------------|-------------------|-------------|-------------------|---|
| $\bar{A} \cdot \bar{B}$ | 0 | 0 | 1 | 1 | |
| $\bar{A} \cdot B$ | 0 | 0 | 1 | 1 | |
| $A \cdot B$ | 1 | 1 | 0 | 0 | |
| $A \cdot \bar{B}$ | 1 | 1 | 1 | 1 | $y = \bar{A} \cdot \bar{C} + \bar{B} \cdot C + A \cdot \bar{C}$ |

| | |
|-------------|-------------------|
| (2,3,6,7) | $\bar{A} \cdot C$ |
| (2,3,10,11) | $\bar{B} \cdot C$ |
| (8,9,12,13) | $A \cdot \bar{C}$ |

5 votes

-- Aditi Tiwari (793 points)

6.0.17 GATE2011_13 [top](#)<http://gateoverflow.in/2115>

ans d)

5 votes

-- Aditi Dan (5.4k points)

6.0.18 GATE2004_60 [top](#)<http://gateoverflow.in/1055>

Selected Answer

answer = **option A**

$$\begin{aligned} Z'X + ZY.. \\ \text{Put } Z = T, X = R, Y = 1 \text{ in } Z'X + ZY.. \\ = T'R + 1*T \end{aligned}$$

$$\begin{aligned} &= (T+T') (T+R) \\ &= T + R \end{aligned}$$

6 votes

-- Digvijay (35.8k points)

6.0.19 GATE2004_59 [top](#)<http://gateoverflow.in/1044>

Selected Answer

answer - A

using K map $f = ac' + a'c$

5 votes

-- ankitrokdeonsns (8.4k points)

6.0.20 GATE2007-IT_7 [top](#)<http://gateoverflow.in/3440>

Selected Answer

For R-S flip flop with NAND gates 11-no change 00-indeterminate.....so option A may make the system oscillate as "00" is the final input. In option D, after "00" flipflop output may oscillate but after "11", it will be stabilized.

7 votes

-- aravind90 (609 points)

6.0.21 GATE1994_2.1 [top](#)<http://gateoverflow.in/2468>

Selected Answer

Let say we have to Design mod-8 counter i.e 000 to 111. so we need 3 bit to represent i.e 3 FF
for Mod N

$$2^x = N$$

$$x = \text{ceiling}(\log_2 N)$$

8 votes

-- Praveen Saini (38.4k points)

6.0.22 GATE1999_1.7 top

<http://gateoverflow.in/1460>



Selected Answer

answer - D

$x \text{ OR } 1 = 1$ and so $x \text{ NOR } 1 = 0$.

5 votes

-- ankitrokdeonsns (8.4k points)

6.0.23 GATE2004_17 top

<http://gateoverflow.in/1014>



Selected Answer

answer = **option D**

$$\begin{aligned} x'y' + x'y &= x'(y+y') = x' \\ x' + xy &= x' + y \end{aligned}$$

4 votes

-- Arjun Suresh (150k points)

6.0.24 GATE1998_16 top

<http://gateoverflow.in/1730>



Selected Answer

Sequence Given is as

1, 4, 2, 3, 1.....

From the given sequence of states we can design the state table and Suppose we are using T-FF for sequential circuit of counter.

| Present state | | | Next State | | | FF Inputs | | |
|---------------|---|---|------------|-------|-------|-----------|-------|-------|
| A | B | C | A^+ | B^+ | C^+ | T_A | T_B | T_C |
| 0 | 0 | 0 | x | x | x | x | x | x |
| 0 | 0 | 1 | 1 | 0 | 0 | 1 | 0 | 1 |
| 0 | 1 | 0 | 0 | 1 | 1 | 0 | 0 | 1 |
| 0 | 1 | 1 | 0 | 0 | 1 | 0 | 1 | 0 |
| 1 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 0 |
| 1 | 0 | 1 | x | x | x | x | x | x |
| 1 | 1 | 0 | x | x | x | x | x | x |
| 1 | 1 | 1 | x | x | x | x | x | x |

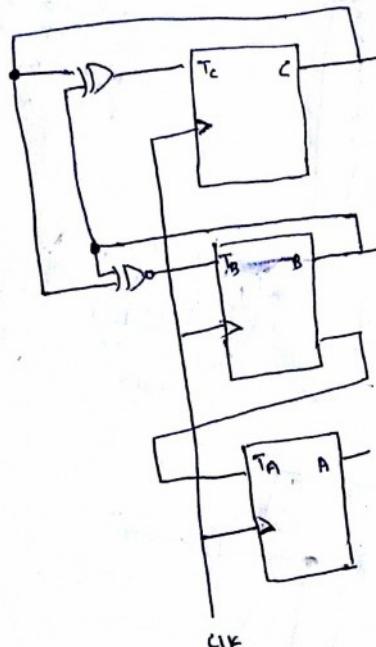
From the above table, we will find the equation of T_A , T_B and T_C

| | \bar{B} | $\bar{B}C$ | $\bar{B}C$ | $B\bar{C}$ | $B\bar{C}$ |
|-----------|-----------|------------|------------|------------|------------|
| A | X | 1 | | | |
| \bar{A} | 1 | X | X | X | |
| | | | | | |

| | $\bar{B}C$ | $\bar{B}C$ | $B\bar{C}$ | $B\bar{C}$ |
|-----------|------------|------------|------------|------------|
| A | X | 1 | | |
| \bar{A} | 1 | X | X | X |
| | | | | |

$$T_B = B \oplus C$$

$$T_C = B \oplus C$$



1 votes

-- Praveen Saini (38.4k points)

6.0.25 GATE2011_14 top

<http://gateoverflow.in/2116>



Selected Answer

Karnaugh map

| | | | |
|---|---|---|---|
| 1 | 0 | 0 | 0 |
| 1 | 1 | 1 | 1 |

Answer is B

7 votes

-- Sona Praneeth Akula (3.8k points)

6.0.26 GATE2014-3_8 top

<http://gateoverflow.in/2042>



Selected Answer

2X1 multiplexer

9 votes

-- Arpit Dhuriya (2.4k points)

6.0.27 GATE2011_15 [top](#)<http://gateoverflow.in/2117>

Selected Answer

mod 258 counter has 258 states. We need to find no. of bits to represent 257 at max.
 $2^n \geq 258 \Rightarrow n \geq 9$.

Answer is **A**

9 votes

-- Sona Praneeth Akula (3.8k points)

6.0.28 GATE2012_7 [top](#)<http://gateoverflow.in/39>

Selected Answer

(B) is the answer. In IEEE uses normalized representation and hence an implicit '1' is used before the decimal point. So, if mantissa is

0000..0

it would be treated as

1.000..0

and hence the exponent need to be -1 for us to get 0.1 which is the binary representation of 0.5.

More into IEEE floating point representation:

<http://steve.hollasch.net/cgindex/coding/ieeefloat.html>

12 votes

-- gatecse (10.7k points)

6.0.29 GATE2014-2_7 [top](#)<http://gateoverflow.in/1959>

Selected Answer

In binary counter of n bits can count upto 2^n numbers..when this op from counter is fed to decoder one of n out of 2^n will be activated..so this arrangement of counter and decoder is behaving as $2^n(k)$ ring counter..

6 votes

-- Pooja (25.9k points)

6.0.30 GATE2014-2_6 [top](#)<http://gateoverflow.in/1958>

Selected Answer

The concept behind number of self-dual function is

- 1) It should be a natural function i.e number of min terms == number of max terms
- 2) Function should not contain two mutually exclusive pair

| | A | B | C |
|---|---|---|---|
| 0 | 0 | 0 | 0 |
| 1 | 0 | 0 | 1 |
| 2 | 0 | 1 | 0 |
| 3 | 0 | 1 | 1 |
| 4 | 1 | 0 | 0 |
| 5 | 1 | 0 | 1 |
| 6 | 1 | 1 | 0 |

| | | | |
|---|---|---|---|
| 7 | 1 | 1 | 1 |
|---|---|---|---|

so here

(0,7) (1,6) (2,5) (3,4) are mutually exclusive terms so in self-dual we can select any one of them

totally $2 \times 2 \times 2 \times 2 = 2^4$ possibility bcz from (0,7) we can pic anyone in minterm

so, let $\Sigma(0,6,2,3)$ **NOTE: here i have taken only one of the mutually exclusive term for min term from the sets.**

so remaining number will go to MAXTERMS

so for above example $= 2^4 = 16$ self dual functions are possible

so if i have N variable how many total Minterms are possible is 2^n

then half of them we selected so 2^{n-1}

and now every time we will have 2 choices for every pair

so $2 \times 2 \times 2 \times 2 \dots \dots \dots 2 (2^{n-1})$ times

$\therefore 2^{2n-1}$ (option D)

10 votes

-- Kalpish Singhal (1.7k points)

6.0.31 GATE2014-1_45 [top](#)

<http://gateoverflow.in/1923>



Selected Answer

S0 and S1 are used to select the input given to be given as output.

| S0 | S1 | Output |
|----|----|--------|
| 0 | 0 | 0 |
| 0 | 1 | 1 |
| 1 | 0 | R |
| 1 | 1 | R' |

So, output becomes 1 for

$$S0'S1 + S0S1'R + S0S1R'$$

$$= P'Q + PQ'R + PQR'$$

$$= P'Q + PQR' + PQ'R$$

$$= Q(P' + PR') + PQ'R$$

$$= Q(P' + R') + PQ'R (\because A + A'B = A + B)$$

$$= P'Q + QR' + PQ'R$$

Option (A)

8 votes

-- Arjun Suresh (150k points)

6.0.32 GATE2014-1_7 [top](#)

<http://gateoverflow.in/1764>



Selected Answer

| PQ | RS | $\bar{R}\bar{S}$ | $\bar{R}S$ | RS | $R\bar{S}$ |
|------------------|------|------------------|------------|------|------------|
| $\bar{P}\bar{Q}$ | 0 | 0 | 0 | 0 | 0 |
| $\bar{P}Q$ | 0 | 1 | 1 | 1 | 1 |
| PQ | 1 | 1 | 1 | 1 | 1 |
| $P\bar{Q}$ | 0 | 0 | 0 | 0 | 0 |

$$\text{Minimal SOP} = PQ + QR + QS$$

Hence, **option A** is correct.

4 votes

-- Amar Vashishth (20.7k points)

6.0.33 GATE1997_2.1 [top](#)

<http://gateoverflow.in/2227>



Selected Answer

answer = **option B**

$$z * x = (x * y) * x$$

$$= (\bar{x} + y) * x$$

$$= \overline{\bar{x} + y} + x$$

$$x \cdot \bar{y} + x = x$$

5 votes

-- Arjun Suresh (150k points)

6.0.34 GATE1999_1.21 [top](#)

<http://gateoverflow.in/1474>

maximum Gate delay should be $O(2n-1) = O(n)$

2 votes

-- Digvijay (35.8k points)

6.0.35 GATE1997_2.5 [top](#)

<http://gateoverflow.in/2231>

For N = 64 bits

Suppose you want to build a 64 bit adder then you need 16 4-bit ALU and 16 4-bit carry generator, at this point there will be 16 carries that will ripple through these 16 ALU modules, to speed up the adder we need to get rid of these 16 rippling carries, now we can again use 4 4-bit carry generator to generate these 16 carries, now we have only 4 carries to ripple through, again we can use the same trick to minimize the rippling of these 4 carries, we can use an additional 4-bit carry generator which will generate these carry and we are done :) there will be no more propagation of carry among the ALU modules.

So we have used 3 level of 4-bit carry generator, and the time taken to add 64 bits will be proportional to 3 which is $\log_4 64$.

So in general to add N-bits it takes $\log_4 N$ time.

2 votes

-- Vikrant Singh (11k points)

6.0.36 GATE1998_2.8 [top](#)<http://gateoverflow.in/1680>

Selected Answer

we all know AND ,OR are both associative and commutative.we dont know about EXOR and NAND

we can consume some time and prove it by truth table..and come up with the results that EXOR is also associative and commutative so the only left out is NAND its commutative but not associative

5 votes

-- Bhagirathi Nayak (11.3k points)

6.0.37 GATE1997_5.1 [top](#)<http://gateoverflow.in/2252>

Selected Answer

Answer: C

$$f(x,y,z) = x' + y'x + xz$$

An implicant of a function is a product term that is included in the function.

so x' , $y'x$ and xz ,all are implicants of given function.

A prime implicant of a function is an implicant that is not included in any other implicant of the function.

option a) $y'x$ is not a prime implicant as it is included in xz [$xy'z + xyz$]

option d) y is not a prime implicant as it include in both x' and xz .

a product term in which all the variables appear is called a **minterm** of the function

option b) xz is not a minterm

3 votes

-- Praveen Saini (38.4k points)

6.0.38 GATE1993_6.6 [top](#)<http://gateoverflow.in/2255>

Selected Answer

A is 4 bit binary no A4A3A2A1

B is 4 bit binary no B4B3B2B1

M is result of multiplication M8M7M6M5M4M3M2M1 [check biggest no 1111 x 1111 =11100001]

| A4 | A3 | A2 | A1 | B4 | B3 | B2 | B1 | M8 | M7 | M6 | M5 | M4 | M3 | M2 | M1 |
|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 0 | 0 | 1 | 0 |
| 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 1 |

So 4 bit of A 4 bit of B

input will consist of 8 bit need address 00000000 to 11111111 = 2^8 address

output will be of 8 bits

so memory will be of $2^8 \times 8$

$$M = 256, N = 8$$

3 votes

-- Praveen Saini (38.4k points)

6.0.39 GATE1998_1.13 [top](#)

<http://gateoverflow.in/1650>



Selected Answer

It should be D.

Let number of \oplus be two (even case):

$B \oplus B \oplus B = B \oplus 0 = B$ (remains unchanged)

Let number of \oplus be three (odd case):

$B \oplus B \oplus B \oplus B = B \oplus B \oplus 0 = B \oplus B = 0$ (gives 0)

6 votes

-- Rajarshi Sarkar (29.7k points)

6.0.40 GATE2013_21 [top](#)

<http://gateoverflow.in/1532>



Selected Answer

A : means both are either true OR both are false. then it will be true = ExNOR

B & C : whenever any one of the literal is complemented then ExOR can be turned to ExNOR and complement sign on the literal can be removed. So these two also represents ExNOR operation of x and y .

answer = **option D** it is the ExOR operation b/w the two.

7 votes

-- Amar Vashishth (20.7k points)

6.0.41 GATE1993_9 [top](#)

<http://gateoverflow.in/2306>



Selected Answer

Half Adder give two output

$$S = A \oplus B$$

$$C = A \cdot B$$

We can Perform any operation using Half adder if we can implement basic gates using half adder

$$\text{AND operation } C = AB$$

$$\text{Not operation } = S \text{ (with } A \text{ and } 1) = A \oplus 1 = A' \cdot 1 + A \cdot 1' = A'$$

$$\text{OR operation } = ((A \oplus 1) \cdot (B \oplus 1)) \oplus 1 = (A' \cdot B')' = A + B$$

4 votes

-- Praveen Saini (38.4k points)

6.0.42 GATE1999_2.16 [top](#)

<http://gateoverflow.in/1494>



Selected Answer

answer - B

for LSB addition we do not need a full adder

for addition of subsequent bits we need full adders since carry from previous addition has to be fed into the addition operation

11 votes

-- ankitrokdeonsns (8.4k points)

6.0.43 GATE1999_2.9 top

<http://gateoverflow.in/1487>



Selected Answer

1. XOR and NOT gates can only make XOR and XNOR which are not functionally complete- $a \oplus \bar{a} = 1, a \oplus a = 0$.
2. 2-1 multiplexer is functionally complete provided we have external 1 and 0 available. For NOT gate, use x as select line and use 0 and 1 as inputs. For AND gate, use y and 0 as inputs and x as select. With {AND, NOT} any other gate can be made.
3. XOR can be used to make a NOT gate ($a \oplus 1 = \bar{a}$) and {AND, NOT} is functionally complete. Again this requires external 1.
4. We have $AB + C$. Using $C = 1$, we get an AND gate. Using $B = 1$ we get an OR gate. But we cannot derive a NOT gate here.

So, options B and C are true provided external 1 and 0 are available.

5 votes

-- Arjun Suresh (150k points)

6.0.44 GATE2004_18, ISRO2007-31 top

<http://gateoverflow.in/1015>



Selected Answer

If both $R = 0, S = 0$, then both Q and Q' tend to be '1'. NAND gate says if both inputs are 1, the output is 0. The logic of the circuit (Q' is complement of Q) not satisfied, Logic state is said to be indeterminate state or racing state. Each state, $Q = 1$ and $Q = 0$, and $Q = 0$, $Q = 1$ trying to race through so "RACE CONDITION" occurs and output become unstable. So ans is (D).

10 votes

-- shekhar chauhan (36.4k points)

6.0.45 GATE2004_62 top

<http://gateoverflow.in/1057>



Selected Answer

It would take 6 time units.

We know that

$$G_i = A_i B_i,$$

$$P_i = A_i \oplus B_i \text{ and}$$

$$S_i = P_i \oplus C_i$$

Also

$$C_1 = G_0 + P_0 C_0$$

$$C_2 = G_1 + P_1 G_0 + P_1 P_0 C_0$$

$$C_3 = G_2 + P_2 G_1 + P_2 P_1 G_0 + P_2 P_1 P_0 C_0$$

$$C_4 = G_3 + P_3 G_2 + P_3 P_2 G_1 + P_3 P_2 P_1 G_0 + P_3 P_2 P_1 P_0 C_0$$

XOR can be implemented in 2 levels; level-1 ANDs and Level-2 OR. Hence it would take 2 time units to calculate P_i and S_i

The 4-bit addition will be calculated in 3 stages

1. **(2 time units)** In 2 time units we can compute

G_i and

P_i in parallel. 2 time units for

P_i since its an XOR operation and 1 time unit for

G_i since its an AND operation.

2. **(2 time units)** Once

G_i and

P_i are available, we can calculate the carries,

C_i , in 2 time units.

Level-1 we compute all the conjunctions (AND). Example

$P_3G_2, P_3P_2G_1, P_3P_2P_1G_0$ and

$P_3P_2P_1P_0C_0$ which are required for

C_4 .

Level-2 we get the carries by computing the disjunction (OR).

3. **(2 time units)** Finally we compute the Sum in 2 time units, as its an XOR operation.

Hence the total is $2 + 2 + 2 = \mathbf{6 \text{ time units}}$.

8 votes

-- ryan sequeira (1.6k points)

6.0.46 GATE2003_46 [top](#)

<http://gateoverflow.in/937>



Selected Answer

following operations can be performed by suitably setting the control lines K and C₀ only !

It is given that we can not touch B here. B input is fixed.

So suppose we set K = 0, C₀ = 0, Then we can perform A + B.

We set K = 1, C₀ = 0 we can perform A - B.

We can not perform A + 1 because ,even though we can set K = 0, & C₀ = 1 we can not set B to 0. Though we can computer now A+B+ 1 !

Answer is A !

4 votes

-- Akash (31.7k points)

6.0.47 GATE2001-11 [top](#)

<http://gateoverflow.in/752>

We can design a Mealy Machine as per the requirement given in the question.

From which we will get state table, and we can design sequential circuit using any Flip-flop from the state table (with the help of excitation table) :

As we get 4 states, we map (state assignment) to binary states
We need two FF to implement it
With A & B are present states, we can input 2² = 4 in output

| Present State | S/P | Next State | S/P | FF Inputs |
|---------------|-----|------------|-----|-------------------------------|
| A'B | x | A'B | y | J _A K _A |
| 00 | 0 | 01 | 0 | 0 X |
| 00 | 1 | 00 | 1 | 0 X |
| 01 | 0 | 10 | 0 | 1 X |
| 01 | 1 | 00 | 1 | 0 X |
| 10 | 0 | 10 | 1 | X 0 |
| 10 | 1 | 11 | 0 | X 0 |
| 11 | 0 | 10 | 1 | X 0 |
| 11 | 1 | 00 | 0 | X 1 |

| Q _A Q _B | J | K |
|-------------------------------|---|---|
| 00 | 0 | X |
| 01 | 1 | X |
| 10 | X | 1 |
| 11 | X | 0 |

$\sum A'X$ $\sum B'X$ $\sum A'X$ $\sum B'X$

$A' \begin{matrix} \bar{B}' \\ \bar{B} \\ B' \\ B \end{matrix}$ $B' \begin{matrix} \bar{A}' \\ \bar{A} \\ A' \\ A \end{matrix}$ $A' \begin{matrix} \bar{B}' \\ \bar{B} \\ B' \\ B \end{matrix}$ $B' \begin{matrix} \bar{A}' \\ \bar{A} \\ A' \\ A \end{matrix}$

$k_A = B'X$ $k_B = A'X$

$Y_A = \bar{A}X + A\bar{X}$
 $= A \oplus X$

$Y_B = \bar{A}X + A\bar{X}$
 $= A \oplus X$

$y = \bar{A}X + A\bar{X}$
 $= A \oplus X$

3 votes

-- Praveen Saini (38.4k points)

6.0.48 GATE2012_19<http://gateoverflow.in/51>

Selected Answer

A ROM cannot be written. So, to implement a 4 bit multiplier we must store all the possible combinations of $2^4 * 2^4$ input bits and 8 output bits giving a total of $2^4 * 2^4 * 8$ bits = 2048 bits. So, (D) is the answer.

10 votes

-- Arjun Suresh (150k points)

6.0.49 GATE2008-26<http://gateoverflow.in/424>

Selected Answer

Ans is (A) $P\bar{Q}$

$$(P + \bar{Q})(P\bar{Q} + PR)(\bar{P}\bar{R} + \bar{Q})$$

$$= (PP\bar{Q} + PPR + P\bar{Q} + P\bar{Q}R)(\bar{P}\bar{R} + \bar{Q})$$

$$\begin{aligned}
 &= (P\bar{Q} + PR + P\bar{Q} + P\bar{Q}R)(\bar{P}\bar{R} + \bar{Q}) \\
 &= P\bar{Q} + P\bar{Q}\bar{R} + P\bar{Q}R \\
 &= P\bar{Q} + P\bar{Q}(\bar{R} + R) \\
 &= P\bar{Q} + P\bar{Q} \\
 &= P\bar{Q}
 \end{aligned}$$

10 votes

-- Keith Kr (6k points)

6.0.50 GATE1991_01,v [top](#)

<http://gateoverflow.in/503>



Selected Answer

$$\begin{array}{r}
 & a_3 & a_2 & a_1 & a_0 \\
 \times & b_3 & b_2 & b_1 & b_0 \\
 \hline
 & a_3b_0 & a_2b_0 & a_1b_0 & a_0b_0 \\
 & a_3b_1 & a_2b_1 & a_1b_1 & a_0b_1 \\
 & a_3b_2 & a_2b_2 & a_1b_2 & a_0b_2 \\
 a_3b_3 & a_2b_3 & a_1b_3 & a_0b_3 & \times \\
 \hline
 c_7 & c_6 & c_5 & c_4 & c_3 & c_2 & c_1 & c_0
 \end{array}$$

$$c_1 = b_1a_0 \oplus a_1b_0$$

10 votes

-- Pooja (25.9k points)

6.0.51 GATE1991-03,ii [top](#)

<http://gateoverflow.in/516>



Selected Answer

Synchronization means less chance of hazards but can only increase the delay. So, synchronous circuits cannot have faster operation than asynchronous one but it is easier to avoid hazards in synchronous circuits. So, (a) is false and (b) is true.

(c) is false if we don't consider how to avoid the hazards in asynchronous circuits.

(d) I guess it is true as a noise can change the behaviour of an asynchronous circuit more easily than a synchronous one.

https://en.wikipedia.org/wiki/Asynchronous_circuit

7 votes

-- Arjun Suresh (150k points)

6.0.52 GATE1991-5,a [top](#)

<http://gateoverflow.in/531>



Selected Answer

(a) The output of the circuit given as :-

$$Q_n = aQ_{n-1} + ab + bQ_{n-1}$$

Hence,

$$Q_n = Q_{n-1}(a+b) + ab$$

$$00 \Rightarrow Q_{n-1}(0+0) + 0.0 = Q_{n-1}(0) + 0 = 0+0 = 0$$

$$01 \Rightarrow Q_{n-1}(0+1) + 0.1 = Q_{n-1}(1) + 0 = Q_{n-1}+0 = Q_{n-1}$$

$$10 \Rightarrow Q_{n-1}(1+0) + 1.0 = Q_{n-1}(1) + 0 = Q_{n-1}+0 = Q_{n-1}$$

$$11 \Rightarrow Q_{n-1}(1+1) + 1.1 = Q_{n-1}(1) + 1 = Q_{n-1}+1 = 1$$

| a | b | Q _n |
|---|---|------------------|
| 0 | 0 | 0 |
| 0 | 1 | Q _{n-1} |
| 1 | 0 | Q _{n-1} |
| 1 | 1 | 1 |

(c)

All the flip flops are operated by same clock , together all takes one propagation delay .

All the AND gates consumes one propagation delay individually.

$$\text{Total propagation delay} = T_{\text{CLK}} \geq T_{\text{flip-flop}} + T_{\text{AND gates}}$$

$$= 10\text{ns} + (10+10+10)\text{ns} = 40\text{ns}$$

$$\text{Maximum clock frequency} = 1/T_{\text{CLK}} = 1/40\text{ns} = 10^9/40 = 25 \text{ MHz}$$

So, Maximum clock frequency at which the counter can operate is 25 MHz

 5 votes

-- Kalpana Bhargav (3k points)

6.0.53 TIFR2015-A-4 [top](#)

<http://gateoverflow.in/29162>

Selected Answer

Invert-AND = NOR

for example,

$$A'B' = \overline{A + B}$$

[Note : Invert-OR = NAND ,
 $A' + B' = \overline{A \cdot B}$]

5 votes

-- Praveen Saini (38.4k points)

6.0.54 GATE1992_02,i [top](#)

<http://gateoverflow.in/555>

Selected Answer

answer - D

6 votes

-- ankitrokdeonsns (8.4k points)

6.0.55 GATE1992_02,ii [top](#)

<http://gateoverflow.in/556>

Selected Answer

Answer: B, C

NOR gate, NAND gate, Multiplexers and Half adders can also be used to realise all digital circuits.

5 votes

-- Rajarshi Sarkar (29.7k points)

6.0.56 GATE1992_04a [top](#)<http://gateoverflow.in/583>

Selected Answer

XOR of C_{in} with C_{out} of the msb position.

5 votes

-- Amar Vashishth (20.7k points)

6.0.57 GATE2007-IT_8 [top](#)<http://gateoverflow.in/3441>

Selected Answer

Answer: A

$$F = (bX_1' + aX_1)X_3 + X_2X_3'$$

Put $X_1 = b$, $X_2 = 0$, $X_3 = a$ to get $F = ab$.

8 votes

-- Rajarshi Sarkar (29.7k points)

6.0.58 GATE2005-IT_48 [top](#)<http://gateoverflow.in/3809>

Selected Answer

$$f = Az + B\bar{z} \text{ (As } A \text{ will be selected when } z \text{ is high).}$$

$$\text{So next function will become } g = xf + y\bar{f}$$

$$= x(Az + B\bar{z}) + y(\overline{Az + B\bar{z}})$$

Putting $x = 0, y = 1, z = A$, we get $g = \overline{AA + B\bar{A}} = \overline{A + B} \quad (\because A + B\bar{A} = A + B)$ and answer will become D

10 votes

-- John Carter (299 points)

6.0.59 GATE2001-2.11 [top](#)<http://gateoverflow.in/729>

Selected Answer

$$g = x_1' \\ \text{So, } f = ac' + bc$$

$$= x_1'x_2' + x_1x_2$$

So, (C).

9 votes

-- Arjun Suresh (150k points)

6.0.60 GATE2001-2.12 [top](#)<http://gateoverflow.in/730>

Selected Answer

| $Q_0 = Q_{1\text{prev}} \oplus Q_{2\text{prev}}$ | $Q_1 = Q_{0\text{prev}}$ | $Q_2 = Q_{1\text{prev}}$ |
|--|--------------------------|--------------------------|
| 1 | 0 | 0 |
| 0 | 1 | 0 |
| 1 | 0 | 1 |
| 1 | 1 | 0 |
| 1 | 1 | 1 |
| 0 | 1 | 1 |
| 0 | 0 | 1 |
| 1 | 0 | 0 |

$$\text{State} = 4Q_2 + 2Q_1 + Q_0$$

So, state sequence = 1, 2, 5, 3, 7, 6, 4

12 votes

-- Arjun Suresh (150k points)

6.0.61 GATE2001-10 [top](#)

<http://gateoverflow.in/751>

there are two condition for a function being self dual.

1- it should be neutral function. (no. of minter = no . of max term)

2-no mutually two exclusive term should be there like (0-7 are mutually exclusive 1-6, 2-5, 3-4) from these pairs only one should be there.

clearly there are 4 minterm, so number of minterms = no of maxterms.

and second condition is also satisfied. so it is a self dual function .

6 votes

-- Ravi Singh (8.2k points)

6.0.62 GATE2014-3_55 [top](#)

<http://gateoverflow.in/2050>



Selected Answer

XOR is associative and commutative. Also,

$$A \oplus A = 0 \text{ and}$$

$$A \oplus 1 = \bar{A} \text{ and}$$

$$A \oplus 0 = A. \text{ So}$$

$$\begin{aligned} & ((1 \oplus P) \oplus (P \oplus Q)) \oplus ((P \oplus Q) \oplus (Q \oplus 0)) \\ & \implies (1 \oplus P) \oplus ((P \oplus Q) \oplus (P \oplus Q)) \oplus (Q \oplus 0) \\ & \implies (1 \oplus 0) \oplus (P \oplus Q) \\ & \implies 1 \oplus (P \oplus Q) \\ & \implies \underline{(P \oplus Q)} \end{aligned}$$

8 votes

-- Arjun Suresh (150k points)

6.0.63 GATE2005-IT_7 [top](#)

<http://gateoverflow.in/3752>

Correct answer is C

$$(A \oplus B) \oplus C$$

$$\text{At } C = 0, (A \oplus B) \oplus C = (A \oplus B) \text{ ----(I) [as } 0 \oplus x = 0.x' + 0'.x = x \text{]}$$

$$\text{At } C = 0, ABC + A'(B \oplus C) + B'(A \oplus C)$$

$$= 0 + A'(B \oplus 0) + B'(A \oplus 0) = A'B + AB' = A \oplus B \text{ -----(II)}$$

$$\text{At } C = 1, (A \oplus B) \oplus C = (A \odot B) \text{ --- (III) [as } 1 \oplus x = 1.x' + 1'.x = x' \text{]}$$

At $C = 1$, $ABC + A'(B \oplus C) + B'(A \oplus C)$
 $= AB + A'(B \oplus 1) + B'(A \oplus 1) = AB + A'B' = (A \odot B)$ --(IV)
from eq (I), (II), (III) and (IV) it is clear
 $(A \oplus B) \oplus C = ABC + A'(B \oplus C) + B'(A \oplus C)$

6 votes

-- Praveen Saini (38.4k points)

6.0.64 GATE2002_7 top

<http://gateoverflow.in/860>



Selected Answer

$$f(x, y, z) = xy' + yz' = xy'z' + xy'z + x'y'z' + xyz'$$

$$f(x, y, z) = \sum_m (2, 4, 5, 6)$$

K-map

| | $y'z'$ | $y'z$ | yz | yz' |
|------|--------|-------|------|-------|
| x' | 0 | 0 | 0 | 1 |
| x | 1 | 1 | 0 | 1 |

By pairing of $1's$, we get two pairs $(2, 6), (4, 5)$ resulting in same expression $F = xy' + yz'$

But by pairing of $0's$, we get two pairs $(0, 1), (2, 7)$, we get $F' = yz + x'y'$

Take complement, $F = \overline{(yz)}.(x + y)$

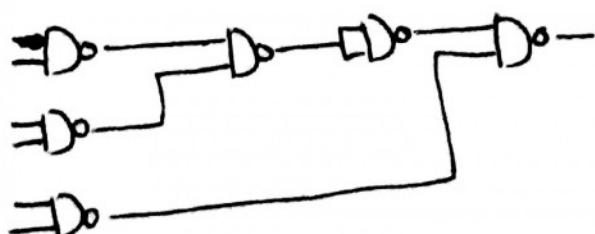
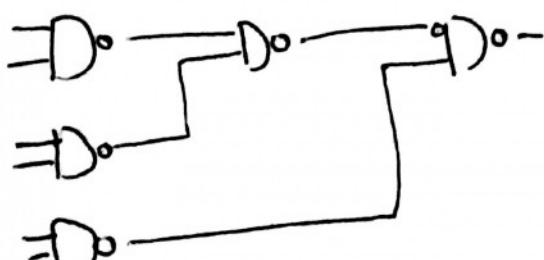
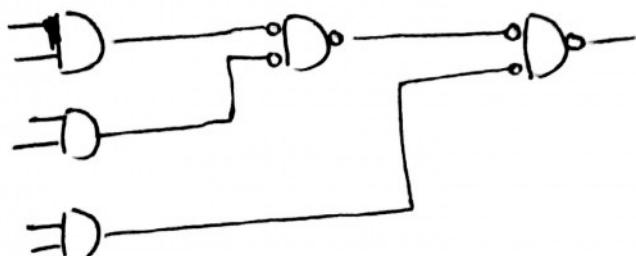
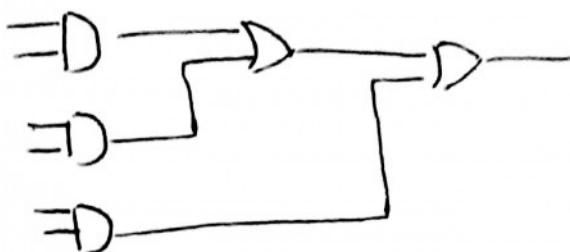
so we can implement the function with 1 NOT, 1 OR and 2 AND gates.

For the second part, we need to implement given circuit using NANDs only.

so best way is to replace OR with Invert NAND, $A + B = \overline{\overline{A} \overline{B}}$

$$A + B = (A' B')'$$

$$\begin{array}{c} A \\ B \end{array} \rightarrow [A+B] = \begin{array}{c} A \\ B \end{array} \rightarrow \overline{A'B'} = A+B$$



5 votes

-- Praveen Saini (38,4k points)

6.0.65 GATE2004-IT_10 top

<http://gateoverflow.in/3651>



Selected Answer

answer - B

multiplying 2 8 bit digits will give result in maximum 16 bits

total number of multiplications possible = $2^8 \times 2^8$

hence space required = $64K \times 16$ bits

9 votes

-- ankitrokdeonsns (8.4k points)

6.0.66 GATE2003_11 [top](#)

<http://gateoverflow.in/902>



Selected Answer

Take A = A₁ A₂ A₃ A₄

B= B₁ B₂ B₃ B₄

NOW TO MULTIPLY THESE TWO NUMBER .

1 AND GATE REQUIRE B₁ MULTIPLY WITH A₁ A₂ A₃ A₄.

1 AND GATE REQUIRE B₂ MULTIPLY WITH A₁ A₂ A₃ A₄.

1 AND GATE REQUIRE B₃ MULTIPLY WITH A₁ A₂ A₃ A₄.

1 AND GATE REQUIRE B₄ MULTIPLY WITH A₁ A₂ A₃ A₄.

NOW 3 OR GATE REQUIRE.

TOTAL 7 GATE REQUIRE FOR 4 BIT TAKE N BIT U FIND $2N-1$.

SO TIME COMPLEXITY WILL BE = $\Theta(n)$

6 votes

-- Anirudh Pratap Singh (17.7k points)

6.0.67 GATE2006_08 [top](#)

<http://gateoverflow.in/887>

B and D are inverting f and hence cannot be the answer.

In A, the output is activated by CLK on the final D flip flop. So, the output will have the same phase as f.

In C, the output is activated by CLK', and since CLK is having 50% duty cycle, this should mean the output will now have a phase difference of 180 degrees.

1 votes

-- Arjun Suresh (150k points)

6.1

Adder [top](#)

6.1.1 Adder: GATE 2016-1-33 [top](#)

<http://gateoverflow.in/39688>

Consider a carry look ahead adder for adding two n-bit integers, built using gates of fan-in at most two. The time to perform addition using this adder is

- A. $\Theta(1)$
- B. $\Theta(\log(n))$
- C. $\Theta(\sqrt{n})$
- D. $\Theta(n)$

[gate2016-1](#) [digital-logic](#) [adder](#) [normal](#)

Answer

6.1.2 Adder: GATE 2016-2-07 [top](#)<http://gateoverflow.in/39575>

Consider an eight-bit ripple-carry adder for computing the sum of A and B , where A and B are integers represented in 2's complement form. If the decimal value of A is one, the decimal value of B that leads to the longest latency for the sum to stabilize is _____

[gate2016-2](#) [digital-logic](#) [adder](#) [normal](#) [numerical-answers](#)

Answer**Answers: Adder****6.1.1 Adder: GATE 2016-1-33** [top](#)<http://gateoverflow.in/39688>

Selected Answer

option "b"

 $O(\log_2 n)$

because as fan-in is at most 2 then we can use two variable to the i/p of one XOR gate and then one i/p and one o/p from previous XOR gate and so, on ..

<https://www.cs.umd.edu/class/fall2003/cmsc311/Lectures/lecture22/lookahead.pdf>

12 votes**-- Gate Target** (171 points)**6.1.2 Adder: GATE 2016-2-07** [top](#)<http://gateoverflow.in/39575>

ans is -1

10 votes**-- viv696** (1.6k points)**6.2****Boolean Algebra** [top](#)**6.2.1 Boolean Algebra: GATE 2016-2-08** [top](#)<http://gateoverflow.in/39540>

Let, $x_1 \oplus x_2 \oplus x_3 \oplus x_4 = 0$ where x_1, x_2, x_3, x_4 are Boolean variables, and \oplus is the XOR operator.

Which one of the following must always be **TRUE**?

- A. $x_1 x_2 x_3 x_4 = 0$
- B. $x_1 x_3 + x_2 = 0$
- C. $\bar{x}_1 \oplus \bar{x}_3 = \bar{x}_2 \oplus \bar{x}_4$
- D. $x_1 + x_2 + x_3 + x_4 = 0$

[gate2016-2](#) [digital-logic](#) [boolean-algebra](#) [normal](#)

Answer**6.2.2 Boolean Algebra: GATE2000-2.10** [top](#)<http://gateoverflow.in/657>

The simultaneous equations on the Boolean variables x, y, z and w ,

$$x + y + z = 1 \\ xy = 0 \\ xz + w = 1 \\ xy + \bar{z}w = 0$$

have the following solution for x, y, z and w , respectively:

- A. 0 1 0 0

- B. 1 1 0 1
 C. 1 0 1 1
 D. 1 0 0 0

gate2000 | digital-logic | boolean-algebra | easy

[Answer](#)

6.2.3 Boolean Algebra: TIFR2010-B-21 [top](#)

<http://gateoverflow.in/18621>

For $x \in \{0, 1\}$, let $\neg x$ denote the negation of x , that is

$$\neg x = \begin{cases} 1 & \text{iff } x = 0 \\ 0 & \text{iff } x = 1 \end{cases}$$

If $x \in \{0, 1\}^n$, then $\neg x$ denotes the component wise negation of x ; that is:

$$(\neg x)_i = \left(\begin{array}{l} \text{---} \\ \text{---} \end{array} \right)$$

Consider a circuit C , computing a function $f : \{0, 1\}^n \rightarrow \{0, 1\}$ using **AND** (\wedge), **OR** (\vee), and **NOT** (\neg) gates. Let D be the circuit obtained from C by replacing each **AND** gate by an **OR** gate and replacing each **OR** gate by an **AND**. Suppose D computes the function g . Which of the following is true for all inputs x ?

- a. $g(x) = \neg f(x)$
- b. $g(x) = f(x) \wedge f(\neg x)$
- c. $g(x) = f(x) \vee f(\neg x)$
- d. $g(x) = \neg f(\neg x)$
- e. None of the above.

tifr2010 | digital-logic | boolean-algebra

[Answer](#)

Answers: Boolean Algebra

6.2.1 Boolean Algebra: GATE 2016-2-08 [top](#)

<http://gateoverflow.in/39540>



Selected Answer

Let
 $x_1 = 1$ $x_2 = 1$ $x_3 = 1$ and $x_4 = 1$

such that

$$x_1 \oplus x_2 \oplus x_3 \oplus x_4 = 1 \oplus 1 \oplus 1 \oplus 1 = 0$$

option A)

$$x_1 x_2 x_3 x_4 = 1.1.1.1 = 1, \text{ False}$$

option B)

$$x_1 x_3 + x_2 = 1.1 + 1 = 1, \text{ False}$$

option D)

$$x_1 + x_2 + x_3 + x_4 = 1 + 1 + 1 + 1 = 1, \text{ False.}$$

Option C) is always True.

11 votes

-- Praveen Saini (38.4k points)

6.2.2 Boolean Algebra: GATE2000-2.10 [top](#)

<http://gateoverflow.in/657>



Selected Answer

Answer: C

Upvote 7 votes

-- Rajarshi Sarkar (29.7k points)

6.2.3 Boolean Algebra: TIFR2010-B-21 [top](#)<http://gateoverflow.in/18621>

Selected Answer

Option d is answer.

The circuit D is the dual of the function $f(x)$ (i.e., replace and by or and vice versa)We can find dual of any function $f(x)$ by $\neg f(\neg x)$

Upvote 3 votes

-- Mari Ganesh Kumar (1.9k points)

6.3**Boolean Expressions** [top](#)<http://gateoverflow.in/8162>**6.3.1 Boolean Expressions: GATE2015-2_37** [top](#)

The number of min-terms after minimizing the following Boolean expression is _____.

 $[D' + AB' + A'C + AC'D + A'C'D]$ [gate2015-2](#) [digital-logic](#) [boolean-expressions](#) [normal](#)

Answer

6.3.2 Boolean Expressions: GATE 2016-1-06 [top](#)<http://gateoverflow.in/39629>

Consider the Boolean operator # with the following properties :

 $x \# 0 = x$, $x \# 1 = \bar{x}$, $x \# x = 0$ and $x \# \bar{x} = 1$. Then $x \# y$ is equivalent to

- A. $x\bar{y} + \bar{x}y$
- B. $x\bar{y} + \bar{x}\bar{y}$
- C. $xy + \bar{x}\bar{y}$
- D. $xy + \bar{x}y$

[gate2016-1](#) [digital-logic](#) [boolean-expressions](#) [easy](#)

Answer

6.3.3 Boolean Expressions: GATE2004-IT_44 [top](#)<http://gateoverflow.in/3687>The function $AB'C + A'BC + ABC' + A'B'C + AB'C'$ is equivalent to

- | | |
|----|-------------------|
| A) | $AC' + AB + A'C$ |
| B) | $AB' + AC' + A'C$ |
| C) | $A'B + AC' + AB'$ |
| D) | $A'B + AC + AB'$ |

[gate2004-it](#) [digital-logic](#) [boolean-expressions](#) [easy](#)

Answer

6.3.4 Boolean Expressions: GATE2002_2.3 [top](#)

<http://gateoverflow.in/833>

Let $f(A, B) = A' + B$. Simplified expression for function $f(f(x + y, y), z)$ is

- A. $x' + z$
- B. xyz
- C. $xy' + z$
- D. None of the above

[gate2002](#) | [digital-logic](#) | [boolean-expressions](#) | [normal](#)

[Answer](#)

6.3.5 Boolean Expressions: GATE1995_2.5 [top](#)

<http://gateoverflow.in/2617>

What values of A, B, C and D satisfy the following simultaneous Boolean equations?

$$\bar{A} + AB = 0, AB = AC, AB + A\bar{C} + CD = \bar{C}D$$

- A. $A = 1, B = 0, C = 0, D = 1$
- B. $A = 1, B = 1, C = 0, D = 0$
- C. $A = 1, B = 0, C = 1, D = 1$
- D. $A = 1, B = 0, C = 0, D = 0$

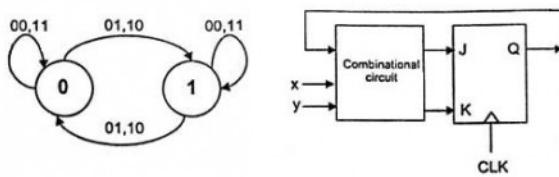
[gate1995](#) | [digital-logic](#) | [boolean-expressions](#) | [easy](#)

[Answer](#)

6.3.6 Boolean Expressions: GATE2008-IT_37 [top](#)

<http://gateoverflow.in/3347>

Consider the following state diagram and its realization by a JK flip flop



The combinational circuit generates J and K in terms of x, y and Q. The Boolean expressions for J and K are :

- A) \overline{x} and \overline{x}
 $\oplus y \quad \oplus y$
- B) \overline{x} and x
 $\oplus y \quad \oplus y$
- C) x and \overline{x}
 $\oplus y \quad \oplus y$
- D) x and x
 $\oplus y \quad \oplus y$

[gate2008-it](#) [digital-logic](#) [boolean-expressions](#) [normal](#)
[Answer](#)

Answers: Boolean Expressions

6.3.1 Boolean Expressions: GATE2015-2_37 [top](#)

<http://gateoverflow.in/8162>


Selected Answer

$$F = [D' + AB' + A'C + AC'D + A'C'D]'$$

$$F' = D' + AB' + A'C + AC'D + A'C'D$$

Now we have F' , so fill 0's (maxterms) in K-map for each term

As for D'

| | C'D' | C'D | CD | CD' |
|-------------|-------------|------------|-----------|------------|
| A'B' | 0 | | | 0 |
| A'B | 0 | | | 0 |
| AB | 0 | | | 0 |
| AB' | 0 | | | 0 |

Similarly for AB' , $A'C$, $AC'D$ and $A'C'D$. We will get

| | C'D' | C'D | CD | CD' |
|-------------|-------------|------------|-----------|------------|
| A'B' | 0 | 0 | 0 | 0 |
| A'B | 0 | 0 | 0 | 0 |
| AB | 0 | 0 | | 0 |
| AB' | 0 | 0 | 0 | 0 |

We get one place for minterm and that is **ABCD**

[Upvote](#) 13 votes

[Praveen Saini](#) (38.4k points)

6.3.2 Boolean Expressions: GATE 2016-1-06 [top](#)

<http://gateoverflow.in/3629>


Selected Answer

These are properties of XOR function.. so answer is A) $x\bar{y} + \bar{x}y$

[Upvote](#) 12 votes

[Abhilash Panicker](#) (7k points)

6.3.3 Boolean Expressions: GATE2004-IT_44 [top](#)

<http://gateoverflow.in/3627>


Selected Answer

K-map

| | A'B' | A'B | AB | AB' |
|-----------|-------------|------------|-----------|------------|
| C' | 0 | 0 | 1 | 1 |
| C | 1 | 1 | 0 | 1 |

So, the equivalent expression will be $A'C + AC' + AB'$

(B) option

[Upvote](#) 8 votes

[Arjun Suresh](#) (150k points)

6.3.4 Boolean Expressions: GATE2002_2.3 [top](#)

<http://gateoverflow.in/833>



Selected Answer

$$\begin{aligned}
 f(f(x+y, y), z) &= f((x+y)' + y), z \\
 &= ((x+y)' + y)' + z \\
 &= (x+y).y' + z \quad (\because (a+b)' = a'.b') \\
 &= xy' + z
 \end{aligned}$$

9 votes

-- Arjun Suresh (150k points)

6.3.5 Boolean Expressions: GATE1995_2.5 [top](#)

<http://gateoverflow.in/2617>



Selected Answer

Answer is A.

For verification, just put up the values and check for AND, OR operations and their outputs.

9 votes

-- Gate Keeda (17.7k points)

6.3.6 Boolean Expressions: GATE2008-IT_37 [top](#)

<http://gateoverflow.in/3347>



Selected Answer

| Transition State Table | | | | | |
|------------------------|---|---|--------|---|---|
| Q | X | Y | Q' + 1 | J | K |
| 0 | 0 | 0 | 0 | 0 | X |
| 0 | 0 | 1 | 1 | 1 | X |
| 0 | 1 | 0 | 1 | 1 | X |
| 0 | 1 | 1 | 0 | 0 | X |
| 1 | 0 | 0 | 1 | X | 0 |
| 1 | 0 | 1 | 0 | X | 1 |
| 1 | 1 | 0 | 0 | X | 1 |
| 1 | 1 | 1 | 1 | X | 0 |

| Excitation Table JK | | | | | |
|---------------------|---|---|--------|---|---|
| Q' | X | Y | Q' + 1 | J | K |
| 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 1 | 1 | 1 | 0 |
| 0 | 1 | 0 | 1 | 0 | 1 |
| 0 | 1 | 1 | 0 | 1 | 0 |
| 1 | 0 | 0 | 1 | 0 | 0 |
| 1 | 0 | 1 | 0 | 1 | 1 |
| 1 | 1 | 0 | 0 | 1 | 1 |
| 1 | 1 | 1 | 1 | 0 | 0 |

$$\begin{aligned}
 J &= x'y + x'y' \\
 K &= x \oplus y \\
 Q' &\leftarrow x \oplus y
 \end{aligned}$$

∴ Option D.

D is correct

13 votes

-- Riya Roy(Arayana) (5.6k points)

6.4

Booths Algorithm [top](#)

6.4.1 Booths Algorithm: GATE2005-IT_8 [top](#)

<http://gateoverflow.in/3753>

Using Booth's Algorithm for multiplication, the multiplier -57 will be recoded as

- A. 0 -1 0 0 1 0 0 -1
- B. 1 1 0 0 0 1 1 1
- C. 0 -1 0 0 1 0 0 0
- D. 0 1 0 0 -1 0 0 1

[gate2005-it](#) [digital-logic](#) [booths-algorithm](#) [normal](#)

[Answer](#)

6.4.2 Booths Algorithm: GATE2008-IT_42 [top](#)

<http://gateoverflow.in/3352>

The two numbers given below are multiplied using the Booth's algorithm.

Multiplicand : 0101 1010 1110 1110
 Multiplier: 0111 0111 1011 1101

How many additions/Subtractions are required for the multiplication of the above two numbers?

- | | |
|----|----|
| A) | 6 |
| B) | 8 |
| C) | 10 |
| D) | 12 |

[gate2008-it](#) [digital-logic](#) [booths-algorithm](#) [normal](#)

[Answer](#)

6.4.3 Booths Algorithm: GATE1996_1.23 [top](#)

<http://gateoverflow.in/2727>

Booth's algorithm for integer multiplication gives worst performance when the multiplier pattern is

- A. 101010 1010
- B. 100000 0001
- C. 111111 1111
- D. 011111 1110

[gate1996](#) [digital-logic](#) [booths-algorithm](#) [normal](#)

[Answer](#)

6.4.4 Booths Algorithm: GATE2006-IT_38 [top](#)

<http://gateoverflow.in/3577>

When multiplicand Y is multiplied by multiplier X = $x_n - 1x_{n-2} \dots x_0$ using bit-pair recoding in Booth's algorithm, partial products are generated according to the following table.

| Row | x_{i+1} | x_i | x_{i-1} | Partial Product |
|-----|-----------|-------|-----------|-----------------|
| 1 | 0 | 0 | 0 | 0 |
| 2 | 0 | 0 | 1 | Y |
| 3 | 0 | 1 | 0 | Y |
| 4 | 0 | 1 | 1 | 2Y |
| 5 | 1 | 0 | 0 | ? |
| 6 | 1 | 0 | 1 | -Y |
| 7 | 1 | 1 | 0 | -Y |
| 8 | 1 | 1 | 1 | ? |

The partial products for rows 5 and 8 are

- A) 2Y and Y
- B) -2Y and 2Y
- C) -2Y and 0
- D) 0 and Y

[gate2006-it](#) [digital-logic](#) [booths-algorithm](#) [normal](#)

[Answer](#)

Answers: Booths Algorithm

6.4.1 Booths Algorithm: GATE2005-IT_8 [top](#)

<http://gateoverflow.in/3753>

Its (A)

2's complement of -57 is 110001110

Now we append a 0 at the LSB and start from right end taking pairs of two symbols which are encoded as:

00-> 0

01-> +1

10-> -1

11->0

4 votes

-- Sandeep_Uniyal (5.5k points)

6.4.2 Booths Algorithm: GATE2008-IT_42 [top](#)

<http://gateoverflow.in/3752>



Selected Answer

Answer : 8

If you want to find out How many additions/Subtractions are required for the multiplication using Booth's algorithm. then Rules are like this

Take multiplicand and multiplier like they are given in the question :

| | |
|----------------|---------------------|
| Multiplicand : | 0101 1010 1110 1110 |
| Multiplier: | 0111 0111 1011 1101 |

Now find out the 01 and 10 pairs combinedly means see both Multiplicand and Multiplier simultaneously first pair is 00 then 11 ,**01** ,11 , **10** **01** 11 **01** 11 **10** 11 **01** 11 11 **10** **01**

why i asked you to do this because this is the rule a/c to Booth's algorithm. to find out no of additions/Subtractions it also says don't do anything if you got 11 or 00 .

13 votes

-- shekhar chauhan (36.4k points)

6.4.3 Booths Algorithm: GATE1996_1.23 [top](#)

<http://gateoverflow.in/2727>



Selected Answer

Answer: A

The worst case of an implementation using Booth's algorithm is when pairs of 01s or 10s occur very frequently in the multiplier.

6 votes

-- Rajarshi Sarkar (29.7k points)

6.4.4 Booths Algorithm: GATE2006-IT_38 [top](#)

<http://gateoverflow.in/3577>

partial product is calculated by using bit pair recording in booths algorithm ,,, which is improvement technique used in booths algorithm.

$$-2 X(i+1) + x(i) + X(i-1)$$

ANS : C

1 votes

-- pramod (2.3k points)

6.5

Booths Coding [top](#)

6.5.1 Booths Coding: GATE1999_1.20 [top](#)

<http://gateoverflow.in/1473>

Booth's coding in 8 bits for the decimal number -57 is

- A. 0-100+1000
- B. 0-100+100-1
- C. 0-1+100-10+1
- D. 00-10+100-1

[gate1999](#) [digital-logic](#) [number-representation](#) [booths-coding](#) [normal](#)

Answer

Answers: Booths Coding

6.5.1 Booths Coding: GATE1999_1.20 [top](#)

<http://gateoverflow.in/1473>



Selected Answer

B -57 is represented as 1000111 on moving from 0 to 1 we get -1 and from 1 to 0 we get 1

so ans is b

3 votes

-- Pooja (25.9k points)

6.6

Canonical Normal Form [top](#)

6.6.1 Canonical Normal Form: GATE2015-3_44 [top](#)

<http://gateoverflow.in/8504>

Given the function $F = P' + QR$, where F is a function in three Boolean variables P, Q and R and $P' = \neg P$, consider the following statements.

$$(S1) F = \sum(4, 5, 6)$$

$$(S2) F = \sum(0, 1, 2, 3, 7)$$

(S3) $F = \Pi(4, 5, 6)$

(S4) $F = \Pi(0, 1, 2, 3, 7)$

Which of the following is true?

- A. (S1)-False, (S2)-True, (S3)-True, (S4)-False
- B. (S1)-True, (S2)-False, (S3)-False, (S4)-True
- C. (S1)-False, (S2)-False, (S3)-True, (S4)-True
- D. (S1)-True, (S2)-True, (S3)-False, (S4)-False

[gate2015-3](#) [digital-logic](#) [canonical-normal-form](#) [normal](#)

[Answer](#)

6.6.2 Canonical Normal Form: GATE2015-3_43 [top](#)

<http://gateoverflow.in/8503>

The total number of prime implicants of the function $f(w, x, y, z) = \sum(0, 2, 4, 5, 6, 10)$ is _____.

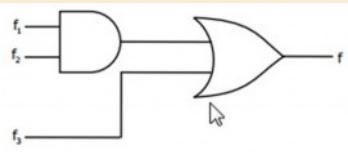
[gate2015-3](#) [digital-logic](#) [canonical-normal-form](#) [normal](#) [numerical-answers](#)

[Answer](#)

6.6.3 Canonical Normal Form: GATE2008-8 [top](#)

<http://gateoverflow.in/406>

Given f_1 , f_3 and f in canonical sum of products form (in decimal) for the circuit



$$f_1 = \Sigma m(4, 5, 6, 7, 8)$$

$$f_3 = \Sigma m(1, 6, 15)$$

$$f = \Sigma m(1, 6, 8, 15)$$

then f_2 is

- A. $\Sigma m(4, 6)$
- B. $\Sigma m(4, 8)$
- C. $\Sigma m(6, 8)$
- D. $\Sigma m(4, 6, 8)$

[gate2008](#) [digital-logic](#) [canonical-normal-form](#) [easy](#)

[Answer](#)

6.6.4 Canonical Normal Form: GATE2010-6 [top](#)

<http://gateoverflow.in/2177>

The minterm expansion of $f(P, Q, R) = PQ + Q\bar{R} + P\bar{R}$ is

- A. $m_2 + m_4 + m_6 + m_7$
- B. $m_0 + m_1 + m_3 + m_5$
- C. $m_0 + m_1 + m_6 + m_7$
- D. $m_2 + m_3 + m_4 + m_5$

[gate2010](#) [digital-logic](#) [canonical-normal-form](#) [normal](#)

[Answer](#)

6.6.5 Canonical Normal Form: TIFR2015-B-9 [top](#)

<http://gateoverflow.in/3004>

A Boolean expression is an expression made out of propositional letters (such as p, q, r) and operators \wedge, \vee and \neg ; e.g. $p \wedge \neg(q \vee \neg r)$. An expression is said to be in sum of product form (also called disjunctive normal form) if all \neg occur just before letters and no \vee occurs in scope of \wedge ; e.g. $(p \wedge \neg q) \vee (\neg p \wedge q)$. The expression is said to be in product of sum form (also called conjunctive normal form) if all negations occur just before letters and no \wedge occurs in the scope of \vee ; e.g. $(p \vee \neg q) \wedge (\neg p \vee q)$. Which of the following is not correct?

- A. Every Boolean expression is equivalent to an expression in sum of product form.
- B. Every Boolean expression is equivalent to an expression in product of sum form.
- C. Every Boolean expression is equivalent to an expression without \vee operator.
- D. Every Boolean expression is equivalent to an expression without \wedge operator.
- E. Every Boolean expression is equivalent to an expression without \neg operator.

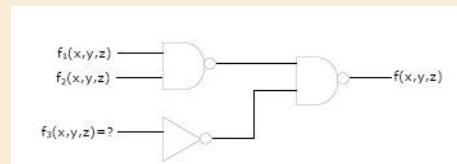
[tifr2015](#) [canonical-normal-form](#)

[Answer](#)

6.6.6 Canonical Normal Form: GATE2002_2.1 [top](#)

<http://gateoverflow.in/831>

Consider the following logic circuit whose inputs are functions f_1, f_2, f_3 and output is f



Given that

$$f_1(x, y, z) = \Sigma(0, 1, 3, 5)$$

$$f_2(x, y, z) = \Sigma(6, 7), \text{ and}$$

$$f(x, y, z) = \Sigma(1, 4, 5).$$

f_3 is

- A. $\Sigma(1, 4, 5)$
- B. $\Sigma(6, 7)$
- C. $\Sigma(0, 1, 3, 5)$
- D. None of the above

[gate2002](#) [digital-logic](#) [normal](#) [canonical-normal-form](#) [circuit-output](#)

[Answer](#)

Answers: Canonical Normal Form

6.6.1 Canonical Normal Form: GATE2015-3_44 [top](#)

<http://gateoverflow.in/8504>



Selected Answer

F=P'+QR, draw the Kmap for this

we can find the minterm $\sum(0,1,2,3,7)$

and maxterm $\Pi(4,5,6)$

so option A is correct ...**(S1)-False, (S2)-True, (S3)-True, (S4)-False**

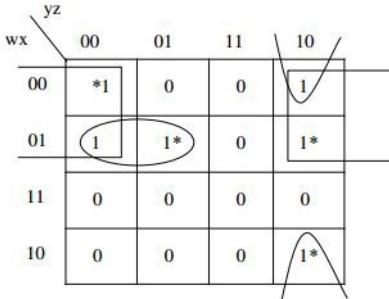
9 votes

-- Anoop Sonkar (4.5k points)

6.6.2 Canonical Normal Form: GATE2015-3_43 [top](#)

<http://gateoverflow.in/8503>

Selected Answer



as u can see that there is 1 4-set and 2 2-set that are covering the star marked 1's(i.e. the ones that are not covered by any other combinations).

So, the answer is 3.

19 votes

-- Tamojit Chatterjee (1.9k points)

6.6.3 Canonical Normal Form: GATE2008-8 [top](#)

<http://gateoverflow.in/406>

Selected Answer

answer - C

with AND gates we will choose intersection of min-terms

with OR gates we will take union of min-terms

12 votes

-- ankitrokdeonsns (8.4k points)

6.6.4 Canonical Normal Form: GATE2010-6 [top](#)

<http://gateoverflow.in/2177>

Selected Answer

$$PQ + QR' + PR' = PQR + PQR' + PQR' + P'QR' + PQR' + PQ'R'$$

$$= PQR + PQR' + P'QR' + PQ'R' (111 + 110 + 010 + 100)$$

$$= m_7 + m_6 + m_2 + m_4$$

Option A.

Alternatively ,
Using K-map

| | | QR | 00 | 01 | 11 | 10 | | |
|--|--|----|----|-------|-------|-------|-------|--|
| | | P | 0 | m_0 | m_1 | m_3 | m_2 | |
| | | P | 1 | m_4 | m_5 | m_7 | m_6 | |
| | | | | | | | | |
| | | | | | | | | |

6 votes

-- Arjun Suresh (150k points)

6.6.5 Canonical Normal Form: TIFR2015-B-9 [top](#)

<http://gateoverflow.in/30030>

Basically they are saying all the same thing as what we have seen. for ex just simplify this. use \wedge and operator (.) for \wedge . so sop will become $(p \cdot q') + (p' \cdot q)$

so no meaning have been changed and we can move further with all the boolean logic we have read.

we know every expression can be expressed in pos or sop form so 1 and 2 are true.

we know that AND and NOT are functionally complete. so any expression can be expressed using these two only. so all the expression can be expressed in a form which does not contain OR but contain and and not, with the same logic point 4 will be true because we know not and OR are also functionally complete.

But without NOT we can't get a functionally complete gate. so E is wrong.

3 votes

-- Ravi Singh (8.2k points)

6.6.6 Canonical Normal Form: GATE2002_2.1 [top](#)

<http://gateoverflow.in/831>

Selected Answer

$$f = ((f_1 f_2)' f_3')' = f_1 f_2 + f_3$$

In minimum sum of products form, AND of two expressions will contain the common terms. Since f_1 and f_2 don't have any common term, $f_1 f_2$ is 0 and hence $f = f_3 = \Sigma(1, 4, 5)$.

12 votes

-- Arjun Suresh (150k points)

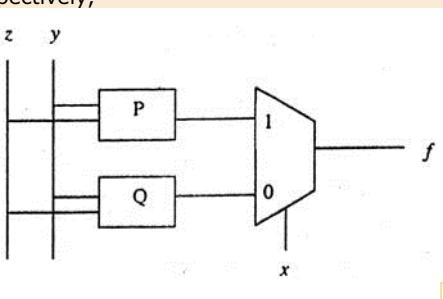
6.7

Circuit Output [top](#)

6.7.1 Circuit Output: GATE2006-IT_36 [top](#)

<http://gateoverflow.in/3575>

The majority function is a Boolean function $f(x, y, z)$ that takes the value 1 whenever a majority of the variables x, y, z and 1. In the circuit diagram for the majority function shown below, the logic gates for the boxes labeled P and Q are, respectively,



- A) XOR, AND
 B) XOR, XOR
 C) OR, OR
 D) OR, AND

[gate2006-it](#) [digital-logic](#) [circuit-output](#) [normal](#)

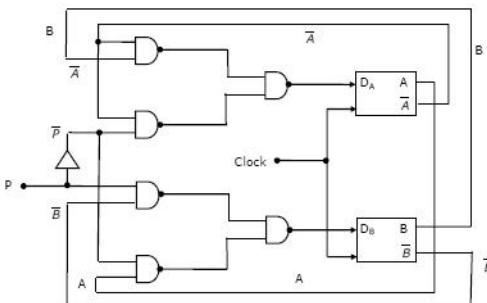
[Answer](#)

6.7.2 Circuit Output: GATE1993_19 [top](#)

<http://gateoverflow.in/2316>

A control algorithm is implemented by the NAND – gate circuitry given in figure below, where A and B are state variable implemented by D flip-flops, and P is control input. Develop the state transition table for this controller.

19. A control algorithm is implemented by the NAND – gate circuitry given in figure below, which A and B are state variable implemented by D flip-flops, and P is control input. Develop the state transition table for this controller.



[gate1993](#) [digital-logic](#) [circuit-output](#) [normal](#)

[Answer](#)

6.7.3 Circuit Output: GATE2007-IT-38 [top](#)

<http://gateoverflow.in/3471>

The following expression was to be realized using 2-input AND and OR gates. However, during the fabrication all 2-input AND gates were mistakenly substituted by 2-input NAND gates. $(a.b).c + (a'.c).d + (b.c).d + a.d$

What is the function finally realized ?

- A. 1
 B. $a' + b' + c' + d'$
 C. $a' + b + c' + d'$
 D. $a' + b' + c + d'$

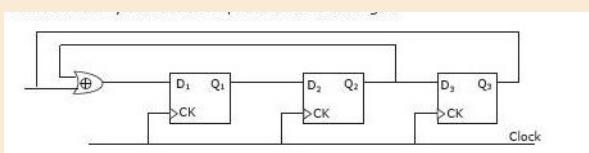
[gate2007-it](#) [digital-logic](#) [circuit-output](#) [normal](#)

[Answer](#)

6.7.4 Circuit Output: GATE1996_24 [top](#)

<http://gateoverflow.in/2776>

Consider the synchronous sequential circuit in the below figure



- a. Draw a state diagram, which is implemented by the circuit. Use the following names for the states corresponding to the values of flip-flops as given below.

| Q1 | Q2 | Q3 | State |
|-----------|-----------|-----------|--------------|
| 0 | 0 | 0 | S_0 |
| 0 | 0 | 1 | S_1 |
| - | - | - | - |
| - | - | - | - |
| - | - | - | - |
| 1 | 1 | 1 | S_7 |

- b. Given that the initial state of the circuit is S_4 , identify the set of states, which are not reachable.

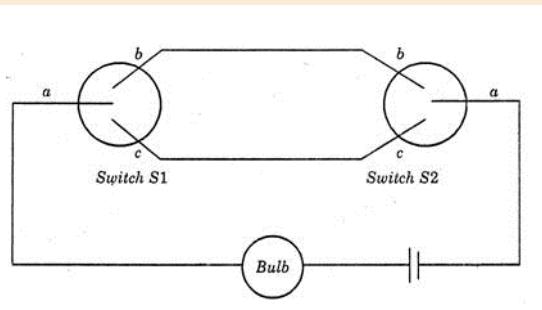
gate1996 | digital-logic | circuit-output | normal

Answer

6.7.5 Circuit Output: GATE2005-IT_10 top

<http://gateoverflow.in/3755>

A two-way switch has three terminals a, b and c. In ON position (logic value 1), a is connected to b, and in OFF position, a is connected to c. Two of these two-way switches S1 and S2 are connected to a bulb as shown below.



Which of the following expressions, if true, will always result in the lighting of the bulb ?

- A. $S_1 \cdot \overline{S_2}$
- B. $S_1 + S_2$
- C. $\overline{S_1} \oplus S_2$
- D. $S_1 \oplus S_2$

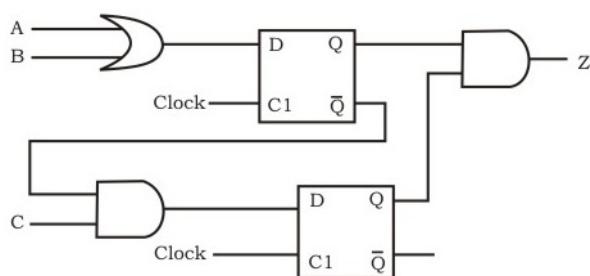
gate2005-it | digital-logic | circuit-output | normal

Answer

6.7.6 Circuit Output: GATE2005-IT_43 top

<http://gateoverflow.in/3804>

Which of the following input sequences will always generate a 1 at the output z at the end of the third cycle?



- A)

| | | |
|---|---|---|
| A | B | C |
| 0 | 0 | 0 |
| 1 | 0 | 1 |
| 1 | 1 | 1 |
- B)

| | | |
|---|---|---|
| A | B | C |
| 1 | 0 | 1 |
| 1 | 1 | 0 |
| 1 | 1 | 1 |
- C)

| | | |
|---|---|---|
| A | B | C |
| 0 | 1 | 1 |
| 1 | 0 | 1 |
| 1 | 1 | 1 |
- D)

| | | |
|---|---|---|
| A | B | C |
| 0 | 0 | 1 |
| 1 | 1 | 0 |
| 1 | 1 | 1 |

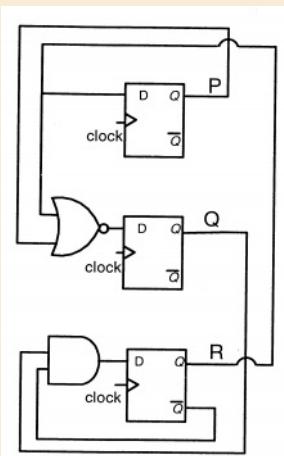
gate2005-it digital-logic circuit-output normal

Answer

6.7.7 Circuit Output: GATE2011-50 [top](#)

<http://gateoverflow.in/2157>

Consider the following circuit involving three D-type flip-flops used in a certain type of counter configuration.



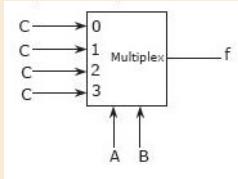
If at some instance prior to the occurrence of the clock edge,
 P, Q and
 R have a value 0, 1 and 0 respectively, what shall be the value of
 PQR after the clock edge?

- A. 000
- B. 001
- C. 010

D. 011

gate2011 digital-logic circuit-output normal

Answer

6.7.8 Circuit Output: GATE1996_2.22 top <http://gateoverflow.in/2751>Consider the circuit in figure. f implements

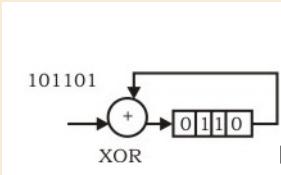
- A. $\overline{A}\overline{B}C + \overline{A}B\overline{C} + ABC$
- B. $A + B + C$
- C. $A \oplus B \oplus C$
- D. $AB + BC + CA$

gate1996 digital-logic circuit-output easy

Answer

6.7.9 Circuit Output: GATE2007-IT_40 top <http://gateoverflow.in/3473>

What is the final value stored in the linear feedback shift register if the input is 101101?

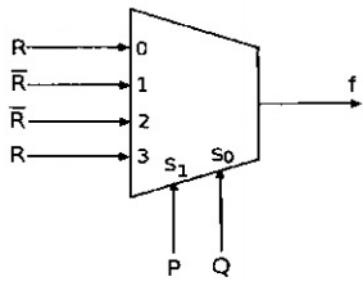


- | | |
|----|------|
| A) | 0110 |
| B) | 1011 |
| C) | 1101 |
| D) | 1111 |

gate2007-it digital-logic circuit-output normal

Answer

6.7.10 Circuit Output: GATE2010-9 top <http://gateoverflow.in/2182>The Boolean expression of the output f of the multiplexer shown below is



- A. $\overline{P \oplus Q \oplus R}$
 B. $P \oplus Q \oplus R$
 C. $P + Q + R$
 D. $\overline{P + Q + R}$

gate2010 | digital-logic | circuit-output | easy

Answer

6.7.11 Circuit Output: GATE1997_5.5 top

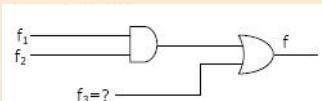
<http://gateoverflow.in/2256>

Consider a logic circuit shown in figure below. The functions f_1, f_2 and f (in canonical sum of products form in decimal notation) are :

$$f_1(w, x, y, z) = \sum 8, 9, 10$$

$$f_2(w, x, y, z) = \sum 7, 8, 12, 13, 14, 15$$

$$f(w, x, y, z) = \sum 8, 9$$



The function

f_3 is

- A. $\sum 9, 10$
 B. $\sum 9$
 C. $\sum 1, 8, 9$
 D. $\sum 8, 10, 15$

gate1997 | digital-logic | circuit-output | normal

Answer

6.7.12 Circuit Output: GATE2010-31 top

<http://gateoverflow.in/2225>

What is the boolean expression for the output f of the combinational logic circuit of NOR gates given below?

- A. $\overline{Q + R}$
 B. $\overline{P + Q}$
 C. $\overline{P + R}$
 D. $\overline{P + Q + R}$

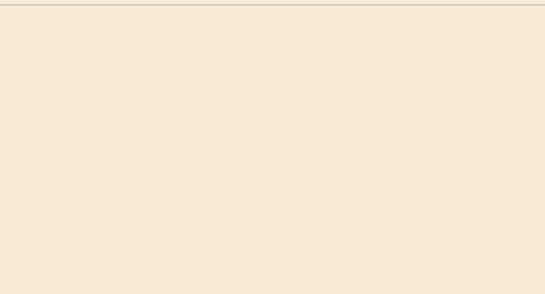
gate2010 | digital-logic | circuit-output | normal

Answer

6.7.13 Circuit Output: GATE2010-32 top

<http://gateoverflow.in/2206>

In the sequential circuit shown below, if the initial value of the output Q_1Q_0 is 00. What are the next four values of Q_1Q_0 ?



- A. 11,10,01,00
 B. 10,11,01,00
 C. 10,00,01,11
 D. 11,10,00,01

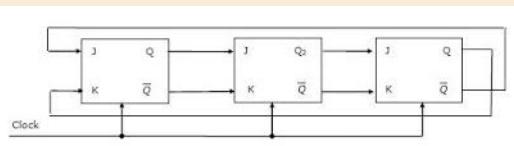
gate2010 | digital-logic | circuit-output | normal

Answer

6.7.14 Circuit Output: GATE1993_6.3 top

<http://gateoverflow.in/17237>

For the initial state of 000, the function performed by the arrangement of the J-K flip-flops in figure is:



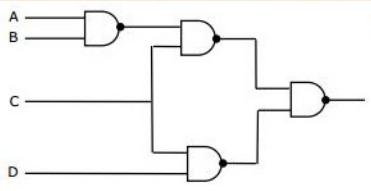
- A. Shift Register
 B. Mod- 3 Counter
 C. Mod- 6 Counter
 D. Mod- 2 Counter
 E. None of the above

gate1993 | digital-logic | circuit-output | normal

Answer

6.7.15 Circuit Output: GATE1994_1.8 [top](#)<http://gateoverflow.in/2445>

The logic expression for the output of the circuit shown in figure below is:



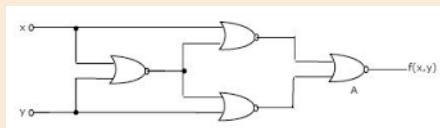
- A. $\overline{AC} + \overline{BC} + CD$
- B. $A\overline{C} + B\overline{C} + CD$
- C. $ABC + \overline{C}D$
- D. $\overline{A}\overline{B} + \overline{B}\overline{C} + CD$

[gate1994](#) [digital-logic](#) [circuit-output](#) [normal](#)

Answer

6.7.16 Circuit Output: GATE1993_6.1 [top](#)<http://gateoverflow.in/2288>

Identify the logic function performed by the circuit shown in figure.



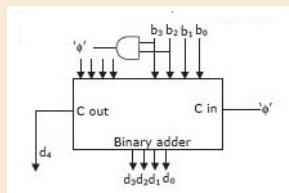
- A. exclusive OR
- B. exclusive NOR
- C. NAND
- D. NOR
- E. None of the above

[gate1993](#) [digital-logic](#) [circuit-output](#) [normal](#)

Answer

6.7.17 Circuit Output: GATE1996_2.21 [top](#)<http://gateoverflow.in/2750>

Consider the circuit in Fig.2.21 which has a four bit binary number $b_3b_2b_1b_0$ as input and a five bit binary number, $d_4d_3d_2d_1d_0$ as output.



- A. Binary to Hex conversion
- B. Binary to BCD conversion
- C. Binary to grey code conversion

D. Binary to radix-12 conversion

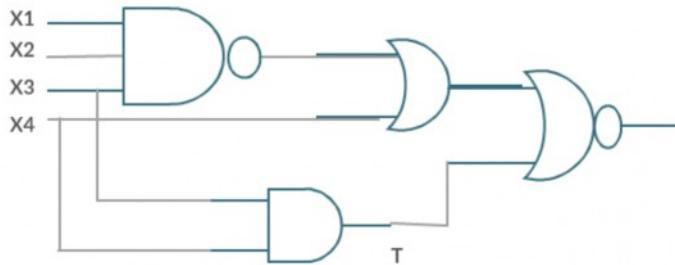
gate1996 | digital-logic | circuit-output | normal

Answer

6.7.18 Circuit Output: GATE2007-IT-45 [top](#)

<http://gateoverflow.in/3480>

The line T in the following figure is permanently connected to the ground.



Which of the following inputs (X1 X2 X3 X4) will detect the fault ?

- A. 0000
- B. 0111
- C. 1111
- D. None of these

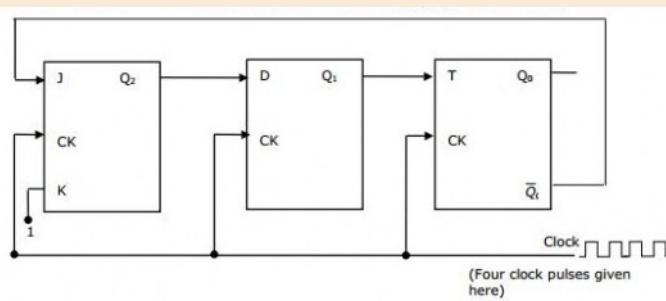
gate2007-it | digital-logic | circuit-output | normal

Answer

6.7.19 Circuit Output: GATE1994_11 [top](#)

<http://gateoverflow.in/2507>

Find the contents of the flip-flop Q_2, Q_1 and Q_0 in the circuit of figure, after giving four clock pulses to the clock terminal. Assume $Q_2Q_1Q_0 = 000$ initially.



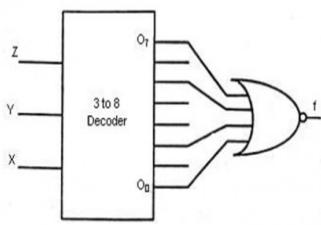
gate1994 | digital-logic | circuit-output | normal

Answer

6.7.20 Circuit Output: GATE2008-IT_9 [top](#)

<http://gateoverflow.in/3269>

What Boolean function does the circuit below realize?



- A) $xz + \bar{x}\bar{z}$
 B) $x\bar{z} + \bar{x}z$
 C) $\bar{x}\bar{y} + yz$
 D) $xy + \bar{y}\bar{z}$

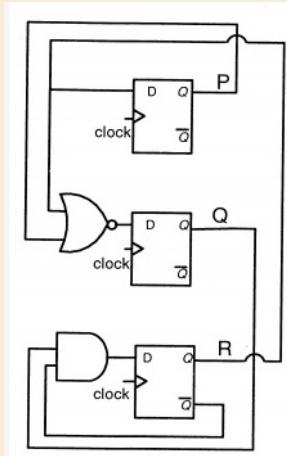
gate2008-it | digital-logic | circuit-output | normal

Answer

6.7.21 Circuit Output: GATE2011-51 [top](#)

<http://gateoverflow.in/43318>

Consider the following circuit involving three D-type flip-flops used in a certain type of counter configuration.



If all the flip-flops were reset to 0 at power on, what is the total number of distinct outputs (states) represented by PQR generated by the counter?

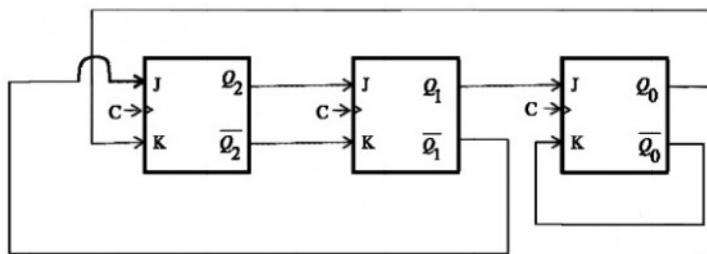
- A. 3
 B. 4
 C. 5
 D. 6

gate2011 | digital-logic | circuit-output | normal

Answer

6.7.22 Circuit Output: GATE2014-3_45 [top](#)

<http://gateoverflow.in/2079>



The above synchronous sequential circuit built using JK flip-flops is initialized with $Q_2Q_1Q_0 = 000$. The state sequence for this circuit for the next 3 clock cycles is

- (A) 001, 010, 011
- (B) 111, 110, 101
- (C) 100, 110, 111
- (D) 100, 011, 001

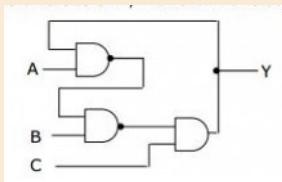
[gate2014-3](#) | [digital-logic](#) | [circuit-output](#) | [normal](#)

[Answer](#)

6.7.23 Circuit Output: GATE1999_2.8 [top](#)

<http://gateoverflow.in/1486>

Consider the circuit shown below. In a certain steady state, the line Y is at '1'. What are the possible values of A, B and C in this state?



- A. $A = 0, B = 0, C = 1$
- B. $A = 0, B = 1, C = 1$
- C. $A = 1, B = 0, C = 1$
- D. $A = 1, B = 1, C = 1$

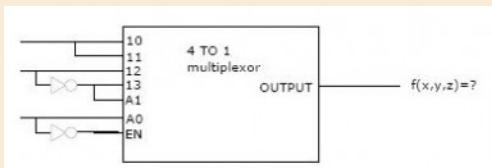
[gate1999](#) | [digital-logic](#) | [circuit-output](#) | [normal](#)

[Answer](#)

6.7.24 Circuit Output: GATE2002_2.2 [top](#)

<http://gateoverflow.in/832>

Consider the following multiplexer where 10, 11, 12, 13 are four data input lines selected by two address line combinations A1A0=00,01,10,11 respectively and f is the output of the multiplexor. EN is the Enable input.



The function $f(x,y,z)$ implemented by the above circuit is

- A. $xz'y'$
- B. $xy + z$
- C. $x + y$
- D. None of the above

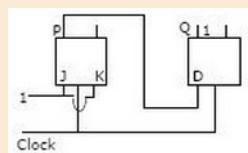
[gate2002](#) [digital-logic](#) [circuit-output](#) [normal](#)

[Answer](#)

6.7.25 Circuit Output: GATE2000-2.12 [top](#)

<http://gateoverflow.in/659>

The following arrangement of master-slave flip flops



has the initial state of P, Q as 0, 1 (respectively). After a clock cycle the output state P, Q is (respectively),

- A. 1, 0
- B. 1, 1
- C. 0, 0
- D. 0, 1

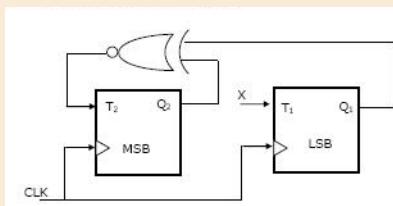
[gate2000](#) [digital-logic](#) [circuit-output](#) [normal](#)

[Answer](#)

6.7.26 Circuit Output: GATE2004_61 [top](#)

<http://gateoverflow.in/1056>

Consider the partial implementation of a 2-bit counter using T flip-flops following the sequence 0-2-3-1-0, as shown below.



To complete the circuit, the input X should be

- A. Q_2^c
- B. $Q_2 + Q_1$
- C. $(Q_1 + Q_2)^c$
- D. $Q_1 \oplus Q_2$

[gate2004](#) [digital-logic](#) [circuit-output](#) [normal](#)

[Answer](#)

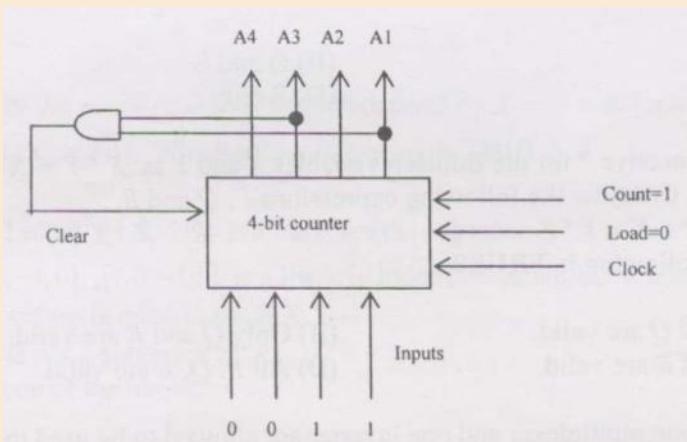
6.7.27 Circuit Output: GATE2007_36 [top](#)

<http://gateoverflow.in/1234>

The control signal functions of a 4-bit binary counter are given below (where X is "don't care"):

| Clear | Clock | Load | Count | Function |
|-------|-------|------|-------|------------|
| 1 | X | X | X | Clear to 0 |
| 0 | X | 0 | 0 | No change |
| 0 | ↑ | 1 | X | Load input |
| 0 | ↑ | 0 | 1 | Count next |

The counter is connected as follows:



Assume that the counter and gate delays are negligible. If the counter starts at 0, then it cycles through the following sequence:

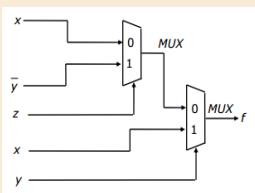
- A. 0, 3, 4
- B. 0, 3, 4, 5
- C. 0, 1, 2, 3, 4
- D. 0, 1, 2, 3, 4, 5

[gate2007](#) [digital-logic](#) [circuit-output](#) [normal](#)

Answer

6.7.28 Circuit Output: GATE2006_35 [top](#)

<http://gateoverflow.in/1292>

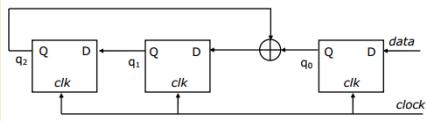


Consider the circuit above. Which one of the following options correctly represents $f(x, y, z)$

- (A) $x\bar{z} + xy + \bar{y}z$
- (B) $x\bar{z} + xy + \bar{y}\bar{z}$
- (C) $xz + xy + \bar{y}z$
- (D) $xz + x\bar{y} + \bar{y}z$

[gate2006](#) [digital-logic](#) [circuit-output](#) [normal](#)
Answer**6.7.29 Circuit Output: GATE2006_37** [top](#)<http://gateoverflow.in/1295>

Consider the circuit in the diagram. The \oplus operator represents Ex-OR. The D flip-flops are initialized to zeroes (cleared).

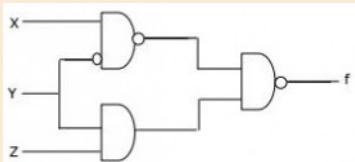


The following data: 100110000 is supplied to the "data" terminal in nine clock cycles. After that the values of $q_2 q_1 q_0$ are:

- (A) 000
- (B) 001
- (C) 010
- (D) 101

[gate2006](#) [digital-logic](#) [circuit-output](#) [easy](#)
Answer**6.7.30 Circuit Output: GATE2005_15** [top](#)<http://gateoverflow.in/1351>

Consider the following circuit.

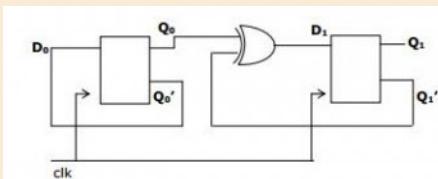


Which one of the following is TRUE?

- A. f is independent of X
- B. f is independent of Y
- C. f is independent of Z
- D. None of X, Y, Z is redundant

[gate2005](#) [digital-logic](#) [circuit-output](#) [normal](#)
Answer**6.7.31 Circuit Output: GATE2005_64** [top](#)<http://gateoverflow.in/1387>

Consider the following circuit:



The flip-flops are positive edge triggered D FFs. Each state is designated as a two-bit string $Q_0 Q_1$. Let the initial state be 00. The state transition sequence is

- A. $00 \rightarrow 11 \rightarrow 01$
- B. $00 \rightarrow 11$
- C. $00 \rightarrow 10 \rightarrow 01 \rightarrow 11$
- D. $00 \rightarrow 11 \rightarrow 01 \rightarrow 10$

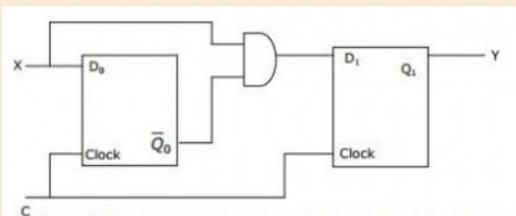
gate2005 | digital-logic | circuit-output

Answer

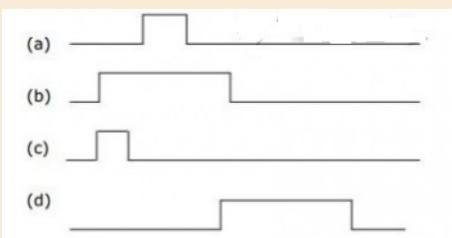
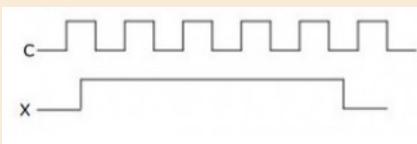
6.7.32 Circuit Output: GATE2001-2.8 top

<http://gateoverflow.in/726>

Consider the following circuit with initial state $Q_0 = Q_1 = 0$. The D Flip-flops are positive edged triggered and have set up times 20 nanosecond and hold times 0.



Consider the following timing diagrams of X and C. The clock period of $C \geq 40$ nanosecond. Which one is the correct plot of Y?



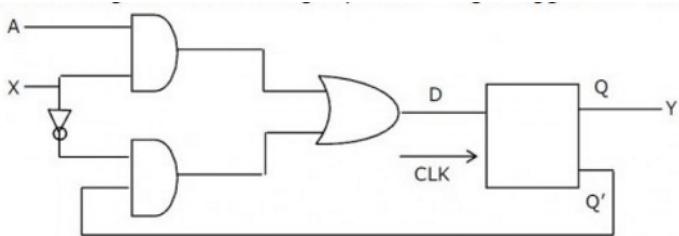
gate2001 | digital-logic | circuit-output | normal

Answer

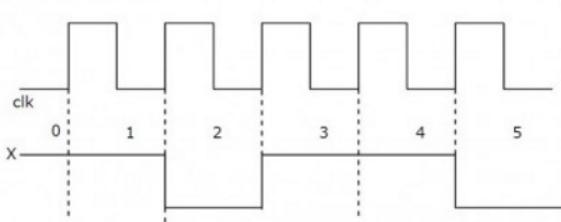
6.7.33 Circuit Output: GATE2005_62 top

<http://gateoverflow.in/264>

Consider the following circuit involving a positive edge triggered D FF.



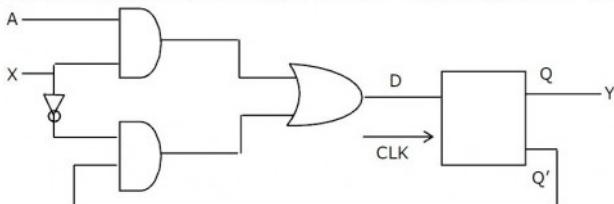
Consider the following timing diagram. Let A_i represent the logic level on the line a in the i -th clock period.



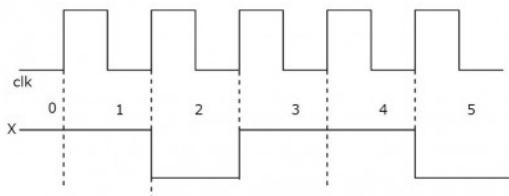
Let A' represent the complement of A . The correct output sequence on Y over the clock periods 1 through 5 is:

- a. $A_0 A_1 A'_1 A_3 A_4$
- b. $A_0 A_1 A'_2 A_3 A_4$
- c. $A_1 A_2 A'_2 A_3 A_4$
- d. $A_1 A'_2 A_3 A_4 A'_5$

Consider the following circuit involving a positive edge triggered D FF.



Consider the following timing diagram. Let A_i represent the logic level on the line a in the i -th clock period.



Let A' represent the complement of A . the correct output sequence on Y over the clock periods 1 through 5 is:

- | | |
|----------------------------|-----------------------------|
| (a) $A_0 A_1 A'_1 A_3 A_4$ | (b) $A_0 A_1 A'_2 A_3 A_4$ |
| (c) $A_1 A_2 A'_2 A_3 A_4$ | (d) $A_1 A'_2 A_3 A_4 A'_5$ |

[gate2005](#) | [digital-logic](#) | [circuit-output](#) | [normal](#)

Answer

Answers: Circuit Output

6.7.1 Circuit Output: GATE2006-IT_36 [top](#)

<http://gateoverflow.in/3575>



Selected Answer

Ans : D) OR,AND

This is because the value of 'f' should be 1 whenever a majority of the variables is 1. If we select x as '1' , the either of z or y or both z& y needs to be 1 for the output 'f' to be '1'

The output can be low only if less than 2 variables are high. ie.atleast 2 variables are low. hence z & y should be 0. therefore AND gates can be used.

10 votes

-- Afaque Ahmad (907 points)

6.7.2 Circuit Output: GATE1993_19 [top](#)

<http://gateoverflow.in/2316>



Selected Answer

$$A(t+1) = DA = A'B + A'P'$$

$$B(t+1) = DB = PB' + P'A$$

| Present State | | Input | Next State | |
|---------------|---|-------|------------|--------|
| A | B | P | A(t+1) | B(t+1) |
| 0 | 0 | 0 | 1 | 0 |
| 0 | 0 | 1 | 0 | 1 |
| 0 | 1 | 0 | 1 | 0 |
| 0 | 1 | 1 | 1 | 0 |
| 1 | 0 | 0 | 0 | 1 |
| 1 | 0 | 1 | 0 | 1 |
| 1 | 1 | 0 | 0 | 1 |
| 1 | 1 | 1 | 0 | 0 |

Note: Recheck the table by putting value of A, B , P in equations of A(t+1) and B (t+1)

2 votes

-- Praveen Saini (38.4k points)

6.7.3 Circuit Output: GATE2007-IT-38 [top](#)

<http://gateoverflow.in/3471>



Selected Answer

the final answer will come as --

$$a' + c' + d' + a'c + ab + bc$$

$$= a'(c+1) + c' + d' + ab + bc$$

$$= a' + c' + d' + ab + bc$$

$$= (a'+a)(a'+b) + (c'+c)(c'+b) + d'$$

$$= a' + b + c' + b + d'$$

$$= a' + b + c' + d'$$

Option C

6 votes

-- Manali (2.5k points)

6.7.4 Circuit Output: GATE1996_24 [top](#)

<http://gateoverflow.in/2776>



Selected Answer

state Diagram :

 $S_7 \rightarrow S_3 \rightarrow S_1 \rightarrow S_4 \rightarrow S_2 \rightarrow S_5 \rightarrow S_6 \rightarrow S_7$

b. Given the initial state S_4 , S_0 state will not be reachable. If the system enters in S_0 state then $Q_0=Q_1=Q_2=0$ and after that it will stay in S_0 state indefinitely and can't go to any other state.

5 votes

-- shreya ghosh (2.9k points)

6.7.5 Circuit Output: GATE2005-IT_10 [top](#)

<http://gateoverflow.in/3755>

Selected Answer

If it's looked carefully, bulb will be on when both switch s1 and s2 are in same state, either off or on. that is exnor operation

| | | |
|----|----|------|
| S1 | S2 | Bulb |
| 0 | 0 | On |
| 0 | 1 | Off |
| 1 | 0 | Off |
| 1 | 1 | On |

it's Ex-NOR operation hence (C) is the correct option.

9 votes

-- Manu Thakur (5.6k points)

6.7.6 Circuit Output: GATE2005-IT_43 [top](#)

<http://gateoverflow.in/3804>

| | A | B | C | Q1 | Q2 | Z | Comment |
|-----------------|---|---|---|----|----|---|---|
| After 1st cycle | X | X | X | X | X | | |
| After 2nd cycle | 0 | 0 | X | 0 | X | X | Q1 is 0 making A and B 0. |
| After 3rd cycle | X | X | 1 | 1 | 1 | 1 | Z is 1 making Q1 and Q2 1, Either A or B is 1. Q1' of previous cycle is 1. |

The filling is done in reverse order. Here, none of the options matches. So, something wrong somewhere.

1 votes

-- Arjun Suresh (150k points)

6.7.7 Circuit Output: GATE2011-50 [top](#)

<http://gateoverflow.in/2157>

Selected Answer

Answer - D

As in D-flip-flop , next output is $Q^+ = D$

$$P_{i+1} = R_i$$

$$Q_{i+1} = (P_i + R_i)'$$

$$R_{i+1} = R'_i Q_i$$

| CLOCK | Inputs | | | Outputs | | |
|-------|-----------|----------------------------|------------------------|---------|---|---|
| | $D_1 = R$ | $D_2 = \overline{(P + R)}$ | $D_3 = Q \overline{R}$ | P | Q | R |
| 1 | 0 | 1 | 0 | 0 | 1 | 0 |
| 2 | 0 | 1 | 1 | 0 | 1 | 1 |
| 3 | 1 | 0 | 0 | 1 | 0 | 0 |
| 4 | 0 | 0 | 0 | 0 | 0 | 0 |

So Total number of distinct outputs is 4

10 votes

-- ankitrokdeonsns (8.4k points)

6.7.8 Circuit Output: GATE1996_2.22 [top](#)

<http://gateoverflow.in/2751>



Selected Answer

Options for this question seem wrong, its expression f will come to $A'B'C + A'BC + AB'C + ABC$, that further can be minimized to C.

7 votes

-- Manu Thakur (5.6k points)

6.7.9 Circuit Output: GATE2007-IT_40 [top](#)

<http://gateoverflow.in/3473>



Selected Answer

Answer: A

The four bit register contains: 1011, 1101, 0110, 1011, 1101, **0110** after each shift.

6 votes

-- Rajarshi Sarkar (29.7k points)

6.7.10 Circuit Output: GATE2010-9 [top](#)

<http://gateoverflow.in/2182>



Selected Answer

$$f = S'_0 S'_1 R + S'_0 S_1 R' + S_0 S'_1 R' + S_0 S_1 R$$

$$= Q' P' R + Q' P R' + Q P' R' + Q P R = Q'(P \oplus R) + Q(P \oplus R)' = Q \oplus P \oplus R = P \oplus Q \oplus R$$

Doing truth value substitution,

| P | Q | R | f | $P \oplus Q$ $\oplus R$ |
|---|---|---|---|----------------------------|
| 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 1 | 1 | 1 |
| 0 | 1 | 0 | 1 | 1 |
| 0 | 1 | 1 | 0 | 0 |
| 1 | 0 | 0 | 1 | 1 |
| 1 | 0 | 1 | 0 | 0 |
| 1 | 1 | 0 | 0 | 0 |
| 1 | 1 | 1 | 1 | 1 |

8 votes

-- Arjun Suresh (150k points)

6.7.11 Circuit Output: GATE1997_5.5 [top](#)<http://gateoverflow.in/2256>

Selected Answer

$$f = (f_1 \wedge f_2) \vee f_3$$

Since f_1 and f_2 are in canonical sum of products form, $f_1 \wedge f_2$ will only contain their common terms- that is $f_1 \wedge f_2 = \Sigma 8$

Now, $\Sigma 8 \vee f_3 = \Sigma 8, 9$
So, $f_3 = \Sigma 9$

5 votes

-- Arjun Suresh (150k points)

6.7.12 Circuit Output: GATE2010-31 [top](#)<http://gateoverflow.in/2205>

Selected Answer

Level 1:

$$\overline{(P+Q)(Q+R)(P+R)(Q+R)}$$

Level 2:

$$\overline{(P+Q)} + \overline{(Q+R)} = (P+Q)(Q+R) = PQ + PR + Q + QR$$

$$\overline{(P+R)(Q+R)} = (P+R)(Q+R) = PQ + R + QR + PR$$

Level 3:

$$= \overline{PR + QR + PQ + Q + R}$$

$$= \overline{Q + R}$$

∴ Answer: Option A

Answer is **A.**

1 votes

-- Sona Praneeth Akula (3.8k points)

$$[((P'Q') + (Q'R'))' + (P'R') + (Q'R'))]'$$

$$[(Q'(P' + R'))' + (R'(P' + Q'))']'$$

$$[(Q + PR + R + PQ)]'$$

$$[Q(1 + P) + R(1 + P)]'$$

[Q + R]-----Answer.

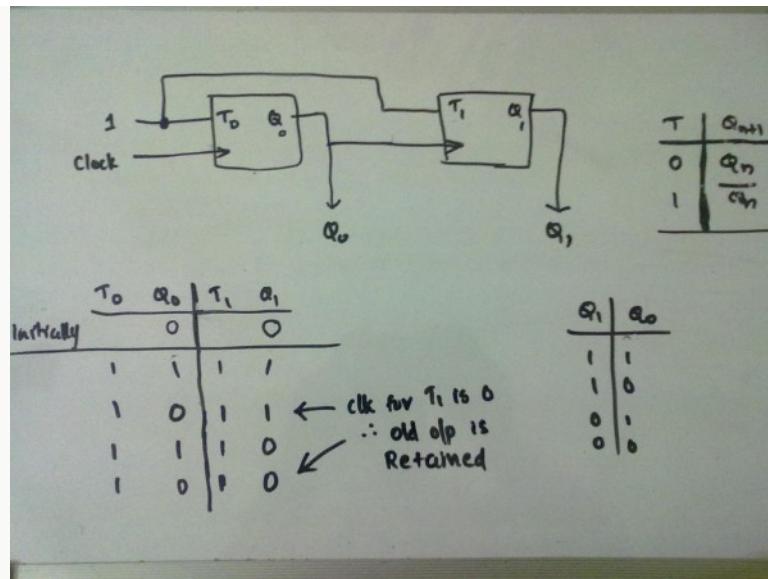
1 votes

-- Gate Keeda (17.7k points)

6.7.13 Circuit Output: GATE2010-32 [top](#)<http://gateoverflow.in/2206>

Selected Answer

Option A



4 votes

-- Akhil Nadh Pullolikkal Chandran (6.9k points)

6.7.14 Circuit Output: GATE1993_6.3 top

<http://gateoverflow.in/17237>

circuit behaves as shift register and mod6 counter

clock cycle output

| | |
|---|-----|
| 1 | 100 |
| 2 | 110 |
| 3 | 111 |
| 4 | 011 |
| 5 | 001 |
| 6 | 000 |

9 votes

-- Pooja (25.9k points)

6.7.15 Circuit Output: GATE1994_1.8 top

<http://gateoverflow.in/2245>

Selected Answer

$$(((AB)' C)' (CD)')' = ((AB)'C) + CD = (A' + B')C + CD = A'C + B'C + CD$$

4 votes

-- Arjun Suresh (150k points)

6.7.16 Circuit Output: GATE1993_6.1 top

<http://gateoverflow.in/2288>

Selected Answer

$$6.1 (x+x'y') \cdot (y+x'y') = (x+y')(x'+y) = xy + x'y' = \text{exclusive nor}$$

6.2 missing data

6.3

it follow the sequence 000, 100,110,111,011,001,000 It is a johnson counter so answer is e none of these

2 votes

-- Praveen Saini (38.4k points)

6.7.17 Circuit Output: GATE1996_2.21 [top](#)

<http://gateoverflow.in/2750>



Selected Answer

when b3b2 is 11 restore circuit to 0000..
it counts from 0 to 11 i.e. Radix 12 no ..
circuit used for binary to radix 12 conversion..

3 votes

-- Digvijay (35.8k points)

6.7.18 Circuit Output: GATE2007-IT-45 [top](#)

<http://gateoverflow.in/3480>



Selected Answer

To detect the fault, we should get an unexpected output. The final gate here is a NOR gate which produces output 0 if either of its input is 1 and else 1. i.e., the output will be 0 for inputs (0,1), (1,0) and (1,1) and output will be 1 for (0,0).

By grounding T is at 0. So, we can ignore the inputs (1,0) and (0,0) as they won't be detecting faults. Now, expected (1,1) input will become (1,0) due to grounding of T but produces same output 0 as for (1,1). Hence this also cannot detect the defect. So, to detect the defect, the input to the final gate must be (0,1) which is expected to produce a 0 but will produce a 1 due to grounding of T .

Now, for (0,1) input for the final gate, we must have,

$$X_3 = X_4 = 1$$

But if $X_4 = 1$, the OR gate makes 1 output and we won't get (0,1) input for the final gate. This means, no input sequence can detect the fault of the circuit.

Alternatively, we can write equation for the circuit as

$$(((x_1 \cdot x_2 \cdot x_3)' + x_4) + x_3 \cdot x_4)' = ((x_1 \cdot x_2 \cdot x_3)' + x_4)' \cdot (x_3 \cdot x_4)' = x_1 \cdot x_2 \cdot x_3 \cdot x_4' \cdot (x_3' + x_4') = x_1 \cdot x_2 \cdot x_3 \cdot x_4'$$

For the faulty circuit output will be

$$((x_1 \cdot x_2 \cdot x_3)' + x_4)' = x_1 \cdot x_2 \cdot x_3 \cdot x_4'$$

So, there is no effect of T being grounded here. Answer is D option.

3 votes

-- Arjun Suresh (150k points)

ans d)

3 votes

-- Aditi Dan (5.4k points)

6.7.19 Circuit Output: GATE1994_11 [top](#)

<http://gateoverflow.in/2507>



Selected Answer

Initial Q2=0,Q1=0,Q0=0

Clock 1

Q2=1 [J = (old Q0)'=1, K=1 , New Q2= Complement of old Q2=1]

Q1 =0 [D =old Q2=0, new Q1= D =0]

$Q_0=0$ [$T = \text{old } Q_1=0$, New $Q_0 = \text{old } Q_0 = 0$]

Clock 2

$Q_2=0$ [$J = (\text{old } Q_0)'=1$, $K=1$, New $Q_2= \text{Complement of old } Q_2=0$]

$Q_1 =1$ [$D =\text{old } Q_2=1$, new $Q_1= D =1$]

$Q_0=0$ [$T = \text{old } Q_1=0$, New $Q_0 = \text{old } Q_0 = 0$]

Clock 3

$Q_2=1$ [$J = (\text{old } Q_0)'=1$, $K=1$, New $Q_2= \text{Complement of old } Q_2=1$]

$Q_1 =0$ [$D =\text{old } Q_2=0$, new $Q_1= D =0$]

$Q_0=1$ [$T = \text{old } Q_1=1$, New $Q_0 = \text{complement of old } Q_0 =1$]

Clock 4

$Q_2=0$ [$J = (\text{old } Q_0)'=0$, $K=1$, New $Q_2= \text{Reset}=0$]

$Q_1 =1$ [$D =\text{old } Q_2=1$, new $Q_1= D =1$]

$Q_0=1$ [$T = \text{old } Q_1=0$, New $Q_0 = \text{old } Q_0 =1$]

After 4 clock pulses $Q_2Q_1Q_0$ is 011

Note : for JK FF $Q(t+1) = JQ' + K'Q$, for D FF $Q(t+1) = D$, and for T FF $Q(t+1)= T \oplus Q$ Where $Q(t+1)$ represent new value of Q

10 votes

-- Praveen Saini (38.4k points)

6.7.20 Circuit Output: GATE2008-IT_9 [top](#)

<http://gateoverflow.in/3269>



Selected Answer

Answer: B

$$F = (x'z' + xz)' = xz' + x'z$$

10 votes

-- Rajarshi Sarkar (29.7k points)

6.7.21 Circuit Output: GATE2011-51 [top](#)

<http://gateoverflow.in/43318>



Selected Answer

Characteristic equation of D FF is ,
 $Q(t+1) = D$

so

$$P^+ = R, \quad Q^+ = \overline{P+R}, \quad \text{and} \quad R^+ = Q \cdot R'$$

Sequence of states will be as

| Clock Pulse | PQR |
|-------------|-----|
| Initially | 000 |
| 1 | 010 |
| 2 | 011 |
| 3 | 100 |
| 4 | 000 |

4 is the number of distinct states.

5 votes

-- Praveen Saini (38.4k points)

6.7.22 Circuit Output: GATE2014-3_45 [top](#)

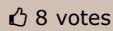
<http://gateoverflow.in/2079>



Selected Answer

| Initial State | | | Input | | | | | | Next State | | |
|---------------|----|----|-------|----|----|----|----|----|------------|-----|-----|
| Q2 | Q1 | Q0 | J2 | K2 | J1 | K1 | J0 | K0 | Q2' | Q1' | Q0' |
| 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 1 | 1 | 0 | 0 |
| 1 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 1 | 1 | 1 | 0 |
| 1 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 1 | 1 | 1 |

∴ Option C



-- Gate_15_isHere (627 points)

6.7.23 Circuit Output: GATE1999_2.8 [top](#)

<http://gateoverflow.in/1486>



Selected Answer

The figure is not clear- I assume there is a NOT gate just before taking Y making the final AND gate a NAND gate.

We have a steady state- meaning output is not changing. Y is 1 and remains 1 in the next state(s). So, we can write

$$\overline{Y} = (\overline{AY}) \cdot B \cdot C$$

$$1 = \overline{A} \cdot B + \overline{C}$$

$$\text{So, } C = 0 \text{ or } \overline{A} \cdot B = 1$$

So, option B is TRUE.



-- Arjun Suresh (150k points)

6.7.24 Circuit Output: GATE2002_2.2 [top](#)

<http://gateoverflow.in/832>



Selected Answer

As X connected to I_0 & I_1 . Y connected to I_2 , Y' connected to I_3 & A_1 , Z connected to A_0 and Z' connected to ENABLE (EN).

$$\begin{aligned} F &= (\\ &\quad \overline{A_1} \cdot \\ &\quad \overline{A_0} \cdot I_0 + \\ &\quad \overline{A_1} \cdot A_0 \cdot I_1 + A_1 \cdot \\ &\quad \overline{A_0} \cdot I_2 + A_1 \cdot A_0 \cdot I_3) \cdot EN \end{aligned}$$

$$F = (XYZ' + XYZ + Y'ZY + ZY')Z'$$

$$= (XYZ' + XYZ + ZY')Z'$$

$$=XYZ'$$

11 votes

-- Digvijay (35.8k points)

6.7.25 Circuit Output: GATE2000-2.12 [top](#)<http://gateoverflow.in/659>

Selected Answer

Here clocks are applied to both flip flops simultaneously

When 11 is applied to jk flip flop it toggles the value of P so op at P will be 1

Input to D flip flop will be 0(initial value of P) so op at Q will be 0

So ans is a

8 votes

-- Pooja (25.9k points)

6.7.26 Circuit Output: GATE2004_61 [top](#)<http://gateoverflow.in/1056>

sequence is

0 – 2 – 3 – 1 – 0

From the given sequence, we have state table as

| Q_2 | Q_1 | Q_2^+ | Q_1^+ |
|-------|-------|---------|---------|
| 0 | 0 | 1 | 0 |
| 0 | 1 | 0 | 0 |
| 1 | 0 | 1 | 1 |
| 1 | 1 | 0 | 1 |

Now we have present state and next state, use excitation table of T flip-flop

| Q_2 | Q_1 | Q_2^+ | Q_1^+ | T_2 | T_1 |
|-------|-------|---------|---------|-------|-------|
| 0 | 0 | 1 | 0 | 1 | 0 |
| 0 | 1 | 0 | 0 | 0 | 1 |
| 1 | 0 | 1 | 1 | 0 | 1 |
| 1 | 1 | 0 | 1 | 1 | 0 |

From state table,
 $T_2 = Q_2 \odot Q_1$, and
 $T_1 = Q_2 \oplus Q_1$

$X = T_1 = Q_2 \oplus Q_1$

11 votes

-- Praveen Saini (38.4k points)

6.7.27 Circuit Output: GATE2007_36 [top](#)<http://gateoverflow.in/1234>

whenever A4 A3 A2 A1 = 0 1 0 1 then clear line will be enabled as A3 and A1 set.

given table says that whenever clear control signal set , it clears to 0 0 0 0 , before the current clock cycle completes.

so 5 is cleared to 0 in the same clock cycle.

so counter sequence is 0, 1 , 2, 3, 4

4 votes

-- pramod (2.3k points)

6.7.28 Circuit Output: GATE2006_35 [top](#)<http://gateoverflow.in/1292>



Selected Answer

if you solve this you will get $XY' + Y'Z + XY$ (this can be simplified to $X + Y'Z$) with min terms as (1,4,5,6,7)

and option A has the same min terms

so option A is equivalent to $XY' + Y'Z + XY$

Ans (A)

3 votes

-- **Vikrant Singh** (11k points)

6.7.29 Circuit Output: GATE2006_37 top

<http://gateoverflow.in/1295>



Selected Answer

| Data | Q0 | Q1 | Q2 |
|------|----|---|------------------|
| 1 | 1 | $Q0_{start} \text{ XOR } Q2_{start} = 0 \text{ XOR } 0 = 0$ | $Q1_{start} = 0$ |
| 0 | 0 | $1 \text{ XOR } 0 = 1$ | 0 |
| 0 | 0 | $0 \text{ XOR } 0 = 0$ | 1 |
| 1 | 1 | $0 \text{ XOR } 1 = 1$ | 0 |
| 1 | 1 | $1 \text{ XOR } 0 = 1$ | 1 |
| 0 | 0 | $1 \text{ XOR } 1 = 0$ | 1 |
| 0 | 0 | $0 \text{ XOR } 1 = 1$ | 0 |
| 0 | 0 | $0 \text{ XOR } 0 = 0$ | 1 |
| 0 | 0 | $0 \text{ XOR } 1 = 1$ | 0 |

So, option C.

6 votes

-- **Arjun Suresh** (150k points)

6.7.30 Circuit Output: GATE2005_15 top

<http://gateoverflow.in/1351>



Selected Answer

The expression will be

$$f = [(x \cdot y')' \cdot (y \cdot z)]' = [(x' + y) \cdot (y \cdot z)]' = [x' \cdot y \cdot z + y \cdot z]' = [(x' + 1) \cdot (y \cdot z)]' = [1 \cdot (y \cdot z)]' = [y \cdot z]' = y' + z'$$

The final expression only contains y and z,

Therefore, answer will be (a) f is Independent of x

9 votes

-- **jec.himanshu** (239 points)

6.7.31 Circuit Output: GATE2005_64 top

<http://gateoverflow.in/1387>



Selected Answer

Clearly Q_0 alternates in every clk cycle as Q_0' is fed as input and it is D flipflop.

Q_1 becomes 1 if its prev value and current Q_0 differs (EXOR).

So, the sequence of transitions will be 00 -> 11 -> 01 -> 10 -> 00 (D) choice.

8 votes

-- Arjun Suresh (150k points)

6.7.32 Circuit Output: GATE2001-2.8 top<http://gateoverflow.in/726>

Answer is (a)

Given clock is + edge triggered.

See the first positive edge. X is 0, and hence output is 0. Q_0 is 1 and Q_0' is 0.Second + edge, X is 1 and Q_0' is also one. So, output is 1. (When second positive edge of the clock arrives, Q_0' would surely be 1 because the set up time of flip flop is given as 20 ns and the clock period is ≥ 40 ns)Third + edge, X is 1 and Q_0' is 0, So, output is 0. (Q_0' becomes 0 before the 3rd positive edge, but output Y won't change as the flip flop is positive edge triggered)Now, output never changes back to 1 as Q_0' is always 0 and when Q_0' finally becomes 1, X is 0.

Set up time and hold times are given just to ensure that edge triggering work properly.

10 votes

-- Arjun Suresh (150k points)

6.7.33 Circuit Output: GATE2005_62 top<http://gateoverflow.in/264>

Selected Answer

$$D = AX + X'Q'$$

$$Y = D$$

A_i represent the logic level on the line A at the i -th clock period. If we see the timing diagram carefully, we can see that during the rising edge, the output Y is determined by the X value just before that rising edge. i.e., during the rising edge say for clk2, X value that determines the output is 1 and not 0 (because it takes some propagation delay for the 0 to reach the flip flop). Similarly, the A output that determines the output for clk i , is A_{i-1}

For clk1, X is 1, so, $D = A = A_0$ For clk2, X is 1, so $D = A = A_1$ For clk 3, X is 0, so $D = Q_2' = A_1'$ For clk4, X is 1, so $D = A = A_3$ For clk5, X is 1, so $D = A = A_4$

So, answer is A choice.

12 votes

-- Arjun Suresh (150k points)

6.8**Counter** top**6.8.1 Counter: GATE 2016-1-8** top<http://gateoverflow.in/39670>

We want to design a synchronous counter that counts the sequence $0 - 1 - 0 - 2 - 0 - 3$ and then repeats. The minimum number of J-K flip-flops required to implement this counter is _____.

[gate2016-1](#) [digital-logic](#) [counter](#) [flip-flop](#) [normal](#) [numerical-answers](#)
Answer

6.8.2 Counter: GATE2005-IT_11 [top](#)

<http://gateoverflow.in/3756>

How many pulses are needed to change the contents of a 8-bit up counter from 10101100 to 00100111 (rightmost bit is the LSB)?

- A. 134
- B. 133
- C. 124
- D. 123

[gate2005-it](#) [digital-logic](#) [counter](#) [normal](#)

[Answer](#)

6.8.3 Counter: GATE2015-2_7 [top](#)

<http://gateoverflow.in/8054>

The minimum number of JK flip-flops required to construct a synchronous counter with the count sequence (0, 0, 1, 1, 2, 2, 3, 3, 0, 0, ...) is _____.

[gate2015-2](#) [digital-logic](#) [counter](#) [normal](#)

[Answer](#)

6.8.4 Counter: GATE2015-1_20 [top](#)

<http://gateoverflow.in/8219>

Consider a 4-bit Johnson counter with an initial value of 0000. The counting sequence of this counter is

- A. 0, 1, 3, 7, 15, 14, 12, 8, 0
- B. 0, 1, 3, 5, 7, 9, 11, 13, 15, 0
- C. 0, 2, 4, 6, 8, 10, 12, 14, 0
- D. 0, 8, 12, 14, 15, 7, 3, 1, 0

[gate2015-1](#) [digital-logic](#) [counter](#) [easy](#)

[Answer](#)

Answers: Counter

6.8.1 Counter: GATE 2016-1-8 [top](#)

<http://gateoverflow.in/39670>



Selected Answer

we need four JK flipflops..
0->1->0->2->0->3
0000->0001->0100->0010->1000->0011
There are 6 states and 3 of them correspond to same state..
to differentiate between 0,1,2,3 we need 2 bits.
to differentiate between 3 0's we need 2 bits..
So total 4 bits=4 FF

Edit:

whether using extra combinational logic for output is allowed in a counter..???

Page No. 10/11 <http://textofvideo.nptel.iitm.ac.in/117105080/lec23.pdf>

Now, if you see the counters, now a counter we can define in this way the counter is a degenerate finite state machine, where the **state** is the **only** output. So, there is **no other primary output** from this machine, so the counter is defined like that.

ALSO

Page No. 3 <http://textofvideo.nptel.iitm.ac.in/117106086/lec24.pdf>

Counter you know what counter it is, that's what we want we count the output of counter what is the particular count what is the current count that is the output of a count so no external output. **The counter is a case of a state machine**

in which there are no external inputs, no external outputs.

Page No. 10 <http://textofvideo.nptel.iitm.ac.in/117106086/lec24.pdf>

always do that let us say 1 0 0 you want count twice you can put 1 0 0 to 1 0 0 but then when you draw the Karnaugh Map you don't know which 1 0 0 you are talking about so instead of doing that you can have an external input defined when x is equal to 0 it remains there so you can put x is equal to 0 and for all of those x is equal to 1. So from S_0 to S_1 it will remain, both 0 and 1 it will take here, from here it will take here only if x is equal to 1 and if x is equal to 0 it will remain here so external input can be used more elegantly for that design.

at 35:30 [www\[dot\]youtube\[dot\]com/watch?v=MiuMYEn3dpg](https://www.youtube.com/watch?v=MiuMYEn3dpg)

Here In Counter, we cannot use external variable, that purpose will be served by FF's only We have four distinct states 0,1,2,3 so 2 FF for them for 3 0's to distinguish we need 2 more FF's

4 FF required.

20 votes

-- Abhilash Panicker (7k points)

6.8.2 Counter: GATE2005-IT_11 [top](#)

<http://gateoverflow.in/3756>



Selected Answer

D.123 Pulses.

As in a 2^8 Counter the range would be from 0-255. Hence to go from 10101100 (172) to 00100111 (39), the counter has to go initially from 172 to 255 and then from 0 to 39.

Hence to go from 172 to 255, $255-172 = 83$ Clock pulses would be required. then from 255 to 0, again 1 clock pulse would be required. Then from 0 to 39, 39 clock pulses would be required. Hence in total $83+1+39 = 123$ Clock pulses would be required.

14 votes

-- Afaque Ahmad (907 points)

6.8.3 Counter: GATE2015-2_7 [top](#)

<http://gateoverflow.in/8054>



Selected Answer

Here it appears to have 8 discrete states. That requires 3 bits, therefore 3 flip-flops. From inspection, there are 4 groups of 2 identical bits per group. I'd break that down to into a divide by two (1 flip-flop) followed by a divide by four (2 flip-flops).

5 votes

-- Vikrant Singh (11k points)

6.8.4 Counter: GATE2015-1_20 [top](#)

<http://gateoverflow.in/8219>



Selected Answer

option D

0000 - 0

1000 - 8

1100 - 12

and so on.

http://en.wikipedia.org/wiki/Ring_counter

8 votes

-- GATERush (1,1k points)

6.9

Flip Flop

6.9.1 Flip Flop: GATE1992_04_c [top](#)<http://gateoverflow.in/17408>

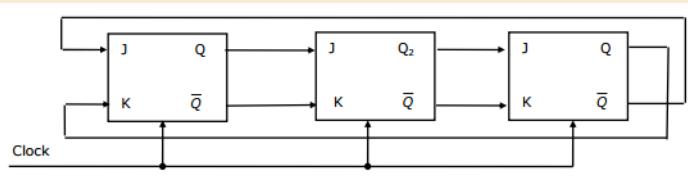
Design a 3-bit counter using D-flip flops such that not more than one flip-flop changes state between any two consecutive states.

[gate1994](#) [digital-logic](#) [flip-flop](#)

Answer

6.9.2 Flip Flop: GATE1993_6.3 [top](#)<http://gateoverflow.in/17236>

For the initial state of 000, the function performed by the arrangement of the J-K flip-flops in figure is:



- A. Shift Register
- B. Mod- 3 Counter
- C. Mod- 6 Counter
- D. Mod- 2 Counter
- E. None of the above

[gate1993](#) [digital-logic](#) [flip-flop](#)

Answer

6.9.3 Flip Flop: GATE2015-1_37 [top](#)<http://gateoverflow.in/8287>

A positive edge-triggered D flip-flop is connected to a positive edge-triggered JK flip-flop as follows. The Q output of the D flip-flop is connected to both the J and K inputs of the JK flip-flop, while the Q output of the JK flip-flop is connected to the input of the D flip-flop. Initially, the output of the D flip-flop is set to logic one and the output of the JK flip-flop is cleared. Which one of the following is the bit sequence (including the initial state) generated at the Q output of the JK flip-flop when the flip-flops are connected to a free-running common clock? Assume that $J = K = 1$ is the toggle mode and $J = K = 0$ is the state holding mode of the JK flip-flops. Both the flip-flops have non-zero propagation delays.

- A. 0110110...
- B. 0100100...
- C. 011101110...
- D. 011001100...

[gate2015-1](#) [digital-logic](#) [flip-flop](#) [normal](#)

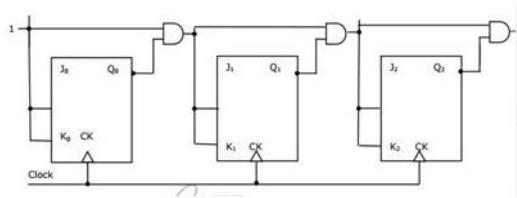
Answer

6.9.4 Flip Flop: GATE1991_5,c [top](#)<http://gateoverflow.in/26442>

Find the maximum clock frequency at which the counter in the figure below can be operated. Assume that the propagation delay through each flip flop and each AND gate is

10

ns. Also assume that the setup time for the JK inputs of the flip flops is negligible.



gate1991 digital-logic flip-flop

Answer

Answers: Flip Flop

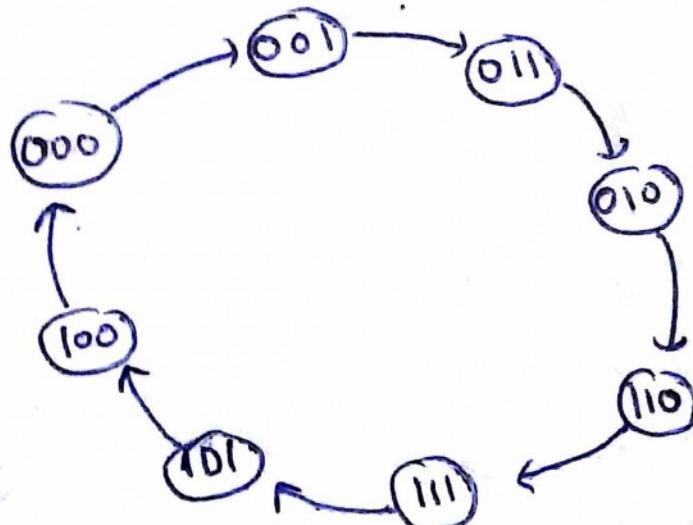
6.9.1 Flip Flop: GATE1992_04_c top

<http://gateoverflow.in/17408>



Selected Answer

State diagram will be as (remember concept of gray code)



State table and 3-bit synchronous counter with D FFs, will be as

| Current state | Next state | FF Input |
|-----------------------|--------------------------|-----------------------------|
| $A = 0, B = 0, C = 0$ | $A' = 1, B' = 1, C' = 1$ | $D_A = 0, D_B = 0, D_C = 1$ |
| $A = 0, B = 0, C = 1$ | $A' = 1, B' = 0, C' = 0$ | $D_A = 0, D_B = 1, D_C = 0$ |
| $A = 0, B = 1, C = 0$ | $A' = 1, B' = 1, C' = 1$ | $D_A = 0, D_B = 1, D_C = 0$ |
| $A = 0, B = 1, C = 1$ | $A' = 1, B' = 0, C' = 0$ | $D_A = 0, D_B = 0, D_C = 1$ |
| $A = 1, B = 0, C = 0$ | $A' = 0, B' = 1, C' = 1$ | $D_A = 1, D_B = 0, D_C = 0$ |
| $A = 1, B = 0, C = 1$ | $A' = 0, B' = 1, C' = 0$ | $D_A = 1, D_B = 0, D_C = 0$ |
| $A = 1, B = 1, C = 0$ | $A' = 0, B' = 0, C' = 1$ | $D_A = 1, D_B = 0, D_C = 0$ |
| $A = 1, B = 1, C = 1$ | $A' = 0, B' = 0, C' = 0$ | $D_A = 0, D_B = 0, D_C = 0$ |

$D_{t+1} = 0$

$D_A = AC + BC\bar{C}$

$D_B = \bar{A}C + B\bar{C}$

$D_C = A\bar{B} + AB = A \oplus B$

6 votes

-- Praveen Saini (38.4k points)

6.9.2 Flip Flop: GATE1993_6.3 top

<http://gateoverflow.in/17236>

thanks to everyone for increasing the confusion on this question.

My answer is Mod -6 counter. 6 states. MOD 6.

1 votes

-- Aspi R Osa (1.4k points)

6.9.3 Flip Flop: GATE2015-1_37 top

<http://gateoverflow.in/8287>

Selected Answer

| Q_{prev} | D | Q (JK) | Explanation |
|------------|-----|----------|---|
| - | 1 | 0 | Now, the D output is 1, meaning J and K = 1, for next cycle |
| 0 | 0 | 1 | J = K = 1 (D output from prev state), so output toggles from 0 to 1 |
| 1 | 1 | 1 | J = K = 0, so output remains 1 |
| 1 | 1 | 0 | J = K = 1, so output toggles from 1 to 0 |
| 0 | 0 | 1 | J = K = 1, so output toggles from 0 to 1 |
| 1 | 1 | 1 | J = K = 0, so output remains 1 |

D flip flop output will be same as its input and JK flip flop output toggles when 1 is given to both J and K inputs.

i.e., $Q = D_{prev}(Q_{prev}') + (D_{prev}')Q_{prev}$

7 votes

-- Arjun Suresh (150k points)

6.9.4 Flip Flop: GATE1991_5,c top

<http://gateoverflow.in/26442>

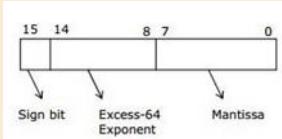
In a JK flip flop the output toggles when both J and K inputs are 1. So, we must ensure that with each clock the output from the previous stage reaches the current stage. From the figure, there is an AND gate between each stage and $2 \times 10 = 20\text{ns}$ (10ns for output to reach the gate and 10ns for the output of AND gate to reach the next flip flop) is needed for the output to reach the next stage. So, minimum time period needed for clock is 20ns which would mean a maximum clock frequency of $1/20\text{GHz} = 50\text{MHz}$

11 votes

-- Arjun Suresh (150k points)

6.10**Floating Point Representation** top**6.10.1 Floating Point Representation: GATE2005_85** top<http://gateoverflow.in/1407>**Statement for Linked Answer Questions 85A & 85B:**

Consider the following floating-point format.



Mantissa is a pure fraction in sign-magnitude form.

(A) The decimal number 0.239×2^{13} has the following hexadecimal representation (without normalization and rounding off):

- A. 0D 24
- B. 0D 4D
- C. 4D 0D
- D. 4D 3D

(B) The normalized representation for the above format is specified as follows. The mantissa has an implicit 1 preceding the binary (radix) point. Assume that only 0's are padded in while shifting a field.

The normalized representation of the above number (0.239×2^{13}) is:

- A. 0A 20
- B. 11 34
- C. 49 D0
- D. 4A E8

[gate2005](#) [digital-logic](#) [number-representation](#) [floating-point-representation](#) [normal](#)

Answer**6.10.2 Floating Point Representation: GATE2003_43** top<http://gateoverflow.in/934>

The following is a scheme for floating point number representation using 16 bits.

| | | | |
|--------------|----------|-----------|-----------|
| Bit Position | 15 | 14 9 | 8 0 |
| s | e | m | |
| Sign | Exponent | Mantissa | |

Let s , e , and m be the numbers represented in binary in the sign, exponent, and mantissa fields respectively. Then the floating point number represented is:

$$\begin{cases} (-1)^s (1 + m \times 2^{-9}) 2^{e-31}, & \text{if the exponent } \neq 111111 \\ 0, & \text{otherwise} \end{cases}$$

What is the maximum difference between two successive real numbers representable in this system?

- A. 2^{-40}
- B. 2^{-9}
- C. 2^{22}

D. 2^{31}
[gate2003](#) [digital-logic](#) [number-representation](#) [floating-point-representation](#) [normal](#)
[Answer](#)

Answers: Floating Point Representation

6.10.1 Floating Point Representation: GATE2005_85 [top](#)

<http://gateoverflow.in/1407>

Selected Answer

answer = **option D** in both questions.

$$0.239 = (0.00111101)_2$$

a) Store exponent = actual + biasing

$$13 + 64 = 77$$

$$(77)_{10} = (1001101)_2$$

$$\text{ans is } 1001101 \ 00111101 = 4D3D$$

b) For normalized representation

$$0.00111101 * 2^{13}$$

$$1.11101 * 2^{10}$$

$$\text{Store exponent} = 10+64=74$$

$$(74)_{10} = (1001010)_2$$

$$\text{ans } 0 \ 1001010 \ 11101000 = 4AE8$$

4 votes

-- Pooja (25.9k points)

6.10.2 Floating Point Representation: GATE2003_43 [top](#)

<http://gateoverflow.in/934>

Selected Answer

Maximum difference between two successive real numbers will occur at extremes.

Biasing will be done by adding $= 2^{6-1} - 1 = 31$

$$\text{maximum actual exponent} = \text{stored} - \text{bias} = (111110)_2 - 31 = 62 - 31 = 31$$

Largest number will be $1.11111111 * 2^{31} = 111111111 * 2^{-9} * 2^{31}$ ----- (A) 1.mantissa(9 times 1)

Second largest number will be $1.11111110 * 2^{31} = 111111110 * 2^{-8} * 2^{31}$ ----- (B) 1.mantissa (8 times 1 then 0)

So, difference between these two numbers = (B) - (A) = 2^{22}

3 votes

-- Ashish Gupta (671 points)

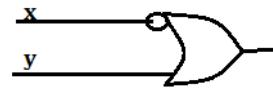
6.11

Functional Completeness [top](#)

6.11.1 Functional Completeness: GATE1998_5 top

<http://gateoverflow.in/1696>

- a. The implication gate, shown below has two inputs (x and y); the output is 1 except when $x = 1$ and $y = 0$, realize $f = \bar{x}y + x\bar{y}$ using only four implication gates.



- b. Show that the implication gate is functionally complete.

[gate1998](#) [digital-logic](#) [functional-completeness](#) [descriptive](#)

[Answer](#)

Answers: Functional Completeness

6.11.1 Functional Completeness: GATE1998_5 top

<http://gateoverflow.in/1696>

implication gate is $A \rightarrow B$ which becomes $A' + B$

so let $f(A,B)=A'+B$

$f(A,0)=A'$ (we get complement)

$f(f(A,0),B)=f(A',B)=A+B$ (we get OR gate)

Thus it is functionally complete.

Let $F(X,Y) = X' + Y$

$F(Y,X) = Y' + X$

$F(F(Y'+X),0) = X'Y$

$F(F(X,Y),X'Y) = XY' + XY$ Therefore the above function is implemented with 4 implication gates.

3 votes

-- Riya Roy(Arayana) (5.6k points)

6.12

Gray Code top

6.12.1 Gray Code: GATE2006_40 top

<http://gateoverflow.in/1816>

Consider numbers represented in 4-bit Gray code. Let $h_3 h_2 h_1 h_0$ be the Gray code representation of a number n and let $g_3 g_2 g_1 g_0$ be the Gray code of $(n+1)(modulo16)$ value of the number. Which one of the following functions is correct?

- (A) $g_0(h_3 h_2 h_1 h_0) = \sum(1, 2, 3, 6, 10, 13, 14, 15)$
- (B) $g_1(h_3 h_2 h_1 h_0) = \sum(4, 9, 10, 11, 12, 13, 14, 15)$
- (C) $g_2(h_3 h_2 h_1 h_0) = \sum(2, 4, 5, 6, 7, 12, 13, 15)$
- (D) $g_3(h_3 h_2 h_1 h_0) = \sum(0, 1, 6, 7, 10, 11, 12, 13)$

[gate2006](#) [digital-logic](#) [number-representation](#) [gray-code](#) [normal](#)

[Answer](#)

Answers: Gray Code

6.12.1 Gray Code: GATE2006_40 top<http://gateoverflow.in/1816>**The answer is C**

| Decimal n | Binary n | H(x) = gray(n) | G(x) = gray[(n+1) mod16] |
|--------------|-------------|-------------------|-----------------------------|
| 0 | 0000 | 0000 (00) | 0001 |
| 1 | 0001 | 0001 (01) | 0011 |
| 2 | 0010 | 0011 (03) | 0010 |
| 3 | 0011 | 0010 (02) | 0110 |
| 4 | 0100 | 0110 (06) | 0111 |
| 5 | 0101 | 0111 (07) | 0101 |
| 6 | 0110 | 0101 (05) | 0100 |
| 7 | 0111 | 0100 (04) | 1100 |
| 8 | 1000 | 1100 (12) | 1101 |
| 9 | 1001 | 1101 (13) | 1111 |
| 10 | 1010 | 1111 (15) | 1110 |
| 11 | 1011 | 1110 (14) | 1010 |
| 12 | 1100 | 1010 (10) | 1011 |
| 13 | 1101 | 1011 (11) | 1001 |
| 14 | 1110 | 1001 (09) | 1000 |
| 15 | 1111 | 1000 (08) | 0000 |

We need to map min terms of

 $g_3 g_2 g_1 g_0$ w.r.t
 $h_3 h_2 h_1 h_0$.
Hence as highlighted g_2 matches with option C

10 votes

-- ryan sequeira (1.6k points)

6.13**Half Adder** top**6.13.1 Half Adder: GATE2015-2_48** top<http://gateoverflow.in/8250>

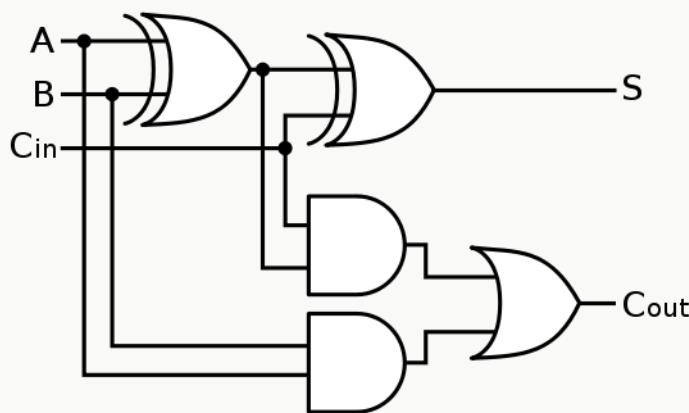
A half adder is implemented with XOR and AND gates. A full adder is implemented with two half adders and one OR gate. The propagation delay of an XOR gate is twice that of an AND/OR gate. The propagation delay of an AND/OR gate is 1.2 milliseconds. A 4-bit-ripple-carry binary adder is implemented by using four full adders. The total propagation time of this 4-bit binary adder in microseconds is _____.

[gate2015-2](#) [digital-logic](#) [half-adder](#) [normal](#)

Answer

Answers: Half Adder**6.13.1 Half Adder: GATE2015-2_48** top<http://gateoverflow.in/8250>

Selected Answer



S1 should wait for C1 to be ready. Delay for generating C is $1 \text{ EXOR} + 1 \text{ AND} + 1 \text{ OR} = 2.4 + 1.2 + 1.2 = 4.8 \text{ ms}$

Delay for sum is $\text{XOR} + \text{XOR} = 2.4 + 2.4 = 4.8 \text{ ms}$

But for the second adder, there the first EXOR can be done even before waiting for the previous output. So, we can get sum in another 2.4 ms and carry in another 2.4 ms. In this way, 4 bit sum can be obtained after

$$4.8 \text{ ms} + 3 * 2.4 \text{ ms} = 12 \text{ ms.}$$

But the question says we use ripple-carry adder. So, each adder must wait for the full output from the previous adder. This would make the total delay = $4 * 4.8 = 19.2 \text{ ms}$ and this is the key given by GATE, so obviously they meant this.

Ref: <http://www.cs.umd.edu/class/sum2003/cmsc311/Notes/Comb/adder.html>

14 votes

-- Arjun Suresh (150k points)

6.14

Ieee Representation top

6.14.1 Ieee Representation: GATE2008-4 top

<http://gateoverflow.in/402>

In the IEEE floating point representation the hexadecimal value 0x00000000 corresponds to

- A. The normalized value 2^{-127}
- B. The normalized value 2^{-126}
- C. The normalized value +0
- D. The special value +0

[gate2008](#) [digital-logic](#) [floating-point-representation](#) [ieee-representation](#) [easy](#)

Answer

6.14.2 Ieee Representation: GATE2008-IT_7 top

<http://gateoverflow.in/3267>

The following bit pattern represents a floating point number in IEEE 754 single precision format

1 10000011 10100000000000000000000000000000

The value of the number in decimal form is

- A) - 10
- B) - 13
- C) - 26
- D) None of the above

[gate2008-it](#) [digital-logic](#) [number-representation](#) [floating-point-representation](#) [ieee-representation](#) [normal](#)
Answer

Answers: IEEE Representation

6.14.1 IEEE Representation: GATE2008-4 [top](#)

<http://gateoverflow.in/402>


Selected Answer

| S | BE | M | Value |
|-----|---------|----------|------------|
| 0/1 | All 0's | All 0's | 0 |
| 0 | All 1's | All 0's | $+\infty$ |
| 1 | All 1's | All 0's | $-\infty$ |
| 0/1 | All 1's | Non zero | <u>NaN</u> |

answer = **option D**
thumb up 7 votes

-- Amar Vashishth (20.7k points)

6.14.2 IEEE Representation: GATE2008-IT_7 [top](#)

<http://gateoverflow.in/3267>


Selected Answer

Sign bit is 1 \rightarrow number is negative

Exponent bits- 10000011

Exponent is added with 127 bias in IEEE single precision format. So, Actual exponent = 10000011 - 127 = 131 - 127 = 4

Mantissa bits- 1010000000000000000000000

In IEEE format, an implied 1 is before mantissa, and hence the actual number is

$$-1.101 * 2^4$$

$$= -(1101)_2 = -26$$

<http://steve.hollasch.net/cgindex/coding/ieeefloat.html>
thumb up 12 votes

-- Arjun Suresh (150k points)

6.15

K Map [top](#)

6.15.1 K Map: GATE2008-5 [top](#)

<http://gateoverflow.in/403>

In the Karnaugh map shown below, X denotes a don't care term. What is the minimal form of the function represented by the Karnaugh map?

| | $a'b$ | $a'b'$ | ab | ab' |
|--------|-------|--------|------|-------|
| $c'd'$ | 1 | 1 | | 1 |
| $c'd$ | X | | | |
| cd | | | | |
| cd' | | | | |

- A. $\bar{b} \cdot \bar{d} + \bar{a} \cdot \bar{d}$
 B. $\bar{a} \cdot \bar{b} + \bar{b} \cdot \bar{d} + \bar{a} \cdot b \cdot \bar{d}$
 C. $\bar{b} \cdot \bar{d} + \bar{a} \cdot b \cdot \bar{d}$
 D. $\bar{a} \cdot \bar{b} + \bar{b} \cdot \bar{d} + \bar{a} \cdot \bar{d}$

gate2008 digital-logic k-map easy

Answer

6.15.2 K Map: GATE2007-IT_78 top

<http://gateoverflow.in/3530>

Consider the following expression

$$ad' + (ac)' + bc'd$$

Which of the following Karnaugh Maps correctly represents the expression?

(A)

| | $c'd'$ | $c'd$ | cd | cd' |
|--------|--------|-------|------|-------|
| $a'b'$ | X | X | | |
| $a'b$ | X | X | | |
| ab | X | X | | X |
| ab' | X | | | X |

(B)

| | $c'd'$ | $c'd$ | cd | cd' |
|--------|--------|-------|------|-------|
| $a'b'$ | X | X | | |
| $a'b$ | X | | | |
| ab | X | X | | X |
| ab' | X | X | | X |

(C)

| | $c'd'$ | $c'd$ | cd | cd' |
|--------|--------|-------|------|-------|
| $a'b'$ | X | X | | |
| $a'b$ | X | X | | X |
| ab | X | X | | X |
| ab' | X | | | X |

(D)

| | $c'd'$ | $c'd$ | cd | cd' |
|--------|--------|-------|------|-------|
| $a'b'$ | X | X | | |
| $a'b$ | X | X | | X |
| ab | X | X | | X |
| ab' | X | | X | X |

[gate2007-it](#) [digital-logic](#) [k-map](#) [normal](#)
Answer**6.15.3 K Map: GATE2007-IT_79** [top](#)<http://gateoverflow.in/3531>

Consider the following expression

$$ad' + (ac)' + bc'd$$

Which of the following expressions does not correspond to the Karnaugh Map obtained for the given expression??

- A) $c'd' + ad' + abc' + (ac)d'$
- B) $(ac)' + c'd' + ad' + abc'd$
- C) $(ac)' + ad' + abc' + c'd$
- D) $b'c'd' + acd' + (ac)' + abc'$

[gate2007-it](#) [digital-logic](#) [k-map](#) [normal](#)
Answer**6.15.4 K Map: GATE2003_45** [top](#)<http://gateoverflow.in/936>

The literal count of a Boolean expression is the sum of the number of times each literal appears in the expression. For example, the literal count of $(xy + xz')$ is 4. What are the minimum possible literal counts of the product-of-sum and sum-of-product representations respectively of the function given by the following Karnaugh map? Here, X denotes "don't care"

| $xy \backslash z\bar{w}$ | 00 | 01 | 11 | 10 |
|--------------------------|----|----|----|----|
| 00 | X | 1 | 0 | 1 |
| 01 | 0 | 1 | X | 0 |
| 11 | 1 | X | X | 0 |
| 10 | X | 0 | 0 | X |

- A. (11, 9)
- B. (9, 13)
- C. (9, 10)
- D. (11,11)

[gate2003](#) [digital-logic](#) [k-map](#) [normal](#)
Answer**6.15.5 K Map: GATE2006-IT_35** [top](#)<http://gateoverflow.in/3574>

The boolean function for a combinational circuit with four inputs is represented by the following Karnaugh map.

| $RS \backslash PQ$ | 00 | 01 | 11 | 10 |
|--------------------|----|----|----|----|
| 00 | 1 | 0 | 0 | 1 |
| 01 | 0 | 0 | 1 | 1 |
| 11 | 1 | 1 | 1 | 0 |
| 10 | 1 | 0 | 0 | 1 |

Which of the product terms given below is an essential prime implicant of the function?

- | | |
|----|-----|
| A) | QRS |
| B) | PQS |

- C) $PQ'S'$
 D) $Q'S'$

gate2006-it digital-logic k-map normal

Answer

6.15.6 K Map: GATE2001-1.11 [top](#)

<http://gateoverflow.in/704>

Given the following karnaugh map, which one of the following represents the minimal Sum-Of-Products of the map?

| yz \ wx | 00 | 01 | 11 | 10 |
|---------|----|----|----|----|
| 00 | 0 | X | 0 | X |
| 01 | X | 1 | X | 1 |
| 11 | 0 | X | 1 | 0 |
| 10 | 0 | 1 | X | 0 |

- A. $XY + Y'Z$
- B. $WX'Y' + XY + XZ$
- C. $W'X + Y'Z + XY$
- D. $XZ + Y$

gate2001 k-map digital-logic normal

Answer

6.15.7 K Map: GATE2002_1.12 [top](#)

<http://gateoverflow.in/816>

Minimum sum of product expression for $f(w,x,y,z)$ shown in Karnaugh-map below

| wx \ yz | 00 | 01 | 11 | 10 |
|---------|----|----|----|----|
| 00 | 0 | 1 | 1 | 0 |
| 01 | x | 0 | 0 | 1 |
| 11 | x | 0 | 0 | 1 |
| 10 | 0 | 1 | 1 | x |

- A. $xz + y'z$
- B. $xz' + zx'$
- C. $x'y + zx'$
- D. None of the above

gate2002 digital-logic k-map normal

Answer

6.15.8 K Map: GATE2000-2.11 [top](#)

<http://gateoverflow.in/658>

Which functions does NOT implement the Karnaugh map given below?

| wz \ xy | 00 | 01 | 11 | 10 |
|---------|----|----|----|----|
| 00 | 0 | x | 0 | 0 |
| 01 | 0 | x | 1 | 1 |
| 11 | 1 | 1 | 1 | 1 |
| 10 | 0 | x | 0 | 0 |

- A. $(w+x)y$

- B. $xy + yw$
 C. $(w+x)(\bar{w}+y)(\bar{x}+y)$
 D. None of the above

gate2000 digital-logic k-map normal

Answer

6.15.9 K Map: GATE1998_2.7 [top](#)

<http://gateoverflow.in/1679>

The function represented by the Karnaugh map is given below is

| | | BC | | | | |
|---|---|----|----|----|----|----|
| | | A | 00 | 01 | 10 | 11 |
| A | 0 | 1 | 1 | 0 | 1 | |
| | 1 | 1 | 0 | 0 | 1 | |

- A. $A \cdot B$
 B. $AB + BC + CA$
 C. $\overline{B} \oplus C$
 D. $A \cdot BC$

gate1998 digital-logic k-map normal

Answer

6.15.10 K Map: GATE1992_01,i [top](#)

<http://gateoverflow.in/545>

The Boolean function in sum of products form where K-map is given below (figure) is _____

- (i) The Boolean function in sum of products form where K-map is given below (figure) is: _____

| | | C | 0 | 1 |
|---|---|----------------|---|---|
| | | B | 1 | 0 |
| A | 0 | 1 | 0 | |
| | 1 | \overline{A} | A | |

gate1992 digital-logic k-map normal

Answer

6.15.11 K Map: GATE1996_2.24 [top](#)

<http://gateoverflow.in/2753>

What is the equivalent Boolean expression in product-of-sums form for the Karnaugh map given in Fig

| | | AB | 00 | 01 | 11 | 20 |
|----|----|----|----|----|----|----|
| | | CD | | 1 | 1 | |
| AB | 00 | 1 | | | | |
| | 01 | 1 | | | 1 | |

- A. $B\overline{D} + \overline{B}D$
 B. $(B + \overline{C} + D)(\overline{B} + C + \overline{D})$
 C. $(B + D)(\overline{B} + \overline{D})$
 D. $(B + \overline{D})(\overline{B} + D)$

[gate1996](#)
[digital-logic](#)
[k-map](#)
[easy](#)
Answer**6.15.12 K Map: GATE2012_30** [top](#)<http://gateoverflow.in/1615>

What is the minimal form of the Karnaugh map shown below? Assume that X denotes a don't care term

| ab \ cd | 00 | 01 | 11 | 10 |
|---------|----|----|----|----|
| 00 | 1 | X | X | 1 |
| 01 | X | | | 1 |
| 11 | | | | |
| 10 | 1 | | | X |

- (A) $\bar{b}\bar{d}$
 (B) $\bar{b}\bar{d} + \bar{b}\bar{c}$
 (C) $\bar{b}\bar{d} + a\bar{b}\bar{c}d$
 (D) $\bar{b}\bar{d} + \bar{b}\bar{c} + \bar{c}\bar{d}$

[gate2012](#)
[digital-logic](#)
[k-map](#)
[easy](#)
Answer**6.15.13 K Map: GATE1999_1.8** [top](#)<http://gateoverflow.in/1461>

Which of the following functions implements the Karnaugh map shown below?

| CD | 00 | 01 | 11 | 10 |
|----|----|----|----|----|
| AB | 0 | 0 | 1 | 0 |
| 00 | 0 | 0 | 1 | 0 |
| 01 | X | X | 1 | X |
| 11 | 0 | 1 | 1 | 0 |
| 10 | 0 | 1 | 1 | 0 |

- A. $\bar{A}B + CD$
 B. $D(C + A)$
 C. $AD + \bar{A}B$
 D. $(C + D)(\bar{C} + D) + (A + B)$

[gate1999](#)
[digital-logic](#)
[k-map](#)
[easy](#)
Answer**6.15.14 K Map: GATE1995_15** [top](#)<http://gateoverflow.in/2651>

- a. Implement a circuit having the following output expression using an inverter and a nand gate

$$Z = \bar{A} + \bar{B} + C$$

- b. What is the equivalent minimal Boolean expression (in sum of products form) for the Karnaugh map given below?

| | AB | 00 | 01 | 11 | 10 |
|----|----|----|----|----|----|
| CD | 00 | 1 | | | 1 |
| | 01 | | 1 | 1 | |
| | 11 | | 1 | 1 | |
| | 10 | 1 | | | 1 |

[gate1995](#) [digital-logic](#) [k-map](#) [normal](#)
Answer

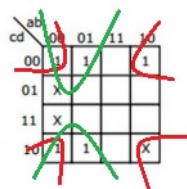
Answers: K Map

6.15.1 K Map: GATE2008-5 [top](#)

<http://gateoverflow.in/403>


Selected Answer

2 Quads are getting formed

Value for First one is $a'd'$ and value for 2nd one is $b'd'$.**Ans is Option A**
Upvote 9 votes

-- GATE_2016 (423 points)

6.15.2 K Map: GATE2007-IT_78 [top](#)

<http://gateoverflow.in/3530>

ans.. (a)

Upvote 1 votes

-- Vicky Bajoria (3.4k points)

6.15.3 K Map: GATE2007-IT_79 [top](#)

<http://gateoverflow.in/3531>


Selected Answer

ad' [fill minterm in K-map in front for a and d']

| | c'd' | c'd | cd | cd' |
|------|------|-----|----|-----|
| a'b' | | | | |
| a'b | | | | |
| ab | 1 | | | 1 |
| ab' | 1 | | | 1 |

similarly fill all minterms for $ad' + a' + c' + bc'd$, resulting K-map will be

| | c'd' | c'd | cd | cd' |
|-------------|-------------|------------|-----------|------------|
| a'b' | 1 | 1 | 1 | 1 |
| a'b | 1 | 1 | 1 | 1 |
| ab | 1 | 1 | | 1 |
| ab' | 1 | 1 | | 1 |

option a) $c'd' + ad' + abc' + (ac)d = c'd' + ad' + abc' + a'd + c'd$

| | c'd' | c'd | cd | cd' |
|-------------|-------------|------------|-----------|------------|
| a'b' | 1 | 1 | 1 | |
| a'b | 1 | 1 | 1 | |
| ab | 1 | 1 | | 1 |
| ab' | 1 | 1 | | 1 |

is not equivalent to given expression

option b) $(ac)' + c'd' + ad' + abc'd = a' + c' + c'd' + ad' + abc'd$

| | c'd' | c'd | cd | cd' |
|-------------|-------------|------------|-----------|------------|
| a'b' | 1 | 1 | 1 | 1 |
| a'b | 1 | 1 | 1 | 1 |
| ab | 1 | 1 | | 1 |
| ab' | 1 | 1 | | 1 |

is equivalent to given expression.

option c) $(ac)' + ad' + abc' + c'd = a' + c' + ad' + abc' + c'd$

| | c'd' | c'd | cd | cd' |
|-------------|-------------|------------|-----------|------------|
| a'b' | 1 | 1 | 1 | 1 |
| a'b | 1 | 1 | 1 | 1 |
| ab | 1 | 1 | | 1 |
| ab' | 1 | 1 | | 1 |

is equivalent to given expression.

option d) $b'c'd' + acd' + (ac)' + abc' = b'c'd' + acd' + a' + c' + abc'$

| | c'd' | c'd | cd | cd' |
|-------------|-------------|------------|-----------|------------|
| a'b' | 1 | 1 | 1 | 1 |
| a'b | 1 | 1 | 1 | 1 |
| ab | 1 | 1 | | 1 |
| ab' | 1 | 1 | | 1 |

is equivalent to given expression.

thumb up 8 votes

-- Praveen Saini (38.4k points)

6.15.4 K Map: GATE2003_45 [top](#)

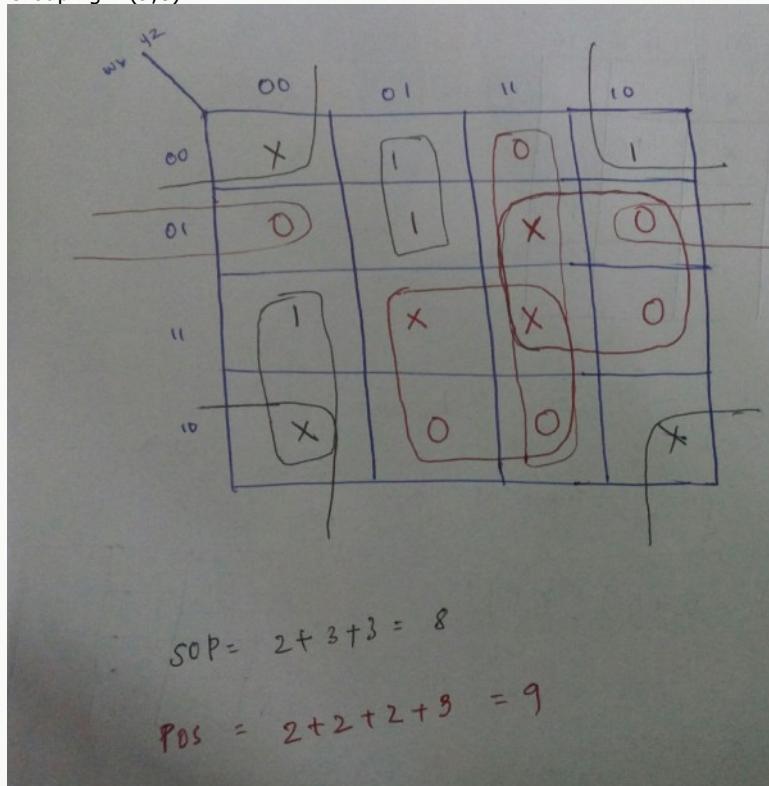
<http://gateoverflow.in/936>



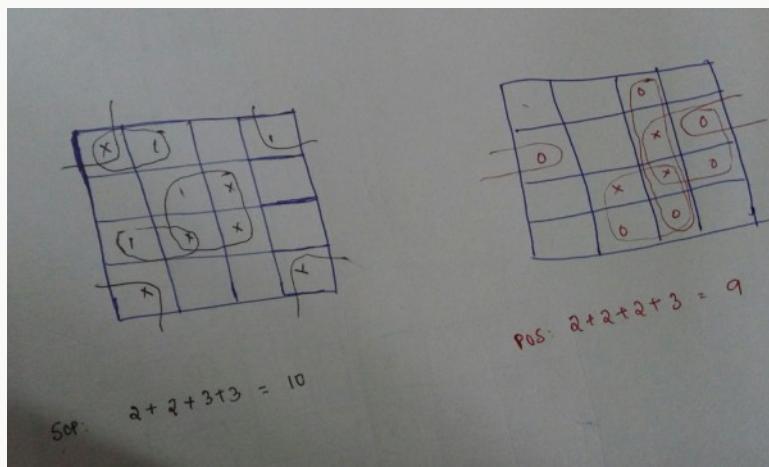
Selected Answer

We will be getting two different grouping..

Grouping 1 (9,8)



GROUPING 2 (9,10)



Both the grouping are correct representation of the function . $f(xyzw)$

(PS: There were statements describing dont cares in many of the comments

""once you have assumed a don't care as '1' u can't use the same don't care for grouping zeros and vice versa"

" if dont care has been used in pos than can't be used in sop "

Both these statements are wrong . Don't care simply means just Dont care , say we use dont care d3 for grouping 1 in SOP we can use d3 for grouping 0 in POS. the literals in SOP and POS May not be same)

K Map- is not unique . And the question says about minimal literals . So the **best answer would be (9,8)** Since there is no option in GATE we can go with (9,110)

4 3 votes

-- Akhil Nadh Pullolikkal Chandran (6.9k points)

POS

$$(z' + w')(y' + z')(x' + w')(x + y' + w)$$

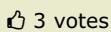
9 literals

SOP:

$$y'w' + yw + xyz' + x'y'z'$$

10 literals

ans is c



3 votes

-- Pooja (25.9k points)

6.15.5 K Map: GATE2006-IT_35<http://gateoverflow.in/3574>

Selected Answer

essential prime implicants which r grouped only by only one method or way

so in above question cornor's ones r grouped by only one method

d) will be the answer



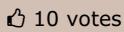
5 votes

-- SAKET NANDAN (2.2k points)

6.15.6 K Map: GATE2001-1.11<http://gateoverflow.in/704>

Selected Answer

answer - A



10 votes

-- ankitrokdeonsns (8.4k points)

6.15.7 K Map: GATE2002_1.12<http://gateoverflow.in/816>

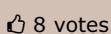
Selected Answer

m1,m3,m9,m11 form one quad xz'

m4,m6,m12,m14 form one quad x'z

So f=x'z+z'x

Ans is b



8 votes

-- Pooja (25.9k points)

6.15.8 K Map: GATE2000-2.11<http://gateoverflow.in/658>

Selected Answer

answer - D

solving K map gives xy +wy

11 votes

-- ankitrokdeonsns (8.4k points)

6.15.9 K Map: GATE1998_2.7 [top](#)<http://gateoverflow.in/1679>

Selected Answer

Here we cant make pair of 4 so we have to go with pair of 2 each

$$BC + B'C'$$

$$B \text{ (EX-NOR) } C$$

it can be represented as negation of EX -OR

$$[B \text{ (EX-OR) } C]'$$

Option C is correct .

2 votes

-- shekhar chauhan (36.4k points)

$$BC + B'C' + A'B' \text{ or } BC + B'C' + A'C$$

2 votes

-- Digvijay (35.8k points)

6.15.10 K Map: GATE1992_01,i [top](#)<http://gateoverflow.in/545>

Selected Answer

$$\text{answer} - ABC + B'C' + A'C' \text{ [EDIT]}$$

expand this K map of 2 variables (4 cells) to K map of three variable (8 cells)

entries which are non zero are $A'B'C'$, $AB'C'$, $A'BC'$ and ABC

minimize SOP expression using that K map

3 votes

-- ankitrokdeonsns (8.4k points)

$$B'C! + BC!A! + ABC = C!(B! + BA!) + ABC = C!(A! + B!) + ABC = A!C! + B!C! + ABC$$

3 votes

-- Arjun Suresh (150k points)

6.15.11 K Map: GATE1996_2.24 [top](#)<http://gateoverflow.in/2753>

Selected Answer

If all the empty cells are filled with '0' and then the POS expression is calculated as:

| CD\AB | 00 | 01 | 11 | 10 |
|-------|----|----|----|----|
| 00 | 0 | | | 0 |
| 01 | | 0 | 0 | |
| 11 | | 0 | 0 | |
| 10 | 0 | | | 0 |

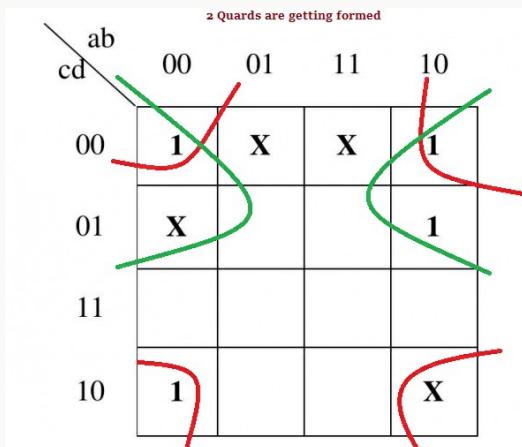
Then the POS expression of $f = (D+B)(D'+B') = BD' + B'D$

5 votes

-- Ujjwal Saini (401 points)

6.15.12 K Map: GATE2012_30 top<http://gateoverflow.in/1615>

Selected Answer



2 quads are getting formed.

Value for First one is $b'd'$ and value for 2nd one is $b'c'$. So, **Ans is option B**

10 votes

-- GATE_2016 (423 points)

6.15.13 K Map: GATE1999_1.8 top<http://gateoverflow.in/1461>

Selected Answer

answer - B

CD+AD

4 votes

-- ankitrokdeonsns (8.4k points)

6.15.14 K Map: GATE1995_15 top<http://gateoverflow.in/2651>ans for B is $BD + B'D'$

4 votes

-- jayendra (6.6k points)

6.16**Memory Interfacing** top**6.16.1 Memory Interfacing: GATE1995_2.2** top<http://gateoverflow.in/2614>

The capacity of a memory unit is defined by the number of words multiplied by the number of bits/word. How many separate address and data lines are needed for a memory of $4K \times 16$?

- 10 address, 16 data lines
- 11 address, 8 data lines
- 12 address, 16 data lines
- 12 address, 12 data lines

[gate1995](#) [digital-logic](#) [memory-interfacing](#) [normal](#)
Answer

Answers: Memory Interfacing

6.16.1 Memory Interfacing: GATE1995_2.2 [top](#)

<http://gateoverflow.in/2614>


Selected Answer

ROM memory size = $2^m \times n$

m =no. of address lines n = no. of data lines

given 4K x 16

$$= 2^2 \times 2^{10} \times 16$$

$$= 2^{12} \times 16$$

address lines = 12

data lines= 16

Upvote 3 votes

-- Sanket_ (1.8k points)

6.17

Min No Gates [top](#)

6.17.1 Min No Gates: GATE2000-9 [top](#)

<http://gateoverflow.in/680>

Design a logic circuit to convert a single digit BCD number to the number modulo six as follows (Do not detect illegal input):

- Write the truth table for all bits. Label the input bits I_1, I_2, \dots with I_1 as the least significant bit. Label the output bits R_1, R_2, \dots with R_1 as the least significant bit. Use 1 to signify truth.
- Draw one circuit for each output bit using, **altogether**, two two-input AND gates, one two-input OR gate and two NOT gates.

[gate2000](#) [digital-logic](#) [min-no-gates](#)
Answer

6.17.2 Min No Gates: GATE2004-IT_8 [top](#)

<http://gateoverflow.in/3649>

What is the minimum number of NAND gates required to implement a 2-input EXCLUSIVE-OR function without using any other logic gate?

- | | |
|----|---|
| A) | 3 |
| B) | 4 |
| C) | 5 |
| D) | 6 |

[gate2004-it](#) [digital-logic](#) [min-no-gates](#) [normal](#)
Answer

6.17.3 Min No Gates: GATE2009-6 [top](#)

<http://gateoverflow.in/1298>

What is the minimum number of gates required to implement the Boolean function ($AB+C$) if we have to use only 2-input NOR gates?

- A. 2
- B. 3
- C. 4
- D. 5

[gate2009](#) [digital-logic](#) [min-no-gates](#) [normal](#)

[Answer](#)

6.17.4 Min No Gates: GATE2004_58 [top](#)

<http://gateoverflow.in/1053>

A circuit outputs a digit in the form of 4 bits. 0 is represented by 0000, 1 by 0001, ..., 9 by 1001. A combinational circuit is to be designed which takes these 4 bits as input and outputs 1 if the digit ≥ 5 , and 0 otherwise. If only AND, OR and NOT gates may be used, what is the minimum number of gates required?

- A. 2
- B. 3
- C. 4
- D. 5

[gate2004](#) [digital-logic](#) [normal](#) [min-no-gates](#)

[Answer](#)

Answers: Min No Gates

6.17.1 Min No Gates: GATE2000-9 [top](#)

<http://gateoverflow.in/680>

| I1 | I2 | I3 | I4 | R1 | R2 | R3 | R4 | |
|----|----|----|----|----------|----|----|----|---|
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 1 |
| 0 | 0 | 1 | 0 | 2 | 0 | 0 | 1 | 0 |
| 0 | 0 | 1 | 1 | 3 | 0 | 0 | 1 | 1 |
| 0 | 1 | 0 | 0 | 4 | 0 | 1 | 0 | 0 |
| 0 | 1 | 0 | 1 | 5 | 0 | 1 | 0 | 1 |
| 0 | 1 | 1 | 0 | 6 | 0 | 0 | 0 | 0 |
| 0 | 1 | 1 | 1 | 7 | 0 | 0 | 0 | 1 |
| 1 | 0 | 0 | 0 | 8 | 0 | 0 | 1 | 0 |
| 1 | 0 | 0 | 1 | 9 | 0 | 0 | 1 | 1 |
| | | | | | | | | |

0 votes

-- Savir husen khan (153 points)

6.17.2 Min No Gates: GATE2004-IT_8 [top](#)

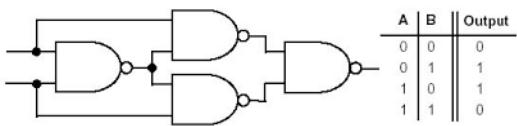
<http://gateoverflow.in/3649>



Selected Answer

Option B 4. See the diagram.

Exclusive OR (XOR)



| A | B | Output |
|---|---|--------|
| 0 | 0 | 0 |
| 0 | 1 | 1 |
| 1 | 0 | 1 |
| 1 | 1 | 0 |

1 votes

-- Manu Madhavan (503 points)

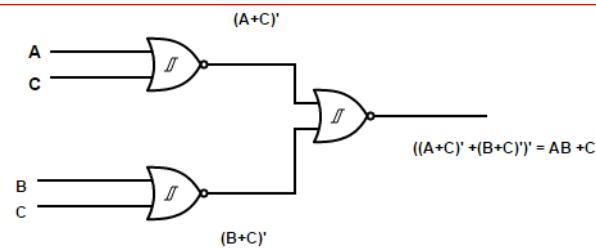
6.17.3 Min No Gates: GATE2009-6 top

<http://gateoverflow.in/1298>

Selected Answer

given boolean function is

$$\begin{aligned} f &= AB + C \\ &= (A+C) \cdot (B+C) \\ &=((A+C)' + (B+C)')' \end{aligned}$$



therefore 3 NOR gate required .

16 votes

-- Mithlesh Upadhyay (3.6k points)

6.17.4 Min No Gates: GATE2004_58 top

<http://gateoverflow.in/1053>

Selected Answer

Answer should be (B) As according to question .. truth table will be like

| A | B | C | D | f |
|---|---|---|---|---|
| 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 1 | 0 |
| 0 | 0 | 1 | 0 | 0 |
| 0 | 0 | 1 | 1 | 0 |
| 0 | 1 | 0 | 0 | 0 |
| 0 | 1 | 0 | 1 | 1 |
| 0 | 1 | 1 | 0 | 1 |
| 0 | 1 | 1 | 1 | 1 |
| 1 | 0 | 0 | 0 | 1 |

```

1 0 0 1    1
1 0 1 0    dont care
1 0 1 1    dont care
1 1 0 0    dont care
1 1 0 1    dont care
1 1 1 0    dont care
1 1 1 1    dont care

```

using this truth table we get 3 sub cube which are combined with following minterms A (8,9,10,11,12,13,14,15) , BD(5,13,7,15) and BC(6,7,14,15)

$$\text{SO } f = A + BD + BC = A + B(C+D)$$

SO minimum gate required 2 OR gate and 1 AND gate = 3 minimum gate ...

12 votes

-- sonam vyas (8.1k points)

6.18

Min Sum Of Products Form [top](#)

6.18.1 Min Sum Of Products Form: GATE1991-5,b [top](#)

<http://gateoverflow.in/26437>

Find the minimum sum of products form of the logic function $f(A, B, C, D) = \sum m(0, 2, 8, 10, 15) + \sum d(3, 11, 12, 14)$ where m and d represent minterm and don't care term respectively.

[gate1991](#) [digital-logic](#) [min-sum-of-products-form](#)

Answer

6.18.2 Min Sum Of Products Form: GATE2014-3_7 [top](#)

<http://gateoverflow.in/2041>

Consider the following minterm expression for F :

$$F(P, Q, R, S) = \sum 0, 2, 5, 7, 8, 10, 13, 15$$

The minterms 2, 7, 8 and 13 are 'do not care' terms. The minimal sum-of-products form for F is

(A) $Q\bar{S} + \bar{Q}S$

(B) $\bar{Q}\bar{S} + QS$

(C) $\bar{Q}\bar{R}\bar{S} + \bar{Q}R\bar{S} + Q\bar{R}S + QR\bar{S}$

(D) $P\bar{Q}\bar{S} + \bar{P}QS + PQS + P\bar{Q}S$

[gate2014-3](#) [digital-logic](#) [min-sum-of-products-form](#) [normal](#)

Answer

6.18.3 Min Sum Of Products Form: GATE2006_38 [top](#)

<http://gateoverflow.in/1814>

Consider a Boolean function $f(w, x, y, z)$. Suppose that exactly one of its inputs is allowed to change at a time. If the function happens to be true for two input vectors $i_1 = \langle w_1, x_1, y_1, z_1 \rangle$ and $i_2 = \langle w_2, x_2, y_2, z_2 \rangle$, we would like the function to remain true as the input changes from i_1 to i_2 (i_1 and i_2 differ in exactly one bit position) without becoming false momentarily. Let $f(w, x, y, z) = \sum(5, 7, 11, 12, 13, 15)$. Which of the following cube covers of f will ensure that the required property is satisfied?

- (A) $\bar{w}xz, wx\bar{y}, x\bar{y}z, xyz, wyz$
 (B) $wxy, \bar{w}xz, wyz$
 (C) $wx\bar{y}z, xz, w\bar{x}yz$
 (D) $wx\bar{y}, wyz, wxz, \bar{w}xz, x\bar{y}z, xyz$

gate2006 | digital-logic | min-sum-of-products-form | normal

Answer

6.18.4 Min Sum Of Products Form: GATE1997_71 [top](#)

<http://gateoverflow.in/19701>

Let $f = (\bar{w} + y)(\bar{x} + y)(w + \bar{x} + z)(\bar{w} + z)(\bar{x} + z)$

- Express f as the minimal sum of products. Write only the answer.
- If the output line is stuck at 0, for how many input combinations will the value of f be correct?

gate1997 | digital-logic | min-sum-of-products-form

Answer

Answers: Min Sum Of Products Form

6.18.1 Min Sum Of Products Form: GATE1991-5,b [top](#)

<http://gateoverflow.in/26437>



Selected Answer

(b)

| | | | |
|---------------|----|-----------------|-------------------|
| 0 | 1 | 3 | x |
| 1 A'B'C'D' | | | 2 1 A'B'CD' |
| 4 | 5 | 7 | 6 |
| 12 x | 13 | 15 1 ABCD | 14 x ABCD' |

| | | | |
|-------------------|---|------------------|------------------|
| 8 1 AB'C'D' | 9 | 11 X AB'CD | 10 1 ABCD' |
|-------------------|---|------------------|------------------|

The minimum SOP form of the logic function is given as : $f(A,B,C,D) = B'D' + AC$

6 votes

-- Kalpana Bhargav (3k points)

4 variable K-map will be used

| | $\bar{C}\bar{D}$ | $\bar{C}D$ | $C\bar{D}$ | CD |
|------------------|------------------|------------|------------|------|
| $\bar{A}\bar{B}$ | 1 | 0 | x | 1 |
| $\bar{A}B$ | 0 | 0 | 0 | 0 |
| AB | x | 0 | 1 | x |
| $A\bar{B}$ | 1 | 0 | x | 1 |

Here we will get two quads

1. quad of (0,2,8,10) ----> $B'D'$
2. quad of (10,11,14,15) ---> AC

$$F = B'D' + AC$$

6 votes

-- Praveen Saini (38.4k points)

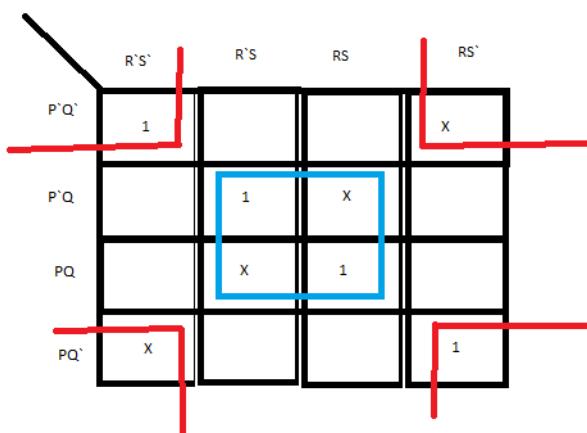
6.18.2 Min Sum Of Products Form: GATE2014-3_7 top

<http://gateoverflow.in/2041>



Selected Answer

While putting the terms to K-map the 3rd and 4th columns are swapped so do 3rd and 4th rows. So, term 2 is going to (0,3) column instead of (0,2), 8 is going to (3,0) instead of (2,0) etc..



Solving this k-map gives B as the answer.

Reference: <http://www.cs.uiuc.edu/class/sp08/cs231/lectures/04-Kmap.pdf>

8 votes

-- Srinath Sri (2.9k points)

6.18.3 Min Sum Of Products Form: GATE2006_38 top

<http://gateoverflow.in/1814>

(A) is the answer for this question.

Make K-MAP using these values $\sum(5,7,11,12,13,15)$, after that you'll find that this constructed K-MAP will exactly map with the first option.

3 votes

-- Manu Thakur (5.6k points)

In this question we have following minterms:

12 - 1100

13 - 1101

5 - 0101

7 - 0111

15- 1111

11 - 1011

Notice that I have written it from top to down so that each minterms differs in only one bit from the minterm above and below it. Now imagine we picked 5 and 7 .Currently circuit is outputting 1 for 0111(7) input. Now the question says (imagine)if a man pulling the y bit from 1 to 0 but output should not be affected .It means it MUST be independent of y bit .That is if $w=0$ $x=1$ and $z=1$ then it must output 1 irrespective of y.This can be done if SOP contains $w'xz +$ other minterm. Like this we have five ways to select two inputs which differs by one bit .So F should contain 5 product terms.

For 1 & 2: wxy^*

For 2&3: xy^z

For 3&4: $w^x z$

For 4&5:xyz

For 5&6:wyz

Sum all those to get $F()$;

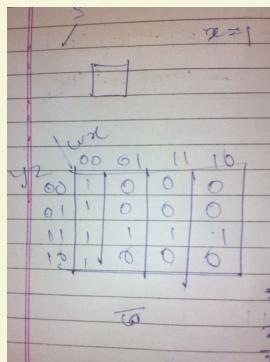
Only option A has these 5 implicants.

 3 votes

-- Prashant Singh (379 points)

6.18.4 Min Sum Of Products Form: GATE1997 71 top

<http://www-nova.flmnp.in/10701>



Answer of question 1 :- $w'x' + yz$

Answer of Question 2 :-

stuck at 0 , means output is fixed at 0(No matter what is input).we got 0 for 9 input combinations(Check Kmpa) ,So answer is 9,

 3 votes

-- Akash (31.7k points)

6-19

Minimal State Automata

6.19.1 Minimal State Automata: GATE2003 44 top

10.000-15.000 €

A 1-input, 2-output synchronous sequential circuit behaves as follows:

Let z_k, n_k denote the number of 0's and 1's respectively in initial k bits of the input

$(z_k + n_k = k)$. The circuit outputs 00 until one of the following conditions holds.

- $z_k = n_k = 2$. In this case, the output at the k -th and all subsequent clock ticks is 10.

- $n_k - z_k = 2$. In this case, the output at the k -th and all subsequent clock ticks is 01.

What is the minimum number of states required in the state transition graph of the above circuit?

- 5
- 6
- 7
- 8

[gate2003](#) [digital-logic](#) [finite-automata](#) [minimal-state-automata](#) [normal](#)

[Answer](#)

Answers: Minimal State Automata

6.19.1 Minimal State Automata: GATE2003_44 [top](#)

<http://gateoverflow.in/935>



Selected Answer

Though the question is from digital logic, answer is purely from automata. As per question, we just need to count the difference of the number of 0's and 1's in the first k bit of a number. And we just need to count till this count reaches 2 or -2 (negative when number of 0's is less than number of 1's). So, the possibilities are -2, -1, 0, 1 and 2 which represents the five states of the state transition diagram.

For state -2, the output of the circuit will be 01, for state 2, output will be 10 (both these states not having any outgoing transitions) and for other 3 states, output will be 00 as per the given description of the circuit.

16 votes

-- gatcse (10.7k points)

6.20

Modular Arithmetic [top](#)

6.20.1 Modular Arithmetic: GATE 2016-2-29 [top](#)

<http://gateoverflow.in/39588>

The value of the expression $13^{99} \pmod{17}$, in the range 0 to 16, is _____.

[gate2016-2](#) [digital-logic](#) [modular-arithmetic](#) [normal](#) [numerical-answers](#)

[Answer](#)

Answers: Modular Arithmetic

6.20.1 Modular Arithmetic: GATE 2016-2-29 [top](#)

<http://gateoverflow.in/39588>



Selected Answer

The remainder cycle is 13, 16, 4, 1.

$$13^{99} \pmod{17} = 13^3 \pmod{17} = 4$$

Note:

for remainder cycle,
 $13 \pmod{17} = 13$, $13^2 \pmod{17} = 16$, $13^3 \pmod{17} = 4$, $13^4 \pmod{17} = 1$

17 votes

-- Ashish Deshmukh (1.4k points)

6.21

Multiplexer top6.21.1 Multiplexer: GATE1992_04_b top<http://gateoverflow.in/17407>

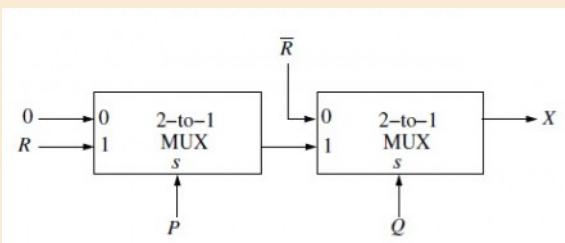
A priority encoder accepts three input signals (A, B and C) and produce a two-bit output (X1 , X0) corresponding to the highest priority active input signal. Assume A has the highest priority followed by B and C has the lowest priority. If none of the inputs are active the output should be 00, design the priority encoder using 4:1 multiplexers as the main components.

[gate1994](#) [digital-logic](#) [multiplexer](#)

Answer

6.21.2 Multiplexer: GATE 2016-1-30 top<http://gateoverflow.in/39722>

Consider the two cascade 2 to 1 multiplexers as shown in the figure .



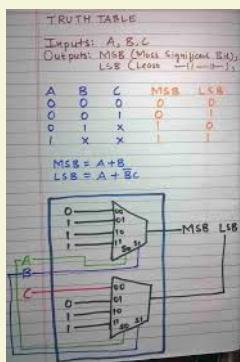
The minimal sum of products form of the output X is

- A). $\overline{P} \overline{Q} + PQR$
- B). $\overline{P} Q + QR$
- C). $PQ + \overline{P} \overline{Q}R$
- D). $\overline{Q} \overline{R} + PQR$

[gate2016-1](#) [digital-logic](#) [multiplexer](#) [normal](#)

Answer

Answers: Multiplexer

6.21.1 Multiplexer: GATE1992_04_b top<http://gateoverflow.in/17407>

It can be implemented using two 4 x 1 Multiplexers.

1 votes

-- Anurag Pandey (9.7k points)

here's one more answer to this :

□

1 votes

-- Amar Vashishth (20.7k points)

6.21.2 Multiplexer: GATE 2016-1-30 [top](#)

<http://gateoverflow.in/39722>



Selected Answer

For 2 : 1 MUX, output $Y = S'I_o + SI_1$

So, output of MUX1 , $f_1 = P'0 + PR = PR$

Output of MUX2 , $f_2 = Q'R' + Qf_1 = Q'R' + PQR$

which is option D

17 votes

-- Monanshi Jain (6.5k points)

6.22

Multiplexor [top](#)

6.22.1 Multiplexor: GATE1998_1.14 [top](#)

<http://gateoverflow.in/1651>

A multiplexer with a $4 - bit$ data select input is a

- A. 4 : 1 multiplexer
- B. 2 : 1 multiplexer
- C. 16 : 1 multiplexer
- D. 8 : 1 multiplexer

[gate1998](#) [digital-logic](#) [multiplexor](#) [easy](#)

Answer

Answers: Multiplexor

6.22.1 Multiplexor: GATE1998_1.14 [top](#)

<http://gateoverflow.in/1651>



Selected Answer

for n bit data select input

$2^n : 1$

for 4 it is 16 : 1

8 votes

-- Bhagirathi Nayak (11.3k points)

6.23

Number Representation [top](#)

6.23.1 Number Representation: TIFR2011-A-16 [top](#)

<http://gateoverflow.in/20253>

A variable that takes thirteen possible values can be communicated using?

- a. Thirteen bits.
- b. Three bits.
- c. $\log_2 13$ bits.
- d. Four bits.
- e. None of the above.

[tifr2011](#) [number-representation](#)

[Answer](#)

6.23.2 Number Representation: GATE 2016-2-09 [top](#)

<http://gateoverflow.in/39546>

Let X be the number of distinct 16-bit integers in 2's complement representation. Let Y be the number of distinct 16-bit integers in sign magnitude representation. Then $X - Y$ is_____.

[gate2016-2](#) [digital-logic](#) [number-representation](#) [normal](#) [numerical-answers](#)

[Answer](#)

6.23.3 Number Representation: GATE2005-IT_47 [top](#)

<http://gateoverflow.in/3808>

$(34.4)_8 \times (23.4)_8$ evaluates to

- A) $(1053.6)_8$
- B) $(1053.2)_8$
- C) $(1024.2)_8$
- D) None of these

[gate2005-it](#) [digital-logic](#) [number-representation](#) [normal](#)

[Answer](#)

6.23.4 Number Representation: GATE1991_01,iii [top](#)

<http://gateoverflow.in/500>

Consider the number given by the decimal expression:

$$16^3 * 9 + 16^2 * 7 + 16 * 5 + 3$$

The number of 1's in the unsigned binary representation of the number is _____

[gate1991](#) [digital-logic](#) [number-representation](#) [normal](#)

[Answer](#)

6.23.5 Number Representation: GATE2008-6 [top](#)

<http://gateoverflow.in/404>

Let r denote number system radix. The only value(s) of r that satisfy the equation $\sqrt{121_r} = 11_r$, is/are

- A. decimal 10
- B. decimal 11
- C. decimal 10 and 11
- D. any value > 2

[gate2008](#) [digital-logic](#) [number-representation](#) [normal](#)

[Answer](#)

6.23.6 Number Representation: GATE2000-1.6 [top](#)

<http://gateoverflow.in/629>

The number 43 in 2's complement representation is

- A. 01010101
- B. 11010101
- C. 00101011
- D. 10101011

[gate2000](#) [digital-logic](#) [number-representation](#) [easy](#)

[Answer](#)

6.23.7 Number Representation: GATE2000-2.14 [top](#)

<http://gateoverflow.in/661>

Consider the values of $A = 2.0 \times 10^{30}$, $B = -2.0 \times 10^{30}$, $C = 1.0$, and the sequence

| | |
|--------------|--------------|
| $X := A + B$ | $Y := A + C$ |
| $X := X + C$ | $Y := Y + B$ |

executed on a computer where floating point numbers are represented with 32 bits. The values for X and Y will be

- A. $X = 1.0$, $Y = 1.0$
- B. $X = 1.0$, $Y = 0.0$
- C. $X = 0.0$, $Y = 1.0$
- D. $X = 0.0$, $Y = 0.0$

[gate2000](#) [digital-logic](#) [number-representation](#) [normal](#)

[Answer](#)

6.23.8 Number Representation: GATE2015-3_35 [top](#)

<http://gateoverflow.in/8494>

Consider the equation $(43)_x = (y3)_8$ where x and y are unknown. The number of possible solutions is _____

[gate2015-3](#) [digital-logic](#) [number-representation](#) [normal](#) [numerical-answers](#)

[Answer](#)

6.23.9 Number Representation: GATE 2016-1-07 [top](#)

<http://gateoverflow.in/39649>

The
16-bit

2's complement representation of an integer is

1111 1111 1111 0101; its decimal representation is _____.

[gate2016-1](#) [digital-logic](#) [number-representation](#) [normal](#) [numerical-answers](#)

[Answer](#)

6.23.10 Number Representation: GATE2003_9 [top](#)

<http://gateoverflow.in/900>

Assuming all numbers are in 2's complement representation, which of the following numbers is divisible by 11111011?

- A. 11100111
- B. 11100100
- C. 11010111
- D. 11011011

[gate2003](#) [digital-logic](#) [number-representation](#) [normal](#)
[Answer](#)

6.23.11 Number Representation: GATE2001-2.10 [top](#)

<http://gateoverflow.in/728>

The 2's complement representation of $(-539)_{10}$ in hexadecimal is

- A. ABE
- B. DBC
- C. DES
- D. 9E7

[gate2001](#) [digital-logic](#) [number-representation](#) [easy](#)
[Answer](#)

6.23.12 Number Representation: GATE2005-16, ISRO2009-18, ISRO2015-2 [top](#)

<http://gateoverflow.in/1352>

The range of integers that can be represented by an n bit 2's complement number system is:

- A. -2^{n-1} to $(2^{n-1} - 1)$
- B. $-(2^{n-1} - 1)$ to $(2^{n-1} - 1)$
- C. -2^{n-1} to 2^{n-1}
- D. $-(2^{n-1} + 1)$ to $(2^{n-1} - 1)$

[gate2005](#) [digital-logic](#) [number-representation](#) [easy](#) [isro2009](#) [isro2015](#)
[Answer](#)

6.23.13 Number Representation: GATE2014-2_8 [top](#)

<http://gateoverflow.in/1961>

Consider the equation
 $(123)_5 = (x8)_y$ with
 x and
 y as unknown. The number of possible solutions is _____.

[gate2014-2](#) [digital-logic](#) [number-representation](#) [numerical-answers](#) [normal](#)
[Answer](#)

6.23.14 Number Representation: GATE2010-8 [top](#)

<http://gateoverflow.in/2179>

P is a 16-bit signed integer. The 2's complement representation of P is $(F87B)_{16}$. The 2's complement representation of $8 \times P$ is

- A. $(C3D8)_{16}$
- B. $(187B)_{16}$
- C. $(F878)_{16}$
- D. $(987B)_{16}$

[gate2010](#) [digital-logic](#) [number-representation](#) [normal](#)
[Answer](#)

6.23.15 Number Representation: GATE2006_39 [top](#)

<http://gateoverflow.in/1815>

We consider the addition of two 2's complement numbers $b_{n-1}b_{n-2}\dots b_0$ and $a_{n-1}a_{n-2}\dots a_0$. A binary adder for adding unsigned binary numbers is used to add the two numbers. The sum is denoted by $c_{n-1}c_{n-2}\dots c_0$ and the carry-out by c_{out} .

Which one of the following options correctly identifies the overflow condition?

- (A) $c_{out} (\overline{a_{n-1}} \oplus \overline{b_{n-1}})$
- (B) $a_{n-1}b_{n-1}\overline{c_{n-1}} + \overline{a_{n-1}}\overline{b_{n-1}}\overline{c_{n-1}}$
- (C) $c_{out} \oplus c_{n-1}$
- (D) $a_{n-1} \oplus b_{n-1} \oplus c_{n-1}$

[gate2006](#) [digital-logic](#) [number-representation](#) [normal](#)

[Answer](#)

6.23.16 Number Representation: GATE2014-1_8 [top](#)

<http://gateoverflow.in/1766>

The base (or radix) of the number system such that the following equation holds is_____.

$$\frac{312}{20} = 13.1$$

[gate2014-1](#) [digital-logic](#) [number-representation](#) [numerical-answers](#) [normal](#)

[Answer](#)

6.23.17 Number Representation: GATE1998_2.20 [top](#)

<http://gateoverflow.in/1693>

Suppose the domain set of an attribute consists of signed four digit numbers. What is the percentage of reduction in storage space of this attribute if it is stored as an integer rather than in character form?

- A. 80%
- B. 20%
- C. 60%
- D. 40%

[gate1998](#) [digital-logic](#) [number-representation](#) [normal](#)

[Answer](#)

6.23.18 Number Representation: GATE1997_5.4 [top](#)

<http://gateoverflow.in/2255>

Given $\sqrt{224}_r = 13)_r$.

The value of the radix r is:

- A. 10
- B. 8
- C. 5
- D. 6

[gate1997](#) [digital-logic](#) [number-representation](#) [normal](#)

[Answer](#)

6.23.19 Number Representation: GATE1998_1.17 [top](#)

<http://gateoverflow.in/1654>

The octal representation of an integer is $(342)_8$. If this were to be treated as an eight-bit integer in an 8085 based computer, its decimal equivalent is

- A. 226
- B. -98
- C. 76

D. -30

gate1998 | digital-logic | number-representation | normal

[Answer](#)**6.23.20 Number Representation: GATE1993_6.5** [top](#)<http://gateoverflow.in/2286>

Convert the following numbers in the given bases into their equivalents in the desired bases:

- a. $(110.101)_2 = (x)_{10}$
- b. $(1118)_{10} = (y)_H$

gate1993 | digital-logic | number-representation | normal

[Answer](#)**6.23.21 Number Representation: GATE1999_2.17** [top](#)<http://gateoverflow.in/1495>

Zero has two representations in

- A. Sign magnitude
- B. 2's complement
- C. 1's complement
- D. None of the above

gate1999 | digital-logic | number-representation | easy

[Answer](#)**6.23.22 Number Representation: GATE2013_4** [top](#)<http://gateoverflow.in/1413>

The smallest integer that can be represented by an 8-bit number in 2's complement form is

- (A) -256
- (B) -128
- (C) -127
- (D) 0

gate2013 | digital-logic | number-representation | easy

[Answer](#)**6.23.23 Number Representation: GATE1994_2.7** [top](#)<http://gateoverflow.in/2474>

Consider n-bit (including sign bit) 2's complement representation of integer numbers. The range of integer values, N , that can be represented is $\underline{\quad} \leq N \leq \underline{\quad}$.

gate1994 | digital-logic | number-representation | easy

[Answer](#)**6.23.24 Number Representation: GATE2005_17** [top](#)<http://gateoverflow.in/1353>

The hexadecimal representation of 657_8 is:

- (a) 1AF
- (b) D78
- (c) D71
- (d) 32F

[gate2005](#) [digital-logic](#) [number-representation](#) [easy](#)
Answer

6.23.25 Number Representation: GATE1995-2.12, ISRO2015-9 [top](#)

<http://gateoverflow.in/2624>

The number of 1's in the binary representation of $(3 \cdot 4096 + 15 \cdot 256 + 5 \cdot 16 + 3)$ are:

- A. 8
- B. 9
- C. 10
- D. 12

[gate1995](#) [digital-logic](#) [number-representation](#) [normal](#) [isro2015](#)
Answer

6.23.26 Number Representation: GATE1995_18 [top](#)

<http://gateoverflow.in/2655>

The following is an incomplete Pascal function to convert a given decimal integer (in the range -8 to +7) into a binary integer in 2's complement representation. Determine the expression A, B, C that complete program.

```
function TWOSCOMP (N:integer):integer;
var
  RAM, EXPONENT:integer;
  BINARY :integer;
begin
  if (N>=-8) and (N<=+7) then
  begin
    if N<0 then
      N:=A;
    BINARY:=0;
    EXPONENT:=1;
    while N>>0 do
    begin
      REM:=N mod 2;
      BIANRY:=BINARY + B*EXPONENT;
      EXPONENT:=EXPONENT*10;
      N:=C
    end
    TWOSCOMP:=BINARY
  end;
end;
```

[gate1995](#) [digital-logic](#) [number-representation](#) [normal](#)
Answer

6.23.27 Number Representation: GATE1996_1.25 [top](#)

<http://gateoverflow.in/2729>

Consider the following floating-point number representation.

| | | | |
|----------|----|----------|---|
| 31 | 24 | 23 | 0 |
| Exponent | | Mantissa | |

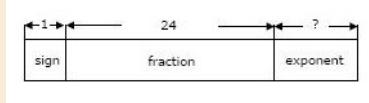
The exponent is in 2's complement representation and mantissa is in the sign magnitude representation. The range of the magnitude of the normalized numbers in this representation is

- A. 0 to 1
- B. 0.5 to 1
- C. 2^{-23} to 0.5
- D. 0.5 to $(1 - 2^{-23})$

[gate1996](#) [digital-logic](#) [number-representation](#) [normal](#)

Answer**6.23.28 Number Representation: GATE2002_9** [top](#)<http://gateoverflow.in/862>

Consider the following 32-bit floating-point representation scheme as shown in the format below. A value is specified by 3 fields, a one bit sign field (with 0 for positive and 1 for negative values), a 24 bit fraction field (with the binary point being at the left end of the fraction bits), and a 7 bit exponent field (in excess-64 signed integer representation, with 16 being the base of exponentiation). The sign bit is the most significant bit.



- It is required to represent the decimal value - 7.5 as a normalized floating point number in the given format. Derive the values of the various fields. Express your final answer in the hexadecimal.
- What is the largest value that can be represented using this format? Express your answer as the nearest power of 10.

[gate2002](#) [digital-logic](#) [number-representation](#) [normal](#)**Answer****6.23.29 Number Representation: GATE2002_1.14** [top](#)<http://gateoverflow.in/818>

The decimal value 0.25

- A. is equivalent to the binary value 0.1
- B. is equivalent to the binary value 0.01
- C. is equivalent to the binary value 0.00111...
- D. cannot be represented precisely in binary

[gate2002](#) [digital-logic](#) [number-representation](#) [easy](#)**Answer****6.23.30 Number Representation: GATE2002_1.15** [top](#)<http://gateoverflow.in/819>

The 2's complement representation of the decimal value -15 is

- A. 1111
- B. 11111
- C. 111111
- D. 10001

[gate2002](#) [digital-logic](#) [number-representation](#) [easy](#)**Answer****6.23.31 Number Representation: GATE2004-IT_43** [top](#)<http://gateoverflow.in/3686>

The number $(123456)_8$ is equivalent to

- A) $(A72E)_{16}$ and $(22130232)_4$
- B) $(A72E)_{16}$ and $(22131122)_4$
- C) $(A73E)_{16}$ and $(22130232)_4$
- D) $(A62E)_{16}$ and $(22120232)_4$

[gate2004-it](#) [digital-logic](#) [number-representation](#) [normal](#)

Answer**6.23.32 Number Representation: GATE2004-IT_42** [top](#)<http://gateoverflow.in/3685>

Using a 4-bit 2's complement arithmetic, which of the following additions will result in an overflow?

- i. 1100 + 1100
- ii. 0011 + 0111
- iii. 1111 + 0111

- A) (i) only
- B) (ii) only
- C) (iii) only
- D) (i) and (iii) only

[gate2004-it](#) [digital-logic](#) [number-representation](#) [normal](#)

Answer**6.23.33 Number Representation: GATE2002_1.21** [top](#)<http://gateoverflow.in/826>

In 2's complement addition, overflow

- A. is flagged whenever there is carry from sign bit addition
- B. cannot occur when a positive value is added to a negative value
- C. is flagged when the carries from sign bit and previous bit match
- D. None of the above

[gate2002](#) [digital-logic](#) [number-representation](#) [normal](#)

Answer**6.23.34 Number Representation: GATE2006-IT-7, ISRO2009-41** [top](#)<http://gateoverflow.in/3546>

The addition of 4-bit, two's complement, binary numbers 1101 and 0100 results in

- A. 0001 and an overflow
- B. 1001 and no overflow
- C. 0001 and no overflow
- D. 1001 and an overflow

[gate2006-it](#) [digital-logic](#) [number-representation](#) [normal](#) [isro2009](#)

Answer**6.23.35 Number Representation: GATE2007-IT_42** [top](#)<http://gateoverflow.in/3477>

$$(C012.25)_H - (10111001110.101)_B =$$

- A) (135103.412)o
- B) (564411.412)o
- C) (564411.205)o
- D) (135103.205)o

[gate2007-it](#) [digital-logic](#) [number-representation](#) [normal](#)

Answer**6.23.36 Number Representation: GATE2004_19** [top](#)<http://gateoverflow.in/1016>

If 73_x (in base-x number system) is equal to 54_y (in base y-number system), the possible values of x and y are

- A. 8, 16
- B. 10, 12
- C. 9, 13
- D. 8, 11

[gate2004](#) [digital-logic](#) [number-representation](#) [easy](#)

[Answer](#)

6.23.37 Number Representation: GATE2004_28 [top](#)

<http://gateoverflow.in/1025>

What is the result of evaluating the following two expressions using three-digit floating point arithmetic with rounding?

$$(113. + -111.) + 7.51$$

$$113. + (-111. + 7.51)$$

- A. 9.51 and 10.0 respectively
- B. 10.0 and 9.51 respectively
- C. 9.51 and 9.51 respectively
- D. 10.0 and 10.0 respectively

[gate2004](#) [digital-logic](#) [number-representation](#) [normal](#)

[Answer](#)

6.23.38 Number Representation: GATE2008-IT_15 [top](#)

<http://gateoverflow.in/3275>

A processor that has carry, overflow and sign flag bits as part of its program status word (PSW) performs addition of the following two 2's complement numbers 01001101 and 11101001. After the execution of this addition operation, the status of the carry, overflow and sign flags, respectively will be:

- | | |
|----|---------|
| A) | 1, 1, 0 |
| B) | 1, 0, 0 |
| C) | 0, 1, 0 |
| D) | 1, 0, 1 |

[gate2008-it](#) [digital-logic](#) [number-representation](#) [normal](#)

[Answer](#)

6.23.39 Number Representation: GATE2004_66 [top](#)

<http://gateoverflow.in/1060>

Let A = 1111 1010 and B = 0000 1010 be two 8-bit 2's complement numbers. Their product in 2's complement is

- A. 1100 0100
- B. 1001 1100
- C. 1010 0101
- D. 1101 0101

[gate2004](#) [digital-logic](#) [number-representation](#) [easy](#)
[Answer](#)

6.23.40 Number Representation: GATE2009-5 [top](#)

<http://gateoverflow.in/1297>

$(1217)_8$ is equivalent to

- A. $(1217)_{16}$
- B. $(028F)_{16}$
- C. $(2297)_{10}$
- D. $(0B17)_{16}$

[gate2009](#) [digital-logic](#) [number-representation](#)
[Answer](#)

6.23.41 Number Representation: GATE2014-2_45 [top](#)

<http://gateoverflow.in/2011>

The value of a

float type variable is represented using the single-precision 32-bit floating point format of IEEE-754 standard that uses 1 bit for sign, 8 bits for biased exponent and 23 bits for mantissa. A

float type variable

X is assigned the decimal value of -14.25 . The representation of

X in hexadecimal notation is

- (A) C1640000H
- (B) 416C0000H
- (C) 41640000H
- (D) C16C0000H

[gate2014-2](#) [digital-logic](#) [number-representation](#) [normal](#)
[Answer](#)

Answers: Number Representation

6.23.1 Number Representation: TIFR2011-A-16 [top](#)

<http://gateoverflow.in/20253>

Selected Answer

As there are only 13 possible values variable can take, we can use $\text{ceil}[\lg 13] = 4$ bits.
need to worry what those values are. Answer :- Option D

As variable can take only 13 values we don't

2 votes

-- Akash (31.7k points)

6.23.2 Number Representation: GATE 2016-2-09 [top](#)

<http://gateoverflow.in/39546>

Selected Answer

For N bits, Distinct values represented in 2's complement is -2^{n-1} to $2^{n-1} - 1$

Distinct values represented in Signed Magnitude is $-(2^{n-1} - 1)$ to $2^{n-1} - 1$

Difference is 1.

17 votes

-- Sharathkumar Anbu (697 points)

6.23.3 Number Representation: GATE2005-IT_47 [top](#)<http://gateoverflow.in/3808>

Selected Answer

Simply Convert 34.4 and 23.4 to decimal. We can do this by this method :

$34.4 = 28.5$ in decimal and $23.4 = 19.5$ in decimal.

Multiplying $28.5 \times 19.5 = 555.75$

Now convert 555.75 back to octal which is 1053.6.

$\xleftrightarrow{(34.4)_8}$ to decimal.

$$\begin{aligned} &= 3 \times 8^1 + 4 \times 8^0 + 4 \times 8^{-1} \\ &= 24 + 4 + \frac{1}{2} = (28.5)_{10} \end{aligned}$$

$\xleftrightarrow{(23.4)_8}$ to decimal

$$\begin{aligned} &= 2 \times 8^1 + 3 \times 8^0 + 4 \times 8^{-1} \\ &= (19.5)_{10} \end{aligned}$$

$$(19.5)_{10} \times (28.5)_{10} = (555.75)_{10}$$

Now, $(555.75)_{10} \rightarrow (?)_8$

To convert the integer part,

$$\begin{array}{r} 555 \\ 8 | \overline{69} - 3 \\ 8 | \overline{8} - 5 \\ 8 | \overline{1} - 0 \\ \hline 0 - 1 \end{array}$$

To convert the decimal part, keep multiplying by 8 till decimal part becomes '0'.

$0.75 \times 8 \rightarrow 0.00$ ↓
 ↑ zero decimal part
 take up the integral part.

$$\therefore (555.75)_{10} = (1053.6)_8$$

11 votes

-- Afaque Ahmad (907 points)

6.23.4 Number Representation: GATE1991_01,iii [top](#)<http://gateoverflow.in/500>

Selected Answer

Hex representation of given no. is $(9753)_{16}$

Its binary representation is $(1001\ 0111\ 0101\ 0011)_2$

The no. of 1's is 9

11 votes

-- Keith Kr (6k points)

6.23.5 Number Representation: GATE2008-6 [top](#)

<http://gateoverflow.in/404>



Selected Answer

$$\sqrt{(121)_r} = 11_r$$

$$\sqrt{(1 * r^0) + (2 * r^1) + (1 * r^2)} = (1 * r^0) + (1 * r^1)$$

$$\sqrt{(1+r)^2} = 1+r$$

$$1+r = 1+r$$

So any integer r satisfies this but r must be > 2 as we have 2 in 121 and radix must be greater than any of the digits. **(D) is the most appropriate answer**

17 votes

-- Keith Kr (6k points)

6.23.6 Number Representation: GATE2000-1.6 [top](#)

<http://gateoverflow.in/629>



Selected Answer

2's complement representation is not same as 2's complement of a number. In 2's complement representation positive integers are represented in its normal binary form while negative numbers are represented in its 2's complement form. So (c) is correct here.

http://www.ele.uri.edu/courses/ele447/proj_pages/divid/twos.html

11 votes

-- Arjun Suresh (150k points)

6.23.7 Number Representation: GATE2000-2.14 [top](#)

<http://gateoverflow.in/661>



Selected Answer

Given 32 bits representation. So, the maximum precision can be 32 bits (In 32-bit IEEE representation, maximum precision is 24 bits but we take best case here). This means approximately 10 digits.

$$A = 2.0 * 10^{30}, C = 1.0$$

So, A + C should make the 31st digit to 1, which is surely outside the precision level of A (it is 31st digit and not 31st bit). So, this addition will just return the value of A which will be assigned to Y.

So, Y + B will return 0.0 while X + C will return 1.0.

B choice.

Sample program if any one wants to try:

```
#include<stdio.h>
int main()
{
    float a = 2.0e30;
    float b = -2.0e30;
    float c = 1.0;
    float y = a+c;
    printf("a = %0.25f y = %0.25f\n",a, y);
    y = y + b;
    float x = a + b;
    printf("x = %0.25f\n",x);
    x = x + c;
    printf("x = %0.25f\n",x);
```

{ }

8 votes

-- Arjun Suresh (150k points)

6.23.8 Number Representation: GATE2015-3_35 [top](#)

<http://gateoverflow.in/8494>



Selected Answer

$$(43)_x = (y3)_8$$

Since a number in base $-k$ can only have digits from 0 to $(k - 1)$, we can conclude that: $x \geq 5$ and $y \leq 7$

Now, the original equation, when converted to decimal base gives:

$$\begin{aligned} 4x^1 + 3x^0 &= y(8^1) + 3(8^0) \\ 4x + 3 &= 8y + 3 \\ x &= 2y \end{aligned}$$

So, we have the following constraints:

$$x \geq 5, y \leq 7, x = 2y, y \text{ are integers}$$

The set of values of (x, y) that satisfy these constraints are:

$$\underline{(x, y)}$$

- (6, 3)
- (8, 4)
- (10, 5)
- (12, 6)
- (14, 7)

I am counting 5 pairs of values.

22 votes

-- Praveen Saini (38.4k points)

6.23.9 Number Representation: GATE 2016-1-07 [top](#)

<http://gateoverflow.in/39649>



Selected Answer

Answer = -11..

Take one's complement and add 1 we get 11, and as it is negative number we get answer as -11

18 votes

-- Abhilash Panicker (7k points)

6.23.10 Number Representation: GATE2003_9 [top](#)

<http://gateoverflow.in/900>



Selected Answer

MSB of 2's compliment number has a weight of -2^{n-1} .

(Trick: (from reversing sign extension) just skip all leading 1's from MSB expect but 1, and then calculate the value as normal signed binary rep.)

so by calculating, we get the given number is -5 in decimal. and options are

- a. -25
- b. -28
- c. -41
- d. -37

Therefore it is clear that - 25 is divisible by - 5. so we can say that (a.) is correct. 😊

Upvote 6 votes

-- Nitin Sharma (437 points)

6.23.11 Number Representation: GATE2001-2.10 [top](#)

<http://gateoverflow.in/728>



Selected Answer

$$\begin{aligned} 539 &= 512 + 16 + 8 + 2 + 1 = 2^9 + 2^4 + 2^3 + 2^1 + 2^0 \\ &= (1000011011)_2 \end{aligned}$$

Now all answers have 12 bits, so we add two 0's at beginning = (001000011011)₂

To convert to 2's complement invert all bits till the rightmost 1, which will be (110111100101)₂

$$= (1101\ 1110\ 0101)_2$$

$$= (\text{DE5})_{16}$$

Upvote 10 votes

-- Arjun Suresh (150k points)

6.23.12 Number Representation: GATE2005-16, ISRO2009-18, ISRO2015-2 [top](#)

<http://gateoverflow.in/1352>



Selected Answer

An n-bit two's-complement numeral system can represent every integer in the range $-(2^{n-1})$ to $+(2^{n-1}-1)$.

while ones' complement can only represent integers in the range $-(2^{n-1}-1)$ to $+(2^{n-1}-1)$.

A is answer

Upvote 3 votes

-- kvkumar (2.9k points)

6.23.13 Number Representation: GATE2014-2_8 [top](#)

<http://gateoverflow.in/1961>



Selected Answer

Converting both sides to decimal,

$$25+10+3=x*y+8$$

$$\text{So } xy=30$$

Possible pairs are (1,30), (2,15), (3,10) as the minimum base should be greater than 8.

Upvote 14 votes

-- Tejas Jaiswal (511 points)

6.23.14 Number Representation: GATE2010-8 [top](#)

<http://gateoverflow.in/2179>



Selected Answer

Multiplication can be directly carried in 2's complement form. $F87B = 1111\ 1000\ 0111\ 1011$ can be left shifted 3 times to give $8P = 1100\ 0011\ 1101\ 1000 = C3D8$.

Or, we can do as follows:

MSB in ($F87B$) is 1. So, P is a negative number. So, $P = -1 * 2's \ complement \ of \ (F87B) = -1 * (0785) = -1 * (0000\ 0111\ 1000\ 0101)$

$$8 * P = -1 * (0011\ 1100\ 0010\ 1000) \text{ (P in binary left shifted 3 times)}$$

In 2's complement representation , this equals, $1100\ 0011\ 1101\ 1000 = C3D8$

12 votes

-- Arjun Suresh (150k points)

6.23.15 Number Representation: GATE2006_39 [top](#)

<http://gateoverflow.in/1815>



Selected Answer

Number representation in 2's complement representation:

- Positive numbers as it is
- Negative numbers in 2's complement form.

So, the overflow conditions are

1. When we add two positive numbers (sign bit 0) and we get a sign bit 1
2. When we add two negative numbers (sign bit 1) and we get sign bit 0
3. **When we add two unsigned numbers and there is an out carry (from MSB position).**

PS: When we add one positive and one negative number we won't get a carry.

Now the question is a bit tricky. It is actually asking the condition of overflow of any number (both signed and unsigned) when we use an adder which is meant to work only for unsigned numbers.

So, if we see the options, B is the correct one here as the first part takes care of case 2 (negative numbers) and the second part takes care of case 1 (positive numbers). We can see a counter example each for other options:

A - Let $n = 4$ and we do $0111 + 0111 = 1110$. This overflows as in 2's complement representation we can store only up to 7. But the overflow condition in A returns false as $c_{out} = 0$.

C - This works for the above example. But fails for $1001 + 0001 = 1010$ where there is no actual overflow ($-7 + 1 = -6$), but the given condition gives an overflow as $c_{out} = 0$ and $c_{n-1} = 1$.

D - This works for both the above examples, but fails for $1111 + 1111 = 1110$ ($-1 + -1 = -2$) where there is no actual overflow but the given condition says so.

Ref: http://www.mhhe.com/engcs/electrical/hamacher/5e/graphics/ch02_025-102.pdf

Thanks @Dilpreet for the link and correction.

14 votes

-- Digvijay (35.8k points)

6.23.16 Number Representation: GATE2014-1_8 [top](#)

<http://gateoverflow.in/1766>



Selected Answer

Let ' x' ' be the base or radix of the number system .

$$\text{The equation is : } (3.x^2 + 1.x^1 + 2.x^0) / (2.x^1 + 0.x^0) = 1.x^1 + 3.x^0 + 1.x^{-1}$$

$$\Rightarrow (3.x^2 + x + 2) / (2.x) = x + 3 + 1/x$$

$$\Rightarrow (3x^2 + x + 2) / (2x) = (x^2 + 3x + 1) / x$$

By solving above quadratic equation you will get **x=0 and x=5**

As base or radix of a number system cannot be zero, **here x = 5**

10 votes

-- vinodmits (367 points)

6.23.17 Number Representation: GATE1998_2.20 [top](#)



Selected Answer

I assume byte addressable memory- nothing smaller than a byte can be used.

We have four digits. So, to represent signed 4 digit numbers we need 5 bytes- 4 for four digits and 1 for the sign (like -7354). So, required memory = 5 bytes

Now, if we use integer, the largest number needed to represent is 9999 and this requires 2 bytes of memory for signed representation.

$$\text{So, memory savings while using integer is } \frac{(5-2)}{5} = \frac{3}{5} = 60\%$$

5 votes

-- Arjun Suresh (150k points)

6.23.18 Number Representation: GATE1997_5.4 [top](#)



Selected Answer

$$\sqrt{(224)_r} = (13)_r$$

convert r base to decimal

$$\sqrt{2r^2 + 2r + 4} = r + 3$$

take square both sides

$$2r^2 + 2r + 4 = r^2 + 6r + 9$$

$$r^2 - 4r - 5 = 0$$

$$r^2 - 5r + r - 5 = 0$$

$$(r-5)(r+1)=0$$

r can not be -1 so

r = 5 is correct answer

7 votes

-- Praveen Saini (38.4k points)

6.23.19 Number Representation: GATE1998_1.17 [top](#)



Selected Answer

$$(3\ 4\ 2)_8 = (011\ 100\ 010)_2 = (11100010)_2.$$

If we treat this as an 8 bit integer, the first bit becomes sign bit and since it is "1", number is negative. Computer uses 2's complement representation for negative numbers and hence the decimal equivalent will be $-(0001110)_2 = -30$.

4 votes

-- Arjun Suresh (150k points)

6.23.20 Number Representation: GATE1993_6.5 [top](#)<http://gateoverflow.in/2286>

Selected Answer

a. $1 * 2^2 + 1 * 2^1 + 0 * 2^0 + 1 * 2^{-1} + 0 * 2^{-2} + 1 * 2^{-3} = 6.625$

b. $1118 \text{ mod } 16 = 14$, quotient = 69
 $69 \text{ mod } 16 = 5$, quotient = 4
 $4 \text{ mod } 16 = 4$.

Writing the mods in the reverse order (in hex) gives $(45E)_H$

Both can be done using calculator also.

5 votes

-- Arjun Suresh (150k points)

6.23.21 Number Representation: GATE1999_2.17 [top](#)<http://gateoverflow.in/1495>

Selected Answer

A and C

Sign Magnitude

$+0 = 0000$
 $-0 = 1000$

1's complement
 $+0 = 0000$
 $-0 = 1111$

http://cs.anu.edu.au/courses/ENGN3213/Documents/PROJECT_READING_MATERIAL/Binary%20Representation%20and%20Com

10 votes

-- neelansh (311 points)

6.23.22 Number Representation: GATE2013_4 [top](#)<http://gateoverflow.in/1413>

Selected Answer

Range of 2's compliment no = $> (-2^{n-1})_{10} + (2^{n-1} - 1)$

Here n = No of bits = 8.

So minimum no = $-2^7 = (B) -128$

10 votes

-- Akash (31.7k points)

6.23.23 Number Representation: GATE1994_2.7 [top](#)<http://gateoverflow.in/2474>

Selected Answer

$-2^{n-1} \leq N \leq 2^{n-1} - 1$

Example : let we have 3 bit binary no (unsigned)

000 (0) to 111(7) total of 8 (2^3) no.

but when we have one signed bit then we have half of negative -4 to -1 and 0 and 1 to 3

| | | | | | | | | |
|--------------|-----|-----|-----|-----|-----|-----|-----|-----|
| bit pattern: | 100 | 101 | 110 | 111 | 000 | 001 | 010 | 011 |
| 1's comp: | -3 | -2 | -1 | 0 | 0 | 1 | 2 | 3 |
| 2's comp.: | -4 | -3 | -2 | -1 | 0 | 1 | 2 | 3 |

11 votes

-- Praveen Saini (38.4k points)

6.23.24 Number Representation: GATE2005_17 [top](#)

<http://gateoverflow.in/1353>



Selected Answer

$$657_8 = (110\ 101\ 111)_2 = (1\ [10\ 10]\ [1\ 111])_2 = (1AF)_{16}$$

6 votes

-- Arjun Suresh (150k points)

6.23.25 Number Representation: GATE1995-2.12, ISRO2015-9 [top](#)

<http://gateoverflow.in/2624>



Selected Answer

I suggest following approach , here we can clearly see that numbers are getting multiplied by powers of 16. So this is nothing but Hexadecimal number in disguise.

$$(3 \times 4096 + 15 \times 256 + 5 \times 16 + 3) = (3F53)_{16} = (001111101010011)_2 \text{ which has total } 2+4+2+2=10 \text{ 1's}$$

19 votes

-- Akash (31.7k points)

6.23.26 Number Representation: GATE1995_18 [top](#)

<http://gateoverflow.in/2655>

A=16-N

B=REM

C=N/2

1 votes

-- Shaun Patel (5.8k points)

6.23.27 Number Representation: GATE1996_1.25 [top](#)

<http://gateoverflow.in/2729>



Selected Answer

Here, we are asked "magnitude" - so we just need to consider the mantissa bits.

Also, we are told "normalized representation"- so most significant bit of mantissa is always 1 (this is different from IEEE 754 normalized representation where this 1 is omitted in representation, but here it seems to be added on the right of decimal point as seen from options).

So, the maximum value of mantissa will be 23 1's where a decimal point is assumed before first 1. So, this value will be $1 - 2^{-23}$.

Due to the 1 in normalized representation, the smallest positive number will be 1 followed by 23 0's which will be $2^{-1} = 0.5$.

So ans d.

7 votes

-- Pooja (25.9k points)

6.23.28 Number Representation: GATE2002_9 [top](#)

<http://gateoverflow.in/862>

Here, mantissa is represented in normalized representation and exponent in excess-64 (subtract 64 to get actual value).

a. We have to represent $-(7.5)_{10} = -(111.1)_2$.

Now we are using base 16 for exponent. So, mantissa will be .01111 and this makes exponent as 1 (4 bit positions and no hiding first 1 as in IEEE 754) which in excess-64 will be $64 + 1 = 65$. Number being negative sign bit is 1. So, we get

$$(1 \underbrace{01111}_{19 \text{ zeroes}} 000 \dots 0 1000001)_2 = (BC000041)_{16}$$

b. Largest value will be with largest possible mantissa, largest possible exponent and positive sign bit. So, this will be all 1's except sign bit which will be

$$\underbrace{1.111 \dots 1}_{24 \text{ ones}} \times 16^{127-64} = (1 - 2^{24}) \times 16^{63} = (1 - 2^{24}) \times 16^{63}$$

$$2^x = 10^y \implies y = \log 2^x = x \log 2$$

So,

$$(1 - 2^{24}) \times 16^{63} = (1 - 10^{24 \log 2}) \times 10^{63 \log 16} = (1 - 10^7) \times 10^{76} \text{ which can be approximated as } 10^{76}.$$

Not directly relevant here, but a useful read: <https://jeapostrophe.github.io/courses/2015/fall/305/notes/dist/reading/help-floating-point.pdf>

4 votes

-- Arjun Suresh (150k points)

6.23.29 Number Representation: GATE2002_1.14 [top](#)

<http://gateoverflow.in/818>



Selected Answer

1st Multiplication Iteration

Multiply 0.25 by 2

$$0.25 \times 2 = 0.50 \text{ (Product)} \quad \text{Fractional part} = 0.50 \quad \text{Carry} = 0 \quad (\text{MSB})$$

2nd Multiplication Iteration

Multiply 0.50 by 2

$$0.50 \times 2 = 1.00 \text{ (Product)} \quad \text{Fractional part} = 1.00 \quad \text{Carry} = 1 \text{ (LSB)}$$

The fractional part in the 2nd iteration becomes zero and hence we stop the multiplication iteration.

Carry from the 1st multiplication iteration becomes **MSB** and carry from 2nd iteration becomes **LSB**

So the Result is 0.01

8 votes

-- shekhar chauhan (36.4k points)

6.23.30 Number Representation: GATE2002_1.15 [top](#)

<http://gateoverflow.in/819>



Selected Answer

D) is the correct ans.In 2's complement representation, positive numbers are represented in simple binary form and negative numbers are represented in its 2's complement form. So, for -15, we have to complement its binary value - 01111 and add a 1 to it, which gives 10001. Option D.

10 votes

-- Ujjwal Saini (401 points)

6.23.31 Number Representation: GATE2004-IT_43 [top](#)

<http://gateoverflow.in/3686>

Selected Answer

$$(123456)_8 = (001\ 010\ 011\ 100\ 101\ 110)_2 = (00\ 1010\ 0111\ 0010\ 1110)_2 = (A72E)_{16}$$

$$= (00\ 10\ 10\ 01\ 11\ 00\ 10\ 11\ 10)_2 = (22130232)_4$$

So, option (A)

11 votes

-- Arjun Suresh (150k points)

6.23.32 Number Representation: GATE2004-IT_42 [top](#)

<http://gateoverflow.in/3685>

Selected Answer

Only (ii) is the answer.

In 2's complement arithmetic, overflow happens only when

1. Sign bit of two input numbers is 0, and the result has sign bit 1
2. Sign bit of two input numbers is 1, and the result has sign bit 0.

Overflow is important only for signed arithmetic while carry is important only for unsigned arithmetic.

A carry happens when there is a carry to (or borrow from) the most significant bit. Here, (i) and (iii) cause a carry but only (ii) causes overflow.

http://teaching.idallen.com/dat2343/10f/notes/040_overflow.txt

10 votes

-- Arjun Suresh (150k points)

6.23.33 Number Representation: GATE2002_1.21 [top](#)

<http://gateoverflow.in/826>

Selected Answer

(B) is the answer. When a positive value and negative value are added overflow never happens.

<http://sandbox.mc.edu/~bennet/cs110/tc/orules.html>

13 votes

-- Arjun Suresh (150k points)

6.23.34 Number Representation: GATE2006-IT-7, ISRO2009-41 [top](#)

<http://gateoverflow.in/3546>

Selected Answer

Answer: C

The addition results in 0001 and no overflow with 1 as carry bit.

In 2's complement addition Overflow happens only when :

- Sign bit of two input numbers is 0, and the result has sign bit 1.
- Sign bit of two input numbers is 1, and the result has sign bit 0.

18 votes

-- Rajarshi Sarkar (29.7k points)

6.23.35 Number Representation: GATE2007-IT_42 [top](#)

<http://gateoverflow.in/3477>



Selected Answer

$$(C012.25)_H - (10111001110.101)_B$$

$$= 1100\ 0000\ 0001\ 0010.\ 0010\ 0101$$

$$- 0000\ 0101\ 1100\ 1110.\ 1010\ 0000$$

$$= 1011\ 1010\ 0100\ 0011.\ 1000\ 0101$$

$$= 1\ 011\ 101\ 001\ 000\ 011.\ 100\ 001\ 010$$

$$= (135103.412)_O$$

Binary subtraction is like decimal subtraction: 0-0 = 0, 1-1 = 0, 1-0 = 1, 0-1 = 1 with 1 borrow.

13 votes

-- Arjun Suresh (150k points)

6.23.36 Number Representation: GATE2004_19 [top](#)

<http://gateoverflow.in/1016>



Selected Answer

ans d)

$$x * 7 + 3 = 5 * y + 4 \Rightarrow 7x = 5y + 1.$$

Only option satisfying this is D.

8 votes

-- Aditi Dan (5.4k points)

6.23.37 Number Representation: GATE2004_28 [top](#)

<http://gateoverflow.in/1025>



Selected Answer

$$(113. + -111.) = 1.13 * 10^2 + -1.11 * 10^2 = 0.02 * 10^2 = 2.0 * 10^0$$

$$2.0 * 10^0 + 7.51 * 10^0 = 9.51 * 10^0$$

$$(-111. + 7.51) = -1.11 * 10^2 + 7.51 * 10^0 = -1.1 * 10^2 + 0.08 * 10^2 = -1.03 * 10^2$$

$$113. + -1.03 * 10^2 = 1.13 * 10^2 + -1.03 * 10^2 = 0.1 * 10^2 = 10.0$$

Ref: <https://www.doc.ic.ac.uk/~eedwards/compsys/float/>

10 votes

-- Arjun Suresh (150k points)

6.23.38 Number Representation: GATE2008-IT_15 [top](#)

<http://gateoverflow.in/3275>



Selected Answer

Answer: B

$$\begin{array}{r} 01001101 \\ + 11101001 \\ \hline 100110110 \end{array}$$

Carry = 1

Overflow = 0 (In 2's complement addition Overflow happens only when : Sign bit of two input numbers is 0, and the result has sign bit 1 OR Sign bit of two input numbers is 1, and the result has sign bit 0.)

Sign bit = 0

11 votes

-- Rajarshi Sarkar (29.7k points)

6.23.39 Number Representation: GATE2004_66 [top](#)

<http://gateoverflow.in/1060>



Selected Answer

$$\begin{aligned} A &= 1111\ 1010 = -6 \\ B &= 0000\ 1010 = 10 \\ A*B &= -60 \\ &= 1100\ 0100 \end{aligned}$$

7 votes

-- Digvijay (35.8k points)

6.23.40 Number Representation: GATE2009-5 [top](#)

<http://gateoverflow.in/1297>



Selected Answer

$$\begin{aligned} (1217)_8 &= (001\ 010\ 001\ 111)_8 \\ \text{Grouping by 4 bits} \\ (0010\ 1000\ 1111)_{16} &= (28F)_{16} \end{aligned}$$

Answer is B.

11 votes

-- Sona Praneeth Akula (3.8k points)

6.23.41 Number Representation: GATE2014-2_45 [top](#)

<http://gateoverflow.in/2011>



Selected Answer

Floating Point Format

Floating point format is always stored in memory with 3 fields of information:

The diagram illustrates the floating-point format. It shows the conversion of a normalized mantissa $(1.m) \times 2^{e-\text{bias}}$ into memory. The memory representation consists of three fields: Sign (1 bit), Biased exponent (8 bits), and mantissa (52 bits). The sign bit is 0 for positive numbers. The biased exponent is the actual exponent plus a bias (127 for IEEE 754). The mantissa is stored in memory in a normalized format, where the first bit is implicitly 1. A table shows the memory states for different combinations of sign, biased exponent, and mantissa.

| S | BE | M | Value |
|-----|---------|----------|-------|
| 0/1 | All 0's | All 0's | 0 |
| 0 | All 1's | All 0's | +∞ |
| 1 | All 1's | All 0's | -∞ |
| 0/1 | All 1's | Non zero | Nan |

Bias = $2^{N-1} - 1$
N = number of bits to represent exponent in binary

$14.25 = 1110.01000 = 1.11001000 \times 2^3$

biased exponent = actual + bias = 3 + bias
where; bias = $2^{8-1} - 1 = 127$
biased exponent = 3+127 = 130 = 10000010

Therefore, number represented as = **1 1000010 11001000000000000000000000000000**

on converting to hexadecimal we get = $(C1640000)_{16}$

6 votes -- Amar Vashishth (20.7k points)

6.24**Priority Encoder** top**6.24.1 Priority Encoder: GATE1992-4,b** top<http://gateoverflow.in/31577>

A priority encoder accepts three input signals (A, B and C) and produce a two-bit output (X_1, X_0) corresponding to the highest priority active input signal. Assume A has the highest priority followed by B and C has the lowest priority. If none of the inputs are active the output should be 00. Design the priority encoder using 4:1 multiplexers as the main components.

[gate1992](#) [digital-logic](#) [priority-encoder](#) [normal](#)

Answer

Answers: Priority Encoder**6.24.1 Priority Encoder: GATE1992-4,b** top<http://gateoverflow.in/31577>

we know the truth table of priority encoder .

| x_3 | x_2 | x_1 | x_0 | y_1 | y_0 |
|-------|-------|-------|-------|-------|-------|
| 1 | x | x | x | 1 | 1 |
| 0 | 1 | x | x | 1 | 0 |
| 0 | 0 | 1 | x | 0 | 1 |
| 0 | 0 | 0 | x | 0 | 0 |

now we have a multiplexer. we need to do selection in a abnormal way. means we have to play with select lines . and we have 2 output from the above function. relize them and then give input to the select line of muxs.

$$y_1 = i_3 + i_2$$

$$y_0 = i_3 + i_2' i_1$$

now make y1 as s1 select line .and y0 as s0.

1 votes

-- Ravi Singh (8.2k points)

6.25

Ram top

6.25.1 Ram: GATE2005-IT_9 top

<http://gateoverflow.in/3754>

A dynamic RAM has a memory cycle time of 64 nsec. It has to be refreshed 100 times per msec and each refresh takes 100 nsec. What percentage of the memory cycle time is used for refreshing?

- A. 10
- B. 6.4
- C. 1
- D. 0.64

gate2005-it digital-logic ram normal

Answer

6.25.2 Ram: GATE2010-7 top

<http://gateoverflow.in/2178>

A main memory unit with a capacity of 4 megabytes is built using $1M \times 1$ -bit DRAM chips. Each DRAM chip has 1K rows of cells with 1K cells in each row. The time taken for a single refresh operation is 100 nanoseconds. The time required to perform one refresh operation on all the cells in the memory unit is

- A. 100 nanoseconds
- B. 100×2^{10} nanoseconds
- C. 100×2^{20} nanoseconds
- D. 3200×2^{20} nanoseconds

gate2010 digital-logic ram normal

Answer

Answers: Ram

6.25.1 Ram: GATE2005-IT_9 top

<http://gateoverflow.in/3754>



Selected Answer

Ans : C) 1

In 1 msec — refresh 100 times
 In 64 nsec — refresh $\frac{100}{10^{-3}} \times 64 \times 10^{-9}$ times
 $= 10^5 \times 10^{-9} \times 64 = 64 \times 10^{-4}$ times.
 In 1 memory cycle, refresh 64×10^{-4} times.
 1 Refresh takes 100 nsec.
 64×10^{-4} refreshes takes $= 100 \times 10^{-9} \times 64 \times 10^{-4}$
 $= 64 \times 10^{-11}$ sec.
 $\therefore \% \text{ time} = \frac{\text{refreshing time in 1 cycle}}{\text{total time}} \times 100$
 $= \frac{64 \times 10^{-11}}{64 \times 10^{-9}} \times 100$
 $= \frac{1}{10^2} \times 10^6 = 1\%$.

9 votes

-- Afaque Ahmad (907 points)

6.25.2 Ram: GATE2010-7 top<http://gateoverflow.in/2178>

Selected Answer

There are $4 \times 8 = 32$ DRAM chips to get 4MB from $1M \times 1$ -bit chips. Now, all chips can be refreshed in parallel so do all cells in a row. So, the total time for refresh will be number of rows times the refresh time

$$= 1K \times 100$$

$$= 100 \times 2^{10} \text{ nanoseconds}$$

Ref: <http://www.downloads.reactivemicro.com/Public/Electronics/DRAM/DRAM%20Refresh.pdf>

10 votes

-- Arjun Suresh (150k points)

7

Discrete Mathematics Combinatorics (37) [top](#)

7.0.1 GATE2008_24 [top](#)

<http://gateoverflow.in/422>

Let $P = \sum_{\substack{1 \leq i \leq 2k \\ i \text{ odd}}} i$ and $Q = \sum_{\substack{1 \leq i \leq 2k \\ i \text{ even}}} i$, where k is a positive integer. Then

- A. $P = Q - k$
- B. $P = Q + k$
- C. $P = Q$
- D. $P = Q + 2k$

[gate2008](#) [combinatorics](#) [easy](#)

[Answer](#)

7.0.2 GATE1998_1.23 [top](#)

<http://gateoverflow.in/1660>

How many sub strings of different lengths (non-zero) can be found formed from a character string of length n ?

- A. n
- B. n^2
- C. 2^n
- D. $\frac{n(n+1)}{2}$

[gate1998](#) [combinatorics](#) [normal](#)

[Answer](#)

7.0.3 TIFR2015-A-8 [top](#)

<http://gateoverflow.in/29571>

There is a set of $2n$ people: n male and n female. A good party is one with equal number of males and females (including the one where none are invited). The total number of good parties is.

- A. 2^n
- B. n^2
- C. $\left(\frac{n}{n/2}\right)^2$
- D. $\left(\frac{2n}{n}\right)$
- E. None of the above.

[tifr2015](#) [combinatorics](#)

[Answer](#)

7.0.4 TIFR2015-A-7 [top](#)

<http://gateoverflow.in/29568>

A 1×1 chessboard has one (1) square, a 2×2 chessboard has (5) squares. Continuing along this fashion, what is the number of squares on the (regular) 8×8 chessboard?

- A. 64
- B. 65
- C. 204
- D. 144
- E. 256

tifr2015 combinatoric

Answer

7.0.5 TIFR2013-A-9 [top](#)<http://gateoverflow.in/25431>

There are n kingdoms and $2n$ champions. Each kingdom gets 2 champions. The number of ways in which this can be done is:

- a. $\frac{(2n)!}{2^n}$
- b. $\frac{(2n)!}{(2n)}$
- c. $\frac{n!}{2^n \cdot n!}$
- d. $n! / 2$
- e. None of the above.

tifr2013 combinatoric

Answer

7.0.6 TIFR2012-A-10 [top](#)<http://gateoverflow.in/25014>

In how many different ways can r elements be picked from a set of n elements if

- (i) Repetition is not allowed and the order of picking matters?
- (ii) Repetition is allowed and the order of picking does not matter?

- a. $\frac{n!}{(n-r)!}$ and $\frac{(n+r-1)!}{r!(n-1)!}$, respectively.
- b. $\frac{n!}{(n-r)!}$ and $\frac{n!}{r!(n-1)!}$, respectively.
- c. $\frac{n!}{r!(n-r)!}$ and $\frac{(n-r+1)!}{r!(n-1)!}$, respectively.
- d. $\frac{n!}{r!(n-r)!}$ and $\frac{n!}{(n-r)!}$, respectively.
- e. $\frac{n!}{r!}$ and $\frac{r!}{n!}$, respectively.

tifr2012 combinatoric

Answer

7.0.7 GATE2005-IT_46 [top](#)<http://gateoverflow.in/3807>

A line L in a circuit is said to have a stuck-at-0 fault if the line permanently has a logic value 0. Similarly a line L in a circuit is said to have a stuck-at-1 fault if the line permanently has a logic value 1. A circuit is said to have a multiple stuck-at fault if one or more lines have stuck at faults. The total number of distinct multiple stuck-at faults possible in a circuit with N lines is

- | | |
|----|-----------|
| A) | 3^N |
| B) | $3^N - 1$ |
| C) | $2^N - 1$ |
| D) | 2 |

gate2005-it combinatoric normal

Answer

7.0.8 GATE2004-IT_35 [top](#)<http://gateoverflow.in/3678>

In how many ways can we distribute 5 distinct balls, B_1, B_2, \dots, B_5 in 5 distinct cells, C_1, C_2, \dots, C_5 such that Ball B_i is not in cell C_i , $\forall i = 1, 2, \dots, 5$ and each cell contains exactly one ball?

- | | |
|----|------|
| A) | 44 |
| B) | 96 |
| C) | 120 |
| D) | 3125 |

gate2004-it combinatory normal

[Answer](#)

7.0.9 GATE2008-IT_25 [top](#)

<http://gateoverflow.in/3286>

In how many ways can b blue balls and r red balls be distributed in n distinct boxes?

- A) $\frac{(n+b-1)! (n+r-1)!}{(n-1)! b! (n-1)! r!}$
- B) $\frac{(n+(b+r)-1)!}{(n-1)! (n-1)! (b+r)!}$
- C) $\frac{n!}{b! r!}$
- D) $\frac{(n+(b+r)-1)!}{n! (b+r-1)!}$

gate2008-it combinatory normal

[Answer](#)

7.0.10 GATE2008-IT_24 [top](#)

<http://gateoverflow.in/3285>

The exponent of 11 in the prime factorization of $300!$ is

- | | |
|----|----|
| 1) | 27 |
| 2) | 28 |
| 3) | 29 |
| 4) | 30 |

gate2008-it combinatory normal

[Answer](#)

7.0.11 GATE1991-02,iv [top](#)

<http://gateoverflow.in/514>

Match the pairs in the following questions by writing the corresponding letters only.

| | |
|--|------------------------------------|
| (A). The number distinct binary trees with n nodes. | (P). $\frac{n!}{2}$ |
| (B). The number of binary strings of length of $2n$ with an equal number of 0's and 1's. | (Q). $\binom{3n}{n}$ |
| (C). The number of even permutation of n objects. | (R). $\binom{2n}{n}$ |
| (D). The number of binary strings of length $6n$ which are palindromes with $2n$ 0's. | (S). $\frac{1}{1+n} \binom{2n}{n}$ |

gate1991 combinatory normal

Answer**7.0.12 GATE2014-2_49** [top](#)<http://gateoverflow.in/2015>

The number of distinct positive integral factors of 2014 is _____

[gate2014-2](#) [combinatory](#) [easy](#)

Answer**7.0.13 GATE2014-1_49** [top](#)<http://gateoverflow.in/1929>

A pennant is a sequence of numbers, each number being 1 or 2. An n -pennant is a sequence of numbers with sum equal to n . For example, $(1, 1, 2)$ is a 4-pennant. The set of all possible 1-pennants is (1) , the set of all possible 2-pennants is $(2), (1, 1)$ and the set of all 3-pennants is $(2, 1), (1, 1, 1), (1, 2)$. Note that the pennant $(1, 2)$ is not the same as the pennant $(2, 1)$. The number of 10-pennants is _____

[gate2014-1](#) [combinatory](#) [numerical-answers](#) [normal](#)

Answer**7.0.14 GATE1994_1.15** [top](#)<http://gateoverflow.in/2458>

The number of substrings (of all lengths inclusive) that can be formed from a character string of length n is

- A. n
- B. n^2
- C. $\frac{n(n-1)}{2}$
- D. $\frac{n(n+1)}{2}$

[gate1994](#) [combinatory](#) [normal](#)

Answer**7.0.15 GATE1999_2.2** [top](#)<http://gateoverflow.in/1480>

Two girls have picked 10 roses, 15 sunflowers and 15 daffodils. What is the number of ways they can divide the flowers among themselves?

- A. 1638
- B. 2100
- C. 2640
- D. None of the above

[gate1999](#) [combinatory](#) [normal](#)

Answer**7.0.16 GATE2003_5** [top](#)<http://gateoverflow.in/896>

n couples are invited to a party with the condition that every husband should be accompanied by his wife. However, a wife need not be accompanied by her husband. The number of different gatherings possible at the party is

- (A) ${}^{2n}C_n \times 2^n$ (B) 3^n (C) $\frac{(2n)!}{2^n}$ (D) ${}^{2n}C_n$

gate2003 | combinatorics | normal

[Answer](#)

7.0.17 GATE1991-16,a [top](#)

<http://gateoverflow.in/543>

Find the number of binary strings w of length $2n$ with an equal number of $1's$ and $0's$ and the property that every prefix of w has at least as many $0's$ as $1's$.

gate1991 | combinatorics | normal

[Answer](#)

7.0.18 GATE2001-2.1 [top](#)

<http://gateoverflow.in/719>

How many 4-digit even numbers have all 4 digits distinct

- A. 2240
- B. 2296
- C. 2620
- D. 4536

gate2001 | combinatorics | normal

[Answer](#)

7.0.19 GATE2002_13 [top](#)

<http://gateoverflow.in/866>

- In how many ways can a given positive integer $n \geq 2$ be expressed as the sum of 2 positive integers (which are not necessarily distinct). For example, for $n = 3$ the number of ways is 2, i.e., $1+2$, $2+1$. Give only the answer without any explanation.
- In how many ways can a given positive integer $n \geq 3$ be expressed as the sum of 3 positive integers (which are not necessarily distinct). For example, for $n = 4$, the number of ways is 3, i.e., $1+2+1$, $2+1+1$. Give only the answer without explanation.
- In how many ways can a given positive integer $n \geq k$ be expressed as the sum of k positive integers (which are not necessarily distinct). Give only the answer without explanation.

gate2002 | combinatorics | normal

[Answer](#)

7.0.20 GATE1999_1.3 [top](#)

<http://gateoverflow.in/1457>

The number of binary strings of n zeros and k ones in which no two ones are adjacent is

- A. ${}^{n-1}C_k$
- B. nC_k
- C. ${}^nC_{k+1}$
- D. None of the above

gate1999 | combinatorics | normal

[Answer](#)

7.0.21 GATE2003_4 [top](#)

<http://gateoverflow.in/895>

Let A be a sequence of 8 distinct integers sorted in ascending order. How many distinct pairs of sequences, B and C are there such that

- (i) each is sorted in ascending order,
- (ii) B has 5 and C has 3 elements, and
- (iii) the result of merging B and C gives A?

(A) 2 (B) 30 (C) 56 (D) 256

gate2003 combinatory normal

Answer

7.0.22 GATE2007-85 top

<http://gateoverflow.in/43509>

Suppose that a robot is placed on the Cartesian plane. At each step it is allowed to move either one unit up or one unit right, i.e., if it is at (i, j) then it can move to either $(i + 1, j)$ or $(i, j + 1)$.

Suppose that the robot is not allowed to traverse the line segment from $(4, 4)$ to $(5, 4)$. With this constraint, how many distinct paths are there for the robot to reach $(10, 10)$ starting from $(0, 0)$?

- A. 2^9
- B. 2^{19}
- C. ${}^8C_4 \times {}^{11}C_5$
- D. ${}^{20}C_{10} - {}^8C_4 \times {}^{11}C_5$

gate2007 combinatory normal

Answer

7.0.23 GATE2003_34 top

<http://gateoverflow.in/924>

m identical balls are to be placed in n distinct bags. You are given that $m \geq kn$, where k is a natural number ≥ 1 . In how many ways can the balls be placed in the bags if each bag must contain at least k balls?

- (A)** $\binom{m-k}{n-1}$
- (B)** $\binom{m-kn+n-1}{n-1}$
- (C)** $\binom{m-1}{n-k}$
- (D)** $\binom{m-kn+n+k-2}{n-k}$

gate2003 combinatory normal

Answer

7.0.24 GATE2004_75 top

<http://gateoverflow.in/1069>

Mala has the colouring book in which each English letter is drawn two times. She wants to paint each of these 52 prints with one of k colours, such that the colour pairs used to colour any two letters are different. Both prints of a letter can also be coloured with the same colour. What is the minimum value of k that satisfies this requirement?

- A. 9
- B. 8

- C. 7
D. 6

gate2004 | combinatorics | normal

[Answer](#)

7.0.25 GATE2007-84 [top](#)

<http://gateoverflow.in/1275>

Suppose that a robot is placed on the Cartesian plane. At each step it is allowed to move either one unit up or one unit right, i.e., if it is at (i, j) then it can move to either $(i + 1, j)$ or $(i, j + 1)$.

How many distinct paths are there for the robot to reach the point $(10, 10)$ starting from the initial position $(0, 0)$?

- A. ${}^{20}C_{10}$
B. 2^{20}
C. 2^{10}
D. None of the above.

gate2007 | combinatorics | normal

[Answer](#)

Answers:

7.0.1 GATE2008_24 [top](#)

<http://gateoverflow.in/422>



Selected Answer

Substitute $k=3$ then we get $p=9$ and $q=12$ on verifying we get option A.

1 upvote

-- kireeti (1k points)

7.0.2 GATE1998_1.23 [top](#)

<http://gateoverflow.in/1660>



Selected Answer

assuming an string of length n provided all alphabets are distinct..

no of strings of length 1 = n

no of strings of length 2 = $n-1$

no of strings of length 3 = $n-2$

.

.

no of string of length $n = 1$

$$\begin{aligned} \text{total} &= n + (n - 1) + (n - 2) + (n - 3) + \dots + 1 \\ &= n(n+1)/2 \end{aligned}$$

1 upvote

-- Digvijay (35.8k points)

7.0.3 TIFR2015-A-8 [top](#)

<http://gateoverflow.in/29571>

There are n men and n women

Now we can select 1 woman from n women in nC_1

With that 1 man can select nC_1 ways

So, by 1 woman and 1 man we can get ${}^nC_1 * {}^nC_1$ ways.....i

Similarly , Now we can select 2 woman from n women in nC_2

With that 2 man can select nC_2 ways

So, by 2 woman and 2 man we can get ${}^nC_2 * {}^nC_2$ ways.....ii

Now, by n woman and n man we can get ${}^nC_n * {}^nC_n$ ways.....iii

So, by adding these equation we get

$${}^nC_1 * {}^nC_1 + {}^nC_2 * {}^nC_2 + {}^nC_3 * {}^nC_3 + \dots {}^nC_n * {}^nC_n = ({}^{2n}C_n)$$

Ans will be (D)

2 votes

-- srestha (27.8k points)

7.0.4 TIFR2015-A-7 top

<http://gateoverflow.in/29568>



Selected Answer

no of squares on chessboard of $n*n$ is equal to sum of squares of n terms

for $8*8$ chessboard

$$= n(n+1)(2n+1)/6$$

$$= 8*9*17/6$$

$$= 204$$

3 votes

-- Pooja (25.9k points)

7.0.5 TIFR2013-A-9 top

<http://gateoverflow.in/25431>



Selected Answer

Option A is correct.

We have n Kingdoms as k_1, k_2, \dots, k_n .

Firstly we can select 2 champions from $2n$ champions and assign to $k_1 = \binom{2n}{2}$ ways(Say w_1)

Then we can select next 2 champions and assign to $k_2 = \binom{2n-2}{2}$ ways(Say w_2)

and so on..

For last kingdom , we have 2 champions left = $\binom{2}{2}$ ways (say w_n)

Total ways for assigning $2n$ champions to n kingdoms = $w_1 * w_2 * \dots * w_n$

$$\binom{2n}{2} * \binom{2n-2}{2} * \dots * \binom{2}{2} =$$

$= (2n)! / 2^n$ So, Option A (Ans) .

1 5 votes

-- Himanshu Agarwal (9.8k points)

7.0.6 TIFR2012-A-10 [top](#)

<http://gateoverflow.in/25014>



Selected Answer

(i) Repetition is not allowed and the order of picking matters =

$$= r \text{ arrangement with no repetition} = nPr = \frac{n!}{(n-r)!}$$

(ii) Repetition is allowed and the order of picking does not matter =

$$= \text{combination with unlimited repetition} = n-1+rCr = \frac{n-1+r!}{(n-1)!r!}$$

Option A

1 2 votes

-- Umang Raman (11.3k points)

7.0.7 GATE2005-IT_46 [top](#)

<http://gateoverflow.in/3807>



Selected Answer

Answer should be $3^N - 1$.

This is because the total possible combinations (i.e a line may either be at fault (in 2 ways i.e stuck at fault 0 or 1) or it may not be , so there are only 3 possibilities for a line) is 3^N . In only one combination the circuit will have all lines to be correct (i.e not at fault.) Hence $3^N - 1$. (as it has been said that circuit is said to have multiple stuck up fault if one or more line is at fault)

Please Comment , if anyone finds it wrong.

1 12 votes

-- Afaque Ahmad (907 points)

7.0.8 GATE2004-IT_35 [top](#)

<http://gateoverflow.in/3678>



Selected Answer

Use Derangement concept $D_5 = 44$ so answer is A

http://oeis.org/wiki/Number_of_derangements

1 12 votes

-- pratikb (323 points)

7.0.9 GATE2008-IT_25 [top](#)

<http://gateoverflow.in/3286>



Selected Answer

r red balls can be distributed into n distinct boxes in $C(n+r-1, r) = (n+r-1)! / (n-1)! r!$

b blue balls can be distributed in $C(n+b-1, b) = (n+b-1)! / (n-1)! b!$

By product rule total ways are $(n+b-1)! (n+r-1)! / (n-1)! b! (n-1)! r!$

SO THE ANSWER IS A.

12 votes

-- Madhu Veluguri (201 points)

7.0.10 GATE2008-IT_24 [top](#)<http://gateoverflow.in/3285>

Selected Answer

300! is $1*2*3*...*300$

Now there are 27 multiples of 11 from 1 to 300, so they will include 11 as a prime factor atleast once.

121 and 242 will contain an extra 11, all other will contain 11 as a factor only once.

So total number of 11's = $27+2 = 29$.

So exponent of 11 is 29 i.e. option 3)

10 votes

-- Happy Mittal (9.5k points)

7.0.11 GATE1991-02,iv [top](#)<http://gateoverflow.in/514>

Selected Answer

(A) - S Catalyn no http://gatcse.in/wiki/Number_of_Binary_trees_possible_with_n_nodes

(B) - R. Choosing n locations out of $2n$ to place 0. Remaining automatically become 1.

(C) -P An even permutation is a [permutation](#) obtainable from an [even number](#) of two-element swaps, For a set of n elements and $n > 2$, there are $\frac{n!}{2}$ even permutations. Ref -> <http://mathworld.wolfram.com/EvenPermutation.html>

(D) -> Q

Length = $6n$, as it is palindrome, we need to only consider half part.

Total Length to consider $3n$ (Remaining $3n$ will be reverse of this $3n$)

now Choosing n 0's out of $3n$. So Q is correct for D.

5 votes

-- Akash (31.7k points)

7.0.12 GATE2014-2_49 [top](#)<http://gateoverflow.in/2015>

Selected Answer

First do prime factorization of 2014 - $2^1 \times 19^1 \times 53^1$

Now to get a factor of 2014, we can choose any combination of the prime factors including 0. i.e; 2^0 and 2^1 are possible and similarly for other prime factors also, there are 2 possibilities. So, total number of positive integral factors

$$= 2 \times 2 \times 2 = 8$$

(When all the powers of prime factors are 0, we get 1 and when all the powers are maximum, we get the given number.)

7 votes

-- Arjun Suresh (150k points)

7.0.13 GATE2014-1_49 [top](#)<http://gateoverflow.in/1929>

Selected Answer

Let us denote number of n-pennants by $f(n)$, so $f(10)$ is number of 10-pennants.

A 10-pennant means sum of numbers in sequence is 10. If we look at any 9-pennant, we can make it a 10-pennant by adding 1 into that sequence. Similarly, we can make any 8-pennant a 10-pennant by adding 2 into that sequence.

So all 10-pennants can be formed by 8-pennants and 9-pennants, and no other pennant (since we can add only 1 or 2 into a sequence)

$$\text{So } f(10) = f(9) + f(8)$$

This is in fact a fibonacci sequence, in which $F(1) = 1$, $F(2) = 2$, so this sequence becomes

1, 2, 3, 5, 8, 13, 21, 34, 55, 89,..

$$\text{So } f(10) = 89.$$

18 votes

-- Happy Mittal (9.5k points)

7.0.14 GATE1994_1.15 [top](#)

<http://gateoverflow.in/2458>



Selected Answer

no. of substrings of length n is 1

no. of substrings of length n-1 is 2

no. of substrings of length n-2 is 3

$$\text{so } n(n+1)/2$$

7 votes

-- Bhagirathi Nayak (11.3k points)

7.0.15 GATE1999_2.2 [top](#)

<http://gateoverflow.in/1480>



Selected Answer

answer - D

number of ways roses can be distributed - { (0, 10), (1, 9), (2, 8).....(10, 0) } - 11 ways

similarly sunflowers and daffodils can be distributed in 16 ways each

$$\text{total number of ways } 11 \times 16 \times 16 = 2816$$

6 votes

-- ankitrokdeonsns (8.4k points)

7.0.16 GATE2003_5 [top](#)

<http://gateoverflow.in/896>



Selected Answer

Possible outcome for a couple:

1. only wife comes
2. both come
3. none come

Thus 3 possibilities for each couple, so $3 \times 3 \times 3 \times \dots n \text{ times} = 3^n$

15 votes

-- Palash Nandi (1.4k points)

7.0.17 GATE1991-16,a [top](#)

<http://gateoverflow.in/543>

Answer to a is $2nC_n/(n+1)$ which is the Catalan number.

This is also equal to the number of possible combinations of balanced parentheses.

See the 5th proof here http://en.wikipedia.org/wiki/Catalan_number

6 votes

-- Arjun Suresh (150k points)

7.0.18 GATE2001-2.1 [top](#)

<http://gateoverflow.in/719>



Selected Answer

- If the number ends with a 0 then there are 9 choices for the first digit, 8 for the second and 7 for the third, which makes $1 \times 9 \times 8 \times 7 = 504$ possibilities.
- If the number is even ending with something else than 0 then there are 4 choices for the last digit, 8 choices for the first digit (no 0 nor the last digit), 8 for the second digit and 7 for the third digit, which makes $4 \times 8 \times 8 \times 7 = 1792$

Together, this gives 2296 numbers with 4 distinct digits that are even. Note that this does not allow leading 0, as you see to want it based from the question

12 votes

-- yallasrikanthreddy (299 points)

7.0.19 GATE2002_13 [top](#)

<http://gateoverflow.in/866>



Selected Answer

$$\text{a. } n=2 (1+1) \quad n=3(1+2, 2+1) \quad n=4(1+3, 3+1, 2+2) \quad n=5(1+4, 4+1, 2+3, 3+2)$$

so $x_1+x_2=n$, $x_1, x_2 > 0$ (no.of integral sol)

This is same as number of ways of putting $n-2$ (as we can't have 0 for either x_1 or x_2) identical balls into two distinct bins, which is obtained by putting a divider across $n-2$ balls and taking all possible permutations with $n-2$ being identical. i.e., $(n-2 + 1)!/(n-2)! = (n-1)$. We can also use the following formula

$$n-2+2-1 C_{2-1} = n-1 C_1$$

$$\text{b. } n=3(1+1+1) \quad n=4(1+1+2, 1+2+1, 2+1+1) \quad n=5(1+1+3, 1+3+1, 3+1+1, 2+2+1, 2+1+2, 1+2+2)$$

so $x_1+x_2+x_3=n$, $x_1, x_2, x_3 > 0$ (no.of integral sol)

Here, we can permute $n-3$ items with 2 dividers which will give $(n-3 + 2)!/(n-3)!2!$

$$= (n-1)!/(n-1-2)!2!$$

$$= n-1 C_2$$

$$\text{c. } n-k+k-1 C_{k-1} = n-1 C_{k-1}$$

7 votes

-- Supromit Roy (577 points)

7.0.20 GATE1999_1.3 [top](#)

<http://gateoverflow.in/1457>



Selected Answer

answer - D

first place n zeroes side by side _ 0 _ 0 _ 0 ... 0 _

k 1's can be placed in any of the $(n+1)$ available gaps hence number of ways = $n+1C_k$

7 votes

-- ankitrokdeonsns (8.4k points)

7.0.21 GATE2003_4 top

<http://gateoverflow.in/895>



Selected Answer

answer - C

select any 3 elements from given 8 elements - 8C_3

12 votes

-- ankitrokdeonsns (8.4k points)

7.0.22 GATE2007-85 top

<http://gateoverflow.in/43509>



Selected Answer

Say,

r = Move Right and

u = Move Up

so using 10 combination of r and 10 combinations of u moves we get a solution.

Convert the graphical moves to text and one such solution we get =

$\{u, u, u, u, u, u, u, u, u, r, r, r, r, r, r, r, r, r\}$ now all possible arrangements of them is given by =
 $\frac{20!}{10! \times 10!} = {}^{20}C_{10}$

now we need to discard the segment move from

$(4, 4)$ to

$(5, 4)$:

to do that we first calculate how many solutions to our problem to reach
 $(10, 10)$ involves that segment. We'll then subtract those solutions from the total number of solutions.

Number of solutions to reach from $(0,0)$ to $(4,4)$ = all possible arrangements of $\{r, r, r, r, u, u, u, u\}$ =
 $\frac{(4+4)!}{4! \times 4!} = {}^8C_4$

definitely we take the segment $(4,4)$ to $(5,4) = 1$

now, Number of solutions to reach from $(5,4)$ to $(10,10)$ = all possible arrangements of $\{r, r, r, r, r, r, u, u, u, u, u\}$ =
 $\frac{(6+5)!}{6! \times 5!} = {}^{11}C_5$

so required number of solutions for Q.85 is given by **option D**

i.e. = ${}^{20}C_{10} - {}^8C_4 \times 1 \times {}^{11}C_5$

3 votes

-- Amar Vashishth (20.7k points)

7.0.23 GATE2003_34 top

<http://gateoverflow.in/924>



Selected Answer

As there have to be atleast k balls in each bag, so firstly put k balls in each bag i.e $k*n$ balls.

Then now we have total $m-k*n$ balls remaining.

We can use balls & sticks method now !

n bags= n variables, they need to equal to $m-k*n$, no restrictions on how many balls in each bag !

$$x_1 + x_2 + \dots + x_n = m - k*n, x_1, x_2, \dots, x_n \geq 0.$$

So when we solve it

We get

$$C(m - k*n + n - 1, n-1) = C(m - k*n + n - 1, m- k*n)$$

5 votes

-- Akash (31.7k points)

7.0.24 GATE2004_75 [top](#)

<http://gateoverflow.in/1069>



Selected Answer

This question is slightly ambiguous. So first let us understand what question is asking. So in a book, we have letters A-Z and each letter is printed twice, so there are 26 letters. Now we have to color each letter, so we need a pair of colors for that, because each letter is printed twice. Also in a pair, both colors can be same. Now condition is that a pair of colors can't be used more than once.

So suppose Mala has 3 colors : Red, Blue, Green. She can color as follows : 1:(Red,Red), 2:(Blue,Blue), 3:(Green,Green), 4: (Red,Blue), 5: (Red,Green),

6 : (Blue,Green).

Now we don't have more pairs of colors left, we have used all pairs, but could color only 6 letters out of 26. So question is to find minimum no. of colors, so that we could color all 26 letters.

So if Mala has k colors, she can have k pairs of same colors, thus coloring k letters, then $kC2$ other pairs of colors, thus coloring $kC2$ more letters.

$$\text{So total no. of letters colored} = k + \binom{k}{2} = k + k \left(\frac{k-1}{2} \right) = k \left(\frac{k+1}{2} \right).$$

$$\text{So we want } k \left(\frac{k+1}{2} \right) \geq 26 \text{ i.e. } k(k+1) \geq 52 \implies k \geq 7, \text{ so option (C) is correct.}$$

Ref: http://www.cse.iitd.ac.in/~mittal/gate/gate_math_2004.html

9 votes

-- Anu (9k points)

7.0.25 GATE2007-84 [top](#)

<http://gateoverflow.in/1275>



Selected Answer

Q.84

Say, r = Move Right and

u = Move Up

so using 10 combination of r and 10 combinations of u moves we get a solution.

Convert the graphical moves to text and one such solution we get =

$$\{u, u, u, u, u, u, u, u, u, r, r, r, r, r, r, r, r, r\} \text{ now all possible arrangements of them is given by} = \frac{20!}{10! \times 10!} = \binom{20}{10}$$

Hence, **option A** is true.

11 votes

-- Amar Vashishth (20.7k points)

7.1

Binary Tree [top](#)

7.1.1 Binary Tree: GATE2011_29 [top](#)<http://gateoverflow.in/2131>

We are given a set of n distinct elements and an unlabeled binary tree with n nodes. In how many ways can we populate the tree with the given set so that it becomes a binary search tree?

- (A) 0
- (B) 1
- (C) $n!$
- (D) $\frac{1}{n+1} \cdot {}^{2n} C_n$

[gate2011](#) [combinatory](#) [binary-tree](#) [normal](#)
Answer**7.1.2 Binary Tree: GATE2005_35** [top](#)<http://gateoverflow.in/1371>

How many distinct binary search trees can be created out of 4 distinct keys?

- A. 5
- B. 14
- C. 24
- D. 42

[gate2005](#) [combinatory](#) [binary-tree](#) [normal](#)
Answer**Answers: Binary Tree****7.1.1 Binary Tree: GATE2011_29** [top](#)<http://gateoverflow.in/2131>

Selected Answer

Given binary tree is unlabeled . So as it is given we are not allowed to change the formation of tree. Then To make it BST we can use atmost 1 way . As for particular structure we can not use $n!$ arrangement of nodes (Becasue they are lebeled and it is BST not BT)

 10 votes
-- Palash Nandi (1.4k points)
7.1.2 Binary Tree: GATE2005_35 [top](#)<http://gateoverflow.in/1371>

Selected Answer

answer - B

number of distinct BSTs = ${}^{2n} C_n / (n + 1)$

 7 votes
-- ankitrokdeonsns (8.4k points)

7.2

Combinations [top](#)7.2.1 Combinations: TIFR2012-A-7 [top](#)<http://gateoverflow.in/21004>

It is required to divide the $2n$ members of a club into n disjoint teams of 2 members each. The teams are not labelled. The number of ways in which this can be done is:

- a. $\frac{(2n)!}{2^n}$
- b. $\frac{n!}{(2n)!}$
- c. $\frac{(2n)!}{2^n \cdot n!}$
- d. $n!/2$
- e. None of the above.

[tifr2012](#) [combinations](#)[Answer](#)

Answers: Combinations

7.2.1 Combinations: TIFR2012-A-7 [top](#)<http://gateoverflow.in/21004>

Selected Answer

$2n$ member to be n teams with 2 member each and teams are unordered so we can exchange n team member among them.

$$\begin{aligned} &= \frac{(2n)!}{\underbrace{2! \cdot 2! \cdot 2! \cdots 2!}_{n \text{ times}} \cdot n!} \\ &= \frac{(2n)!}{2^n \cdot n!} \end{aligned}$$

Option c.

[Upvote](#) 2 votes

-- Umang Raman (11.3k points)

7.3

Combinatorics [top](#)7.3.1 Combinatorics: GATE2004-IT_34 [top](#)<http://gateoverflow.in/3677>

Let H_1, H_2, H_3, \dots be harmonic numbers. Then, for $n \in \mathbb{Z}^+$, $\sum_{j=1}^n H_j$ can be expressed as

- A) $nH_{n+1} - (n + 1)$
- B) $(n + 1)H_n - n$
- C) $nH_n - n$
- D) $(n + 1) H_{n+1} - (n + 1)$

[gate2004-it](#) [recurrence](#) [combinatorics](#) [normal](#)[Answer](#)7.3.2 Combinatorics: TIFR 2015 Part A -3 [top](#)<http://gateoverflow.in/29057>

Please solve following question. Correct answer is marked !

3. Let $|z| < 1$. Define $M_n(z) = \sum_{i=1}^{10} z^{10^n(i-1)}$? What is

$$\prod_{i=0}^{\infty} M_i(z) = M_0(z) \times M_1(z) \times M_2(z) \times \dots?$$

- (a) Can't be determined
- (b) $1/(1-z)$ ✓
- (c) $1/(1+z)$
- (d) $1 - z^9$
- (e) None of the above

tifr | 2015 | combinatorics | recurrence | difficult

Answer

Answers: Combinatorics

7.3.1 Combinatorics: GATE2004-IT_34 [top](#)

<http://gateoverflow.in/3677>



Selected Answer

The n^{th} **Harmonic Number** is defined as the summation of the reciprocals of all numbers from 1 to n .

$$H_n = \sum_{i=1}^n \frac{1}{i} = \frac{1}{1} + \frac{1}{2} + \frac{1}{3} + \frac{1}{4} + \dots + \frac{1}{n}$$

Lets call the value of

$$\sum_{j=1}^n H_j \text{ as}$$

$$S_n$$

Then,

$$\begin{aligned}
 S_n &= H_1 + H_2 + H_3 + \dots + H_n \\
 &= \underbrace{\left(\frac{1}{1} \right)}_{H_1} + \underbrace{\left(\frac{1}{1} + \frac{1}{2} \right)}_{H_2} + \underbrace{\left(\frac{1}{1} + \frac{1}{2} + \frac{1}{3} \right)}_{H_3} + \dots + \underbrace{\left(\frac{1}{1} + \frac{1}{2} + \frac{1}{3} + \dots + \frac{1}{n} \right)}_{H_n} \\
 &= \cancel{n} \times \frac{1}{1} + \cancel{(n-1)} \times \frac{1}{2} + \cancel{(n-2)} \times \frac{1}{3} + \dots + 1 \times \frac{1}{n} \\
 &= \sum_{i=1}^n \left(\frac{n+1}{i} - 1 \right) \\
 &= \left(\sum_{i=1}^n \frac{n+1}{i} \right) - \left(\sum_{i=1}^n 1 \right) \\
 &= \left((n+1) \times \underbrace{\sum_{i=1}^n \frac{1}{i}}_{=H_n} \right)
 \end{aligned}$$

$$S_n = (n+1) \cdot H_n - n$$

Hence, the answer is option B.

11 votes

-- Pragy Agarwal (14.4k points)

7.3.2 Combinatorics: TIFR 2015 Part A -3 [top](#)

<http://gateoverflow.in/29057>

I found this link with similar question hope it helps to solve -

<http://math.stackexchange.com/questions/1552317/infinite-product-prod-limits-k-0-infty-sum-limits-n-09z10kn-leading>

for telescopic method:-

<http://www.cut-the-knot.org/m/Algebra/TelescopingSums.shtml>

0 votes

-- UK (1.5k points)

7.4

Counting [top](#)

7.4.1 Counting: GATE2015-2_9 [top](#)

<http://gateoverflow.in/8058>

The number of divisors of 2100 is ____.

gate2015-2 | combinatorics | counting | easy

Answer

7.4.2 Counting: TIFR 2015 A-13 [top](#)

<http://gateoverflow.in/29069>

13. Imagine the first quadrant of the real plane as consisting of unit squares. A typical square has 4 corners: (i, j) , $(i + 1, j)$, $(i + 1, j + 1)$, and $(i, j + 1)$, where (i, j) is a pair of non-negative integers. Suppose a line segment ℓ connecting $(0, 0)$ to $(90, 1100)$ is drawn. We say that ℓ passes through a unit square if it passes through a point in the interior of the square. How many unit squares does ℓ pass through?

- (a) 98,990
- (b) 9,900
- (c) 1,190
- (d) 1,180 ✓
- (e) 1,010

counting | tifr | 2015 | difficult

Answer

7.4.3 Counting: GATE2000-3 [top](#)

<http://gateoverflow.in/674>

Consider the following sequence:

$s_1 = s_2 = 1$ and $s_i = 1 + \min(s_{i-1}, s_{i-2})$ for $i > 2$.

Prove by induction on n that $s_n = \lceil \frac{n}{2} \rceil$.

gate2000 | combinatorics | counting | descriptive

Answer

Answers: Counting

7.4.1 Counting: GATE2015-2_9 [top](#)

<http://gateoverflow.in/8058>



Selected Answer

Answer: 36

$$2100 = 7 \times 3 \times 2^2 \times 5^2$$

Hence, total number of factors will be $(1+1) \times (1+1) \times (2+1) \times (2+1) = 2 \times 2 \times 3 \times 3 = 36$,

because any factor is obtained by multiplying the prime factors zero or more times. (one extra for zero)

10 votes

-- Rajarshi Sarkar (29.7k points)

7.4.2 Counting: TIFR 2015 A-13 top

<http://gateoverflow.in/29069>

<http://gateoverflow.in/28910/math>

0 votes

-- srestha (27.8k points)

7.4.3 Counting: GATE2000-3 top

<http://gateoverflow.in/674>



Selected Answer

$$s_3 = 1 + \min(s_1, s_2) = 1 + \min(1, 1) = 2 = \lceil \frac{3}{2} \rceil .$$

So, base condition of induction satisfied.

Assume, $s_{n-2} = \lceil \frac{n-2}{2} \rceil$ and $s_{n-1} = \lceil \frac{n-1}{2} \rceil$ (Induction hypothesis)

Now, we have to prove,

$$s_n = \lceil \frac{n}{2} \rceil$$

$$s_n = 1 + \min(s_{n-1}, s_{n-2}) = 1 + \lceil \frac{n-2}{2} \rceil = 1 + \lceil \frac{n}{2} \rceil - 1 = \lceil \frac{n}{2} \rceil$$

(Hence, proved)

3 votes

-- Arjun Suresh (150k points)

7.5

Permutation top

7.5.1 Permutation: TIFR2011-A-2 top

<http://gateoverflow.in/19829>

In how many ways can the letters of the word ABACUS be rearranged such that the vowels always appear together?

a. $\frac{(6+3)!}{2!}$

b. $\frac{6!}{2!}$

c. $\frac{3!3!}{2!}$

d. $\frac{4!3!}{2!}$

e. None of the above.

tifr2011 combinatorics permutation

Answer

Answers: Permutation

7.5.1 Permutation: TIFR2011-A-2 top

<http://gateoverflow.in/19829>



Selected Answer

Take **AAU** together and treat it like 1 entity. Now arrange **AAU BCS** in $4!$ ways.

Then, the **AAU** can be arranged in $\frac{3!}{2!}$ ways because **A** has been repeated twice.

$$\text{So, total arrangements} = \frac{4!3!}{2!}$$

Option d. is the correct answer.

Upvote 7 votes

-- yes (1.3k points)

7.6

Pigeonhole top

7.6.1 Pigeonhole: TIFR2014-A-5 top

<http://gateoverflow.in/25990>

The rules for the University of Bombay five-a-side cricket competition specify that the members of each team must have birthdays in the same month. What is the minimum number of mathematics students needed to be enrolled in the department to guarantee that they can raise a team of students?

- a. 23
- b. 91
- c. 60
- d. 49
- e. None of the above.

tifr2014 | combinatorics | pigeonhole

Answer

Answers: Pigeonhole

7.6.1 Pigeonhole: TIFR2014-A-5 top

<http://gateoverflow.in/25990>



Selected Answer

There are 12 months and we have to get 5 people having birthdays in the same month in order to form a team . we can apply the pigeon hole principal :

$$\lceil N/12 \rceil = 5$$

On solving we get $N=49$.

Hence answer is D.

Upvote 7 votes

-- Riya Roy(Arayana) (5.6k points)

7.7

Recurrence top

7.7.1 Recurrence: TIFR2014-A-3 [top](#)

<http://gateoverflow.in/25988>

The Fibonacci sequence is defined as follows: $F_0 = 0, F_1 = 1$, and for all integers $n \geq 2, F_n = F_{n-1} + F_{n-2}$. Then which of the following statements is FALSE?

- a. $F_{n+2} = 1 + \sum_{i=0}^n F_i$ for any integer $n \geq 0$
- b. $F_{n+2} \geq \emptyset^n$ for any integer $n \geq 0$, where $\emptyset = (\sqrt{5} + 1)/2$ is the positive root of $x^2 - x - 1 = 0$.
- c. F_{3n} is even, for every integer $n \geq 0$.
- d. F_{4n} is a multiple of 3, for every integer $n \geq 0$.
- e. F_{5n} is a multiple of 4, for every integer $n \geq 0$.

[tifr2014](#) [recurrence](#) [easy](#)

[Answer](#)

7.7.2 Recurrence: TIFR Part B-1 [top](#)

<http://gateoverflow.in/29070>

Part B Computer Science

1. Consider the following recurrence relation:

$$T(n) = \begin{cases} 2T(\lfloor \sqrt{n} \rfloor) + \log n & \text{if } n \geq 2 \\ 1 & \text{if } n = 1. \end{cases}$$

Which of the following statements is TRUE?

- (a) $T(n)$ is $O(\log n)$.
- (b) $T(n)$ is $O(\log n \cdot \log \log n)$ but not $O(\log n)$.
- (c) $T(n)$ is $O(\log^{3/2} n)$ but not $O(\log n \cdot \log \log n)$.
- (d) $T(n)$ is $O(\log^2 n)$ but not $O(\log^{3/2} n)$.
- (e) $T(n)$ is $O(\log^2 n \cdot \log \log n)$ but not $O(\log^2 n)$.

[tifr](#) [2015](#) [algorithms](#) [recurrence](#) [normal](#)

[Answer](#)

Answers: Recurrence

7.7.1 Recurrence: TIFR2014-A-3 [top](#)

<http://gateoverflow.in/25988>



Selected Answer

| F0 | F1 | F2 | F3 | F4 | F5 | F6 | F7 |
|----|----|----|----|----|----|----|----|
| 0 | 1 | 1 | 2 | 3 | 5 | 8 | 13 |

OPTION E) F_{5n} is a multiple of 4, for every integer $n \geq 0$ **False**

4 votes

-- Umang Raman (11.3k points)

7.7.2 Recurrence: TIFR Part B-1 [top](#)

<http://gateoverflow.in/29070>

$$T(n) = T(\sqrt{n}) + \log n$$

$$\text{now put } n = 2^m, m = \log n \dots \dots \dots \text{(I)}$$

then the equation is

$$T(2^m) = T(2^{m/2}) + m$$

$$\text{Now, put } T(2^m) = S(m)$$

Now, equation becomes

$S(m) = S(m/2) + m$

here $f(m) = m$

and $n^{\log_b} = m$

So, complexity will be $O(m \log m)$

putting m value from equation (I) we get

Complexity $T(n) = O(\log n \cdot \log \log n)$

Ans will be (B)

2 votes

-- srestha (27.8k points)

8 Discrete Mathematics Graph Theory (53) top

8.0.1 GATE2006-73 top

<http://gateoverflow.in/43567>

The 2^n vertices of a graph G corresponds to all subsets of a set of size n , for $n \geq 6$. Two vertices of G are adjacent if and only if the corresponding sets intersect in exactly two elements.

The number of connected components in G is:

- A. n
- B. $n + 2$
- C. $2^{n/2}$
- D. $\frac{2^n}{n}$

[gate2006](#) [graph-theory](#) [normal](#)

[Answer](#)

8.0.2 GATE2005_11 top

<http://gateoverflow.in/1161>

Let G be a simple graph with 20 vertices and 100 edges. The size of the minimum vertex cover of G is 8. then, the size of the maximum independent set of G is:

- (A) 12 (B) 8 (C) less than 8 (D) more than 12

[gate2005](#) [graph-theory](#) [normal](#)

[Answer](#)

8.0.3 GATE2014-2_51 top

<http://gateoverflow.in/2018>

A cycle on n vertices is isomorphic to its complement. The value of n is _____.

[gate2014-2](#) [graph-theory](#) [numerical-answers](#) [normal](#)

[Answer](#)

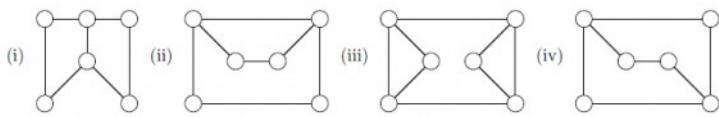
8.0.4 TIFR2015-B-5 top

<http://gateoverflow.in/29858>

Suppose

$$\begin{pmatrix} 0 & 1 & 0 & 0 & 0 & 1 \\ 1 & 0 & 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 1 & 0 & 1 \\ 0 & 0 & 1 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 & 0 & 1 \\ 1 & 0 & 1 & 0 & 1 & 0 \end{pmatrix}$$

is the adjacency matrix of an undirected graph with six vertices: that is, the rows and columns are indexed by vertices of the graph, and an entry is 1 if the corresponding vertices are connected by an edge and is 0 otherwise; the same order of vertices is used for the rows and columns. Which of the graphs below has the above adjacency matrix?



- A. Only (i)
 B. Only (ii)
 C. Only (iii)
 D. Only (iv)
 E. (i) and (ii)

tifr2015

Answer

8.0.5 GATE1995_24 top<http://gateoverflow.in/2663>

Prove that in finite graph, the number of vertices of odd degree is always even.

gate1995 graph-theory

Answer

8.0.6 GATE2014-1_51 top<http://gateoverflow.in/1931>

Consider an undirected graph G where self-loops are not allowed. The vertex set of G is $\{(i, j) \mid 1 \leq i \leq 12, 1 \leq j \leq 12\}$. There is an edge between (a, b) and (c, d) if $|a - c| \leq 1$ and $|b - d| \leq 1$. The number of edges in this graph is _____.

gate2014-1 graph-theory numerical-answers normal

Answer

8.0.7 GATE2006-71 top<http://gateoverflow.in/1850>

The 2^n vertices of a graph G corresponds to all subsets of a set of size n , for $n \geq 6$. Two vertices of G are adjacent if and only if the corresponding sets intersect in exactly two elements.

The number of vertices of degree zero in G is:

- A. 1
 B. n
 C. $n + 1$
 D. 2^n

gate2006 graph-theory normal

Answer

8.0.8 GATE2013_26 top<http://gateoverflow.in/1537>

The line graph $L(G)$ of a simple graph G is defined as follows:

- There is exactly one vertex $v(e)$ in $L(G)$ for each edge e in G .
- For any two edges e and e' in G , $L(G)$ has an edge between $v(e)$ and $v(e')$, if and only if e and e' are incident with the same vertex in G .

Which of the following statements is/are **TRUE**?

- (P) The line graph of a cycle is a cycle.
 (Q) The line graph of a clique is a clique.
 (R) The line graph of a planar graph is planar.
 (S) The line graph of a tree is a tree.

- (A) P only
- (B) P and R only
- (C) R only
- (D) P, Q and S only

gate2013 | graph-theory | normal

[Answer](#)

8.0.9 GATE2013_25 [top](#)

<http://gateoverflow.in/1536>

Which of the following statements is/are **TRUE** for undirected graphs?

- P: Number of odd degree vertices is even.
 Q: Sum of degrees of all vertices is even.
- (A) P only (B) Q only (C) Both P and Q (D) Neither P nor Q

gate2013 | graph-theory | easy

[Answer](#)

8.0.10 TIFR2015-B-11 [top](#)

<http://gateoverflow.in/30043>

Let K_n be the complete graph on n vertices labelled $\{1, 2, \dots, n\}$ with $m = n(n - 1)/2$ edges. What is the number of spanning trees of K_n ?

- A. $\frac{m}{n-1}$
- B. m^{n-1}
- C. n^{n-2}
- D. n^{n-1}
- E. None of the above.

tifr2015 | graph-theory

[Answer](#)

8.0.11 TIFR2010-B-36 [top](#)

<http://gateoverflow.in/19248>

In a directed graph, every vertex has exactly seven edges coming in. What can one always say about the number of edges going out of its vertices?

- a. Exactly seven edges leave every vertex.
- b. Exactly seven edges leave some vertex.
- c. Some vertex has at least seven edges leaving it.
- d. The number of edges coming out of vertex is odd.
- e. None of the above.

tifr2010 | graph-theory

[Answer](#)

8.0.12 GATE2007-23 [top](#)

<http://gateoverflow.in/1221>

Which of the following graphs has an Eulerian circuit?

- A. Any k -regular graph where k is an even number.
- B. A complete graph on 90 vertices.
- C. The complement of a cycle on 25 vertices.
- D. None of the above

gate2007 graph-theory normal

Answer

8.0.13 GATE2006-72 [top](#)<http://gateoverflow.in/43566>

The 2^n vertices of a graph G corresponds to all subsets of a set of size n , for $n \geq 6$. Two vertices of G are adjacent if and only if the corresponding sets intersect in exactly two elements.

The maximum degree of a vertex in G is:

- A. $\binom{n/2}{2} 2^{n/2}$
- B. 2^{n-2}
- C. $2^{n-3} \times 3$
- D. 2^{n-1}

gate2006 graph-theory normal

Answer

8.0.14 GATE1994_1.6, ISRO2008-29 [top](#)<http://gateoverflow.in/2443>

The number of distinct simple graphs with up to three nodes is

- A. 15
- B. 10
- C. 7
- D. 9

gate1994 graph-theory combinatorics normal isro2008

Answer

8.0.15 GATE2010-1 [top](#)<http://gateoverflow.in/1147>

Let $G=(V, E)$ be a graph. Define $\xi(G) = \sum_d i_d * d$, where i_d is the number of vertices of degree d in G. If S and T are two different trees with $\xi(S) = \xi(T)$, then

- A. $|S| = 2|T|$
- B. $|S| = |T| - 1$
- C. $|S| = |T|$
- D. $|S| = |T| + 1$

gate2010 graph-theory normal

Answer

8.0.16 GATE2004_79 [top](#)<http://gateoverflow.in/1073>

How many graphs on n labeled vertices exist which have at least $\frac{(n^2-3n)}{2}$ edges ?

(a) $\binom{\frac{n^2-n}{2}}{C_{\frac{n^2-3n}{2}}}$

(b) $\sum_{k=0}^{\left(\frac{n^2-3n}{2}\right)} (n^2-n) C_k$

(c) $\binom{\frac{n^2-n}{2}}{C_n}$

(d) $\sum_{k=0}^n \binom{\frac{n^2-n}{2}}{k} C_k$

gate2004 | graph-theory | combinatorics | normal

[Answer](#)

8.0.17 TIFR2011-B-33 [top](#)

<http://gateoverflow.in/20624>

Which of the following is **NOT** a sufficient and necessary condition for an undirected graph G to be a tree?

- a. G is connected and has $n - 1$ edges.
- b. G is acyclic and connected.
- c. G is acyclic and has $n - 1$ edges.
- d. G is acyclic, connected and has $n - 1$ edges.
- e. G has $n - 1$ edges.

tifr2011 | graph-theory

[Answer](#)

8.0.18 GATE2003_40 [top](#)

<http://gateoverflow.in/931>

A graph $G = (V, E)$ satisfies $|E| \leq 3|V| - 6$. The min-degree of G is defined as $\min_{v \in V} \{ \text{degree}(v) \}$. Therefore, min-degree of G cannot be

- (A) 3 (B) 4 (C) 5 (D) 6

gate2003 | graph-theory | normal

[Answer](#)

8.0.19 TIFR2012-B-2 [top](#)

<http://gateoverflow.in/25047>

In a graph, the degree of a vertex is the number of edges incident (connected) on it. Which of the following is true for every graph G ?

- a. There are even number of vertices of even degree.
- b. There are odd number of vertices of even degree.
- c. There are even number of vertices of odd degree.
- d. There are odd number of vertices of odd degree.
- e. All the vertices are of even degree.

tifr2012 | graph-theory

[Answer](#)

8.0.20 TIFR2013-B-1 [top](#)

<http://gateoverflow.in/25508>

Let $G = (V, E)$ be a simple undirected graph on n vertices. A colouring of G is an assignment of colours to each vertex such that endpoints of every edge are given different colours. Let $\chi(G)$ denote the chromatic number of G , i.e. the minimum numbers of colours needed for a valid colouring of G . A set $B \subseteq V$ is an independent set if no pair of vertices in B is connected by an edge. Let $a(G)$ be the number of vertices in a largest possible independent set in G . In the absence of any further information about G we can conclude.

- a. $\chi(G) \geq a(G)$
- b. $\chi(G) \leq a(G)$
- c. $a(G) \geq n/\chi(G)$
- d. $a(G) \leq n/\chi(G)$
- e. None of the above.

tifr2013 | graph-theory

[Answer](#)

8.0.21 GATE2002-1.25, ISRO2008-30, ISRO2016-6 [top](#)

<http://gateoverflow.in/830>

The maximum number of edges in a n-node undirected graph without self loops is

- A. n^2
- B. $\frac{n(n-1)}{2}$
- C. $n - 1$
- D. $\frac{(n+1)(n)}{2}$

[gate2002](#) [graph-theory](#) [easy](#) [isro2008](#) [isro2016](#)

[Answer](#)

8.0.22 GATE1991-16,b [top](#)

<http://gateoverflow.in/26647>

Show that all vertices in an undirected finite graph cannot have distinct degrees, if the graph has at least two vertices.

[gate1991](#) [graph-theory](#)

[Answer](#)

8.0.23 GATE2009-3 [top](#)

<http://gateoverflow.in/804>

Which one of the following is **TRUE** for any simple connected undirected graph with more than 2 vertices?

- A. No two vertices have the same degree.
- B. At least two vertices have the same degree.
- C. At least three vertices have the same degree.
- D. All vertices have the same degree.

[gate2009](#) [graph-theory](#) [normal](#)

[Answer](#)

8.0.24 GATE2001-2.15 [top](#)

<http://gateoverflow.in/733>

How many undirected graphs (not necessarily connected) can be constructed out of a given set $V = \{v_1, v_2, \dots, v_n\}$ of n vertices?

- A. $\frac{n(n-1)}{2}$
- B. 2^n
- C. $n!$
- D. $2^{\frac{n(n-1)}{2}}$

[gate2001](#) [graph-theory](#) [normal](#)

[Answer](#)

8.0.25 GATE1994_2.5 [top](#)

<http://gateoverflow.in/2472>

The number of edges in a regular graph of degree d and n vertices is _____

[gate1994](#) [graph-theory](#) [easy](#)

[Answer](#)

Answers:

8.0.1 GATE2006-73 [top](#)

<http://gateoverflow.in/43567>



Selected Answer

B.

$$\begin{aligned}
 & n+1 \text{ (subsets of size } < 2 \text{ are all disconnected)} \\
 & +1 \text{ (subsets of size } \geq 2 \text{ are all connected)} \\
 & = n+2.
 \end{aligned}$$

6 votes

-- Vikrant Singh (11k points)

8.0.2 GATE2005_11<http://gateoverflow.in/1161>

Selected Answer

Vertex cover: A set of vertices such that each edge of the graph is incident to atleast one vertex of the set.

Therefore, removing all the vertices of the vertex cover from the graph results in an isolated graph and the same set of nodes would be the independent set in the original graph.

size of minimum vertex cover = 8

size of maximum independent set = $20 - 8 = 12$

Therefore, correct answer would be (A).

9 votes

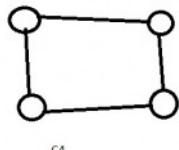
-- suraj (3.7k points)

8.0.3 GATE2014-2_51<http://gateoverflow.in/2018>

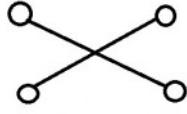
Selected Answer

its $n=5$ only.

only C_5 is isomorphic to its complement.

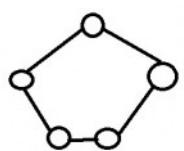


C4

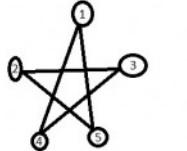


complement of C4

Here, C_4 and its complement is not isomorphic because both have different structure.



C5



complement of C5

Here, C_5 is isomorphic to its complement. just imagine the reorganization of vertices in complement of C_5 it will become same as C_5 .

imagine 1 is below 4 & 5 and then flip 2 & 3. imagine the structure it is same as C_5 .

13 votes

-- jayendra (6.6k points)

8.0.4 TIFR2015-B-5<http://gateoverflow.in/29858>

Yes, Option (e) must be the right answer.

Number of edges in the graph:

Since the graphs are undirected, it can be observed that there will be two 1's in the adjacency matrix corresponding to

each edge in the graph.

For example, suppose two there is an edge between nodes A & B, then there will be 1 in position [A, B] & there will be a 1 in position [B,A] of the adjacency matrix.

That's why the given adjacency matrix is symmetric.

So the number of edges in the graph must be equal to half the number of 1's in the adjacency matrix.

Hence number of edges will be 7 in the graph.

All the other graphs except (iii), have 7 edges. So it is clear that the adjacency matrix does not represent graph (iii).

Isomorphism:

From the definition of Isomorphic graphs, it can be inferred that,

Isomorphic graphs must have same (adjacency matrix) representation.

Thus after eliminating graph (iii) we have to check for isomorphism among graphs (i), (ii) & (iv).

It can clearly be observed that graphs (ii) & (iv) are not isomorphic to each other.

It can also be observed that graph (i) & (ii) are isomorphic (Rotate graph (i) by 90 degree left/right).

Graph (ii) is looking like a closed envelope in the figure, try to view it like an open envelope, like a trapezium over a rectangle.)

So now it can be inferred that either the adjacency matrix is representing both graphs (i) & (ii) or it is only representing (iv).

Cycles of length 6 :

Now from the adjacency matrix it can be observed that there should be a cycle of length 6 in the graph, since [1, 2], [2, 3], [3, 4], [4, 5], [5, 6], [6, 1] are all 1's in the matrix. (as 1 at any position [x, y] represents an edge between x & y in the graph).

& both graphs (i) & (ii) have cycles of length 6, but graph (iv) does not have any cycle of length 6, it has cycles of length 4 & 5 only.

Thus graph (iv) can not have the above adjacency matrix.

Hence the adjacency matrix represents graphs (i) & (ii).

4 votes

-- Anurag Pandey (9.7k points)

8.0.5 GATE1995_24 top

<http://gateoverflow.in/2663>



Selected Answer

In any finite graph,

Sum of degree of all the vertices = 2* number of edges

sum of degree of all the vertices with even degree + sum of degree of all the vertices with odd degree = 2* number of edges

even number + sum of degree of all the vertices with odd degree = even number

It is possible iff Number of odd degree vertices are even.

7 votes

-- suraj (3.7k points)

8.0.6 GATE2014-1_51 top

<http://gateoverflow.in/1931>



Selected Answer

If you think of a 12×12 grid (like a chess board of size 12×12), then each point (i,j) , which is in i th row and j th column, is a vertex (i,j) .

Now we are allowed to connect only those points which are atmost 1 distance apart (in both horizontal and vertical direction). So we will connect only horizontal neighbours, vertical neighbours, and diagonal neighbours.

So horizontal edges on each row are 11 i.e. $11 \times 12 = 132$ horizontal edges. Similarly we have 132 vertical edges.

To count diagonal edges, think of 1×1 square boxes in which diagonals meet each other. There are 11×11 such square boxes, and each box contains 2 diagonals, so total diagonals = 242.

So total edges = $132 + 132 + 242 = 506$.

37 votes

-- Happy Mittal (9.5k points)

8.0.7 GATE2006-71 top

<http://gateoverflow.in/1850>



Selected Answer

C. no. of vertices with degree zero = no. of subsets with size $\leq 1 = n+1$, as edges are there for every vertex with two or more elements as we have a vertex for all subsets of n.

10 votes

-- Vikrant Singh (11k points)

8.0.8 GATE2013_26 top

<http://gateoverflow.in/1537>



Selected Answer

P)True. Because every edge in cycle graph will become a vertex in new graph $L(G)$ and every vertex of cycle graph will become an edge in new graph.

R)False .We can give counter example. G has 5 vertex and 9 edge is a planar graph but its Line graph has 9 vertices(because G has 9 edge) and 24 edge(add degree of each vertices and divided by 2 ie. $48/2$).But for a graph to be planar $|E| \leq 3|V| - 6$.

For 9 vertices $|E| \leq 3*9 - 6$

$$\Rightarrow |E| \leq 27 - 6$$

$\Rightarrow |E| \leq 21$. But the $L(G)$ has 24 edge so not planar.

As R is False option B, C are eliminated.

<http://www.personal.kent.edu/~rmuhamma/GraphTheory/MyGraphTheory/planarity.htm>

S)False. By counter example. Try drawing a simple tree which has a Root node ,Root node has one child A, node A has two child B and C. Draw its Line graph acc. to given rules in question you will get a cycle graph of 3 vertices.

So D) also not correct.

\therefore option A is correct.

7 votes

-- prashant singh (299 points)

8.0.9 GATE2013_25 top

<http://gateoverflow.in/1536>



Selected Answer

Both are correct

P:sum of odd degree + sum of even degree=2*no of edges

sum of odd degree=2*no of edges - sum of even degree

The right hand side must be even as the difference of 2 even numbers is always even.

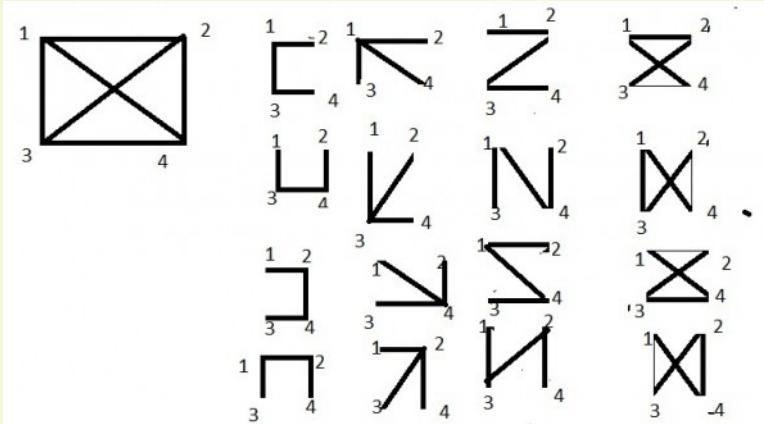
Q:each edge is counted twice so sum of degree is always even

14 votes

-- Bhagirathi Nayak (11.3k points)

8.0.10 TIFR2015-B-11 top<http://gateoverflow.in/30043>

Answer will be (C)

e.g. for K_4 no. of spanning tree will be 16

1 votes

-- srestha (27.8k points)

8.0.11 TIFR2010-B-36 top<http://gateoverflow.in/19248>

Selected Answer

Since 7 edges come to every vertex, total no. of edges leaving n vertices must be $7n$. So, option a is a possibility but it needn't be always true. We can have 8 edges leave one vertex and 6 edges leave another (and similarly any other combination of outgoing edges ensuring total no. of outgoing edges remain constant). But option c must always be true as if none of the n vertices have at least 7 edges leaving, sum of outgoing edges can never be $7n$.

5 votes

-- Arjun Suresh (150k points)

8.0.12 GATE2007-23 top<http://gateoverflow.in/1221>

Selected Answer

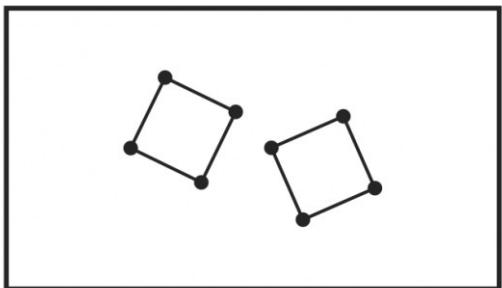
A connected Graph has Euler Circuit

 \iff all of its vertices have even degree

A connected Graph has Euler Path

 \iff exactly 2 of its vertices have odd degree(a) k -regular graph where k is even number.a k -regular graph need not be connected always. Example : The given below graph is a

2 regular graph is not a Euler graph. This is so because there is no single walk which covers all edges.



Graph G with 2 Components

(b) the complete graph of 90 vertices

In such a graph every vertex will have an odd degree = 89, Hence it cannot have a Euler path/Circuit.

(c) to get degree of all vertices of the complement of cycle on 25 vertices we need to subtract the degree of a complete graph of 25 vertices with degree of vertices in the original given graph i.e. cycle on 25 vertices.

Degree of complement
= $24 - 2 = 22$ Since, every degree is Even therefore, Graph has a Euler Cycle.

answer = **Option C**

15 votes

-- Mithlesh Upadhyay (3.6k points)

8.0.13 GATE2006-72 [top](#)

<http://gateoverflow.in/43566>



Selected Answer

$$\text{C. } \max_k ({}^k C_2 \cdot 2^{n-k}) = {}^3 C_2 \cdot 2^{n-3} = 3 \cdot 2^{n-3} .$$

Let the vertex having the max degree contain k elements. Now, as per the given condition, it can have edges to all vertices having two common elements (exactly 2 common). So, we can choose the 2 common elements in ${}^k C_2$ ways. Now, for each of these 2 pair of elements, it can have an edge to a vertex containing $n - k$ elements + the 2 common elements. This will be equal to 2^{n-k} possible subsets as the 2 common elements must always be present and other k elements must always be absent. So, we get the degree as

$${}^k C_2 \cdot 2^{n-k}$$

Now, our answer will be the maximum value for this. We can differentiate this (w.r.t k) and equate to 0. But in other way we can try different values for k starting with 2. As we see if we increase k from 2 onwards, the 2^{n-k} term gets divided by 2. The other term is ${}^k C_2$, which goes like 1, 3, 6, 10... for $k = 2, 3, 4, 5, \dots$. So, we get the max. degree for $k = 3$ or 4 and this will be $3 \cdot 2^{n-3}$.

4 votes

-- Vikrant Singh (11k points)

8.0.14 GATE1994_1.6, ISRO2008-29 [top](#)

<http://gateoverflow.in/2443>



Selected Answer

Answer: C

The number of max edges a simple graph can have is $\frac{n \times (n-1)}{2}$.

So, for a graph with 3 nodes the max number of edges is 3.

Now there can be 0 edges, 1 edge, 2 edges or 3 edges in a 3 node simple graph.

So the total number of unlabeled simple graphs on 3 nodes will be 4.

Similarly for two node graph we have option of 0 or 1 edge and for one node graph we have option of 0 edge.

So the total number of simple graphs upto three nodes are: $4+2+1=7$.

6 votes

-- Rajarshi Sarkar (29.7k points)

8.0.15 GATE2010-1 [top](#)<http://gateoverflow.in/1147>

Selected Answer

Sum of degrees in a graph = $2 |E|$, as each edge contributes two to the sum of degrees. So, when sum of degrees are same, number of edges must also be same.

Trees with equal no of edges has to have equal no of vertices as No of Edges = No of vertices - 1, in a tree.

So, should be $|S| = |T|$

12 votes

-- Digvijay (35.8k points)

8.0.16 GATE2004_79 [top](#)<http://gateoverflow.in/1073>

Selected Answer

$$\text{Let } a = \frac{n(n-1)}{2}, b = \frac{n^2-3n}{2}$$

Minimum no of edges has to be $\frac{n^2-3n}{2} = b$.

Maximum no of edges in simple graph = $\frac{n(n-1)}{2} = a$.

So, no of graph with minimum b edges :

$$\begin{aligned} &= C(a, b) + C(a, b+1) + C(a, b+2) + \dots + C(a, a) \\ &= C(a, a-b) + C(a, a-(b+1)) + C(a, a-(b+2)) + \dots + C(a, 0) \\ &= C(a, n) + C(a, n-1) + C(a, n-2) + \dots + C(a, 0) (\because a-b=n) \\ &= C\left(\frac{n(n-1)}{2}, n\right) + C\left(\frac{n(n-1)}{2}, n-1\right) + C\left(\frac{n(n-1)}{2}, n-2\right) + \dots + C\left(\frac{n(n-1)}{2}, 0\right) \\ &= \sum_{k=0}^n \binom{\frac{n^2-n}{2}}{k} C_k \end{aligned}$$

Option D..

14 votes

-- Digvijay (35.8k points)

8.0.17 TIFR2011-B-33 [top](#)<http://gateoverflow.in/20624>

Selected Answer

Option a

\iff **Option b**
 \iff **Option c**
 \iff **Option d.**

- You need atleast $n - 1$ edges to have a connected graph. This leaves no edges to make any cycles. Thus, Option a $\implies G$ is acyclic.
- A connected graph with $n - 1$ edges is acyclic, as shown above. Now, if we add any more edges to this graph, we will be connecting two vertices that are already connected. Thus, adding any more than edges to a connected graph will cause cycles. So, if a graph is acyclic and connected, it has exactly $(n - 1)$ edges.
- You can't fit $(n - 1)$ edges between $(n - 1)$ vertices without causing cycles. Thus, if graph with $(n - 1)$ edges is acyclic, it must connect n vertices. Hence, an acyclic graph with $(n - 1)$ edges is connected.

Thus, all options, a to d are equivalent.

Option b
 $\Leftrightarrow G$ is a tree.

- Any acyclic connected graph is a tree by definition.
- A graph G is a tree if it is both acyclic and connected by definition.

Thus, all option a to d are both necessary and sufficient for an undirected graph G to be a tree.

Option e
 $\not\Rightarrow G$ is a tree.

- Since G is not constrained to be acyclic, we can create a cyclic graph with $(n - 1)$ edges. This graph will be cyclic, and it won't be connected. And thus, it won't be a tree.

Hence, option e is the correct answer.

4 5 votes

-- Pragy Agarwal (14.4k points)

8.0.18 GATE2003_40 [top](#)

<http://gateoverflow.in/931>

Let the min-degree of G is x . then G has at least $|v| * x/2$ edges.

$$|v| * x/2 \leq 3 * |v| - 6$$

for $x=6$, we get $0 \leq -6$, Therefore, min degree of G cannot be 6.

Correct answer is (D).

alternative approach ,
let the min_degree of a graph is 'x' , then

$$\begin{aligned} x &\leq (2e / n), \\ \text{given } e &\leq (3n - 6) \quad \{ \text{it will be planner graph}\} \\ \text{put the value of } e, \text{ then min_degree will be ,} \end{aligned}$$

$$x \leq (2(3n-6))/n$$

$$\begin{aligned} x &\leq (6n - 12) / n \\ x &\leq (6n/n - 12/n) \end{aligned}$$

$$x \leq (6 - 12/n),$$

when number of vertices is more , then value of $(12/n)$ will be less , ($12/n = 0.000001$ assume) , then min_degree will be ,

$$\begin{aligned} x &\leq (6 - 0.000001) \\ x &\leq 5.999999, \text{ max value} \\ x &\leq \text{floor value}(5.999999....) \\ x &= 5, \text{ maximum value of min_degree of defined graph (i.e. planner graph)} \end{aligned}$$

4 11 votes

-- suraj (3.7k points)

8.0.19 TIFR2012-B-2 [top](#)

<http://gateoverflow.in/25047>



Selected Answer

As we know that sum of degree of vertex = $2 * \text{edges}$
let there are u vertex with odd degrees and v vertex with even degrees

Then $\Sigma(u) + \Sigma(v) = 2e$

now $2e = \text{even}$

$\Sigma(v) = \text{sum of even number will be even}$

$\Sigma(u) = \text{if you consider odd number of vertices of odd degree then sum will be odd and this will violate } 2e$
so there will be always even number of vertices with odd degree

C) There are even number of vertices of odd degree

6 votes

-- Umang Raman (11.3k points)

8.0.20 TIFR2013-B-1 [top](#)

<http://gateoverflow.in/25508>



Selected Answer

Independence number : Size of largest maximum independent set. $a(G)$ (it covers all adjacent vertices)
 Chromatic Number : Minimum No. of color required to properly color the graph $\chi(G)$

The vertices of G can be partitioned into $\chi(G)$ monochromatic classes. Each class is an independent set, and hence cannot have size larger than $a(G)$

$a(G) \leq \chi(G) \geq n$ (its a theorem)
 option C

3 votes

-- Umang Raman (11.3k points)

8.0.21 GATE2002-1.25, ISRO2008-30, ISRO2016-6 [top](#)

<http://gateoverflow.in/830>



Selected Answer

In a graph of n vertices you can draw an edge from a vertex to $n-1$ vertex we will do it for n vertices so total number of edges is $n(n-1)$ now each edge is counted twice so the required maximum number of edges is $n(n-1)/2$

11 votes

-- Bhagirathi Nayak (11.3k points)

8.0.22 GATE1991-16,b [top](#)

<http://gateoverflow.in/26647>



Selected Answer

Let $n > 2$ and all the vertices have distinct degrees. Now, let the degrees be $0, 1, 2, \dots, n-1$ which are all distinct and possible as a vertex can be connected to $n-1$ other vertices. But, there is a problem here- if a vertex is connected to $n-1$ other vertices, it means there cannot be a vertex with 0 degree any more. Thus for n vertices we now have only $n-1$ possible degrees meaning at least one must repeat- pigeonhole principle comes here :)

10 votes

-- Arjun Suresh (150k points)

8.0.23 GATE2009-3 [top](#)

<http://gateoverflow.in/804>



Selected Answer

answer = **option B**

There are n vertices and at least $n-1$ edges. So, for each vertex, degree should range from 1 (since graph is connected) to $n-1$ (since graph is simple). But we have n such vertices- filling n things with $n-1$ numbers.

$$\left\lceil \frac{n}{n-1} \right\rceil$$

So, at least 2 of them must be equal (pigeonhole principle).

12 votes

-- gatecse (10.7k points)

8.0.24 GATE2001-2.15 top<http://gateoverflow.in/733>

Selected Answer

with n vertices we have nC_2 edges and each subset of these edges will form a graph, so total number of undirected graph possible = $2^{n(n-1)/2}$

13 votes

-- Vikrant Singh (11k points)

8.0.25 GATE1994_2.5 top<http://gateoverflow.in/2472>

Selected Answer

in a complete graph which is $(n-1)$ regular (where n is the no of vertices) has edges $n(n-1)/2$
 n vertices are adjacent to $n-1$ vertices and an edge contributes two degree so dividing by 2.

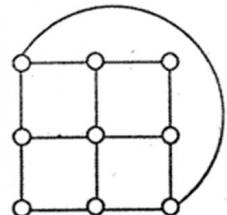
so in d regular graph No of edges will be $n*d/2$

6 votes

-- Manu Thakur (5.6k points)

8.1**Chromatic Number** top**8.1.1 Chromatic Number: GATE2008-IT_3** top<http://gateoverflow.in/3263>

What is the chromatic number of the following graph?



- | | |
|----|---|
| A) | 2 |
| B) | 3 |
| C) | 4 |
| D) | 5 |

[gate2008-it](#) [graph-theory](#) [graph-coloring](#) [chromatic-number](#) [normal](#)

Answer**8.1.2 Chromatic Number: GATE2009-2** top<http://gateoverflow.in/796>

What is the chromatic number of an n vertex simple connected graph which does not contain any odd length cycle? Assume $n > 2$.

- A. 2
- B. 3

- C. $n-1$
D. n

gate2009 graph-theory graph-coloring chromatic-number normal

Answer

Answers: Chromatic Number

8.1.1 Chromatic Number: GATE2008-IT_3 [top](#)

<http://gateoverflow.in/3263>



Selected Answer

The chromatic number of a graph is the smallest number of colors needed to color the vertices so that no two adjacent vertices share the same color.

Hence minimum number of colors needed to color given graph is equal to 3(**option 2**)

For odd length cycles we need minimum 3 colors for vertex coloring and for even length cycles we need just 2.

9 votes

-- vinodmits (367 points)

8.1.2 Chromatic Number: GATE2009-2 [top](#)

<http://gateoverflow.in/796>



Selected Answer

Lemma 1.- G is bipartite, if and only if it does not contain any cycle of odd length.

Proof. Suppose G has an odd cycle. Then obviously it cannot be bipartite, because no odd cycle is 2-colorable. Conversely, suppose G has no odd cycle. Then we can color the vertices greedily by 2 colors, always choosing a different color for a neighbor of some vertex which has been colored already. Any additional edges are consistent with our coloring, otherwise they would close a cycle of odd length with the edges we considered already. The easiest extremal question is about the maximum possible number of edges in a bipartite graph on n vertices. 1 ref@ <http://math.mit.edu/~fox/MAT307-lecture07.pdf>

Bipartite Graph: A graph which is 2-colorable is called bipartite. We have already seen several bipartite graphs, including paths, cycles with even length, and the graph of the cube (but not any other regular polyhedra)

ref@ http://ocw.mit.edu/high-school/mathematics/combinatorics-the-fine-art-of-counting/lecture-notes/MITHFH_lecturenotes_9.pdf

3. Bipartite graphs: By definition, every bipartite graph with at least one edge has chromatic number 2. (otherwise 1 if graph is null graph)

ref@ http://math.ucsb.edu/~padraig/mathcamp_2011/introGT/MC2011_intro_to_GT_wk1_day4.pdf

7 votes

-- Mithlesh Upadhyay (3.6k points)

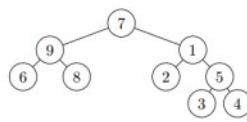
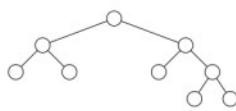
8.2

Combinatorics [top](#)

8.2.1 Combinatorics: TIFR 2015 B 4 [top](#)

<http://gateoverflow.in/29343>

4. First, consider the tree on the left.



On the right, the nine nodes of the tree have been assigned numbers from the set $\{1, 2, \dots, 9\}$ so that for every node, the numbers in its left subtree and right subtree lie in disjoint intervals (that is, all numbers in one subtree are less than all numbers in the other subtree). How many such assignments are possible? Hint: Fix a value for the root and ask what values can then appear in its left and right subtrees.

- (a) $2^9 = 512$
- (b) $2^4 \cdot 3^2 \cdot 5 \cdot 9 = 6480 \checkmark$
- (c) $2^3 \cdot 3 \cdot 5 \cdot 9 = 1080$
- (d) $2^4 = 16$
- (e) $2^3 \cdot 3^3 = 216$

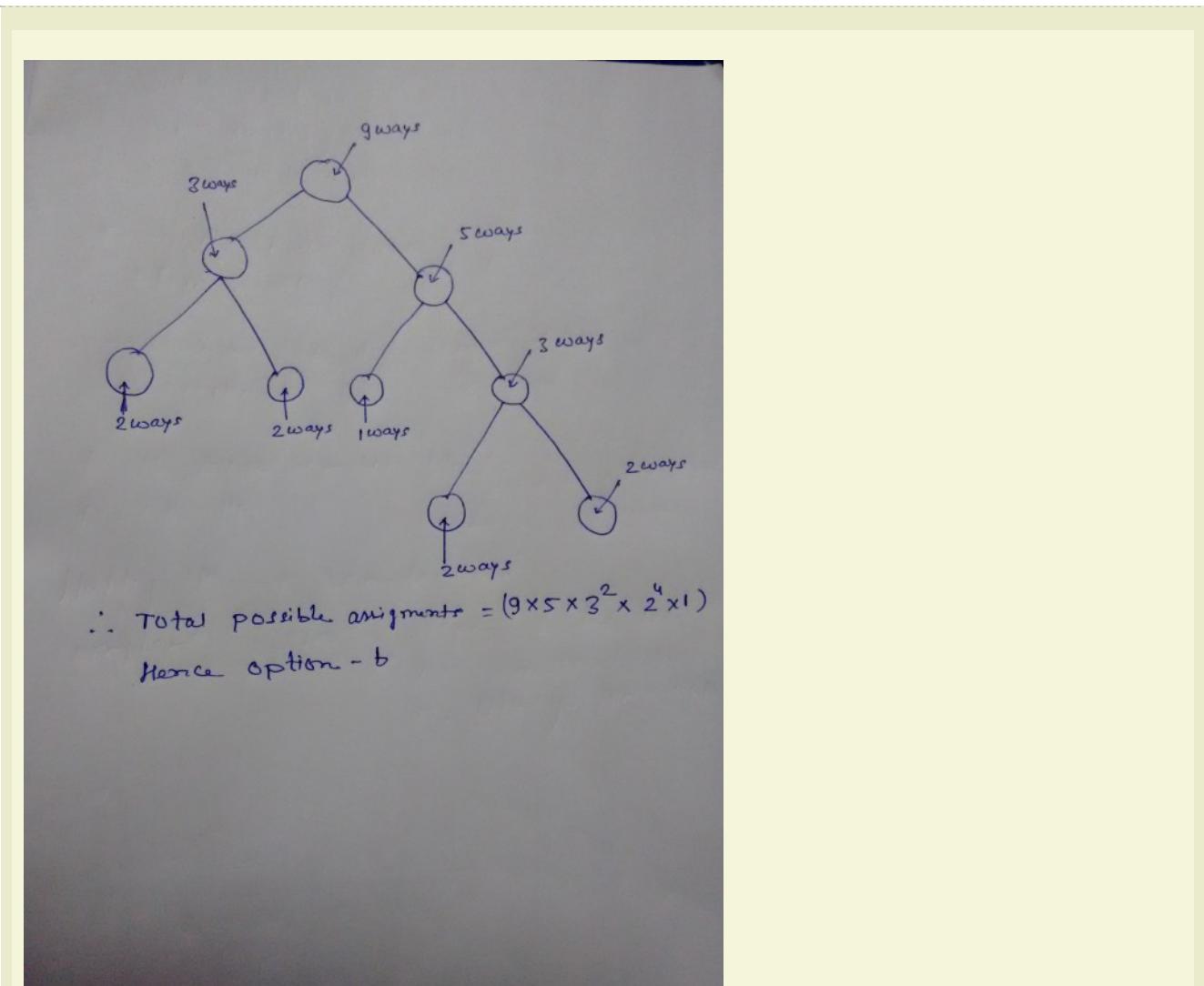
graph-theory tifr 2015 difficult combinatorics

Answer

Answers: Combinatorics

8.2.1 Combinatorics: TIFR 2015 B 4 top

<http://gateoverflow.in/29343>



Based on concepts of Combination

2 votes

-- Shashi Kant Verma (31 points)

8.3

Connected Components [top](#)

8.3.1 Connected Components: GATE1991_01,xv [top](#)

<http://gateoverflow.in/510>

The maximum number of possible edges in an undirected graph with n vertices and k components is _____.

[gate1991](#) [graph-theory](#) [connected-components](#) [normal](#)

Answer

8.3.2 Connected Components: GATE2003-8, ISRO2009-53 [top](#)

<http://gateoverflow.in/899>

Let G be an arbitrary graph with n nodes and k components. If a vertex is removed from G , the number of components in the resultant graph must necessarily lie down between

- A. k and n

- B. $k - 1$ and $k + 1$
 C. $k - 1$ and $n - 1$
 D. $k + 1$ and $n - k$

gate2003 | graph-theory | connected-components | normal | isro2009

Answer

8.3.3 Connected Components: GATE2014-3_51 [top](#)

<http://gateoverflow.in/2085>

If
 G is the forest with
 n vertices and
 k connected components, how many edges does
 G have?

- (A) $\lfloor n/k \rfloor$
 (B) $\lceil n/k \rceil$
 (C) $n - k$
 (D) $n - k + 1$

gate2014-3 | graph-theory | connected-components | normal

Answer

Answers: Connected Components

8.3.1 Connected Components: GATE1991_01,xv [top](#)

<http://gateoverflow.in/510>



Selected Answer

Hopefully it should be clear that in any such graph all components will be complete, i.e., have all possible edges. Thus the only remaining question is how large each component should be?

If there are two components with
 a and
 b vertices,
 $a > 1, b > 1$, then together they can have at most

$$\binom{a}{2} + \binom{b}{2} = \frac{1}{2}(a^2 - a + b^2 - b) \text{ edges.}$$

However, if we place all but one of the vertices in a single component, we could have

$$\begin{aligned} \binom{a+b-1}{2} + \binom{1}{2} &= \frac{1}{2}(a+b-1)(a+b-2) \\ &= \frac{1}{2}(a^2 + 2ab - 3a + b^2 - 3b + 2) \text{ edges.} \end{aligned}$$

Subtracting the first quantity from the second gives

$$\frac{1}{2}((2ab - 3a - 3b + 2) - (-a - b)) = ab - a - b + a = (a - 1)(b - 1) \text{ which is } > 0$$

Hence it is better not to have two components with multiple vertices.

This leaves us with the answer that all components should have one vertex except one, which will have $n - k + 1$ vertices, for a total of $\binom{n-k+1}{2}$ edges.

in simple connected graph , number of edges ,

$$(n - 1) \leq e \leq n \cdot \frac{(n-1)}{2}$$

in simple unconnected graph with k component , number of edges ,

$$(n - k) \leq e \leq (n - k) \cdot \frac{(n-k+1)}{2}$$

note :- put k=1 then it will be connected graph .

reference @ <http://www.quora.com/What-is-the-maximum-number-of-edges-in-graph-with-n-vertices-and-k-components>

another read @ <http://stackoverflow.com/questions/24003861/maximum-number-of-edges-in-undirected-graph-with-n-vertices-with-k-connected-com>

12 votes

-- Mithlesh Upadhyay (3.6k points)

8.3.2 Connected Components: GATE2003-8, ISRO2009-53 [top](#)

<http://gateoverflow.in/899>



Selected Answer

If a vertex is removed from the graph G ,

Lower Bound: number of components decreased by one = $k - 1$ (remove an isolated vertex which was a component)

Upper Bound: number of components = $n - 1$ (consider a vertex connected to all other vertices in a component as in a star and all other vertices outside this component being isolated. Now, removing the considered vertex makes all other $n - 1$ vertices isolated making $n - 1$ components)

Therefore (C).

19 votes

-- Danish (2.4k points)

8.3.3 Connected Components: GATE2014-3_51 [top](#)

<http://gateoverflow.in/2085>



Selected Answer

a forest is a collection of trees. here we are given a forest with n vertices and k components. a component is itself a tree.

since there are k components means that every component has a root(every tree has one), therefore we have k roots.

introduction of each new vertex to the forest introduces a single edge to a forest. so for remaining $n-k$ vertices when introduced, to make up to n vertices, contributes to $n-k$ edges.

Hence, ans = **option C** = $(n-k)$

5 votes

-- Amar Vashishth (20.7k points)

8.4

Cutvertices&edges [top](#)

8.4.1 Cutvertices&edges: GATE1999_5 [top](#)

<http://gateoverflow.in/1504>

Let G be a connected, undirected graph. A cut in G is a set of edges whose removal results in G being broken into two or more components, which are not connected with each other. The size of a cut is called its cardinality. A min-cut of G is a cut in G of minimum cardinality. Consider the following graph.

- a. Which of the following sets of edges is a cut

- i. $\{(A, B), (E, F), (B, D), (A, E), (A, D)\}$
ii. $\{(B, D), (C, F), (A, B)\}$
- b. What is cardinality of min-cut in this graph?
- c. Prove that if a connected undirected graph G with n vertices has a min-cut of cardinality k , then G has at least $(nk/2)$ edges
5. Let G be a connected, undirected graph. A cut in G is a set of edges whose removal results in G being broken into two or more components, which are not connected with each other. The size of a cut is called its cardinality. A min-cut of G is a cut in G of minimum cardinality. Consider the following graph.
-
- (a) Which of the following sets of edges is a cut?
(i) $\{(A, B), (E, F), (B, D), (A, E), (A, D)\}$
(ii) $\{(B, D), (C, F), (A, B)\}$
- (b) What is the cardinality of min-cut in this graph?
- (c) Prove that if a connected undirected graph G with n vertices has a min-cut of cardinality k , then G has at least $(nk/2)$ edges.

gate1999 | graph-theory | cutvertices&edges | normal

Answer

Answers: Cutvertices&edges

8.4.1 Cutvertices&edges: GATE1999_5 [top](#)

<http://gateoverflow.in/1504>



Selected Answer

Answer :-

a

(i) Not a cut. We have spanning tree after removing this edges.

(ii) This is cut. we break graph into two pieces.

B) Min cut size -> 2. (BC,CF). Removing this two edges disconnects C from remaining graph.

4 5 votes

-- Akash (31.7k points)

8.5

Graph Coloring [top](#)

8.5.1 Graph Coloring: GATE2002_1.4 [top](#)

<http://gateoverflow.in/808>

The minimum number of colours required to colour the vertices of a cycle with n nodes in such a way that no two adjacent nodes have the same colour is

- A. 2
- B. 3
- C. 4
- D. $n - 2 \lfloor \frac{n}{2} \rfloor + 2$

gate2002 | graph-theory | graph-coloring | normal

Answer

8.5.2 Graph Coloring: GATE 2016-2-03 [top](#)<http://gateoverflow.in/39553>

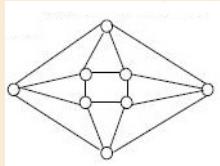
The minimum number of colours that is sufficient to vertex-colour any planar graph is _____.

[gate2016-2](#) [graph-theory](#) [graph-coloring](#) [normal](#) [numerical-answers](#)

[Answer](#)

8.5.3 Graph Coloring: GATE2004_77 [top](#)<http://gateoverflow.in/1071>

The minimum number of colours required to colour the following graph, such that no two adjacent vertices are assigned the same color, is



- A. 2
- B. 3
- C. 4
- D. 5

[gate2004](#) [graph-theory](#) [graph-coloring](#) [easy](#)

[Answer](#)

8.5.4 Graph Coloring: GATE2006-IT_25 [top](#)<http://gateoverflow.in/3564>

Consider the undirected graph G defined as follows. The vertices of G are bit strings of length n . We have an edge between vertex u and vertex v if and only if u and v differ in exactly one bit position (in other words, v can be obtained from u by flipping a single bit). The ratio of the chromatic number of G to the diameter of G is

- | | |
|----|---------------|
| A) | $1/(2^{n-1})$ |
| B) | $1/n$ |
| C) | $2/n$ |
| D) | $3/n$ |

[gate2006-it](#) [graph-theory](#) [graph-coloring](#) [normal](#)

[Answer](#)

Answers: Graph Coloring**8.5.1 Graph Coloring: GATE2002_1.4** [top](#)<http://gateoverflow.in/808>

Selected Answer

Chromatic number will be 3 for when n is odd and will be 2 when n is even. Option (d) is a representation for this, hence the correct answer

10 votes

-- Madhur Rawat (2.4k points)

8.5.2 Graph Coloring: GATE 2016-2-03 [top](#)<http://gateoverflow.in/39553>



Selected Answer

Four colour theorem is famous result, it says that any planar graphs can be coloured with only 4 colours !

Ref -> https://en.wikipedia.org/wiki/Four_color_theorem

Note for confused people => 😊

Here ANY is used in sense of FOR ALL x , so , here ANY means literally any one of graph can be selected !

What are you saying , is something like There exists, but in that case, they will say, That specific graph directly..

Any man alive is gonna die => This means all men are gonna die ! Not specific to anyone !
Hope this clears thing a bit !

12 votes

-- Akash (31.7k points)

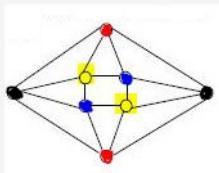
8.5.3 Graph Coloring: GATE2004_77 [top](#)

<http://gateoverflow.in/1071>



Selected Answer

4 colors are required to color the graph in the prescribed way.



answer = **option C**

4 votes

-- Amar Vashishth (20.7k points)

8.5.4 Graph Coloring: GATE2006-IT_25 [top](#)

<http://gateoverflow.in/3564>



Selected Answer

Answer is (C)

For the given condition we can simply design a K-MAP and mark an edge between every two adjacent cells in K-Map.(adjacency has to seen just as we do for minimization)

That will give us a Bipartite graph. chromatic number for this =2

Also from the same we can conclude that we need ,for a 'n' bit string, to traverse NO MORE than $(n-1)$ edges or 'n' vertices to get a path b/w two arbitrary points.

So ratio is $2/n$.

The given graph is actually hypercube graph.

https://en.wikipedia.org/wiki/Hypercube_graph

See problem 4 here:

http://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-042j-mathematics-for-computer-science-spring-2005/assignments/pset5_soln.pdf

9 votes

-- Sandeep_Uniyal (5.5k points)

8.6

Graph Connectivity top8.6.1 Graph Connectivity: GATE1993_8.1 top<http://gateoverflow.in/2299>

Consider a simple connected graph G with n vertices and n edges ($n > 2$). Then, which of the following statements are true?

- A. G has no cycles
- B. The graph obtained by removing any edge from G is not connected
- C. G has at least one cycle
- D. The graph obtained by removing any two edges from G is not connected
- E. None of the above

[gate1993](#) [graph-theory](#) [graph-connectivity](#) [easy](#)

Answer

8.6.2 Graph Connectivity: GATE2015-2_50 top<http://gateoverflow.in/8252>

In a connected graph, a bridge is an edge whose removal disconnects the graph. Which one of the following statements is true?

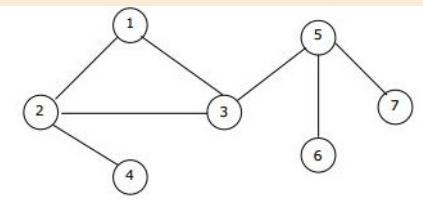
- A. A tree has no bridges
- B. A bridge cannot be part of a simple cycle
- C. Every edge of a clique with size ≥ 3 is a bridge (A clique is any complete subgraph of a graph)
- D. A graph with bridges cannot have cycle

[gate2015-2](#) [graph-theory](#) [graph-connectivity](#) [easy](#)

Answer

8.6.3 Graph Connectivity: GATE1999_1.15 top<http://gateoverflow.in/1468>

The number of articulation points of the following graph is



- A. 0
- B. 1
- C. 2
- D. 3

[gate1999](#) [graph-theory](#) [graph-connectivity](#) [normal](#)

Answer

8.6.4 Graph Connectivity: GATE2004-IT_5 top<http://gateoverflow.in/3646>

What is the maximum number of edges in an acyclic undirected graph with n vertices?

- A) $n - 1$
 B) n
 C) $n + 1$
 D) $2n - 1$

gate2004-it graph-theory graph-connectivity normal

Answer

8.6.5 Graph Connectivity: GATE2005-IT_56 [top](#)

<http://gateoverflow.in/3817>

Let G be a directed graph whose vertex set is the set of numbers from 1 to 100. There is an edge from a vertex i to a vertex j iff either $j = i + 1$ or $j = 3i$. The minimum number of edges in a path in G from vertex 1 to vertex 100 is

- A) 4
 B) 7
 C) 23
 D) 99

gate2005-it graph-theory graph-connectivity normal

Answer

8.6.6 Graph Connectivity: GATE2004-IT_37 [top](#)

<http://gateoverflow.in/3680>

What is the number of vertices in an undirected connected graph with 27 edges, 6 vertices of degree 2, 3 vertices of degree 4 and remaining of degree 3?

- A) 10
 B) 11
 C) 18
 D) 19

gate2004-it graph-theory graph-connectivity normal

Answer

8.6.7 Graph Connectivity: GATE2006-IT_11 [top](#)

<http://gateoverflow.in/3550>

If all the edge weights of an undirected graph are positive, then any subset of edges that connects all the vertices and has minimum total weight is a

- A) Hamiltonian cycle
 B) grid
 C) hypercube
 D) tree

gate2006-it graph-theory graph-connectivity normal

Answer

8.6.8 Graph Connectivity: GATE2008-IT_27 [top](#)

<http://gateoverflow.in/3317>

G is a simple undirected graph. Some vertices of G are of odd degree. Add a node v to G and make it adjacent to each odd degree vertex of G . The resultant graph is sure to be

- A) regular

- B) complete
 C) Hamiltonian
 D) Euler

gate2008-it graph-theory graph-connectivity normal

[Answer](#)

8.6.9 Graph Connectivity: GATE1995_1.25 [top](#)

<http://gateoverflow.in/2612>

The minimum number of edges in a connected cyclic graph on n vertices is:

- (a) $n - 1$
 (b) n
 (c) $n + 1$
 (d) None of the above

gate1995 graph-theory graph-connectivity easy

[Answer](#)

8.6.10 Graph Connectivity: GATE2014-2_3 [top](#)

<http://gateoverflow.in/1955>

The maximum number of edges in a bipartite graph on 12 vertices is _____

gate2014-2 graph-theory graph-connectivity numerical-answers normal

[Answer](#)

Answers: Graph Connectivity

8.6.1 Graph Connectivity: GATE1993_8.1 [top](#)

<http://gateoverflow.in/2299>



Selected Answer

This seems like multiple answer questions.

Here we have n vertices & n edges. So we must have cycle.

So C) has at least one cycle is True & A) is false.

D) The graph obtained by removing any two edges from G is not connected \rightarrow This is true, for graph of n vertices to be connected, we need at least $n-1$ edges. If we remove 2 out of n , we get $n-2$ edges, which can connect at max $n-1$ vertices. 1 vertex at least will be disconnected. So D is true.

B) B is false as if graph is cyclic graph then removing any edge will not disconnect graph.

ANSWER \rightarrow C & D.

3 votes

-- Akash (31.7k points)

if there are n vertices if you want to make it as a connected graph , there should be at least $n-1$ edges. hence if we remove two edges, it wont be a connected graph hence answer :d

3 votes

-- Sankaranarayanan P.N (9.8k points)

8.6.2 Graph Connectivity: GATE2015-2_50 [top](#)

<http://gateoverflow.in/8252>



Selected Answer

Ans B

In a cycle if we remove an edge, it will still be connected. So, bridge cannot be part of a cycle.

12 votes

-- Vikrant Singh (11k points)

8.6.3 Graph Connectivity: GATE1999_1.15 [top](#)

<http://gateoverflow.in/1468>



Selected Answer

ARTICULATION POINT: are those points whose removal from the graph makes the graph disconnected.!!

here if we remove the vertex no 2 than we get disconnected graph.

similarly if we remove the vertex no 3 than we get disconnected graph.

similarly if we remove the vertex no 5 than we get disconnected graph.

So, D choice.

8 votes

-- kunal chalotra (6.3k points)

8.6.4 Graph Connectivity: GATE2004-IT_5 [top](#)

<http://gateoverflow.in/3646>



Selected Answer

This is possible with spanning tree.

A spanning tree with n nodes has $n-1$ edges.

Therefore, Answer is (A)

6 votes

-- Dhananjay (737 points)

8.6.5 Graph Connectivity: GATE2005-IT_56 [top](#)

<http://gateoverflow.in/3817>



Selected Answer

Edge set consists of edges from i to j using either

- 1) $j = i+1$ OR
- 2) $j=3i$.

Second option will help us reach from 1 to 100 rapidly.

The trick to solve this question is to **think in reverse way**. Instead of finding a path from 1 to 100, try to find a path from 100 to 1.

The edge sequence with minimum number of edges is 1 - 3 - 9 - 10 - 11 - 33 - 99 - 100 which consists of 7 edges.
The answer is option 2.

14 votes

-- Shridhar (393 points)

8.6.6 Graph Connectivity: GATE2004-IT_37 [top](#)

<http://gateoverflow.in/3680>



Selected Answer

sum of degree of all the vertices = $2 * \text{number of edges}$

$$2*6 + 4*3 + 3*x = 27*2$$

$x=10$.

Number of vertices = $6 + 3 + x = 19$
The correct answer is (D).

11 votes

-- suraj (3.7k points)

8.6.7 Graph Connectivity: GATE2006-IT_11 top

<http://gateoverflow.in/3550>

A) Hamiltonian cycle -> This is cycle guys. Cycle will not only connect all vertices, it will have 1 extra edge than necessary. So I can just remove that edge & get better cost "subset of edges" which connect all vertices. So this is false.

B) grid -> This is unrelated concept. This is false.

ref-> https://en.wikipedia.org/wiki/Electrical_grid

C) Hypercube -> This is also unrelated concept. Also it have cycles too..This is false.

D) Tree -> This is answer. We need to have Minimum spanning Tree to be exact.

Ref -> https://en.wikipedia.org/wiki/Minimum_spanning_tree

"If all the edge weights of an undirected graph are positive, then any subset of edges that connects all the vertices and has minimum total weight is a Minimum Spanning Tree". !

D is true.

6 votes

-- Akash (31.7k points)

8.6.8 Graph Connectivity: GATE2008-IT_27 top

<http://gateoverflow.in/3317>



Selected Answer

In any simple undirected graph, total degree of all vertices is even (since each edge contributes 2 degrees). So number of vertices having odd degrees must be even, otherwise their sum would have been odd, making total degree also odd.

Now Single vertex v is connected to all these even number of vertices (which have odd degrees). So degree of v is also even. Moreover, now degree of all vertices which are connected to v is increased by 1, hence vertices which had odd degree earlier now have even degree.

So now, all vertices in graph have even degree, which is necessary and sufficient condition for euler graph. So 4) is correct.

14 votes

-- Happy Mittal (9.5k points)

8.6.9 Graph Connectivity: GATE1995_1.25 top

<http://gateoverflow.in/2612>



Selected Answer

B.

For making a cyclic graph, the minimum number of edges have to be equal to the number of vertices.

12 votes

-- Gate Keeda (17.7k points)

8.6.10 Graph Connectivity: GATE2014-2_3 top

<http://gateoverflow.in/1955>



Selected Answer

Maximum no. of edges occur in a complete bipartite graph i.e. when every vertex has an edge to every opposite vertex.

Number of edges in a complete bipartite graph is $m \cdot n$, where m and n are no. of vertices on each side. This quantity is maximum when $m = n$ i.e. when there are 6 vertices on each side, so answer is 36.

11 votes

-- Happy Mittal (9.5k points)

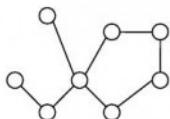
8.7

Graph Isomorphism top

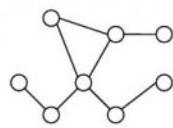
8.7.1 Graph Isomorphism: GATE2012_26 top

<http://gateoverflow.in/1611>

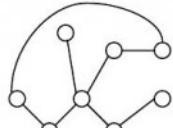
Which of the following graphs is isomorphic to



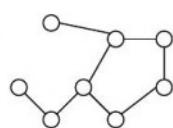
(A)



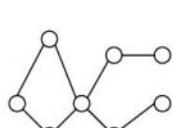
(B)



(C)



(D)



[gate2012](#) [graph-theory](#) [graph-isomorphism](#) [normal](#)

Answer

Answers: Graph Isomorphism

8.7.1 Graph Isomorphism: GATE2012_26 top

<http://gateoverflow.in/1611>



Selected Answer

for this type of questions find which are **not isomorphic**

The graph in option A has a 3 length cycle whereas the original graph does not have a 3 length cycle

The graph in option C has vertex with degree 3 whereas the original graph does not have a vertex with degree 3

The graph in option D has a 4 length cycle whereas the original graph does not have a 4 length cycle

so option B is correct

8 votes

-- Bhagirathi Nayak (11.3k points)

8.8

Graph Matching top

8.8.1 Graph Matching: GATE2003_36 top

<http://gateoverflow.in/926>

How many perfect matching are there in a complete graph of 6 vertices?

- (A) 15 (B) 24 (C) 30 (D) 60

gate2003 | graph-theory | graph-matching | normal

[Answer](#)

Answers: Graph Matching

8.8.1 Graph Matching: GATE2003_36 [top](#)

<http://gateoverflow.in/926>



Selected Answer

Perfect matching is a set of edges such that each vertex appears only once and all vertices appear at least once (EXACTLY one appearance). So for n vertices perfect matching will have $n/2$ edges and there won't be any perfect matching if n is odd.

For $n = 6$, we can choose the first edge in ${}^6C_2 = 15$ ways, second in ${}^4C_2 = 6$ ways and third in ${}^2C_2 = 1$ way. So, total number of ways $= 15 \times 6 = 90$. But perfect matching being a set, order of elements is not important. i.e., the 3! permutations of the 3 edges are same only. So, total number of perfect matching $= 90/3! = 90/6 = 15$.

Alternatively we can also say there are 3 identical buckets to be filled from 6 vertices such that 2 should go to each of them. Now the first vertex can combine with any of the other 5 vertices and go to bucket 1- 5 ways. Now only 4 vertices remain and 2 buckets. We can take one vertex and it can choose a companion in 3 ways and go to second bucket- 3 ways. Now only a single bucket and 2 vertices remain- so just 1 way to fill the last one. So total ways=5*3=15.

11 votes

-- Arjun Suresh (150k points)

8.9

Groups [top](#)

8.9.1 Groups: GATE2014-3_3 [top](#)

<http://gateoverflow.in/2037>

Let G be a group with 15 elements. Let L be a subgroup of G . It is known that $L \neq G$ and that the size of L is at least 4. The size of L is _____.

gate2014-3 | graph-theory | groups | numerical-answers | normal

[Answer](#)

Answers: Groups

8.9.1 Groups: GATE2014-3_3 [top](#)

<http://gateoverflow.in/2037>



Selected Answer

Lagranges theorem : For any finite group G , the order (number of elements) of every subgroup L of G divides the order of G . G has 15 elements.

Factors of 15 are 1,3,5, and 15.

Since given the size of L is atleast 4(1 and 3 eliminated) and not equal to G (15 eliminated) , the only size left is 5.

Size of L is 5.

16 votes

-- Srinath Sri (2.9k points)

8.10

Havel Hakimi Theorem [top](#)

8.10.1 Havel Hakimi Theorem: GATE2010-28 [top](#)

<http://gateoverflow.in/1154>

The degree sequence of a simple graph is the sequence of the degrees of the nodes in the graph in decreasing order. Which of the following sequences can not be the degree sequence of any graph?

- I. 7, 6, 5, 4, 4, 3, 2, 1
- II. 6, 6, 6, 3, 3, 2, 2
- III. 7, 6, 6, 4, 4, 3, 2, 2
- IV. 8, 7, 7, 6, 4, 2, 1, 1
 - A. I and II
 - B. III and IV
 - C. IV only
 - D. II and IV

[gate2010](#) | [graph-theory](#) | [degree-sequence](#) | [havel-hakimi-theorem](#) | [normal](#)

[Answer](#)

8.10.2 Havel Hakimi Theorem: GATE2014-1_52 [top](#)

<http://gateoverflow.in/1932>

An ordered n -tuple (d_1, d_2, \dots, d_n) with $d_1 \geq d_2 \geq \dots \geq d_n$ is called *graphic* if there exists a simple undirected graph with n vertices having degrees d_1, d_2, \dots, d_n respectively. Which one of the following 6-tuples is NOT graphic?

- (A) (1, 1, 1, 1, 1, 1)
- (B) (2, 2, 2, 2, 2, 2)
- (C) (3, 3, 3, 1, 0, 0)
- (D) (3, 2, 1, 1, 1, 0)

[gate2014-1](#) | [graph-theory](#) | [degree-sequence](#) | [havel-hakimi-theorem](#) | [normal](#)

[Answer](#)

Answers: Havel Hakimi Theorem

8.10.1 Havel Hakimi Theorem: GATE2010-28 [top](#)

<http://gateoverflow.in/1154>



Selected Answer

The answer is clearly D.

You can eliminate the last sequence i.e 4th one as... the total number of vertices is 8 and the maximum degree given is 8 too. which isn't possible at all. The maximum degree you can have out of 8 vertices is 7.

Now coming to the method for solving such questions is through Havel-Hakimi Algorithm.

you can implement it by following one simple video. Here it is. :)

7 votes

-- Gate Keeda (17.7k points)

8.10.2 Havel Hakimi Theorem: GATE2014-1_52 [top](#)

<http://gateoverflow.in/1932>



Selected Answer

This can be solved using havel-hakimi theorem.

The idea is simple : Remove a vertex, which results into decrease of degree by 1 of each vertex which was connected to it. Keep removing like this, and if we get any negative degree, the degree sequence was not possible.

We need not check (A) and (B) as they are clearly graphs : (A) is 3 disconnected edges, (B) is 2 disconnected triangles.

For (C), we remove first vertex of degree 3, and thus decrease degree by 1 of next 3 vertices, so we get (2,2,0,0,0), then we remove vertex of degree 2, and decrease degree of next 2 vertices to get (1,-1,0,0). Since we get negative degree, original degree sequence is impossible.

For (D) : (3,2,1,1,1,0) \rightarrow (1,0,0,1,0). Now since this list is not sorted (which is required to apply further steps of algorithm), we sort it to get (1,1,0,0,0). Then we continue our algorithm on this list to get (0,0,0,0), which is valid (4 isolated vertices).

So (C) is answer.

14 votes

-- Happy Mittal (9.5k points)

8.11

Permutation top

8.11.1 Permutation: GATE2012_38 top

<http://gateoverflow.in/473>

Let G be a complete undirected graph on 6 vertices. If vertices of G are labeled, then the number of distinct cycles of length 4 in G is equal to

- (A) 15 (B) 30 (C) 90 (D) 360

gate2012 graph-theory normal marks-to-all permutation

Answer

Answers: Permutation

8.11.1 Permutation: GATE2012_38 top

<http://gateoverflow.in/473>



Selected Answer

From 6 vertices we can select 4 distinct vertices in ${}_6C_4 = 15$ ways.

Now, with 4 vertices, we can form only 3 distinct cycles. [See below]
So, total no. of distinct cycles of length 4 = $15 * 3 = 45$.

No. of cyclic permutations of n objects = $(n-1)!$ and for n = 4, we get $3! = 6$ ways. But number of distinct cycles in a graph is exactly half the number of cyclic permutations as there is no left/right ordering in a graph. For example a - b - c - d and a - d - c - b are different permutations but in a graph they form the same cycle.

Since, 45 was not in the choice, marks were given to all in GATE.

21 votes

-- gatecse (10.7k points)

8.12

Spanning Tree top

8.12.1 Spanning Tree: GATE2007-IT-25 top

<http://gateoverflow.in/348>

What is the largest integer m such that every simple connected graph with n vertices and n edges contains at least m different spanning trees ?

- A. 1

- B. 2
- C. 3
- D. n

gate2007-it graph-theory spanning-tree normal

Answer

Answers: Spanning Tree

8.12.1 Spanning Tree: GATE2007-IT-25 [top](#)

<http://gateoverflow.in/3458>



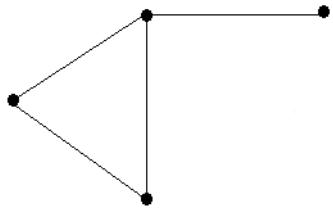
Selected Answer

OPTION (C) is Correct , reason is as follows:

Graph is **connected** and has '**n**' **edges** means **exactly one cycle** is there , if n vertices are there.

Now we can make a different spanning tree by removing one edge from the cycle, one at a time.

Minimum cycle length can be 3 , So, there must be atleast 3 spanning trees in any such Graph.



Consider this Graph ,Here n = 4 and three spanning trees possible at max (removing edges of cycle one at a time, alternatively).

So, any such Graph with minimum cycle length '3' will have atleast 3 spanning trees.

16 votes

-- Himanshu Agarwal (9.8k points)

9 Discrete Mathematics Mathematical Logic (66) [top](#)

9.0.1 GATE2012_1 [top](#)

<http://gateoverflow.in/33>

Consider the following logical inferences.

- I_1 : If it rains then the cricket match will not be played.
The cricket match was played.
Inference: There was no rain.
- I_2 : If it rains then the cricket match will not be played.
It did not rain.
Inference: The cricket match was played.

Which of the following is **TRUE**?

- (A) Both I_1 and I_2 are correct inferences
 (B) I_1 is correct but I_2 is not a correct inference
 (C) I_1 is not correct but I_2 is a correct inference
 (D) Both I_1 and I_2 are not correct inferences

[gate2012](#) [mathematical-logic](#) [easy](#)

[Answer](#)

9.0.2 GATE2004-IT_31 [top](#)

<http://gateoverflow.in/3674>

Let p , q , r and s be four primitive statements. Consider the following arguments:

- P: $[(\neg p \vee q) \wedge (r \rightarrow s) \wedge (p \vee r)] \rightarrow (\neg s \rightarrow q)$
 Q: $[(\neg p \wedge q) \wedge [q \rightarrow (p \rightarrow r)]] \rightarrow \neg r$
 R: $[[((q \wedge r) \rightarrow p) \wedge (\neg q \vee p)] \rightarrow r$
 S: $[p \wedge (p \rightarrow r) \wedge (q \vee \neg r)] \rightarrow q$

Which of the above arguments are valid?

- A) P and Q only
 B) P and R only
 C) P and S only
 D) P, Q, R and S

[gate2004-it](#) [mathematical-logic](#) [normal](#)

[Answer](#)

9.0.3 GATE2014-3_53 [top](#)

<http://gateoverflow.in/2087>

The CORRECT formula for the sentence, "not all Rainy days are Cold" is

- (A) $\forall d(\text{Rainy}(d) \wedge \neg \text{Cold}(d))$
 (B) $\forall d(\neg \text{Rainy}(d) \rightarrow \text{Cold}(d))$
 (C) $\exists d(\neg \text{Rainy}(d) \rightarrow \text{Cold}(d))$
 (D)

$\exists(\text{Rainy}(d) \wedge \neg\text{Cold}(d))$

gate2014-3 | mathematical-logic | easy

Answer

9.0.4 GATE2011_30 top

<http://gateoverflow.in/2132>

Which one of the following options is **CORRECT** given three positive integers x, y and z , and a predicate

$$P(x) = \neg(x = 1) \wedge \forall y (\exists z (x = y * z) \Rightarrow (y = x) \vee (y = 1))$$

(A)
 $P(x)$ being true means that
 x is a prime number

(B)
 $P(x)$ being true means that
 x is a number other than 1

(C)
 $P(x)$ is always true irrespective of the value of
 x

(D)
 $P(x)$ being true means that
 x has exactly two factors other than 1 and
 x

gate2011 | mathematical-logic | normal

Answer

9.0.5 GATE1997_3.2 top

<http://gateoverflow.in/2233>

Which of the following propositions is a tautology?

- A. $(p \vee q) \rightarrow p$
- B. $p \vee (q \rightarrow p)$
- C. $p \vee (p \rightarrow q)$
- D. $p \rightarrow (p \rightarrow q)$

gate1997 | mathematical-logic | easy

Answer

9.0.6 GATE1993_8.2 top

<http://gateoverflow.in/2300>

The proposition $p \wedge (\sim p \vee q)$ is:

- A. a tautology
- B. logically equivalent to $p \wedge q$
- C. logically equivalent to $p \vee q$
- D. a contradiction
- E. none of the above

gate1993 | mathematical-logic | easy

Answer

9.0.7 GATE1993_18 [top](#)<http://gateoverflow.in/2315>

Show that proposition C is a logical consequence of the formula

$$A \wedge (A \rightarrow (B \vee C)) \wedge (B \rightarrow \neg A)$$

using truth tables.

[gate1993](#) [mathematical-logic](#) [normal](#)

[Answer](#)

9.0.8 GATE1994_3.13 [top](#)<http://gateoverflow.in/2499>

Let p and q be propositions. Using only the Truth Table, decide whether

$p \iff q$ does not imply $p \rightarrow \neg q$

is **True** or **False**.

[gate1994](#) [mathematical-logic](#) [normal](#)

[Answer](#)

9.0.9 GATE1995_2.19 [top](#)<http://gateoverflow.in/2631>

If the proposition $\neg p \rightarrow v$ is true, then the truth value of the proposition $\neg p \vee (p \rightarrow q)$, where \neg is negation, \vee is inclusive OR and \rightarrow is implication, is

- a) True
- b) Multiple Values
- c) False
- d) Cannot be determined

[gate1995](#) [mathematical-logic](#) [normal](#)

[Answer](#)

9.0.10 GATE1996_2.3 [top](#)<http://gateoverflow.in/2732>

Which of the following is false? Read \wedge as AND, \vee as OR, \sim as NOT, \rightarrow as one way implication and \leftrightarrow as two way implication

- A. $((x \rightarrow y) \wedge x) \rightarrow y$
- B. $((\sim x \rightarrow y) \wedge (\sim x \rightarrow \sim y)) \rightarrow x$
- C. $(x \rightarrow (x \vee y))$
- D. $((x \vee y) \leftrightarrow (\sim x \rightarrow \sim y))$

[gate1996](#) [mathematical-logic](#) [normal](#)

[Answer](#)

9.0.11 GATE2008-IT_22 [top](#)<http://gateoverflow.in/3283>

Which of the following is the negation of $[\forall x, a \rightarrow (\exists y, \beta \rightarrow (\forall u, \exists v, y))]$

- A. $[\exists x, a \rightarrow (\forall y, \beta \rightarrow (\exists u, \forall v, y))]$

- B: $\exists x \forall y \neg (\forall y \beta \neg \beta (\exists u \forall y \neg y))$
 D. $\exists x, a \wedge (\forall y, \beta \wedge (\exists u, \forall v, \neg y))$

gate2008-it | mathematical-logic | normal

Answer

9.0.12 GATE2007-IT-21 top

<http://gateoverflow.in/3454>

Which one of these first-order logic formulae is valid?

- A. $\forall x(P(x) \Rightarrow Q(x)) \Rightarrow (\forall xP(x) \Rightarrow \forall xQ(x))$
- B. $\exists x(P(x) \vee Q(x)) \Rightarrow (\exists xP(x) \Rightarrow \exists xQ(x))$
- C. $\exists x(P(x) \wedge Q(x)) \Leftrightarrow (\exists xP(x) \wedge \exists xQ(x))$
- D. $\forall x \exists y P(x, y) \Rightarrow \exists y \forall x P(x, y)$

gate2007-it | mathematical-logic | normal

Answer

9.0.13 GATE2006-IT_21 top

<http://gateoverflow.in/3560>

Consider the following first order logic formula in which R is a binary relation symbol.

$$\forall x \forall y (R(x, y) \Rightarrow R(y, x))$$

The formula is

- A) satisfiable and valid
- B) satisfiable and so is its negation
- C) unsatisfiable but its negation is valid
- D) satisfiable but its negation is unsatisfiable

gate2006-it | mathematical-logic | normal

Answer

9.0.14 GATE2004-IT_3 top

<http://gateoverflow.in/3644>

Let $a(x, y), b(x, y)$ and $c(x, y)$ be three statements with variables x and y chosen from some universe. Consider the following statement:

$$(\exists x)(\forall y)[(a(x, y) \wedge b(x, y)) \wedge \neg c(x, y)]$$

Which one of the following is its equivalent?

- A) $(\forall x)(\exists y)[(a(x, y) \vee b(x, y)) \rightarrow c(x, y)]$
- B) $(\exists x)(\forall y)[(a(x, y) \vee b(x, y)) \wedge \neg c(x, y)]$
- C) $\neg(\forall x)(\exists y)[(a(x, y) \wedge b(x, y)) \rightarrow c(x, y)]$
- D) $\neg(\forall x)(\exists y)[(a(x, y) \vee b(x, y)) \rightarrow c(x, y)]$

gate2004-it | mathematical-logic | normal

Answer

9.0.15 GATE2005-IT_36 top

<http://gateoverflow.in/3783>

Let $P(x)$ and $Q(x)$ be arbitrary predicates. Which of the following statements is always TRUE?

- A. $((\forall x(P(x) \vee Q(x)))) \Rightarrow ((\forall xP(x)) \vee (\forall xQ(x)))$
- B. $((\forall x(P(x) \Rightarrow Q(x)))) \Rightarrow ((\forall xP(x)) \Rightarrow (\forall xQ(x)))$
- C. $((\forall x(P(x)) \Rightarrow \forall x(Q(x)))) \Rightarrow ((\forall x(P(x) \Rightarrow Q(x)))$
- D. $((\forall x(P(x)) \Leftrightarrow (\forall x(Q(x)))) \Rightarrow ((\forall x(P(x) \Leftrightarrow Q(x)))$

[gate2005-it](#) | [mathematical-logic](#) | [normal](#)
Answer**9.0.16 GATE2014-1_53** [top](#)<http://gateoverflow.in/1933>

Which one of the following propositional logic formulas is TRUE when exactly two of p , q and r are **TRUE**?

- (A) $((p \leftrightarrow q) \wedge r) \vee (p \wedge q \wedge \sim r)$
- (B) $(\sim (p \leftrightarrow q) \wedge r) \vee (p \wedge q \wedge \sim r)$
- (C) $((p \rightarrow q) \wedge r) \vee (p \wedge q \wedge \sim r)$
- (D) $(\sim (p \leftrightarrow q) \wedge r) \wedge (p \wedge q \wedge \sim r)$

[gate2014-1](#) | [mathematical-logic](#) | [normal](#)
Answer**9.0.17 GATE2002_5b** [top](#)<http://gateoverflow.in/3915>

Determine whether each of the following is a tautology, a contradiction, or neither (" \vee " is disjunction, " \wedge " is conjunction, " \rightarrow " is implication, " \neg " is negation, and " \leftrightarrow " is biconditional (if and only if).

- A. $A \leftrightarrow (A \vee A)$
- B. $(A \vee B) \rightarrow B$
- C. $A \wedge (\neg(A \vee B))$

[gate2002](#) | [mathematical-logic](#) | [easy](#)
Answer**9.0.18 GATE2015-2_3** [top](#)<http://gateoverflow.in/8049>

Consider the following two statements.

S1: If a candidate is known to be corrupt, then he will not be elected

S2: If a candidate is kind, he will be elected

Which one of the following statements follows from S1 and S2 as per sound inference rules of logic?

- A. If a person is known to be corrupt, he is kind
- B. If a person is not known to be corrupt, he is not kind
- C. If a person is kind, he is not known to be corrupt
- D. If a person is not kind, he is not known to be corrupt

[gate2015-2](#) | [mathematical-logic](#) | [normal](#)
Answer**9.0.19 GATE2015-1_14** [top](#)<http://gateoverflow.in/8209>

Which one of the following is NOT equivalent to $p \leftrightarrow q$?

- A. $(\Box p \vee q) \wedge (p \vee \neg q)$
 B. $(\Box p \vee q) \wedge (q \rightarrow p)$
 C. $(\Box p \wedge q) \vee (p \wedge \neg q)$
 D. $(\Box p \wedge \neg q) \vee (p \wedge q)$

gate2015-1 | mathematical-logic | easy

Answer

9.0.20 GATE2015-2_55 top

<http://gateoverflow.in/8259>

Which one of the following well formed formulae is a tautology?

- A. $\forall x \exists y R(x, y) \leftrightarrow \exists y \forall x R(x, y)$
 B. $(\forall x [\exists y R(x, y) \rightarrow S(x, y)]) \rightarrow \forall x \exists y S(x, y)$
 C. $[\forall x \exists y (P(x, y) \rightarrow R(x, y))] \leftrightarrow [\forall x \exists y (\neg P(x, y) \vee R(x, y))]$
 D. $\forall x \forall y P(x, y) \rightarrow \forall x \forall y P(y, x)$

gate2015-2 | mathematical-logic | normal

Answer

9.0.21 GATE2015-3_24 top

<http://gateoverflow.in/8427>

In a room there are only two types of people, namely Type 1 and Type 2. Type 1 people always tell the truth and Type 2 people always lie. You give a fair coin to a person in that room, without knowing which type he is from and tell him to toss it and hide the result from you till you ask for it. Upon asking the person replies the following

"The result of the toss is head if and only if I am telling the truth"

Which of the following options is correct?

- A. The result is head
 B. The result is tail
 C. If the person is of Type 2, then the result is tail
 D. If the person is of Type 1, then the result is tail

gate2015-3 | mathematical-logic | difficult

Answer

9.0.22 TIFR2011-A-12 top

<http://gateoverflow.in/20221>

The action for this problem takes place in an island of Knights and Knaves, where Knights always make true statements and Knaves always make false statements and everybody is either a Knight or a Knave. Two friends A and B lives in a house. The census taker (an outsider) knocks on the door and it is opened by A. The census taker says "I need information about you and your friend. Which if either is a Knight and which if either is a Knave?". "We are both Knaves" says A angrily and slams the door. What, if any thing can the census taker conclude?

- a. A is a Knight and B is a Knave.
 b. A is a Knave and B is a Knight.
 c. Both are Knaves.
 d. Both are Knights.
 e. No conclusion can be drawn.

tifr2011 | mathematical-logic

Answer

9.0.23 TIFR2012-A-2 top

<http://gateoverflow.in/20939>

If Mr. M is guilty, then no witness is lying unless he is afraid. There is a witness who is afraid. Which of the following statements is true?

(Hint: Formulate the problem using the following predicates

- $G - Mr. M$ is guilty
 - $W(x) - x$ is a witness
 - $L(x) - x$ is lying
 - $A(x) - x$ is afraid)
- $Mr. M$ is guilty.
 - $Mr. M$ is not guilty.
 - From these facts one cannot conclude that $Mr. M$ is guilty.
 - There is a witness who is lying.
 - No witness is lying.

tifr2012 mathematical-logic

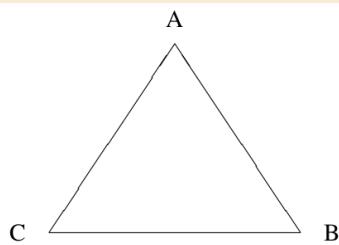
Answer

9.0.24 TIFR2012-A-3 [top](#)

<http://gateoverflow.in/20981>

Long ago, in a planet far far away, there lived three races of intelligent inhabitants: the blues (who always tell the truth), the whites (who always lie), and the pinks (who, when asked a series of questions, start with a lie and then tell the truth and lie alternately). To three creatures, chosen from the planet and seated facing each other at A , B , and C (see figure), the following three questions are put:

- What race is your left-hand neighbour?
- What race is your right-hand neighbour?
- What race are you?



Here are their answers:

- (A) (i) White (ii) Pink (iii) Blue
 (B) (i) Pink (ii) Pink (iii) Blue
 (C) (i) White (ii) Blue (iii) Blue

What is the actual race of each of the three creatures?

- A is Pink, B is White, C is Blue.
- A is Blue, B is Pink, C is White.
- A is Pink, B is Blue, C is Pink.
- A is White, B is Pink, C is Blue.
- Cannot be determined from the above data.

tifr2012 mathematical-logic

Answer

9.0.25 TIFR2014-A-8 [top](#)

<http://gateoverflow.in/25994>

All that glitters is gold. No gold is silver.

Claims:

- No silver glitters.
- Some gold glitters.

Then, which of the following is TRUE?

- a. Only claim 1 follows.
- b. Only claim 2 follows.
- c. Either claim 1 or claim 2 follows but not both.
- d. Neither claim 1 nor claim 2 follows.
- e. Both claim 1 and claim 2 follow.

[tifr2014](#) | [mathematical-logic](#)

Answer

9.0.26 GATE1991-15,b [top](#)

<http://gateoverflow.in/26748>

(b)

Consider the following first order formula:

$$\left(\begin{array}{c}
 \forall x \exists y : R(x, y) \\
 \wedge \\
 \forall x \forall y : \quad (\quad \quad R(x, y) \implies \neg R(y, x) \quad) \\
 \wedge \\
 \forall x \forall y \forall z : \quad (\quad \quad R(x, y) \wedge R(y, z) \implies R(x, z) \quad) \\
 \wedge \\
 \forall x : \neg R(x, x)
 \end{array} \right)$$

Does it have finite models?

Is it satisfiable? If so, give a countable model for it.

[gate1991](#)

Answer

9.0.27 TIFR2015-A-5 [top](#)

<http://gateoverflow.in/29454>

What is logically equivalent to "If Kareena and Parineeti go to the shopping mall then it is raining":

- a. If Kareena and Parineeti do not go to the shopping mall then it is not raining.
- b. If Kareena and Parineeti do not go to the shopping mall then it is raining.
- c. If it is raining then Kareena and Parineeti go to the shopping mall.
- d. If it is not raining then Kareena and Parineeti do not go to the shopping mall.
- e. None of the above.

[tifr2015](#) | [mathematical-logic](#)

Answer

9.0.28 GATE 2016-2-01 [top](#)

<http://gateoverflow.in/39568>

Consider the following expressions:

- i. *false*
- ii. *Q*
- iii. *true*
- iv. *P ∨ Q*
- v. *¬Q ∨ P*

The number of expressions given above that are logically implied by $P \wedge (P \Rightarrow Q)$ is _____.

gate2016-2 | mathematical-logic | normal | numerical-answers

[Answer](#)

9.0.29 GATE2012_13 [top](#)

<http://gateoverflow.in/45>

What is the correct translation of the following statement into mathematical logic?

"Some real numbers are rational"

- (A) $\exists x(\text{real}(x) \vee \text{rational}(x))$
- (B) $\forall x(\text{real}(x) \rightarrow \text{rational}(x))$
- (C) $\exists x(\text{real}(x) \wedge \text{rational}(x))$
- (D) $\exists x(\text{rational}(x) \rightarrow \text{real}(x))$

gate2012 | mathematical-logic | easy

[Answer](#)

9.0.30 GATE2014-3_1 [top](#)

<http://gateoverflow.in/2035>

Consider the following statements:

P: Good mobile phones are not cheap

Q: Cheap mobile phones are not good

L: P implies Q

M: Q implies P

N: P is equivalent to Q

Which one of the following about L, M, and N is **CORRECT**?

- (A) Only L is TRUE.
- (B) Only M is TRUE.
- (C) Only N is TRUE.
- (D) L, M and N are TRUE.

gate2014-3 | mathematical-logic | easy

[Answer](#)

9.0.31 GATE1998_1.5 [top](#)

<http://gateoverflow.in/1642>

What is the converse of the following assertion?

I stay only if you go

- A. I stay if you go
- B. If I stay then you go
- C. If you do not go then I do not stay
- D. If I do not stay then you go

gate1998 mathematical-logic easy

Answer

9.0.32 GATE2002_1.8 top<http://gateoverflow.in/812>

"If X then Y unless Z" is represented by which of the following formulas in propositional logic? (" \neg " is negation, " \wedge " is conjunction, and " \rightarrow " is implication)

- A. $(X \wedge \neg Z) \rightarrow Y$
- B. $(X \wedge Y) \rightarrow \neg Z$
- C. $X \rightarrow (Y \wedge \neg Z)$
- D. $(X \rightarrow Y) \wedge \neg Z$

gate2002 mathematical-logic normal

Answer

9.0.33 GATE2013_47 top<http://gateoverflow.in/80>

Which one of the following is **NOT** logically equivalent to $\neg \exists x(\forall y(\alpha) \wedge \forall z(\beta))$?

- (A) $\forall x(\exists z(\neg \beta) \rightarrow \forall y(\alpha))$
- (B) $\forall x(\forall z(\beta) \rightarrow \exists y(\neg \alpha))$
- (C) $\forall x(\forall y(\alpha) \rightarrow \exists z(\neg \beta))$
- (D) $\forall x(\exists y(\neg \alpha) \rightarrow \exists z(\neg \beta))$

mathematical-logic normal marks-to-all gate2013

Answer

9.0.34 TIFR2011-A-1 top<http://gateoverflow.in/237>

If either wages or prices are raised, there will be inflation. If there is inflation, then either the government must regulate it or the people will suffer. If the people suffer, the government will be unpopular. Government will not be unpopular. Which of the following can be validly concluded from the above statements.

- A. People will not suffer
- B. If the inflation is not regulated, then wages are not raised
- C. Prices are not raised
- D. If the inflation is not regulated, then the prices are not raised
- E. Wages are not raised

tifr2011 mathematical-logic normal

Answer

9.0.35 GATE1992_92,xv top<http://gateoverflow.in/256>

Which of the following predicate calculus statements is/are valid?

- (1) $(\forall(x))P(x) \vee (\forall(x))Q(x) \implies (\forall(x))(P(x) \vee Q(x))$
- (2) $(\exists(x))P(x) \wedge (\exists(x))Q(x) \implies (\exists(x))(P(x) \wedge Q(x))$
- (3) $(\forall(x))(P(x) \vee Q(x)) \implies (\forall(x))P(x) \vee (\forall(x))Q(x)$
- (4) $(\exists(x))(P(x) \vee Q(x)) \implies \sim (\forall(x))P(x) \vee (\exists(x))Q(x)$

gate1992 mathematical-logic normal

Answer

9.0.36 GATE2008-30 [top](#)<http://gateoverflow.in/441>

Let fsa and pda be two predicates such that $\text{fsa}(x)$ means x is a finite state automaton and $\text{pda}(y)$ means that y is a pushdown automaton. Let equivalent be another predicate such that $\text{equivalent}(a, b)$ means a and b are equivalent. Which of the following first order logic statements represent the following?

- Each finite state automaton has an equivalent pushdown automaton
- $(\forall x \text{fsa}(x)) \implies (\exists y \text{pda}(y) \wedge \text{equivalent}(x, y))$
 - $\neg \forall y (\exists x \text{fsa}(x) \implies \text{pda}(y) \wedge \text{equivalent}(x, y))$
 - $\forall x \exists y (\text{fsa}(x) \wedge \text{pda}(y) \wedge \text{equivalent}(x, y))$
 - $\forall x \exists y (\text{fsa}(y) \wedge \text{pda}(x) \wedge \text{equivalent}(x, y))$

[gate2008](#) [easy](#) [mathematical-logic](#)**Answer****9.0.37 GATE2008-31** [top](#)<http://gateoverflow.in/442>

P and Q are two propositions. Which of the following logical expressions are equivalent?

- $P \vee \neg Q$
 - $\neg(\neg P \wedge Q)$
 - $(P \wedge Q) \vee (P \wedge \neg Q) \vee (\neg P \wedge \neg Q)$
 - $(P \wedge Q) \vee (P \wedge \neg Q) \vee (\neg P \wedge Q)$
- Only I and II
 - Only I, II and III
 - Only I, II and IV
 - All of I, II, III and IV

[gate2008](#) [normal](#) [mathematical-logic](#)**Answer****9.0.38 GATE1991_03,xii** [top](#)<http://gateoverflow.in/526>

Choose the correct alternatives (more than one may be correct) and write the corresponding letters only:

If
 F_1 ,
 F_2 and
 F_3 are propositional formulae such that
 $F_1 \wedge F_2 \rightarrow F_3$ and
 $F_1 \wedge F_2 \rightarrow \neg F_3$ are both tautologies, then which of the following is true:

- Both F_1 and F_2 are tautologies
- The conjunction $F_1 \wedge F_2$ is not satisfiable
- Neither is tautologous
- Neither is satisfiable
- None of the above.

[gate1991](#) [mathematical-logic](#) [normal](#)**Answer****9.0.39 GATE1991-15,a** [top](#)<http://gateoverflow.in/542>

Show that the product of the least common multiple and the greatest common divisor of two positive integers a and b is

$a \times b.$

gate1991 | mathematical-logic | normal

Answer

9.0.40 GATE1992_02,xvi top

<http://gateoverflow.in/574>

02. Choose the correct alternatives (more than one may be correct) and write the corresponding letters only:

Which of the following is/are tautology?

- a. $a \vee b \rightarrow b \wedge c$
- b. $a \wedge b \rightarrow b \vee c$
- c. $a \vee b \rightarrow (b \rightarrow c)$
- d. $a \rightarrow b \rightarrow (b \rightarrow c)$

gate1992 | mathematical-logic | easy

Answer

9.0.41 GATE2000-2.7 top

<http://gateoverflow.in/654>

Let a, b, c, d be propositions. Assume that the equivalence $a \Leftrightarrow (b \vee \neg b)$ and $b \Leftrightarrow c$ hold. Then the truth-value of the formula $(a \wedge b) \rightarrow (a \wedge c) \vee d$ is always

- A. True
- B. False
- C. Same as the truth-value of b
- D. Same as the truth-value of d

gate2000 | mathematical-logic | normal

Answer

9.0.42 GATE2001-1.3 top

<http://gateoverflow.in/696>

Consider two well-formed formulas in propositional logic

$$F1 : P \Rightarrow \neg P \quad F2 : (P \Rightarrow \neg P) \vee (\neg P \Rightarrow P)$$

Which one of the following statements is correct?

- A. $F1$ is satisfiable, $F2$ is valid
- B. $F1$ unsatisfiable, $F2$ is satisfiable
- C. $F1$ is unsatisfiable, $F2$ is valid
- D. $F1$ and $F2$ are both satisfiable

gate2001 | mathematical-logic | easy

Answer

9.0.43 GATE2014-1_1 top

<http://gateoverflow.in/769>

Consider the statement

"Not all that glitters is gold"

Predicate $\text{glitters}(x)$ is true if x glitters and predicate $\text{gold}(x)$ is true if x is gold. Which one of the following logical formulae represents the above statement?

- (A)

- $\forall x : \text{glitters}(x) \Rightarrow \neg \text{gold}(x)$
- (B) $\forall x : \text{gold}(x) \Rightarrow \text{glitters}(x)$
- (C) $\exists x : \text{gold}(x) \wedge \neg \text{glitters}(x)$
- (D) $\exists x : \text{glitters}(x) \wedge \neg \text{gold}(x)$

gate2014-1 mathematical-logic

Answer

9.0.44 GATE2009-23 top

<http://gateoverflow.in/800>

Which one of the following is the most appropriate logical formula to represent the statement?

"Gold and silver ornaments are precious".
The following notations are used:

- $G(x)$: x is a gold ornament
- $S(x)$: x is a silver ornament
- $P(x)$: x is precious

- A. $\forall x(P(x) \implies (G(x) \wedge S(x)))$
- B. $\forall x((G(x) \wedge S(x)) \implies P(x))$
- C. $\exists x((G(x) \wedge S(x)) \implies P(x))$
- D. $\forall x((G(x) \vee S(x)) \implies P(x))$

gate2009 mathematical-logic easy

Answer

9.0.45 GATE2009-24 top

<http://gateoverflow.in/801>

The binary operation \square is defined as follows

| P | Q | $P \square Q$ |
|---|---|---------------|
| T | T | T |
| T | F | T |
| F | T | F |
| F | F | T |

Which one of the following is equivalent to $P \vee Q$?

- A. $\neg Q \square \neg P$
 B. $P \square \neg Q$
 C. $\neg P \square Q$
 D. $\neg P \square \neg Q$

gate2009 mathematical-logic easy

Answer

9.0.46 GATE2013_27 top

<http://gateoverflow.in/1538>

What is the logical translation of the following statement?

"None of my friends are perfect."

- (A) $\exists x(F(x) \wedge \neg P(x))$
- (B) $\exists x(\neg F(x) \wedge P(x))$
- (C) $\exists x(\neg F(x) \wedge \neg P(x))$

(D) $\neg \exists x(F(x) \wedge P(x))$

gate2013 | mathematical-logic | easy

Answer

9.0.47 GATE2009-26 [top](#)

<http://gateoverflow.in/803>

Consider the following well-formed formulae:

- I. $\neg \forall x(P(x))$
- II. $\neg \exists x(P(x))$
- III. $\neg \exists x(\neg P(x))$
- IV. $\exists x(\neg P(x))$

Which of the above are equivalent?

- A. I and III
- B. I and IV
- C. II and III
- D. II and IV

gate2009 | mathematical-logic | normal

Answer

9.0.48 GATE2005_41 [top](#)

<http://gateoverflow.in/1166>

What is the first order predicate calculus statement equivalent to the following?

"Every teacher is liked by some student"

- (A) $\forall(x)[\text{teacher}(x) \rightarrow \exists(y)[\text{student}(y) \rightarrow \text{likes}(y, x)]]$
- (B) $\forall(x)[\text{teacher}(x) \rightarrow \exists(y)[\text{student}(y) \wedge \text{likes}(y, x)]]$
- (C) $\exists(y)\forall(x)[\text{teacher}(x) \rightarrow [\text{student}(y) \wedge \text{likes}(y, x)]]$
- (D) $\forall(x)[\text{teacher}(x) \wedge \exists(y)[\text{student}(y) \rightarrow \text{likes}(y, x)]]$

gate2005 | mathematical-logic | easy

Answer

9.0.49 GATE2003_72 [top](#)

<http://gateoverflow.in/959>

The following resolution rule is used in logic programming.

Derive clause $(P \vee Q)$ from clauses $(P \vee R)$, $(Q \vee \neg R)$.

Which of the following statements related to this rule is FALSE?

- (A) $((P \vee R) \wedge (Q \vee \neg R)) \Rightarrow (P \vee Q)$ is logically valid.
- (B) $(P \vee Q) \Rightarrow ((P \vee R) \wedge (Q \vee \neg R))$ is logically valid.
- (C) $(P \vee Q)$ is satisfiable if and only if $(P \vee R) \wedge (Q \vee \neg R)$ is satisfiable.
- (D) $(P \vee Q) \Rightarrow \text{FALSE}$ if and only if both P and Q are unsatisfiable.

gate2003 | mathematical-logic | normal

Answer

9.0.50 GATE2006_26 [top](#)

<http://gateoverflow.in/989>

Which one of the first order predicate calculus statements given below correctly expresses the following English statement?

Tigers and lions attack if they are hungry or threatened.

- (A) $\forall x[(\text{tiger}(x) \wedge \text{lion}(x)) \rightarrow \{(\text{hungry}(x) \vee \text{threatened}(x)) \rightarrow \text{attacks}(x)\}]$

- (B)** $\forall x[(\text{tiger}(x) \vee \text{lion}(x)) \rightarrow \{(\text{hungry}(x) \vee \text{threatened}(x)) \wedge \text{attacks}(x)\}]$
(C) $\forall x[(\text{tiger}(x) \vee \text{lion}(x)) \rightarrow \{\text{attacks}(x) \rightarrow (\text{hungry}(x) \vee \text{threatened}(x))\}]$
(D) $\forall x[(\text{tiger}(x) \vee \text{lion}(x)) \rightarrow \{(\text{hungry}(x) \vee \text{threatened}(x)) \rightarrow \text{attacks}(x)\}]$

gate2006 | mathematical-logic | normal

Answer

9.0.51 GATE2006_27 [top](#)

<http://gateoverflow.in/990>

Consider the following propositional statements:

$$\begin{aligned} P1 &: ((A \wedge B) \rightarrow C) \equiv ((A \rightarrow C) \wedge (B \rightarrow C)) \\ P2 &: ((A \vee B) \rightarrow C) \equiv ((A \rightarrow C) \vee (B \rightarrow C)) \end{aligned}$$

Which one of the following is true?

- (A) P1 is a tautology, but not P2
- (B) P2 is a tautology, but not P1
- (C) P1 and P2 are both tautologies
- (D) Both P1 and P2 are not tautologies

gate2006 | mathematical-logic | normal

Answer

9.0.52 GATE2004_23, ISRO2007-32 [top](#)

<http://gateoverflow.in/1020>

Identify the correct translation into logical notation of the following assertion.

Some boys in the class are taller than all the girls

Note: taller (x, y) is true if x is taller than y.

- A. $(\exists x)(\text{boy}(x) \rightarrow (\forall y)(\text{girl}(y) \wedge \text{taller}(x, y)))$
- B. $(\exists x)(\text{boy}(x) \wedge (\forall y)(\text{girl}(y) \wedge \text{taller}(x, y)))$
- C. $(\exists x)(\text{boy}(x) \rightarrow (\forall y)(\text{girl}(y) \rightarrow \text{taller}(x, y)))$
- D. $(\exists x)(\text{boy}(x) \wedge (\forall y)(\text{girl}(y) \rightarrow \text{taller}(x, y)))$

gate2004 | mathematical-logic | easy | isro2007

Answer

9.0.53 GATE1999_14 [top](#)

<http://gateoverflow.in/1513>

- a. Show that the formula $[(\sim p \vee q) \Rightarrow (q \Rightarrow p)]$ is not a tautology.
- b. Let A be a tautology and B any other formula. Prove that $(A \vee B)$ is a tautology.

gate1999 | mathematical-logic | normal

Answer

9.0.54 GATE2003_33 [top](#)

<http://gateoverflow.in/923>

Consider the following formula and its two interpretations I_1 and I_2 .

$$\alpha : (\forall x) [P_x \Leftrightarrow (\forall y) [Q_{xy} \Leftrightarrow \neg Q_{yy}]] \Rightarrow (\forall x) [\neg P_x]$$

I_1 : Domain: the set of natural numbers

- P_x = 'x is a prime number'
- Q_{xy} = 'y divides x'

I_2 : same as I_1 except that P_x = 'x is a composite number'.

Which of the following statements is true?

- (A) I_1 satisfies α , I_2 does not (B) I_2 satisfies α , I_1 does not
 (C) Neither I_1 nor I_2 satisfies α (D) Both I_1 and I_2 satisfies α

gate2003 | mathematical-logic | difficult

Answer

9.0.55 GATE2004_70 top

<http://gateoverflow.in/1064>

The following propositional statement is $(P \Rightarrow (Q \vee R)) \Rightarrow ((P \wedge Q) \Rightarrow R)$

- A. satisfiable but not valid
- B. valid
- C. a contradiction
- D. None of the above

gate2004 | mathematical-logic | normal

Answer

9.0.56 GATE2010-30 top

<http://gateoverflow.in/1156>

Suppose the predicate $F(x, y, t)$ is used to represent the statement that person x can fool person y at time t . Which one of the statements below expresses best the meaning of the formula

$\forall x$

?

- A. Everyone can fool some person at some time
- B. No one can fool everyone all the time
- C. Everyone cannot fool some person all the time
- D. No one can fool some person at some time

gate2010 | mathematical-logic | easy

Answer

9.0.57 GATE2005_40 top

<http://gateoverflow.in/1165>

Let P , Q and R be three atomic propositional assertions. Let X denote $(P \vee Q) \rightarrow R$ and Y denote $(P \rightarrow R) \vee (Q \rightarrow R)$. Which one of the following is a tautology?

- (A) $X \equiv Y$ (B) $X \rightarrow Y$ (C) $Y \rightarrow X$ (D) $\neg Y \rightarrow X$

gate2005 | mathematical-logic | normal

Answer

9.0.58 GATE2007-22 top

<http://gateoverflow.in/1220>

Let $\text{Graph}(x)$ be a predicate which denotes that x is a graph. Let $\text{Connected}(x)$ be a predicate which denotes that x is connected. Which of the following first order logic sentences **DOES NOT** represent the statement:

"Not every graph is connected"

- A. $\neg \forall x (\text{Graph}(x) \implies \text{Connected}(x))$
- B. $\exists x (\text{Graph}(x) \wedge \neg \text{Connected}(x))$
- C. $\neg \forall x (\neg \text{Graph}(x) \vee \text{Connected}(x))$
- D. $\forall x (\text{Graph}(x) \implies \neg \text{Connected}(x))$

gate2007 | mathematical-logic | easy

Answer

Answers:

9.0.1 GATE2012_1 top

<http://gateoverflow.in/33>



Selected Answer

I_1 is a correct inference. I_2 is not a correct inference as it was not mentioned what would have happened if it hadn't rained- They might have played or they might not have played.

11 votes

-- Arjun Suresh (150k points)

9.0.2 GATE2004-IT_31 top

<http://gateoverflow.in/3674>



Selected Answer

$$P: [(\neg p \vee q) \wedge (r \rightarrow s) \wedge (p \vee r)] \rightarrow (\neg s \rightarrow q)$$

This must be valid (All options contains P) No need to evaluate.

$$R: [[(q \wedge r) \rightarrow p] \wedge (\neg q \vee p)] \rightarrow r \rightarrow$$

This is invalid, Put q = False, P= True, R = False to derive "False" result !

$$S: [p \wedge (p \rightarrow r) \wedge (q \vee \neg r)] \rightarrow q \text{ This is valid !}$$

\rightarrow

p

$$P \rightarrow r$$

r

$$q \vee \neg r$$

q

So Answer \rightarrow

3) P and S only

4 votes

-- Akash (31.7k points)

9.0.3 GATE2014-3_53 top<http://gateoverflow.in/2087>

- A) No rainy days are cold
 B) All non-rainy days are cold
 C) Some non-rainy days are cold.
 D) Some rainy days are not cold.

option D

11 votes

-- Manali (2.5k points)

9.0.4 GATE2011_30 top<http://gateoverflow.in/2132>

Selected Answer

Answer is A.

 $P(x) = (\neg(x = 1)) \wedge \forall y(\exists z(x = y * z) \Rightarrow ((y = x) \vee (y = 1)))$

Statement: x is not equal to 1 and if there exists some z :

alternative approach ,
 the formula

$$\exists x \forall y \forall z [x(y, z, x) \rightarrow ((y = 1) \vee (z = 1))]$$

expresses the statement "there exists a prime number" (the number 1 also satisfies this statement).

Note here that $x(y, z, x)$ is equivalent to $(x = y \times z)$.

but $\neg(x = 1)$ removes 1 as satisfying given number in question's formula , so the option A is True.

ref@ https://en.wikibooks.org/wiki/Logic_for_Computer_Science/First-Order_Logic#Semantics

ref@ <http://math.stackexchange.com/questions/1037795/what-is-the-meaning-of-this-predicate-statement>

9 votes

-- Sona Praneeth Akula (3.8k points)

9.0.5 GATE1997_3.2 top<http://gateoverflow.in/2233>

Selected Answer

$$C) P \text{ OR } (P \rightarrow Q) = P \text{ OR } (\text{NOT } P \text{ OR } Q)$$

$$= (P \text{ OR } \text{NOT } P) \text{ OR } Q \quad \text{Associativity rule}$$

$$= T \text{ OR } Q$$

$$= T$$

5 votes

-- Manali (2.5k points)

9.0.6 GATE1993_8.2 top<http://gateoverflow.in/2300>

Selected Answer

OPTION (B)

5 votes

-- Manali (2.5k points)

9.0.7 GATE1993_18 top<http://gateoverflow.in/2315>

$$\begin{aligned} & A \wedge (A \rightarrow (B \vee C)) \wedge (B \rightarrow \neg A) \\ & = A(A' + B + C)(A' + B') \\ & = AB'(A' + B + C) \\ & = AB'C \end{aligned}$$

C is logical consequence of a formula X if,
 $X \rightarrow C$ is true

here $X = A \wedge (A \rightarrow (B \vee C)) \wedge (B \rightarrow \neg A)$
 $= AB'C$

cheaking , $AB'C \rightarrow C$
 $= (AB'C)' + C$
 $= A' + B + C' + C$
 $= 1$

C is logical consequence of $A \wedge (A \rightarrow (B \vee C)) \wedge (B \rightarrow \neg A)$..

 2 votes

-- Digvijay (35.8k points)

| A | B | C | $A \rightarrow (B \vee C)$ | B | $\neg A$ | $A \wedge (A \rightarrow (B \vee C)) \wedge (B \rightarrow \neg A)$ | C |
|---|---|---|----------------------------|---|----------|---|---|
| T | T | T | T | F | F | F | T |
| T | T | F | T | F | F | F | T |
| T | F | T | T | T | T | F | T |
| T | F | F | F | T | F | F | T |
| F | T | T | T | T | F | F | T |
| F | T | F | T | T | F | F | T |
| F | F | T | T | T | F | F | T |
| F | F | F | T | T | F | F | T |

Logical consequence (also entailment) is one of the most fundamental concepts in **logic**. It is the relationship between statements that holds true when one **logically** "follows from" one or more others.

 2 votes

-- Anu (9k points)

9.0.8 GATE1994_3.13 top<http://gateoverflow.in/2499>

Selected Answer

| p | q | $p \leftrightarrow q$ | $p \rightarrow \neg q$ | $(p \leftrightarrow q) \rightarrow (p \rightarrow \neg q)$ |
|---|---|-----------------------|------------------------|--|
| 0 | 0 | 1 | 1 | 1 |
| 0 | 1 | 0 | 1 | 1 |
| 1 | 0 | 0 | 1 | 1 |
| 1 | 1 | 1 | 0 | 0 |

So, "imply" is FALSE making does not imply TRUE.

1 6 votes

-- Arjun Suresh (150k points)

9.0.9 GATE1995_2.19 [top](#)

<http://gateoverflow.in/2631>



Selected Answer

Cannot be determined.

From the axiom $\neg p \rightarrow v$, we can conclude that $p + v$.

So, p can be True or False, i.e. nothing can be said about its value.

$$\neg p \vee (p \rightarrow q)$$

$$\equiv \neg p \vee (\neg p \vee q)$$

$$\equiv \neg p \vee q$$

Since nothing can be said about the Truth value of p , it implies that $\neg p \vee q$ can also be True or False.

Hence, the value cannot be determined.

1 13 votes

-- Pragy Agarwal (14.4k points)

9.0.10 GATE1996_2.3 [top](#)

<http://gateoverflow.in/2732>



Selected Answer

OPTION D... when $x = F$ & $y = F$

1 8 votes

-- Manali (2.5k points)

9.0.11 GATE2008-IT_22 [top](#)

<http://gateoverflow.in/3283>



Selected Answer

$$[\forall x, \alpha \rightarrow (\exists y, \beta \rightarrow (\forall u, \exists v, y))] = [\forall x, \neg\alpha \vee (\exists y, \neg\beta \vee (\forall u, \exists v, y))]$$

Now, doing complement gives (complement of \forall is \exists and vice versa while propagating negation inwards as $\forall x (P) = \neg\exists x (\neg P)$ and $\exists x (P) = \neg\forall x (\neg P)$)

$$[\exists x, \alpha \wedge (\forall y, \beta \wedge (\exists u, \forall v, \neg y))]$$

D choice

1 11 votes

-- Arjun Suresh (150k points)

9.0.12 GATE2007-IT-21 [top](#)

<http://gateoverflow.in/3454>



Selected Answer

(A) is the answer

(A)

LHS: For every x , if P holds then Q holds

RHS: If $P(x)$ holds for all x , then $Q(x)$ holds for all x .

LHS implies RHS but RHS does not imply LHS.

(B)

LHS: An x exist for which either $P(x)$ is true or $Q(x)$ is true.

RHS: If an x exist for which $P(x)$ is true then another x exist for which $Q(x)$ is true.

LHS does not imply RHS, but on RHS if we change $\exists x P(x)$ to $\sim \exists x P(x)$, implication becomes TRUE.

(C)

LHS: There exist an x for which both $P(x)$ and $Q(x)$ are true.

RHS: There exist an x for which $P(x)$ is true and there exist an x for which $Q(x)$ is true.

LHS implies RHS but RHS does not imply LHS as the ' x ' for P and Q can be different on the RHS

(D)

LHS: For every x , there exist a y such that $P(x, y)$ holds.

RHS: There exist a y such that for all x $P(x, y)$ holds.

Here RHS implies LHS but LHS does not imply RHS as the y on LHS can be different for each x .

10 votes

-- Arjun Suresh (150k points)

9.0.13 GATE2006-IT_21 [top](#)

<http://gateoverflow.in/3560>



Selected Answer

The given relation is nothing but symmetry. We have both symmetric relations possible as well as anti-symmetric but neither always holds for all sets. So they both are not valid but are satisfiable. B option.

15 votes

-- Arjun Suresh (150k points)

9.0.14 GATE2004-IT_3 [top](#)

<http://gateoverflow.in/3644>



Selected Answer

$$\begin{aligned}
 & (\exists x)(\forall y)[(a(x, y) \wedge b(x, y)) \wedge \neg c(x, y)] \\
 &= \neg(\forall x)\neg(\forall y)[(a(x, y) \wedge b(x, y)) \wedge \neg c(x, y)] \\
 & (\because (\exists x)F(x) = \neg\forall x\neg F(x)) \\
 &= \neg(\forall x)(\exists y)\neg[(a(x, y) \wedge b(x, y)) \wedge \neg c(x, y)] \\
 & (\because (\forall x)F(x) = \neg\exists x\neg F(x), \neg\neg F(x) = F(x)) \\
 &= \neg(\forall x)(\exists y)[\neg(a(x, y) \wedge b(x, y)) \vee c(x, y)] \\
 &= \neg(\forall x)(\exists y)[(a(x, y) \wedge b(x, y)) \rightarrow c(x, y)]
 \end{aligned}$$

(C) choice.

8 votes

-- Arjun Suresh (150k points)

9.0.15 GATE2005-IT_36 [top](#)

<http://gateoverflow.in/3783>



Selected Answer

Answer: B

Let P: Student is a girl.

and Q: Student is smart.

Option B says: IF for all student x if x is a girl then the student is smart THEN if the whole class comprises of girls then the whole class comprises of smart students.

12 votes

-- Rajarshi Sarkar (29.7k points)

9.0.16 GATE2014-1_53 top

<http://gateoverflow.in/1933>



Selected Answer

- A. will be true if P,Q,R are true,((p ↔ q) ∧ r) will return true. So "exactly two" is false
- C. if only r is true and p and q are false, first part of implication itself will result in true
- D. if r is true or false, this returns false due to r and ~r present in conjunction. So, this is a CONTRADICTION.

B is the answer. B is true if p is TRUE and q is FALSE or vice versa, and r is true or if p and q are TRUE and r is FALSE.

PS: Actually the question should have been "TRUE **ONLY** when exactly two of p,q and r are TRUE"

9 votes

-- Manu Thakur (5.6k points)

9.0.17 GATE2002_5b top

<http://gateoverflow.in/3915>



Selected Answer

This can be solved by Truth table. But there is something else which can be done quickly. See what each formula means:

1. $A \leftrightarrow (A \vee A)$ It says if A then (A or A) and if (A or A) then A. Always a tautology
2. $(A \vee B) \rightarrow B$ If A or B then B. No guarantee that if only A is true, B need to be true. Hence neither tautology nor contradiction
3. $A \wedge (\neg(A \vee B))$ When A is true $\neg(A \vee B)$ will be false. So, this formula is a contradiction

11 votes

-- Arjun Suresh (150k points)

9.0.18 GATE2015-2_3 top

<http://gateoverflow.in/8049>



Selected Answer

option c ...If a person is kind, he is not known to be corrupt

Let

- $C(x)$: x is known to be corrupt
 $K(x)$: x is kind
 $E(x)$: x will be elected

- $S1 : C(x) \rightarrow \neg E(x)$
- $S2 : K(x) \rightarrow E(x)$

$S1$ can be written as $E(x) \rightarrow \neg C(x)$ as $A \rightarrow B = \neg B \rightarrow \neg A$.
 Thus, from $S1$ and $S2$,

$K(x) \rightarrow E(x) \rightarrow \neg C(x)$.

Thus we get C option.

10 votes

-- Anoop Sonkar (4.5k points)

9.0.19 GATE2015-1_14 [top](#)<http://gateoverflow.in/8209>

Selected Answer

$$\begin{aligned}
 & p \leftrightarrow q \\
 &= (p \rightarrow q) \wedge (q \rightarrow p) \\
 &= (\neg p \vee q) \wedge (q \rightarrow p) \quad (\text{As } p \rightarrow q = \neg p \vee q) \\
 &= (\neg p \vee q) \wedge (\neg q \vee p) \\
 &= (\neg p \wedge \neg q) \vee (p \wedge q)
 \end{aligned}$$

So, answer C

14 votes

-- Priya_das (663 points)

9.0.20 GATE2015-2_55 [top](#)<http://gateoverflow.in/8259>

Selected Answer

Ans C.

$$(P \rightarrow Q) \leftrightarrow (\neg P \vee Q)$$

D is wrong as shown below.

Let $S = \{2, 3, 4, 5\}$ and $P(x, y)$ be $x < y$.Now, $P(2, 3)$ is true but $P(3, 2)$, $P(4, 2)$ etc are false and hence the implication also.

This is because the given formula is evaluated as:

$$\forall x \forall y (P(x, y) \rightarrow \forall x \forall y P(y, x))$$

For every (x, y) if $P(x, y)$ is true then for every (x, y) $P(y, x)$ is true.

On the RHS, $P(y, x)$ can be replaced with $P(x, y)$ and then also the formula means the same. So, here precedence rule used is \rightarrow having more precedence than quantification which is against the convention used in [Wikipedia](#). I guess all books only talk about conventions and there is no standard here. C option being so straight forward I guess, GATE did not even consider this as an ambiguity. Also, it works only if x, y belongs to same domain.

The below one is a tautology provided x, y have the same domain.

$$(\forall x \forall y P(x, y)) \rightarrow (\forall x \forall y P(y, x))$$

If $P(x, y)$ is true for all (x, y) , then $P(y, x)$ is true for all (x, y) .

11 votes

-- Vikrant Singh (11k points)

9.0.21 GATE2015-3_24 [top](#)<http://gateoverflow.in/8427>

Selected Answer

Person 1, result is head. No doubt here as he is a truth teller.

Person 2. result is head if and only if he is telling truth. He is telling lies. So, the truth is the opposite of his statement. We can analyze his statement as two

1. If I'm telling the truth result is head
2. If result is head I'm telling the truth

Both these are of the form $A \rightarrow B = \neg A \vee B$. Now, the truth will be the negation of these statements which will be

$A \wedge \neg B$ which can be expressed as

1. I'm telling the truth and result is not head
2. Result is head and I'm telling false

Both of these means, result is head. (Actually even if iff is replaced with if, answer would be A)

So, option A.

19 votes

-- Arjun Suresh (150k points)

9.0.22 TIFR2011-A-12 top

<http://gateoverflow.in/20221>



Selected Answer

Option B should be the correct answer, that is A is a Knave & B is a Knight.

A must be either a Knight or a Knave.

Suppose A is a Knight, it means that the statement "We are both Knaves." must be true.

This is contradicting our assumption.

So the assumption that "A is a Knight" is not logically satisfiable simultaneously with the statement he made, which implies that A must be a Knave.

Now since A is a Knave, the statement made by him : "We are both Knaves." must be false.

The statement "We are both Knaves." will be false in any one of the following 3 conditions :

1. A is a Knight, B is a Knave.
2. A is a Knave, B is a Knight.
3. A is a Knight, B is a Knight.

But since we have already deduced that A is a Knave so in order to make the statement "We are both Knaves." false, we are only left with condition 2.

So B must be a Knight.

3 votes

-- Anurag Pandey (9.7k points)

9.0.23 TIFR2012-A-2 top

<http://gateoverflow.in/20939>



Selected Answer

If Mr. M is guilty, then if we pick a witness, we know that the witness won't lie unless he is afraid. If the witness is afraid, it may lie or it may not lie (nothing is guaranteed).

However, unless we know what the victim said in the court (whether he said that Mr. M was guilty or not guilty), we can't say anything about Mr. M .

All we know is that we've a witness who is afraid, so he may or may not lie in the court. We haven't been told anything about what actually happened in the court proceeding.

So, we can't logically conclude anything about Mr. M being guilty or not guilty.

Thus, options a and b are False.

Furthermore, that witness who was afraid, he may or may not lie. Since he is afraid, we know that he "can" lie, but we're not guaranteed that he will lie.

Thus, options d and e are False too.

This leaves option c, and as we have seen earlier, we cannot conclude anything about Mr. M being guilty or not guilty.

Hence, option c is the correct answer.

Although not necessary, the logic equivalent of the given statement will be:

$$G \implies \neg \exists x : (W(x) \wedge L(x) \wedge \neg A(x))$$

≡

$$G \implies \forall x : (W(x) \implies$$

3 votes

-- Pragy Agarwal (14.4k points)

9.0.24 TIFR2012-A-3 top

<http://gateoverflow.in/20981>



Selected Answer

If A is Blue (honest), then

- Whatever A says about B and C must be True.
- A says that B is White(liar) and C is Pink(alternating). So, if A is Blue, B must be White and C must be Pink.
- B says that C is Pink. But B is a liar, and B agrees with A on the race of C (they must not agree). Thus, we reached a contradiction.

So, A can't be Blue.

If B is Blue (honest), then

- Whatever B says about A and C must be True.
- B says that A is Pink(alternating) and C is Pink(alternating). So, if B is Blue, A must be Pink and C must be Pink.
- Since A is pink, it must lie about B, say the truth about C and then lie about itself. Which it does.
- Since C is pink, it must lie about A, say the truth about B, and then lie about itself. Which it does.

So we see that Blue B, Pink A and Pink C is a possible solution!

Thus, option C is correct.

However, there is another option e, which says Cannot be determined from the above data.

So, what if there are multiple solutions that satisfy these constraints? If that is the case, option e will be correct. Sadly, there is no way of proving that no other solutions work except checking each one of them (using branch and bound to somewhat improve). Sadly, that will be lengthy.

Here is a Python3 program that finds all solutions to this problem: <http://ideone.com/7EFXCn>

2 votes

-- Pragy Agarwal (14.4k points)

9.0.25 TIFR2014-A-8 top

<http://gateoverflow.in/25994>



Selected Answer

The correct answer is option a) Only claim 1 follows.



$\text{Glitters}(x) \implies \text{Gold}(x) \implies \neg \text{Silver}(x)$. Hence, Claim 1 follows. If something Glitters, it cannot be Silver.

For claim 2:

The set of things that Glitter could be empty.

We can still assert that All that Glitters is Gold, because nothing Glitters in the first place.

So, in the case when nothing Glitters, there is no Gold that Glitters. Glitters is still a subset of Gold, but there is no element in the subset Glitters.



13 votes

-- Pragy Agarwal (14.4k points)

9.0.26 GATE1991-15,b [top](#)

<http://gateoverflow.in/26748>



Selected Answer

Let's break it down. Consider an ordered structure (directed graph).

- A. $\forall x \exists y : R(x, y) \equiv$ Every vertex has atleast 1 outgoing edge.
- B. $\forall x \forall y : (R(x, y) \implies \neg R(y, x)) \equiv$ If there is a directed edge from vertex u to vertex v , there should not be an edge back from v to u . That is, our relation $R(x, y)$ is antisymmetric.
- C. $\forall x \forall y \forall z : (R(x, y) \wedge R(y, z) \implies R(x, z)) \equiv$ If $u \rightarrow v \rightarrow z$, then $u \rightarrow z$ is also true. That is, our relation $R(x, y)$ is transitive.
- D. $\forall x : \neg R(x, x) \equiv$ We cannot have a self-loop in the graph. That is, $R(x, y)$ is irreflexive.

Now, such a non-trivial (size > 0) finite structure cannot exist.

Proof by contradiction:

Assume, for the sake of contradiction, that such a finite structure $S = (V, E)$ exists. Since it is finite, let the number of vertices in this structure be $|V| = n, n \in \mathbb{N}, n > 0$.

Edit: A summarized version of the following proof is in the comments. You can directly skip to that.

Lemma 1: v_n has an incoming edge from every vertex $v_i, i < n$

Proof by Induction:

Induction Hypothesis: $P(n) =$ For every $1 \leq i < j \leq n$, there is an out edge from vertex v_i to vertex v_j , that is $v_i \rightarrow v_j$.

Base Cases:

- **Let**
 $n = 2$.
 $v_1 \rightarrow v_2$ must be true since there has to be an out edge from v_1 (Property A) and the only available vertex is v_2 (no self loops allowed - Property D).
Hence, our hypothesis $P(2)$ is satisfied.
- **Let**
 $n = 3$.
There must be an out edge from v_1 to some vertex. Let's call that vertex v_2 , that is
 $v_1 \rightarrow v_2$.
Similarly, there must be an out edge from v_2 . But due to property B, we can't have an out edge from v_2 back to v_1 . Hence, the out edge from v_2 must lead us to a new vertex. Lets call that v_3 .
Since $v_1 \rightarrow v_2 \rightarrow v_3$, due to Property C, we must have $v_1 \rightarrow v_3$.
Hence, our hypothesis $P(3)$ is satisfied.

Inductive Step:

For $P(n+1)$: The n th vertex v_n must have an out edge. Since $P(n)$ is true, the n th vertex has incoming edges from all vertices $v_i, i < n$. Hence, the out edge from v_n cannot be to any of those vertices. Self loops aren't allowed either.

Hence, the out edge from vertex v_n must be to the new vertex v_{n+1} . That is, $\overbrace{v_n}^{\nearrow} \rightarrow v_{n+1}$

Since every vertex $v_i, i < n$ has an out edge to v_n , and v_n has an out edge to v_{n+1} , due to Property C, we have that v_i has an out edge to v_{n+1} . That is, $v_i \rightarrow v_{n+1}, \forall i \leq n$.

This is exactly what $P(n + 1)$ states.

Hence, $P(n) \implies P(n + 1)$.

Q.E.D

Since $P(n)$ is true as proven above, every vertex v_i must have an out edge to the vertex v_n .

Since the

n th vertex has incoming edges from all other vertices (Lemma 1), it cannot have an out edge to any vertex. It can't have self loop either. Thus, it fails to satisfy Property A.

Hence, our assumption that S exists leads to a contradiction.

Q.E.D

The given logic formula can be satisfied by an infinite model.

For example, $R(x, y) \iff x < y$, $x, y \in S$, where S is any infinite ordered set, satisfies the given formula.

7 votes

-- Pragy Agarwal (14.4k points)

9.0.27 TIFR2015-A-5 [top](#)

<http://gateoverflow.in/29454>



Selected Answer

Answer will be (D)

"If Kareena and Parineeti go to the shopping mall then it is raining"

Let Kareena and Parineeti go to the shopping mall = p

it is raining = q

Now the statement told that $p \rightarrow q$

a. If Kareena and Parineeti do not go to the shopping mall then it is not raining.

i.e. $\sim p \rightarrow \sim q$

So, it is not matching with the previous implication

b. If Kareena and Parineeti do not go to the shopping mall then it is raining.

that means $\sim p \rightarrow q$

it is also not matching

c. If it is raining then Kareena and Parineeti go to the shopping mall.

that means $q \rightarrow p$. So, it is also false

d. If it is not raining then Kareena and Parineeti do not go to the shopping mall.

i.e. $\sim q \rightarrow \sim p = q \vee \sim p = p \rightarrow q$

So, correct option is (D)

7 votes

-- srestha (27.8k points)

9.0.28 GATE 2016-2-01 [top](#)

<http://gateoverflow.in/39568>



Selected Answer

4 should be the correct answer.

| P | Q | $P \Rightarrow Q$ | $P \wedge (P \Rightarrow Q)$ |
|---|---|-------------------|------------------------------|
| F | F | T | F |
| F | T | T | F |
| T | F | F | F |
| T | T | T | T |

Suppose $(P \wedge (P \Rightarrow Q)) \Leftrightarrow A$ (notational convenience)

Then for options (i), (ii), (iii), (iv), (v),
If $(A \Rightarrow \text{option})$ is a tautology
then $P \wedge (P \Rightarrow Q)$ logically implies that option x
else $P \wedge (P \Rightarrow Q)$ does not logically implies that option x.

| P | Q | A | option(i) | option(ii) | Option(iii) | Option(iv) | Option(v) |
|---|---|---|-----------|-------------------|----------------------------|------------|--|
| F | F | F | False | $A \Rightarrow F$ | $Q \wedge A \Rightarrow Q$ | True | $A \Rightarrow (\neg P \vee Q) \wedge A \Rightarrow (\neg P \vee Q) \wedge Q \vee P$ |
| F | T | F | | T | T | T | T |
| T | F | F | | T | T | T | T |
| T | T | T | F | F | T | T | T |

Answer = 9

P.S. - Blank entries in the above truth table are like don't care conditions because in those rows the value of A is set to False, hence $(A \Rightarrow \text{Anything})$ would be set to True.

30 votes

-- Anurag Pandey (9.7k points)

9.0.29 GATE2012_13 top

<http://gateoverflow.in/45>



Selected Answer

Meaning of each choices:

- (A): There exists a number which is either real or rational
- (B): If a number is real it is rational
- (C): There exists a number which is real and rational
- (D): There exists a number such that if it is rational, it is real

So, (C) is the answer.

11 votes

-- Arjun Suresh (150k points)

9.0.30 GATE2014-3_1 top

<http://gateoverflow.in/2035>



Selected Answer

D)

Lets break the given compound statements into atomic statements.

A : Good mobile phones.
B : Cheap mobile phones.

P : $A \rightarrow \neg B \iff \neg A \vee \neg B$
Q : $B \rightarrow \neg A \iff \neg B \vee \neg A \iff \neg A \vee \neg B$ (Disjunction is commutative)
Hence $P \iff Q$ (P is equivalent to Q, which means P implies Q ,and Q implies P)

9 votes

-- Srinath Sri (2.9k points)

9.0.31 GATE1998_1.5 [top](#)

<http://gateoverflow.in/1642>

Selected Answer

I stay only if you go **is equivalent to** If I stay then you go.

A only if B $\Rightarrow A \rightarrow B$

A= "I stay" **and** B= "You go"

converse(A \rightarrow B) = B \rightarrow A

" If you go then I stay "

Answer is A

7 votes

-- Manali (2.5k points)

9.0.32 GATE2002_1.8 [top](#)

<http://gateoverflow.in/812>

Selected Answer

```
while ( not z ) {
    if (X) then
        Y
}
or
unless( z ) {
    if (X) then
        Y
}
```

this is what it means in programming. if you want to execute statement Y then X must be True and Z False,
which is equivalent to $(X \text{ AND NOT } Z) \rightarrow Y$

option A

15 votes

-- Vikrant Singh (11k points)

9.0.33 GATE2013_47<http://gateoverflow.in/80>

Selected Answer

A useful rule:

$$\forall x(\alpha) = \neg \exists(x)(\neg \alpha)$$

i.e.; If some property α is true for all x , then it is equivalent to say that no x exists such that property α does not hold for it.

Starting with choices:

$$A: \forall x(\exists z(\neg \beta) \rightarrow \forall y(\alpha))$$

$$\implies \forall x(\neg \exists z(\neg \beta) \vee \forall y(\alpha))$$

$$\implies \forall x(\forall z(\beta) \vee \forall y(\alpha))$$

$$\implies \neg \exists x \neg (\forall z(\beta) \vee \forall y(\alpha))$$

$$\implies \neg \exists x(\neg \forall z(\beta) \wedge \neg \forall y(\alpha))$$

So, A is not matching with the logical statement in question.

$$B: \forall x(\forall z(\beta) \rightarrow \exists y(\neg \alpha))$$

$$\implies \forall x(\neg \forall z(\beta) \vee \exists y(\neg \alpha))$$

$$\implies \neg \exists x \neg (\neg \forall z(\beta) \vee \exists y(\neg \alpha))$$

$$\implies \neg \exists x(\forall z(\beta) \wedge \neg \exists y(\neg \alpha))$$

$$\implies \neg \exists x(\forall z(\beta) \wedge \forall y(\alpha))$$

Hence matches with the given statement.

$$C: \forall x(\forall y(\alpha) \rightarrow \exists z(\neg \beta))$$

$$\implies \forall x(\neg \forall y(\alpha) \vee \exists z(\neg \beta))$$

$$\implies \neg \exists x \neg (\neg \forall y(\alpha) \vee \exists z(\neg \beta))$$

$$\implies \neg \exists x(\forall y(\alpha) \wedge \neg \exists z(\neg \beta))$$

$$\implies \neg \exists x(\forall y(\alpha) \wedge \forall z(\beta))$$

Hence matches with the given statement.

$$D: \forall x(\exists y(\neg \alpha) \rightarrow \exists z(\beta))$$

$$\implies \forall x(\neg \exists y(\neg \alpha) \vee \exists z(\beta))$$

$$\implies \forall x(\forall y(\alpha) \vee \exists z(\beta))$$

$$\implies \neg \exists x \neg (\forall y(\alpha) \vee \exists z(\beta))$$

$$\implies \neg \exists x(\neg \forall y(\alpha) \wedge \neg \exists z(\beta))$$

$$\implies \neg \exists x(\neg \forall y(\alpha) \wedge \forall z(\beta))$$

So, D is not matching with the logical statement in question.

Thus both A and D are not logically equivalent to the given statement.

In GATE 2013 marks were given to all for this question

13 votes

-- Arjun Suresh (150k points)

9.0.34 TIFR2011-A-1 top<http://gateoverflow.in/237>

Selected Answer

It is told in the question "If the people suffer, the government will be unpopular". And "government will not be unpopular" means, people will not suffer.

It is like $A \rightarrow B$ is true and $\sim B$ is given. So, $\sim A$ must be true.

So, (a) is valid (always true).

Lets take the English meaning

Government will not be unpopular

- \implies People will not suffer
- \implies Either no inflation or government regulates it
- \implies If no regulation then no inflation
- \implies if no regulation then no wage or price rise

So, (b) and (d) are valid (always true) and (c) and (e) are not valid.

3 votes

-- Arjun Suresh (150k points)

9.0.35 GATE1992_92,xv top<http://gateoverflow.in/256>

Selected Answer

(1) The corresponding English meaning: If $P(x)$ is true for all x , or if $Q(x)$ is true for all x , then for all x , either $P(x)$ is true or $Q(x)$ is true. This is always true and hence valid. To understand deeply, consider $X = \{3, 6, 9, 12\}$. For LHS of implication to be true, either $P(x)$ must be true for all elements in X or $Q(x)$ must be true for all elements in X . In either case, if we take each element x in X , either one of $P(x)$ or $Q(x)$ will be true. Hence, this implication is always valid.

(If still in doubt, let $P(x)$ mean x is a multiple of 3 and $Q(x)$ means x is a multiple of 2)

(2) The corresponding English meaning: If $P(x)$ is true for at least one x , and if $Q(x)$ is true for at least one x , then there is at least one x for which both $P(x)$ and $Q(x)$ are true. This is not always true as $P(x)$ can be true for one x and $Q(x)$ can be true for some other x . To understand deeply, consider $X = \{3, 6, 9, 12\}$. Let $P(x)$ be x is a multiple of 9 and $Q(x)$ be x is a multiple of 6. Now, LHS of implication is true, since $P(x)$ is true for $x = 9$, and $Q(x)$ is true for $x = 6$. But RHS of implication is not true as there is no x for which both $P(x)$ and $Q(x)$ holds. Hence, this implication is not valid.

(3) If for each x , either $P(x)$ is true or $Q(x)$ is true then $P(x)$ is true for all x or $Q(x)$ is true for all x . Just one read is enough to see this is an invalid implication. Consider set $\{2, 4, 5\}$. Here every element is either a multiple of 2 or 5. But all elements are neither multiple of 2 nor 5.

(4) If there is at least one x for which either $P(x)$ or $Q(x)$ is true then either it is not the case that $P(x)$ is true for all x or $Q(x)$ is true for at least one x . This is clearly invalid as LHS of implication becomes true if $P(x)$ is true for some x and $Q(x)$ is not true for any x , but RHS will be false (if $P(x)$ is true for all x).

A little modification to the statement is enough to make it valid:

$$\exists(x)(P(x) \vee Q(x)) \implies \sim(\forall(x)\sim P(x)) \vee \exists(x)Q(x)$$

which means if there is at least one x for which either $P(x)$ or $Q(x)$ is true then either it is not the case that $\sim P(x)$ is true for all x (which means $P(x)$ is true for some x) or $Q(x)$ is true for some x .

Note

De Morgan's law is applicable in first order logic and is quite useful:

$$\forall(x)(P(x)) \equiv \neg\exists(x)(\neg P(x))$$

This is a logical reasoning statement which means if $P(x)$ is true for all x , then there can never exist an x for which $P(x)$

is not true. This formula is quite useful in proving validity of many statements as is its converse given below:

$$\exists(x)(P(x)) \equiv \neg\forall(x)(\neg P(x))$$

12 votes

-- gatecse (10.7k points)

9.0.36 GATE2008-30 [top](#)

<http://gateoverflow.in/441>



Selected Answer

None of these.

- A. If everything is a FSA, then there exists an equivalent PDA for everything.
- B. It is not the case that for all y if there exist a FSA then it has an equivalent PDA.
- C. Everything is a FSA and has an equivalent PDA.
- D. Everything is a PDA and has exist an equivalent FSA.

The correct answer would be

\forall

$x(\text{fsa})$

9 votes

-- Arjun Suresh (150k points)

9.0.37 GATE2008-31 [top](#)

<http://gateoverflow.in/442>



Selected Answer

(B) Only I, II and III. Draw truth table to check, evaluating individual expression will consume lot of time with no guaranteed answer.

8 votes

-- Keith Kr (6k points)

9.0.38 GATE1991_03,xii [top](#)

<http://gateoverflow.in/526>



Selected Answer

answer = option B

False \rightarrow anything = True, always

4 votes

-- Amar Vashishth (20.7k points)

9.0.39 GATE1991-15,a [top](#)

<http://gateoverflow.in/542>

$\text{lcm}(x,y) : \text{lcm of } x \text{ and } y$

$\text{gcd}(x,y) : \text{gcd of } x \text{ and } y$

$$\forall x \forall y (x \geq 0 \wedge y \geq 0) \rightarrow (\text{LCM}(x,y) * \text{GCD}(x,y) = x * y)$$

1 votes

-- Khush Tak (3.3k points)

Let $a(120) = f_1 * f_2 * f_3 * f_4 * f_5 \dots (2 * 2 * 2 * 3 * 5)$.

$$b(18) = F_1 * F_2 * F_3 \dots (2 * 3 * 3)$$

LCM of a(120) and b(18) = product of elements of a **union** b.

$$= M(\{f_1, f_2, f_3, f_4, f_5\} \cup \{F_1, F_2, F_3\}) \quad // M- > \text{multiplication.}$$

$$= M((f_1/F_1), f_2, f_3, (f_4/F_2), F_3, f_5) \quad // f_1/F_1 -> f_1 \text{ or } F_1$$

HCF of a(120) and b(18) = product of elements of a **intersection** b.

$$= M(\{f_1, f_2, f_3, f_4, f_5\} \cap \{F_1, F_2, F_3\})$$

$$= M((f_1/F_1), (f_4/F_2)) \quad // f_1/F_1 -> f_1 \text{ or } F_1$$

// Remember if a $\cap b = \emptyset$, then HCF = 1.

From equation A and B,

Product of LCM and HCF = $M((f_1/F_1), f_2, f_3, (f_4/F_2), F_3, f_5) * M((f_1/F_1), (f_4/F_2))$

$$= M(f_1, f_2, f_3, f_4, F_3, f_5, F_1, F_2)$$

= Product of a and b.

1 votes

-- vijaycs (10.7k points)

9.0.40 GATE1992_02,xvi [top](#)

<http://gateoverflow.in/654>



Selected Answer

Answer: B

$$\begin{aligned} (a \wedge b) &\rightarrow b \vee c \\ \implies \neg(a \wedge b) &\vee b \vee c \\ \implies \neg a \vee \neg b &\vee b \vee c \\ \implies T & \end{aligned}$$

Option A is not TRUE when C is FALSE

Option C is not TRUE when b is TRUE and C is FALSE

Option D is not TRUE when a and b are TRUE and C is FALSE.

6 votes

-- Rajarshi Sarkar (29.7k points)

9.0.41 GATE2000-2.7 [top](#)

<http://gateoverflow.in/654>



Selected Answer

Given that, $a \Leftrightarrow b \vee \sim b$

It is equivalent to $a \Leftrightarrow \text{TRUE}$

$$\therefore (a \wedge b) \rightarrow ((a \wedge c) \vee d)$$

wkt, $1 \wedge x = x$

$$\therefore (a \wedge b) = 1 \wedge b = b$$

similarly, $1 \wedge c = c$

We now have, $b \rightarrow (c \vee d)$

Which can be written as,

$\sim b \vee c \vee d$

We also know that $b \Leftrightarrow c$

$\therefore \sim b \vee c = \text{TRUE}$

$\therefore \text{TRUE} \vee d = \text{TRUE}$

And hence answer is option a

6 votes

-- Gate_15_isHere (627 points)

9.0.42 GATE2001-1.3 [top](#)

<http://gateoverflow.in/696>



Selected Answer

$$F1: P \Rightarrow \neg P$$

$$= \neg P \vee \neg P$$

$= \neg P$ can be true when P is false (Atleast one T hence satisfiable)

$$F2: (P \Rightarrow \neg P) \vee (\neg P \Rightarrow P)$$

$$= \neg P \vee (P \vee P)$$

$$= \neg P \vee P$$

$$= T$$

VALID

Option A

12 votes

-- Manali (2.5k points)

9.0.43 GATE2014-1_1 [top](#)

<http://gateoverflow.in/769>



Selected Answer

Option D is correct .

"Not all that glitters is gold"

can be expressed as :

$$\Rightarrow \neg(\forall x(\text{glitters}(x) \Rightarrow \text{gold}(x)))$$

\Rightarrow

$$\exists x \neg(\text{glitters}(x) \Rightarrow \text{gold}(x))$$

\Rightarrow

$$\exists x(\neg(\text{glitters}(x) \Rightarrow \text{gold}(x)))$$

can be expressed as :

" some glitters are not gold"

7 votes

-- Anu (9k points)

9.0.44 GATE2009-23 [top](#)

<http://gateoverflow.in/800>



Selected Answer

Answer

The statement could be translated as, If x is either Gold or Silver, then it would be precious. Rather than, If x is both Gold and Silver, as an item cannot both Gold and silver at the same time.

is D.

16 votes

-- Sona Praneeth Akula (3.8k points)

9.0.45 GATE2009-24 [top](#)<http://gateoverflow.in/801>

Selected Answer

Answer is B because the truth values for option B is same as that of P "or" Q.

The given truth table is for $Q \implies P$ which is $\bar{Q} + P$.

Now, with A option we get $\bar{Q} + P = P + Q$

10 votes

-- chetna (471 points)

9.0.46 GATE2013_27 [top](#)<http://gateoverflow.in/1538>

Selected Answer

- A. some of my friends are not perfect
- B. some of those who are not my friends are perfect
- C. some of those who are not my friends are not perfect
- D. NOT (some of my friends are perfect) / none of my friends are perfect

13 votes

-- Bhagirathi Nayak (11.3k points)

9.0.47 GATE2009-26 [top](#)<http://gateoverflow.in/803>

Selected Answer

I and IV are equal

10 votes

-- Bhagirathi Nayak (11.3k points)

9.0.48 GATE2005_41 [top](#)<http://gateoverflow.in/1166>

Selected Answer

Answer is B. In simpler way we can say **If X is a teacher then there exists some Y who is a student and likes X.**

A choice: If X is a teacher, then there exists a Y such that if Y is a student, then Y likes X.
 C choice: There exist a student who likes all teachers.
 D choice: Everyone is a teacher and there exists a Y such that if Y is student then y likes X. Assuming one cannot be both student and teacher at same time, this just means, everyone is a teacher.

8 votes

-- Manali (2.5k points)

9.0.49 GATE2003_72 [top](#)

<http://gateoverflow.in/959>

Option B is false...
 $((P \vee R) \wedge (Q \vee \neg R))$
 $= (P \wedge \neg R) \vee (Q \wedge R)$
 $(P \vee Q)$ doesn't imply $(P \wedge \neg R) \vee (Q \wedge R)$

2 votes

-- Digvijay (35.8k points)

9.0.50 GATE2006_26 [top](#)

<http://gateoverflow.in/989>



Selected Answer

The statement "Tigers and lions attack if they are hungry or threatened" means that if an animal is either tiger or lion, then if it is hungry or threatened, it will attack. So option (D) is correct.

Don't get confused by "and" between tigers and lions in the statement. This "and" doesn't mean that we will write "tiger(x) \wedge lion(x)", because that would have meant that an animal is both tiger and lion, which is not what we want.

http://www.cse.iitd.ac.in/~mittal/gate/gate_math_2006.html

6 votes

-- Anu (9k points)

9.0.51 GATE2006_27 [top](#)

<http://gateoverflow.in/990>



Selected Answer

(D) Both P1 and P2 are not tautologies.

P1: If A is true and B is false, LHS of P1 is true but RHS becomes false. Hence not tautology.

P2: Forward side is true. But reverse side is not true. When A is false and B is true and C is false, RHS is true but LHS is false.

LHS of P2 can be simplified as follows:

$$((A \vee B) \rightarrow C) = (\sim(A \vee B) \vee C) = (\sim A \wedge \sim B) \vee C = (\sim A \vee C) \wedge (\sim B \vee C) = (A \rightarrow C) \wedge (B \rightarrow C)$$

7 votes

-- Arjun Suresh (150k points)

9.0.52 GATE2004_23, ISRO2007-32 [top](#)

<http://gateoverflow.in/1020>



Selected Answer

Now many people get confused when to use \wedge and when to use \rightarrow . This question tests exactly that.

We use \wedge when we want to say that the both predicates in this statement are always true, no matter what the value of x is.

We use \rightarrow when we want to say that although there is no need for left predicate to be true always, but whenever it becomes true, right predicate must also be true.

Now we have been given the statement "Some boys in the class are taller than all the girls". Now we know for sure that there is atleast a boy in class. So we want to proceed with " $(\exists x) (boy(x) \wedge$ " and not " $(\exists x) (boy(x) \rightarrow$ ", because latter would have

meant that we are putting no restriction on the existence of boy i.e. there may be a boy-less class, which is clearly we don't want, because in the statement itself, we are given that there are some boys in the class. So options **(A)** and **(C)** are ruled out.

Now if we see option **(B)**, it says, every y in class is a girl i.e. every person in class is a girl, which is clearly false. So we eliminate this option also, and we get correct option **(D)**. Let us see option **(D)** explicitly also whether it is true or not. So it says that if person y is a girl, then x is taller than y, which is really we wanted to say.

So option **(D)** is correct.

http://www.cse.iitd.ac.in/~mittal/gate/gate_math_2004.html

19 votes

-- Anu (9k points)

9.0.53 GATE1999_14 [top](#)

<http://gateoverflow.in/1513>



Selected Answer

a.

$$[(\sim p \vee q) \Rightarrow (q \Rightarrow p)] = \sim (\sim p \vee q) \vee (q \Rightarrow p) = (p \wedge \sim q) \vee (\sim q \vee p) = p \vee \sim q .$$

Hence not tautology.

b.

$$(A \vee B) = T \vee B = T$$

4 votes

-- Arjun Suresh (150k points)

9.0.54 GATE2003_33 [top](#)

<http://gateoverflow.in/923>



Selected Answer

$$\alpha : (\forall x) [P_x \Leftrightarrow (\forall y) [Q_{xy} \Leftrightarrow \neg Q_{yy}]] \Rightarrow (\forall x) [\neg P_x]$$

This is can be interpreted as:

- $\alpha : ((\forall x) [P_x \Leftrightarrow (\forall y) [Q_{xy} \Leftrightarrow \neg Q_{yy}]]) \Rightarrow ((\forall x) [\neg P_x])$

See the RHS. It says $P(x)$ is false for any natural number. But there are natural numbers which are prime and hence this RHS is FALSE. Now, to make α TRUE, LHS must be FALSE for any x . Here, LHS is bit complex, so lets consider it separately.

$$(\forall x) [P_x \Leftrightarrow (\forall y) [Q_{xy} \Leftrightarrow \neg Q_{yy}]]$$

LHS is TRUE only if the given implication is TRUE for all x . Here the rightmost double implication $(\forall y) [Q_{xy} \Leftrightarrow \neg Q_{yy}]$ is always FALSE, because x can be equal to y and hence **forall** can never be TRUE. So the LHS reduces to just $(\forall x) \neg P(x)$ and returns FALSE as we have prime as well as non-prime natural numbers. So, FALSE \Rightarrow FALSE returns TRUE making both I_1 and I_2 satisfy α . D choice.

12 votes

-- Arjun Suresh (150k points)

9.0.55 GATE2004_70 [top](#)

<http://gateoverflow.in/1064>



Selected Answer

Answer a

It is false when P = T, Q = T, R = F

It is true (satisfiable) when P = T, Q = T, R = T

6 votes

-- Anu (9k points)

9.0.56 GATE2010-30 [top](#)

<http://gateoverflow.in/1156>



Selected Answer

B is the correct answer. The trick is to bring the negate sign to the extreme left. Form a sentence without using negate and just negate that.

$$\forall x \exists y \exists t (\neg F(x, y, t)) = \neg(\forall x \neg \exists y \neg \exists t)(\neg F(x, y, t)) = \neg(\neg \forall x \neg \exists y \neg \exists t(F(x, y, t))) = \neg(\exists x \forall y \forall t(F(x, y, t))).$$

20 votes

-- Bhagirathi Nayak (11.3k points)

9.0.57 GATE2005_40 [top](#)

<http://gateoverflow.in/1165>



Selected Answer

$$\begin{aligned} X &= (P \vee Q) \rightarrow R \\ &= \sim(P \vee Q) \vee R \\ &= (\sim P \wedge \sim Q) \vee R \\ &= (\sim P \vee R) \wedge (\sim Q \vee R) \\ &= (P \rightarrow R) \wedge (Q \rightarrow R) \end{aligned}$$

So, X → Y is true as (A ∧ B) → (A ∨ B) is always TRUE but reverse implication is not always true.

Hence, B.

6 votes

-- Arjun Suresh (150k points)

9.0.58 GATE2007-22 [top](#)

<http://gateoverflow.in/1220>



Selected Answer

D says "all graphs are not connected" but the question says "not every graph is connected" .i.e " there exists at least one graph which is not connected". Hence the answer is D

9 votes

-- Manali (2.5k points)

9.1

Boolean Expressions [top](#)

9.1.1 Boolean Expressions: GATE2014-2_53 [top](#)

<http://gateoverflow.in/2020>

Which one of the following Boolean expressions is NOT a tautology?

(A) $((a \rightarrow b) \wedge (b \rightarrow c)) \rightarrow (a \rightarrow c)$

(B) $(a \rightarrow c) \rightarrow (\sim b \rightarrow (a \wedge c))$

(C) $(a \wedge b \wedge c) \rightarrow (c \vee a)$

(D) $a \rightarrow (b \rightarrow a)$

gate2014-2 | mathematical-logic | boolean-expressions | normal

[Answer](#)

Answers: Boolean Expressions

9.1.1 Boolean Expressions: GATE2014-2_53 [top](#)



Selected Answer

Another way to solve it...

Implication $A \rightarrow B$ is not tautology if B is false and A is true

For b option Let RHS ie $\neg b \rightarrow (a \wedge c)$ be false ie b is false and $(a \wedge c)$ is false

Now a AND c is false if both a and c are false or one of them is true and other is false

Now if a and c both are false then $a \rightarrow c$ is true Now LHS is true and RHS is false

So option b is not tautology..

9 votes

-- Pooja (25.9k points)

9.2

Canonical Normal Form [top](#)

9.2.1 Canonical Normal Form: GATE1995_13 [top](#)

<http://gateoverflow.in/2649>

Obtain the principal (canonical) conjunctive normal form of the propositional formula

$$(p \wedge q) \vee (\neg q \wedge r)$$

where \wedge is logical and, \vee is inclusive or and \neg is negation.

gate1995 | mathematical-logic | canonical-normal-form | normal

[Answer](#)

Answers: Canonical Normal Form

9.2.1 Canonical Normal Form: GATE1995_13 [top](#)

<http://gateoverflow.in/2649>



Selected Answer

$$(p \vee \neg q \vee r) \wedge (p \vee \neg q \vee \neg r) \wedge (p \vee q \vee r) \wedge (\neg p \vee q \vee r)$$

6 votes

-- Anu (9k points)

9.3

First Order Logic [top](#)

9.3.1 First Order Logic: GATE2003_32 [top](#)

<http://gateoverflow.in/922>

Which of the following is a valid first order formula? (Here α and β are first order formulae with x as their only free variable)

- (A) $((\forall x)[\alpha] \Rightarrow (\forall x)[\beta]) \Rightarrow (\forall x)[\alpha \Rightarrow \beta]$
- (B) $(\forall x)[\alpha] \Rightarrow (\exists x)[\alpha \wedge \beta]$
- (C) $((\forall x)[\alpha \vee \beta] \Rightarrow (\exists x)[\alpha]) \Rightarrow (\forall x)[\alpha]$
- (D) $(\forall x)[\alpha \Rightarrow \beta] \Rightarrow ((\forall x)[\alpha] \Rightarrow (\forall x)[\beta])$

gate2003 mathematical-logic first-order-logic normal

[Answer](#)

9.3.2 First Order Logic: TIFR2010-A-8 [top](#)

<http://gateoverflow.in/18239>

Which of the following is NOT necessarily true? { Notation: The symbol "¬" notes negation; $P(x, y)$ means that for given x and y , the property $P(x, y)$ is true }.

- a. $(\forall x \forall y P(x, y)) \Rightarrow (\forall y \forall x P(x, y))$
- b. $(\forall x \exists y \neg P(x, y)) \Rightarrow \neg(\exists x \forall y P(x, y))$
- c. $(\exists x \exists y P(x, y)) \Rightarrow (\exists y \exists x P(x, y))$
- d. $(\exists x \forall y P(x, y)) \Rightarrow (\forall y \exists x P(x, y))$
- e. $(\forall x \exists y P(x, y)) \Rightarrow (\exists y \forall x P(x, y))$

tifr2010 mathematical-logic first-order-logic

[Answer](#)

9.3.3 First Order Logic: TIFR2012-B-3 [top](#)

<http://gateoverflow.in/25048>

For a person p , let $w(p)$, $A(p, y)$, $L(p)$ and $J(p)$ denote that p is a woman, p admires y , p is a lawyer and p is a judge respectively. Which of the following is the correct translation in first order logic of the sentence: "All woman who are lawyers admire some judge"?

- a. $\forall x : [(w(x) \Lambda L(x)) \Rightarrow (\exists y : (J(y) \Lambda w(y) \Lambda A(x, y)))]$
- b. $\forall x : [(w(x) \Rightarrow L(x)) \Rightarrow (\exists y : (J(y) \Lambda A(x, y)))]$
- c. $\forall x \forall y : [(w(x) \Lambda L(x)) \Rightarrow (J(y) \Lambda A(x, y))]$
- d. $\exists y \forall x : [(w(x) \Lambda L(x)) \Rightarrow (J(y) \Lambda A(x, y))]$
- e. $\forall x : [(w(x) \Lambda L(x)) \Rightarrow (\exists y : (J(y) \Lambda A(x, y)))]$

tifr2012 mathematical-logic first-order-logic

[Answer](#)

9.3.4 First Order Logic: GATE2008-IT_21 [top](#)

<http://gateoverflow.in/3282>

Which of the following first order formulae is logically valid? Here $\alpha(x)$ is a first order formula with x as a free variable, and β is a first order formula with no free variable.

- A. $[\beta \rightarrow (\exists x, \alpha(x))] \rightarrow [\forall x, \beta \rightarrow \alpha(x)]$
- B. $[\exists x, \beta \rightarrow \alpha(x)] \rightarrow [\beta \rightarrow (\forall x, \alpha(x))]$
- C. $[(\exists x, \alpha(x)) \rightarrow \beta] \rightarrow [\forall x, \alpha(x) \rightarrow \beta]$
- D. $[(\forall x, \alpha(x)) \rightarrow \beta] \rightarrow [\forall x, \alpha(x) \rightarrow \beta]$

gate2008-it first-order-logic normal

[Answer](#)

9.3.5 First Order Logic: GATE2016-2-27 [top](#)

<http://gateoverflow.in/39618>

Which one of the following well-formed formulae in predicate calculus is **NOT** valid ?

- A. $(\forall x p(x) \implies \forall x q(x)) \implies (\exists x \neg p(x) \vee \forall x q(x))$

- B. $(\exists xp(x) \vee \exists xq(x)) \implies \exists x(p(x) \vee q(x))$
 C. $\exists x(p(x) \wedge q(x)) \implies (\exists xp(x) \wedge \exists xq(x))$
 D. $\forall x(p(x) \vee q(x)) \implies (\forall xp(x) \vee \forall xq(x))$

gate2016-2 | mathematical-logic | first-order-logic | normal

Answer

Answers: First Order Logic

9.3.1 First Order Logic: GATE2003_32 [top](#)

<http://gateoverflow.in/922>



Selected Answer

(D) is the answer.

(A) Let $X = \{3, 6, 9, 8\}$. Let a denote multiple of 3 and β denote multiple of 4. $(\forall x)[a]$ becomes false as 8 is not a multiple of 3, and so $(\forall x)[a] \Rightarrow (\forall x)[\beta]$ becomes TRUE. Now, this won't imply $(\forall x)[a \Rightarrow \beta]$ as multiple of 3 doesn't imply multiple of 4 for 3, 6 or 9.

(B) Let $X = \{3, 6, 9\}$. Let a denote multiple of 3 and β denote multiple of 4. Now LHS is TRUE but RHS is false as none of the x in X , is a multiple of 4.

(C) Let $X = \{3, 6, 9, 7\}$. Let a denote multiple of 3 and β denote multiple of 4. Now $(\forall x)[a \vee \beta]$ becomes false and hence $LHS = ((\forall x)[a \vee \beta] \Rightarrow (\exists x)[a])$ becomes true. But RHS is false as 7 is not a multiple of 3.

(D) This is valid. LHS is saying that if a is holding for any x , then β also holds for that x . RHS is saying if a is holding for all x , then β also holds for all x . Clearly LHS \implies RHS (but RHS does not imply LHS).

For example, let $X = \{4, 8, 12\}$, a denote multiple of 2 and β denote multiple of 4. LHS = $(\forall x)[a \Rightarrow \beta]$, is TRUE. RHS is also true. If we add '3' to X , then LHS is true, first part of RHS becomes false and thus RHS also becomes TRUE. There is no way we can make LHS true and RHS false here. But if we add 2 and 3 to X , RHS will be true and LHS will be false. So, we can't say RHS implies LHS.

8 votes

-- Arjun Suresh (150k points)

9.3.2 First Order Logic: TIFR2010-A-8 [top](#)

<http://gateoverflow.in/18239>



Selected Answer

a is TRUE as both LHS and RHS are equivalent- English would be for every x , and for every y , $P(x,y)$ is TRUE. Changing y and x wouldn't change the meaning.

b is TRUE as both LHS and RHS are equivalent- RHS is obtained by double negation of LHS.

c. Similar to a, both are equivalent.

d.

- LHS: For some x , for all y , $P(x,y)$ is TRUE.
- RHS: For all y and for some x , $P(x,y)$ is TRUE.

Both are not equivalent. LHS is stronger and implies RHS. For example, on the natural number set, we have $x = 1$ such that for every y , $P(x \leq y)$ is TRUE. Clearly, this implies for all y there exists some x (here x could be different for different y but on RHS, it must be the same).

e.

- LHS: For all x and for some y , $P(x, y)$ is TRUE.
- RHS: For some y and for all x , $P(x, y)$ is TRUE.

As explained in d, these are not equivalent and here RHS is stronger than LHS, making the implication false. For example consider the " \leq " relation on the integer set. LHS is true here as for every integer we have another integer which is greater. But RHS is false as there is no single integer (infinity is not an integer) which is greater than all other integers.

4 votes

-- Arjun Suresh (150k points)

9.3.3 First Order Logic: TIFR2012-B-3 [top](#)

<http://gateoverflow.in/25048>

Selected Answer

Just translating to English:

- a. Every women who is a lawyer admires some women judge.
- b. If a person being women implies she is a lawyer then she admires some judge. OR If a person is not women or is a lawyer he/she admires some judge.
- c. Every women who is a lawyer admires every judge.
- d. There is some judge who is admired by every women lawyer.
- e. Every women lawyer admire some judge.

So, option E is the answer.

3 votes

-- Arjun Suresh (150k points)

9.3.4 First Order Logic: GATE2008-IT_21 [top](#)

<http://gateoverflow.in/3282>

Selected Answer

A. $[\beta \rightarrow (\exists x, \alpha(x))] \rightarrow [\forall x, \beta \rightarrow \alpha(x)]$

LHS: If β (some condition) is true, then there exists an x for which $\alpha(x)$ is true.

RHS: For all x , if β is true then $\alpha(x)$ is true. This is same as saying if β is true then for all x , $\alpha(x)$ is true. ($\beta \implies \forall x, \alpha(x)$).

So,

$$\text{RHS} \implies \text{LHS and LHS} \implies \text{RHS}.$$

B. $[\exists x, \beta \rightarrow \alpha(x)] \rightarrow [\beta \rightarrow (\forall x, \alpha(x))]$

LHS: There exists an x such that if β is true then $\alpha(x)$ is true.

RHS: If β is true then for all x , $\alpha(x)$ is true.

So,

$$\text{RHS} \implies \text{LHS and LHS} \implies \text{RHS}.$$

C. $[(\exists x, \alpha(x)) \rightarrow \beta] \rightarrow [\forall x, \alpha(x) \rightarrow \beta]$

LHS: If there is an x such that $\alpha(x)$ is true, then β is true.

RHS: For all x , if $\alpha(x)$ is true, then β is true.

Here, both LHS and RHS are in fact same as β is a formula which is independent of x . (if β is true for one x , it is true for every x and vice versa).

So,

$$\text{RHS} \implies \text{LHS and LHS} \implies \text{RHS}.$$

D. $[(\forall x, \alpha(x)) \rightarrow \beta] \rightarrow [\forall x, \alpha(x) \rightarrow \beta]$

LHS: If $\alpha(x)$ is true for every x , then β is true.

RHS: For every x , if $\alpha(x)$ is true then β is true.

So,

$\text{RHS} \implies \text{LHS}$ and $\text{LHS} \implies \text{RHS}$.

So, answer here is **option C**. Any of options A, B or D could be valid if their implication is reversed. For option C, LHS and RHS being equivalent, even if the implication is reversed (or changed to double implies) it remains valid.

8 votes

-- Arjun Suresh (150k points)

9.3.5 First Order Logic: GATE2016-2-27 [top](#)

<http://gateoverflow.in/39618>



Selected Answer

Here D is not valid

Let me prove by example

What D is saying here is something like this

For all x (x is even no or x is odd no) \implies For all x (x is even no) or For all x (x is odd no) this is surely wrong. So

Ans \Rightarrow D

11 votes

-- Akash (31.7k points)

9.4

Logical Reasoning [top](#)

9.4.1 Logical Reasoning: TIFR2010-A-4 [top](#)

<http://gateoverflow.in/18212>

If the bank receipt is forged, then Mr. M is liable. If Mr. M is liable, he will go bankrupt. If the bank will loan him money, he will not go bankrupt. The bank will loan him money.

Which of the following can be concluded from the above statements?

- a. Mr. M is liable
- b. The receipt is not forged
- c. Mr. M will go bankrupt
- d. The bank will go bankrupt
- e. None of the above

[tifr2010](#) [logical-reasoning](#) [mathematical-logic](#)

Answer

Answers: Logical Reasoning

9.4.1 Logical Reasoning: TIFR2010-A-4 [top](#)

<http://gateoverflow.in/18212>



Selected Answer

Let us denote sentences with variables F:Bank receipt is forged

L:Mr M is liable

B:He will go bankrupt

M:Bank loan him money

1.F \rightarrow L

2.L \rightarrow B

3.M \rightarrow B'

4.M

From 3 and 4 modus ponens we get

5.B'

From 2 and 5 modus tollens we get

6.L'

From 1 and 6 modus tollens we get

F'

Ans is bank receipt is not forged

4 5 votes

-- Pooja (25.9k points)

10 Discrete Mathematics Set Theory & Algebra (161) top

10.0.1 GATE2013_1 top

<http://gateoverflow.in/59>

A binary operation \oplus on a set of integers is defined as $x \oplus y = x^2 + y^2$. Which one of the following statements is **TRUE** about \oplus ?

- (A) Commutative but not associative
- (B) Both commutative and associative
- (C) Associative but not commutative
- (D) Neither commutative nor associative

gate2013 | set-theory&algebra | easy

Answer

10.0.2 GATE2008-2 top

<http://gateoverflow.in/400>

If P, Q, R are subsets of the universal set U , then

$$(P \cap Q \cap R) \cup (P^c \cap Q \cap R) \cup Q^c \cup R^c$$

is

- A. $Q^c \cup R^c$
- B. $P \cup Q^c \cup R^c$
- C. $P^c \cup Q^c \cup R^c$
- D. U

gate2008 | normal | set-theory&algebra

Answer

10.0.3 GATE1994_15 top

<http://gateoverflow.in/2511>

Use the patterns given to prove that

a.
$$\sum_{i=0}^{n-1} (2i+1) = n^2$$

(You are not permitted to employ induction)

| | | |
|---|---|-----|
| . | . | . |
| . | . | . |
| . | . | etc |

- b. Use the result obtained in (a) to prove that

$$\sum_{i=1}^n i = \frac{n(n+1)}{2}$$

gate1994 | set-theory&algebra | proof

Answer

10.0.4 GATE1994_3.9 top

<http://gateoverflow.in/2495>

Every subset of a countable set is countable.

State whether the above statement is true or false with reason.

gate1994 | set-theory&algebra | normal

Answer

10.0.5 GATE1994_3.8 top

<http://gateoverflow.in/2494>

Give a relational algebra expression using only the minimum number of operators from (\cup , $-$) which is equivalent to $R \cap S$.

gate1994 | set-theory&algebra | normal

Answer

10.0.6 GATE1994_2.4 top

<http://gateoverflow.in/2471>

The number of subsets $\{1, 2, \dots, n\}$ with odd cardinality is _____

gate1994 | set-theory&algebra | easy

Answer

10.0.7 GATE1994_2.3 top

<http://gateoverflow.in/2470>

Amongst the properties {reflexivity, symmetry, anti-symmetry, transitivity} the relation $R = \{(x, y) \in N^2 | x \neq y\}$ satisfies _____

gate1994 | set-theory&algebra | normal

Answer

10.0.8 GATE1994_2.2 top

<http://gateoverflow.in/2469>

On the set N of non-negative integers, the binary operation _____ is associative and non-commutative.

gate1994 | set-theory&algebra | normal

Answer

10.0.9 GATE1994_1.2 top

<http://gateoverflow.in/2438>

Let A and B be real symmetric matrices of size $n \times n$. Then which one of the following is true?

- A. $AA' = I$
- B. $A = A^{-1}$
- C. $AB = BA$
- D. $(AB)' = BA$

gate1994 | set-theory&algebra | linear-algebra | normal

Answer

10.0.10 GATE1993_8.4 top

<http://gateoverflow.in/2302>

Let A be a finite set of size n . The number of elements in the power set of $A \times A$ is:

- A. 2^{2^n}
- B. 2^{n^2}
- C. $(2^n)^2$
- D. $(2^2)^n$
- E. None of the above

[gate1993](#)
[set-theory&algebra](#)
[easy](#)
Answer**10.0.11 GATE1995_2.8** [top](#)<http://gateoverflow.in/2620>

If the cube roots of unity are $1, \omega$ and ω^2 , then the roots of the following equation are

$$(x - 1)^3 + 8 = 0$$

- A. $-1, 1 + 2\omega, 1 + 2\omega^2$
- B. $1, 1 - 2\omega, 1 - 2\omega^2$
- C. $-1, 1 - 2\omega, 1 - 2\omega^2$
- D. $-1, 1 + 2\omega, -1 + 2\omega^2$

[gate1995](#)
[set-theory&algebra](#)
[normal](#)
Answer**10.0.12 GATE1993_8.3** [top](#)<http://gateoverflow.in/2301>

Let S be an infinite set and S_1, S_2, \dots, S_n be sets such that $S_1 \cup S_2 \cup \dots \cup S_n = S$. Then

- A. at least one of the set S_i is a finite set
- B. not more than one of the set S_i can be finite
- C. at least one of the sets S_i is an infinite
- D. not more than one of the sets S_i can be infinite
- E. None of the above

[gate1993](#)
[set-theory&algebra](#)
[normal](#)
Answer**10.0.13 GATE1997_4.4** [top](#)<http://gateoverflow.in/2245>

A polynomial $p(x)$ is such that $p(0) = 5, p(1) = 4, p(2) = 9$ and $p(3) = 20$. The minimum degree it should have is

- A. 1
- B. 2
- C. 3
- D. 4

[gate1997](#)
[set-theory&algebra](#)
[normal](#)
Answer**10.0.14 GATE2014-2_50** [top](#)<http://gateoverflow.in/2016>

Consider the following relation on subsets of the set S of integers between 1 and 2014. For two distinct subsets U and V of S we say $U < V$ if the minimum element in the symmetric difference of the two sets is in U .

Consider the following two statements:

S1: There is a subset of S that is larger than every other subset.

S_2 : There is a subset of S that is smaller than every other subset.

Which one of the following is CORRECT?

(A) Both
 S_1 and
 S_2 are true

(B)
 S_1 is true and
 S_2 is false

(C)
 S_2 is true and
 S_1 is false

(D) Neither
 S_1 nor
 S_2 is true

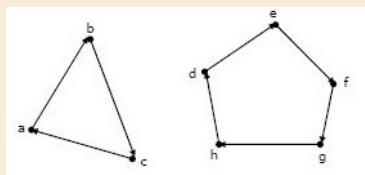
gate2014-2 | set-theory&algebra | normal

Answer

10.0.15 GATE1998_10 top

<http://gateoverflow.in/1724>

- a. Prove by induction that the expression for the number of diagonals in a polygon of n sides is $\frac{n(n-3)}{2}$
- b. Let R be a binary relation on $A = \{a, b, c, d, e, f, g, h\}$ represented by the following two component digraph. Find the smallest integers m and n such that $m < n$ and $R^m = R^n$.



gate1998 | set-theory&algebra | descriptive

Answer

10.0.16 GATE1998_2.4 top

<http://gateoverflow.in/1676>

In a room containing 28 people, there are 18 people who speak English, 15, people who speak Hindi and 22 people who speak Kannada. 9 persons speak both English and Hindi, 11 persons speak both Hindi and Kannada whereas 13 persons speak both Kannada and English. How many speak all three languages?

- A. 9
- B. 8
- C. 7
- D. 6

gate1998 | set-theory&algebra | easy

Answer

10.0.17 GATE1998_2.3 top

<http://gateoverflow.in/1675>

The binary relation $R = \{(1, 1), (2, 1), (2, 2), (2, 3), (2, 4), (3, 1), (3, 2), (3, 3), (3, 4)\}$ on the set $A = \{1, 2, 3, 4\}$ is

- A. reflective, symmetric and transitive
- B. neither reflective, nor irreflexive but transitive

- C. irreflexive, symmetric and transitive
 D. irreflexive and antisymmetric

gate1998 | set-theory&algebra | easy

Answer

10.0.18 GATE1999_2.3 top

<http://gateoverflow.in/1481>

Let L be a set with a relation R which is transitive, anti-symmetric and reflexive and for any two elements $a, b \in L$, let the least upper bound $\text{lub}(a, b)$ and the greatest lower bound $\text{glb}(a, b)$ exist. Which of the following is/are true?

- A. L is a poset
 B. L is a Boolean algebra
 C. L is a lattice
 D. None of the above

gate1999 | set-theory&algebra | normal

Answer

10.0.19 GATE1995_1.20 top

<http://gateoverflow.in/2607>

The number of elements in the power set $P(S)$ of the set $S = \{\{\emptyset\}, 1, \{2, 3\}\}$ is:

- A. 2
 B. 4
 C. 8
 D. None of the above

gate1995 | set-theory&algebra | normal

Answer

10.0.20 GATE1995_23 top

<http://gateoverflow.in/2661>

Prove using mathematical induction for $n \geq 5$, $2^n > n^2$

gate1995 | set-theory&algebra | proof

Answer

10.0.21 GATE2007_2 top

<http://gateoverflow.in/1201>

Let S be a set of n elements. The number of ordered pairs in the largest and the smallest equivalence relations on S are:

- (A) n and n (B) n^2 and n (C) n^2 and 0 (D) n and 1

gate2007 | set-theory&algebra | normal

Answer

10.0.22 GATE2005-IT_34 top

<http://gateoverflow.in/3780>

Let $n = p^2q$, where p and q are distinct prime numbers. How many numbers m satisfy $1 \leq m \leq n$ and $\text{gcd}(m, n) = 1$? Note that $\text{gcd}(m, n)$ is the greatest common divisor of m and n .

- A) $p(q - 1)$
 B) pq
 C) $(p^2 - 1)(q - 1)$
 D) $p(p - 1)(q - 1)$

gate2005-it | set-theory&algebra | normal

Answer

10.0.23 GATE 2016-1-1 top

<http://gateoverflow.in/39663>

Let p, q, r, s represents the following propositions.

$p : x \in \{8, 9, 10, 11, 12\}$

$q : x$ is a composite number.

$r : x$ is a perfect square.

$s : x$ is a prime number.

The integer $x \geq 2$ which satisfies $\neg((p \Rightarrow q) \wedge (\neg r \vee \neg s))$ is _____.

gate2016-1 | set-theory&algebra | normal | numerical-answers

Answer

10.0.24 GATE 2016-2-28 top

<http://gateoverflow.in/39595>

Consider a set U of 23 different compounds in a chemistry lab. There is a subset S of U of 9 compounds, each of which reacts with exactly 3 compounds of U . Consider the following statements:

- I. Each compound in $U \setminus S$ reacts with an odd number of compounds.
- II. At least one compound in $U \setminus S$ reacts with an odd number of compounds.
- III. Each compound in $U \setminus S$ reacts with an even number of compounds.

Which one of the above statements is **ALWAYS TRUE**?

- A. Only I
 B. Only II
 C. Only III
 D. None.

gate2016-2 | set-theory&algebra | difficult

Answer

10.0.25 TIFR2013-A-3 top

<http://gateoverflow.in/25384>

Three candidates, Amar, Birendra and Chanchal stand for the local election. Opinion polls are conducted and show that fraction a of the voters prefer Amar to Birendra, fraction b prefer Birendra to Chanchal and fraction c prefer Chanchal to Amar. Which of the following is impossible?

- a. $(a, b, c) = (0.51, 0.51, 0.51);$
- b. $(a, b, c) = (0.61, 0.71, 0.67);$
- c. $(a, b, c) = (0.68, 0.68, 0.68);$
- d. $(a, b, c) = (0.49, 0.49, 0.49);$
- e. None of the above.

tifr2013 | set-theory&algebra

Answer

10.0.26 TIFR2012-A-8 [top](#)<http://gateoverflow.in/21007>

How many pairs of sets (A, B) are there that satisfy the condition $A, B \subseteq \{1, 2, \dots, 5\}, A \cap B = \{\}$?

- a. 125
- b. 127
- c. 130
- d. 243
- e. 257

[tifr2012](#) | [set-theory&algebra](#)

[Answer](#)

10.0.27 GATE2015-3_5 [top](#)<http://gateoverflow.in/8399>

The number of 4 digit numbers having their digits in non-decreasing order (from left to right) constructed by using the digits belonging to the set $\{1, 2, 3\}$ is _____.

[gate2015-3](#) | [set-theory&algebra](#) | [normal](#)

[Answer](#)

10.0.28 GATE2015-1_26 [top](#)<http://gateoverflow.in/8248>

$$\sum_{x=1}^{99} \frac{1}{x(x+1)} = \text{_____}.$$

[gate2015-1](#) | [set-theory&algebra](#) | [normal](#)

[Answer](#)

10.0.29 GATE2015-1_28 [top](#)<http://gateoverflow.in/8226>

The binary operator \neq is defined by the following truth table.

| p | q | $p \neq q$ |
|---|---|------------|
| 0 | 0 | 0 |
| 0 | 1 | 1 |
| 1 | 0 | 1 |
| 1 | 1 | 0 |

Which one of the following is true about the binary operator \neq ?

- A. Both commutative and associative
- B. Commutative but not associative
- C. Not commutative but associative
- D. Neither commutative nor associative

[gate2015-1](#) | [set-theory&algebra](#) | [easy](#)

[Answer](#)

10.0.30 GATE2005-IT_33 [top](#)<http://gateoverflow.in/3779>

Let A be a set with n elements. Let C be a collection of distinct subsets of A such that for any two subsets S_1 and S_2 in C , either $S_1 \subset S_2$ or $S_2 \subset S_1$. What is the maximum cardinality of C ?

- 1) n
- 2) $n + 1$
- 3) $2^{n-1} + 1$
- 4) $n!$

[gate2005-it](#) | [set-theory&algebra](#) | [normal](#)

Answer

10.0.31 GATE1996_1.1 [top](#)<http://gateoverflow.in/2705>

Let A and B be sets and let A^c and B^c denote the complements of the sets A and B . The set $(A - B) \cup (B - A) \cup (A \cap B)$ is equal to

- A. $A \cup B$
- B. $A^c \cup B^c$
- C. $A \cap B$
- D. $A^c \cap B^c$

[gate1996](#) | [set-theory&algebra](#) | [easy](#)

Answer

10.0.32 GATE2004-IT_2 [top](#)<http://gateoverflow.in/3643>

In a class of 200 students, 125 students have taken Programming Language course, 85 students have taken Data Structures course, 65 students have taken Computer Organization course; 50 students have taken both Programming Language and Data Structures, 35 students have taken both Data Structures and Computer Organization; 30 students have taken both Data Structures and Computer Organization, 15 students have taken all the three courses.

How many students have not taken any of the three courses?

- | | |
|----|----|
| A) | 15 |
| B) | 20 |
| C) | 25 |
| D) | 30 |

[gate2004-it](#) | [set-theory&algebra](#) | [easy](#)

Answer

10.0.33 GATE2006-IT_23 [top](#)<http://gateoverflow.in/3562>

Let P , Q and R be sets let Δ denote the symmetric difference operator defined as $P\Delta Q = (P \cup Q) - (P \cap Q)$. Using Venn diagrams, determine which of the following is/are TRUE?

- I. $P\Delta(Q \cap R) = (P\Delta Q) \cap (P\Delta R)$
- II. $P \cap (Q \cap R) = (P \cap Q) \Delta (P \cap R)$

- | | |
|----|------------------|
| A) | I only |
| B) | II only |
| C) | Neither I nor II |
| D) | Both I and II |

[gate2006-it](#) | [set-theory&algebra](#) | [normal](#)

Answer

10.0.34 GATE2006-IT_2 [top](#)<http://gateoverflow.in/3539>

For the set N of natural numbers and a binary operation $f : N \times N \rightarrow N$, an element $z \in N$ is called an identity for f , if $f(a, z) = a = f(z, a)$, for all $a \in N$. Which of the following binary operations have an identity?

- I. $f(x, y) = x + y - 3$
- II. $f(x, y) = \max(x, y)$
- III. $f(x, y) = x^y$

- A) I and II only
 B) II and III only
 C) I and III only
 D) None of these

[gate2006-it](#) [set-theory&algebra](#) [easy](#)

[Answer](#)

10.0.35 GATE2007-IT_77 [top](#)

<http://gateoverflow.in/3529>

Consider the sequence $\langle x_n \rangle$, $n \geq 0$ defined by the recurrence relation $x_{n+1} = c \cdot (x_n)^2 - 2$, where $c > 0$.

For which of the following values of c , does there exist a non-empty open interval (a, b) such that the sequence x_n converges for all x_0 satisfying $a < x_0 < b$?

- (i) 0.25 (iii) 0.35 (iii) 0.45 (iv) 0.5

- A) (i) only
 B) (i) and (ii) only
 C) (i), (ii) and (iii) only
 D) (i), (ii), (iii) and (iv)

[gate2007-it](#) [set-theory&algebra](#) [normal](#)

[Answer](#)

10.0.36 GATE2007-IT_16 [top](#)

<http://gateoverflow.in/3449>

The minimum positive integer p such that 3^p modulo 17 = 1 is

- | | |
|----|----|
| A) | 5 |
| B) | 8 |
| C) | 12 |
| D) | 16 |

[gate2007-it](#) [set-theory&algebra](#) [normal](#)

[Answer](#)

10.0.37 GATE2008-IT_26 [top](#)

<http://gateoverflow.in/3316>

Consider the field C of complex numbers with addition and multiplication. Which of the following form(s) a subfield of C with addition and multiplication?

- (S1) the set of real numbers
 (S2) $\{(a + ib) \mid a \text{ and } b \text{ are rational numbers}\}$
 (S3) $\{a + ib \mid (a^2 + b^2) \leq 1\}$
 (S4) $\{ia \mid a \text{ is real}\}$

- 1) only S1
 2) S1 and S3
 3) S2 and S3
 4) S1 and S2

[gate2008-it](#) [set-theory&algebra](#) [normal](#)

[Answer](#)

10.0.38 GATE1996_2.6 [top](#)

<http://gateoverflow.in/2735>

The matrices $\begin{bmatrix} \cos \theta & -\sin \theta \\ \sin \theta & \cos \theta \end{bmatrix}$ and $\begin{bmatrix} a & 0 \\ 0 & b \end{bmatrix}$ commute under multiplication

- A. if $a = b$ or $\theta = n\pi, n$ an integer
- B. always
- C. never
- D. if $a \cos \theta = b \sin \theta$

gate1996 set-theory&algebra normal

Answer

10.0.39 GATE1996_2.4 top

<http://gateoverflow.in/2733>

Which one of the following is false?

- A. The set of all bijective functions on a finite set forms a group under function composition.
- B. The set $\{1, 2, \dots, p-1\}$ forms a group under multiplication mod p , where p is a prime number.
- C. The set of all strings over a finite alphabet forms a group under concatenation.
- D. A subset $S \neq \emptyset$ of G is a subgroup of the group $\langle G, * \rangle$ if and only if for any pair of elements $a, b \in S, a * b^{-1} \in S$.

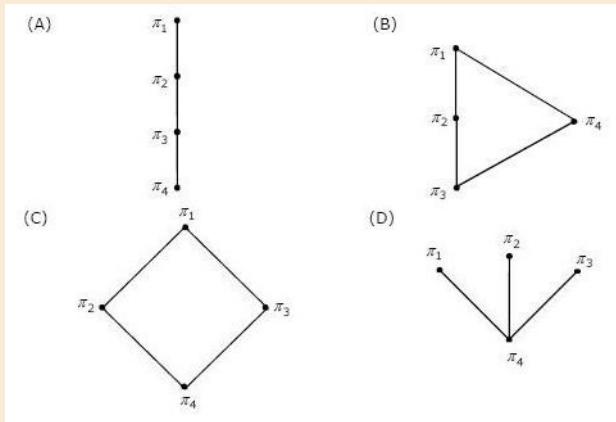
gate1996 set-theory&algebra normal

Answer

10.0.40 GATE2007_26 top

<http://gateoverflow.in/1224>

Consider the set $S = \{a, b, c, d\}$. Consider the following 4 partitions $\pi_1, \pi_2, \pi_3, \pi_4$ on $S : \pi_1 = \{\overline{abcd}\}, \pi_2 = \{\overline{ab}, \overline{cd}\}, \pi_3 = \{\overline{abc}, \overline{d}\}, \pi_4 = \{\bar{a}, \bar{b}, \bar{c}, \bar{d}\}$. Let \prec be the partial order on the set of partitions $S' = \{\pi_1, \pi_2, \pi_3, \pi_4\}$ defined as follows: $\pi_i \prec \pi_j$ if and only if π_i refines π_j . The poset diagram for (S', \prec) is:



gate2007 set-theory&algebra normal

Answer

10.0.41 GATE1993_17 top

<http://gateoverflow.in/2314>

Out of a group of 21 persons, 9 eat vegetables, 10 eat fish and 7 eat eggs. 5 persons eat all three dishes. How many persons eat at least two out of the three dishes?

gate1993 set-theory&algebra easy

Answer

10.0.42 GATE2006_22 [top](#)<http://gateoverflow.in/983>

Let E, F and G be finite sets. Let

$$X = (E \cap F) - (F \cap G) \text{ and} \\ Y = (E - (E \cap G)) - (E - F).$$

Which one of the following is true?

- (A) $X \subset Y$ (B) $X \supset Y$ (C) $X = Y$ (D) $X - Y \neq \emptyset$ and $Y - X \neq \emptyset$

[gate2006](#) [set-theory&algebra](#) [normal](#)

[Answer](#)

10.0.43 GATE2010-3 [top](#)<http://gateoverflow.in/1149>

What is the possible number of reflexive relations on a set of 5 elements?

- A. 2^{10}
- B. 2^{15}
- C. 2^{20}
- D. 2^{25}

[gate2010](#) [set-theory&algebra](#) [easy](#)

[Answer](#)

10.0.44 GATE2006_24 [top](#)<http://gateoverflow.in/987>

Given a set of elements $N = \{1, 2, \dots, n\}$ and two arbitrary subsets $A \subseteq N$ and $B \subseteq N$, how many of the $n!$ permutations π from N to N satisfy $\min(\pi(A)) = \min(\pi(B))$, where $\min(S)$ is the smallest integer in the set of integers S , and $\pi(S)$ is the set of integers obtained by applying permutation π to each element of S ?

- (A) $(n - |A \cup B|) |A| |B|$ (B) $(|A|^2 + |B|^2)n^2$ (C) $n! \frac{|A \cap B|}{|A \cup B|}$ (D) $\frac{|A \cap B|^2}{n! C_{|A \cup B|}}$

[gate2006](#) [set-theory&algebra](#) [normal](#)

[Answer](#)

10.0.45 GATE2003_31 [top](#)<http://gateoverflow.in/921>

Let (S, \leq) be a partial order with two minimal elements a and b , and a maximum element c . Let $P: S \rightarrow \{\text{True, False}\}$ be a predicate defined on S . Suppose that $P(a) = \text{True}$, $P(b) = \text{False}$ and $P(x) \implies P(y)$ for all $x, y \in S$ satisfying $x \leq y$, where \implies stands for logical implication. Which of the following statements CANNOT be true?

- (A) $P(x) = \text{True}$ for all $x \in S$ such that $x \neq b$
 (B) $P(x) = \text{False}$ for all $x \in S$ such that $x \neq a$ and $x \neq c$
 (C) $P(x) = \text{False}$ for all $x \in S$ such that $b \leq x$ and $x \neq c$
 (D) $P(x) = \text{False}$ for all $x \in S$ such that $a \leq x$ and $b \leq x$

[gate2003](#) [set-theory&algebra](#) [normal](#)

[Answer](#)

10.0.46 GATE2006_25 [top](#)<http://gateoverflow.in/988>

Let $S = \{1, 2, 3, \dots, m\}$, $m > 3$. Let X_1, \dots, X_n be subsets of S each of size 3. Define a function f from S to the set of natural numbers as, $f(i)$ is the number of sets X_j that contain the element i . That is $f(i) = |\{j \mid i \in X_j\}|$ then $\sum_{i=1}^n f(i)$ is:

- (A) $3m$
 (B) $3n$

- (C) $2m+1$
(D) $2n+1$

gate2006 | set-theory&algebra | normal

Answer

10.0.47 GATE2006_04 top

<http://gateoverflow.in/883>

A relation R is defined on ordered pairs of integers as follows:

$$(x, y)R(u, v) \text{ if } x < u \text{ and } y > v$$

Then R is:

- (A) Neither a Partial Order nor an Equivalence Relation
(B) A Partial Order but not a Total Order
(C) A total Order
(D) An Equivalence Relation

gate2006 | set-theory&algebra | normal

Answer

10.0.48 GATE2006_02 top

<http://gateoverflow.in/881>

Let X, Y, Z be sets of sizes x, y and z respectively. Let $W = X \times Y$ and E be the set of all subsets of W . The number of functions from Z to E is:

- (A) z^{2^y} (B) $z \times 2^{xy}$ (C) $z^{2^{x+y}}$ (D) 2^{xyz}

gate2006 | set-theory&algebra | normal

Answer

10.0.49 GATE2004_24 top

<http://gateoverflow.in/1021>

Consider the binary relation:

$$S = \{(x, y) \mid y = x + 1 \text{ and } x, y \in \{0, 1, 2\}\}$$

The reflexive transitive closure is S is

- A. $\{(x, y) \mid y > x \text{ and } x, y \in \{0, 1, 2\}\}$
B. $\{(x, y) \mid y \geq x \text{ and } x, y \in \{0, 1, 2\}\}$
C. $\{(x, y) \mid y < x \text{ and } x, y \in \{0, 1, 2\}\}$
D. $\{(x, y) \mid y \leq x \text{ and } x, y \in \{0, 1, 2\}\}$

gate2004 | set-theory&algebra | easy

Answer

10.0.50 GATE2002_3 top

<http://gateoverflow.in/856>

Let A be a set of $n(>0)$ elements. Let N_r be the number of binary relations on A and let N_f be the number of functions from A to A

- A. Give the expression for N_r , in terms of n.

- B. Give the expression for N_f , terms of n.
 C. Which is larger for all possible n , N_r or N_f

gate2002 | set-theory&algebra | normal

Answer

10.0.51 GATE2002_2.17 top

<http://gateoverflow.in/847>

The binary relation $S = \emptyset$ (empty set) on a set $A = \{1, 2, 3\}$ is

- A. Neither reflexive nor symmetric
 B. Symmetric and reflexive
 C. Transitive and reflexive
 D. Transitive and symmetric

gate2002 | set-theory&algebra | normal

Answer

10.0.52 GATE2009-22 top

<http://gateoverflow.in/799>

For the composition table of a cyclic group shown below:

| * | a | b | c | d |
|---|---|---|---|---|
| a | a | b | c | d |
| b | b | a | d | c |
| c | c | b | d | a |
| d | d | c | a | b |

Which one of the following choices is correct?

- A. a,b are generators
 B. b,c are generators
 C. c,d are generators
 D. d,a are generators

gate2009 | set-theory&algebra | normal

Answer

10.0.53 GATE2009-4 top

<http://gateoverflow.in/797>

Consider the binary relation $R = \{(x, y), (x, z), (z, x), (z, y)\}$ on the set $\{x, y, z\}$. Which one of the following is **TRUE**?

- A. R is symmetric but NOT antisymmetric
 B. R is NOT symmetric but antisymmetric
 C. R is both symmetric and antisymmetric
 D. R is neither symmetric nor antisymmetric

gate2009 | set-theory&algebra | easy

Answer

10.0.54 GATE2009-1 top

<http://gateoverflow.in/795>

Which one of the following is **NOT** necessarily a property of a Group?

- A. Commutativity
 B. Associativity
 C. Existence of inverse for every element
 D. Existence of identity

gate2009 | set-theory&algebra | easy

[Answer](#)

10.0.55 GATE2001-2.2 [top](#)

<http://gateoverflow.in/720>

Consider the following statements:

- S1: There exists infinite sets A, B, C such that $A \cap (B \cup C)$ is finite.
- S2: There exists two irrational numbers x and y such that $(x + y)$ is rational.

Which of the following is true about S1 and S2?

- A. Only S1 is correct
 B. Only S2 is correct
 C. Both S1 and S2 are correct
 D. None of S1 and S2 is correct

gate2001 | set-theory&algebra | normal

[Answer](#)

10.0.56 GATE2003_38 [top](#)

<http://gateoverflow.in/929>

Consider the set $\{a, b, c\}$ with binary operators + and * defined as follows.

| | | | |
|---|---|---|---|
| + | a | b | c |
| a | b | a | c |
| b | a | b | c |
| c | a | c | b |

| | | | |
|---|---|---|---|
| * | a | b | c |
| a | a | b | c |
| b | b | c | a |
| c | c | b | a |

For example, $a + c = c$, $c + a = a$, $c * b = c$ and $b * c = a$.

Given the following set of equations:

$$(a * x) + (a * y) = c(b * x) + (c * y) = c$$

The number of solution(s) (i.e., pair(s) (x, y)) that satisfy the equations) is

- (A) 0 (B) 1 (C) 2 (D) 3**

gate2003 | set-theory&algebra | normal

[Answer](#)

10.0.57 GATE2001-1.2 [top](#)

<http://gateoverflow.in/695>

Consider the following relations:

- R1 (a, b) iff $(a + b)$ is even over the set of integers
- R2 (a, b) iff $(a + b)$ is odd over the set of integers
- R3 (a, b) iff $a \cdot b > 0$ over the set of non-zero rational numbers

- R4 (a, b) iff $|a - b| \leq 2$ over the set of natural numbers

Which of the following statements is correct?

- R1 and R2 are equivalence relations, R3 and R4 are not
- R1 and R3 are equivalence relations, R2 and R4 are not
- R1 and R4 are equivalence relations, R2 and R3 are not
- R1, R2, R3 and R4 all are equivalence relations

[gate2001](#) [set-theory&algebra](#) [normal](#)

[Answer](#)

10.0.58 GATE2000-6 [top](#)

<http://gateoverflow.in/677>

Let S be a set of n elements $\{1, 2, \dots, n\}$ and G a graph with 2^n vertices, each vertex corresponding to a distinct subset of S . Two vertices are adjacent iff the symmetric difference of the corresponding sets has exactly 2 elements. Note: The symmetric difference of two sets R_1 and R_2 is defined as $(R_1 \setminus R_2) \cup (R_2 \setminus R_1)$

- Every vertex in G has the same degree. What is the degree of a vertex in G ?
- How many connected components does G have?

[gate2000](#) [set-theory&algebra](#) [normal](#)

[Answer](#)

10.0.59 GATE2005_8 [top](#)

<http://gateoverflow.in/1157>

Let A, B and C be non-empty sets and let $X = (A - B) - C$ and $Y = (A - C) - (B - C)$. Which one of the following is TRUE?

- $X = Y$
- $X \subset Y$
- $Y \subset X$
- None of these

[gate2005](#) [set-theory&algebra](#) [easy](#)

[Answer](#)

10.0.60 GATE2005_42 [top](#)

<http://gateoverflow.in/1167>

Let R and S be any two equivalence relations on a non-empty set A. Which one of the following statements is TRUE?

- $R \cup S, R \cap S$ are both equivalence relations.
- $R \cup S$ is an equivalence relation.
- $R \cap S$ is an equivalence relation.
- Neither $R \cup S$ nor $R \cap S$ are equivalence relations.

[gate2005](#) [set-theory&algebra](#) [normal](#)

[Answer](#)

10.0.61 GATE2005_13 [top](#)

<http://gateoverflow.in/1163>

The set $\{1, 2, 4, 7, 8, 11, 13, 14\}$ is a group under multiplication modulo 15. the inverses of 4 and 7 are respectively:

- 3 and 13
- 2 and 11
- 4 and 13
- 8 and 14

[gate2005](#) [set-theory&algebra](#) [normal](#)

[Answer](#)

10.0.62 GATE2000-2.4 [top](#)

<http://gateoverflow.in/651>

A polynomial $p(x)$ satisfies the following:

$$\begin{aligned} p(1) &= p(3) = p(5) = 1 \\ p(2) &= p(4) = -1 \end{aligned}$$

The minimum degree of such a polynomial is

- A. 1
- B. 2
- C. 3
- D. 4

[gate2000](#) [set-theory&algebra](#) [normal](#)

[Answer](#)

10.0.63 GATE2000-4 [top](#)

<http://gateoverflow.in/675>

Let $S = \{0, 1, 2, 3, 4, 5, 6, 7\}$ and \otimes denote multiplication modulo 8, that is, $x \otimes y = (xy) \bmod 8$

- a. Prove that $(\{0, 1\}, \otimes)$ is not a group.
- b. Write 3 distinct groups (G, \otimes) where $G \subset S$ and G has 2 elements.

[gate2000](#) [set-theory&algebra](#)

[Answer](#)

10.0.64 GATE2000-2.6 [top](#)

<http://gateoverflow.in/653>

Let $P(S)$ denotes the power set of set S . Which of the following is always true?

- A. $P(P(S)) = P(S)$
- B. $P(S) \cap P(P(S)) = \{\emptyset\}$
- C. $P(S) \cap S = P(S)$
- D. $S \notin P(S)$

[gate2000](#) [set-theory&algebra](#) [easy](#)

[Answer](#)

Answers:

10.0.1 GATE2013_1 [top](#)

<http://gateoverflow.in/59>



Selected Answer

Answer is (A) Commutative but not associative.

$y \oplus x = y^2 + x^2 = x \oplus y$. Hence, commutative.

$$\begin{aligned} (x \oplus y) \oplus z &= (x^2 + y^2) \oplus z = (x^2 + y^2)^2 + z^2 \\ x \oplus (y \oplus z) &= x \oplus (y^2 + z^2) = x^2 + (y^2 + z^2)^2 \end{aligned}$$

So, $((x \oplus y) \oplus z) \neq (x \oplus (y \oplus z))$, hence not associative.

10 votes

-- Arjun Suresh (150k points)

10.0.2 GATE2008-2 [top](#)

<http://gateoverflow.in/400>



Selected Answer

Answer D

$$(P \cap Q \cap R) \cup (P^c \cap Q \cap R) \cup Q^c \cup R^c = (P \cup P^c) \cap (Q \cap R) \cup Q^c \cup R^c = (Q \cap R) \cup Q^c \cup R^c = (Q \cap R) \cup (Q \cap R)^c$$

11 votes

-- Anu (9k points)

10.0.3 GATE1994_15 top

<http://gateoverflow.in/2511>

Selected Answer

a. Using the pattern we can see that n^2 is obtained by summing all the odd numbers from 1 to $2n - 1$. For i^{th} row if we sum the dots to right end and then down we get $2i - 1$. Then sum up the values of all rows and we get n^2 .

b.

$$\sum_{i=0}^{n-1} (2i + 1) = n^2 \implies 1 + \sum_{i=1}^n (2i + 1) = n^2 + 2n + 1 \implies \sum_{i=1}^n 2i + \sum_{i=1}^n 1 = n^2 + 2n \implies 2 \cdot \sum_{i=1}^n i + n = n^2 + 2n$$

1 votes

-- Arjun Suresh (150k points)

10.0.4 GATE1994_3.9 top

<http://gateoverflow.in/2495>

Selected Answer

True

https://proofwiki.org/wiki/Subset_of_Countable_Set_is_Countable

1 votes

-- Anu (9k points)

10.0.5 GATE1994_3.8 top

<http://gateoverflow.in/2494>

Selected Answer

R-(R-S)

There is no need to use Union operator here.

Just because they say you can use operators from (\cup , $-$) we don't need to use both of them.

Also they are saying that **only the minimum number of operators from (\cup , $-$)** which is equivalent to $R \cap S$.

My expression is Minimal.

6 votes

-- Akash (31.7k points)

10.0.6 GATE1994_2.4 top

<http://gateoverflow.in/2471>

Selected Answer

Answer: 2^{n-1}

No. of subsets with cardinality $i = {}^n C_i$

So, no. of subsets with odd cardinality = $\sum_{i=1,3,\dots,n-1} {}^n C_i = 2^{n-1}$ (Proof given below)

We have,

$${}^n C_0 + {}^n C_1 + {}^n C_2 + \dots + {}^n C_n = 2^n$$

$$\begin{aligned} {}^n C_0 + {}^n C_1 + {}^n C_2 + \dots + {}^n C_n &= \left\{ \begin{array}{l} {}^{n+1} C_1 + {}^{n+1} C_3 + \dots + {}^{n+1} C_n, n \text{ is even} \\ {}^{n+1} C_1 + {}^{n+1} C_3 + \dots + {}^{n+1} C_{n-1} + {}^n C_n, n \text{ is odd} \end{array} \right. \quad (\because {}^n C_r + {}^n C_{r-1} = {}^{n+1} C_r) = 2^n \\ &\Rightarrow \left. \begin{array}{l} {}^n C_1 + {}^n C_3 + \dots + {}^n C_{n-1}, n \text{ is even} \\ {}^n C_1 + {}^n C_3 + \dots + {}^n C_n, n \text{ is odd} \end{array} \right\} = 2^{n-1} \quad (\text{replacing } n \text{ by } n-1, {}^n C_n = {}^{n-1} C_{n-1}) \end{aligned}$$

Proof for ${}^n C_r + {}^n C_{r-1} = {}^{n+1} C_r$

$${}^n C_r + {}^n C_{r-1} = \frac{n!}{r!(n-r)!} + \frac{n!}{(r-1)!(n-r+1)!} = \frac{n!(n-r+1)+n!r}{r!(n-r+1)!} = \frac{n!(n+1)}{r!(n-r+1)!} = \frac{(n+1)!}{r!(n-r+1)!} = {}^{n+1} C_r$$

2 votes

-- Rajarshi Sarkar (29.7k points)

10.0.7 GATE1994_2.3 [top](#)

<http://gateoverflow.in/2470>



Selected Answer

It is not reflexive as xRx is not possible.

It is symmetric as if xRy then yRx .

It is not antisymmetric as xRy and yRx are possible and we can have $x \neq y$.

It is not transitive as if xRy and yRz then xRz need not be true. This is violated when $z = x$.

So, symmetry is the answer.

4 votes

-- Rajarshi Sarkar (29.7k points)

10.0.8 GATE1994_2.2 [top](#)

<http://gateoverflow.in/2469>



Selected Answer

Define Binary operation $*$ on (a, b) as : $a * b = a$

1. It is associative : $(a * b) * c = a * c = a$, and $a * (b * c) = a * b = a$

2. It is not commutative : $a * b = a$, whereas $b * a = b$.

5 votes

-- Happy Mittal (9.5k points)

10.0.9 GATE1994_1.2 [top](#)

<http://gateoverflow.in/2438>



Selected Answer

Answer: D

Given $A = A'$ and $B = B'$

$$(AB)' = B'A' = BA$$

3 votes

-- Rajarshi Sarkar (29.7k points)

10.0.10 GATE1993_8.4 [top](#)

<http://gateoverflow.in/2302>



Selected Answer

Cardinality of $A \times A = n^2$
 Cardinality of power set of $A \times A = 2^{n^2}$

8 votes

-- Digvijay (35.8k points)

10.0.11 GATE1995_2.8 top

<http://gateoverflow.in/2620>

Selected Answer

ans is C,
 just put values of C in place of x. it will satisfy the equation.

3 votes

-- jayendra (6.6k points)

10.0.12 GATE1993_8.3 top

<http://gateoverflow.in/2301>

Selected Answer

A) at least one of the set S_i is Finite Set. Well it is not said that S_1, S_2, \dots, S_n whether they are finite or infinite. It is possible to break down infinite set into few sets (Some of which can be finite). This seems True, but I'm not able to prove it.
Please Give suitable counterexample here, if you think this is false.

Ex-> a^* , this is infinite set. I can write it as $\{\} \cup \{a^*\}$, where $\{a^*\}$ is infinite.

B) Not more than one of set can be finite \rightarrow This is false.

ex -> $a^*b^* \Rightarrow \{ab\} \cup \{\} \cup \{aa+bb+\}$

C) at least one of the sets is Infinite \rightarrow This must be True. As this is finite union of sets, one of set must be infinite to make whole thing infinite. True.

D) not more than one of the sets S_i can be infinite. This is false.

Ex -> $a^*b^* = \{a^pb^q | p=q\} \cup \{a^mb^n | m \neq n\}$ such that $p,q,m,n \geq 0$.

Answer -> C is surely true.

3 votes

-- Akash (31.7k points)

10.0.13 GATE1997_4.4 top

<http://gateoverflow.in/2245>

Selected Answer

Lets take $p(x) = ax + b$
 Now, $p(0) = 5 \Rightarrow b = 5$.
 $p(1) = 4 \Rightarrow a + b = 4$, $a = -1$
 $p(2) = 9 \Rightarrow 4a + b = 9 \Rightarrow -4 + 5 = 9$, which is false. So, degree 1 is not possible.

Let $p(x) = ax^2 + bx + c$

$p(0) = 5 \Rightarrow c = 5$
 $p(1) = 4 \Rightarrow a + b + c = 4 \Rightarrow a + b = -1 \rightarrow (1)$
 $p(2) = 9 \Rightarrow 4a + 2b + c = 9 \Rightarrow 2a + b = 2 \rightarrow (2)$
 $(2) - (1) \Rightarrow a = 3, b = -1 - 3 = -4$
 $p(3) = 20 \Rightarrow 9a + 3b + c = 20, 27 - 12 + 5 = 20, \text{ equation holds.}$
 So, degree 2 also will suffice.

7 votes

-- Arjun Suresh (150k points)

10.0.14 GATE2014-2_50 top

<http://gateoverflow.in/2016>



Selected Answer

S1 seems satisfied by $\{L\}$ where L is largest element in S, only until we compare it to $\{\}$, where symm. diff. is $\{L\}$. Now consider $\{\}$. Any other subset of S is smaller than $\{\}$ as the minimum element in their symmetric difference will be in that set. So, $\{\}$, satisfies S1, any other subset should be less than it.

S2 on the other hand, will be satisfied by S, as any other subset will be like $S - \{\text{some other elements}\}$. So symm. diff. will be $\{\text{some other elems}\}$, which will belong in S, so min. elem. will belong in S. So, that's it - (A)

10 votes

-- Arindam Sarkar (653 points)

10.0.15 GATE1998_10 top

<http://gateoverflow.in/1724>

part A

Statement:

$$\text{no_of_diagonal} = D(n) = \frac{n*(n-3)}{2}$$

Step 1) Basis : for $n=4$, $\frac{4*(4-3)}{2} = 2$ is true.

Step 2) Inductive Step :

If $D(k)$ is true. we need to prove $D(k+1)$ is also true.

We add one more vertex to the set of k vertices. Assume added vertex is C.

Further assume C will connects vertex A and B to close the polygon. (A and B already exists in k sided polygon)

From C, no of pairs to each k vertices = k, out of these two will be used to close the polygon, i.e. used as sides of new $(k+1)$ sided polygon. Further more, initial connection (edge or side) between A and B is now becomes a diagonal.

No of Digonals in for $(k+1)$ sided polygon = diagonal from k sided polygon + $k - 2 + 1$

$$\frac{k*(k-3)}{3} + k - 1 = \frac{k^2 - k - 2}{2} = \frac{(k+1)(k-2)(k+1)((k+1)-3)}{2}$$

$\Rightarrow D(k+1)$ holds.

Since both the basis and the inductive step have been performed, by mathematical induction, the statement $D(n)$ holds for all natural numbers $n > 3$

1 votes

-- Debarshish Deka (10.9k points)

10.0.16 GATE1998_2.4 [top](#)<http://gateoverflow.in/1676>

Selected Answer

apply set formula of A union B union C
 $28 = (18 + 15 + 22) - (9 + 11 + 13) + x$
 $28 = 55 - 33 + x$
 $x = 6$

4 votes

-- Digvijay (35.8k points)

10.0.17 GATE1998_2.3 [top](#)<http://gateoverflow.in/1675>

Selected Answer

Not reflexive - (4,4) not present.
 Not irreflexive - (1, 1) is present.
 Not symmetric - (2, 1) is present but not (1, 2).
 Not antisymmetric - (2, 3) and (3, 2) are present.
 Not Asymmetric - asymmetry requires both antisymmetry and irreflexivity
 It is transitive so the correct option is B.

6 votes

-- Digvijay (35.8k points)

10.0.18 GATE1999_2.3 [top](#)<http://gateoverflow.in/1481>

Selected Answer

Which of the following **is/are** true? This is question with Multiple answers.
 As our Relation R on Set L is Reflexive , anti symmetric & Transitive it is poset.
 Since LUB & GLB exists for any two elements it is lattice.
 Answer -> A & C.
 B is not guaranteed to be true.
 Ref: <http://uosis.mif.vu.lt/~valdas/PhD/Kursinis2/Sasao99/Chapter2.pdf>

1 votes

-- Akash (31.7k points)

As it is Reflexive , anti-symmetric , transitive , it is poset.

Since lub and gub exist for any pair of elements, the poset becomes a lattice. So, C is the answer.

1 votes

-- Shounak Kundu (4.1k points)

10.0.19 GATE1995_1.20 [top](#)<http://gateoverflow.in/2607>

Selected Answer

no of elements in power set is = $2^{(\text{no of elements in the set})} = 2^3 = 8$

Elements are $\{\emptyset, \{\{\emptyset\}\}, \{1\}, \{\{2,3\}\}, \{\{\emptyset\}, 1\}, \{1, \{2,3\}\}, \{\{\emptyset\}, \{2,3\}\}, \{\{\emptyset\}, 1, \{2,3\}\}\}$

Hence, Option(C)8.

5 votes

-- jayendra (6.6k points)

10.0.20 GATE1995_23 top

<http://gateoverflow.in/2661>



Selected Answer

Base case: $n = 1, 2^1 = 2 > 1^2$

Induction hypothesis: $2^n > n^2$

To prove: $2^{n+1} > (n + 1)^2$

$LHS = 2 \cdot 2^n > 2 \cdot n^2$ (Induction hypothesis)

$RHS = (n + 1)^2 = n^2 + 2n + 1 < LHS$, hence proved.

4 votes

-- Arjun Suresh (150k points)

10.0.21 GATE2007_2 top

<http://gateoverflow.in/1201>



Selected Answer

ans is B.

equivalence relation means it is reflexive, symmetric and transitive

and if the relation is reflexive then it must have all the pairs of diagonal elements. and relation with only diagonal elements is also symmetric and transitive. therefore smallest is of size n.

with diagonal elements we can include all the elements therefore largest is n^2

8 votes

-- jayendra (6.6k points)

10.0.22 GATE2005-IT_34 top

<http://gateoverflow.in/3780>



Selected Answer

$n = p^2q$, where p and q are prime.

So, number of multiples of p in n = pq

Number of multiples of q in n = p^2

Number of multiples of pq in n = p

Since prime factorisation of n consists of only p and q, gcd(m, n) will be a multiple of these or 1. So, number of possible m such that gcd(m, n) is 1 will be n - number of multiples of either p or q.

$$= n - p^2 - pq + p$$

$$= p^2q - p^2 - pq + p$$

$$= p(pq - p - q + 1)$$

$$= p(p-1)(q-1)$$

8 votes

-- Arjun Suresh (150k points)

10.0.23 GATE 2016-1-1 top

<http://gateoverflow.in/39663>



Selected Answer

$$\begin{aligned} & \sim((p \rightarrow q) \wedge (\sim r \vee \sim s)) \\ & = (\sim(\sim p \vee q)) \vee (\sim(\sim r \vee \sim s)) \\ & = (p \wedge \sim q) \vee (r \wedge s) \end{aligned}$$

which can be read as

($x \in \{8, 9, 10, 11, 12\}$ AND x is not a composite number) OR (x is a perfect square AND x is a prime number)

Now for

x is a perfect square and x is a prime number

it can never be true as every square has atleast 3 factors, 1, x and x^2 .

So second condition can never be true..

That implies the first condition must be true..

$x \in \{8, 9, 10, 11, 12\}$ AND x is not a composite number

But here only 11 is not a composite number.. so only 11 satisfies the above statement..

Hence, ANSWER 11

16 votes

-- Abhilash Panicker (7k points)

10.0.24 GATE 2016-2-28 top

<http://gateoverflow.in/39595>



Selected Answer

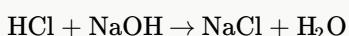
Option *B* should be the correct answer.

It is given that the number of compounds in $U = 23$ and the number of compounds in $S = 9$, so the number of compounds in $U \setminus S = 23 - 9 = 14$.

Considering each of these compounds as nodes of a graph G . So vertex set of G is U and S is a subset of vertices of G .

The relation "*A* reacts with *B*" is a symmetric relation, that is *A* reacts with *B* is same as *B* reacts with *A*.

for example, consider the following reaction:



Here we can say either HCl reacts with NaOH to produce NaCl + H₂O or we can say that NaOH reacts with HCl to produce NaCl + H₂O, so both of these statements are equivalent.

Since the relation based on which we are going to draw the edges is symmetric, we can use an undirected edge (A, B) between any two compounds to represent the fact that *A* reacts with *B* as well as *B* reacts with *A*.

Each compound in S reacts with exactly 3 compounds in U .

It means that the degree of every node(or compound) in S is 3.

So sum of all the degree in S = number of nodes in S × degree of each node = $9 \times 3 = 27$.

Now in $U \setminus S$ we have 14 nodes(or compounds), thus clearly $U \setminus S$ contains an even number of compounds.

Now if each compound in $U \setminus S$ reacts with an even number of compounds, the sum of degrees of all the node in $U \setminus S$ would be even, and consequently, the sum of degrees of all the nodes in our graph G would be odd as the sum of degrees of all the nodes in S is odd, and an odd number added with an even number produces an odd number.

But since in a graph, every edge corresponds to two degrees and the number of edges in a graph must be a (non-negative)integral value & not fractional value hence the sum of the degrees all the nodes of a graph must be even. (This is Handshaking Lemma).

So statement III should be false(always).

Also, adding fourteen odd numbers gives an even number.

Hence, if each compound in $U \setminus S$ reacts with an odd number of compounds, the sum of degrees of all the node in $U \setminus S$ would be even, and consequently, the sum of degrees of all the nodes in our graph G would be odd as the sum of degrees of all the nodes in S is odd, and an odd number added with an even number produces an odd number.

Again by using Handshaking Lemma, this is not possible.

So statement I should also be false(always).

Thus, from the previous two cases, it can be observed that to satisfy the Handshaking Lemma for G , the sum of the degrees of all the nodes $U \setminus S$ must be odd. To make this happen, we must assign at least one node of $U \setminus S$, an odd degree.

If at least, one node(or compound) in $U \setminus S$ would have an odd degree(or reacts with odd numbers of compounds) then we can assign degrees in such a way that the sum of the degrees of all the nodes $U \setminus S$ will be odd, & thus the Handshaking Lemma would be satisfied.

Hence, statement II is the only statement which is guaranteed to be true always.

Moreover, we can also make some stronger claims from the given information like,

always an odd number of compounds in $U \setminus S$ reacts with an odd number of compounds and

at least, one compound in S reacts with a compound in $U \setminus S$ and so on.

13 votes

-- Anurag Pandey (9.7k points)

10.0.25 TIFR2013-A-3 top

<http://gateoverflow.in/2534>

6 preference order for voter are possible:

ABC,ACB,BCA,BAC,CAB,CBA also Given that

$$a = ABC + ACB + CAB \quad (1)$$

$$b = BCA + BAC + ABC \quad (2)$$

$$c = CAB + CBA + BCA \quad (3)$$

Adding 1,2 and 3 we get

$$a+b+c = 2(ABC+BCA+CAB)+ACB+BAC+CAB$$

Now we know that $ABC+ACB+BAC+BCA+CAB+CBA=1$ therefore

$$[ABC+ACB+BAC+BCA+CAB+CBA] < [2(ABC+BCA+CAB)+ACB+BAC+CAB] < 2(ABC+ACB+BAC+BCA+CAB+CBA)$$

Hence we can say that value of $a+b+c$ must be between 1 and 2

option c value greater than 2 hence correct answer is c

3 votes

-- Saurav Shrivastava (719 points)

10.0.26 TIFR2012-A-8 top<http://gateoverflow.in/21007>

Selected Answer

D) 243. First take A as ϕ and B as power set of $\{1, 2, 3, 4, 5\}$ which is 2^5 . then take A as set of one element ex: when A={1} then set B could be any of the 2^4 elements of power set. This will give us 16×5 . In similar fashion when A consist of 2 element set we get total pairs $5C2 \times 2^3$; when A is of three elements we get 40; for 4 elements we get 10 pairs and when A is of 5 elements we get one pair which is A={1,2,3,4,5} and B={}.....so in total = $32+80+80+40+10+1=243$

6 votes

-- Shaun Patel (5.8k points)

10.0.27 GATE2015-3_5 top<http://gateoverflow.in/8399>

Selected Answer

Dynamic programming Approach

| | 1 digit | 2 digit | 3 digit | 4 digits |
|-------------------|----------------|----------------|----------------|-----------------|
| Starting 1 | 1 | 1 | 1 | 1 |
| Starting 2 | 1 | 2 | 3 | 4 |
| Starting 3 | 1 | 3 | 6 | 10 |

Here Starting 1 means numbers starting with 1. And cell (i, j) is for number of numbers starting with i and having j digits. We can have the relation

$$c(i, j) = \sum_{k=1}^i c(k, j - 1)$$

as per the non-decreasing condition given in the question. So, our answer will be $c(1, 4) + c(2, 4) + c(3, 4) = 1 + 4 + 10 = 15$

Brute force

```

3 3 3 3
2 2 2 2
2 2 2 3
2 2 3 3
2 3 3 3
1 1 1 1
1 1 1 2
1 1 1 3
1 1 2 2
1 1 2 3
1 1 3 3
1 2 2 2
1 2 2 3
1 2 3 3
1 3 3 3

```

12 votes

-- Arjun Suresh (150k points)

10.0.28 GATE2015-1_26 top<http://gateoverflow.in/8248>

Selected Answer

It can be answered by using the concept of partial fraction

$$\frac{1}{x(x+1)} = \frac{A}{x} + \frac{B}{(x+1)}$$

solving this we will get A=1 and B=-1

so this will form a sequence in which 2 terms will remain 1-1/100 so we will get 99/100 as ans

8 votes

-- Aditi Tiwari (793 points)

10.0.29 GATE2015-1_28 [top](#)

<http://gateoverflow.in/8226>



Selected Answer

option A : as it is XOR operation

8 votes

-- GATERush (1.1k points)

10.0.30 GATE2005-IT_33 [top](#)

<http://gateoverflow.in/3779>



Selected Answer

Let's take an example set {a,b,c}

Now lets try to create the required set of subsets, say S.

Let's start by adding sets of size 1 to S. We can only add one of the sets {a}, {b}, {c}.

Lets say we add {a}, so S now becomes {{a}}

Now lets add sets of size 2 to S. Again we see that we can only add one of {a,b}, {a,c} or {b,c}, and we cannot add {b,c} since we already added {a}.

Continuing this way we see we can add only one set for all size till n.

So the awnser should be 2) n+1 (include the empty set)

10 votes

-- Omesh Pandita (2.3k points)

10.0.31 GATE1996_1.1 [top](#)

<http://gateoverflow.in/2705>



Selected Answer

$$(A - B) \cup (B - A) \cup (A \cap B)$$

$A - B$ is A but not B. i.e. only A

$B - A$ is B but not A. i.e. only B

$A \cap B$ is A and B both

$$\begin{aligned} \text{Union of all is (only A) } & U (\text{only B}) U (\text{both A and B}) \\ & = A \cup B \end{aligned}$$

6 votes

-- Digvijay (35.8k points)

10.0.32 GATE2004-IT_2 [top](#)

<http://gateoverflow.in/3643>



Selected Answer

The question has a slight misprint. It should be what Bhagirathi says in the comments.

Nevertheless,

$$|A \cup B \cup C| = |A| + |B| + |C| - |A \cap B| - |A \cap C| - |B \cap C| + |A \cap B \cap C|$$

$A \equiv$ Students who have taken Programming.

$B \equiv$ Students who have taken Data Structures.

$C \equiv$ Students who have taken Computer Organisation.

So, the number of students who have taken any of the 3 courses is given by:

$$\begin{array}{ccccccccc} | & A \cup B \cup C & | & | & A \cap B & | & | & B \cap C & + | & | \\ & & - & | & & | & & & | & \\ & = 125 + 85 + 65 & & -50 & & -35 & & -30 & & +15 \\ & & & & & & & & & \\ & & & 350 & & 250 & & 200 & & 175 \end{array}$$

Therefore, the number of students who haven't taken any of the 3 courses is: $200 - 175 = 25$

Hence, the answer is Option C.

Upvote 5 votes

-- Pragy Agarwal (14.4k points)

10.0.33 GATE2006-IT_23 [top](#)

<http://gateoverflow.in/3562>

Selected Answer

$P \Delta (Q \cap R)$

$P \Delta (Q \cap R)$

$P \Delta (Q \cap R)$

I got answer c

Upvote 7 votes

-- Anu (9k points)

10.0.34 GATE2006-IT_2 [top](#)

<http://gateoverflow.in/3539>

Selected Answer

Answer: A

I. Identity element is 3.

II. Identity element is 1.

III. There is no identity element. ($x^y \neq y^x$, when $x \neq y$)

Upvote 9 votes

-- Rajarshi Sarkar (29.7k points)

10.0.35 GATE2007-IT_77 [top](#)

<http://gateoverflow.in/3529>

Answer: D

For the series to converge the limit: n tends to infinity of (x_{n+1}/x_n) should be < 1.

From the recurrence we should have $cx_n^2 - x_n - 2 < 0$.

For all the above values of c we have the above equation as negative.

0 votes

-- Rajarshi Sarkar (29.7k points)

10.0.36 GATE2007-IT_16 top

<http://gateoverflow.in/3449>



Selected Answer

D) fermat's little theorem

6 votes

-- Shaun Patel (5.8k points)

10.0.37 GATE2008-IT_26 top

<http://gateoverflow.in/3316>



Selected Answer

A field is an algebraic structure over two operations + and * if :

1. It is closed under both + and *.
2. + and * are both commutative and associative. (+ and * in this question are already commutative and associative, so no need to check).
3. Existence of additive identity(0) and multiplicative identity(1)
4. Existence of additive and multiplicative inverses for each non-zero element.
5. Distributive property of * over + (This is also satisfied in question)

So for each option, we have to check only properties 1, 3, and 4.

(S1) : set of all real numbers

1. Closed : Yes, real+real = real, real*real=real

3. Additive and multiplicative identity : Yes, 0 and 1 are real numbers

4. Additive and multiplicative inverse for each non-zero element : Yes, for any real number a, additive inverse is -a, which is also a real number, and multiplicative inverse is 1/a, which is also a real number.

(S2) : $\{(a + ib) \mid a \text{ and } b \text{ are rational numbers}\}$

1. Closed : Yes, rational+rational=rational, rational*rational=rational

3. Additive and multiplicative identity : Yes, $0+0i$ (additive identity) and $1+0i$ (multiplicative identity) belong to given set.

4. Additive and multiplicative inverse for each non-zero element : Additive inverse is $-a-ib$, which belongs to given set.

Multiplicative identity is $\frac{1}{a+ib} = \frac{a-ib}{a^2+b^2} = \frac{a}{a^2+b^2} + i\frac{-b}{a^2+b^2}$, which also belongs to given set.

(S3) : $\{a + ib \mid (a^2 + b^2) \leq 1\}$

1. Closed : No, for example : $(0.3+0.4i) + (0.7 + 0.6i) = 1 + i$. Here both complex numbers which were added were in the given set, but resultant complex number is not.

(S4) : $\{ia \mid a \text{ is real}\}$

Here this set doesn't contain 1 (multiplicative identity)

So (S1) and (S2) are subfields of C. So option 4) is correct.

7 votes

-- Happy Mittal (9.5k points)

10.0.38 GATE1996_2.6 [top](#)<http://gateoverflow.in/2735>

Selected Answer

Answer: A

$$\begin{bmatrix} \cos(\theta) & -\sin(\theta) \\ \sin(\theta) & \cos(\theta) \end{bmatrix} * \begin{bmatrix} a & 0 \\ 0 & b \end{bmatrix} = \begin{bmatrix} a\cos(\theta) & -b\sin(\theta) \\ a\sin(\theta) & b\cos(\theta) \end{bmatrix}$$

and

$$\begin{bmatrix} a & 0 \\ 0 & b \end{bmatrix} * \begin{bmatrix} \cos(\theta) & -\sin(\theta) \\ \sin(\theta) & \cos(\theta) \end{bmatrix} = \begin{bmatrix} a\cos(\theta) & -a\sin(\theta) \\ b\sin(\theta) & b\cos(\theta) \end{bmatrix}$$

The multiplication will commute if $a\sin(\theta) = b\sin(\theta)$ or $a = b$ or $\theta = n\pi$

3 votes

-- Rajarshi Sarkar (29.7k points)

10.0.39 GATE1996_2.4 [top](#)<http://gateoverflow.in/2733>

Selected Answer

(a) Let set = {1, 2, 3, 4}

We can have identity function as {(1,1), (2,2), (3,3), (4,4)}

Since function is bijective and mapping to same set, we can have an inverse for any function by inverting the relation (changing the mapping $a \rightarrow b$ to $b \rightarrow a$)

Since the function maps to the same set, it must be closed and associative also. So, all four properties of group satisfied. So, (a) is true.

(b) Let p = 5. So, set = {1, 2, 3, 4}

Identity element is 1.

| * | 1 | 2 | 3 | 4 |
|----------|----------|----------|----------|----------|
| 1 | 1 | 2 | 3 | 4 |
| 2 | 2 | 4 | 1 | 3 |
| 3 | 3 | 1 | 4 | 2 |
| 4 | 4 | 3 | 2 | 1 |

This forms a group. Similarly for any p, we get a group. So, (b) is also true.

(c) is false as string concatenation operation is a monoid (doesn't have inverse to become a group).

<http://en.wikipedia.org/wiki/Concatenation>

(d) is True.

http://www.math.niu.edu/~beachy/abstract_algebra/study_guide/32.html

6 votes

-- Arjun Suresh (150k points)

10.0.40 GATE2007_26 [top](#)<http://gateoverflow.in/1224>

Selected Answer

Answer is C.

Suppose we have two partitions of a set S : $P_1 = \{A_1, A_2, \dots\}$ and $P_2 = \{B_1, B_2, \dots\}$.

- We say that P_1 is a refinement of P_2 if every A_i is a subset of some B_j .

Refer <https://www.cs.sfu.ca/~ggbaker/zju/math/equiv-rel.html>

π_1 refines all of them. π_2 & π_3 refines π_4 .

As as it is poset we are not showing transitive dependency.

Partition concept :- https://en.wikipedia.org/wiki/Partition_of_a_set

Upvote 4 votes

-- Akash (31.7k points)

10.0.41 GATE1993_17 top

<http://gateoverflow.in/2314>



Selected Answer

Answer: 10

$$P(A \cup B \cup C) = P(A) + P(B) + P(C) - P(A \cap B) - P(A \cap C) - P(B \cap C) + P(A \cap B \cap C)$$

$$21 = 9 + 10 + 7 - [P(A \cap B) + P(A \cap C) + P(B \cap C)] + 5$$

$$[P(A \cap B) + P(A \cap C) + P(B \cap C)] = 10.$$

Upvote 4 votes

-- Rajarshi Sarkar (29.7k points)

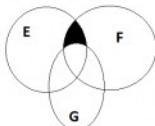
10.0.42 GATE2006_22 top

<http://gateoverflow.in/983>



Selected Answer

Answer c using **Venn diagram**



Upvote 6 votes

-- Anu (9k points)

10.0.43 GATE2010-3 top

<http://gateoverflow.in/1149>



Selected Answer

A relation consists of set of ordered pairs (a, b) . Here a can be chosen in n ways and similarly b can be chosen in n ways. So, totally n^2 possible ordered pairs are possible for a relation. Now each of these ordered pair can either be present in the relation or not- 2 possibilities for each of the n^2 pair. So, total number of possible relations =

$$2^{(n^2)}$$

Now, for a relation R to be reflexive, ordered pairs $\{(a, a) \mid a \in S\}$, must be present in R . i.e.; the relation set R must have n ordered pairs fixed. So, number of ordered pairs possible is $n^2 - n$ and hence total number of reflexive relations is equal to

$$2^{(n^2-n)}$$

11 votes

-- Arjun Suresh (150k points)

10.0.44 GATE2006_24 [top](#)

<http://gateoverflow.in/987>



Selected Answer

$\min(n(N)) = 1$, since in a permutation of n elements from $1..n$, some element must get 1.

Similarly, in any subsets A and B, $\min(n(A)) = \min(n(B))$ only if A and B has a common element and it is the smallest of all the other elements in A and B.

(With this understanding itself we can eliminate options A and B)

Now we have $n!$ total permutations and we have to see the number of permutations satisfying the given condition. If A = B, all of the $n!$ permutations satisfy the given condition. (This is enough to get the answer as C). Otherwise, the fraction of the $n!$ permutations satisfying the given condition

$$= |A \cap B| / |A \cup B|$$

This is because without the given restriction, the smallest element (among the $|A \cup B|$ elements) can be any one of the $|A \cup B|$ elements, and with the restriction, the smallest element must be one of the $|A \cap B|$ elements.

So, answer is C.

8 votes

-- Arjun Suresh (150k points)

10.0.45 GATE2003_31 [top](#)

<http://gateoverflow.in/921>



Selected Answer

Maximum element is c : So, c is of higher order than any other element in S

Minimal elements are a and b : No other element in S is of lower order than either a or b .

We are given $P(a) = \text{TRUE}$. So, for all x such that $a \leq x$, $P(x)$ must be **TRUE**. We do have at least one such x , which is c as it is the maximum element. So, D **CANNOT** be true.

- A can be **TRUE** as all elements mapped to **TRUE** doesn't violate the given implication.
- B can be **TRUE** if a is related only to c .
- C can be **TRUE** as $b \leq x$ ensures $x \neq a$ and for all other elements $P(x)$ can be **FALSE** without violating the given implication.

Ref: https://en.wikipedia.org/wiki/Partially_ordered_set

6 votes

-- Arjun Suresh (150k points)

10.0.46 GATE2006_25 [top](#)

<http://gateoverflow.in/988>



Selected Answer

Total elements in S = m

Total number of subsets of size 3 each can be ${}^m C_3$.

Now suppose take 1st element 1. Out of ${}^m C_3$ subsets 1 wont be there in $(m-1)C_3$ subsets.

So 1 will be there in ${}^m C_3 - (m-1)C_3 = (m-1)(m-2)/2$ subsets.

$$\sum f(i) = \sum (m-1)(m-2)/2 = m(m-1)(m-2)/2$$

We know ${}^m C_3 = n$ (No of X subset) therefore $m(m-1)(m-2)/2 = 3n$. (B)

Upvote 9 votes

-- Madhur Rawat (2.4k points)

10.0.47 GATE2006_04 [top](#)

<http://gateoverflow.in/883>



Selected Answer

ans is (A).. because the relation is not reflexive.. which is a necessary condition for both partial order and equivalence relation..!!

Upvote 6 votes

-- Vicky Bajoria (3.4k points)

10.0.48 GATE2006_02 [top](#)

<http://gateoverflow.in/881>



Selected Answer

D is Correct.

$E = 2^{XY}$ Which is the total number of subsets of W.

Now, the mapping for a function from A to B with N and M elements respectively... we have M^N .

Here,

$$E^Z = 2^{XY(Z)} = 2^{XYZ}$$

Upvote 10 votes

-- Snehil Joshi (293 points)

10.0.49 GATE2004_24 [top](#)

<http://gateoverflow.in/1021>



Selected Answer

Option b. Transitive means, x is related to all greater y (as every x is related to $x + 1$) and reflexive means x is related to x.

Upvote 6 votes

-- anshu (2.5k points)

10.0.50 GATE2002_3 [top](#)

<http://gateoverflow.in/856>



Selected Answer

$$\text{no of binary relation} = 2^{n^2}$$

$$\text{no of function} = n^n$$

$$2^{n^2}$$

$$n^n$$

$$n^2 \log(2)$$

```

n log(n)      // apply log on both
n2 log(2)    >
n log(n)

```

No of relation > No of function

7 votes

-- Digvijay (35.8k points)

10.0.51 GATE2002_2.17 top

<http://gateoverflow.in/847>



Selected Answer

answer = **option D**

$S=\emptyset$ (empty set) on a set $A = \{1,2,3\}$ is Irreflexive, Symmetric, Anti Symmetric, Asymmetric, Transitive.. but it is not Reflexive

6 votes

-- Digvijay (35.8k points)

10.0.52 GATE2009-22 top

<http://gateoverflow.in/799>



Selected Answer

An element is a generator for a cyclic group if on repeated applications of it upon itself, it can generate all elements of group.

For example here : $a*a = \mathbf{a}$, then $(a*a)*a = a*a = \mathbf{a}$, and so on. Here we see that no matter how many times we apply a on itself, we can't generate any other element except a , so a is not a generator.

Now for b , $b*b = \mathbf{a}$. Then $(b*b)*b = b*b = \mathbf{a}$, and so on. Here again we see that we can only generate a and b on repeated application of b on itself. So it is not a generator.

Now for c , $c*c = \mathbf{b}$. Then $(c*c)*c = b*c = \mathbf{d}$. Then $(c*c*c)*c = d*c = \mathbf{a}$. Then $(c*c*c*c)*c = a*c = \mathbf{c}$. So we see that we have generated all elements of group. So c is a generator.

For d , $d*d = \mathbf{b}$. Then $(d*d)*d = b*d = \mathbf{c}$. Then $(d*d*d)*d = c*d = \mathbf{a}$. Then $(d*d*d*d)*d = a*d = \mathbf{d}$. So we have generated all elements of group from d , so d is a generator.

So c and d are generators. So option **(C)** is correct.

http://www.cse.iitd.ac.in/~mittal/gate/gate_math_2009.html

6 votes

-- Anu (9k points)

10.0.53 GATE2009-4 top

<http://gateoverflow.in/797>



Selected Answer

Answer

A binary relation R over a set X is symmetric if it holds for all a and b in X that if a is related to b then b is related to a . $\forall a, b \in X, aRb \Rightarrow bRa$.

Here (x, y) is there in R but (y, x) is not there.

\therefore Not Symmetric.

For Antisymmetric Relations: $\forall a, b \in X, R(a, b) \& R(b, a) \Rightarrow a = b$

Here (x, z) is there in R also (z, x) is there violating antisymmetric rule.

\therefore Not AntiSymmetric.

9 votes

-- Sona Praneeth Akula (3.8k points)

10.0.54 GATE2009-1 [top](#)<http://gateoverflow.in/795>

Selected Answer

Grupoid- closure property Semigroup- closure,associative Monoid-closure,associative,identity Group-closure,associative,identity,inverse Abelian group- group property+commutative So ans should be A..

9 votes

-- **sonu** (1.5k points)**10.0.55 GATE2001-2.2** [top](#)<http://gateoverflow.in/720>

Selected Answer

S1->

CounterExample -> $a^* \cap (b^* \cup c^*)$, Here a^*, b^*, c^* all are infinite, Result is finite language = { ϵ }

So S1 is True

S2->

Counterexample ->

$$x = 1 + \sqrt{2}, y = 1 - \sqrt{2},$$

$$x+y = 2.$$

So S2 is True.

Answer -> C

4 votes

-- **Aakash** (31.7k points)**10.0.56 GATE2003_38** [top](#)<http://gateoverflow.in/929>

Selected Answer

consider each pair

$$1. (a,a) \quad (a^*a) + (a^*a) = a+a = b \\ \neq c \text{ so } (a,a) \text{ is not possible}$$

$$2. (a,b) \quad (a^*a) + (a^*b) = a+b = a \\ \neq c \text{ so } (a,b) \text{ is not possible}$$

$$3. (a,c) \quad (a^*a) + (a^*c) = a+c = c$$

$$(b^*a) + (c^*c) = b+b = b \\ \neq c, \text{ so } (a,c) \text{ is not possible}$$

$$4. (b,a) \quad (a^*b) + (a^*a) = b+a = a \\ \neq c, \text{ so } (b,a) \text{ is not possible}$$

$$5. (b,b) \quad (a^*b) + (a^*b) = b+b = b \\ \neq c, \text{ so } (b,b) \text{ is not possible}$$

$$6. (b,c) \quad (a^*b) + (a^*c) = b+c = c \\ (b^*b) + (c^*c) = c+b = c, \text{ so } (b,c) \text{ is a solution}$$

7. (c,a) $(a*c) + (a*a) = c+a = a$
 $\neq c$, so (c,a) is not possible

8.(c,b) $(a*c) + (a*b) = c+b = c$
 $(b*c) + (c*b) = a+c = c$, so (c,b) is a solution

9. (c,c) $(a*c) + (a*c) = c+c = b$
 $\neq c$, so (c,c) is not possible

so no of possible solution is 2

6 votes

-- Praveen Saini (38.4k points)

10.0.57 GATE2001-1.2 [top](#)

<http://gateoverflow.in/695>



Selected Answer

R1) Reflexive : $a+a=2a$ always even

Symmetric: either (a,b) both must be odd or both must be even to have sum as even

therefore, if(a,b) then definitely (b,a)

Transitive: if(a,b) and (b,c) , then both of them must be even pairs or odd pairs and therefore (a,c) is even

R2) Reflexive : $a+a=2a$ can't be odd ever

R3) Reflexive: $a.a>0$

Symmetric: if $a,b>0$ then both must be +ve or -ve, which means $b.a > 0$ also exists

Transitive : if $a.b>0$ and $b.c>0$ then to have b as same number, both pairs must be +ve or -ve which implies $a.c>0$

R4) Reflexive: $|a-a| \leq 2$

Symmetric: if $|a-b| \leq 2$ definitely $|b-a| \leq 2$ when a,b are natural numbers

Transitive: $|a-b| \leq 2$ and $|b-c| \leq 2$, doesn't imply $|a-c| \leq 2$

ex: $|4-2| \leq 2$ and $|2-0| \leq 2$, but $|4-0| > 2$,

hence, R2 and R4 are not equivalence

B)

2 votes

-- confused_luck (329 points)

10.0.58 GATE2000-6 [top](#)

<http://gateoverflow.in/677>

Best way to solve this for GATE is to take $n = 2$ and $n = 3$ and we get degree of each vertex = ${}^n C_2$ and no. of connected components = 2.

Lets do it more formally.

It is clear {} should get connected to all 2 element subsets (and not to any other) of S . So, degree of the corresponding vertex is ${}^n C_2$ as we have ${}^n C_2$ ways of choosing 2 elements from n . So, answer to first part must be this as it is given degree of all vertices are same.

Now, for the second part, from the definition of G all the vertices of cardinality k will be disconnected from all the vertices of cardinality $k-1$. This is because either all the $k-1$ elements must be same in both or $k-2$ elements must be same in both or else the symmetric difference will be more than 2. Now if $k-1$ elements are same, symmetric difference will just be 1. If $k-2$ elements are same, we have one element in one set not in other and 2 elements in other set not in this, making symmetric difference 3. Thus symmetric difference won't be 2 for any vertices of adjacent cardinality making them disconnected.

All the vertices of same cardinality will be connected - when just one element differs. Also, vertices with cardinality difference 2 will be connected- when 2 new elements are in one vertex. Thus we will be getting 2 connected components in total.

•
Upvote 2 votes

-- Arjun Suresh (150k points)

10.0.59 GATE2005_8 [top](#)

<http://gateoverflow.in/1157>

Option a ,make venn diagram.

Upvote 2 votes

-- anshu (2.5k points)

10.0.60 GATE2005_42 [top](#)

<http://gateoverflow.in/1167>



Selected Answer

RUS might not be transitive. Say (a,b) be present in R and (b,c) be present in S and (a, c) not present in either, R U S will contain, (a, b) and (b, c) but not (a, c) and hence not transitive.

option c.

Upvote 4 votes

-- anshu (2.5k points)

10.0.61 GATE2005_13 [top](#)

<http://gateoverflow.in/1163>



Selected Answer

Option c.

Identity element here is 1.

$$4 * 4 \bmod 15 = 1$$

$$7 * 13 \bmod 15 = 1.$$

Upvote 4 votes

-- anshu (2.5k points)

10.0.62 GATE2000-2.4 [top](#)

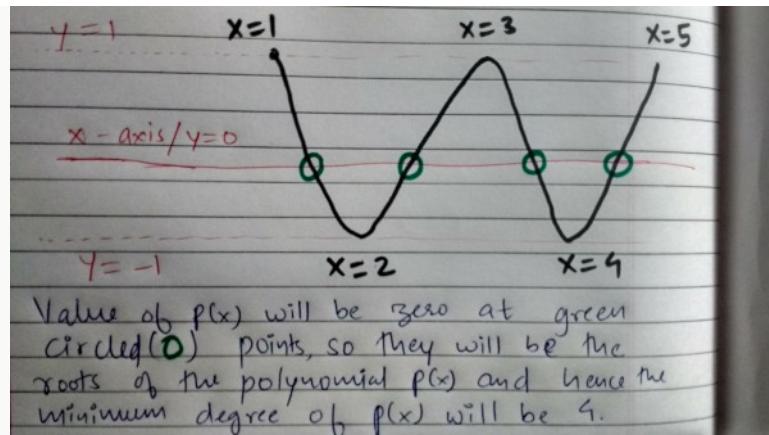
<http://gateoverflow.in/651>



Selected Answer

yes, option D is the correct answer.

Here is how $p(x)$ should look like:



10 votes

-- Anurag Pandey (9.7k points)

10.0.63 GATE2000-4 top

<http://gateoverflow.in/675>

Selected Answer

| | | | | | |
|---|---|---|---|---|---|
| A | $\begin{array}{c cc} \oplus & 0 & 1 \\ \hline 0 & 0 & 0 \\ 1 & 0 & 1 \end{array}$ | B | $\begin{array}{c cc} \oplus & 1 & 3 \\ \hline 1 & 1 & 3 \\ 3 & 3 & 1 \end{array}$ | $\begin{array}{c cc} \oplus & 1 & 5 \\ \hline 1 & 1 & 5 \\ 5 & 5 & 1 \end{array}$ | $\begin{array}{c cc} \oplus & 1 & 7 \\ \hline 1 & 1 & 7 \\ 7 & 7 & 1 \end{array}$ |
|---|---|---|---|---|---|

A) 1 is the identity element. inverse doesn't exist for zero. so it is not a group

4 votes

-- Anu (9k points)

10.0.64 GATE2000-2.6 top

<http://gateoverflow.in/653>

$$S = \{1\},$$

$$P(S) = \{\{\}, \{1\}\},$$

$$P(P(S)) = \{\{\}, \{\{\}\}, \{\{1\}\}, \{\{\}, \{1\}\}\}$$

A) $P(P(S)) = P(S) \Rightarrow$ This is false. Counterexample given above.

C) $P(S) \cap S = P(S)$, This is false. This intersection is usually Empty set.

D) $S \notin P(S)$. This is false. S belongs to $P(S)$.

B) It seems like B is true, but there is countexample for B too. (Given By @Pragy Below)

$$S = \{\}$$

$$P(S) = \{ \{\}, \{\{\}\} \}$$

$$P(P(S)) = \{ \{\}, \{ \{\} \}, \{ \{\{\}\} \}, \{ \{\}, \{\{\}\} \}$$

$$P(S) \cap P(P(S)) - \{ \{\}, \{\{\}\} \} \neq \{ \emptyset \}$$

So Answer is none of the above , all options are false. Though I would answer C if None of the above option is not present !

5 votes

-- Akash (31.7k points)

10.1

Boolean Algebra top

10.1.1 Boolean Algebra: GATE2006_28 top

<http://gateoverflow.in/991>

A logical binary relation \odot , is defined as follows:

| A | B | $A \odot B$ |
|-------|-------|-------------|
| True | True | True |
| True | False | True |
| False | True | False |
| False | False | True |

Let

\sim be the unary negation (NOT) operator, with higher precedence than \odot .

Which one of the following is equivalent to $A \wedge B$?

- A. $(\sim A \odot B)$
- B. $\sim (A \odot \sim B)$
- C. $\sim (\sim A \odot \sim B)$
- D. $\sim (\sim A \odot B)$

[gate2006](#) [set-theory&algebra](#) [normal](#) [boolean-algebra](#)

[Answer](#)

Answers: Boolean Algebra

10.1.1 Boolean Algebra: GATE2006_28 top

<http://gateoverflow.in/991>



Selected Answer

This question is easier to Answer With Boolean Algebra ->

$A \text{ op } B = B \rightarrow A$, i.e. $\sim B \vee A$.

now

Lets look at Option D

$$\sim (\sim A \text{ op } B) \Rightarrow \sim (B \rightarrow \sim A) \Rightarrow \sim (\sim B \vee \sim A) \Rightarrow B \wedge A$$

So Answer is D.

Other options ->

- A) $\sim B \vee \sim A$
- B) $\sim B \wedge \sim A$
- C) $\sim B \wedge A$

5 votes

-- Akash (31.7k points)

10.2

Boolean Expressions top10.2.1 Boolean Expressions: GATE2015-3_2 top<http://gateoverflow.in/8393>

Let # be the binary operator defined as

$X \# Y = X' + Y'$ where X and Y are Boolean variables.

Consider the following two statements.

$$(S1) (P \# Q) \# R = P \# (Q \# R)$$

$$(S2) Q \# R = (R \# Q)$$

Which are the following is/are true for the Boolean variables P, Q and R?

- A. Only S1 is true
- B. Only S2 is true
- C. Both S1 and S2 are true
- D. Neither S1 nor S2 are true

[gate2015-3](#) [set-theory&algebra](#) [boolean-expressions](#) [normal](#)

Answer

Answers: Boolean Expressions

10.2.1 Boolean Expressions: GATE2015-3_2 top<http://gateoverflow.in/8393>

Selected Answer

Answer=B

$$(P \# Q) \# R = (P' + Q') \# R$$

$$= P \cdot Q + R'$$

whereas

$$P \# (Q \# R) = P' + (Q \# R)'$$

$$= P' + (Q' + R)'$$

$$= P' + QR$$

12 votes

-- overtomanu (1.1k points)

10.3

Convergence top10.3.1 Convergence: TIFR2014-A-15 top<http://gateoverflow.in/26402>

Consider the following statements:

$$(1) b_1 = \sqrt{2}, \text{ series with each } b_i = \sqrt{b_{i-1} + \sqrt{2}}, i \geq 2, \text{ converges.}$$

(2) $\sum_{i=1}^{\infty} \frac{\cos(i)}{i^2}$ converges.

(3) $\sum_{i=0}^{\infty} b_i$ converges if $\lim_{i \rightarrow \infty} \frac{|b_{i+1}|}{|b_i|} < 1$

Which of the following is TRUE?

- a. Statements (1) and (2) but not (3).
- b. Statements (2) and (3) but not (1).
- c. Statements (1) and (3) but not (2).
- d. All the three statements.
- e. None of the three statements.

tifr2014 convergence

Answer

Answers: Convergence

10.3.1 Convergence: TIFR2014-A-15 top

<http://gateoverflow.in/26402>

1. for large value of i, b_i and b_{i+1} becomes equal... so $b_i^2 = b_i + \sqrt{2}$. this is quadratic. solving this results to a fix number.

2. $\cos(i) \leq i$ so $\cos(i) \leq i^2$ that means series is decreasing that will return again a fix value.

3. it is condition of convergence . if $b(i+1) < b(i)$ then series will always convergent.

1 votes

-- Digvijay (35.8k points)

10.4

Countable Uncountable Set top

10.4.1 Countable Uncountable Set: GATE2014-3_16 top

<http://gateoverflow.in/2050>

Let

Σ be a finite non-empty alphabet and let
 2^{Σ^*} be the power set of

Σ^* . Which one of the following is **TRUE**?

(A) Both
 2^{Σ^*} and
 Σ^* are countable

(B)
 2^{Σ^*} is countable and
 Σ^* is uncountable

(C)
 2^{Σ^*} is uncountable and
 Σ^* is countable

(D) Both
 2^{Σ^*} and
 Σ^* are uncountable

gate2014-3 set-theory&algebra countable-uncountable-set normal

Answer

Answers: Countable Uncountable Set

10.4.1 Countable Uncountable Set: GATE2014-3_16 [top](#)

<http://gateoverflow.in/2050>



Selected Answer

A set is countable means there exist a enumeration procedure to generate each of its elements and for a given element of set, it take finite step to generate it using the enumeration procedure.

Let $\Sigma = \{a, b\}$ and there exist a enumeration procedure to generate all the string of the language Σ^* .

$\Sigma^* = \{\epsilon, a, b, aa, ab, ba, bb, aaa, \dots\}$

Here enumeration procedure is simply the generating string of the language by length for the fixed length string are in alphabetical order.

This way Σ^* is countably infinite & 2^{Σ^*} will be uncountable set

Because the power set of countably infinite set are uncountable.

Ref: <http://www.cs.xu.edu/csci250/06s/Theorems/powerSetuncountable.pdf>

Upvote 5 votes

-- Sandeep Singh (7.4k points)

10.5

Counting [top](#)

10.5.1 Counting: GATE2006-IT_24 [top](#)

<http://gateoverflow.in/3563>

What is the cardinality of the set of integers X defined below?

$X = \{n \mid 1 \leq n \leq 123, n \text{ is not divisible by either } 2, 3 \text{ or } 5\}$

- | | |
|----|----|
| A) | 28 |
| B) | 33 |
| C) | 37 |
| D) | 44 |

[gate2006-it](#) [set-theory&algebra](#) [normal](#) [counting](#)

Answer

10.5.2 Counting: GATE2015-2_40 [top](#)

<http://gateoverflow.in/8212>

The number of onto functions (surjective functions) from set $X = \{1, 2, 3, 4\}$ to set $Y = \{a, b, c\}$ is _____.

[gate2015-2](#) [set-theory&algebra](#) [functions](#) [counting](#) [normal](#)

Answer

Answers: Counting

10.5.1 Counting: GATE2006-IT_24 [top](#)

<http://gateoverflow.in/3563>



Selected Answer

No's divisible by 2 in X = 61 [= integer(123/2)]

No's divisible by 3 in X = 41

No's divisible by 5 in X = 24

No's divisible by 2 and 3 .i.e by 6 = 20

No's divisible by 2 and 5 i.e by 10 = 12

No's divisible by 3 and 5 , i.e by 15 = 8

No's divisible by 2 and 3 and 5 ..ie by 30 = 4

No's divisible by either 2 or 3 or 5 = $N(A \cup B \cup C) = N(A) + N(B) + N(C) - N(A \cap B) - N(B \cap C) - N(A \cap C) + N(A \cap B \cap C)$

$$= 61 + 41 + 24 - 20 - 12 - 8 + 4 = 90$$

$X = \{ n, 1 \leq n \leq 123, n \text{ is not divisible by either 2, 3 or 5} \}$

Cardinality = $123 - 90 = 33$

12 votes

-- Praveen Saini (38.4k points)

10.5.2 Counting: GATE2015-2_40 [top](#)

<http://gateoverflow.in/8212>



Selected Answer

We have 3 elements in set B and 4 elements in set A and surjection means every element in B must be mapped to. So, this problem reduces to distributing 4 distinct elements ($r = 4$) among 3 distinct bins ($n = 3$) such that no bin is empty, which is given by $n! S(r, n)$, where $S(r, n)$ is Stirling's number of 2nd kind. So, here we need $S(4, 3)$.

We have $S(r+1, n) = n * S(r, n) + S(r, n-1)$

So, Stirling numbers of second kind can be generated as follows:

1

1 1

1 3 1

1 7 6 1

So, $S(4, 3) = 6$ and $3! = 6$ giving, number of surjective functions = $6 * 6 = 36$

Ref: See Theorem 9:

<http://www.cse.iitm.ac.in/~theory/tcslab/mfcs98page/mfcshtml/notes1/partset.html>

alternative approach ,

Answer is 36

for onto function from a set A(m-element) to a set B(n-element) ,
should be hold " $m \geq n$ "

then number of onto function

$$= n^m - {}^n C_1 (n-1)^m + {}^n C_2 (n-2)^m - {}^n C_3 (n-3)^m + \dots \text{and so on till } {}^n C_n (n-n)^m + \dots \text{, alternative}$$

$$= \sum_{i=0}^n (-1)^i {}^n C_i (n-i)^m$$

here $m=4$ and $n=3$ (here above condition valid)

then

number of onto function

$$= 3^4 - {}^3 C_1 (3-1)^4 + {}^3 C_2 (3-2)^4 - {}^3 C_3 (3-3)^4$$

$$= 81 - 3 * 16 + 3 * 1 - 1 * 0$$

$$= 36$$

ref@ <http://www.cse.iitd.ac.in/~mittal/stirling.html>

11 votes

-- Arjun Suresh (150k points)

10.6**Functions** top**10.6.1 Functions: GATE2003_37** top<http://gateoverflow.in/927>

Let $f : A \rightarrow B$ be an injective (one-to-one) function. Define $g : 2^A \rightarrow 2^B$ as:
 $g(C) = \{f(x) \mid x \in C\}$, for all subsets C of A .

Define $h : 2^B \rightarrow 2^A$ as: $h(D) = \{x \mid x \in A, f(x) \in D\}$, for all subsets D of B . Which of the following statements is always true?

- (A) $g(h(D)) \subseteq D$
- (B) $g(h(D)) \supseteq D$
- (C) $g(h(D)) \cap D = \emptyset$
- (D) $g(h(D)) \cap (B - D) \neq \emptyset$

[gate2003](#) [set-theory&algebra](#) [functions](#) [normal](#)

Answer**10.6.2 Functions: GATE 2016-1-28** top<http://gateoverflow.in/39717>

A function $f : \mathbb{N}^+ \rightarrow \mathbb{N}^+$, defined on the set of positive integers \mathbb{N}^+ , satisfies the following properties:

$$f(n) = f(n/2) \quad \text{if } n \text{ is even}$$

$$f(n) = f(n+5) \quad \text{if } n \text{ is odd}$$

Let $R = \{i \mid \exists j : f(j) = i\}$ be the set of distinct values that f takes. The maximum possible size of R is _____.

[gate2016-1](#) [set-theory&algebra](#) [functions](#) [normal](#) [numerical-answers](#)

Answer**10.6.3 Functions: TIFR2014-B-18** top<http://gateoverflow.in/27351>

Let k be an integer at least 4 and let $[k] = \{1, 2, \dots, k\}$. Let $f : [k]^4 \rightarrow \{0, 1\}$ be defined as follows: $f(y_1, y_2, y_3, y_4) = 1$ if and only if the y_i 's are all distinct. For each choice $z = (z_1, z_2, z_3) \in [k]^3$, let $g_z : [k] \rightarrow \{0, 1\}$ be defined by $g_z(Y) = f(Y, z_1, z_2, z_3)$. Let N be the number of distinct functions g_z that are obtained as z varies in $\{1, 2, \dots, k\}^3$, that is, $N = |\{g_z : z \in \{1, 2, \dots, k\}^3\}|$. What is N ?

- a. $k^3 + 1$
- b. $2^{\binom{k}{3}}$
- c. $\binom{k}{3}$
- d. $\binom{k}{3} + 1$
- e. $4^{\binom{k}{3}}$

[tifr2014](#) [set-theory&algebra](#) [functions](#)

Answer**10.6.4 Functions: TIFR2014-B-17** top<http://gateoverflow.in/27344>

Let $f : \{0, 1\}^n \rightarrow \{0, 1\}$ be a boolean function computed by a logical circuit comprising just binary AND and binary OR gates (assume that the circuit does not have any feedback). Let PARITY : $\{0, 1\}^n \rightarrow \{0, 1\}$ be the boolean function that outputs 1 if the total number of input bits set to 1 is odd. Similarly, let MAJORITY be the boolean function that outputs 1 if the number of input bits that are set to 1 is at least as large as the number of input bits that are set to 0. Then, which of the following is

NOT possible?

- a. $f(0, 0, \dots, 0) = f(1, 1, \dots, 1) = 0$.
- b. $f(0, 0, \dots, 0) = f(1, 1, \dots, 1) = 1$
- c. f is the MAJORITY function.
- d. f is the PARITY function.
- e. f outputs 1 at exactly one assignment of the input bits.

[tifr2014](#) [set-theory&algebra](#) [functions](#)

[Answer](#)

10.6.5 Functions: GATE2015-2_GA_9 [top](#)

<http://gateoverflow.in/8040>

If p, q, r, s are distinct integers such that:

$$f(p, q, r, s) = \max(p, q, r, s)$$

$$g(p, q, r, s) = \min(p, q, r, s)$$

$h(p, q, r, s) = \text{remainder of } (p \times q) / (r \times s) \text{ if } (p \times q) > (r \times s)$
or remainder of $(r \times s) / (p \times q)$ if $(r \times s) > (p \times q)$

Also a function $fg(h(p, q, r, s)) = f(p, q, r, s) \times g(p, q, r, s) \times h(p, q, r, s)$

Also the same operations are valid with two variable functions of the form $f(p, q)$

What is the value of $fg(h(2, 5, 7, 3), 4, 6, 8)$?

[gate2015-2](#) [set-theory&algebra](#) [functions](#) [normal](#)

[Answer](#)

10.6.6 Functions: GATE2015-2_GA_3 [top](#)

<http://gateoverflow.in/8030>

Consider a function $f(x) = 1 - |x|$ on $-1 \leq x \leq 1$. The value of x at which the function attains a maximum, and the maximum value of the function are:

- A. 0, -1
- B. -1, 0
- C. 0, 1
- D. -1, 2

[gate2015-2](#) [set-theory&algebra](#) [functions](#) [normal](#)

[Answer](#)

10.6.7 Functions: GATE1996_1.3 [top](#)

<http://gateoverflow.in/2707>

Suppose X and Y are sets and $|X|$ and $|Y|$ are their respective cardinalities. It is given that there are exactly 97 functions from X to Y. From this one can conclude that

- A. $|X| = 1, |Y| = 97$
- B. $|X| = 97, |Y| = 1$
- C. $|X| = 97, |Y| = 97$
- D. None of the above

[gate1996](#) [set-theory&algebra](#) [functions](#) [normal](#)

[Answer](#)

10.6.8 Functions: GATE2001-2.3 [top](#)

<http://gateoverflow.in/721>

Let $f : A \rightarrow B$ a function, and let E and F be subsets of A . Consider the following statements about images.

- S1 : $f(E \cup F) = f(E) \cup f(F)$
- S2 : $f(E \cap F) = f(E) \cap f(F)$

Which of the following is true about S1 and S2?

- A. Only S1 is correct
- B. Only S2 is correct
- C. Both S1 and S2 are correct
- D. None of S1 and S2 is correct

[gate2001](#) [set-theory&algebra](#) [functions](#) [normal](#)

[Answer](#)

10.6.9 Functions: TIFR2013-B-16 [top](#)

<http://gateoverflow.in/25859>

Consider a function $T_{k,n} : \{0,1\}^n \rightarrow \{0,1\}$ which returns 1 if at least k of its n inputs are 1. Formally, $T_{k,n}(x) = 1$ if $\sum_1^n x_i \geq k$. Let $y \in \{0,1\}^n$ be such that y has exactly k ones. Then, the function $T_{k,n-1}(y_1, y_2, \dots, y_{i-1}, y_{i+1}, \dots, y_n)$ (where y_i is omitted) is equivalent to

- a. $T_{k-1,n}(y)$
- b. $T_{k,n}(y)$
- c. y_i
- d. $\neg y_i$
- e. None of the above.

[tifr2013](#) [set-theory&algebra](#) [functions](#)

[Answer](#)

10.6.10 Functions: GATE2015-1_5 [top](#)

<http://gateoverflow.in/8025>

If $g(x) = 1 - x$ and $h(x) = \frac{x}{x-1}$, then $\frac{g(h(x))}{h(g(x))}$ is:

- A. $\frac{h(x)}{g(x)}$
- B. $\frac{-1}{x}$
- C. $\frac{g(x)}{h(x)}$
- D. $\frac{x}{(1-x)^2}$

[gate2015-1](#) [set-theory&algebra](#) [functions](#) [normal](#)

[Answer](#)

10.6.11 Functions: GATE2015-2_54 [top](#)

<http://gateoverflow.in/8257>

Let X and Y denote the sets containing 2 and 20 distinct objects respectively and F denote the set of all possible functions defined from X to Y . Let f be randomly chosen from F . The probability of f being one-to-one is _____.

[gate2015-2](#) [set-theory&algebra](#) [functions](#) [normal](#)

[Answer](#)

10.6.12 Functions: GATE2005-IT_31 [top](#)

<http://gateoverflow.in/3777>

Let f be a function from a set A to a set B , g a function from B to C , and h a function from A to C , such that $h(a) = g(f(a))$ for all $a \in A$. Which of the following statements is always true for all such functions f and g ?

- A) g is onto $\Rightarrow h$ is onto

- B) h is onto $\Rightarrow f$ is onto
 C) h is onto $\Rightarrow g$ is onto
 D) h is onto $\Rightarrow f$ and g are onto

[gate2005-it](#) [set-theory&algebra](#) [functions](#) [normal](#)

[Answer](#)

10.6.13 Functions: GATE2015-1_39 [top](#)

<http://gateoverflow.in/8294>

Consider the operations

$$f(X, Y, Z) = X'YZ + XY' + Y'Z' \text{ and } g(X, Y, Z) = X'YZ + X'YZ' + XY$$

Which one of the following is correct?

- A. Both $\{f\}$ and $\{g\}$ are functionally complete
- B. Only $\{f\}$ is functionally complete
- C. Only $\{g\}$ is functionally complete
- D. Neither $\{f\}$ nor $\{g\}$ is functionally complete

[gate2015-1](#) [set-theory&algebra](#) [functions](#) [difficult](#)

[Answer](#)

10.6.14 Functions: GATE2006-IT_6 [top](#)

<http://gateoverflow.in/3545>

Given a boolean function $f(x_1, x_2, \dots, x_n)$, which of the following equations is NOT true

- A) $f(x_1, x_2, \dots, x_n) = x_1'f(x_1, x_2, \dots, x_n) + x_1f(x_1, x_2, \dots, x_n)$
- B) $f(x_1, x_2, \dots, x_n) = x_2f(x_1, x_2, \dots, x_n) + x_2'f(x_1, x_2, \dots, x_n)$
- C) $f(x_1, x_2, \dots, x_n) = x_n'f(x_1, x_2, \dots, 0) + x_nf(x_1, x_2, \dots, 1)$
- D) $f(x_1, x_2, \dots, x_n) = f(0, x_2, \dots, x_n) + f(1, x_2, \dots, x_n)$

[gate2006-it](#) [set-theory&algebra](#) [functions](#) [normal](#)

[Answer](#)

10.6.15 Functions: GATE2005_43 [top](#)

<http://gateoverflow.in/1168>

Let $f: B \rightarrow C$ and $g: A \rightarrow B$ be two functions and let $h = fog$. Given that h is an onto function which one of the following is TRUE?

- (A) f and g should both be onto functions.
- (B) f should be onto but g need not be onto
- (C) g should be onto but f need not be onto.
- (D) both f and g need not be onto.

[gate2005](#) [set-theory&algebra](#) [functions](#) [normal](#)

[Answer](#)

10.6.16 Functions: GATE1996_2.1 [top](#)

<http://gateoverflow.in/2730>

Let R denote the set of real numbers. Let $f: R \times R \rightarrow R \times R$ be a bijective function defined by $f(x, y) = (x+y, x-y)$. The inverse function of f is given by

$$(a) f^{-1}(x, y) = \left(\frac{1}{x+y}, \frac{1}{x-y} \right)$$

$$(b) f^{-1}(x, y) = (x-y, x+y)$$

(c) $f^{-1}(x, y) = \left(\frac{x+y}{2}, \frac{x-y}{2}\right)$

(d) $f^{-1}(x, y) = [2(x - y), 2(x + y)]$

[gate1996](#) [set-theory&algebra](#) [functions](#) [normal](#)

[Answer](#)

10.6.17 Functions: GATE2003_39 [top](#)

<http://gateoverflow.in/930>

Let $\Sigma = \{a, b, c, d, e\}$ be an alphabet. We define an encoding scheme as follows:

$$g(a) = 3, g(b) = 5, g(c) = 7, g(d) = 9, g(e) = 11 .$$

Let p_i denote the i -th prime number ($p_1 = 2$).

For a non-empty string $s = a_1 \dots a_n$, where each $a_i \in \Sigma$, define $f(s) = \prod_{i=1}^n P_i^{g(a_i)}$.

For a non-empty sequence $\langle s_j, \dots, s_n \rangle$ of strings from Σ^+ , define $h(\langle s_i \dots s_n \rangle) = \prod_{i=1}^n P_i^{f(s_i)}$

Which of the following numbers is the encoding, h , of a non-empty sequence of strings?

- A. $2^7 3^7 5^7$
- B. $2^8 3^8 5^8$
- C. $2^9 3^9 5^9$
- D. $2^{10} 3^{10} 5^{10}$

[gate2003](#) [set-theory&algebra](#) [functions](#) [normal](#)

[Answer](#)

10.6.18 Functions: GATE1997_13 [top](#)

<http://gateoverflow.in/2273>

Let F be the set of one-to-one functions from the set $\{1, 2, \dots, n\}$ to the set $\{1, 2, \dots, m\}$ where $m \geq n \geq 1$.

- a. How many functions are members of F ?
- b. How many functions f in F satisfy the property $f(i) = 1$ for some $i, 1 \leq i \leq n$?
- c. How many functions f in F satisfy the property $f(i) < f(j)$ for all $1 \leq i \leq j \leq n$?

[gate1997](#) [set-theory&algebra](#) [functions](#) [normal](#)

[Answer](#)

10.6.19 Functions: GATE2007_3 [top](#)

<http://gateoverflow.in/1202>

What is the maximum number of different Boolean functions involving n Boolean variables?

- (A) n^2 (B) 2^n (C) 2^{2^n} (D) 2^{n^2}

[gate2007](#) [combinatory](#) [functions](#) [normal](#)

[Answer](#)

10.6.20 Functions: GATE1998_1.8 [top](#)<http://gateoverflow.in/1645>

The number of functions from an m element set to an n element set is

- A. $m + n$
- B. m^n
- C. n^m
- D. $m * n$

[gate1998](#) | [set-theory&algebra](#) | [combinatory](#) | [functions](#) | [easy](#)

Answer**10.6.21 Functions: GATE2014-1_50** [top](#)<http://gateoverflow.in/1930>

Let

S denote the set of all functions

$f : \{0, 1\}^4 \rightarrow \{0, 1\}$. Denote by

N the number of functions from S to the set

$\{0, 1\}$. The value of

$\log_2 \log_2 N$ is _____.

[gate2014-1](#) | [set-theory&algebra](#) | [functions](#) | [combinatory](#) | [numerical-answers](#)

Answer**10.6.22 Functions: GATE2014-3_2** [top](#)<http://gateoverflow.in/2036>

Let

X and

Y be finite sets and

$f : X \rightarrow Y$ be a function. Which one of the following statements is TRUE?

(A) For any subsets
 A and
 B of
 X , $|f(A \cup B)| = |f(A)| + |f(B)|$

(B) For any subsets
 A and
 B of
 X , $f(A \cap B) = f(A) \cap f(B)$

(C) For any subsets
 A and
 B of
 X , $|f(A \cap B)| = \min\{|f(A)|, |f(B)|\}$

(D) For any subsets
 S and
 T of
 Y , $f^{-1}(S \cap T) = f^{-1}(S) \cap f^{-1}(T)$

[gate2014-3](#) | [set-theory&algebra](#) | [functions](#) | [normal](#)

Answer**10.6.23 Functions: GATE2014-3_49** [top](#)<http://gateoverflow.in/2083>

Consider the set of all functions $f : \{0, 1, \dots, 2014\} \rightarrow \{0, 1, \dots, 2014\}$ such that $f(f(i)) = i$, for all $0 \leq i \leq 2014$. Consider the following statements:

P. For each such function it must be the case that for every i , $f(i) = i$.

Q. For each such function it must be the case that for some i , $f(i) = i$.

R. Each function must be onto.

Which one of the following is CORRECT?

(A)
 P, Q and
 R are true

(B) Only
 Q and
 R are true

(C) Only
 P and
 Q are true

(D) Only
 R is true

gate2014-3 | set-theory&algebra | functions | normal

Answer

10.6.24 Functions: GATE2012_37 top

<http://gateoverflow.in/1759>

How many onto (or surjective) functions are there from an n -element ($n \geq 2$) set to a 2-element set?

- (A) 2^n
 (B) $2^n - 1$
 (C) $2^n - 2$
 (D) $2(2^n - 2)$

gate2012 | set-theory&algebra | functions | normal

Answer

Answers: Functions

10.6.1 Functions: GATE2003_37 top

<http://gateoverflow.in/927>



Selected Answer

$f : A \rightarrow B$ is a one to one function. Every element in A will have a corresponding element in B. Therefore, the size of range for this is $n(A)$ and $n(B) \geq n(A)$.

$g : 2^A \rightarrow 2^B, g(C) = \{f(x) \mid x \in C\}$, since f is one to one, for every subset of A there will be corresponding subset of B. Therefore this is also a one to one function and size of range for this is $n(2^A)$.

$h : 2^B \rightarrow 2^A, h(D) = \{x \mid x \in A, f(x) \in D\}$ this function is not a one to one function. Every subset of B will be mapped to subset of A for which it has all the images of subset of A. size of range for this function will be $n(2^A)$

That said, now $g(h(D))$ will also have the range of size $n(2^A)$. Since $n(A) \leq n(B)$, $n(2^A)$ must be less than or equal to $n(2^B)$. The answer is $g(h(D)) \subseteq D$.

For example let $A = \{1, 2\}$ and $B = \{a, b, c\}$. Let $f(1) = a, f(2) = b$. Now,

$$g(\{\}) = \{\}$$

$$g(\{1\}) = \{a\}$$

$$g(\{2\}) = \{b\}$$

$$g(\{1, 2\}) = \{a, b\}$$

$$h(\{\}) = \{\}$$

$h(\{a\}) = \{1\}$
 $h(\{b\}) = \{2\}$
 $h(\{c\}) = \{\}$
 $h(\{a, b\}) = \{1, 2\}$
 $h(\{a, c\}) = \{1\}$
 $h(\{b, c\}) = \{2\}$
 $h(\{a, b, c\}) = \{1, 2\}$

Now we can see that for any $D \subseteq B$, $g(h(D)) \subseteq D$. Had the function f been bijective (one-one and onto or one-one and co-domain = range), then we would have got $g(h(D)) = D$.

10 votes

-- Mari Ganesh Kumar (1.9k points)

10.6.2 Functions: GATE 2016-1-28 [top](#)

<http://gateoverflow.in/39717>



Selected Answer

Answer 2..

for multiples of 5.. $f(5)=f(10)\dots$
and one for rest of the numbers in N.

9 votes

-- Abhilash Panicker (7k points)

10.6.3 Functions: TIFR2014-B-18 [top](#)

<http://gateoverflow.in/27351>

$f=1$ if all of its elements are distinct.

Now $g=Y$. where the number of different values of Y depend on the number of possible distinct sets $\{z_1, z_2, z_3\}$.

each z value lies between 1 and k . for $\{z_1, z_2, z_3\}$ to be distinct, 3 elements should be selected without repetition from $\{1, 2, 3, 4, \dots, k\}$

this can be done in $k*(k-1)*(k-2)$ ways and there are $k-3$ possibilities for Y if $g(z)$ should be distinct.

I am getting $kP4 = k(k-1)(k-2)(k-3)(k-4)$ as answer.

0 votes

-- Vikranth Inti (239 points)

10.6.4 Functions: TIFR2014-B-17 [top](#)

<http://gateoverflow.in/27344>

Note : NOT is absent in function f .

for two boolean variables, $p_1=1, p_2=1$, neither $p_1 \text{AND} p_2$ nor $p_1 \text{OR} p_2$ is 0. ie, $f(1, 1)$ is never 0.

for $i = 1$ to n , $f(p_i)$ is a function of AND, OR operations on p_i . if all $p_i=1$, then f can never be 0;

similarly if all $p_i=0$, f can never be 1;

Therefore A, B are not possible.

for $j < n$, if all $p_j=0$ and $p_{n-j}=1$, then $f(p_j, p_{n-j})$ = majority if each 0 is AND with each 1. The remaining 1's or 0's are OR with the result.

Hence MAJORITY can be computed from f.

Option C is possible.

To check odd number of 1's, for PARITY function, we have to get the result 0 for even number of 1's which is not possible with just AND and OR operations, how might we combine(since NOT is absent in f);

D is not possible.

For option E, we check by symmetry. When the inputs are complemented among 0's and 1's, can f change to f' ? f is not always fixed for a particular input,. example, $f(0,1) = 0 \text{OR} 1 = 1 \quad 0 \text{AND} 1 = 0$, hence f can take multiple values for same input. Therefore E is also not right.

The only possible answer is C .Hence A,B,D,E are not possible.

1 votes

-- Vikranth Inti (239 points)

10.6.5 Functions: GATE2015-2_GA_9 [top](#)

<http://gateoverflow.in/8040>



Selected Answer

It is given that $h(p, q, r, s) = \text{remainder of } (p \times q) / (r \times s) \text{ if } (p \times q) > (r \times s) \text{ or remainder of } (r \times s) / (p \times q) \text{ if } (r \times s) > (p \times q)$.

$$h(2, 5, 7, 3) = \text{remainder of } (7 \times 3) / (2 \times 5), \because (7 \times 3) > (2 \times 5)$$

$$\text{Thus, } h(2, 5, 7, 3) = 1$$

Again, it is given that $fg(p, q, r, s) = f(p, q, r, s) \times g(p, q, r, s)$

Also, $f(p, q, r, s) = \max(p, q, r, s)$, and $g(p, q, r, s) = \min(p, q, r, s)$

So we have:

$$fg(1, 4, 6, 8) = 8 \times 1, \because \max(1, 4, 6, 8) = 8 \text{ & } \min(1, 4, 6, 8) = 1$$

$$\text{Thus, } fg(1, 4, 6, 8) = 8$$

Answer: 8

10 votes

-- Shyam Singh (1.4k points)

10.6.6 Functions: GATE2015-2_GA_3 [top](#)

<http://gateoverflow.in/8030>



Selected Answer

Answer: C

Put the value of x of all the options in $f(x)$ and find value of $f(x)$.

7 votes

-- Rajarshi Sarkar (29.7k points)

10.6.7 Functions: GATE1996_1.3 [top](#)

<http://gateoverflow.in/2707>



Selected Answer

We can say $|Y|^{|X|} = 97$. Only option A satisfies this. Still, this can be concluded only because 97 is a prime number and hence no other power gives 97.

5 votes

-- Arjun Suresh (150k points)

10.6.8 Functions: GATE2001-2.3 [top](#)

<http://gateoverflow.in/721>



Selected Answer

Here Answer is A .

S1 is always True.

S2 is false Consider case where E & F do not intersect, i.e. Intersection is empty set. In that case , F(E) and F(F) might have some common elements.

2 votes

-- Akash (31.7k points)

10.6.9 Functions: TIFR2013-B-16 [top](#)

<http://gateoverflow.in/25859>

ANS : D

as number of y's exactly k and yi is missing . if yi =1 then result becomes 0 , because number of 1s are less than k now.

if yi = 0 then result becomes 1. as number of 1s remain same. removal of which won't effect final value.

2 votes

-- pramod (2.3k points)

10.6.10 Functions: GATE2015-1_5 [top](#)

<http://gateoverflow.in/8025>



Selected Answer

option a) is correct.

$$\begin{aligned} g(h(x)) &= g\left(\frac{x}{x-1}\right) \\ &= 1 - \frac{x}{x-1} \\ &= \frac{-1}{x-1} \end{aligned}$$

$$\begin{aligned} h(g(x)) &= h(1-x) \\ &= \frac{1-x}{-x} \end{aligned}$$

$$\frac{g(h(x))}{h(g(x))} = \frac{x}{(1-x)(x-1)} = \frac{h(x)}{g(x)}$$

option A)

11 votes

-- GateMaster Prime (1.3k points)

10.6.11 Functions: GATE2015-2_54 [top](#)

<http://gateoverflow.in/8257>



Selected Answer

For a function, the first element in X has 20 choices (to map to) and the second element also has 20 choices. For a one-to-one function the second element has only 19 choices left after 1 being taken by the first. So, required probability

$$= 20 * 19 / (20 * 20) = 0.95$$

12 votes

-- Vikrant Singh (11k points)

10.6.12 Functions: GATE2005-IT_31 [top](#)

<http://gateoverflow.in/3777>



Selected Answer

Let h be onto (onto means co-domain = range). So, h maps to every element in C from A . Since $h(a) = g(f(a))$, g should also map to all elements in C . So, g is also onto \rightarrow option (C).

Upvote 6 votes

-- Arjun Suresh (150k points)

10.6.13 Functions: GATE2015-1_39 [top](#)

<http://gateoverflow.in/8294>



Selected Answer

g is preserving 0 as when all inputs are zero, output is always 0 and so g cannot be functionally complete.

f is not preserving 0.

f is not preserving 1. (when all inputs are 1, output is 0).

f is not linear as in XY' only one (odd) input ($X = 1, Y = Z = 0$) needs to be 1 and in $X'YZ$ two inputs (even) ($X = 0, Y = Z = 1$) need to be 1.

f is not monotone as changing Y from 0 to 1, can take f from 1 to 0.

f is not self dual as $f(X, Y, Z) \neq \sim f(\sim X, \sim Y, \sim Z)$

So, f satisfies all 5 conditions required for functional completeness and hence B is the answer.

<http://cs.ucsb.edu/~victor/ta/cs40/posts-criterion.pdf>

Upvote 22 votes

-- Arjun Suresh (150k points)

10.6.14 Functions: GATE2006-IT_6 [top](#)

<http://gateoverflow.in/3545>



Selected Answer

Answer: D

Proceed by taking $f(x_1) = x_1$

LHS: $f(x_1) = 0$ when $x_1 = 0$

LHS: $f(x_1) = 1$ when $x_1 = 1$

RHS: $f(0) + f(1) = 0 + 1 = \text{always } 1$

Upvote 3 votes

-- Rajarshi Sarkar (29.7k points)

10.6.15 Functions: GATE2005_43 [top](#)

<http://gateoverflow.in/1168>



Selected Answer

B. g need not be onto.

Let,

$$A = \{0, 1, 2\}, B = \{0, 3, 4, 25\}, C = \{3, 4, 5\}$$

$$f = \{(0, 3), (3, 5), (4, 4), (25, 3)\}$$

$g = \{(1, 3), (2, 4), (0, 0)\}$ (25 in B not mapped to by g , hence g is not ONTO)

$$h = \{(0, 3), (1, 5), (2, 4)\}$$

Now, h is an onto function but g is not.

f must be an onto function as otherwise we are sure to miss some elements in range of h making it not onto.

Upvote 8 votes

-- Arjun Suresh (150k points)

10.6.16 Functions: GATE1996_2.1 [top](#)

<http://gateoverflow.in/2730>



Selected Answer

to find inverse of the function take

$$z_1 = x + y \rightarrow (1)$$

$$z_2 = x - y \rightarrow (2)$$

Adding (1) and (2) we get,

$$x = \frac{z_1 + z_2}{2} \text{ and } y = \frac{z_1 - z_2}{2}$$

$$\text{So, } f\left(\frac{z_1}{2}, \frac{z_2}{2}\right) = \left(\frac{z_1 + z_2}{2}, \frac{z_1 - z_2}{2}\right) = (x, y) \implies f^{-1}(x, y) = \left(\frac{x+y}{2}, \frac{x-y}{2}\right) = \left\{\frac{x+y}{2}, \frac{x-y}{2}\right\}$$

Upvote 4 votes

-- neha pawar (3.8k points)

10.6.17 Functions: GATE2003_39 [top](#)

<http://gateoverflow.in/930>

It is clear from the choices that there are 3 strings in the sequence as we have the first 3 prime numbers in the product. Now, in $f(s)$ the first term is 2^x for some x , so, A and C choices can be eliminated straight away as neither 7 nor 9 is a multiple of 2.

The sequence of strings are "a", "a" and "a"

$$f(a) = 2^3 = 8. \text{ So, we get } 2^8 3^8 5^8 \text{ as per the definition of } h.$$

Upvote 6 votes

-- Arjun Suresh (150k points)

10.6.18 Functions: GATE1997_13 [top](#)

<http://gateoverflow.in/2273>



Selected Answer

(a) A function from A to B must map every element in A. Being one-one, each element must map to a unique element in B. So, for n elements in A, we have m choices in B and so we can have mP_n functions.

(b) Continuing from (a) part. Here, we are forced to fix $f(i) = 1$. So, one element from A and B gone with n possibilities for the element in A and 1 possibility for that in B, and we get $n \times m-1 P_{n-1}$ such functions.

(c) $f(i) < f(j)$ means only one order for the n selection permutations from B is valid. So, the answer from (a) becomes mC_n here.

Upvote 5 votes

-- Arjun Suresh (150k points)

10.6.19 Functions: GATE2007_3 [top](#)

<http://gateoverflow.in/1202>



Selected Answer

answer - C

size of domain = number of different combinations of inputs = 2^n size of codomain = $2^{\{0,1\}}$ number of functions = (size of co-domain)^(size of domain)

7 votes

-- ankitrokdeonsns (8.4k points)

10.6.20 Functions: GATE1998_1.8 [top](#)<http://gateoverflow.in/1645>

Selected Answer

No. of functions from an m element set to an n element set is n^m as for each of the m element, we have n choices to map to, giving $\underbrace{n \times n \times \dots n}_{m \text{ times}} = n^m$.

PS: Each element of the domain set in a function must be mapped to some element of the co-domain set.

7 votes

-- Digvijay (35.8k points)

10.6.21 Functions: GATE2014-1_50 [top](#)<http://gateoverflow.in/1930>

Selected Answer

For a function from set A to set B, we need to have a mapping for all elements of A and mapping must be unique. Let number of elements in A be m and that in B be n

So, if we consider an element from A, it can be mapped to any of the element from B. i.e., it has n possibilities when a function is formed. Similarly, for all other members also there are n possibilities as one element from A can be mapped to only a single element in B (though reverse need not true). So, for n elements in A, we totally have $\underbrace{n \times \dots \times n}_{m \text{ times}} = n^m$ possible functions.

In the question Number of elements (functions) in f is 2^{2^4} as $\{0,1\}^4$ contains 2^4 elements. So, number of functions from S to $\{0,1\}$ will be 2^{2^4} . So, $\log_2 \log_2 N = 2^4 = 16$.

15 votes

-- Arjun Suresh (150k points)

10.6.22 Functions: GATE2014-3_2 [top](#)<http://gateoverflow.in/2036>

Selected Answer

D)

3 out of 4 options can be eliminated with the help of a counter example.

Let $X = \{a, b, c\}$ and $Y = \{1, 2\}$

A Function f maps each element of X to exactly one element in Y .

Let $f(a) = 1, f(b) = 1, f(c) = 1$ and

$A = \{a\}, B = \{b, c\}$

A)

$$|f(A \cup B)| = |f(\{a, b, c\})| = |\{1\}| = 1$$

$$|f(A)| + |f(B)| = 1 + 1 = 2, \text{ LHS } != \text{ RHS.}$$

B) $f(A \cap B) = f(\{\}) = \{\} .$
 $f(A) \cap f(B) = \{1\} \cap \{1\} = \{1\}$

LHS!=RHS

C) $|f(A \cap B)| = |f(\{\})| = |\{\}| = 0$
 $\min\{|f(A)|, |f(B)|\} = \min(1, 1) = 1$

LHS!=RHS

D) Its easy to see that this is true because in a function a value can be mapped only to one value. The option assumes inverse of function f exists.

11 votes

-- Srinath Sri (2.9k points)

10.6.23 Functions: GATE2014-3_49 [top](#)

<http://gateoverflow.in/2083>



Selected Answer

Let $f(i) = j$. Now, we have $f(j) = i$, as per the given condition $f(f(i)) = i$.

For any $i \neq j$, we can have a mapping $f(i) = j, f(j) = i$ thus avoiding the condition $f(i) = i$. But the domain containing odd number of elements, at least for one element we must have $f(i) = i$. So, Q must be TRUE.

Since $f(i) = j$ and $f(j) = i$, and since $0 \leq i \leq 2014$ i must take all 2015 possible values (since f is a function, it must have a value for any element in the domain). We can easily see that $f(i)$ cannot be the same for two different i s because suppose $f(2) = 5$, and $f(3) = 5$. Now as per given condition, $f(5) = 2$ and $f(5) = 3$, which is not allowed in a function. So, all $f(i)$ values are unique \Rightarrow co-domain = range as there are only 2015 values in co-domain. So, R is true.

An identity function satisfies the given conditions. But that alone cant prove that P is true. We can also have a different function where all even numbers maps to the next odd number and all odd numbers map to the previous even number which satisfies the given conditions, except the last one as we have odd number in set. i.e., $f(0) = 1, f(1) = 0, f(2) = 3, f(3) = 2 \dots, f(2013) = 2012, f(2014) = 2014$.

This proves, P is false.

So, (B) is the answer.

12 votes

-- Arjun Suresh (150k points)

10.6.24 Functions: GATE2012_37 [top](#)

<http://gateoverflow.in/1759>

2^{n-2} in words (total functions - 2 functions where all elements maps exactly one element)

6 votes

-- Bhagirathi Nayak (11.3k points)

10.7

Generating Functions [top](#)

10.7.1 Generating Functions: GATE 2016-1-26 [top](#)

<http://gateoverflow.in/3969>

The coefficient of x^{12} in $(x^3 + x^4 + x^5 + x^6 + \dots)^3$ is _____.

gate2016-1 | set-theory&algebra | generating-functions | normal | numerical-answers

Answer

10.7.2 Generating Functions: TIFR2010-A-12 [top](#)

<http://gateoverflow.in/18391>

The coefficient of x^3 in the expansion of $(1+x)^3(2+x^2)^{10}$ is.

- a. 2^{14}
 b. 31
 c. $\left(\frac{3}{3}\right) + \left(\frac{10}{1}\right)$
 d. $\left(\frac{3}{3}\right) + 2\left(\frac{10}{1}\right)$
 e. $\left(\frac{3}{3}\right)\left(\frac{10}{1}\right)2^9$

tifr2010 generating-functions

Answer

Answers: Generating Functions

10.7.1 Generating Functions: GATE 2016-1-26 [top](#)

<http://gateoverflow.in/39693>



Selected Answer

we will get
 x^{12} as

1.
 $(x^4)^3$ having coefficient
 ${}^3C_0 = 1$

2.
 $(x^3)^2(x^6)$ having coefficient
 ${}^3C_1 = 3$

3.
 $(x^3)(x^4)(x^5)$ having coefficient
 ${}^3C_2 \times {}^2C_1 = 6$

So it is
 10

14 votes

-- Praveen Saini (38.4k points)

10.7.2 Generating Functions: TIFR2010-A-12 [top](#)

<http://gateoverflow.in/18391>



Selected Answer

$$(1+x)^3 = (1+x^3+3x+3x^2)$$

$$\text{and } (2+x^2)^{10} = {}_{10}^0 C * 2^0 * (x^2)^{10} + {}_{10}^1 C * 2^1 * (x^2)^9 + \dots + {}_{10}^9 C * 2^9 * (x^2)^1 + {}_{10}^{10} C * 2^{10} * (x^2)^0$$

$$\text{So , coefficient of } x^3 = {}_{10}^0 C * 2^{10} + 3 * {}_{10}^1 C * 2^9 = 2^9(32) = 2^{14}$$

As here we need to multiply last term of second expansion with first term of first coefficient (x^3) and $3x$ with x^2 in the second expansion.

4 votes

-- Shounak Kundu (4.1k points)

10.8

Groups [top](#)

10.8.1 Groups: GATE1995_2.17 [top](#)

<http://gateoverflow.in/2629>

Let A be the set of all non-singular matrices over real number and let $*$ be the matrix multiplication operation. Then

- A. A is closed under $*$ but $\langle A, * \rangle$ is not a semigroup.
- B. $\langle A, * \rangle$ is a semigroup but not a monoid.
- C. $\langle A, * \rangle$ is a monoid but not a group.
- D. $\langle A, * \rangle$ is a group but not an abelian group.

[gate1995](#) [set-theory&algebra](#) [groups](#)

[Answer](#)

10.8.2 Groups: GATE2004_72 [top](#)

<http://gateoverflow.in/1066>

The following is the incomplete operation table of a 4-element group.

| | | | | |
|---|---|---|---|---|
| * | e | a | b | c |
| e | e | a | b | c |
| a | a | b | c | e |
| b | | | | |
| c | | | | |

The last row of the table is

- A. c a e b
- B. c b a e
- C. c b e a
- D. c e a b

[gate2004](#) [set-theory&algebra](#) [groups](#) [normal](#)

[Answer](#)

10.8.3 Groups: GATE2005_46 [top](#)

<http://gateoverflow.in/1171>

Consider the set H of all 3×3 matrices of the type

$$\begin{pmatrix} a & f & e \\ 0 & b & d \\ 0 & 0 & c \end{pmatrix}$$

where a, b, c, d, e and f are real numbers and $abc \neq 0$. under the matrix multiplication operation, the set H is:

- (A) a group (B) a monoid but not a group (C) a semi group but not a monoid (D) neither a group nor a semi group

[gate2005](#) [set-theory&algebra](#) [groups](#) [normal](#)

[Answer](#)

10.8.4 Groups: GATE1992-14a [top](#)

<http://gateoverflow.in/593>

If G is a group of even order, then show that there exists an element $a \neq e$,

e , the identity in G , such that $a^2 = e$.

gate1992 set-theory&algebra groups normal

Answer

10.8.5 Groups: GATE1994_1.10 [top](#)

<http://gateoverflow.in/2451>

Some group (G, o) is known to be abelian. Then, which one of the following is true for G ?

- A. $g = g^{-1}$ for every $g \in G$
- B. $g = g^2$ for every $g \in G$
- C. $(goh)^2 = g^2oh^2$ for every $g, h \in G$
- D. G is of finite order

gate1994 set-theory&algebra groups normal

Answer

10.8.6 Groups: GATE2007_21 [top](#)

<http://gateoverflow.in/1219>

How many different non-isomorphic Abelian groups of order 4 are there?

- (A) 2 (B) 3 (C) 4 (D) 5**

gate2007 groups normal

Answer

10.8.7 Groups: GATE1993_28 [top](#)

<http://gateoverflow.in/2324>

Let $(\{p, q\}, *)$ be a semigroup where $p * p = q$. Show that:

- a. $p * q = q * p$ and
- b. $q * q = p$

gate1993 set-theory&algebra groups normal

Answer

10.8.8 Groups: GATE1995_21 [top](#)

<http://gateoverflow.in/2659>

Let G_1 and G_2 be subgroups of a group G .

- a. Show that $G_1 \cap G_2$ is also a subgroup of G .
- b. Is $G_1 \cup G_2$ always a subgroup of G ?

gate1995 set-theory&algebra groups normal

Answer

10.8.9 Groups: GATE1998_12 [top](#)

<http://gateoverflow.in/1726>

Let $(A, *)$ be a semigroup. Furthermore, for every a and b in A , if $a \neq b$, then $a * b \neq b * a$.

- a. Show that for every a in A , $a * a = a$
- b. Show that for every a, b in A , $a * b * a = a$
- c. Show that for every a, b, c in A , $a * b * c = a * c$

[gate1998](#) | [set-theory&algebra](#) | [groups](#) | [descriptive](#)

[Answer](#)

10.8.10 Groups: GATE2003_7 [top](#)

<http://gateoverflow.in/898>

Consider the set Σ^* of all strings over the alphabet $\Sigma = \{0, 1\}$. Σ^* with the concatenation operator for strings

- A. does not form a group
- B. forms a non-commutative group
- C. does not have a right identity element
- D. forms a group if the empty string is removed from Σ^*

[gate2003](#) | [set-theory&algebra](#) | [groups](#) | [normal](#)

[Answer](#)

10.8.11 Groups: GATE2014-3_50 [top](#)

<http://gateoverflow.in/2084>

There are two elements x, y in a group $(G, *)$ such that every element in the group can be written as a product of some number of x 's and y 's in some order. It is known that

$$x * x = y * y = x * y * x * y = y * x * y * x = e$$

where e is the identity element. The maximum number of elements in such a group is ____.

[gate2014-3](#) | [set-theory&algebra](#) | [groups](#) | [numerical-answers](#) | [normal](#)

[Answer](#)

10.8.12 Groups: GATE1997_3.1 [top](#)

<http://gateoverflow.in/2232>

Let $(Z, *)$ be an algebraic structure where Z is the set of integers and the operation $*$ is defined by $n * m = \max(n, m)$. Which of the following statements is true for $(Z, *)$?

- A. $(Z, *)$ is a monoid
- B. $(Z, *)$ is an Abelian group
- C. $(Z, *)$ is a group
- D. None of the above

[gate1997](#) | [set-theory&algebra](#) | [groups](#) | [normal](#)

[Answer](#)

10.8.13 Groups: GATE1992-14b [top](#)

<http://gateoverflow.in/43580>

Consider the set of integers $\{1, 2, 3, 4, 6, 8, 12, 24\}$ together with the two binary operations LCM (lowest common multiple) and GCD (greatest common divisor). Which of the following algebraic structures does this represent?

- A. group
- B. ring
- C. field
- D. lattice

[gate1992](#) | [set-theory&algebra](#) | [groups](#) | [normal](#)

[Answer](#)

10.8.14 Groups: GATE2006_03 top<http://gateoverflow.in/882>

The set $\{1, 2, 3, 5, 7, 8, 9\}$ under multiplication modulo 10 is not a group. Given below are four possible reasons. Which one of them is false?

- (A) It is not closed
- (B) 2 does not have an inverse
- (C) 3 does not have an inverse
- (D) 8 does not have an inverse

[gate2006](#) [set-theory&algebra](#) [groups](#) [normal](#)
Answer**10.8.15 Groups: GATE2002_1.6** top<http://gateoverflow.in/810>

Which of the following is true?

- A. The set of all rational negative numbers forms a group under multiplication.
- B. The set of all non-singular matrices forms a group under multiplication.
- C. The set of all matrices forms a group under multiplication.
- D. Both B and C are true.

[gate2002](#) [set-theory&algebra](#) [groups](#) [normal](#)
Answer**10.8.16 Groups: GATE1996_1.4** top<http://gateoverflow.in/2708>

Which of the following statements is false?

- A. The set of rational numbers is an abelian group under addition
- B. The set of integers is an abelian group under addition
- C. The set of rational numbers form an abelian group under multiplication
- D. The set of real numbers excluding zero is an abelian group under multiplication

[gate1996](#) [set-theory&algebra](#) [groups](#) [normal](#)
Answer**Answers: Groups****10.8.1 Groups: GATE1995_2.17** top<http://gateoverflow.in/2629>**Selected Answer**

Answer: D

As the matrices are non singular so their determinant is $\neq 0$. Hence, the inverse matrix can be found.

But for a group to be abelian it should follow commutativity. As, matrix multiplication is not commutative so $\langle A, * \rangle$ is a group but not an abelian group.

6 votes

-- Rajarshi Sarkar (29.7k points)

10.8.2 Groups: GATE2004_72 top<http://gateoverflow.in/1066>**Selected Answer**

From First row you can conclude that e is the identity element.

=> Using the above fact, from second row you can conclude that a and c are inverses of each other.

=> In fourth row:

First element : $c * e = c$ (e is identity)

Second element : $c * a = e$ (inverse)

Option 4 matches this.

2 votes

-- Mojo Jojo (3.2k points)

10.8.3 Groups: GATE2005_46 [top](#)

<http://gateoverflow.in/1171>



Selected Answer

Given Information - > Matrix is upper triangular. It's determinant is multiplication of principle diagonal elements. i.e. abc.

It is given that abc != 0. So Inverse for every such matrix exists.

Now this set is

1. Closed.(You can see after multiplication Matrix is in Same format & $|AB| = |A||B| = \text{Non zero as } |A|, |B| \text{ are non zero}$)
2. Associative (Matrix multiplication is associative).
3. Identity -> Identity Matrix In
4. Inverse, as determinant is non zero there exist inverse for every matrix.

So it is group.

7 votes

-- Akash (31.7k points)

10.8.4 Groups: GATE1992-14a [top](#)

<http://gateoverflow.in/593>



Selected Answer

| + | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|---|---|
| 0 | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 1 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 0 |
| 2 | 2 | 3 | 4 | 5 | 6 | 7 | 0 | 1 |
| 3 | 3 | 4 | 5 | 6 | 7 | 0 | 1 | 2 |
| 4 | 4 | 5 | 6 | 7 | 0 | 1 | 2 | 3 |
| 5 | 5 | 6 | 7 | 0 | 1 | 2 | 3 | 4 |
| 6 | 6 | 7 | 0 | 1 | 2 | 3 | 4 | 5 |
| 7 | 7 | 0 | 1 | 2 | 3 | 4 | 5 | 6 |

now what i can say for group of even order has even no. of elemnt in it at-east one time identity elemnet come to diagonal place except for identity element itself, at that time $a_2 = e$ is happen .

0 votes

-- Anirudh Pratap Singh (17.7k points)

10.8.5 Groups: GATE1994_1.10 [top](#)

<http://gateoverflow.in/2451>



Selected Answer

Associativity property of Group.

- For all a, b and c in G , the equation $(aob)oc = ao(boc)$ holds.

For an Abelian group, commutative property also holds.

- For all a, b in G , the equation $aob = boa$

From option C, using these two properties,

$$(goh)^2 = (goh)o(goh) = (hog)o(goh) = ((hog)og)oh = (ho(gog))oh = (hog^2)oh = (g^2oh)oh = g^2o(hoh) = g^2oh^2$$

So, C is correct.

Integer addition $(\mathbb{Z}, +)$ is an Abelian group.

Inverse of 1 is -1 and not 1. So, A is false.

$1^2 = 1 + 1 = 2 \neq 1$. So B also false.

Order of a group is the number of elements in it. Integer is an infinite set, so D is also false.

ref @ <http://math.stackexchange.com/questions/40996/prove-that-if-abi-aibi-forall-a-b-in-g-for-three-consecutive-integers/41004#41004>

@ <http://math.stackexchange.com/questions/423745/a-group-g-is-abelian-iff-abn-an-bn-for-all-a-b-in-g-and-n-in-bb?lq=1>

Upvote 6 votes

-- Arjun Suresh (150k points)

10.8.6 Groups: GATE2007_21 [top](#)

<http://gateoverflow.in/1219>



Selected Answer

The number of Abelian groups of order P^k (P is prime) is the number of partitions of k . here order is 4 i.e. 2^2 .

Partition of 2 are $\{1,1\}$, $\{2,0\}$.

total 2 partition so no of different abelian groups are 2.

http://oeis.org/wiki/Number_of_groups_of_order_n

Upvote 5 votes

-- Digvijay (35.8k points)

10.8.7 Groups: GATE1993_28 [top](#)

<http://gateoverflow.in/2324>

```
p*p = q
p*p*p = p*q      //left operations with p
(p*p)*p = p*q    //associative property
q*p = p*q        //p*p=q
```

m not getting 2nd part.

Upvote 1 votes

-- Digvijay (35.8k points)

10.8.8 Groups: GATE1995_21 [top](#)

<http://gateoverflow.in/2659>



Selected Answer

ans for B:

No, G1 union G2 is not subgroup of G always.

G1 union G2 is subgroup of G if and only if either G1 is contained in G2 or G2 is contained in G1.

2 votes

-- jayendra (6.6k points)

10.8.9 Groups: GATE1998_12 [top](#)

<http://gateoverflow.in/1726>



Selected Answer

a. Let $a * a = b$. $(a * a) * a = b * a$. Since $(A, *)$ is a semigroup, $*$ is closed and associative. So, $(a * a) * a = a * (a * a) \Rightarrow a * b = b * a$, which is possible only if $a = b$. Thus we proved $a * a = a$.

b. Let $(a * b) * a = c \Rightarrow (a * b) * a * a = c * a \Rightarrow a * b * a = c * a \Rightarrow c * a = a$.

Similarly, $a * (a * b * a) = a * c \Rightarrow a * a * (b * a) = a * c \Rightarrow a * (b * a) = a * c \Rightarrow a * c = a = c * a$.

So, $c = a$.

c. Let $(a * b) * c = d \Rightarrow (a * b) * c * c = d * c \Rightarrow a * b * c = d * c \Rightarrow d * c = d$.

Similarly, $a * (a * b * c) = a * d \Rightarrow a * a * (b * c) = a * d \Rightarrow a * (b * c) = a * d \Rightarrow a * d = d$.

Thus
 $d * c = a * d = d$

Now
 $c * d * c = c * a * d = c * d \Rightarrow c = c * a * d = c * d$

and

$d * c * a = a * d * a = d * a \Rightarrow d * c * a = a = d * a$

So,

$a * c = (d * a) * (c * d) = d * (a * c) * d = d$.

Thus,
 $a * b * c = a * c$.

3 votes

-- Arjun Suresh (150k points)

10.8.10 Groups: GATE2003_7 [top](#)

<http://gateoverflow.in/898>



Selected Answer

Identity element for concatenation is empty string ϵ . Now, we cannot concatenate any string with a given string to get empty string \Rightarrow there is no inverse for string concatenation. Only other 3 group properties -- closure, associative and existence of identity -- are satisfied and hence, ans should be (a).

9 votes

-- Madhur Rawat (2.4k points)

10.8.11 Groups: GATE2014-3_50 [top](#)

<http://gateoverflow.in/2084>

Exp: $x \times x = e \Rightarrow x$ is its own inverse
 $y \times y = e \Rightarrow y$ is its own inverse
 $(x \times y) \times (x \times y) = e \Rightarrow (x \times y)$ is its own inverse
 $(y \times x) \times (y \times x) = e \Rightarrow (y \times x)$ is its own inverse
also $x \times x \times e = e \times e$ can be rewritten as follows
 $x \times y \times y \times x = e \times y \times y \times e = e [\because y \times y = e]$
 $(x \times y) \times (y \times x) = e$ shows that $(x \times y)$ and $(y \times x)$ are each other's inverse and we already know that $(x \times y)$ and $(y \times x)$ are inverse of its own.
As per $(G, *)$ to be group any element should have only one inverse element (unique)
This process $x \times y = y \times x$ (is one element)
So the elements of such group are 4 which are $\{x, y, e, x \times y\}$

And so the answer is 4.

10 votes

-- Gate Keeda (17.7k points)

10.8.12 Groups: GATE1997_3.1 [top](#)

<http://gateoverflow.in/2232>

Lets follow our checklist one by one to see what property this algebraic structure follows.

Closure -yes ($m * n = \max(m, n)$) Output is either m or n whichever is maximum and since m, n belongs to Z , the result of the binary operation also belongs to Z . So closure property is satisfied.

Associative-Yes the output is max among the elements and it is associative

Now for identity, we don't have a single unique element for all the elements which is less than all the elements. ie, $m * e = m \Rightarrow \max(m, e) = m$. We can't find a single unique e which is less than all possible integer m , such that comparison between the two would always give m itself.

If the set was for Natural numbers we could have had 1 as identity element as it is less than any other natural number and we would have got a monoid.

- Semi-group - Closed and associative
- Monoid - Closed, associative and has an identity
- Group - Monoid with inverse
- Abelian group- Group with commutative property.

Hence this is just a semigroup- D option.

Ans D)

5 votes

-- Sourav Roy (2.7k points)

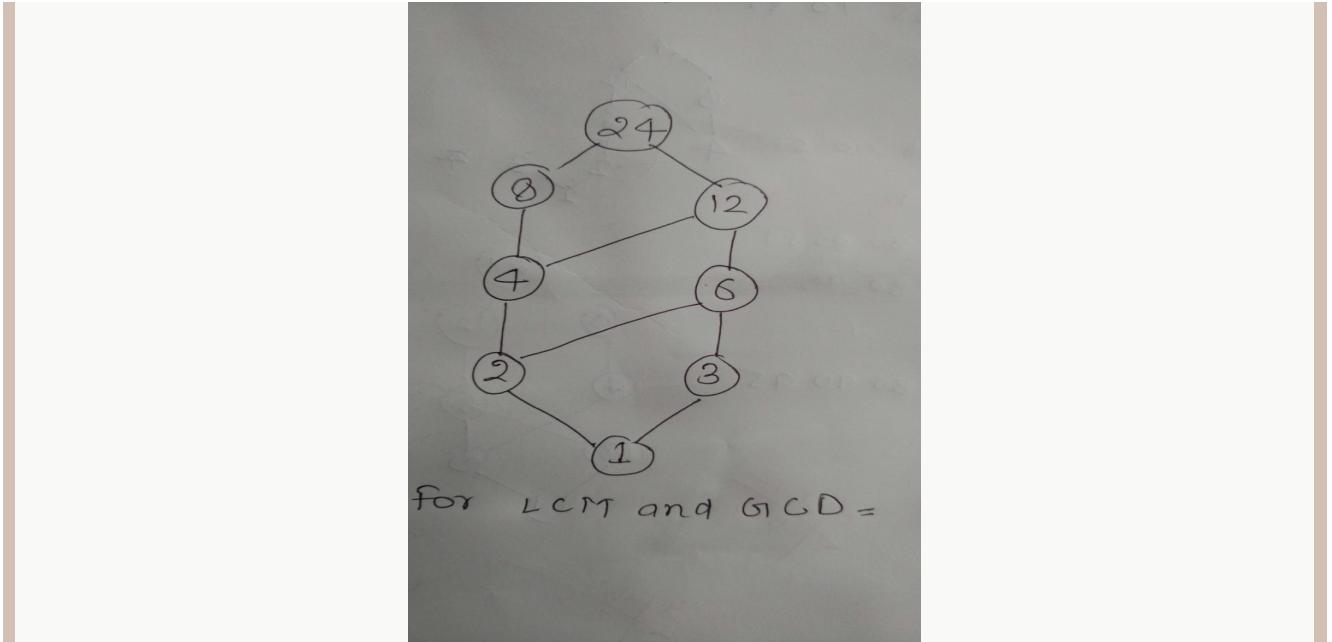
10.8.13 Groups: GATE1992-14b [top](#)

<http://gateoverflow.in/43580>



Selected Answer

ans is lattice .



1 votes

-- Anirudh Pratap Singh (17.7k points)

10.8.14 Groups: GATE2006_03 top

<http://gateoverflow.in/882>



Selected Answer

Answer: C

3 has an inverse, which is 7. As, $3 \cdot 7 \bmod 10 = 1$.

5 votes

-- Rajarshi Sarkar (29.7k points)

10.8.15 Groups: GATE2002_1.6 top

<http://gateoverflow.in/810>



Selected Answer

Answer: B

A: False. Multiplication of two negative rational numbers give positive number. So, closure property is not satisfied.

B: True. Matrices have to be non-singular (determinant $\neq 0$) for the inverse to exist.

C: False. Singular matrices do not form a group under multiplication.

D. False as C is false.

4 votes

-- Rajarshi Sarkar (29.7k points)

10.8.16 Groups: GATE1996_1.4 top

<http://gateoverflow.in/2708>



Selected Answer

Answer: C

Rational numbers will include 0. As the group should be under multiplication we will not have any inverse element for 0.

Thus, not even satisfying the group property.

2 votes

-- Rajarshi Sarkar (29.7k points)

10.9

Injective Functions top

10.9.1 Injective Functions: GATE1993_8.6 top

<http://gateoverflow.in/2304>

Let
 A and
 B be sets with cardinalities
 m and
 n respectively. The number of one-one mappings from
 A to
 B , when
 $m < n$, is

- A. m^n
- B. ${}^n P_m$
- C. ${}^m C_n$
- D. ${}^n C_m$
- E. ${}^m P_n$

[gate1993](#) [set-theory&algebra](#) [functions](#) [injective-functions](#) [easy](#)

[Answer](#)

Answers: Injective Functions

10.9.1 Injective Functions: GATE1993_8.6 top

<http://gateoverflow.in/2304>



Selected Answer

Answer: B

Theorem 4

For any finite sets A and B , the number of one-to-one functions from A to B is $\frac{|B|!}{(|B|-|A|)!} = P(|B|, |A|)$

Proof. Let $A = \{a_1, a_2, \dots, a_n\}$ and $B = \{b_1, b_2, \dots, b_m\}$. A one-to-one function f assigns each element a_i of A a distinct element $b_j = f(a_i)$ of B ; for a_1 there are m choices, for a_2 there are $m - 1$ choices, ..., for a_n there are $(m - (n - 1))$ choices.

Hence by the rule of product, we have

$$\underbrace{m(m-1)\dots(m-(n-1))}_n = \frac{m!}{(m-n)!} = \frac{|B|!}{(|B|-|A|)!} = P(|B|, |A|)$$

injective functions from A to B . □

Ref: Page 33 of <http://www.cs.toronto.edu/~stacho/macm101-2.pdf>

4 votes

-- Rajarshi Sarkar (29.7k points)

10.10

Lattice top

10.10.1 Lattice: TIFR2012-B-4 top

<http://gateoverflow.in/25090>

Let \wedge, \vee denote the meet and join operations of lattice. A lattice is called distributive if for all x, y, z ,

$$x \wedge (y \vee z) = (x \wedge y) \vee (x \wedge z)$$

It is called complete if meet and join exist for every subset. It is called modular if for all x, y, z

$$z \leq x \Rightarrow x \wedge (y \vee z) = (x \wedge y) \vee z$$

The positive integers under divisibility ordering i.e. $p \leq q$ if p divides q forms a.

- a. Complete lattice.
- b. Modular, but not distributive lattice.
- c. Distributive lattice.
- d. Lattice but not a complete lattice.
- e. Under the given ordering positive integers do not form a lattice.

[tifr2012](#) [set-theory&algebra](#) [lattice](#)

[Answer](#)

10.10.2 Lattice: GATE1994_2.9 [top](#)

<http://gateoverflow.in/2476>

The Hasse diagrams of all the lattices with up to four elements are _____ (write all the relevant Hasse diagrams)

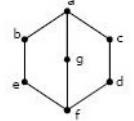
[gate1994](#) [set-theory&algebra](#) [lattice](#) [normal](#)

[Answer](#)

10.10.3 Lattice: GATE1997_3.3 [top](#)

<http://gateoverflow.in/2234>

In the lattice defined by the Hasse diagram given in following figure, how many complements does the element 'e' have?



- A. 2
- B. 3
- C. 0
- D. 1

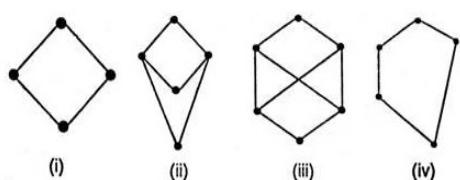
[gate1997](#) [set-theory&algebra](#) [lattice](#) [normal](#)

[Answer](#)

10.10.4 Lattice: GATE2008-IT_28 [top](#)

<http://gateoverflow.in/3318>

Consider the following Hasse diagrams.



(Ctrl) ▾

Which all of the above represent a lattice?

- A) (i) and (iv) only
 B) (ii) and (iii) only
 C) (iii) only
 D) (i), (ii) and (iv) only

[gate2008-it](#) [set-theory&algebra](#) [normal](#) [lattice](#)

[Answer](#)

10.10.5 Lattice: GATE2002_4 [top](#)

<http://gateoverflow.in/857>

$S = \{(1, 2), (2, 1)\}$ is binary relation on set $A = \{1, 2, 3\}$. Is it irreflexive? Add the minimum number of ordered pairs to S to make it an equivalence relation. Give the modified S .

Let $S = \{a, b\}$ and let $\square(S)$ be the powerset of S . Consider the binary relation ' \subseteq (set inclusion)' on $\square(S)$. Draw the Hasse diagram corresponding to the lattice $(\square(S), \subseteq)$

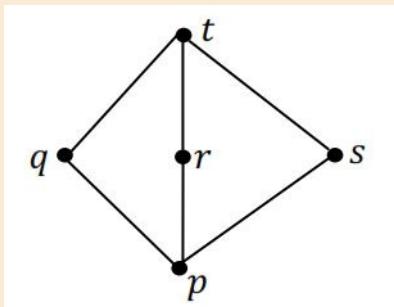
[gate2002](#) [set-theory&algebra](#) [normal](#) [lattice](#)

[Answer](#)

10.10.6 Lattice: GATE2015-1_34 [top](#)

<http://gateoverflow.in/8281>

Suppose $L = \{p, q, r, s, t\}$ is a lattice represented by the following Hasse diagram:



For any $x, y \in L$, not necessarily distinct, $x \vee y$ and $x \wedge y$ are join and meet of x, y , respectively. Let $L^3 = \{(x, y, z) : x, y, z \in L\}$ be the set of all ordered triplets of the elements of L . Let p_r be the probability that an element $(x, y, z) \in L^3$ chosen equiprobably satisfies $x \vee (y \wedge z) = (x \vee y) \wedge (x \vee z)$. Then

- A. $p_r = 0$
- B. $p_r = 1$
- C. $0 < p_r \leq \frac{1}{5}$
- D. $\frac{1}{5} < p_r < 1$

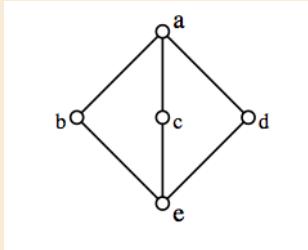
[gate2015-1](#) [set-theory&algebra](#) [normal](#) [lattice](#)

[Answer](#)

10.10.7 Lattice: GATE2005_9 [top](#)

<http://gateoverflow.in/1158>

The following is the Hasse diagram of the poset $[\{a, b, c, d, e\}, \prec]$



The poset is :

- A. not a lattice
- B. a lattice but not a distributive lattice
- C. a distributive lattice but not a Boolean algebra
- D. a Boolean algebra

[gate2005](#) [set-theory&algebra](#) [lattice](#) [normal](#)

[Answer](#)

Answers: Lattice

10.10.1 Lattice: TIFR2012-B-4 [top](#)

<http://gateoverflow.in/25090>

Lattice with gcd as meet and lcm as join.

it is distributive

$$\begin{aligned} \text{gcd}(a, \text{lcm}(b, c)) &= \text{lcm}(\text{gcd}(a, b), \text{gcd}(a, c)) \\ \text{lcm}(a, \text{gcd}(b, c)) &= \text{gcd}(\text{lcm}(a, b), \text{lcm}(a, c)). \end{aligned}$$

it is complete semi-meet lattice as there is no upper bound it is not complete semi-join lattice.

ANS: C

1 votes

-- pramod (2.3k points)

10.10.2 Lattice: GATE1994_2.9 [top](#)

<http://gateoverflow.in/2476>



Selected Answer

1. Diamond structure
2. Straight line structure

6 votes

-- Digvijay (35.8k points)

10.10.3 Lattice: GATE1997_3.3 [top](#)

<http://gateoverflow.in/2234>



Selected Answer

Answer: B

Complement of an element a is a' if:

- $a \wedge a' = 0$ (lowest vertex in the Hasse diagram)
- $a \vee a' = 1$ (highest vertex in the Hasse diagram)

g, c and d are the complements of e.

5 votes

-- Rajarshi Sarkar (29.7k points)

10.10.4 Lattice: GATE2008-IT_28 [top](#)

<http://gateoverflow.in/3318>



Selected Answer

ans is (A)

hasse diagram is lattice when every pair of element have least upper bound and greatest lower bound.in fig 2 and 3 every element will not have least upper bound and greatest lower bound so they are not lattice.

10 votes

-- neha pawar (3.8k points)

10.10.5 Lattice: GATE2002_4 top

<http://gateoverflow.in/857>



Selected Answer

$S = \{(1,2), (2,1)\}$ -> This relation is Irreflexive, Symmetric, Not Transitive, Not Reflexive, Not Asymmetric, Not antisymmetric.

Equivalence Relation -> Symmetric, Transitive, Reflexive.

It is not transitive & Reflexive.

So Reflexive closure of $S = \{(1,1), (2,2), (3,3), (1,2), (2,1)\}$

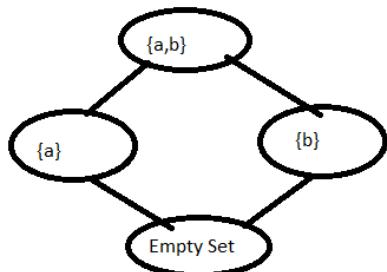
After taking transitive closure relation does not change.

Answer $S = \{(1,1), (2,2), (3,3), (1,2), (2,1)\}$

$S = \{a, b\}$

$P(S) = \{\{\}, \{a\}, \{b\}, \{a, b\}\}$

Related Hasse Diagram



2 votes

-- Akash (31.7k points)

10.10.6 Lattice: GATE2015-1_34 top

<http://gateoverflow.in/8281>



Selected Answer

Number of elements in L^3 = Number of ways in which we can choose 3 elements from 5 with repetition = $5 * 5 * 5 = 125$.

Now, when we take $x = t$, then the given condition for L is satisfied for any y and z . Here, y and z can be taken in $5 * 5 = 25$ ways.

Take $x = r, y = p, z = p$. Here also, the given condition is satisfied.

When $x = t$, we have $5 \times 5 = 25$ cases (for any y and z) where the given conditions are satisfied. Now, with $x = r, y = p, z = p$, we have one more case. So, $26/125$ which means strictly greater than $1/5$

So, this makes $p_r > \frac{25}{125}$

also,

For $x = q, y = r, z = s$, the given condition is **not satisfied** as $q \vee (r \wedge s) = q \vee p = q$, while $(q \vee r) \wedge (q \vee s) = t \wedge t = t$. So, $p_r \neq 1$.

These all findings make option A, B, C as FALSE.

Hence, answer = **option D**

16 votes

-- Arjun Suresh (150k points)

10.10.7 Lattice: GATE2005_9 [top](#)

<http://gateoverflow.in/1158>



Selected Answer

Option b ,a lattice has lub and glb but to be distributive it should have unique complement.

7 votes

-- anshu (2.5k points)

10.11

Lines Curves [top](#)

10.11.1 Lines Curves: GATE2007-IT_80 [top](#)

<http://gateoverflow.in/3522>

Let P_1, P_2, \dots, P_n be n points in the xy -plane such that no three of them are collinear. For every pair of points P_i and P_j , let L_{ij} be the line passing through them. Let L_{ab} be the line with the steepest gradient amongst all $n(n - 1)/2$ lines.

Which one of the following properties should necessarily be satisfied ?

- A) P_a and P_b are adjacent to each other with respect to their x -coordinate
- B) Either P_a or P_b has the largest or the smallest y -coordinate among all the points
- C) The difference between x -coordinates of P_a and P_b is minimum
- D) None of the above

[gate2007-it](#) [lines-curves](#)

Answer

Answers: Lines Curves

10.11.1 Lines Curves: GATE2007-IT_80 [top](#)

<http://gateoverflow.in/3522>

Answer: C

$$\text{Gradient} = \frac{y_2 - y_1}{x_2 - x_1}$$

For gradient to be maximum $x_2 - x_1$ should be minimum.

1 votes

-- Rajarshi Sarkar (29.7k points)

10.12

Partial Order [top](#)

10.12.1 Partial Order: TIFR2012-B-5 [top](#)

<http://gateoverflow.in/2502>

Let R be a binary relation over a set S . The binary relation R is called an equivalence relation if it is reflexive transitive and symmetric. The relation is called partial order if it is reflexive, transitive and anti symmetric. (Notation: Let aRb denote that order pair $(a,b) \in R$.) The relation R is called a well-order if R is a partial order and there does not exist an infinite descending chain (with respect to R) within S . An infinite sequence x_1, x_2, \dots of elements of S is called an infinite descending chain if for all i we have $x_{i+1}Rx_i$ and $x_i \neq x_{i+1}$.

Take $S = \mathbb{N} \times \mathbb{N}$ and let the binary relation \sqsubseteq over S be such that $(i_1, j_1) \sqsubseteq (i_2, j_2)$ if and only if either $(i_1 < i_2)$ or $((i_1 = i_2) \wedge (j_1 \leq j_2))$. Which statement is true of \sqsubseteq ?

- a. \sqsubseteq is an equivalence relation but not a well order.
- b. \sqsubseteq is a partial order but not a well order.
- c. \sqsubseteq is a partial order and a well order.
- d. \sqsubseteq is an equivalence relation and a well order.
- e. \sqsubseteq is neither a partial order nor an equivalence relation.

[tifr2012](#) [set-theory&algebra](#) [partial-order](#)

[Answer](#)

10.12.2 Partial Order: TIFR2013-B-4 [top](#)

<http://gateoverflow.in/25664>

A set S together with partial order \ll is called a well order if it has no infinite descending chains, i.e. there is no infinite sequence x_1, x_2, \dots of elements from S such that $x_{i+1} \ll x_i$ and $x_{i+1} \neq x_i$ for all i .

Consider the set of all words (finite sequence of letters $a - z$), denoted by W , in dictionary order.

- a. Between “aa” and “az” there are only 24 words.
- b. Between “aa” and “az” there are only 2^{24} words.
- c. W is not a partial order.
- d. W is a partial order but not a well order.
- e. W is a well order.

[tifr2013](#) [set-theory&algebra](#) [partial-order](#)

[Answer](#)

10.12.3 Partial Order: GATE2007-IT-23 [top](#)

<http://gateoverflow.in/3456>

A partial order P is defined on the set of natural numbers as follows. Here x/y denotes integer division.

- i. $(0, 0) \in P$.
- ii. $(a, b) \in P$ if and only if $a \% 10 \leq b \% 10$ and $(a/10, b/10) \in P$.

Consider the following ordered pairs:

- i. $(101, 22)$
- ii. $(22, 101)$
- iii. $(145, 265)$
- iv. $(0, 153)$

Which of these ordered pairs of natural numbers are contained in P ?

- A. (i) and (iii)
- B. (ii) and (iv)
- C. (i) and (iv)
- D. (iii) and (iv)

[gate2007-it](#) [set-theory&algebra](#) [partial-order](#) [normal](#)

[Answer](#)

10.12.4 Partial Order: TIFR2014-B-15 [top](#)

<http://gateoverflow.in/27322>

Consider the set N^* of finite sequences of natural numbers with $x \leq_p y$ denoting that sequence x is a prefix of sequence y . Then, which of the following is true?

- a. N^* is uncountable.
- b. \leq_p is a total order.

- c. Every non-empty subset of N^* has a least upper bound.
d. Every non-empty subset of N^* has a greatest lower bound.
e. Every non-empty finite subset of N^* has a least upper bound.

[tifr2014](#) [set-theory&algebra](#) [partial-order](#)

[Answer](#)

10.12.5 Partial Order: TIFR2014-B-16 [top](#)

<http://gateoverflow.in/27341>

Consider the ordering relation $x | y \subseteq N \times N$ over natural numbers N such that $x | y$ if there exists $z \in N$ such that $x \bullet z = y$. A set is called lattice if every finite subset has a least upper bound and greatest lower bound. It is called a complete lattice if every subset has a least upper bound and greatest lower bound. Then,

- a. $|$ is an equivalence relation.
b. Every subset of N has an upper bound under $|$.
c. $|$ is a total order.
d. $(N, |)$ is a complete lattice.
e. $(N, |)$ is a lattice but not a complete lattice.

[tifr2014](#) [set-theory&algebra](#) [partial-order](#)

[Answer](#)

10.12.6 Partial Order: GATE1991_01,xiv [top](#)

<http://gateoverflow.in/509>

If the longest chain in a partial order is of length n , then the partial order can be written as a _____ of n antichains.

[gate1991](#) [set-theory&algebra](#) [partial-order](#) [normal](#)

[Answer](#)

10.12.7 Partial Order: GATE1993_8.5 [top](#)

<http://gateoverflow.in/2303>

The less-than relation, $<$, on reals is

- A. a partial ordering since it is asymmetric and reflexive
B. a partial ordering since it is antisymmetric and reflexive
C. not a partial ordering because it is not asymmetric and not reflexive
D. not a partial ordering because it is not antisymmetric and reflexive
E. none of the above

[gate1993](#) [set-theory&algebra](#) [partial-order](#) [easy](#)

[Answer](#)

10.12.8 Partial Order: GATE1996_1.2 [top](#)

<http://gateoverflow.in/2706>

Let $X = \{2, 3, 6, 12, 24\}$, Let \leq be the partial order defined by $X \leq Y$ if x divides y . Number of edges in the Hasse diagram of (X, \leq) is

- A. 3
B. 4
C. 9
D. None of the above

[gate1996](#) [set-theory&algebra](#) [partial-order](#) [normal](#)

[Answer](#)

10.12.9 Partial Order: GATE1998_11 [top](#)<http://gateoverflow.in/1725>

Suppose $A = \{a, b, c, d\}$ and Π_1 is the following partition of A

$$\Pi_1 = \{\{a, b, c\}, \{d\}\}$$

- a. List the ordered pairs of the equivalence relations induced by Π_1 .
- b. Draw the graph of the above equivalence relation.
- c. Let $\Pi_2 = \{\{a\}, \{b\}, \{C\}, \{d\}\}$

$$\Pi_3 = \{\{a, b, c, d\}\}$$

$$\text{and } \Pi_4 = \{\{a, b\}, \{c, d\}\}$$

Draw a Poset diagram of the poset, $\langle \{\Pi_1, \Pi_2, \Pi_3, \Pi_4\}, \text{refines} \rangle$.

[gate1998](#) [set-theory&algebra](#) [normal](#) [partial-order](#)

Answer

10.12.10 Partial Order: GATE2004_73 [top](#)<http://gateoverflow.in/1067>

The inclusion of which of the following sets into

$$S = \{\{1, 2\}, \{1, 2, 3\}, \{1, 3, 5\}, \{1, 2, 4\}, \{1, 2, 3, 4, 5\}\}$$

is necessary and sufficient to make S a complete lattice under the partial order defined by set containment?

- A. $\{1\}$
- B. $\{1\}, \{2, 3\}$
- C. $\{1\}, \{1, 3\}$
- D. $\{1\}, \{1, 3\}, \{1, 2, 3, 4\}, \{1, 2, 3, 5\}$

[gate2004](#) [set-theory&algebra](#) [partial-order](#) [normal](#)

Answer

10.12.11 Partial Order: GATE1997_6.1 [top](#)<http://gateoverflow.in/2257>

A partial order \leq is defined on the set $S = \{x, a_1, a_2, \dots, a_n, y\}$ as $x \leq a_i$ for all i and $a_i \leq y$ for all i , where $n \geq 1$. The number of total orders on the set S which contain the partial order \leq is

- A. $n!$
- B. $n+2$
- C. n
- D. 1

[gate1997](#) [set-theory&algebra](#) [partial-order](#) [normal](#)

Answer

Answers: Partial Order**10.12.1 Partial Order: TIFR2012-B-5** [top](#)<http://gateoverflow.in/25092>

$S = (i_1 j_1) \sqsubseteq (i_2 j_2)$ iff **($i_1 < i_2$) or ($(i_1 = i_2) \wedge (j_1 \leq j_2)$)**

for reflexive

aRb where $a=b$ here $(i_1 j_1) \sqsubseteq (i_2 j_2)$

if we take any value which satisfy the reflexive property and exist in set it will also satisfy the given condition
e.g $(12) \sqsubseteq (12)$ here **$((i_1 = i_2) \wedge (j_1 \leq j_2))$** so its a Reflexive

for anti-symmetric

$aRb \rightarrow bRb$ unless $a=b$

here if we take any set like $i_1 < i_2$ surely it $i_2 \not\leq i_1$

if $i_1 = i_2$ and $j_1 \leq j_2$ then surely $j_2 \leq j_1$

e.g. $(12) \sqsubseteq (23)$ exist in S but $(23) \sqsubseteq (12)$ doesn't exist since $i_1 \not\leq i_2$ and $j_1 \not\leq j_2$
 $(32) \sqsubseteq (36)$ exist in S but $(36) \sqsubseteq (32)$ doesn't exist $i_1 = i_2$ but $j_1 \not\leq j_2$

so it is Anti-symmetric

for Transitive

$aRb \& bRc$ then aRc

here $(i_1 j_1) \sqsubseteq (i_2 j_2) \& (i_2 j_2) \sqsubseteq (i_3 j_3)$ then $(i_1 j_1) \sqsubseteq (i_3 j_3)$

if $i_1 < i_2 \& i_2 < i_3$ then surely $i_1 < i_3$

if $i_1 = i_2 \& j_1 \leq j_2 \& j_2 \leq j_3$ then surely $i_1 = i_3 \& j_1 \leq j_3$

so it is Transitive

Hence it is Poset

For well ordered for all $x_i+1 R x_i$ and $x_i \neq x_{i+1}$

$(i_1 j_1) \sqsubseteq (i_2 j_2)$ given $i_1 < i_2$

$(21) \sqsubseteq (14)$ is well ordered pair but it doesn't exist in set S . $i_1 \not\leq i_2 \& i_1 \neq i_2$

so i think option B

0 votes

-- Umang Raman (11.3k points)

Answer -> C

$S = (i_1 j_1) \sqsubseteq (i_2 j_2)$ iff **($i_1 < i_2$) or ($(i_1 = i_2) \wedge (j_1 \leq j_2)$)**

1. $(m,n) R (m,n)$?

yes, here $m < n$, so we go at second criteria.

Now $m=n$ & $n=n$. So This is reflexive.

2. Antisymmetric

$(1,2) R (2,3)$

Is $(2,3) R (1,2)$? No as $2 < 1$.

If you see the definition, it is clear that other than diagonal element no other element is related to itself. So antisymmetric.

3. Transitive ->

$(1,2) R (2,3) \& (2,3) R (2,4)$ (It is easy to prove)

$(1,2) R (2,4)$? Yes. It can be seen easily from following property

$S = (i_1 j_1) \sqsubseteq (i_2 j_2)$ iff **($i_1 < i_2$) or ($(i_1 = i_2) \wedge (j_1 \leq j_2)$)**.

Not going to prove this formally.

4. It is Not reflexive $(1,2) R (2,3)$ but $(2,3) \sim R (3,2)$

5. This is well ordered. We do not have infinite descending chain. As we have least element $(0,0)$ our chain stops there.

Ref :-

https://en.wikipedia.org/wiki/Infinite_descending_chain

<https://books.google.co.in/books?id=OR5KAAAAQBAJ&pg=PA17&lpg=PA17&dq=does+natural+no+have+infinite+descending+chain&source=bl&ots=dDJdZ26vWP>

35YMNbgkR5twmKDMwL2bo&hl=en&sa=X&ved=0ahUKEwje9of1-rfJAhUSC44KHRqGDI4Q6AEIKjAC#v=onepage&q=does%20natural%20no%20have%20infinite%20descending%20chain&f=false
https://en.wikipedia.org/wiki/Well-order#Examples_and_counterexamples

0 votes

-- Akash (31.7k points)

10.12.2 Partial Order: TIFR2013-B-4 [top](#)

<http://gateoverflow.in/25664>

Ans will be (c) W is not partial order

0 votes

-- srestha (27.8k points)

Answer -> E) well order

Minimal Element is 'a', it is less than all elements !

a) False, after aa, we can have ab. Then aba, abb, abc.. Not limited to 2⁴

b) False. after aa, we can have ab, aba, abc.. In fact ab(a-z)*. Not limited to 2²⁴

C) False. Why not partial order ? Dictionary order is partial order ! It is Reflexive, Antisymmetric & Transitive. Even definition of wikipedia says it is !

D) False. Dictionary order is well order .

Definition of Dictionary order -> Ref -> https://en.wikipedia.org/wiki/Lexicographical_order

Given two partially ordered sets A and B, the lexicographical order on the Cartesian product A × B is defined as

(a,b) ≤ (a',b') if and only if a < a' or (a = a' and b ≤ b').

The result is a partial order. If A and B are each totally ordered, then the result is a total order as well. The lexicographical order of two totally ordered sets is thus a linear extension of their product order.

0 votes

-- Akash (31.7k points)

10.12.3 Partial Order: GATE2007-IT-23 [top](#)

<http://gateoverflow.in/3456>



Selected Answer

Ans. D

For ordered pair (a, b), to be in P, each digit in a starting from unit place must not be larger than the corresponding digit in b.

This condition is satisfied by options

(iii) (145, 265) => 5 ≤ 5, 4 < 6 and 1 < 2

and

(iv) (0, 153) => 0 < 3 and no need to examine further

9 votes

-- Vikrant Singh (11k points)

10.12.4 Partial Order: TIFR2014-B-15 [top](#)

<http://gateoverflow.in/27322>



Selected Answer

Consider any sequence like "43,9,8,2" - it can have many (infinite) least upper bounds like "43,9,8,2,5", "43,9,8,2,1" ... but can have only 1 greatest lower bound - "43,9,8" because we are using prefix relation. So, option D is true.

1 votes

-- Arjun Suresh (150k points)

10.12.5 Partial Order: TIFR2014-B-16 [top](#)

<http://gateoverflow.in/27341>

i think ans will be E)

as every subset of this will not have LUB and GLB .

0 votes

-- Pranay Datta (6.8k points)

10.12.6 Partial Order: GATE1991_01,xiv [top](#)

<http://gateoverflow.in/509>



Selected Answer

Suppose the length of the longest chain in a partial order is n. Then the elements in the poset can be partitioned into n disjoint antichains.

4 votes

-- Rajarshi Sarkar (29.7k points)

10.12.7 Partial Order: GATE1993_8.5 [top](#)

<http://gateoverflow.in/2303>



Selected Answer

- relation less than is :
- not Reflexive
 - Irreflexive
 - not symmetric
 - Asymmetric
 - Anti symmetric

relation is not POSET because it is irreflexive.

check AntiSymmetry..

$aRb \neq bRa$ unless $a=b$.

A relation may be 'not Asymmetric and not reflexive' bt still Antisymmetric.
as $\{(1,1) (1,2)\}$

not Asymmetric and Irreflexive = Antisymmetric
Option E

6 votes

-- Digvijay (35.8k points)

10.12.8 Partial Order: GATE1996_1.2 [top](#)

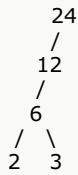
<http://gateoverflow.in/2766>



Selected Answer

Answer: B

Hasse Diagram is:



4 votes

-- Rajarshi Sarkar (29.7k points)

10.12.9 Partial Order: GATE1998_11 [top](#)

<http://gateoverflow.in/1725>

(a) the ordered pairs of the equivalence relations induced = { (a,a) (a,b) (a,c) (b,a) (b,b) (b,c) (c,a) (c,b) (c,c) (d,d) }

ps : equivalence relations = each partition power set - phi

0 votes

-- Nitin Sharma (437 points)

10.12.10 Partial Order: GATE2004_73 [top](#)

<http://gateoverflow.in/1067>

Selected Answer

Answer: A

A lattice is complete if every subset of partial order set has a supremum and infimum element

For example, here we are given a partial order set S. Now it will be a complete lattice if whatever be the subset we choose, it has a supremum and infimum element. Here relation given is set containment, so supremum element will be just union of all sets in the subset we choose. Similarly, infimum element will be just intersection of all the sets in the subset we choose.

Now as we can see, S now is not complete lattice, because although it has a supremum for every subset we choose, but some subsets have no infimum. For example : if we take subset $\{\{1,3,5\}, \{1,2,4\}\}$, then intersection of sets in this is $\{1\}$, which is not present in S. So clearly, if we add set $\{1\}$ in S, we will solve the problem. So adding $\{1\}$ is necessary and sufficient condition for S to be complete lattice. So option (A) is correct.

6 votes

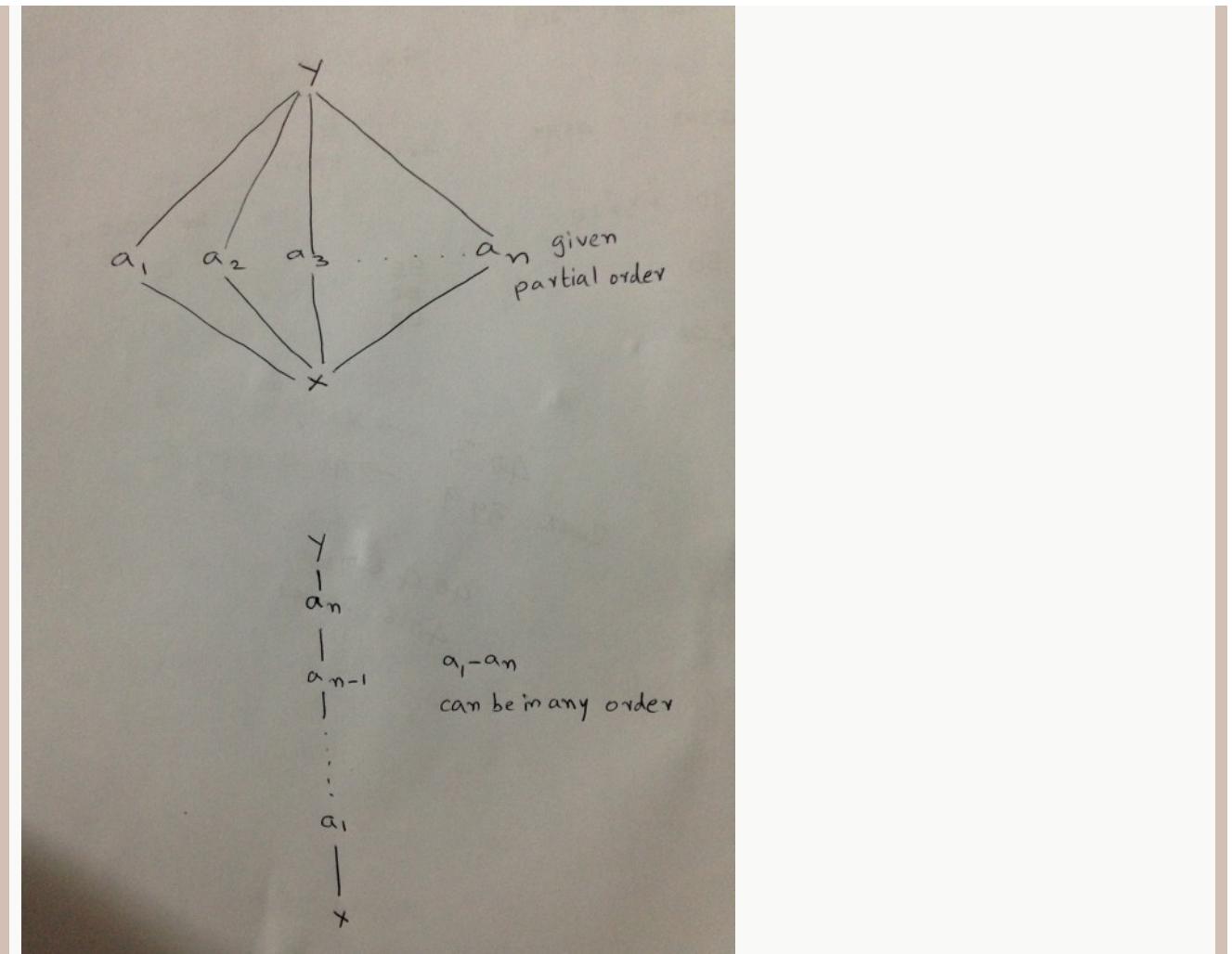
-- Rajarshi Sarkar (29.7k points)

10.12.11 Partial Order: GATE1997_6.1 [top](#)

<http://gateoverflow.in/2257>

Selected Answer

To make this partial order a total order, we need the relation to hold for every two elements of the partial order. Currently between any a_i and a_j , there is no relation. So, for every a_i, a_j , we have to add either (a_i, a_j) or (a_j, a_i) in total order. So, this translates to giving an ordering for n elements between x and y, which can be done in $n!$ ways. So, answer is (a).



The bottom figure is for a total order. We can permute the a_i from $i = 1$ to n , and each permutation will also be a total order containing the given partial order.

8 votes

-- Arjun Suresh (150k points)

10.13

Pigeonhole top

10.13.1 Pigeonhole: GATE2005_44 top

<http://gateoverflow.in/1170>

What is the minimum number of ordered pairs of non-negative numbers that should be chosen to ensure that there are two pairs (a,b) and (c,d) in the chosen set such that

$$a \equiv c \pmod{3} \text{ and } b \equiv d \pmod{5}$$

- (A) 4 (B) 6 (C) 16 (D) 24

gate2005 | set-theory&algebra | normal | pigeonhole | counting

Answer

Answers: Pigeonhole

10.13.1 Pigeonhole: GATE2005_44 top

<http://gateoverflow.in/1170>



Selected Answer

order pair for (a,b) are
 $(0,0), (0,1), (0,2), (0,3), (0,4)$
 $(1,0), (1,1), (1,2), (1,3), (1,4)$
 $(2,0), (2,1), (2,2), (2,3), (2,4)$
take any other combination for (c,d) that will surely match with one of the above 15 combination.(Pigeon Hole principle)
total $15+1 = 16$ combination

9 votes

-- Digvijay (35.8k points)

10.14

Polynomials top10.14.1 Polynomials: GATE2014-2_5 top<http://gateoverflow.in/1957>

A non-zero polynomial $f(x)$ of degree 3 has roots at $x = 1, x = 2$ and $x = 3$. Which one of the following must be TRUE?

- (A) $f(0)f(4) < 0$
- (B) $f(0)f(4) > 0$
- (C) $f(0) + f(4) > 0$
- (D) $f(0) + f(4) < 0$

[gate2014-2](#) [set-theory&algebra](#) [polynomials](#) [numerical-answers](#) [normal](#)

Answer

Answers: Polynomials

10.14.1 Polynomials: GATE2014-2_5 top<http://gateoverflow.in/1957>

Selected Answer

The roots are $x=1, x=2$, and $x=3$.

So polynomial is $f(x) = (x-1)(x-2)(x-3)$

$f(0) = -6, f(4) = 6$

So $f(0)f(4) < 0$.

13 votes

-- Happy Mittal (9.5k points)

10.15

Recurrence top10.15.1 Recurrence: GATE 2016-1-27 top<http://gateoverflow.in/39714>

Consider the recurrence relation $a_1 = 8, a_n = 6n^2 + 2n + a_{n-1}$. Let $a_{99} = K \times 10^4$. The value of K is _____.

[gate2016-1](#) [set-theory&algebra](#) [recurrence](#) [normal](#) [numerical-answers](#)

Answer

10.15.2 Recurrence: GATE 2016-1-2 top<http://gateoverflow.in/39636>

Let a_n be the number of n -bit strings that do **NOT** contain two consecutive 1s. Which one of the following is the recurrence relation for a_n ?

- A. $a_n = a_{n-1} + 2a_{n-2}$
- B. $a_n = a_{n-1} + a_{n-2}$
- C. $a_n = 2a_{n-1} + a_{n-2}$
- D. $a_n = 2a_{n-1} + 2a_{n-2}$

[gate2016-1](#) [set-theory&algebra](#) [recurrence](#) [easy](#)

Answer

Answers: Recurrence**10.15.1 Recurrence: GATE 2016-1-27** top<http://gateoverflow.in/39714>

Selected Answer

$$\begin{aligned}
 a_n &= 6n^2 + 2n + a_{n-1} \\
 &= 6n^2 + 2n + 6(n-1)^2 + 2(n-1) + a_{n-2} \\
 &= 6n^2 + 2n + 6(n-1)^2 + 2(n-1) + 6(n-2)^2 + 2(n-2) + \dots + a_1 \\
 &= 6n^2 + 2n + 6(n-1)^2 + 2(n-1) + 6(n-2)^2 + 2(n-2) + \dots + 6 \cdot 1^2 + 2 \cdot 1 \\
 &= 6(n^2 + (n-1)^2 + \dots + 2^2 + 1^2) + 2(n + (n-1) + \dots + 2 + 1) \\
 &= 6 \times \frac{n(n+1)(2n+1)}{6} + 2 \times \frac{n(n+1)}{2} \\
 &= n(n+1)(2n+1) \\
 a_n &= 2n(n+1)^2 \\
 \text{for } n = 99 \quad a_{99} &= 2 \times 99 \times (99+1)^2 = 198 \times 10^4
 \end{aligned}$$

✍ 29 votes

-- Praveen Saini (38.4k points)

10.15.2 Recurrence: GATE 2016-1-2 top<http://gateoverflow.in/39636>

Selected Answer

| n | n-bit strings that do NOT contain consecutive 11 | a_n | those contain 11 |
|-----|---|-----------|-------------------------|
| 1 | {0, 1} | $a_1 = 2$ | - |
| 2 | {00, 01, 10} | $a_2 = 3$ | {11} |
| 3 | {000, 001, 010, 100, 101} | $a_3 = 5$ | {011, 110, 111} |

$$a_n = a_{n-1} + a_{n-2}$$

Rest of the options are already out.

Alternatively, we can get a string in a_n by appending "0" to any string in a_{n-1} as well as by appending "01" to any string in a_{n-2} and the two cases are mutually exclusive (no common strings) as well as exhaustive (covers all cases).

18 votes

-- Praveen Saini (38.4k points)

10.16

Relations top

10.16.1 Relations: GATE1998_1.33 top

<http://gateoverflow.in/1670>

Given two union compatible relations $R_1(A, B)$ and $R_2(C, D)$, what is the result of the operation $R_1 \bowtie_{A=C \wedge B=D} R_2$?

- A. $R_1 \cup R_2$
- B. $R_1 \times R_2$
- C. $R_1 - R_2$
- D. $R_1 \cap R_2$

gate1998 | set-theory&algebra | relations | normal | relational-algebra

Answer

10.16.2 Relations: GATE1997_6.3 top

<http://gateoverflow.in/2259>

The number of equivalence relations of the set $\{1, 2, 3, 4\}$ is

- A. 15
- B. 16
- C. 24
- D. 4

gate1997 | set-theory&algebra | relations | normal

Answer

10.16.3 Relations: GATE2004-IT_4 top

<http://gateoverflow.in/3645>

Let R_1 be a relation from $A = \{1, 3, 5, 7\}$ to $B = \{2, 4, 6, 8\}$ and R_2 be another relation from B to $C = \{1, 2, 3, 4\}$ as defined below:

- i. An element x in A is related to an element y in B (under R_1) if $x + y$ is divisible by 3.
- ii. An element x in B is related to an element y in C (under R_2) if $x + y$ is even but not divisible by 3.

Which is the composite relation R_1R_2 from A to C ?

- A) $R_1R_2 = \{(1, 2), (1, 4), (3, 3), (5, 4), (7, 3)\}$
- B) $R_1R_2 = \{(1, 2), (1, 3), (3, 2), (5, 2), (7, 3)\}$
- C) $R_1R_2 = \{(1, 2), (3, 2), (3, 4), (5, 4), (7, 2)\}$
- D) $R_1R_2 = \{(3, 2), (3, 4), (5, 1), (5, 3), (7, 1)\}$

gate2004-it | set-theory&algebra | relations | normal

Answer

10.16.4 Relations: GATE 2016-2-26 [top](#)<http://gateoverflow.in/39603>

A binary relation R on $\mathbb{N} \times \mathbb{N}$ is defined as follows: $(a, b)R(c, d)$ if $a \leq c$ or $b \leq d$. Consider the following propositions:

P: R is reflexive.

Q: R is transitive.

Which one of the following statements is **TRUE**?

- A. Both P and Q are true.
- B. P is true and Q is false.
- C. P is false and Q is true.
- D. Both P and Q are false.

[gate2016-2](#) [set-theory&algebra](#) [relations](#) [normal](#)

Answer

10.16.5 Relations: GATE1995_1.19 [top](#)<http://gateoverflow.in/2606>

Let R be a symmetric and transitive relation on a set A . Then

- A. R is reflexive and hence an equivalence relation
- B. R is reflexive and hence a partial order
- C. R is reflexive and hence not an equivalence relation
- D. None of the above

[gate1995](#) [set-theory&algebra](#) [relations](#) [normal](#)

Answer

10.16.6 Relations: GATE1997_14 [top](#)<http://gateoverflow.in/2274>

Let R be a reflexive and transitive relation on a set A . Define a new relation E on A as

$$E = \{(a, b) \mid (a, b) \in R \text{ and } (b, a) \in R\}$$

1. Prove that E is an equivalence relation on A .
2. Define a relation \leq on the equivalence classes of E as $E_1 \leq E_2$ if $\exists a, b$ such that $a \in E_1, b \in E_2$ and $(a, b) \in R$. Prove that \leq is a partial order.

[gate1997](#) [set-theory&algebra](#) [relations](#) [normal](#)

Answer

10.16.7 Relations: GATE1996_8 [top](#)<http://gateoverflow.in/2760>

Let F be the collection of all functions $f : \{1, 2, 3\} \rightarrow \{1, 2, 3\}$. If f and $g \in F$, define an equivalence relation \sim by $f \sim g$ if and only if $f(3) = g(3)$.

- a. Find the number of equivalence classes defined by \sim .
- b. Find the number of elements in each equivalence class.

[gate1996](#) [set-theory&algebra](#) [relations](#) [functions](#) [normal](#)
Answer

10.16.8 Relations: GATE1999_1.2 [top](#)

<http://gateoverflow.in/1456>

The number of binary relations on a set with n elements is:

- A. n^2
- B. 2^n
- C. 2^{n^2}
- D. None of the above

[gate1999](#) [set-theory&algebra](#) [relations](#) [combinatory](#) [easy](#)
Answer

10.16.9 Relations: GATE2015-2_16 [top](#)

<http://gateoverflow.in/8089>

Let R be the relation on the set of positive integers such that aRb if and only if a and b are distinct and let have a common divisor other than 1. Which one of the following statements about R is true?

- A. R is symmetric and reflexive but not transitive
- B. R is reflexive but not symmetric not transitive
- C. R is transitive but not reflexive and not symmetric
- D. R is symmetric but not reflexive and not transitive

[gate2015-2](#) [set-theory&algebra](#) [relations](#) [normal](#)
Answer

10.16.10 Relations: GATE1996_2.2 [top](#)

<http://gateoverflow.in/2731>

Let R be a non-empty relation on a collection of sets defined by ARB if and only if $A \cap B = \emptyset$. Then, (pick the true statement)

- A. R is reflexive and transitive
- B. R is symmetric and not transitive
- C. R is an equivalence relation
- D. R is not reflexive and not symmetric

[gate1996](#) [set-theory&algebra](#) [relations](#) [normal](#)
Answer

10.16.11 Relations: GATE2000-2.5 [top](#)

<http://gateoverflow.in/652>

A relation R is defined on the set of integers as xRy iff $(x+y)$ is even. Which of the following statements is true?

- A. R is not an equivalence relation
- B. R is an equivalence relation having 1 equivalence class
- C. R is an equivalence relation having 2 equivalence classes
- D. R is an equivalence relation having 3 equivalence classes

[gate2000](#) [set-theory&algebra](#) [relations](#) [normal](#)

Answer**10.16.12 Relations: GATE2015-3_41** [top](#)<http://gateoverflow.in/8500>

Let R be a relation on the set of ordered pairs of positive integers such that $((p, q), (r, s)) \in R$ if and only if $p - s = q - r$. Which one of the following is true about R ?

- A. Both reflexive and symmetric
- B. Reflexive but not symmetric
- C. Not reflexive but symmetric
- D. Neither reflexive nor symmetric

[gate2015-3](#) [set-theory&algebra](#) [relations](#) [normal](#)**Answer****10.16.13 Relations: GATE1998_1.6** [top](#)<http://gateoverflow.in/1643>

Suppose A is a finite set with n elements. The number of elements in the largest equivalence relation of A is

- (a) n
- (b) n^2
- (c) 1
- (d) $n + 1$

[gate1998](#) [set-theory&algebra](#) [relations](#) [easy](#)**Answer****10.16.14 Relations: GATE1998_1.7** [top](#)<http://gateoverflow.in/1644>

Let R_1 and R_2 be two equivalence relations on a set. Consider the following assertions:

- i. $R_1 \cup R_2$ is an equivalence relation
- ii. $R_1 \cap R_2$ is an equivalence relation

Which of the following is correct?

- A. Both assertions are true
- B. Assertions (i) is true but assertions (ii) is not true
- C. Assertions (ii) is true but assertions (i) is not true
- D. Neither (i) nor (ii) is true

[gate1998](#) [set-theory&algebra](#) [relations](#) [normal](#)**Answer****10.16.15 Relations: GATE1999_3** [top](#)<http://gateoverflow.in/1522>

- a. Mr. X claims the following:

If a relation R is both symmetric and transitive, then R is reflexive. For this, Mr. X offers the following proof:

"From xRy , using symmetry we get yRx . Now because R is transitive xRy and yRx together imply xRx . Therefore, R is reflexive".

- b. Give an example of a relation R which is symmetric and transitive but not reflexive.

[gate1999](#) [set-theory&algebra](#) [relations](#) [normal](#)
Answer

Answers: Relations

10.16.1 Relations: GATE1998_1.33 [top](#)

<http://gateoverflow.in/1670>


Selected Answer

The join here will be selecting only those tuples where A = C and B = D, meaning it is the intersection. D option.

拇指图标 2 votes

-- Arjun Suresh (150k points)

10.16.2 Relations: GATE1997_6.3 [top](#)

<http://gateoverflow.in/2259>


Selected Answer

Ans A. no. of equivalence relations = no. of partition set possible = 1 (all four elements) + 3(2 + 2 elements partition) + 4(3 + 1 element partition) + 6 (2 + 1 + 1 element partition) + 1 (1 + 1 + 1 + 1 element partition) = 15

拇指图标 7 votes

-- Vikrant Singh (11k points)

10.16.3 Relations: GATE2004-IT_4 [top](#)

<http://gateoverflow.in/3645>


Selected Answer

Answer is C.

Explanation:

$R_1 = \{(1,2), (1,8), (3,6), (5,4), (7,2), (7,8)\}$

$R_2 = \{(2,2), (4,4), (6,2), (6,4), (8,2)\}$

So, $R_1 R_2 = \{(1,2), (3,2), (3,4), (5,4), (7,2)\}$

拇指图标 8 votes

-- chetna (471 points)

10.16.4 Relations: GATE 2016-2-26 [top](#)

<http://gateoverflow.in/39603>


Selected Answer

B) Reflexive, but not transitive.

its " $a \leq c$ **OR** $b \leq d$ ",

NOT

" $a \leq c$ AND $b \leq d$ "

(2,5) R (6, 3) R (1, 4),
but NOT (2,5) R (1, 4)

拇指图标 11 votes

-- Ashish Deshmukh (1.4k points)

10.16.5 Relations: GATE1995_1.19 [top](#)

<http://gateoverflow.in/2606>



Selected Answer

Answer: D

Let $A = \{(1,2), (2,1), (1,1)\}$ A is symmetric and transitive but not reflexive as $(2,2)$ is not there.

4 votes

-- Rajarshi Sarkar (29.7k points)

10.16.6 Relations: GATE1997_14 [top](#)<http://gateoverflow.in/2274>

1. since it is given that relation R is reflexive and transitive...and the new defined relation is the definition of symmetric only

so it is reflexive, symmetric and transitive => equivalence.

2

partial order is a binary relation " \leq " over a set P which is reflexive, antisymmetric, and transitive

- $a \leq a$ (reflexivity);
- if $a \leq b$ and $b \leq a$, then $a = b$ (antisymmetry);
- if $a \leq b$ and $b \leq c$, then $a \leq c$ (transitivity).

0 votes

-- asutosh kumar Biswal (5.9k points)

10.16.7 Relations: GATE1996_8 [top](#)<http://gateoverflow.in/2760>

Selected Answer

Total number of functions = $3 * 3 * 3 = 27$ as each of 1, 2, and 3 has 3 choice to map to.

Now, for the equivalence relation, we need the mapping of 3 to be fixed. So, with $3 \rightarrow 1$, we can get $3 * 3 = 9$ functions and similarly 9 each for $3 \rightarrow 2$ and $3 \rightarrow 3$.

a. So, total number of equivalence classes = 3, one each for $3 \rightarrow 1$, $3 \rightarrow 2$, and $3 \rightarrow 3$.

b. Number of elements in each equivalence class = 9.

5 votes

-- Arjun Suresh (150k points)

10.16.8 Relations: GATE1999_1.2 [top](#)<http://gateoverflow.in/1456>

Selected Answer

Answer: C

In a binary relation two elements are chosen from the set. So, with n elements n^2 pairings are possible. Now, a relation can be any subset of these n^2 pairings and thus we get 2^{n^2} binary relations.

5 votes

-- Rajarshi Sarkar (29.7k points)

10.16.9 Relations: GATE2015-2_16 [top](#)<http://gateoverflow.in/8089>

Selected Answer

Answer: D

Take (3, 6) and (6, 2) elements of R. For transitivity (3, 2) must be element of R, but 3 and 2 don't have a common divisor and hence not in R.

For any positive integer n, (n, n) is not element of R as only distinct m and n are allowed for (m, n) in R. So, not reflexive also.

12 votes

-- Rajarshi Sarkar (29.7k points)

10.16.10 Relations: GATE1996_2.2 [top](#)

<http://gateoverflow.in/2731>



Selected Answer

Let A = {1,2,3} and B = {4,5} and C = {1,6,7}

now $A \cap B = \emptyset$ and $B \cap C = \emptyset$ but $A \cap C \neq \emptyset$, so

R is non transitive.

$A \cap A = A$, so

R is not reflexive.

$A \cap B = B \cap A$, so

R is symmetric

so A is false as

R is not reflexive or transitive

B is true

C is false because

R is not transitive or reflexive

D is false because

R is symmetric

6 votes

-- akash (795 points)

10.16.11 Relations: GATE2000-2.5 [top](#)

<http://gateoverflow.in/652>



Selected Answer

R is reflexive as $(x + x)$ is even for any integer.

R is symmetric as if $(x + y)$ is even $(y + x)$ is also even.

R is transitive as if $(x + (y + z))$ is even, then $((x + y) + z)$ is also even.

So, R is an equivalence relation.

For set of natural numbers, sum of even numbers always give even, sum of odd numbers always give even and sum of any even and any odd number always give odd. So, R must have two equivalence classes -one for even and one for odd.

$\{\dots, -4, -2, 0, 2, 4, \dots\}, \{\dots, -3, -1, 1, 3, \dots\}$

C choice.

10 votes

-- Anu (9k points)

10.16.12 Relations: GATE2015-3_41 [top](#)

<http://gateoverflow.in/8500>



Selected Answer

The key trick here is to realize that the relation is of the form :

{ordered pair, ordered pair} and not simply ordered pair.

Ok, so for reflexive

$$\forall_{a,b} if((a,b),(a,b)) \in R \rightarrow \text{reflexive}$$

$((a,b),(a,b)) \in R \leftrightarrow (a-b = b-a)$ (not possible for any positive integers b and a)

but that is a contradiction hence it is not reflexive.

now, for symmetric

$$((a,b),(c,d)) \in R \rightarrow ((c,d),(a,b)) \in R$$

$$((a,b),(c,d)) \in R \rightarrow (a-d = b-c)$$

$$((c,d),(a,b)) \in R \because (c-b = d-a) \leftrightarrow (d-a = c-b) \leftrightarrow (-a+d) = -(b-c) \leftrightarrow (a-d = b-c)$$

so it is symmetric.

hence **C is the correct option.**

18 votes

-- Tamojit Chatterjee (1.9k points)

10.16.13 Relations: GATE1998_1.6 top

<http://gateoverflow.in/1643>



Selected Answer

Ans B.

The largest equivalence relation will be when every element is related to every other element. So, $n \times n = n^2$ possible ordered pairs.

5 votes

-- Keith Kr (6k points)

10.16.14 Relations: GATE1998_1.7 top

<http://gateoverflow.in/1644>



Selected Answer

Answer: C

R1 intersection R2 is equivalence relation..

R1 union R2 is not equivalence relation because transitivity needn't hold. For example, (a, b) can be in R1 and (b, c) be in R2 and (a, c) not in either R1 or R2.

7 votes

-- Digvijay (35.8k points)

10.16.15 Relations: GATE1999_3 top

<http://gateoverflow.in/1522>



Selected Answer

Let set A be $\{1,2,3\}$, and let a relation R on A be

$$R = \{(1,1), (1,2), (2,1)\}$$

R is both symmetric and transitive, but not reflexive. The key point here is that there may be some element in set A which is not related to any of the elements in R, but to be reflexive, all elements must be related to themselves.

9 votes

-- Happy Mittal (9.5k points)

10.17

Ring top10.17.1 Ring: GATE2010-4 top<http://gateoverflow.in/1150>

Consider the set $S = \{1, \omega, \omega^2\}$, where ω and ω^2 are cube roots of unity. If $*$ denotes the multiplication operation, the structure $(S, *)$ forms

- A. A Group
- B. A Ring
- C. An integral domain
- D. A field

[gate2010](#) [set-theory&algebra](#) [normal](#) [ring](#) [groups](#)

Answer

Answers: Ring

10.17.1 Ring: GATE2010-4 top<http://gateoverflow.in/1150>

Selected Answer

Answer: A

Cayley Table

| | 1 | ω | ω^2 |
|------------|------------|------------|------------|
| 1 | 1 | ω | ω^2 |
| ω | ω | ω^2 | 1 |
| ω^2 | ω^2 | 1 | ω |

The structure $(S, *)$ satisfies closure property, associativity, commutativity. The structure also has an identity element (i.e. 1) and an inverse for each element. So, the structure is an abelian group.

8 votes

-- Rajarshi Sarkar (29.7k points)

10.18

Sequence top10.18.1 Sequence: GATE2007-IT_76 top<http://gateoverflow.in/3528>

Consider the sequence $\langle x_n \rangle, n \geq 0$ defined by the recurrence relation $x_{n+1} = c \cdot x_n^2 - 2$, where $c > 0$.

Suppose there exists a **non-empty, open** interval (a, b) such that for all x_0 satisfying $a < x_0 < b$, the sequence converges to a limit. The sequence converges to the value?

- A) $\frac{1 + \sqrt{1 + 8c}}{2c}$
- B) $\frac{1 - \sqrt{1 + 8c}}{2c}$
- C) $\frac{2}{c}$
- D) $\frac{2}{2c - 1}$

[gate2007-it](#) [set-theory&algebra](#) [normal](#) [recurrence](#) [sequence](#)
[Answer](#)

Answers: Sequence

10.18.1 Sequence: GATE2007-IT_76 [top](#)

<http://gateoverflow.in/3528>


Selected Answer

Since it converges, we can write:

$$x = cx^2 - 2$$

or

$$cx^2 - x - 2 = 0$$

Solving for x:

$$x = \frac{1 \pm \sqrt{1 + 8c}}{2c}$$

So both A) and B) can be the values.

5 votes

-- Ashis Kumar Sahoo (797 points)

10.19

Sets [top](#)

10.19.1 Sets: GATE2015-2_18 [top](#)

<http://gateoverflow.in/8092>

The cardinality of the power set of $\{0, 1, 2, \dots, 10\}$ is _____

[gate2015-2](#) [set-theory&algebra](#) [sets](#) [easy](#)
[Answer](#)

10.19.2 Sets: TIFR2011-A-10 [top](#)

<http://gateoverflow.in/20039>

Let m, n denote two integers from the set $\{1, 2, \dots, 10\}$. The number of ordered pairs (m, n) such that $2^m + 2^n$ is divisible by 5 is.

- a. 10
- b. 14
- c. 24
- d. 8
- e. None of the above.

[tifr2011](#) [set-theory&algebra](#) [sets](#)
[Answer](#)

10.19.3 Sets: TIFR2010-A-18 [top](#)

<http://gateoverflow.in/18496>

Let X be a set of size n . How many pairs of sets (A, B) are there that satisfy the condition $A \subseteq B \subseteq X$?

- a. 2^{n+1}
- b. 2^{2n}
- c. 3^n
- d. $2^n + 1$
- e. 3^{n+1}

tifr2010 sets

Answer

10.19.4 Sets: TIFR2010-A-15 top<http://gateoverflow.in/18394>

Let A, B be sets. Let \bar{A} denote the complement of set A (with respect to some fixed universe), and $(A - B)$ denote the set of elements in A which are not in B . Set $(A - (A - B))$ is equal to:

- B
- $A \cap \bar{B}$
- $A - B$
- $A \cap B$
- \bar{B}

tifr2010 set-theory&algebra sets

Answer

10.19.5 Sets: GATE2015-3_23 top<http://gateoverflow.in/8426>

Suppose U is the power set of the set $S = \{1, 2, 3, 4, 5, 6\}$. For any $T \in U$, let $|T|$ denote the number of elements in T and T' denote the complement of T . For any $T, R \in U$ let $T \setminus R$ be the set of all elements in T which are not in R . Which one of the following is true?

- $\forall X \in U, (|X| = |X'|)$
- $\exists X \in U, \exists Y \in U, (|X| = 5, |Y| = 5 \text{ and } X \cap Y = \emptyset)$
- $\forall X \in U, \forall Y \in U, (|X| = 2, |Y| = 3 \text{ and } X \setminus Y = \emptyset)$
- $\forall X \in U, \forall Y \in U, (X \setminus Y = Y' \setminus X')$

gate2015-3 set-theory&algebra sets normal

Answer

10.19.6 Sets: GATE2001-3 top<http://gateoverflow.in/744>

- Prove that powerset $(A \cap B) = \text{powerset}(A) \cap \text{powerset}(B)$
- Let $\text{sum}(n) = 0 + 1 + 2 + \dots + n$ for all natural numbers n . Give an induction proof to show that the following equation is true for all natural numbers m and n :

$$\text{sum}(m+n) = \text{sum}(m) + \text{sum}(n) + mn$$

gate2001 set-theory&algebra normal sets

Answer

10.19.7 Sets: GATE2015-1_16 top<http://gateoverflow.in/8238>

For a set A , the power set of A is denoted by 2^A . If $A = \{5, \{6\}, \{7\}\}$, which of the following options are TRUE?

- $\phi \in 2^A$
- $\phi \subseteq 2^A$
- $\{5, \{6\}\} \in 2^A$
- $\{5, \{6\}\} \subseteq 2^A$

- I and III only
- II and III only
- I, II and III only

D. I, II and IV only

gate2015-1 set-theory&algebra sets normal

Answer

Answers: Sets

10.19.1 Sets: GATE2015-2_18 [top](#)

<http://gateoverflow.in/8092>



Selected Answer

Answer: 2048

Number of elements in set = 11.

Therefore, cardinality of power set = $2^{11} = 2048$.

11 votes

-- Rajarshi Sarkar (29.7k points)

10.19.2 Sets: TIFR2011-A-10 [top](#)

<http://gateoverflow.in/2009>



Selected Answer

Ending in 2 : $\{2^1, 2^5, 2^9\}$

Ending in 4 : $\{2^2, 2^6, 2^{10}\}$

Ending in 6 : $\{2^4, 2^8\}$

Ending in 8 : $\{2^3, 2^7\}$

To make $2^m + 2^n$ divisible by 5, it must end in either a 0 or a 5.

Since $m, n > 1$, all numbers $2^m, 2^n$ are even. Since sum of even numbers is even, $2^m + 2^n$ cannot end in a 5

Thus, $2^m + 2^n$ must end in a 0

Possible ways to achieve a number ending with 0 are:

$$2^m + 2^n : \quad m \in \{1, 5, 9\}, \quad n \in \{3, 7\} \implies 3 \times 2 = 6 \text{ pairs}$$

$$2^m + 2^n : \quad m \in \{3, 7\}, \quad n \in \{1, 5, 9\} \implies 2 \times 3 = 6 \text{ pairs}$$

$$2^m + 2^n : \quad m \in \{2, 6, 10\}, \quad n \in \{4, 8\} \implies 3 \times 2 = 6 \text{ pairs}$$

$$2^m + 2^n : \quad m \in \{4, 8\}, \quad n \in \{2, 6, 10\} \implies 2 \times 3 = 6 \text{ pairs}$$

$$\text{Total} = 6 + 6 + 6 + 6 = 24 \text{ ordered pairs}$$

Thus, option c is correct.

7 votes

-- Pragy Agarwal (14.4k points)

10.19.3 Sets: TIFR2010-A-18 [top](#)

<http://gateoverflow.in/18496>



Selected Answer

Option C) i.e. 3^n must be the right answer.

It is given that there are n elements in the set X .

Consider an element p of set X .

What are the choices it will have,

- 1) Either it can be present in set A & set B both,
- 2) Or it can absent from set A & present in set B ,
- 3) Or it can be absent from both set A & set B .

but since it is given that A must be a subset of B , it is not possible that it can be present in A & absent from B .

So it each of the n elements of set X have 3 choices available.

So total choices available for formation of sets A & $B = 3^n$, which will give 3^n such different (A, B) pairs.

5 votes

-- Anurag Pandey (9.7k points)

10.19.4 Sets: TIFR2010-A-15 [top](#)

<http://gateoverflow.in/1834>



Selected Answer

$$\begin{aligned} (A - (A - B)) &= A \cap (A \cap B)' \quad \text{Since } A-B=A\cap B' \\ &= A \cap (A' \cup B) \quad \text{Since } (A \cap B)' = A' \cup B' \\ &= A \cap B \quad \text{Option D} \end{aligned}$$

4 votes

-- Umang Raman (11.3k points)

10.19.5 Sets: GATE2015-3_23 [top](#)

<http://gateoverflow.in/8426>



Selected Answer

Answer D

As X and $Y \in U$, X and Y are subsets of S

Option A is wrong consider $X=\{1,2\}$ therefore $X'=\{3,4,5,6\}$ $|X|=2$ and $|X'|=4$

Option B is wrong as any two possible subsets of S with 5 elements should have atleast 4 elements in common. Hence X intersection Y not null

Option C is wrong, consider $X=\{1,2\}$ $Y=\{3,4,5\}$ and $X \setminus Y=\{1,2\}$ which is not null

16 votes

-- overtomanu (1.1k points)

10.19.6 Sets: GATE2001-3 [top](#)

<http://gateoverflow.in/744>

proof by contradiction:

assume : $P(A \cap B) \neq P(A) \cap P(B)$

now,

```
A={1,2}
B={2,3}
P(A)={ empty set, {1}, {2}, {1,2} }
P(B)={ empty set, {3}, {2}, {3,2} }
A intersection B = {2}
P(A int B)={ empty set, {2} } = P(A) int P(B), which is contradicting our assumption.
therefore our assumption is wrong. hence the statement is proved.
```

1 votes

-- **jayendra** (6.6k points)

For question (a):

To prove $P(A \cap B) = P(A) \cap P(B)$ we should show that $P(A \cap B) \subseteq P(A) \cap P(B)$ and $P(A) \cap P(B) \subseteq P(A \cap B)$.

for first part:

let take some subset $X \subseteq A \cap B$ then $X \in P(A \cap B)$. Also $X \subseteq A \wedge X \subseteq B$, means $X \in P(A) \wedge X \in P(B)$. Again this proves that $X \in P(A) \cap P(B)$. This proves $P(A \cap B) \subseteq P(A) \cap P(B)$ (1)

for second part:

Take any X such that $X \subseteq A$ and $X \subseteq B$. This is $X \in P(A) \wedge X \in P(B)$. That means $X \in P(A) \cap P(B)$. Now also $X \subseteq (A \cap B)$. This also means that $X \in P(A \cap B)$. This proves $P(A) \cap P(B) \subseteq P(A \cap B)$ (2)

From result (1) and (2),

$$P(A) \cap P(B) = P(A \cap B)$$

For question (b):

$$\text{as obvious } sum(n) = \frac{n(n+1)}{2}$$

so for n=1

$$sum(1) = \frac{1(1+1)}{2} = 1, \text{ which is true.}$$

let assume that for n=n+m,

$$\begin{aligned} sum(m+n) &= sum(m) + sum(n) + mn \\ &= \frac{m(m+1)}{2} + \frac{n(n+1)}{2} + mn \\ &= \frac{(m+n)(m+n+1)}{2} \text{ is true.} \end{aligned}$$

then for n=m+n+1,

$$sum(m+n+1) = sum(m+n) + sum(1) + (m+n)*1$$

from above results,

$$\begin{aligned} sum(m+n+1) &= \frac{(m+n)(m+n+1)}{2} + 1 + (m+n) \\ &= \frac{(m+n+1)(m+n+2)}{2} \end{aligned}$$

is proved by mathematical induction.

1 votes

-- **Sheshang M. Ajwalia** (121 points)

10.19.7 Sets: GATE2015-1_16 [top](#)<http://gateoverflow.in/8238>

Selected Answer

Power set of A consists of all subsets of A and from the definition of a subset, \square is a subset of any set. So, I and II are TRUE.

5 and $\{6\}$ are elements of A and hence $\{5, \{6\}\}$ is a subset of A and hence an element of 2^A . An element of a set is never a subset of the set. For that the element must be inside a set- i.e., a singleton set containing the element is a subset of the set, but the element itself is not. Here, option IV is false. To make IV true we have to do as follows:

$\{5, \{6\}\}$ is an element of 2^A . So, $\{ \{5, \{6\}\} \} \subseteq 2^A$.

So, option C.

22 votes

-- Arjun Suresh (150k points)

10.20**Time Complexity** [top](#)**10.20.1 Time Complexity: GATE2005_7** [top](#)<http://gateoverflow.in/1349>

The time complexity of computing the transitive closure of a binary relation on a set of n elements is known to be:

- A. $O(n)$
- B. $O(n \log n)$
- C. $O\left(n^{\frac{3}{2}}\right)$
- D. $O(n^3)$

[gate2005](#) [set-theory&algebra](#) [normal](#) [time-complexity](#)

Answer

Answers: Time Complexity**10.20.1 Time Complexity: GATE2005_7** [top](#)<http://gateoverflow.in/1349>

Selected Answer

Answer D

Calculating Transitive Closure boils down To Matrix Multiplication.

We can do Matrix Multiplication in $O(n^3)$. There are better algo that do less than cubic time , but we can not surely do matrix multiplication in

- A) $O(N)$
- B) $O(N \log n)$
- C) $O(N^{1.5})$

6 votes

-- Akash (31.7k points)

11 Engineering Mathematics

Calculus (50)

[top](#)

11.0.1 Gate mathematics [top](#)

<http://gateoverflow.in/41570>

The function $y = |2 - 3x|$

- a) is continuous $\forall x \in \mathbb{R}$ and differentiable $\forall x \in \mathbb{R}$
- b) is continuous $\forall x \in \mathbb{R}$ and differentiable $\forall x \in \mathbb{R}$ except at $x = 3/2$
- c) is continuous $\forall x \in \mathbb{R}$ and differentiable $\forall x \in \mathbb{R}$ except at $x = 2/3$
- d) is continuous $\forall x \in \mathbb{R}$ except $x = 3$ and differentiable $\forall x \in \mathbb{R}$

[calculus](#) [gate](#) [engineering-mathematics](#)

[Answer](#)

11.0.2 GATE2014-1_46 [top](#)

<http://gateoverflow.in/1924>

The function $f(x) = x \sin x$ satisfies the following equation:

$$f''(x) + f(x) + t \cos x = 0$$

. The value of
 t is _____.

[gate2014-1](#) [calculus](#) [easy](#) [numerical-answers](#)

[Answer](#)

11.0.3 GATE1995_25 [top](#)

<http://gateoverflow.in/2664>

- a. Find the minimum value of $3 - 4x + 2x^2$.
- b. Determine the number of positive integers (≤ 720) which are not divisible by any of 2, 3 or 5.

[gate1995](#) [calculus](#) [normal](#)

[Answer](#)

11.0.4 GATE1993_01.5 [top](#)

<http://gateoverflow.in/262>

Fourier series of the periodic function (period 2π) defined by

$$f(x) = \begin{cases} 0, & -\pi < x < 0 \\ x, & 0 < x < \pi \end{cases} \text{ is } \frac{\pi}{4} + \sum \left[\frac{1}{\pi n^2} (\cos n\pi - 1) \cos nx - \frac{1}{n} \cos n\pi \sin nx \right]$$

But putting $x = \pi$, we get the sum of the series

$$1 + \frac{1}{3^2} + \frac{1}{5^2} + \frac{1}{7^2} + \dots \text{ is}$$

- A. $\frac{\pi^2}{4}$
- B. $\frac{\pi^2}{6}$

- C. $\frac{\pi^2}{8}$
 D. $\frac{\pi^2}{12}$

gate1993 calculus normal

Answer

11.0.5 GATE1995_1.21 top

<http://gateoverflow.in/2608>

In the interval $[0, \pi]$ the equation $x = \cos x$ has

- A. No solution
- B. Exactly one solution
- C. Exactly two solutions
- D. An infinite number of solutions

gate1995 calculus normal

Answer

11.0.6 TIFR2012-A-14 top

<http://gateoverflow.in/25037>

The limit $\lim_{n \rightarrow \infty} (\sqrt{n^2 + n} - n)$ equals.

- a. ∞
- b. 1
- c. 1/2
- d. 0
- e. None of the above.

tifr2012 calculus

Answer

11.0.7 TIFR2012-A-12 top

<http://gateoverflow.in/25035>

For the polynomial $p(x) = 8x^{10} - 7x^3 + x - 1$ consider the following statements (which may be true or false)

- (i) It has a root between [0, 1].
- (ii) It has a root between [0, -1].
- (iii) It has no roots outside (-1, 1).

Which of the above statements are true?

- a. Only (i).
- b. Only (i) and (ii).
- c. Only (i) and (iii).
- d. Only (ii) and (iii).
- e. All of (i), (ii) and (iii).

tifr2012 calculus

Answer

11.0.8 TIFR 2015 Part A-11 top

<http://gateoverflow.in/28905>

Suppose $f(x)$ is a continuous function such that $0.4 \leq f(x) \leq 0.6$ for $0 \leq x \leq 1$. Which of the following is always true?

- a) $f(0.5)=0.5$
- b) There exists x between 0 and 1 such that $f(x)=0.8x$
- c) There exists x between 0 and 0.5 such that $f(x)=x$
- d) $f(0.5)>0.5$
- e) None of the above statements are always true

answer given is b)

How do we evaluate such ques?

tifr 2015

[Answer](#)

11.0.9 GATE 2016-2-02 [top](#)

<http://gateoverflow.in/39571>

Let $f(x)$ be a polynomial and $g(x) = f'(x)$ be its derivative. If the degree of $(f(x) + f(-x))$ is 10, then the degree of $(g(x) - g(-x))$ is _____.

gate2016-2 calculus normal numerical-answers

[Answer](#)

Answers:

11.0.1 Gate mathematics [top](#)

<http://gateoverflow.in/41570>

The function $|2-3x|$ is continuous $\forall x \in \mathbb{R}$ except at $x=2/3$ as if $x > 2/3$ (i.e. in RHL case) then function will become $f(x) = 2-3x$

if $x < 2/3$ (i.e. in LHL case) then function will become $f(x) = 3x-2$. Now, if you put any value of $x \in \mathbb{R}$ in these equation you will always get some value i.e. function is continuous for LHL and RHL both.

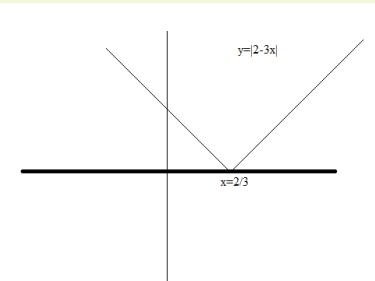
For differentiability, for LHL (Left Hand Limit) i.e. if $x < 2/3$ then value of function at which min/max occur will be 3 and for RHL (Right Hand Limit) for $x > 2/3$ the value of function at which min/max occur will be -3.

Since both are different values hence, function cannot be differentiable at $x=2/3$

Hence, option C is the answer.

1 votes

-- Ashish Gupta (671 points)



We can say from the above graph of function $y = |2-3x|$ that it is continuous for all real x but not differentiable at $x=2/3$ as its graph is making sharp corner at this point.

At $x = 2/3$

LHD = -3 and RHD = 3 which are not equal so not differentiable at $x=2/3$.

1 votes

-- vijaycs (10.7k points)

11.0.2 GATE2014-1_46 [top](#)

<http://gateoverflow.in/1924>



Selected Answer

$$f'(x) = x \cos(x) + \sin(x)$$

$$f''(x) = x(-\sin x) + \cos x + \cos x$$

$$\text{now } f''(x) + f(x) + t \cos x = 0 \implies x(-\sin x) + \cos x + \cos x + x \sin x + t \cos x = 0$$

$$\implies 2 \cos x + t \cos x = 0$$

$$\implies \cos x(t+2) = 0$$

$$\implies t+2=0, t=-2$$

6 votes

-- SAKET NANDAN (2.2k points)

11.0.3 GATE1995_25 [top](#)

<http://gateoverflow.in/2664>



Selected Answer

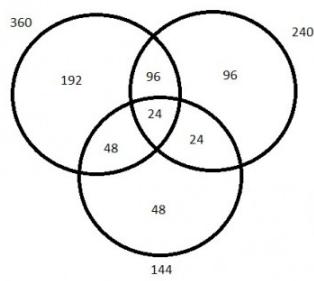
$$f(x) = 3 - 4x + 2x^2$$

$$f'(x) = -4 + 4x = 0 \implies x=1$$

$$f''(x) = 4$$

$f'(1) = 4 > 0$, therefore at $x=1$ we will get minimum value, which is : $3 - 4(1) + 2(1)^2 = 1$

ans for B:



total = 720
div by 2 or 3 or 5 = 528
not divisible = 192

6 votes

-- jayendra (6.6k points)

11.0.4 GATE1993_01.5 [top](#)

<http://gateoverflow.in/262>

First of all, Fourier series of given function is calculated wrong here.

Refer This :

The Fourier coefficients are

$$\begin{aligned} a_0 &= \frac{1}{\pi} \int_0^\pi x dx = \frac{1}{\pi} \frac{\pi^2}{2} = \frac{\pi}{2}, \\ a_n &= \frac{1}{\pi} \int_0^\pi x \cos(nx) dx = \frac{1}{\pi} \left[\frac{1}{n} \sin(nx)x \Big|_{x=0}^\pi - \frac{1}{n} \int_0^\pi \sin nx dx \right] \\ &= \frac{1}{\pi} \left[\frac{1}{n^2} \cos nx \Big|_{x=0}^\pi \right] = \frac{\cos(n\pi) - 1}{\pi n^2} = \frac{(-1)^n - 1}{\pi n^2} \\ b_n &= \frac{1}{\pi} \int_0^\pi x \sin(nx) dx = \frac{1}{\pi} \left[-\frac{1}{n} \cos(nx)x \Big|_{x=0}^\pi + \frac{1}{n} \int_0^\pi \cos(nx) dx \right] \\ &= \frac{1}{\pi} \left[-\frac{\pi}{n} \cos(n\pi) + \frac{1}{n^2} \sin(nx) \Big|_{x=0}^\pi \right] = -\frac{(-1)^n}{n} \end{aligned}$$

So the Fourier Series for f converges pointwise to

$$\frac{f(x+0) + f(x-0)}{2} = \frac{\pi}{4} + \sum_{n=1}^{\infty} \left(\frac{(-1)^n - 1}{\pi n^2} \cos(nx) - \frac{(-1)^n}{n} \sin(nx) \right)$$

At the endpoints of $[-\pi, \pi]$, the left and right limits at x are interpreted in terms of the periodic extension of f , which gives $\{f(-\pi+0) + f(\pi-0)\}/2 = \pi/2$. Evaluate at $x = \pi$:

$$\frac{\pi}{2} = \frac{f(\pi-0) + f(-\pi+0)}{2} = \frac{\pi}{4} + \sum_{n=1}^{\infty} \frac{(-1)^n - 1}{\pi n^2} (-1)^n = \frac{\pi}{4} + \frac{2}{\pi} \sum_{k=1}^{\infty} \frac{1}{(2k-1)^2}.$$

Solving for the sum,

$$\frac{\pi^2}{8} = \sum_{k=1}^{\infty} \frac{1}{(2k-1)^2}$$

0 votes

-- Rahul6991 (13 points)

11.0.5 GATE1995_1.21 top

<http://gateoverflow.in/2608>



Selected Answer

ans is B.

if you consider $x=0$ then $\cos x=1$

now if $x = \pi/4 = 0.785$ then $\cos x=0.7071$

for some x value $x=\cos x$

after this x is increasing and $\cos x$ is decreasing. so we can say exactly 1 solution.

4 votes

-- jayendra (6.6k points)

11.0.6 TIFR2012-A-14 top

<http://gateoverflow.in/25037>



Selected Answer

$$\begin{aligned}
 L &= \lim_{n \rightarrow \infty} \sqrt{n^2 + n} - n \\
 &= \lim_{n \rightarrow \infty} \left(\sqrt{n^2 + n} - n \right) \times \left(\frac{\sqrt{n^2 + n} + n}{\sqrt{n^2 + n} + n} \right) \\
 &= \lim_{n \rightarrow \infty} \frac{n^2 + n - n^2}{\sqrt{n^2 + n} + n} \\
 &= \lim_{n \rightarrow \infty} \frac{n}{n \left(\sqrt{1 + \frac{1}{n}} + 1 \right)} \\
 &= \lim_{n \rightarrow \infty} \frac{1}{\sqrt{1 + \frac{1}{n}} + 1} \\
 &= \frac{1}{\sqrt{1 + \frac{1}{\infty}} + 1} \\
 L &= \frac{1}{2}
 \end{aligned}$$

Hence, option C is the correct answer.

3 votes

-- Jagdish Singh (317 points)

11.0.7 TIFR2012-A-12 top

<http://gateoverflow.in/25035>

At $f(0)$ it is negative, at $f(1)$ it is positive, and at $f(-1)$ it is positive, which means there will be roots between $(0,1)$ and $(-1,0)$. Any values below -1 and above 1 will always yield positive values for $f(x)$, which means no roots available.

2 votes

-- Shaun Patel (5.8k points)

11.0.8 TIFR 2015 Part A-11 top

<http://gateoverflow.in/28905>

(A) $f(0.5)=0.5$, we **cannot say here $f(x)$ value always true** Because we need to know $f(x)$ value between $0.4 \leq f(x) \leq 0.6$, and here we are getting $f(x)$ value when $x=0.5$

(C) Here we know $f(x)$ value between 0 to 0.5. But when **$f(x)=0.6$, x value may be ≥ 1**

(D) Here also we cannot predict $f(x)$ value when $0.4 \leq f(x) \leq 0.6$

$f(0.5)>0.5$ is an **inequality**. So, we **cannot get any exact value of x**

Now for **(B)** Here we can see the $f(x)$ value $0.4 \leq f(x) \leq 0.6$ when x between 0 to 1

for eg: $f(0.5)=0.4$, where x value is 0.5

$f(0.6)=0.48$, where x value is 0.6

$f(0.7)=0.56$, where x value is 0.7

here we are only concern about $f(x)$ is between 0.4 and 0.6.

so, here value of **x always between $0 \leq x \leq 1$ when $0.4 \leq f(x) \leq 0.6$**

So, answer will be (B)

0 votes

-- srestha (27.8k points)

11.0.9 GATE 2016-2-02 [top](#)<http://gateoverflow.in/39571>

Selected Answer

9

F is some function where the largest even degree term is having degree 10. no restriction on odd degree terms.

since $f(x) + f(-x)$ = degree 10

even power gets converted to odd in derivative.

then the degree of required expression = 9.

the odd powers in F will become even in derivative and $G(X) - G(-X)$ retains only odd powers.

10 votes

-- viv696 (1.6k points)

11.1**Continuity** [top](#)**11.1.1 Continuity: GATE2013_22** [top](#)<http://gateoverflow.in/1533>

Which one of the following functions is continuous at $x = 3$?

$$(A) f(x) = \begin{cases} 2, & \text{if } x = 3 \\ x - 1 & \text{if } x > 3 \\ \frac{x+3}{3} & \text{if } x < 3 \end{cases}$$

$$(B) f(x) = \begin{cases} 4, & \text{if } x = 3 \\ 8 - x & \text{if } x \neq 3 \end{cases}$$

$$(C) f(x) = \begin{cases} x + 3, & \text{if } x \leq 3 \\ x - 4 & \text{if } x > 3 \end{cases}$$

$$(D) f(x) = \begin{cases} \frac{1}{x^3 - 27} & \text{if } x \neq 3 \end{cases}$$

[gate2013](#) [calculus](#) [continuity](#) [normal](#)

Answer

11.1.2 Continuity: GATE2015-2_26 [top](#)<http://gateoverflow.in/8124>

Let $f(x) = x^{-(1/3)}$ and A denote the area of region bounded by $f(x)$ and the X-axis, when x varies from -1 to 1. Which of the following statements is/are TRUE?

- I. f is continuous in $[-1, 1]$
- II. f is not bounded in $[-1, 1]$
- III. A is nonzero and finite

- A. II only
- B. III only
- C. II and III only
- D. I, II and III

[gate2015-2](#) [continuity](#) [functions](#) [normal](#)

Answer

11.1.3 Continuity: GATE2014-1_47 [top](#)

<http://gateoverflow.in/1925>

A function

$f(x)$ is continuous in the interval

$[0, 2]$. It is known that

$f(0) = f(2) = -1$ and

$f(1) = 1$. Which one of the following statements must be true?

(A) There exists a
 y in the interval
 $(0, 1)$ such that
 $f(y) = f(y + 1)$

(B) For every
 y in the interval
 $(0, 1)$,
 $f(y) =$
 $f(2 - y)$

(C) The maximum value of the function in the interval
 $(0, 2)$ is
1

(D) There exists a
 y in the interval
 $(0, 1)$ such that
 $f(y) =$
 $-f(2 - y)$

[gate2014-1](#) [calculus](#) [continuity](#) [normal](#)

[Answer](#)

Answers: Continuity

11.1.1 Continuity: GATE2013_22 [top](#)

<http://gateoverflow.in/1533>



Selected Answer

For continuity, Left hand limit must be equal to right hand limit. For continuity at $x = 3$, the value of $f(x)$ just above and just below 3 must be the same.

- A. $f(3) = 2$. $f(3+) = x - 1 = 2$. $f(3-) = (x+3)/3 = 6/3 = 2$. Hence continuous.
- B. $f(3) = 4$. $f(3+) = f(3-) = 8 - 3 = 5$. So, not continuous.
- C. $f(3) = f(3-) = x + 3 = 6$. $f(3+) = x - 4 = -1$. So, not continuous.
- D. $f(3)$ is not existing. So, not continuous.

13 votes

-- Arjun Suresh (150k points)

11.1.2 Continuity: GATE2015-2_26 [top](#)

<http://gateoverflow.in/8124>

Answer: C

I. False.

II. True.

III. True. An area is always positive, while the definite integral might be composed of several regions, some positive and some negative. A definite integral gets you the net area, because any part of the graph that is below the x-axis will give you a negative area. So, a definite integral is not necessarily the area under the curve, but the value of the area above the x-axis less the area under the x-axis. So, A is non-zero and finite.

5 votes

-- Rajarshi Sarkar (29.7k points)

11.1.3 Continuity: GATE2014-1_47 [top](#)<http://gateoverflow.in/1925>

Selected Answer

Let's define a new function g ,

$$g(y) = f(y) - f(y+1)$$

Since function f is continuous in $[0,2]$, therefore g would be continuous in $[0,1]$

$$g(0) = -2, g(1) = 2$$

since g is continuous and goes from negative to positive value in $[0,1]$. therefore at some point g would be 0 in $(0,1)$.

$$g=0 \Rightarrow f(y) = f(y+1) \text{ for some } y \text{ in } (0,1).$$

Therefore, correct answer would be (A).

14 votes

-- suraj (3.7k points)

11.2**Counting** [top](#)**11.2.1 Counting: GATE1995_7** [top](#)<http://gateoverflow.in/2642>

a. Determine the number of divisors of 600.

b. Compute without using power series expansion $\lim_{x \rightarrow 0} \frac{\sin x}{x}$

[gate1995](#) [calculus](#) [normal](#) [counting](#)

Answer

Answers: Counting**11.2.1 Counting: GATE1995_7** [top](#)<http://gateoverflow.in/2642>

Answer for Part A)

Prime factorization of 600 = $2^3 * 3 * 5^2$

Total no of divisors = $(3+1)(1+1)(2+1) = 4 * 2 * 3 = 24$ Divisors

Here we are choosing either 0, 1, 2 or 3 2's so $3 + 1 = 4$ choices for 2 & So on for all .

In case we do not choose any of above factor, we get 1 as divisor !

4 votes

-- Akash (31.7k points)

11.3**Differentiability** [top](#)**11.3.1 Differentiability: GATE2007_1** [top](#)<http://gateoverflow.in/1200>

Consider the following two statements about the function $f(x) = |x|$:

- P. $f(x)$ is continuous for all real values of x .
- Q. $f(x)$ is differentiable for all real values of x .

Which of the following is **TRUE**?

- (A) P is true and Q is false. (B) P is false and Q is true.
 (C) Both P and Q are true. (D) Both P and Q are false.

[gate2007](#) [calculus](#) [continuity](#) [differentiability](#) [easy](#)

[Answer](#)

11.3.2 Differentiability: GATE1996_3 [top](#)

<http://gateoverflow.in/2755>

Let f be a function defined by

$$f(x) = \begin{cases} x^2 & \text{for } x \leq 1 \\ ax^2 + bx + c & \text{for } 1 < x \leq 2 \\ x + d & \text{for } x > 2 \end{cases}$$

Find the values for the constants a , b , c and d so that f is continuous and differentiable everywhere on the real line.

[gate1996](#) [calculus](#) [continuity](#) [differentiability](#) [normal](#)

[Answer](#)

11.3.3 Differentiability: GATE1996_1.6 [top](#)

<http://gateoverflow.in/2710>

The formula used to compute an approximation for the second derivative of a function f at a point X_0 is

- A. $\frac{f(x_0+h)+f(x_0-h)}{2}$
 B. $\frac{f(x_0+h)-f(x_0-h)}{2h}$
 C. $\frac{f(x_0+h)+2f(x_0)+f(x_0-h)}{h^2}$
 D. $\frac{f(x_0+h)-2f(x_0)+f(x_0-h)}{h^2}$

[gate1996](#) [calculus](#) [differentiability](#) [normal](#)

[Answer](#)

11.3.4 Differentiability: GATE1998_1.4 [top](#)

<http://gateoverflow.in/1641>

Consider the function $y = |x|$ in the interval $[-1, 1]$. In this interval, the function is

- A. continuous and differentiable
 B. continuous but not differentiable
 C. differentiable but not continuous
 D. neither continuous nor differentiable

[gate1998](#) [calculus](#) [continuity](#) [differentiability](#) [easy](#)

[Answer](#)

Answers: Differentiability

11.3.1 Differentiability: GATE2007_1 [top](#)

<http://gateoverflow.in/1200>



Selected Answer

ans is A. $f(x) = |x|$ here for all values of x , $f(x)$ exists. therefore it is continuous for all real values of x .

At $x=0$, $f(x)$ is not differentiable. Because if we take the left hand limit here, it is negative while the right hand limit is positive.

Ref: <http://math.stackexchange.com/questions/991475/why-is-the-absolute-value-function-not-differentiable-at-x-0>

7 votes

-- jayendra (6.6k points)

11.3.2 Differentiability: GATE1996_3 [top](#)

<http://gateoverflow.in/2755>



Selected Answer

f is differentiable at 1 if

$$\lim_{h \rightarrow 0^-} \frac{f(1+h) - f(1)}{h} = \lim_{h \rightarrow 0^+} \frac{f(1+h) - f(1)}{h}$$

$$\Rightarrow 2 = 2a+b \quad (1)$$

f is differentiable at 2 if

$$\lim_{h \rightarrow 0^-} \frac{f(2+h) - f(2)}{h} = \lim_{h \rightarrow 0^+} \frac{f(2+h) - f(2)}{h}$$

$$\Rightarrow 4a+b = 1 \quad (2)$$

Solving (1) and (2), we get

$$a = -0.5, b = 3$$

Now f has to be continuous on 1 also, so

$$\lim_{x \rightarrow 1^-} f(x) = \lim_{x \rightarrow 1^+} f(x) = f(1)$$

$$\Rightarrow 1 = a + b + c$$

$$\Rightarrow c = -1.5$$

Similarly f has to be continuous on 2 also, so

$$\lim_{x \rightarrow 2^-} f(x) = \lim_{x \rightarrow 2^+} f(x) = f(2)$$

$$\Rightarrow 4a+2b+c = 2+d$$

$$\Rightarrow d = 0.5$$

$$\text{So } a = -0.5, b = 3, c = -1.5, d = 0.5$$

7 votes

-- Happy Mittal (9.5k points)

11.3.3 Differentiability: GATE1996_1.6 [top](#)

<http://gateoverflow.in/2700>



Selected Answer

Option D.

Ref: http://en.wikipedia.org/wiki/Second_derivative

3 votes

-- Arjun Suresh (150k points)

11.3.4 Differentiability: GATE1998_1.4 top<http://gateoverflow.in/1641>

Selected Answer

(b) It is continuous but not differentiable at $x=0$ as left hand limit will be negative while the right hand limit will be positive but for differentiation, both must be same.

5 votes

-- Gate_15_isHere (627 points)

11.4**Integration** top**11.4.1 Integration: TIFR2011-A-11** top<http://gateoverflow.in/2019>

$$\int_0^1 \ln x \, dx =$$

- a. 1
- b. -1
- c. ∞
- d. $-\infty$
- e. None of the above.

tifr2011 calculus integration

Answer

11.4.2 Integration: GATE2015-3_45 top<http://gateoverflow.in/8554>

If for non-zero x , $af(x) + bf(\frac{1}{x}) = \frac{1}{x} - 25$ where $a \neq b$ then $\int_1^2 f(x)dx$ is

- A. $\frac{1}{a^2-b^2} \left[a(\ln 2 - 25) + \frac{47b}{2} \right]$
- B. $\frac{1}{a^2-b^2} \left[a(2\ln 2 - 25) - \frac{47b}{2} \right]$
- C. $\frac{1}{a^2-b^2} \left[a(2\ln 2 - 25) + \frac{47b}{2} \right]$
- D. $\frac{1}{a^2-b^2} \left[a(\ln 2 - 25) - \frac{47b}{2} \right]$

gate2015-3 calculus integration normal

Answer

11.4.3 Integration: GATE2015-1_44 top<http://gateoverflow.in/8314>

Compute the value of:

$$\int_{\frac{1}{\pi}}^{\frac{2}{\pi}} \frac{\cos(1/x)}{x^2} dx$$

gate2015-1 calculus integration normal

Answer

11.4.4 Integration: GATE2005-IT_35 top<http://gateoverflow.in/3782>

What is the value of $\int_0^{2\pi} (x - \pi)^2 (\sin x) dx$

- | | |
|----|-------|
| A) | -1 |
| B) | 0 |
| C) | 1 |
| D) | π |

gate2005-it calculus integration normal

Answer

11.4.5 Integration: GATE2009-25 [top](#)

<http://gateoverflow.in/802>

$$\int_0^{\pi/4} (1 - \tan x) / (1 + \tan x) dx$$

- A. 0
- B. 1
- C. $\ln 2$
- D. $1/2 \ln 2$

gate2009 calculus integration normal

Answer

11.4.6 Integration: GATE2014-3_47 [top](#)

<http://gateoverflow.in/2081>

The value of the integral given below is

$$\int_0^{\pi} x^2 \cos x dx$$

- A. -2π
- B. π
- C. $-\pi$
- D. 2π

gate2014-3 calculus limits integration normal

Answer

11.4.7 Integration: GATE2014-3_6 [top](#)

<http://gateoverflow.in/2040>

If $\int_0^{2\pi} |x \sin x| dx = k\pi$, then the value of k is equal to _____.

gate2014-3 calculus integration limits numerical-answers easy

Answer

11.4.8 Integration: GATE2000-2.3 [top](#)

<http://gateoverflow.in/650>

Let $S = \sum_{i=3}^{100} i \log_2 i$, and

$$T = \int_2^{100} x \log_2 x dx.$$

Which of the following statements is true?

- A. $S > T$

- B. $S = T$
 C. $S < T$ and $2S > T$
 D. $2S \leq T$

gate2000 calculus integration normal

Answer

11.4.9 Integration: GATE1998_8 [top](#)

<http://gateoverflow.in/1722>

- (a) Find the points of local maxima and minima, if any, of the following function defined in $0 \leq x \leq 6$.

$$x^3 - 6x^2 + 9x + 15$$

- (b) Integrate

$$\int_{-\pi}^{\pi} x \cos x dx$$

gate1998 calculus maxima-minima integration normal

Answer

11.4.10 Integration: GATE2011_31 [top](#)

<http://gateoverflow.in/2133>

Given
 $i = \sqrt{-1}$, what will be the evaluation of the definite integral

$$\int_0^{\pi/2} \frac{\cos x + i \sin x}{\cos x - i \sin x} dx ?$$

- (A) 0
 (B) 2
 (C) $-i$
 (D) i

gate2011 calculus integration normal

Answer

Answers: Integration

11.4.1 Integration: TIFR2011-A-11 [top](#)

<http://gateoverflow.in/2029>

Use Integration by Parts

$$\int \ln(x) dx$$

set
 $u = \ln(x), dv = dx$
 then we find
 $du = (1/x) dx, v = x$

substitute

$$\int \ln(x) dx = \int u dv$$

and use integration by parts

$$= uv - \int v du$$

substitute $u = \ln(x)$, $v = x$, and $du = (1/x)dx$

$$\begin{aligned} &= \ln(x)x - \int x(1/x)dx \\ &= \ln(x)x - \int dx \\ &= \ln(x)x - x + C \\ &= x\ln(x) - x + C. \end{aligned}$$

Now Put Limits

$$[\ln(1)-1+C] - [0-0+C] = -1$$

3 votes

-- Sonu (1.5k points)

11.4.2 Integration: GATE2015-3_45 [top](#)

<http://gateoverflow.in/8554>



Selected Answer

$$af(x) + bf\left(\frac{1}{x}\right) = \frac{1}{x} - 25 \quad \dots (1)$$

Integrating both sides,

$$a \int_1^2 f(x)dx + b \int_1^2 f\left(\frac{1}{x}\right)dx = [\log(x) - 25x]_1^2 = \log 2 - 25 \quad \dots (2)$$

Replacing x by $\frac{1}{x}$ in (1), we get

$$af\left(\frac{1}{x}\right) + bf(x) = x - 25$$

Integrating both sides, we get

$$a \int_1^2 f\left(\frac{1}{x}\right)dx + b \int_1^2 f(x)dx = \left[\frac{x^2}{2} - 25x\right]_1^2 = -\frac{47}{2} \quad \dots (3)$$

Eliminate $\int_1^2 f\left(\frac{1}{x}\right)dx$ between (2) and (3) by multiplying (2) by a and (3) by b and subtracting

$$\therefore (a^2 - b^2) \int_1^2 f(x)dx = a(\log 2 - 25) + b \times \frac{47}{2}$$

$$\therefore \int_1^2 f(x)dx = \frac{1}{(a^2 - b^2)} \left[a(\log 2 - 25) + \frac{47b}{2} \right]$$

$$\text{Answer: A. } \frac{1}{(a^2 - b^2)} \left[a(\log 2 - 25) + \frac{47b}{2} \right]$$

14 votes

-- Shyam Singh (1.4k points)

11.4.3 Integration: GATE2015-1_44 [top](#)

<http://gateoverflow.in/8314>



Selected Answer

For the integrand $\frac{\cos(1/x)}{x^2}$, substitute $u = \frac{1}{x}$ and $du = -\frac{1}{x^2}dx$.

This gives a new lower bound $u = \frac{1}{1/\pi} = \pi$ and upper bound $u = \frac{1}{2/\pi} = \frac{\pi}{2}$. Now, our integral becomes:

$$I = - \int_{\pi}^{\pi/2} \cos(u) du$$

$$= \int_{\pi/2}^{\pi} \cos(u) du$$

Since the antiderivative of $\cos(u)$ is $\sin(u)$, applying the fundamental theorem of calculus, we get:

$$\begin{aligned} I &= \sin(u) \Big|_{\pi/2}^{\pi} \\ &= \sin(\pi) - \sin\left(\frac{\pi}{2}\right) \\ &= 0 - 1 \\ I &= -1 \end{aligned}$$

20 votes

-- Shyam Singh (1.4k points)

11.4.4 Integration: GATE2005-IT_35 top

<http://gateoverflow.in/3782>



Selected Answer

answer is (b)

Put $x - \pi = t$ then limit 0 changes to $-\pi$ and upper limit 2π changes to π .

$$\frac{d}{dx}(x - \pi) = dt \implies dx = dt$$

Integration of $t^2 \sin t dt$ for limit $-\pi$ to π . One is an odd function and one is even and product of odd and even functions is odd function and integrating an odd function from the same negative value to positive value gives 0.

3 votes

-- SAKET NANDAN (2.2k points)

11.4.5 Integration: GATE2009-25 top

<http://gateoverflow.in/802>



Selected Answer

Multiply and divide by $\cos(x)\sin(x)$

$$\begin{aligned} &= \int_0^{\pi/4} \frac{1 - 2 \cos x \sin x}{\cos 2x} \\ &= \int_0^{\pi/4} \frac{1 - \sin 2x}{\cos 2x} \\ &= \int_0^{\pi/4} \sec 2x - \tan 2x \\ &= \frac{1}{2} \ln |1 + \sin 2x| \\ &= \frac{1}{2} \ln 2. \end{aligned}$$

Answer is D.

2 votes

-- Sona Praneeth Akula (3.8k points)

11.4.6 Integration: GATE2014-3_47 [top](#)<http://gateoverflow.in/2081>

Selected Answer

ans is A

$$\int_0^\pi x^2 \cos x dx = x^2 \sin x + 2x \cos x - 2 \sin x = [\pi^2(0) - 0] + 2[\pi(-1) - 0] - 2[0 - 0] = -2\pi$$

7 votes

-- Keith Kr (6k points)

11.4.7 Integration: GATE2014-3_6 [top](#)<http://gateoverflow.in/2040>

Selected Answer

There is a mod term in the given integral. So, first we have to remove that. We know that x is always positive here and $\sin x$ is positive from 0 to π . From π to 2π , x is positive while $\sin x$ changes sign. So, we can write

$$\int_0^{2\pi} |x \sin x| dx = \int_0^\pi x \sin x dx + \left(- \int_\pi^{2\pi} x \sin x dx \right) = \int_0^\pi x \sin x dx - \int_\pi^{2\pi} x \sin x dx$$

$$\int_0^\pi u dv = uv - \int_0^\pi v du \text{ Here } u = x, du = dx, dv = \sin x dx, \text{ so } v = -\cos x \therefore \int_0^\pi x \sin x dx = [-x \cos x]_0^\pi + \int_0^\pi \cos x dx = \pi -$$

$$\text{So, given integral} = \pi - (-3\pi) = 4\pi$$

$$\text{So, k} = 4.$$

8 votes

-- Arjun Suresh (150k points)

11.4.8 Integration: GATE2000-2.3 [top](#)<http://gateoverflow.in/650>

Selected Answer

$x \log_2 x$ is a continuously increasing function, and for a continuously increasing function $f(x)$,

$$\sum_{x=a}^b f(x) > \int_a^b f(x) dx$$

But in question, summation of L.H.S. above, $a = 3$ and in R.H.S, $a = 2$, so we don't know whether $S > T$. So we compute some initial values :

$$\sum_{x=3}^4 x \log_2 x \approx 12.754, \text{ and } \int_2^4 x \log_2 x = 11$$

Since $\sum_{x=3}^4 x \log_2 x > \int_2^4 x \log_2 x$, and since we already know that

$$\sum_{x=5}^{100} x \log_2 x > \int_5^{100} x \log_2 x$$

$$\text{So } \sum_{x=3}^{100} x \log_2 x > \int_2^{100} x \log_2 x$$

So $S > T$, and option (A) is correct.

5 votes

-- Happy Mittal (9.5k points)

11.4.9 Integration: GATE1998_8 [top](#)<http://gateoverflow.in/1722>



Selected Answer

(a) $f(x) = x^3 - 6x^2 + 9x + 15$

so $f'(x) = 3x^2 - 12x + 9 = 0 \implies x = 1, 3$

Now $f''(x) = 6x - 12$

$f''(1) < 0$, so $x = 1$ is point of local maxima, $f''(3) > 0$, so $x = 3$ is point of local minima.

Also the end points 0 and 6 are critical points. 0 is point of local minima, because it is to the left of $x = 1$ (which is point of maxima). Similarly $x = 6$ is point of local maxima.

(b) Since $\int_0^6 x \cos x dx$ is an odd function, by the properties of definite integration, answer is 0.

Upvote 5 votes

-- Happy Mittal (9.5k points)

11.4.10 Integration: GATE2011_31 [top](#)

<http://gateoverflow.in/2133>



Selected Answer

Answer is D.

$$\int_0^{\frac{\pi}{2}} \frac{e^{ix}}{e^{-ix}} dx = \int_0^{\frac{\pi}{2}} e^{2ix} dx = \frac{e^{2ix}}{2i} \Big|_0^{\frac{\pi}{2}} = \frac{-2}{2i} = \frac{i^2}{i} = i.$$

Upvote 8 votes

-- Sona Praneeth Akula (3.8k points)

11.5

Limits [top](#)

11.5.1 Limits: TIFR2011-A-14 [top](#)

<http://gateoverflow.in/20224>

What is the value of the following limit?

$$\lim_{x \rightarrow 0} \frac{d}{dx} \frac{\sin^2 x}{x}$$

- a. 0
- b. 2
- c. 1
- d. $\frac{1}{2}$
- e. None of the above

tifr2011 calculus limits

Answer

11.5.2 Limits: GATE1993_02.1 [top](#)

<http://gateoverflow.in/605>

Q2). In questions 2.1 to 2.10 below, each blank (____) is to be suitably filled in. $\lim_{x \rightarrow 0} \frac{x(e^x - 1) + 2(\cos x - 1)}{x(1 - \cos x)}$ is _____

gate1993 limits calculus normal

Answer

11.5.3 Limits: TIFR2014-A-18 [top](#)<http://gateoverflow.in/27128>

We are given a collection of real numbers where a real number $a_i \neq 0$ occurs n_i times. Let the collection be enumerated as $\{x_1, x_2, \dots, x_n\}$ so that $x_1 = x_2 = \dots = x_{n1} = a_1$ and so on, and $n = \sum_i n_i$ is finite. What is

$$\lim_{k \rightarrow \infty} \left(\sum_{i=1}^n \frac{1}{|x_i|^k} \right)^{-1/k} ?$$

- A. $\max_i (n_i |a_i|)$
- B. $\min_i |a_i|$
- C. $\min_i (n_i |a_i|)$
- D. $\max_i |a_i|$
- E. None of the above.

[tifr2014](#) [limits](#)**Answer****11.5.4 Limits: TIFR2011-A-17** [top](#)<http://gateoverflow.in/20254>

What is the value of the following limit?

$$\lim_{x \rightarrow 0} \frac{2^x - 1}{x}$$

- a. 0
- b. $\log_2(e)$
- c. $\log_e(2)$
- d. 1
- e. None of the above.

[tifr2011](#) [limits](#)**Answer****11.5.5 Limits: TIFR2014-A-16** [top](#)<http://gateoverflow.in/27107>

Let $x_0 = 1$ and

$$x_{n+1} = \frac{3+2x_n}{3+x_n}, n \geq 0.$$

$x_\infty = \lim_{n \rightarrow \infty} x_n$ is

- A. $(\sqrt{5} - 1)/2$
- B. $(\sqrt{5} + 1)/2$
- C. $(\sqrt{13} - 1)/2$
- D. $(-\sqrt{13} - 1)/2$
- E. None of the above.

[tifr2014](#) [limits](#)**Answer****11.5.6 Limits: TIFR2010-A-7** [top](#)<http://gateoverflow.in/18234>

The limit of $10^n/n!$ as $n \rightarrow \infty$ is.

- A. 0
- B. 1
- C. e
- D. 10
- E. ∞

[tifr2010](#)
[calculus](#)
[limits](#)
[Answer](#)**11.5.7 Limits: GATE2010-5** [top](#)<http://gateoverflow.in/1151>

What is the value of $\lim_{n \rightarrow \infty} \left(1 - \frac{1}{n}\right)^{2n}$?

- A. 0
- B. e^{-2}
- C. $e^{-1/2}$
- D. 1

[gate2010](#)
[calculus](#)
[limits](#)
[normal](#)
[Answer](#)**11.5.8 Limits: GATE2015-3_9** [top](#)<http://gateoverflow.in/8403>

The value of $\lim_{x \rightarrow \infty} (1 + x^2)^{e^{-x}}$ is

- A. 0
- B. $\frac{1}{2}$
- C. 1
- D. ∞

[gate2015-3](#)
[calculus](#)
[limits](#)
[normal](#)
[Answer](#)**11.5.9 Limits: GATE2008-1** [top](#)<http://gateoverflow.in/399>

$\lim_{x \rightarrow \infty} \frac{x - \sin x}{x + \cos x}$ equals

- A. 1
- B. -1
- C. ∞
- D. $-\infty$

[gate2008](#)
[calculus](#)
[limits](#)
[easy](#)
[Answer](#)**11.5.10 Limits: GATE2015-1_4** [top](#)<http://gateoverflow.in/8021>

$\lim_{x \rightarrow \infty} x^{\frac{1}{x}}$ is

- A. ∞
- B. 0
- C. 1
- D. Not defined

[gate2015-1](#)
[calculus](#)
[limits](#)
[normal](#)
[Answer](#)**11.5.11 Limits: GATE 2016-1-3** [top](#)<http://gateoverflow.in/39630>

$$\lim_{x \rightarrow 4} \frac{\sin(x - 4)}{x - 4}$$

= _____.

gate2016-1 calculus limits easy numerical-answers

[Answer](#)

Answers: Limits

11.5.1 Limits: TIFR2011-A-14 [top](#)

<http://gateoverflow.in/20224>

$$\begin{aligned}
 1 - 2\sin^2(x) &= \cos(2x) \\
 d/dx ((1-\cos(2x))/2x) &= \{2x(2\sin(2x)) - (1-\cos 2x)(2)\}/4x^2 \\
 &= 4\sin(2x)/(4x) - (4\sin^2(x)/4x^2) \\
 &= 2\sin(2x)/2x - \sin^2(x)/x^2 \\
 \text{Lt } x \rightarrow 0 \text{ sin } x/x &= 1 \\
 \text{Lt } x \rightarrow 0 (2\sin(2x)/2x - \sin^2(x)/x^2) &= (2 \text{ Lt } x \rightarrow 0 \sin(2x)/2x - \text{Lt } x \rightarrow 0 (\sin x/x) \cdot \text{Lt } x \rightarrow 0 (\sin x/x)) \\
 &= 2 - 1 \\
 &= 1
 \end{aligned}$$

2 votes

-- zambus (169 points)

11.5.2 Limits: GATE1993_02.1 [top](#)

<http://gateoverflow.in/605>



Selected Answer

Use LH rule:

$$\text{First Derivative: } [x(e^x) + (e^x - 1) - 2(\sin x)]/[xs \in x + (1 - \cos x)]$$

$$\text{Second Derivative: } [xe^x + e^x + e^x - 2\cos x]/[\{x \cos x + \sin x + \sin x\}]$$

$$\text{Third Derivative: } [xe^x + e^x + e^x + e^x + 2\sin x]/[-xs \in x + \cos x + \cos x + \cos x]$$

$$\text{Put } x = 0: [0+1+1+1+0]/[0+1+1+1] = 3/3 = 1.$$

4 votes

-- Rajarshi Sarkar (29.7k points)

11.5.3 Limits: TIFR2014-A-18 [top](#)

<http://gateoverflow.in/27128>

we get 2 cases:

when k is even and k is odd.

k is even implies

sum of $(1/x(i))^k$ is always positive and has maximum value.

when k is odd, there might be negative values $x(i) < 0$;

now the total sum for all k, the sum results in its minimum value since $1/|x(i)|$ values will be subtracted when they are negative.

To find the value, it is given that all $x(n_i) = a(i)$.

therefor the sum results as $\text{pow}(\text{sum}(n(i)/a(i))^k, -1/k) = \text{pow}(\min(n(i)/a(i)), -1) = \max(n(i)/a(i))$.

Hence A.

0 votes

-- Vikranth Inti (239 points)

11.5.4 Limits: TIFR2011-A-17 [top](#)

<http://gateoverflow.in/20254>



Selected Answer

Since we have a $\frac{0}{0}$ form, we can apply the L'Hôpital's rule.

$$\begin{aligned} L &= \lim_{x \rightarrow 0} \frac{2^x - 1}{x} \\ &= \lim_{x \rightarrow 0} \frac{\frac{d}{dx}(2^x - 1)}{\frac{d}{dx}x} \\ &= \lim_{x \rightarrow 0} \frac{2^x \ln 2}{1} \\ &= \ln 2 \\ L &= \log_e(2) \end{aligned}$$

Hence, option c is correct.

7 votes

-- Pragy Agarwal (14.4k points)

11.5.5 Limits: TIFR2014-A-16 [top](#)

<http://gateoverflow.in/27107>

Answer : C,D

$x(n+1)=1+\{x(n)/(3+x(n))\}$

as n tends to infinity,

$x=1+1/(1+3/x)$

$=>x^2x+x-3=0$,

the roots are:

$(-1+\sqrt{13})/2, (-1-\sqrt{13})/2$.

Hence C,D

0 votes

-- Vikranth Inti (239 points)

11.5.6 Limits: TIFR2010-A-7 [top](#)

<http://gateoverflow.in/18234>



Selected Answer

$$\lim_{n \rightarrow \infty} \frac{10^n}{n!} = \overbrace{\frac{10 \times 10 \times 10 \times \dots \times 10 \times 10}{1 \times 2 \times 3 \times \dots \times (n-1) \times n}}^{n \text{ times}}$$

$$= \underbrace{\frac{10}{1} \cdot \frac{10}{2} \cdots \frac{10}{10}}^{\approx 2755} \cdot \underbrace{\frac{10}{11} \cdots \frac{10}{100} \cdot \frac{10}{101} \cdots}_{\ll 1} \underbrace{\frac{10}{10000} \cdot \frac{10}{10001} \cdots}_{\ll 1} \text{ goes forever}$$

Now we can see that after the $\frac{10}{10}$ term, all subsequent terms are < 1 , and keep decreasing. As we increase the value of n it the product will get close to 0.

So as $n \rightarrow \infty 10^n/n! \rightarrow 0$.

Hence, the answer is option a) 0

8 votes

-- sonam vyas (8.1k points)

11.5.7 Limits: GATE2010-5 top

<http://gateoverflow.in/1151>



Selected Answer

i will solve by two methods

method 1

$$y = \lim_{n \rightarrow \infty} (1 - 1/n)^{2n}$$

taking log

$$\log y = \lim_{n \rightarrow \infty} 2n \log(1 - 1/n)$$

$$= \lim_{n \rightarrow \infty} \log(1 - 1/n) / (1/2n) \quad (\text{converted this so as to have form } o/o)$$

apply l hospital rule

$$\log y = \lim_{n \rightarrow \infty} (1 - 1/n) / n^2 / (-1/2n^2)$$

$$\log y = -2$$

$$y = e^{-2}$$

method two

it takes 1 to power infinity form

$$\lim_{x \rightarrow \infty} f(x)g(x)$$

$$= e^{\lim_{x \rightarrow \infty} (f(x)-1)g(x)}$$

$$(f(x)-1)*g(x) = -1/n * 2n = -2$$

ie -2 constant

so we get final ans e^{-2}

M-I:

$$\lim_{n \rightarrow \infty} \left(1 - \frac{1}{n}\right)^{2n}$$

$$\log y = \lim_{n \rightarrow \infty} 2n \log\left(1 - \frac{1}{n}\right)$$

$$= \lim_{n \rightarrow \infty} \frac{\log\left(1 - \frac{1}{n}\right)}{\frac{1}{2n}}$$

$$= \frac{\frac{1}{n} \times \frac{1}{n}}{1 - \frac{1}{n^2}}$$

$$= \frac{-1}{2n^2}$$

$$\log y = \lim_{n \rightarrow \infty} -\frac{1}{n}$$

$$\log y = -2$$

$$y = e^{-2}$$

M-II

$$\lim_{n \rightarrow \infty} f(x) g(x) \quad \text{for } n \rightarrow \infty$$

$$\frac{1}{n} \rightarrow 0 \quad \text{when } n \rightarrow \infty$$

$$2n \rightarrow \infty \quad n \rightarrow \infty$$

$$\lim_{n \rightarrow \infty} e^{f(x) g(x)} = e^{\lim_{n \rightarrow \infty} \frac{(1-\frac{1}{n})^{2n}}{n}} = e^{\lim_{n \rightarrow \infty} -\frac{1}{n}} = e^{-2}$$

u can refer this link for second method

http://www.vitutor.com/calculus/limits/one_infinity.html

8 votes

-- Pooja (25.9k points)

11.5.8 Limits: GATE2015-3_9 [top](#)

<http://gateoverflow.in/8403>



Selected Answer

Apply an exponential of a logarithm to the expression.

$$\lim_{x \rightarrow \infty} (x^2 + 1)^{e^{-x}} = \lim_{x \rightarrow \infty} \exp\left(\log\left((x^2 + 1)^{e^{-x}}\right)\right) = \lim_{x \rightarrow \infty} \exp\left(\frac{\log(x^2 + 1)}{e^x}\right);$$

$$\lim_{x \rightarrow \infty} \exp\left(\frac{\log(x^2 + 1)}{e^x}\right)$$

Since the exponential function is continuous, we may factor it out of the limit.

$$\lim_{x \rightarrow \infty} \exp\left(\frac{\log(x^2 + 1)}{e^x}\right) = \exp\left(\lim_{x \rightarrow \infty} \frac{\log(x^2 + 1)}{e^x}\right);$$

$$\exp\left(\lim_{x \rightarrow \infty} \frac{\log(x^2 + 1)}{e^x}\right)$$

The numerator of $e^{-x} \log(x^2 + 1)$ grows asymptotically slower than its denominator as x approaches ∞ .

Since $\log(x^2 + 1)$ grows asymptotically slower than e^x as x approaches ∞ , $\lim_{x \rightarrow \infty} e^{-x} \log(x^2 + 1) = 0$.

e^0

Evaluate e^0 .

$e^0 = 1$:

Answer: 1

17 votes

-- Shyam Singh (1.4k points)

11.5.9 Limits: GATE2008-1 [top](#)

<http://gateoverflow.in/399>



Selected Answer

$$\begin{aligned}\lim_{x \rightarrow \infty} \frac{x - \sin x}{x + \cos x} &= \lim_{x \rightarrow \infty} \frac{x(1 - \frac{\sin x}{x})}{x(1 + \frac{\cos x}{x})} \\ &= \lim_{x \rightarrow \infty} \frac{1 - \frac{\sin x}{x}}{1 + \frac{\cos x}{x}}\end{aligned}$$

now to calculate values of $\frac{\sin x}{x}$ and $\frac{\cos x}{x}$ we use Squeezing Theorem.

$$\begin{aligned}-1 \leq \sin x &\leq +1 & -1 \leq \cos x &\leq +1 \\ -\frac{1}{x} \leq \frac{\sin x}{x} &\leq \frac{+1}{x} & -\frac{1}{x} \leq \frac{\cos x}{x} &\leq \frac{+1}{x}\end{aligned}$$

now as $x \rightarrow \infty$ we get $\frac{1}{x} \rightarrow 0$, this implies that:

$$0 \leq \frac{\sin x}{x} \leq 0 \quad 0 \leq \frac{\cos x}{x} \leq 0$$

Hence,

$$\begin{aligned}\lim_{x \rightarrow \infty} \frac{x - \sin x}{x + \cos x} &= \lim_{x \rightarrow \infty} \frac{1 - \frac{\sin x}{x}}{1 + \frac{\cos x}{x}} \\ &= \lim_{x \rightarrow \infty} \frac{1 - 0}{1 + 0} \\ &= 1\end{aligned}$$

answer = **option A**

10 votes

-- Amar Vashishth (20.7k points)

11.5.10 Limits: GATE2015-1_4 [top](#)

<http://gateoverflow.in/8021>



Selected Answer

Apply an exponential of a logarithm to the expression.

$$\lim_{x \rightarrow \infty} x^{\frac{1}{x}} = \lim_{x \rightarrow \infty} \exp\left(\log\left(x^{\frac{1}{x}}\right)\right) = \lim_{x \rightarrow \infty} \exp\left(\frac{\log(x)}{x}\right)$$

$$\lim_{x \rightarrow \infty} \exp\left(\frac{\log(x)}{x}\right)$$

Since the exponential function is continuous, we may factor it out of the limit.

$$\lim_{x \rightarrow \infty} \exp\left(\frac{\log(x)}{x}\right) = \exp\left(\lim_{x \rightarrow \infty} \frac{\log(x)}{x}\right)$$

$$\exp\left(\lim_{x \rightarrow \infty} \frac{\log(x)}{x}\right)$$

Logarithmic functions grow asymptotically slower than polynomials.

Since $\log(x)$ grows asymptotically slower than the polynomial x as x approaches ∞ ,

$$\lim_{x \rightarrow \infty} \frac{\log(x)}{x} = 0 :$$

$$e^0 = 1$$

11 votes

-- Shyam Singh (1.4k points)

11.5.11 Limits: GATE 2016-1-3 [top](#)

<http://gateoverflow.in/39630>



Selected Answer

substitute $h=x-4$..so it becomes $\lim_{h \rightarrow 0} (\sinh)/h$... which is a standard limit.. Ans would be 1.

10 votes

-- Abhilash Panicker (7k points)

11.6

Maxima Minima [top](#)

11.6.1 Maxima Minima: GATE2008_25 [top](#)

<http://gateoverflow.in/423>

A point on a curve is said to be an extremum if it is a local minimum or a local maximum. The number of distinct extrema for the curve $3x^4 - 16x^3 + 24x^2 + 37$ is

- A. 0
- B. 1
- C. 2
- D. 3

[gate2008](#) [calculus](#) [maxima-minima](#) [easy](#)

Answer

11.6.2 Maxima Minima: TIFR2014-A-9 [top](#)

<http://gateoverflow.in/25996>

Solve $\min x^2 + y^2$

subject to

$$x + y \geq 10,$$

$$2x + 3y \geq 20,$$

$$x \geq 4,$$

$$y \geq 4.$$

- a. 32
- b. 50
- c. 52
- d. 100

- e. None of the above

[tifr2014](#) [calculus](#) [maxima-minima](#)

[Answer](#)

11.6.3 Maxima Minima: TIFR2015-A-11 [top](#)

<http://gateoverflow.in/29581>

Suppose that $f(x)$ is a continuous function such that $0.4 \leq f(x) \leq 0.6$ for $0 \leq x \leq 1$. Which of the following is always true?

- A. $f(0.5) = 0.5$.
- B. There exists x between 0 and 1 such that $f(x) = 0.8x$.
- C. There exists x between 0 and 0.5 such that $f(x) = x$.
- D. $f(0.5) > 0.5$.
- E. None of the above statements are always true.

[tifr2015](#) [maxima-minima](#)

[Answer](#)

11.6.4 Maxima Minima: GATE1997_4.1 [top](#)

<http://gateoverflow.in/2242>

What is the maximum value of the function $f(x) = 2x^2 - 2x + 6$ in the interval $[0, 2]$?

- A. 6
- B. 10
- C. 12
- D. 5.5

[gate1997](#) [calculus](#) [maxima-minima](#) [normal](#)

[Answer](#)

11.6.5 Maxima Minima: TIFR2013-A-16 [top](#)

<http://gateoverflow.in/2546>

The minimum of the function $f(x) = x \log_e(x)$ over the interval $[1/2, \infty)$ is

- a. 0
- b. $-e$
- c. $-\log_e(2)/2$
- d. $-1/e$
- e. None of the above

[tifr2013](#) [calculus](#) [maxima-minima](#)

[Answer](#)

11.6.6 Maxima Minima: TIFR2012-A-15 [top](#)

<http://gateoverflow.in/25040>

Consider the differential equation $dx/dt = (1-x)(2-x)(3-x)$. Which of its equilibria is unstable?

- a. $x = 0$
- b. $x = 1$
- c. $x = 2$
- d. $x = 3$
- e. None of the above.

[tifr2012](#) [calculus](#) [maxima-minima](#)

[Answer](#)

11.6.7 Maxima Minima: TIFR2012-A-13 [top](#)<http://gateoverflow.in/25036>

The maximum value of the function.

$$f(x, y, z) = (x - 1/3)^2 + (y - 1/3)^2 + (z - 1/3)^2$$

Subject to the constraints

$$x + y + z = 1, x \geq 0, y \geq 0, z \geq 0$$

is

- a. $1/3$
- b. $2/3$
- c. 1
- d. $4/3$
- e. $4/9$

[tifr2012](#) [calculus](#) [maxima-minima](#)

[Answer](#)

11.6.8 Maxima Minima: TIFR2011-A-4 [top](#)<http://gateoverflow.in/20002>

Consider the problem of maximizing $x^2 - 2x + 5$ such that $0 < x < 2$. The value of x at which the maximum is achieved is:

- a. 0.5
- b. 1
- c. 1.5
- d. 1.75
- e. None of the above.

[tifr2011](#) [calculus](#) [maxima-minima](#)

[Answer](#)

11.6.9 Maxima Minima: TIFR2010-A-3 [top](#)<http://gateoverflow.in/18209>

The function $f(x) = 2.5 \log_e(2 + \exp(x^2 - 4x + 5))$ attains a minimum at $x = ?$

- a. 0
- b. 1
- c. 2
- d. 3
- e. 4

[tifr2010](#) [calculus](#) [maxima-minima](#)

[Answer](#)

11.6.10 Maxima Minima: GATE2008-IT_31 [top](#)<http://gateoverflow.in/3341>

If $f(x)$ is defined as follows, what is the minimum value of $f(x)$ for $x \in (0, 2]$?

$$f(x) = \begin{cases} \frac{25}{8x} & \text{when } x \leq \frac{3}{2} \\ x + \frac{1}{x} & \text{otherwise} \end{cases}$$

- | | |
|----|-----------|
| A) | 2 |
| B) | $2(1/12)$ |
| C) | $2(1/6)$ |
| D) | $2(1/2)$ |

[gate2008-it](#) [calculus](#) [maxima-minima](#) [normal](#)

Answer**11.6.11 Maxima Minima: GATE2012_9** top<http://gateoverflow.in/41>

Consider the function $f(x) = \sin(x)$ in the interval $x = [\pi/4, 7\pi/4]$. The number and location(s) of the local minima of this function are

- (A) One, at $\pi/2$
- (B) One, at $3\pi/2$
- (C) Two, at $\pi/2$ and $3\pi/2$
- (D) Two, at $\pi/4$ and $3\pi/2$

[gate2012](#) [calculus](#) [maxima-minima](#) [normal](#)
Answer**Answers: Maxima Minima****11.6.1 Maxima Minima: GATE2008_25** top<http://gateoverflow.in/423>

Selected Answer

answer is (b)

$$f(x) = 3x^4 - 16x^3 + 24x^2 + 37$$

$$f'(x) = 12x^3 - 48x^2 + 48x = 0$$

$$\implies 12x(x^2 - 4x + 4) = 0$$

$$x(x-2)^2 = 0$$

$$\implies x = 0, 2$$

$$f''(x) = 36x^2 - 96x + 48$$

at $x = 0$, $f''(x) = 48 > 0$ it means that $x = 0$ is local minima.

but at $x = 2$, $f''(x) = 0$ so we can't apply second derivative test. So, we can apply first derivative test.

$f'(1) = 12$, $f'(3) = 36$. So, $f'(x)$ is not changing sign on either side of 2. So, $x = 2$ is neither maxima nor minima.

So, only one extremum i.e. $x=0$.

R e f : https://cims.nyu.edu/~kiryl/Calculus/Section_4.3--Derivatives_and_the_Shapes_of_Graphs/Derivatives_and_the_Shapes_of_Graphs.pdf

6 votes

-- SAKET NANDAN (2.2k points)

11.6.2 Maxima Minima: TIFR2014-A-9 top<http://gateoverflow.in/25996>

Selected Answer

Answer -> Option B) 50

$x \geq 4$ and $y \geq 4$, So we can take both $x = 5$ & $y = 5$

$x+y \geq 10 \Rightarrow$ Satisfied , $5+5 = 10$

$2x + 3y \geq 20$. Satisfied.

This is infact minimum value.

Other options =>

4,4 => $x+y$ constraint fail

4,5 => $x+y$ fail

6,4 => Still giving 52 as sum which is more than 50 !, This can not be answer.

7,3 => $49+9 > 58 > 50$.

Upvote 3 votes

-- Akash (31.7k points)

11.6.3 Maxima Minima: TIFR2015-A-11 [top](#)

<http://gateoverflow.in/29581>

(A) $f(0.5)=0.5$, we **cannot say here $f(x)$ value always true** Because we need to know $f(x)$ value between $0.4 \leq f(x) \leq 0.6$, and here we are getting $f(x)$ value when $x=0.5$

(C) Here we know $f(x)$ value between 0 to 0.5. But when $f(x)=0.6$, **x value may be ≥ 1**

(D) Here also we cannot predict $f(x)$ value when $0.4 \leq f(x) \leq 0.6$

$f(0.5)>0.5$ is an **inequality**. So, we **cannot get any exact value of x**

Now for (B) Here we can see the $f(x)$ value $0.4 \leq f(x) \leq 0.6$ when x between 0 to 1

for eg: $f(0.5)=0.4$, where x value is 0.5

$f(0.6)=0.48$, where x value is 0.6

$f(0.7)=0.56$, where x value is 0.7

here we are only concern about $f(x)$ is between 0.4 and 0.6.

so, here value of x **always between $0 \leq x \leq 1$ when $0.4 \leq f(x) \leq 0.6$**

So, answer will be (B)

Upvote 0 votes

-- srestha (27.8k points)

11.6.4 Maxima Minima: GATE1997_4.1 [top](#)

<http://gateoverflow.in/2242>



Selected Answer

Answer: B

For $f(x)$ to be maximum

$$f'(x) = 4x - 2 = 0 \implies x = \frac{1}{2}$$

So at $x = \frac{1}{2}$, $f(x)$ is an extremum (either maximum or minimum).

$$f(2) = 2(2)^2 - 2(2) + 6 = 8 - 4 + 6 = 10$$

$$f\left(\frac{1}{2}\right) = 2\frac{1}{2}^2 - 2\frac{1}{2} + 6 = 5.5, \text{ so } x = \frac{1}{2} \text{ is a minimum.}$$

$$f(0) = 6.$$

So, the maximum value is at $x = 2$ which is 10 as there are no other extremum for the given function.

Upvote 8 votes

-- Rajarshi Sarkar (29.7k points)

11.6.5 Maxima Minima: TIFR2013-A-16 [top](#)

<http://gateoverflow.in/25496>

Minimum value of function occurs at end points or critical points

$$f'(x) = 1 + \log x$$

Equate it to 0

$$x = 1/e$$

$$f''(x) = 1/x$$

Put $x = 1/e$ $f''(x) = e$ so minima at $1/e$

$$But 1/e = 0.36$$

$$But x \in [1/2, \infty)$$

So min occurs at $1/2$

$$So \min \text{ value} = 1/2 \log 1/2$$

So ans is c

3 votes

-- Pooja (25.9k points)

11.6.6 Maxima Minima: TIFR2012-A-15 [top](#)

<http://gateoverflow.in/25040>

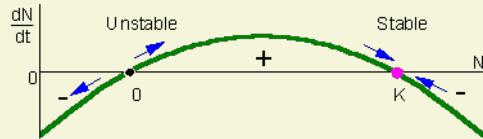
For unstable equilibrium point, $dx/dt > 0$

$$At x = 0, dx/dt = (1-0)(2-0)(3-0) = 6 > 0$$

Hence $x = 0$ is point of unstable equilibrium.

We can understand equilibrium in terms of radioactive decay.

Let $dN/dt = -KN$; $K > 0$ its significance is that an element is losing energy so it is getting stability because we know more energy an element gets, more de-stability it gains and vice versa.



1 votes

-- Shashank Kumar (2.9k points)

11.6.7 Maxima Minima: TIFR2012-A-13 [top](#)

<http://gateoverflow.in/25066>

Since all X, Y, Z are greater than equal to zero. So in $X+Y+Z=1$ means any two out of three variable will be zero and remaining variable will have value one..

So, Max value will be

$$(1-1/3)^2 + (0-1/3)^2 + (0-1/3)^2 = 2/3$$

0 votes

-- SONU (1.5k points)

11.6.8 Maxima Minima: TIFR2011-A-4 [top](#)

<http://gateoverflow.in/20002>



Selected Answer

$$P(x) = x^2 - 2x + 5$$

Since a polynomial is defined and continuous everywhere, we only need to check the critical point and the boundaries.

$$\frac{d}{dx} P(x) = 2x - 2$$

Critical point: $2x - 2 = 0 \implies x = 1$ gives $P(x) = 4$, which is the minimum.

Boundaries: $\lim_{x \rightarrow 0^+} P(x) = \lim_{x \rightarrow 2^-} P(x) = 5$

Since $P(x)$ increases as x goes farther away from the 1, but

$P(x)$ is defined on an open interval,

$P(x)$ never attains a maximum!

Hence, e. **None of the above** is the correct answer.

Graph for $P(x)$

4 votes

-- Pragy Agarwal (14.4k points)

11.6.9 Maxima Minima: TIFR2010-A-3 [top](#)

<http://gateoverflow.in/18209>

Just differentiate whole function and put value = 0, x comes out to be 2.
1nd derivative +ve here, so minima

2 votes

-- Digvijay (35.8k points)

11.6.10 Maxima Minima: GATE2008-IT_31 [top](#)

<http://gateoverflow.in/3341>



Selected Answer

Answer: B

at $x = 3/2$, $f(x) = 2\frac{1}{12}$ = Option B.

6 votes

-- Rajarshi Sarkar (29.7k points)

11.6.11 Maxima Minima: GATE2012_9 [top](#)

<http://gateoverflow.in/41>



Selected Answer

Sine function increases till $\pi/2$ and so for the considered interval $\pi/4$ would be a local minimum. From $\pi/2$, value of sine keeps on decreasing till $3\pi/2$ and hence $3\pi/2$ would be another local minima. So, (D) is the correct answer here.

7 votes

-- gatecse (10.7k points)

11.7

Mean Value Theorem [top](#)

11.7.1 Mean Value Theorem: GATE2014-1-6 [top](#)

<http://gateoverflow.in/1763>

Let the function

$$f(\theta) = \begin{vmatrix} \sin \theta & \cos \theta & \tan \theta \\ \sin\left(\frac{\pi}{6}\right) & \cos\left(\frac{\pi}{6}\right) & \tan\left(\frac{\pi}{6}\right) \\ \sin\left(\frac{\pi}{3}\right) & \cos\left(\frac{\pi}{3}\right) & \tan\left(\frac{\pi}{3}\right) \end{vmatrix}$$

where

$\theta \in \left[\frac{\pi}{6}, \frac{\pi}{3}\right]$ and $f'(\theta)$ denote the derivative of f with respect to θ . Which of the following statements is/are **TRUE**?

- (I) There exists $\theta \in \left(\frac{\pi}{6}, \frac{\pi}{3}\right)$ such that $f'(\theta) = 0$
- (II) There exists $\theta \in \left(\frac{\pi}{6}, \frac{\pi}{3}\right)$ such that $f'(\theta) \neq 0$

- (A) I only
- (B) II only
- (C) Both I and II
- (D) Neither I Nor II

[gate2014-1](#) [calculus](#) [differentiability](#) [mean-value-theorem](#) [normal](#)

[Answer](#)

Answers: Mean Value Theorem

11.7.1 Mean Value Theorem: GATE2014-1-6 [top](#)

<http://gateoverflow.in/1763>



Selected Answer

We need to solve this by [rolle's theorem](#), to apply rolle's theorem following 3 conditions should be satisfied:

- 1) $f(x)$ should be continuous in interval $[a, b]$,
- 2) $f(x)$ should be differentiable in interval (a, b) , and
- 3) $f(a) = f(b)$

If these 3 conditions are satisfied simultaneously then, there exists at least one 'x' such that $f'(x) = 0$

So, for the above question, it satisfies all the three conditions, so we can apply rolle's theorem, i.e, there exists 'at least one' theta that gives $f'(\theta) = 0$

Also, the given function is also not a constant function, i.e $f'(\theta) \neq 0$

So, answer is C

9 votes

-- Saurabh Sharma (503 points)

12 Engineering Mathematics

Linear Algebra (64) top

12.0.1 GATE2012_11 top

<http://gateoverflow.in/43>

Let A be the 2×2 matrix with elements $a_{11} = a_{12} = a_{21} = +1$ and $a_{22} = -1$. Then the eigenvalues of the matrix A^{19} are

- (A) 1024 and -1024
- (B) $1024\sqrt{2}$ and $-1024\sqrt{2}$
- (C) $4\sqrt{2}$ and $-4\sqrt{2}$
- (D) $512\sqrt{2}$ and $-512\sqrt{2}$

gate2012 linear-algebra

Answer

12.0.2 GATE2004_26 top

<http://gateoverflow.in/1023>

The number of different $n \times n$ symmetric matrices with each element being either 0 or 1 is: (Note: $\text{power}(2, X)$ is same as 2^X)

- A. $\text{power}(2, n)$
- B. $\text{power}(2, n^2)$
- C. $\text{power}(2, (n^2 + n) / 2)$
- D. $\text{power}(2, (n^2 - n) / 2)$

gate2004 linear-algebra normal

Answer

12.0.3 GATE2006-IT_77 top

<http://gateoverflow.in/3621>

$$\begin{aligned}x + y/2 &= 9 \\3x + y &= 10\end{aligned}$$

What can be said about the Gauss-Siedel iterative method for solving the above set of linear equations?

- A) it will converge
- B) It will diverse
- C) It will neither converge nor diverse
- D) It is not applicable

gate2006-it linear-algebra normal

Answer

12.0.4 GATE2013_3 top

<http://gateoverflow.in/1412>

Which one of the following does **NOT** equal

$$\begin{vmatrix} 1 & x & x^2 \\ 1 & y & y^2 \\ 1 & z & z^2 \end{vmatrix}$$

?

(A)

$$\begin{vmatrix} 1 & x(x+1) & x+1 \\ 1 & y(y+1) & y+1 \\ 1 & z(z+1) & z+1 \end{vmatrix}$$

(B)

$$\begin{vmatrix} 1 & x+1 & x^2+1 \\ 1 & y+1 & y^2+1 \\ 1 & z+1 & z^2+1 \end{vmatrix}$$

(C)

$$\begin{vmatrix} 0 & x-y & x^2-y^2 \\ 0 & y-z & y^2-z^2 \\ 1 & z & z^2 \end{vmatrix}$$

(D)

$$\begin{vmatrix} 2 & x+y & x^2+y^2 \\ 2 & y+z & y^2+z^2 \\ 1 & z & z^2 \end{vmatrix}$$

[gate2013](#) [linear-algebra](#) [normal](#)

[Answer](#)

12.0.5 GATE2007-27 [top](#)

<http://gateoverflow.in/1225>

Consider the set of (column) vectors defined by

$$X = \left\{ x \in R^3 \mid x_1 + x_2 + x_3 = 0, \text{ where } x^T = [x_1, x_2, x_3]^T \right\}$$

Which of the following is **TRUE**?

- A. $\left\{ [1, -1, 0]^T, [1, 0, -1]^T \right\}$ is a basis for the subspace X .
- B. $\left\{ [1, -1, 0]^T, [1, 0, -1]^T \right\}$ is a linearly independent set, but it does not span X and therefore is not a basis of X .
- C. X is not a subspace of R^3 .
- D. None of the above

[gate2007](#) [linear-algebra](#) [normal](#)

[Answer](#)

12.0.6 GATE2005-IT_3 [top](#)

<http://gateoverflow.in/3747>

The determinant of the matrix given below is

$$\begin{bmatrix} 0 & 1 & 0 & 2 \\ -1 & 1 & 1 & 3 \\ 0 & 0 & 0 & 1 \\ 1 & -2 & 0 & 1 \end{bmatrix}$$

- A) -1
 B) 0
 C) 1
 D) 2

[gate2005-it](#) [linear-algebra](#) [normal](#)

[Answer](#)

12.0.7 GATE2008-IT_29 [top](#)

<http://gateoverflow.in/3319>

If M is a square matrix with a zero determinant, which of the following assertion (s) is (are) correct?

- (S1) Each row of M can be represented as a linear combination of the other rows
 (S2) Each column of M can be represented as a linear combination of the other columns
 (S3) $MX = 0$ has a nontrivial solution
 (S4) M has an inverse

- 1) S3 and S2
 2) S1 and S4
 3) S1 and S3
 4) S1, S2 and S3

[gate2008-it](#) [linear-algebra](#) [normal](#)

[Answer](#)

12.0.8 GATE2014-2_4 [top](#)

<http://gateoverflow.in/1956>

If the matrix A is such that

$$A = \begin{bmatrix} 2 \\ -4 \\ 7 \end{bmatrix} [1 \ 9 \ 5]$$

then the determinant of A is equal to _____.

[gate2014-2](#) [linear-algebra](#) [numerical-answers](#) [easy](#)

[Answer](#)

12.0.9 GATE2004_76 [top](#)

<http://gateoverflow.in/1070>

In an $M \times N$ matrix all non-zero entries are covered in a rows and b columns. Then the maximum number of non-zero entries, such that no two are on the same row or column, is

- A. $\leq a + b$
 B. $\leq \max(a, b)$
 C. $\leq \min(M - a, N - b)$
 D. $\leq \min(a, b)$

[gate2004](#) [linear-algebra](#) [normal](#)
Answer**12.0.10 GATE1997_1.3** [top](#)<http://gateoverflow.in/2219>

The determinant of the matrix

$$\begin{bmatrix} 6 & -8 & 1 & 1 \\ 0 & 2 & 4 & 6 \\ 0 & 0 & 4 & 8 \\ 0 & 0 & 0 & -1 \end{bmatrix}$$

- A. 11
 B. -48
 C. 0
 D. -24

[gate1997](#) [linear-algebra](#) [normal](#)
Answer**12.0.11 GATE2004_27** [top](#)<http://gateoverflow.in/1024>

Let A, B, C, D be $n \times n$ matrices, each with non-zero determinant. If $ABCD = I$, then B^{-1} is

- A. $D^{-1}C^{-1}A^{-1}$
 B. CDA
 C. ADC
 D. Does not necessarily exist

[gate2004](#) [linear-algebra](#) [normal](#)
Answer**12.0.12 GATE2006_23** [top](#)<http://gateoverflow.in/984>

F is an $n \times n$ real matrix. b is an $n \times 1$ real vector. Suppose there are two $n \times 1$ vectors, u and v such that, $u \neq v$ and $Fu = b, Fv = b$. Which one of the following statements is false?

- (A) Determinant of F is zero.
 (B) There are an infinite number of solutions to $Fx = b$
 (C) There is an $x \neq 0$ such that $Fx = 0$
 (D) F must have two identical rows

[gate2006](#) [linear-algebra](#) [normal](#)
Answer**12.0.13 TIFR2010-A-11** [top](#)<http://gateoverflow.in/18503>

The length of a vector $x = (x_1, \dots, x_n)$ is defined as

$$\|x\| = \sqrt{\sum_{i=1}^n x_i^2}.$$

Given two vectors $x = (x_1, \dots, x_n)$ and $y = (y_1, \dots, y_n)$, which of the following measures of discrepancy between x and y is insensitive to the length of the vectors?

- a. $\|x - y\|$
 b. $\|x - y\| / \|x\| \|y\|$
 c. $\|x\| - \|y\|$

- d. $\left\| \frac{X}{\|X\|} - \frac{Y}{\|Y\|} \right\|$
e. None of the above.

tifr2010 linear-algebra

Answer

12.0.14 GATE2002_1.1 top

<http://gateoverflow.in/805>

The rank of the matrix $\begin{bmatrix} 1 & 1 \\ 0 & 0 \end{bmatrix}$ is

- A. 4
B. 2
C. 1
D. 0

gate2002 linear-algebra easy

Answer

12.0.15 GATE2001-1.1 top

<http://gateoverflow.in/694>

Consider the following statements:

- S1: The sum of two singular $n \times n$ matrices may be non-singular
- S2: The sum of two $n \times n$ non-singular matrices may be singular

Which one of the following statements is correct?

- A. S1 and S2 both are true
B. S1 is true, S2 is false
C. S1 is false, S2 is true
D. S1 and S2 both are false

gate2001 linear-algebra normal

Answer

12.0.16 GATE2000-1.3 top

<http://gateoverflow.in/626>

The determinant of the matrix

$$\begin{bmatrix} 2 & 0 & 0 & 0 \\ 8 & 1 & 7 & 2 \\ 2 & 0 & 2 & 0 \\ 9 & 0 & 6 & 1 \end{bmatrix}$$

- A. 4
B. 0
C. 15
D. 20

gate2000 linear-algebra easy

Answer

12.0.17 GATE 2012 What is Normalised Eigen Vector ? top

<http://gateoverflow.in/34573>

For the Matrix $\begin{bmatrix} 5 & 3 \\ 1 & 3 \end{bmatrix}$

One of the Normalised Eigen Vector is given as _____

Answer

$$\begin{bmatrix} \frac{1}{\sqrt{2}} \\ \frac{-1}{\sqrt{2}} \end{bmatrix}$$

What is Normalised Eigen Vector ?
How to Find the Solution ?

[linear-algebra](#) [gate-2012](#)

Answer

12.0.18 GATE1995_2.13 [top](#)

<http://gateoverflow.in/2625>

A unit vector perpendicular to both the vectors

$a = 2i - 2j + k$ and
 $b = 1 + j - 2k$ is:

- A. $\frac{1}{\sqrt{3}}(i + j + k)$
- B. $\frac{1}{3}(i + j - k)$
- C. $\frac{1}{3}(i - j - k)$
- D. $\frac{1}{\sqrt{3}}(i + j - k)$

[gate1995](#) [linear-algebra](#) [normal](#)

Answer

12.0.19 GATE2008-3 [top](#)

<http://gateoverflow.in/401>

The following system of equations

$$x_1 + x_2 + 2x_3 = 1$$

$$x_1 + 2x_2 + 3x_3 = 2$$

$x_1 + 4x_2 + \alpha$
has a unique solution. The only possible value(s) for α is/are

- A. 0
- B. either 0 or 1
- C. one of 0, 1, or -1
- D. any real number

[gate2008](#) [easy](#) [linear-algebra](#)

Answer

12.0.20 GATE2006-IT_76 [top](#)

<http://gateoverflow.in/3620>

$$\begin{aligned} x + y/2 &= 9 \\ 3x + y &= 10 \end{aligned}$$

The value of the Frobenius norm for the above system of equations is

- | | |
|----|------|
| 1) | 0.5 |
| 2) | 0.75 |
| 3) | 1.5 |
| 4) | 2.0 |

gate2006-it linear-algebra normal

[Answer](#)

Answers:

12.0.1 GATE2012_11 [top](#)

<http://gateoverflow.in/43>



Selected Answer

Characteristic Equation is $A - \mu I = 0$

$$\begin{vmatrix} 1 - \mu & 1 \\ 1 & -1 - \mu \end{vmatrix} = 0$$

$$\implies (1 - \mu)(-1 - \mu) - 1 = 0$$

$$\implies -1 - \mu + \mu + \mu^2 - 1 = 0$$

$$\implies \mu^2 - 2 = 0$$

$$\implies \mu = +\sqrt{2} \text{ and } -\sqrt{2}$$

so according to properties of Eigen values,

eigen values of
 A^{19}_{19} = (eigen value of A)¹⁹

=

$(\sqrt{2})^{19}$ and
 $(-\sqrt{2})^{19}$

= option (D)

11 votes

-- Narayan Kunal (389 points)

12.0.2 GATE2004_26 [top](#)

<http://gateoverflow.in/1023>



Selected Answer

In symmetric matrix, $A[i][j] = A[j][i]$. So, we have choice only for either the upper triangular elements or the lower triangular elements. Number of such elements will be $n + (n - 1) + (n - 2) + \dots + 1 = n \frac{(n+1)}{2} = \frac{(n^2+n)}{2}$. Now, each element being either 0 or 1 means, we have 2 choices for each element and thus for $\frac{(n^2+n)}{2}$ elements we have $2^{\frac{(n^2+n)}{2}}$ possibilities.

Choice C.

7 votes

-- Arjun Suresh (150k points)

12.0.3 GATE2006-IT_77 [top](#)<http://gateoverflow.in/3621>

Answer: A

As,

$$|1| + |1/2| \leq |9|$$

$$\text{and } |3| + |1| \leq |10|$$

0 votes

-- Rajarshi Sarkar (29.7k points)

12.0.4 GATE2013_3 [top](#)<http://gateoverflow.in/1412>

Selected Answer

Answer is **A**.

Answer is **A**

Operations are:

$$C_3 \leftarrow C_3 + C_2$$

$$C_2 \leftarrow C_2 + C_1$$

Swap C_2 & C_3

The Swapping operations make the determinant as $(-1) * |A|$ whereas the other options have their determinant as $|A|$

6 votes

-- Sona Praneeth Akula (3.8k points)

12.0.5 GATE2007-27 [top](#)<http://gateoverflow.in/1225>

B I think is the answer we require two constant c_1 and c_2 which satisfy the R3 which is

let X=

| | | |
|---|---|---|
| 1 | 0 | 0 |
| 0 | 1 | 0 |
| 0 | 0 | 1 |

A=

| |
|---|
| 1 |
| - |
| 1 |
| 0 |

B=

| |
|---|
| 1 |
| 0 |
| - |
| 1 |

write it as echo-lean form ABX it comes to be inconsistent and hence it does not span.

1 votes

-- Arpit Dhuriya (2.4k points)

12.0.6 GATE2005-IT_3 [top](#)<http://gateoverflow.in/3747>

ans is a

5 votes

-- neha pawar (3.8k points)

12.0.7 GATE2008-IT_29 top<http://gateoverflow.in/3319>

Selected Answer

Since M has zero determinant, its rank is not full i.e. if M is of size 3×3 , then its rank is not 3. So there is a linear combination of rows which evaluates to 0 i.e.

$$k_1 R_1 + k_2 R_2 + \dots + k_n R_n = 0$$

and there is a linear combination of columns which evaluates to 0 i.e.

$$k_1 C_1 + k_2 C_2 + \dots + k_n C_n = 0$$

Now any row R_i can be written as linear combination of other rows as :

$$R_i = -\frac{k_1}{k_i} R_1 - \frac{k_2}{k_i} R_2 - \dots - \frac{k_{i-1}}{k_i} R_{i-1} - \frac{k_{i+1}}{k_i} R_{i+1} - \dots - \frac{k_n}{k_i} R_n$$

Similar is the case for columns.

Now $MX = 0$ always has one solution : $X = 0$ (which is called trivial solution). Now if $|M| = 0$, then $MX = 0$ has non-trivial solutions also.

So (S1), (S2), and (S3) are true. So option 4) is correct.

10 votes

-- Happy Mittal (9.5k points)

12.0.8 GATE2014-2_4 top<http://gateoverflow.in/1956>

Selected Answer

Hi,

For this kind of matrices Determinant is zero.

A will be a 3×3 matrix where the first row will be 2 [1 9 5], second row will be -4 [1 9 5] and third will be 7 [1 9 5]. That is, all the rows of A are linearly dependent which means A is singular.

When matrix is singular $|A| = 0$.

References: https://www.youtube.com/watch?v=aKX5_DucNq8&list=PL221E2BBF13BECF6C&index=19

7 votes

-- Prasanna Ranganathan (2.5k points)

12.0.9 GATE2004-76 top<http://gateoverflow.in/1070>

Selected Answer

maximum number of non-zero entries, such that no two are on the same row or column

Any entry will be a member of some row and some column. So, with a rows we can have maximum a elements such that no row has a repeated element. Same is applicable for b columns also. So, combining both, answer should be $\leq \min(a, b)$.

We can also apply pigeonhole principle here. Let $p = \min(a, b)$ be the number of holes. So, we can place up to p non-zero entries (pigeons) and as soon as $(p + 1)^{th}$ entry comes it must be making two entries in some column or row.

2 votes

-- Arjun Suresh (150k points)

12.0.10 GATE1997_1.3 [top](#)<http://gateoverflow.in/2219>

Selected Answer

As it's upper triangular matrix ... So determinant will be product of main diagonal element.

$$\det(A) = 6*2*4*-1 = -48.$$

Similar concept can be applied, if Matrix is lower triangular or Diagonal Matrix

5 votes

-- durgesh (155 points)

12.0.11 GATE2004_27 [top](#)<http://gateoverflow.in/1024>

Selected Answer

Given

$$ABCD = I$$

multiply lhs,rhs by A-1

$$A^{-1}ABCD = A^{-1}I \quad (\text{position of } A^{-1} \text{ on both sides should be left})$$

$$\Rightarrow BCD = A^{-1}$$

$$\Rightarrow BCDD^{-1} = A^{-1}D^{-1}$$

$$\Rightarrow BC = A^{-1}D^{-1}$$

$$\Rightarrow BCC^{-1} = A^{-1}D^{-1}C^{-1}$$

$$\Rightarrow B = A^{-1}D^{-1}C^{-1}$$

$$\text{Now } B^{-1} = (A^{-1}D^{-1}C^{-1})^{-1}$$

$$B^{-1} = CDA$$

8 votes

-- Madhur Rawat (2.4k points)

12.0.12 GATE2006_23 [top](#)<http://gateoverflow.in/984>

Selected Answer

(A) : Correct. We are given

$$Fu = b$$

$$Fv = b$$

$$\text{So } F(u - v) = 0$$

Since $u \neq v$, so we have a non-zero solution $w = (u - v)$ to homogeneous equation $Fx = 0$. Now any vector λw is also a solution of $Fx = 0$, and so we have infinitely many solutions of $Fx = 0$, and so determinant of F is zero.

(B) : Correct. Consider a vector $u + \lambda w$.

$$F(u + \lambda w) = Fu + F(\lambda w) = b + 0 = b$$

So there are infinitely many vectors of the form $u + \lambda w$, which are solutions to equation $Fx = b$.

(C) : Correct. In option (a), we proved that vector $(u - v) \neq 0$ satisfies equation $Fx = 0$.

(D) : False. This is not necessary.

So option (D) is the answer.

6 votes

-- Happy Mittal (9.5k points)

12.0.13 TIFR2010-A-11 [top](#)

<http://gateoverflow.in/18503>



Selected Answer

Option D is the correct answer.

The following statement

discrepancy between x and y is insensitive to the length of the vectors

means that The discrepancy, as measured by the formula, between two vectors x and y is same as the discrepancy between the vectors c_1x and c_2y , for any **constant scalars** c_1, c_2 . That is,

$$D(x, y) = D(c_1x, c_2y), \quad \forall c_1, c_2 \in \mathbb{R}$$

Now, lets think about which formula achieves that.

Let us also define two pairs of vectors as follows:

$$x_1 = (0.1067, 0.9619, 0.0046, 0.7749, 0.8173) y_1 = (0.8687, 0.0844, 0.3998, 0.2599, 0.8001)$$

$$x_2 = 0.4314 \times x_1 = (0.0460, 0.4150, 0.0020, 0.3343, 0.3526) y_2 = 0.9106 \times y_1 = (0.7911, 0.0769, 0.3641, 0.2367, 0.7286)$$

A) $\|x - y\|$

Since the definition of $\|x\|$ is sensitive to scaling, option A won't be insensitive to scaling either.

For example,

$$D(x_1, y_1) = \|x_1 - y_1\| \approx 1.3313$$

$$D(x_2, y_2) = \|x_2 - y_2\| \approx 0.9754$$

$$D(x_1, y_1) \neq D(x_2, y_2)$$

B) $\frac{\|x-y\|}{\|x\|\|y\|}$

Once we've subtracted the vectors, scaling them according to their original lengths won't help at all.

For example,

$$D(x_1, y_1) = \frac{\|x_1 - y_1\|}{\|x_1\|\|y_1\|} \approx 0.7024$$

$$D(x_2, y_2) = \frac{\|x_2 - y_2\|}{\|x_2\|\|y_2\|} \approx 1.3099$$

$$D(x_1, y_1) \neq D(x_2, y_2)$$

C) $\|x\| - \|y\|$

We aren't doing any scaling in this definition of discrepancy. So, this definition is certainly sensitive to scaling, and thus, not the correct answer.

For example,

$$D(x_1, y_1) = \|x_1\| - \|y_1\| \approx 0.2086$$

$$D(x_2, y_2) = \|x_2\| - \|y_2\| \approx -0.5217$$

$$D(x_1, y_1) \neq D(x_2, y_2)$$

D) $\left\| \frac{x}{\|x\|} - \frac{y}{\|y\|} \right\|$

In this, we first scale each vector x and y down to their unit vectors, and then calculate the discrepancy.

Since $x_2 = c_1 x_1$, x_2 will have the same unit vector as x_1 .
Similarly, y_2 will have the same unit vector as y_1 .

Thus, no matter how we scale x_2 and y_2 , as long as they are derived from x_1 and y_1 , their discrepancy will be the same.

Therefore, our formula will be insensitive to scaling, which is exactly what we want!

For example,

$$D(x_1, y_1) = \left\| \frac{x_1}{\|x_1\|} - \frac{y_1}{\|y_1\|} \right\| \approx 0.9551$$

$$D(x_2, y_2) = \left\| \frac{x_2}{\|x_2\|} - \frac{y_2}{\|y_2\|} \right\| \approx 0.9551$$

$$D(x_1, y_1) = D(x_2, y_2)$$

Thus, **option D** is the correct answer.

You can use this matlab code to test the options with randomly generated vectors.

```
%% Get two random vectors x1 and y1, each of length 5
x1 = rand(5,1);
y1 = rand(5,1);

%% Create two more vectors x2 and y2, which are multiples of x1 and y1
x2 = rand()*x1;
y2 = rand()*y1;

%% Define the modd function
modd = @(z) sqrt(sum(z.^2));

%% Define the answers function that computes the values
% obtained from options A, B, C and D
answers = @(x,y) [
    modd(x-y);
    modd(x-y) / (modd(x)*modd(y));
    modd(x) - modd(y);
    modd(x/modd(x)) - y/modd(y))
];

%% Define function to perform floating point comparision
% Copied from stackoverflow.com/a/2203483/2570622
isequalRel = @(x,y,tol) ( abs(x-y) <= ( tol*max(abs(x),abs(y)) + eps ) );

%% Calculate the answers for (x1, y1) and (x2, y2) and see which option
% remains unaffected.
isequalRel(answers(x1,y1), answers(x2,y2), 1e-6)
```

1 votes

-- Pragy Agarwal (14.4k points)

12.0.14 GATE2002_1.1 [top](#)

<http://gateoverflow.in/805>



Selected Answer

Rank of this matrix is 1 as the determinant of 2nd order matrix is 0 and 1st order matrix is non zero so rank is 1

6 votes

-- Bhagirathi Nayak (11.3k points)

12.0.15 GATE2001-1.1 [top](#)

<http://gateoverflow.in/694>

ans should be A.

for S1 : singular matrices matrix[0,0,0,1] + matrix[1,0,0,0] = matrix[1,0,0,1], which is non singular

for S2 : non-singular matrices matrix[1,0,0,1] + matrix[0,1,1,0] = matrix[1,1,1,1], which is singular

5 votes

-- jayendra (6.6k points)

12.0.16 GATE2000-1.3 top<http://gateoverflow.in/626>

Selected Answer

Answer: A

$$2 * \begin{bmatrix} 1 & 7 & 2 \\ 0 & 2 & 0 \\ 0 & 6 & 1 \end{bmatrix} = 4$$

1 votes

-- Rajarshi Sarkar (29.7k points)

12.0.17 GATE 2012 What is Normalised Eigen Vector ? top<http://gateoverflow.in/3453>

Selected Answer

Normalised eigen value is similar to unit vector. i.e. if $[x_1, x_2] = [a, b]$ is eigen vector then its normalized eigen vector will be

$$= [a/\sqrt{a^2+b^2}, b/\sqrt{a^2+b^2}]$$

Hence find the eigen vector first and divide it with its magnitude like above to get normalized eigen vector.

4 votes

-- Shashank Kumar (2.9k points)

12.0.18 GATE1995_2.13 top<http://gateoverflow.in/2625>

Selected Answer

ans should be A

dot product of two perpendicular vector is 0.

vector given in option A gives 0 dotproduct with vector b. while any other vector is not giving 0 in dotproduct. therefore ans should be A.

to find the perpendicular unit vector to two vectors the procedure is as follows:

<http://www.leadinglesson.com/problem-on-finding-a-vector-perpendicular-to-two-vectors>

1 votes

-- jayendra (6.6k points)

12.0.19 GATE2008-3 top<http://gateoverflow.in/401>

Selected Answer

$$A \cdot X = B \implies \begin{bmatrix} 1 & 1 & 2 \\ 1 & 2 & 3 \\ 1 & 4 & \alpha \end{bmatrix} \begin{bmatrix} x \\ y \\ z \end{bmatrix} = \begin{bmatrix} 1 \\ 2 \\ 4 \end{bmatrix}$$

So, $X = A^{-1}BA^{-1} = adj(A)/det(A)$ ($adj(A) = Transpose(cofactor(A))$, $cofactor(A) = (-1)^{i+j}minor(A)$)

$$adj(A) = \begin{bmatrix} 2\alpha - 12 & 8 - \alpha & -1 \\ 3 - \alpha & \alpha - 2 & -1 \\ 2 & -3 & 1 \end{bmatrix} \quad det(A) = 2\alpha - 12 + 3 - \alpha + 4 = \alpha - 5$$

$$\text{Now, } A^{-1}B = \frac{1}{\alpha-5} \begin{bmatrix} 0 \\ \alpha - 5 \\ 0 \end{bmatrix} = \begin{bmatrix} 0 \\ 1 \\ 0 \end{bmatrix}$$

So, the solution is independent of α and any real value of α would suffice. (This can be seen even by observing the equations carefully- each equation value is dependent only on x_2). But a value of 5 would cause the determinant to be 0 and multiple solutions to the given equation. So, any real value except 5 should be the answer- none of the choices is correct.

Ref: http://www.mathwords.com/i/inverse_of_a_matrix.htm

7 votes

-- Arjun Suresh (150k points)

12.0.20 GATE2006-IT_76 top

<http://gateoverflow.in/3620>

Answer: D

Frobenius norm = $\sqrt{\text{trace}(A * A)} = 2.23$ which is close to option D.

0 votes

-- Rajarshi Sarkar (29.7k points)

12.1

Cayley Hamilton Theorem top

12.1.1 Cayley Hamilton Theorem: TIFR2010-A-16 top

<http://gateoverflow.in/18492>

Let the characteristic equation of matrix M be $\lambda^2 - \lambda - 1 = 0$. Then.

- a. M^{-1} does not exist.
- b. M^{-1} exists but cannot be determined from the data.
- c. $M^{-1} = M + I$
- d. $M^{-1} = M - I$
- e. M^{-1} exists and can be determined from the data but the choices (c) and (d) are incorrect.

tifr2010 linear-algebra matrices cayley-hamilton-theorem

Answer

12.1.2 Cayley Hamilton Theorem: GATE1993_02.7 top

<http://gateoverflow.in/611>

If $A = \begin{pmatrix} 1 & 0 & 0 & 1 \\ 0 & -1 & 0 & -1 \\ 0 & 0 & i & i \\ 0 & 0 & 0 & -i \end{pmatrix}$ the matrix A^4 , calculated by the use of Cayley-Hamilton theorem or otherwise, is _____

gate1993 linear-algebra normal cayley-hamilton-theorem

Answer

Answers: Cayley Hamilton Theorem

12.1.1 Cayley Hamilton Theorem: TIFR2010-A-16 [top](#)



I think we can solve using Cayley- Hamilton Theorem

$$\lambda^2 - \lambda - 1 = 0$$

$$M^2 - M - I = 0$$

$$I = M^2 - M$$

NOW PRE MULTIPLYING M^{-1}

$$M^{-1}I = M^{-1}M^2 - M^{-1}M$$

$$M^{-1} = M - I$$

SHOULD BE D.

4 votes

-- Umang Raman (11.3k points)

<http://gateoverflow.in/18492>

12.1.2 Cayley Hamilton Theorem: GATE1993_02.7 [top](#)



Let λ be eigen value

Characteristic polynomial is

$$(1-\lambda)(-1-\lambda)(i-\lambda)(-i-\lambda)$$

$$=(\lambda^2-1)(\lambda^2+1)$$

$$=\lambda^4-1$$

Characteristic equation is $\lambda^4-1=0$

According to Cayley Hamilton theorem every matrix satisfies its own characteristic equation

So $A^4=I$

8 votes

-- Pooja (25.9k points)

12.2

Eigen Value [top](#)

12.2.1 Eigen Value: GATE2007-IT-2 [top](#)

<http://gateoverflow.in/3433>

Let A be the matrix $\begin{bmatrix} 3 & 1 \\ 1 & 2 \end{bmatrix}$. What is the maximum value of $x^T Ax$ where the maximum is taken over all x that are the unit eigenvectors of A?

A. 3

- B. $(5 + \sqrt{5})/2$
 C. 3
 D. $(5 - \sqrt{5})/2$

gate2007-it linear-algebra eigen-value normal

Answer

12.2.2 Eigen Value: GATE2015-3_15 top

<http://gateoverflow.in/8411>

In the given matrix $\begin{bmatrix} 1 & -1 & 2 \\ 0 & 1 & 0 \\ 1 & 2 & 1 \end{bmatrix}$, one of the eigenvalues is 1. The eigenvectors corresponding to the eigenvalue 1 are

- A. $\{a(4, 2, 1) \mid a \neq 0, a \in \mathbb{R}\}$
 B. $\{a(-4, 2, 1) \mid a \neq 0, a \in \mathbb{R}\}$
 C. $\{a(\sqrt{2}, 0, 1) \mid a \neq 0, a \in \mathbb{R}\}$
 D. $\{a(-\sqrt{2}, 0, 1) \mid a \neq 0, a \in \mathbb{R}\}$

gate2015-3 linear-algebra eigen-value normal

Answer

12.2.3 Eigen Value: GATE2006-IT_26 top

<http://gateoverflow.in/3565>

What are the eigenvalues of the matrix P given below

$$P = \begin{pmatrix} a & 1 & 0 \\ 1 & a & 1 \\ 0 & 1 & a \end{pmatrix}$$

- A) $a, a - \sqrt{2}, a + \sqrt{2}$
 B) a, a, a
 C) $0, a, 2a$
 D) $-a, 2a, 2a$

gate2006-it linear-algebra eigen-value normal

Answer

12.2.4 Eigen Value: GATE2015-2_5 top

<http://gateoverflow.in/8051>

The larger of the two eigenvalues of the matrix $\begin{bmatrix} 4 & 5 \\ 2 & 1 \end{bmatrix}$ is _____.

gate2015-2 linear-algebra eigen-value easy

Answer

12.2.5 Eigen Value: GATE2015-1_36 top

<http://gateoverflow.in/8285>

Consider the following 2×2 matrix A where two elements are unknown and are marked by a and b . The eigenvalues of this matrix are -1 and 7. What are the values of a and b ?

$$A = \left(\begin{array}{cc} 1 & 4 \\ b & a \end{array} \right)$$

- A. $a = 6, b = 4$
 B. $a = 4, b = 6$
 C. $a = 3, b = 5$
 D. $a = 5, b = 3$

gate2015-1 linear-algebra eigen-value normal

Answer

12.2.6 Eigen Value: GATE 2016-2-06 [top](#)

<http://gateoverflow.in/39549>

Suppose that the eigenvalues of matrix A are $1, 2, 4$. The determinant of $(A^{-1})^T$ is _____.

gate2016-2 linear-algebra eigen-value normal numerical-answers

Answer

12.2.7 Eigen Value: GATE2007_25 [top](#)

<http://gateoverflow.in/254>

Let A be a 4×4 matrix with eigen values $-5, -2, 1, 4$. Which of the following is an eigen value of the matrix

$\begin{bmatrix} A & I \\ I & A \end{bmatrix}$, where
 I is the
 4×4 identity matrix?

- A) -5 B) -7 C) 2 D) 1

gate2007 eigen-value linear-algebra difficult

Answer

12.2.8 Eigen Value: GATE 2016-1-05 [top](#)

<http://gateoverflow.in/39634>

Two eigenvalues of a 3×3 real matrix P are $(2 + \sqrt{-1})$ and 3. The determinant of P is _____

gate2016-1 linear-algebra eigen-value numerical-answers normal

Answer

12.2.9 Eigen Value: GATE2011_40 [top](#)

<http://gateoverflow.in/2142>

Consider the matrix as given below.

$$\begin{bmatrix} 1 & 2 & 3 \\ 0 & 4 & 7 \\ 0 & 0 & 3 \end{bmatrix}$$

Which one of the following options provides the **CORRECT** values of the eigenvalues of the matrix?

- (A) 1, 4, 3
 (B) 3, 7, 3
 (C) 7, 3, 2
 (D) 1, 2, 3

gate2011 linear-algebra eigen-value easy

Answer

12.2.10 Eigen Value: GATE2005_49 [top](#)

<http://gateoverflow.in/1174>

What are the eigenvalues of the following 2×2 matrix?

$$\begin{pmatrix} 2 & -1 \\ -4 & 5 \end{pmatrix}$$

- (A) -1 and 1 (B) 1 and 6 (C) 2 and 5 (D) 4 and -1

gate2005 linear-algebra eigen-value easy

Answer

12.2.11 Eigen Value: GATE2014-3_4 [top](#)

<http://gateoverflow.in/2038>

Which one of the following statements is TRUE about every $n \times n$ matrix with only real eigenvalues?

- (A) If the trace of the matrix is positive and the determinant of the matrix is negative, at least one of its eigenvalues is negative.
- (B) If the trace of the matrix is positive, all its eigenvalues are positive.
- (C) If the determinant of the matrix is positive, all its eigenvalues are positive.
- (D) If the product of the trace and determinant of the matrix is positive, all its eigenvalues are positive.

gate2014-3 linear-algebra eigen-value normal

Answer

12.2.12 Eigen Value: GATE2008-28 [top](#)

<http://gateoverflow.in/426>

How many of the following matrices have an eigenvalue 1?

$$\begin{bmatrix} 1 & 0 \\ 0 & 0 \end{bmatrix}, \begin{bmatrix} 0 & 1 \\ 0 & 0 \end{bmatrix}, \begin{bmatrix} 1 & -1 \\ 1 & 1 \end{bmatrix} \text{ and } \begin{bmatrix} -1 & 0 \\ 1 & -1 \end{bmatrix}$$

- A. one
- B. two
- C. three
- D. four

gate2008 eigen-value linear-algebra

Answer

12.2.13 Eigen Value: GATE1993_01.1 [top](#)

<http://gateoverflow.in/596>

In questions 1.1 to 1.7 below, one or more of the alternatives are correct. Write the code letter(s) a, b, c, d corresponding to the correct alternative(s) in the answer book. Marks will be given only if all the correct alternatives have been selected and no incorrect alternative is picked up.

- 1.1). The eigen vector (s) of the matrix

$$\begin{bmatrix} 0 & 0 & \alpha \\ 0 & 0 & 0 \\ 0 & 0 & 0 \end{bmatrix}, \alpha \neq 0$$

is (are)

- (a). $(0, 0, \alpha)$
- (b). $(\alpha, 0, 0)$
- (c). $(0, 0, 1)$
- (d). $(0, \alpha, 0)$

gate1993 eigen-value linear-algebra easy

Answer

12.2.14 Eigen Value: GATE2014-2_47 [top](#)<http://gateoverflow.in/2013>

The product of the non-zero eigenvalues of the matrix is _____

$$\begin{pmatrix} 1 & 0 & 0 & 0 & 1 \\ 0 & 1 & 1 & 1 & 0 \\ 0 & 1 & 1 & 1 & 0 \\ 0 & 1 & 1 & 1 & 0 \\ 1 & 0 & 0 & 0 & 1 \end{pmatrix}$$

[gate2014-2](#) [linear-algebra](#) [eigen-value](#) [normal](#)

Answer

12.2.15 Eigen Value: GATE2014-1_5 [top](#)<http://gateoverflow.in/1760>

The value of the dot product of the eigenvectors corresponding to any pair of different eigenvalues of a 4×4 symmetric positive definite matrix is _____

[gate2014-1](#) [linear-algebra](#) [eigen-value](#) [numerical-answers](#) [normal](#)

Answer

12.2.16 Eigen Value: GATE2002_5a [top](#)<http://gateoverflow.in/858>

a. Obtain the eigen values of the matrix

$$A = \begin{bmatrix} 1 & 2 & 34 & 49 \\ 0 & 2 & 43 & 94 \\ 0 & 0 & -2 & 104 \\ 0 & 0 & 0 & -1 \end{bmatrix}$$

[gate2002](#) [linear-algebra](#) [eigen-value](#) [normal](#)

Answer

12.2.17 Eigen Value: GATE2010-29 [top](#)<http://gateoverflow.in/1155>

Consider the following matrix

$$A = \begin{bmatrix} 2 & 3 \\ x & y \end{bmatrix}$$

If the eigenvalues of A are 4 and 8, then

- A. $x = 4, y = 10$
- B. $x = 5, y = 8$
- C. $x = 3, y = 9$
- D. $x = -4, y = 10$

[gate2010](#) [linear-algebra](#) [eigen-value](#) [easy](#)

Answer

Answers: Eigen Value

12.2.1 Eigen Value: GATE2007-IT-2 [top](#)

<http://gateoverflow.in/3433>



Selected Answer

$x = [x_1, x_2]$ be a unit eigen vector

Given $\sqrt{x_1^2 + x_2^2} = 1$ i.e. $x_1^2 + x_2^2 = 1$ {
 $\because x$ is a unit Eigen vector}

$Ax = Lx$, where L = eigen value

$$x^T Ax = x^T Lx = L[x_1, x_2]^T [x_1, x_2] = L[x_1^2 + x_2^2] = L(1) = L.$$

The maximum value of $L = (5 + \sqrt{5})/2$.

maximum value of $x^T Ax$ is $(5 + \sqrt{5})/2$. Option B

11 votes

-- saloni (205 points)

12.2.2 Eigen Value: GATE2015-3_15 [top](#)

<http://gateoverflow.in/3411>



Selected Answer

$$\begin{bmatrix} 1-1 & -1 & 2 \\ 0 & 1-1 & 0 \\ 1 & 2 & 1-1 \end{bmatrix} = \begin{bmatrix} 0 & -1 & 2 \\ 0 & 0 & 0 \\ 1 & 2 & 0 \end{bmatrix} * \begin{bmatrix} x \\ y \\ z \end{bmatrix}$$

$$-y + 2z = 0$$

$$x + 2y = 0$$

now consider each of the triplets as the value of x, y, z and put in these equations the one which satisfies is the answer.

why so because an eigen vector represents a vector which passes through all the points which can solve these equations.

so we can observe that only option B is satisfying the equations.

13 votes

-- Tamojit Chatterjee (1.9k points)

12.2.3 Eigen Value: GATE2006-IT_26 [top](#)

<http://gateoverflow.in/3565>



Selected Answer

$$\det(A - \lambda I) = 0$$

$$\begin{vmatrix} a-\lambda & 1 & 0 \\ 1 & a-\lambda & 1 \\ 0 & 1 & a-\lambda \end{vmatrix} = 0$$

$$(a-\lambda)*[(a-\lambda)*(a-\lambda)-1*1] - 1*[1*(a-\lambda)-0*1] + 0*[1*1 - 0*(a-\lambda)] = 0$$

$$(a - \lambda)^3 - 2(a - \lambda) = 0$$

$$(a - \lambda)((a - \lambda)^2 - 2) = 0$$

$$(a - \lambda)((a - \lambda)^2 - (\sqrt{2})^2) = 0$$

$$(a - \lambda)(a - \lambda + \sqrt{2})(a - \lambda - \sqrt{2}) = 0$$

Eigen values ,
 $\lambda = a, a + \sqrt{2}, a - \sqrt{2}$

6 votes

-- Praveen Saini (38.4k points)

12.2.4 Eigen Value: GATE2015-2_5 top

<http://gateoverflow.in/8051>



Selected Answer

For finding the Eigen Values of a Matrix we need to build the Characteristic equation which is of the form,

$$A - \lambda I$$

Where A is the given Matrix.

λ is a constant

I is the identity matrix.

We'll have a Linear equation after solving $A - \lambda I$. Which will give us 2 roots for λ .

$$(4-\lambda)(1-\lambda) - 10 = 0$$

$$4 - 5\lambda + \lambda^2 = 10$$

$$\lambda^2 - 5\lambda - 6 = 0$$

$$(\lambda - 6)(\lambda + 1) = 0$$

So $\lambda = -1, 6$.

6 is larger and hence is the Answer.

12 votes

-- Gate Keeda (17.7k points)

12.2.5 Eigen Value: GATE2015-1_36 top

<http://gateoverflow.in/8285>



Selected Answer

$$\begin{array}{ll} \text{Sum of Eigens} & = \text{trace of matrix} \\ -1 + 7 & = 1 + a \\ \text{Product of Eigens} = \text{Determinant of matrix} & \\ -1 \times 7 & = a - 4b \end{array}$$

this gives $a = 5$ and $b = 3$

answer = option D

10 votes

-- Amar Vashishth (20.7k points)

12.2.6 Eigen Value: GATE 2016-2-06 [top](#)

<http://gateoverflow.in/3959>



Selected Answer

Determinant of Matrix A = product of eigen values =
 $1 \times 2 \times 4 = 8$

Determinant of Inverse Matrix of A,
 $\det(A^{-1}) = \frac{1}{\det(A)} = \frac{1}{8}$

Determinant remains same after the Transpose

so, Determinant of
 $(A^{-1})^T =$
 $\det(A^{-1}) = \frac{1}{8} = 0.125$

13 votes

-- Praveen Saini (38.4k points)

12.2.7 Eigen Value: GATE2007_25 [top](#)

<http://gateoverflow.in/254>



Selected Answer

Ans is (C) 2

$Ax = \lambda x$, where λ is the eigen value of A . Hence $(A - \lambda I)x = 0$ or

|

$A -$

So, for our given matrix, we have

$$\begin{bmatrix} A - \lambda I & I \\ I & A - \lambda I \end{bmatrix} = 0$$

This is a

2×2 block matrix where the first and last and the second and third elements are the same. So, applying the formula for determinant of a block matrix as given here (second last case) https://en.wikipedia.org/wiki/Determinant#Block_matrices we get

$$|A - \lambda I - I| \times |A - \lambda I + I| = 0$$

$$\implies |A - (\lambda + 1)I| \times |A - (\lambda - 1)I| = 0$$

Each of the eigen value of A is the solution of the equation $|A - \alpha I| = 0$ (α being the eigen value of A). So, we can equate $\lambda + 1$ and $\lambda - 1$ to any of the eigen value of A , and that will get our value of λ . If we take $\alpha = 1$, we get $\lambda = 2$, and that is one of the choice. For no other choice, this equation holds. So, (c) 2 is the answer.

10 votes

-- Keith Kr (6k points)

12.2.8 Eigen Value: GATE 2016-1-05 [top](#)

<http://gateoverflow.in/39634>



Selected Answer

Given two eigen values are $(2+i)$ and $3..$ since it is a real matrix the 3rd eigen value is $2-i$
determinant of $P =$ product of eigen values.
Solving we get,

Answer 15.

Up 22 votes

-- Abhilash Panicker (7k points)

12.2.9 Eigen Value: GATE2011_40 [top](#)

<http://gateoverflow.in/2142>



Selected Answer

Answer is **A.**

The given matrix is a upper triangular matrix and the eigenvalues of upper or lower traingular matrix are the diagonal values itself. (Property)

Up 9 votes

-- Sona Praneeth Akula (3.8k points)

12.2.10 Eigen Value: GATE2005_49 [top](#)

<http://gateoverflow.in/1174>



Selected Answer

Let the eigen values be a,b

Sum of Eigen Values = Trace(Diagonal Sum)

$$\Rightarrow a+b = 2+5 = 7$$

Product of Eigen Values = Det(A)

$$\Rightarrow a.b = 6$$

Solving these we get **1 and 6..** So, **Option(B)** is **Correct ..**

Up 5 votes

-- Himanshu Agarwal (9.8k points)

12.2.11 Eigen Value: GATE2014-3_4 [top](#)

<http://gateoverflow.in/2038>



Selected Answer

Trace is the sum of all diagonal elements of a square matrix.
Determinant of a matrix = Product of eigen values.

A) Is the right answer. To have the determinant negative ,atleast one eigen value has to be negative(but reverse may not be true).

{you can take simple example with upper or lower triangular matrices. In the case option (b) , (c) and (d) reverse is always true .}

Up 10 votes

-- Srinath Sri (2.9k points)

12.2.12 Eigen Value: GATE2008-28 [top](#)

<http://gateoverflow.in/426>



Selected Answer

Characteristic equation is $|A - \lambda I| = 0$

(1)

$$\begin{vmatrix} 1-\lambda & 0 \\ 0 & -\lambda \end{vmatrix} = 0$$

$$(1-\lambda)(-\lambda) = 0$$

$$\lambda = 0, 1$$

$$\text{Similarly, (2)} \quad \lambda = 0, 0$$

$$(3) \lambda \neq 1$$

$$(4) \lambda = 0, -2$$

Therefore, Answer is (A) one

Upvotes: 6

-- Keith Kr (6k points)

12.2.13 Eigen Value: GATE1993_01.1 [top](#)

<http://gateoverflow.in/596>

Answer: B, D

Eigen values are: 0,0,0

The eigen vector should satisfy the equation: $\alpha z = 0$

Upvotes: 2

-- Rajarshi Sarkar (29.7k points)

12.2.14 Eigen Value: GATE2014-2_47 [top](#)

<http://gateoverflow.in/2013>



Selected Answer

We can see that the rank of the given matrix is 2 (since 3 rows are same, and other 2 rows are also same). Sum of eigen values = sum of diagonals. So, we have two eigen values which sum to 5. This information can be used to get answer in between the following solution.

Let Eigen value be X. Now, equating the determinant of the following to 0 gives us the values for X. To find X in the following matrix, we can equate the determinant to 0. For finding the determinant we can use row and column additions and make the matrix a triangular one. Then determinant will just be the product of the diagonals which should equate to 0.

$$\begin{array}{ccccc} 1-X & 0 & 0 & 0 & 1 \\ 0 & 1-X & 1 & 1 & 0 \\ 0 & 1 & 1-X & 1 & 0 \\ 0 & 1 & 1 & 1-X & 0 \\ 1 & 0 & 0 & 0 & 1-X \end{array}$$

$$R1 \leftarrow R1 + R5, R4 \leftarrow R4 - R3$$

$$\begin{array}{ccccc} 2-X & 0 & 0 & 0 & 2-X \\ 0 & 1-X & 1 & 1 & 0 \\ 0 & 1 & 1-X & 1 & 0 \\ 0 & 0 & X & -X & 0 \end{array}$$

$$\begin{array}{ccccc} 1 & 0 & 0 & 0 & 1-X \end{array}$$

Taking X out from R4, 2-X from R1, (so, X = 2 is one eigen value)

$$\begin{array}{ccccc} 1 & 0 & 0 & 0 & 1 \\ 0 & 1-X & 1 & 1 & 0 \\ 0 & 1 & 1-X & 1 & 0 \\ 0 & 0 & 1 & -1 & 0 \\ 1 & 0 & 0 & 0 & 1-X \end{array}$$

$R2 \leftarrow R2 - R3, R5 \leftarrow R5 - R1$

$$\begin{array}{ccccc} 1 & 0 & 0 & 0 & 1 \\ 0 & -X & X & 0 & 0 \\ 0 & 1 & 1-X & 1 & 0 \\ 0 & 0 & 1 & -1 & 0 \\ 0 & 0 & 0 & 0 & -X \end{array}$$

$C3 \leftarrow C3 + C4$

$$\begin{array}{ccccc} 1 & 0 & 0 & 0 & 1 \\ 0 & -X & X & 0 & 0 \\ 0 & 1 & 2-X & 1 & 0 \\ 0 & 0 & 0 & -1 & 0 \\ 0 & 0 & 0 & 0 & -X \end{array}$$

Taking X out from R2

$$\begin{array}{ccccc} 1 & 0 & 0 & 0 & 1 \\ 0 & -1 & 1 & 0 & 0 \\ 0 & 1 & 2-X & 1 & 0 \\ 0 & 0 & 0 & -1 & 0 \\ 0 & 0 & 0 & 0 & -X \end{array}$$

$R3 \leftarrow R3 + R2$

$$\begin{array}{ccccc} 1 & 0 & 0 & 0 & 1 \\ 0 & -1 & 1 & 0 & 0 \\ 0 & 0 & 3-X & 1 & 0 \\ 0 & 0 & 0 & -1 & 0 \\ 0 & 0 & 0 & 0 & -X \end{array}$$

Now, we got a triangular matrix and determinant of a triangular matrix is product of the diagonal.

So $(3-X)(-X) = 0 \Rightarrow X = 3 \text{ or } X = 0$. So, X = 3 is another eigen value and product of non-zero eigen values = $2 * 3 = 6$.

<https://people.richland.edu/james/lecture/m116/matrices/determinant.html>

16 votes

-- Arjun Suresh (150k points)

12.2.15 Eigen Value: GATE2014-1_5 top

<http://gateoverflow.in/1760>



Selected Answer

Answer to this question is ZERO.

This is because eigen vectors corresponding to DIFFERENT eigen values of a REAL symmetric matrix are ORTHOGONAL to each other.

However, same eigen values they may not be.

And Dot -product of orthogonal vectors(perpendicular vectors) is 0 (ZERO)

For more info see the link: <http://math.stackexchange.com/questions/82467/eigenvectors-of-real-symmetric-matrices-are-orthogonal>

8 votes

-- Sandeep_Uniyal (5.5k points)

12.2.16 Eigen Value: GATE2002_5a top<http://gateoverflow.in/858>

Selected Answer

5(a) the eigen value for upper triangular/lower triangular/diagonal matrices are the diagonal elements of the matrix

6 votes

-- Madhur Rawat (2.4k points)

12.2.17 Eigen Value: GATE2010-29 top<http://gateoverflow.in/1155>

Selected Answer

Sum of eigen values is equal to trace(sum of diagonal elements), and product of eigen values is equal to det of matrix

So $2+y=8+4$ $y=10$

$2y-3x=32$

Solving this we get

$x=-4$

Option d is ans

6 votes

-- Pooja (25.9k points)

12.3**Matrices** top**12.3.1 Matrices: TIFR2015-A-14** top<http://gateoverflow.in/2958>

Consider the following 3×3 matrices.

$$M_1 = \begin{pmatrix} 0 & 1 & 1 \\ 1 & 0 & 1 \\ 1 & 1 & 0 \end{pmatrix}$$

$$M_2 = \begin{pmatrix} 1 & 0 & 1 \\ 0 & 0 & 0 \\ 1 & 0 & 1 \end{pmatrix}$$

How many $0 - 1$ column vectors of the form

$$X = \begin{pmatrix} x_1 \\ x_2 \\ x_3 \end{pmatrix}$$

are there such that $M_1 X = M_2 X$ (modulo 2)? (modulo 2 means all operations are done modulo 2, i.e., $3 = 1$ (modulo 2), $4 = 0$ (modulo 2)).

- a. None
- b. Two
- c. Three
- d. Four
- e. Eight

[tifr2015](#) [matrices](#)

Answer

12.3.2 Matrices: TIFR2013-B-3 top<http://gateoverflow.in/25659>

How many 4×4 matrices with entries from 0, 1 have odd determinant?

Hint: Use modulo 2 arithmetic.

- a. 20160
- b. 32767
- c. 49152
- d. 57343
- e. 65520

[tifr2013](#) [linear-algebra](#) [matrices](#)

[Answer](#)

12.3.3 Matrices: TIFR2012-B-12 [top](#)

<http://gateoverflow.in/25141>

Let A be a matrix such that $A^k = 0$. What is the inverse of $I - A$?

- a. 0
- b. I
- c. A
- d. $1 + A + A^2 + \dots + A^{k-1}$
- e. Inverse is not guaranteed to exist.

[tifr2012](#) [linear-algebra](#) [matrices](#)

[Answer](#)

12.3.4 Matrices: TIFR2010-A-5 [top](#)

<http://gateoverflow.in/18216>

A is symmetric positive definite matrix (i.e., $x^T Ax > 0$ for all non zero x). Which of the following statements is false?

- a. At least one element is positive.
- b. All eigen values are positive real.
- c. Sum of the diagonal elements is positive.
- d. $\det(A)$ is positive.
- e. None of the above.

[tifr2010](#) [linear-algebra](#) [matrices](#)

[Answer](#)

12.3.5 Matrices: GATE2015-1_18 [top](#)

<http://gateoverflow.in/8241>

In the LU decomposition of the matrix $\begin{bmatrix} 2 & 2 \\ 4 & 9 \end{bmatrix}$, if the diagonal elements of U are both 1, then the lower diagonal entry l_{22} of L is _____.

[gate2015-1](#) [linear-algebra](#) [matrices](#)

[Answer](#)

12.3.6 Matrices: GATE2015-2_27 [top](#)

<http://gateoverflow.in/8131>

Perform the following operations on the matrix $\begin{bmatrix} 3 & 4 & 45 \\ 7 & 9 & 105 \\ 13 & 2 & 195 \end{bmatrix}$

- i. Add the third row to the second row
- ii. Subtract the third column from the first column.

The determinant of the resultant matrix is _____.

[gate2015-2](#)
[linear-algebra](#)
[matrices](#)
[easy](#)
Answer**12.3.7 Matrices: GATE1994_1.9** [top](#)<http://gateoverflow.in/2446>

The rank of matrix $\begin{bmatrix} 0 & 0 & -3 \\ 9 & 3 & 5 \\ 3 & 1 & 1 \end{bmatrix}$ is:

- A. 0
- B. 1
- C. 2
- D. 3

[gate1994](#)
[linear-algebra](#)
[matrices](#)
[easy](#)
Answer**12.3.8 Matrices: GATE2004-IT_36** [top](#)<http://gateoverflow.in/3679>

If matrix $X = \begin{bmatrix} a & 1 \\ -a^2 + a - 1 & 1-a \end{bmatrix}$ and $X^2 - X + I = O$ (I is the identity matrix and O is the zero matrix), then the inverse of X is

- A) $\begin{bmatrix} 1-a & -1 \\ a^2 & a \end{bmatrix}$
- B) $\begin{bmatrix} 1-a & -1 \\ a^2 - a + 1 & a \end{bmatrix}$
- C) $\begin{bmatrix} -a & 1 \\ -a^2 + a - 1 & 1-a \end{bmatrix}$
- D) $\begin{bmatrix} a^2 - a + 1 & a \\ 1 & 1-a \end{bmatrix}$

[gate2004-it](#)
[linear-algebra](#)
[matrices](#)
[normal](#)
Answer**12.3.9 Matrices: GATE1998_2.1** [top](#)<http://gateoverflow.in/1673>

The rank of the matrix given below is:

$$\begin{bmatrix} 1 & 4 & 8 & 7 \\ 0 & 0 & 3 & 0 \\ 4 & 2 & 3 & 1 \\ 3 & 12 & 24 & 2 \end{bmatrix}$$

- A. 3
- B. 1
- C. 2
- D. 4

[gate1998](#)
[linear-algebra](#)
[matrices](#)
[normal](#)
Answer

12.3.10 Matrices: GATE1994_3.12 [top](#)<http://gateoverflow.in/2498>

Find the inverse of the matrix $\begin{bmatrix} 1 & 0 & 1 \\ -1 & 1 & 1 \\ 0 & 1 & 0 \end{bmatrix}$

[gate1994](#) [linear-algebra](#) [matrices](#) [easy](#)
Answer**12.3.11 Matrices: GATE1995_1.24** [top](#)<http://gateoverflow.in/2611>

The rank of the following $(n+1) \times (n+1)$ matrix, where a is a real number is

$$\begin{bmatrix} 1 & a & a^2 & \dots & a^n \\ 1 & a & a^2 & \dots & a^n \\ \vdots & \vdots & \vdots & & \vdots \\ \vdots & \vdots & \vdots & & \vdots \\ 1 & a & a^2 & \dots & a^n \end{bmatrix}$$

- A. 1
- B. 2
- C. n
- D. Depends on the value of a

[gate1995](#) [linear-algebra](#) [matrices](#) [normal](#)
Answer**12.3.12 Matrices: GATE1996_10** [top](#)<http://gateoverflow.in/2762>

Let $A = \begin{bmatrix} a_{11} & a_{12} \\ a_{21} & a_{22} \end{bmatrix}$ and $B = \begin{bmatrix} b_{11} & b_{12} \\ b_{21} & b_{22} \end{bmatrix}$ be two matrices such that $AB = I$. Let $C = A \begin{bmatrix} 1 & 0 \\ 1 & 1 \end{bmatrix}$ and $CD = I$. Express the elements of D in terms of the elements of B .

[gate1996](#) [linear-algebra](#) [matrices](#) [normal](#)
Answer**12.3.13 Matrices: GATE1998_2.2** [top](#)<http://gateoverflow.in/1674>

Consider the following determinant $\Delta = \begin{vmatrix} 1 & a & bc \\ 1 & b & ca \\ 1 & C & ab \end{vmatrix}$

Which of the following is a factor of Δ ?

- A. $a+b$
- B. $a-b$
- C. $a+b+c$
- D. abc

[gate1998](#) [linear-algebra](#) [matrices](#) [normal](#)
Answer**12.3.14 Matrices: GATE2004-IT_32** [top](#)<http://gateoverflow.in/3675>

Let A be an $n \times n$ matrix of the following form.

$$A = \begin{bmatrix} 3 & 1 & 0 & 0 & 0 & \dots & 0 & 0 & 0 \\ 1 & 3 & 1 & 0 & 0 & \dots & 0 & 0 & 0 \\ 0 & 1 & 3 & 1 & 0 & \dots & 0 & 0 & 0 \\ 0 & 0 & 1 & 3 & 1 & \dots & 0 & 0 & 0 \\ \dots & \dots \\ 0 & 0 & 0 & 0 & 0 & \dots & 1 & 3 & 1 \\ 0 & 0 & 0 & 0 & 0 & \dots & 0 & 1 & 3 \end{bmatrix}_{n \times n}$$

What is the value of the determinant of A?

- A. $\left(\frac{5+\sqrt{3}}{2}\right)^{n-1} \left(\frac{5\sqrt{3}+7}{2\sqrt{3}}\right) + \left(\frac{5-\sqrt{3}}{2}\right)^{n-1} \left(\frac{5\sqrt{3}-7}{2\sqrt{3}}\right)$
- B. $\left(\frac{7+\sqrt{5}}{2}\right)^{n-1} \left(\frac{7\sqrt{5}+3}{2\sqrt{5}}\right) + \left(\frac{7-\sqrt{5}}{2}\right)^{n-1} \left(\frac{7\sqrt{5}-3}{2\sqrt{5}}\right)$
- C. $\left(\frac{3+\sqrt{7}}{2}\right)^{n-1} \left(\frac{3\sqrt{7}+5}{2\sqrt{7}}\right) + \left(\frac{3-\sqrt{7}}{2}\right)^{n-1} \left(\frac{3\sqrt{7}-5}{2\sqrt{7}}\right)$
- D. $\left(\frac{3+\sqrt{5}}{2}\right)^{n-1} \left(\frac{3\sqrt{5}+7}{2\sqrt{5}}\right) + \left(\frac{3-\sqrt{5}}{2}\right)^{n-1} \left(\frac{3\sqrt{5}-7}{2\sqrt{5}}\right)$

gate2004-it linear-algebra matrices normal

[Answer](#)

Answers: Matrices

12.3.1 Matrices: TIFR2015-A-14 [top](#)

<http://gateoverflow.in/29588>

Option b

$X'=[0 \ 0 \ 0]$

$X'=[1 \ 1 \ 1]$

0 votes

-- Rasika Sapate (79 points)

12.3.2 Matrices: TIFR2013-B-3 [top](#)

<http://gateoverflow.in/25659>

OPTION a is correct

whenever 1st row is 0 then its determinant is 0 , and similarly if any 2 or more rows are linearly dependent then its $|\det|=0$

In order to find the odd determinant the

1st row must be non zero --> totally(2^{4-1}) possibilities $|0/1 \ 0/1 \ 0/1 \ 0/1|$ like totally=16-1

2nd row must be non zero and not linearly depends on 1st row so--> totally (2^{4-2}) possibilities

for 3rd row it must be non-zero as well as not linearly depends on first 2 rows(not start with 0) --->totally (2^{4-3})

for 4th row -->(2^{4-4})

:: total possibilities=(2^{4-1}) * (2^{4-2}) * (2^{4-3}) * (2^{4-4})=15*14*12*8= **20160** possible

3 votes

-- venky.victory35 (565 points)

12.3.3 Matrices: TIFR2012-B-12 [top](#)

<http://gateoverflow.in/25141>



Selected Answer

Given $A^K = 0$

$$I - A^k = I$$

$$I - A^k = (I - A)(I + A + A^2 + A^3 + \dots + A^{k-1})$$

$$I = (I - A)(I + A + A^2 + A^3 + \dots + A^{k-1})$$

$$(I - A)^{-1} = (I + A + A^2 + A^3 + \dots + A^{k-1})$$

Hence (D) is the Answer.

9 votes

-- Leen Sharma (23k points)

12.3.4 Matrices: TIFR2010-A-5 [top](#)

<http://gateoverflow.in/18216>

Positive Definite matrix means all Eigenvalues are positive i.e. > 0

0 votes

-- Digvijay (35.8k points)

ALL eigenvalues will be positive as $X^TAX > 0$

As eigen values ppositive so the trace of matrix i.e sum of diagonal elements are positive

$\text{Det}(a)$ also positive as all eigen values are positive

Only Option (A) may or may not always follow

A is the answer here

0 votes

-- Uddipto (4.8k points)

12.3.5 Matrices: GATE2015-1_18 [top](#)

<http://gateoverflow.in/8241>



Selected Answer

$$\text{Given, } \begin{bmatrix} l_{11} & 0 \\ l_{21} & l_{22} \end{bmatrix} * \begin{bmatrix} u_{11} & u_{12} \\ 0 & u_{22} \end{bmatrix} = \begin{bmatrix} l_{11} & 0 \\ l_{21} & l_{22} \end{bmatrix} * \begin{bmatrix} 1 & u_{12} \\ 0 & 1 \end{bmatrix} = \begin{bmatrix} 2 & 2 \\ 4 & 9 \end{bmatrix}$$

$$\begin{aligned} L11 &= 2 \\ L11 \cdot U12 &= 2 \\ \text{Solving, } U12 &= 1 \\ L21 &= 4 \\ L21 \cdot U12 + L22 &= 9 \\ \text{Solving, } L22 &= 5 \end{aligned}$$

11 votes

-- GATERush (1.1k points)

12.3.6 Matrices: GATE2015-2_27 [top](#)

<http://gateoverflow.in/8131>



Selected Answer

Answer :- 0, because it is easy to see that first column and third column are multiple of each other.

Third column = First column * 15.

So rank is < 3, so Determinant must be 0.

It stays zero as row & column transformations don't affect determinant.

7 votes

-- Akash (31.7k points)

12.3.7 Matrices: GATE1994_1.9 top

<http://gateoverflow.in/2446>



Selected Answer

Answer: C

Determinant comes out to be 0. So, rank cannot be 3. The minor $\begin{bmatrix} 3 & 5 \\ 1 & 1 \end{bmatrix} \neq 0$. So, rank is 2.

5 votes

-- Rajarshi Sarkar (29.7k points)

12.3.8 Matrices: GATE2004-IT_36 top

<http://gateoverflow.in/369>



Selected Answer

It's a very simple question, We need to calculate the inverse of a 2x2 matrix,

Inverse of a matrix A = $A^{-1} = \text{Adjoint}(A) / \text{determinant of } A$

adjoint of A = [cofactors of A] T , but for 2x2 matrix we have direct formula:

A = $\begin{bmatrix} a & b \\ c & d \end{bmatrix}$ is a 2x2 matrix then

Adjoint of A = $\begin{bmatrix} d & -b \\ -c & a \end{bmatrix}$

$|A| = ad-bc$
so answer is (B)

5 votes

-- Manu Thakur (5.6k points)

12.3.9 Matrices: GATE1998_2.1 top

<http://gateoverflow.in/1673>



Selected Answer

Ans D

4 votes

-- Keith Kr (6k points)

12.3.10 Matrices: GATE1994_3.12 top

<http://gateoverflow.in/2498>



Selected Answer

Answer:

$$\begin{bmatrix} \frac{1}{2} & \frac{-1}{2} & \frac{1}{2} \\ 0 & 0 & 1 \\ \frac{1}{2} & \frac{1}{2} & \frac{-1}{2} \end{bmatrix}$$

5 votes

-- Rajarshi Sarkar (29.7k points)

12.3.11 Matrices: GATE1995_1.24 [top](#)<http://gateoverflow.in/2611>

Selected Answer

Ans is A.

we can eliminate all other rows using row 1. in the last only 1 row will be left.

rank = no of non zero rows = 1

10 votes

-- jayendra (6.6k points)

12.3.12 Matrices: GATE1996_10 [top](#)<http://gateoverflow.in/2762>

$$AB = I$$

$$\text{so, } B = A^{-1}$$

$$\text{now } CD = I$$

$$\text{so, } D = C^{-1}$$

$$\begin{aligned} &= \left(A \cdot \begin{bmatrix} 1 & 0 \\ 1 & 1 \end{bmatrix} \right)^{-1} \\ &= \begin{bmatrix} 1 & 0 \\ 1 & 1 \end{bmatrix}^{-1} \cdot A^{-1} \\ &= \begin{bmatrix} 1 & 0 \\ -1 & 1 \end{bmatrix} \cdot B \\ &= \begin{bmatrix} b_{11} & b_{12} \\ b_{21} - b_{11} & b_{22} - b_{12} \end{bmatrix} \end{aligned}$$

8 votes

-- Sayantan Ganguly (5.3k points)

12.3.13 Matrices: GATE1998_2.2 [top](#)<http://gateoverflow.in/1674>

Selected Answer

Answer is B

R2 \rightarrow R2 - R1R3 \rightarrow R3 - R2you will get $\det = (a-b)(a-c)(b+c)$

in matrix operations, you cannot multiply rows or columns. That will not yield the same matrix. So abc is not correct

4 votes

-- Dhananjay (737 points)

12.3.14 Matrices: GATE2004-IT_32 [top](#)<http://gateoverflow.in/3675>

Best part of this question is don't solve by mathematical procedures. Verification is very easy in this question.

just put n=1 , u ll get a matrix like [3].. find itsdeterminant.. determinant = 3. now check options.

by putting n=1, i am getting following results..

- A. 5
- B. 7
- C. 3
- D. 3

A,B cant be answer..

now check for n=2.

determinant = 9-1 = 8

put n=2 in C,D.

C = 7

D = 8

so D is answer..

9 votes

-- Digvijay (35.8k points)

12.4

System Of Equations top

12.4.1 System Of Equations: GATE2015-3_33 top

<http://gateoverflow.in/8490>

If the following system has non-trivial solution,

$$px + qy + rz = 0$$

$$qx + ry + pz = 0$$

$$rx + py + qz = 0,$$

then which one of the following options is TRUE?

- A. $p - q + r = 0$ or $p = q = -r$
- B. $p + q - r = 0$ or $p = -q = r$
- C. $p + q + r = 0$ or $p = q = r$
- D. $p - q + r = 0$ or $p = -q = -r$

[gate2015-3](#) [linear-algebra](#) [system-of-equations](#) [normal](#)

Answer

12.4.2 System Of Equations: GATE2004_71 top

<http://gateoverflow.in/1065>

How many solutions does the following system of linear equations have?

$$-x + 5y = -1$$

$$x - y = 2$$

$$x + 3y = 3$$

- A. infinitely many
- B. two distinct solutions
- C. unique
- D. none

[gate2004](#) | [linear-algebra](#) | [system-of-equations](#) | [normal](#)

[Answer](#)

12.4.3 System Of Equations: GATE2003_41 [top](#)

<http://gateoverflow.in/932>

Consider the following system of linear equations

$$\begin{pmatrix} 2 & 1 & -4 \\ 4 & 3 & -12 \\ 1 & 2 & -8 \end{pmatrix} \begin{pmatrix} x \\ y \\ z \end{pmatrix} = \begin{pmatrix} \alpha \\ 5 \\ 7 \end{pmatrix}$$

Notice that the second and the third columns of the coefficient matrix are linearly dependent. For how many values of α , does this system of equations have infinitely many solutions?

- (A) 0
- (B) 1
- (C) 2
- (D) 3

[gate2003](#) | [linear-algebra](#) | [system-of-equations](#) | [normal](#)

[Answer](#)

12.4.4 System Of Equations: GATE2014-1_4 [top](#)

<http://gateoverflow.in/1757>

Consider the following system of equations:

$$3x + 2y = 1$$

$$4x + 7z = 1$$

$$x + y + z = 3$$

$$x - 2y + 7z = 0$$

The number of solutions for this system is _____

[gate2014-1](#) | [linear-algebra](#) | [system-of-equations](#) | [numerical-answers](#) | [normal](#)

[Answer](#)

12.4.5 System Of Equations: GATE1998_1.2 [top](#)

<http://gateoverflow.in/1639>

Consider the following set of equations

$$x + 2y = 5 \quad 4x + 8y = 12 \quad 3x + 6y + 3z = 15$$

This set

- A. has unique solution
- B. has no solution
- C. has finite number of solutions
- D. has infinite number of solutions

[gate1998](#) | [linear-algebra](#) | [system-of-equations](#) | [easy](#)

Answer**12.4.6 System Of Equations: TIFR2014-A-1** [top](#)<http://gateoverflow.in/25979>

Consider the reactions



Let n_X, n_Y, n_Z denote the numbers of molecules of chemicals X, Y, Z in the reaction chamber. Then which of the following is conserved by both reactions?

- a. $n_X + n_Y + n_Z$.
- b. $n_X + 7n_Y + 5n_Z$.
- c. $2n_X + 9n_Y - 3n_Z$.
- d. $3n_X - 3n_Y + 13n_Z$.
- e. None of the above.

[tifr2014](#) [linear-algebra](#) [system-of-equations](#)**Answer****12.4.7 System Of Equations: GATE1996_1.7** [top](#)<http://gateoverflow.in/2711>

Let $Ax = b$ be a system of linear equations where A is an $m \times n$ matrix and b is a $m \times 1$ column vector and X is an $n \times 1$ column vector of unknowns. Which of the following is false?

- A. The system has a solution if and only if, both A and the augmented matrix $[Ab]$ have the same rank.
- B. If $m < n$ and b is the zero vector, then the system has infinitely many solutions.
- C. If $m = n$ and b is a non-zero vector, then the system has a unique solution.
- D. The system will have only a trivial solution when $m = n$, b is the zero vector and $\text{rank}(A) = n$.

[gate1996](#) [linear-algebra](#) [system-of-equations](#) [normal](#)**Answer****12.4.8 System Of Equations: GATE2004-IT_6** [top](#)<http://gateoverflow.in/3647>

What values of x, y and z satisfy the following system of linear equations?

$$\begin{bmatrix} 1 & 2 & 3 \\ 1 & 3 & 4 \\ 2 & 2 & 3 \end{bmatrix} \begin{bmatrix} x \\ y \\ z \end{bmatrix} = \begin{bmatrix} 6 \\ 8 \\ 12 \end{bmatrix}$$

- A) $x = 6, y = 3, z = 2$
- B) $x = 12, y = 3, z = -4$
- C) $x = 6, y = 6, z = -4$
- D) $x = 12, y = -3, z = 0$

[gate2004-it](#) [linear-algebra](#) [system-of-equations](#) [easy](#)**Answer****12.4.9 System Of Equations: GATE 2016-2-04** [top](#)<http://gateoverflow.in/39545>

Consider the system, each consisting of m linear equations in n variables.

- I. If $m < n$, then all such systems have a solution.
- II. If $m > n$, then none of these systems has a solution.
- III. If $m = n$, then there exists a system which has a solution.

Which one of the following is **CORRECT**?

- a. I, II and III are true.
- b. Only II and III are true.
- c. Only III is true.
- d. None of them is true.

Consider the systems, each consisting of m linear equations in n variables.

- I. If $m < n$, then all such systems have a solution
- II. If $m > n$, then none of these systems has a solution
- III. If $m = n$, then there exists a system which has a solution

Which one of the following is **CORRECT**?

- (A) I, II and III are true
- (B) Only II and III are true
- (C) Only III is true
- (D) None of them is true

[gate2016-2](#) [linear-algebra](#) [system-of-equations](#) [normal](#)

[Answer](#)

12.4.10 System Of Equations: GATE2005_48 [top](#)

<http://gateoverflow.in/1173>

Consider the following system of linear equations :

$$\begin{aligned} 2x_1 - x_2 + 3x_3 &= 1 \\ 3x_1 + 2x_2 + 5x_3 &= 2 \\ -x_1 + 4x_2 + x_3 &= 3 \end{aligned}$$

The system of equations has

- (A)** no solution **(B)** a unique solution **(C)** more than one but a finite number of solutions **(D)** an infinite number of solutions

[gate2005](#) [linear-algebra](#) [system-of-equations](#) [normal](#)

[Answer](#)

Answers: System Of Equations

12.4.1 System Of Equations: GATE2015-3_33 [top](#)

<http://gateoverflow.in/8490>



Selected Answer

for non-trivial solution

$$|A| = 0$$

where

$$\begin{aligned} |A| &= \begin{bmatrix} p & q & r \\ q & r & p \\ r & p & q \end{bmatrix} = p * (rq - p^2) - q * (q^2 - pr) + r * (qp - r^2) \\ &= prq - p^3 - q^3 + prq + prq - r^3 = 3prq - p^3 - q^3 - r^3 = -(p + q + r)^3 + 3(p + q + r)(pq + qr + pr) \end{aligned}$$

now if you check the options the only options where each individual condition can make $|A| = 0$ zero is C

1 9 votes

-- Tamojit Chatterjee (1.9k points)

12.4.2 System Of Equations: GATE2004_71 [top](#)

<http://gateoverflow.in/1065>

C unique solution..

3 equation , 2 variable.

solve any two equation and check 3rd equation by putting values in 3rd equation.

$x = 9/4$, $y = 1/4$

1 4 votes

-- Digvijay (35.8k points)

12.4.3 System Of Equations: GATE2003_41 [top](#)

<http://gateoverflow.in/932>



Selected Answer

Determinant=0. Therefore apply reduction method on (A|B)

$R_2 \leftarrow R_2 - 2R_1$, $R_3 \leftarrow R_3 - 0.5R_1$, $R_3 \leftarrow R_3 - 1.5R_2$ obtain the resultant matrix

$$\begin{pmatrix} 2 & 1 & -4 & a \\ 4 & 3 & -12 & 5 \\ 1 & 2 & -8 & 7 \end{pmatrix} \rightarrow \begin{pmatrix} 1 & 0.5 & -2 & 0.5a \\ 0 & 1 & -4 & 5 - 2a \\ 0 & 0 & 0 & 2 + 1.5a \end{pmatrix}$$

or infinitely many solutions, we must have $2+1.5a=0$ i.e., $a=-4/3$ so for only 1 value of a , this system has infinitely many solutions. So option (B) is correct.

1 6 votes

-- Keith Kr (6k points)

12.4.4 System Of Equations: GATE2014-1_4 [top](#)

<http://gateoverflow.in/1757>



Selected Answer

Since equation (2) - equation (1) produces equation (4), we have 3 independent equations in 3 variables, hence unique solution.

So answer is 1.

1 5 votes

-- Happy Mittal (9.5k points)

12.4.5 System Of Equations: GATE1998_1.2 [top](#)

<http://gateoverflow.in/1639>



Selected Answer

There are no solutions.

If we multiply 1st equation by 4, we get

$$4x + 8y = 20$$

But 2nd equation says

$$4x + 8y = 12$$

Clearly, there can not be any pair of (x,y) , which satisfies both equations.

8 votes

-- Happy Mittal (9.5k points)

12.4.6 System Of Equations: TIFR2014-A-1 [top](#)

<http://gateoverflow.in/25979>

Basically here we need to find the number of molecules are same before and after the reaction ie. the conservation of mass.

To check that just take options and eliminate one by one. Following is the breakdown of options

In first reaction put the values of option a) $n+2n = 3n$ ie. true for second equation if we put the values we get $2n+n = n$ so option a) is conserving mass for equation 1 but not for equation 2.

similarly eliminating all options we can conclude option b) is correct. As for equation 1 $n + 2*7n = 3*5n$, for equation 2 $2n + 5n = 7n$ so mass is conserved for both reactions.

0 votes

-- curious_karan (11 points)

12.4.7 System Of Equations: GATE1996_1.7 [top](#)

<http://gateoverflow.in/2711>



Selected Answer

Ans would be C because it is a case of linear non-homogeneous equations so by having $m = n$, we can't say that it will have unique solution. Solution depends on rank of matrix \mathbf{A} and matrix $[\mathbf{AB}]$.

If $\text{rank}[\mathbf{A}] = \text{rank}[\mathbf{AB}]$ then it will have solution otherwise no solution

3 votes

-- Vivek sharma (1.3k points)

12.4.8 System Of Equations: GATE2004-IT_6 [top](#)

<http://gateoverflow.in/3647>



Selected Answer

Correct answer is (C). It can be easily verified by keeping the value of variables in the equations.

3 votes

-- suraj (3.7k points)

12.4.9 System Of Equations: GATE 2016-2-04 [top](#)

<http://gateoverflow.in/39545>



Selected Answer

Correct answer => C)

why ?

I) This is false. Consider a system with $m < n$, which are inconsistent like

$$a+b+c = 2$$

$$a+b+c = 3$$

Here $m < n$ but no solution because of inconsistency !

II) $m > n$ but no solution for none of system => What if this system of equations have 2 equations which are dependent ?

$$\text{ex} \Rightarrow a+b = 2$$

$$2a + 2b = 4$$

$$a-b = 0$$

Then $a = 1, b = 1$ is solutions . II) Is false.

III) this is true, $M = 2, N = 2$

$$a+b = 2$$

$$a-b = 0$$

Then $m= 1, n= 1$ Now there exists system which has solution . III) is correct. Answer is C !

8 votes

-- Akash (31.7k points)

12.4.10 System Of Equations: GATE2005_48 [top](#)

<http://gateoverflow.in/1173>



Selected Answer

rank of matrix = rank of augmented matrix = no of unknown = 3
so unique solution..

3 votes

-- Digvijay (35.8k points)

12.5

Vector Space [top](#)

12.5.1 Vector Space: GATE2014-3_5 [top](#)

<http://gateoverflow.in/2039>

If
 V_1 and
 V_2 are
4-dimensional subspaces of a
6-dimensional vector space
 V , then the smallest possible dimension of
 $V_1 \cap V_2$ is ____.

[gate2014-3](#) [linear-algebra](#) [vector-space](#) [normal](#)

[Answer](#)

Answers: Vector Space

12.5.1 Vector Space: GATE2014-3_5 [top](#)

<http://gateoverflow.in/2039>

A 6-dimensional vector space { a1,a2,a3,a4,a5,a6}
Let V_1 be {a1,a2,a3,a4}
and V_2 be {a3,a4,a5,a6}
 $V_1 \cap V_2 = \{a3,a4\}$

This is the smallest possible dimension, which is 2.

The largest possible dimension will be 4 ,when $V_1 = V_2$

10 votes

-- Srinath Sri (2.9k points)

13 Engineering Mathematics Probability (94) [top](#)

13.0.1 GATE2014-EC01-GA10 [top](#)

<http://gateoverflow.in/41499>

You are given three coins: one has heads on both faces, the second has tails on both faces, and the third has a head on one face and a tail on the other. You choose a coin at random and toss it, and it comes up heads. The probability that the other face is tails is

- A. $1/4$
- B. $1/3$
- C. $1/2$
- D. $2/3$

[gate2014-ec01](#)

[Answer](#)

13.0.1 GATE 2011 A fair die is tossed two times. the probability that 2d toss results in value greater than first [top](#)

<http://gateoverflow.in/33714>

[gate2011-ec](#)

[Answer](#)

13.0.2 TIFR 2015 [top](#)

<http://gateoverflow.in/17811>

Consider a 6 sided die with all sides not necessarily equally likely such that probability of an even number is $P(\{2,4,6\}) = 1/2$, probability of a multiple 3 is $P(\{3,6\}) = 1/3$, and probability of 1 is $P(\{1\}) = 1/6$. Given the above conditions choose the strongest (most stringent) condition of the following that must always hold about $P(\{5\})$ the probability of 5?

- a) $P(\{5\}) = 1/6$
- b) $P(\{5\}) \geq 1/6$
- c) $P(\{5\}) \leq 1/6$
- d) $P(\{5\}) \geq 1/3$
- e) None of the above

[tifr](#) [2015](#)

[Answer](#)

Answers:

13.0.1 GATE2014-EC01-GA10 [top](#)

<http://gateoverflow.in/41499>

ans is option B.1/3

1 votes

-- amollawate (25 points)

13.0.1 GATE 2011 A fair die is tossed two times. the probability that 2d toss results in value greater than first [top](#)

<http://gateoverflow.in/33714>



Selected Answer

total outcomes = 36

expected outcomes={\{(1,2),(1,3),(1,4),(1,5),(1,6),(2,3),(2,4),(2,5),(2,6),(3,4),(3,5),(3,6),(4,5),(4,6),(5,6)\}}=15

hence Probability=15/36=5/12

3 votes

-- Daddy's little gal (247 points)

13.0.2 TIFR 2015 top

<http://gateoverflow.in/17821>



Selected Answer

$$P\{3,5\} = 1 - P\{2,4,6\} - P\{1\} = 1/2 - 1/6 = 1/3$$

Can $P\{3\} = 0$? then $P\{6\} = 1/3$ and $P\{2,4\} = 1/2 - 1/3 = 1/6$. And $P\{5\} = 1/3$. Possible. So, option D.

2 votes

-- Arjun Suresh (150k points)

13.1

Bayes Theorem top

13.1.1 Bayes Theorem: GATE2005_51 top

<http://gateoverflow.in/1176>

Box P has 2 red balls and 3 blue balls and box Q has 3 red balls and 1 blue ball. A ball is selected as follows: (i) select a box (ii) choose a ball from the selected box such that each ball in the box is equally likely to be chosen. The probabilities of selecting boxes P and Q are $1/3$ and $2/3$ respectively. Given that a ball selected in the above process is a red ball, the probability that it came from the box P is:

- (A) $4/19$ (B) $5/19$ (C) $2/9$ (D) $19/30$

gate2005 | probability | conditional-probability | bayes-theorem | normal

Answer

13.1.2 Bayes Theorem: GATE2012_33 top

<http://gateoverflow.in/11751>

Suppose a fair six-sided die is rolled once. If the value on the die is 1, 2, or 3, the die is rolled a second time. What is the probability that the sum total of values that turn up is at least 6?

- A. $10/21$
- B. $5/12$
- C. $2/3$
- D. $1/6$

gate2012 | probability | conditional-probability | bayes-theorem | normal

Answer

Answers: Bayes Theorem

13.1.1 Bayes Theorem: GATE2005_51 top

<http://gateoverflow.in/1176>



Selected Answer

The probability of selecting a red ball =

$$(1/3) * (2/5) + (2/3) * (3/4) = 2/15 + 1/2$$

$$= 19/30$$

Probability of selecting a red ball from box P =

$$(1/3) * (2/5) = 2/15$$

Given that a ball selected in the above process is a red ball, the probability that it came from the box P is = $(2/15) / (19/30) = 4/19$

5 votes

-- akash (795 points)

13.1.2 Bayes Theorem: GATE2012_33 [top](#)

<http://gateoverflow.in/1751>



Selected Answer

Here our sample space consists of $3 + 3 * 6 = 21$ events- (4), (5), (6), (1,1), (1,2) ... (3,6).

Favorable cases = (6), (1,5), (1,6), (2, 4), (2, 5), (2, 6), (3, 3), (3,4), (3,5), (3,6)

Required Probability = No. of favorable cases/Total cases = $10/21$

But this is wrong way of doing. Because due to 2 tosses for some and 1 for some, individual probabilities are not the same. i.e., while (6) has $1/6$ probability of occurrence, (1,5) has only $1/36$ probability. So, our required probability

$$= 1/6 + (9 * 1/36) = 5/12$$

9 votes

-- Arjun Suresh (150k points)

13.2

Binomial Distribution [top](#)

13.2.1 Binomial Distribution: GATE2005_52 [top](#)

<http://gateoverflow.in/1177>

A random bit string of length n is constructed by tossing a fair coin n times and setting a bit to 0 or 1 depending on outcomes head and tail, respectively. The probability that two such randomly generated strings are not identical is:

- (A) $\frac{1}{2^n}$ (B) $1 - \frac{1}{n}$ (C) $\frac{1}{n!}$ (D) $1 - \frac{1}{2^n}$

gate2005 | probability | binomial-distribution | easy

Answer

13.2.2 Binomial Distribution: GATE2006_21 [top](#)

<http://gateoverflow.in/982>

For each element in a set of size $2n$, an unbiased coin is tossed. The $2n$ coin tosses are independent. An element is chosen if the corresponding coin toss was a head. The probability that exactly n elements are chosen is

- (A) $\frac{2^n C_n}{4^n}$
 (B) $\frac{2^n C_n}{2^n}$
 (C) $\frac{1}{2^n C_n}$
 (D) $\frac{1}{2}$

gate2006 | probability | binomial-distribution | normal

Answer

13.2.3 Binomial Distribution: GATE2006-IT_22 [top](#)

<http://gateoverflow.in/3561>

When a coin is tossed, the probability of getting a Head is p , $0 < p < 1$. Let N be the random variable denoting the number of tosses till the first Head appears, including the toss where the Head appears. Assuming that successive tosses are independent, the expected value of N is

- A) $1/p$
- B) $1/(1-p)$
- C) $1/p^2$
- D) $1/(1-p^2)$

[gate2006-it](#) [probability](#) [binomial-distribution](#) [expectation](#) [normal](#)

[Answer](#)

13.2.4 Binomial Distribution: GATE2005-IT_32 [top](#)

<http://gateoverflow.in/3778>

An unbiased coin is tossed repeatedly until the outcome of two successive tosses is the same. Assuming that the trials are independent, the expected number of tosses is

- A) 3
- B) 4
- C) 5
- D) 6

[gate2005-it](#) [probability](#) [binomial-distribution](#) [expectation](#) [normal](#)

[Answer](#)

Answers: Binomial Distribution

13.2.1 Binomial Distribution: GATE2005_52 [top](#)

<http://gateoverflow.in/1177>



Selected Answer

answer - D

suppose there are k places within n bit string where mismatch has occurred

probability of this occurring is ${}^n C_k (\text{prob. of mismatch})^k (\text{prob. of match})^{(n-k)} = {}^n C_k (1/2)^k (1/2)^{(n-k)} = {}^n C_k (1/2)^n$

k can range from 1 to n hence required probability sum(${}^n C_k (1/2)^n$) where k ranges from 1 to n

hence $(1/2^n)(2^n - 1)$

Alternatively

Probability of matching at given place $1/2$

there are n places hence probability of matching $1/(2^n)$

hence probability of mismatch $1 - 1/(2^n)$

7 votes

-- ankitrokdeonsns (8.4k points)

13.2.2 Binomial Distribution: GATE2006_21 [top](#)

<http://gateoverflow.in/982>



Selected Answer

answer - A

ways of getting n heads out of $2n$ tries = ${}^{2n}C_n$

probability of getting exactly n heads and n tails = $(1/2^n)(1/2^n)$

number of ways = ${}^{2n}C_n/4^n$

8 votes

-- ankitrokdeonsns (8.4k points)

13.2.3 Binomial Distribution: GATE2006-IT_22 [top](#)



Selected Answer

$$E = 1 \times p + 2 \times (1-p)p + 3 \times (1-p)(1-p)p + \dots$$

multiply both side with $(1-p)$ and subtract:

$$E - (1-p)E = 1 \times p + (1-p)p + (1-p)(1-p)p + \dots$$

$$= p/(1 - (1-p)) = 1 \quad (\text{because it is now forming a GP})$$

$$\Rightarrow (1 - 1 + p)E = 1$$

$$\Rightarrow E = 1/p$$

So, Option (A)...

9 votes

-- Vicky Bajoria (3.4k points)

13.2.4 Binomial Distribution: GATE2005-IT_32 [top](#)



Selected Answer

Answer is (A)

$$E(X) = \sum (X_i * P_i)$$

Where X=no of tosses when you get successive HEAD/TAIL(only one is possible at a time though).

Pi=Probability that you get in X_i tosses.

Now see solution:

You need atleast 2 tosses to get 2 heads/tails. Now see if you throw twice probability to get 2 heads/tails is $1/2$ out of 4 outcomes HT,HH,TH,TT.

Similarly if you get result in 3rd toss that means you did not get in 2nd toss so favourable cases for this can be THH and HTT only out of total 8 outcomes. So probability is $2/8 = 1/\text{square}(2)$.

To generalize ,you can see that in every case you will have only two favourable cases and 2^n sample space. So for n th throw probability is $1/(2^{(n-1)})$.

Now coming to $E(X) = 2 * 1/2 + 3 * 1/4 + 4 * 1/8 + \dots$ till infinity

See this is combined AP-GP, So multiplying $E(X)$ by $1/2$ and subtracting from $E(X)$

$$E(X) = 2 * 1/2 + 3 * 1/4 + 4 * 1/8 + \dots$$

$$0.5 * E(X) = 2 * 1/4 + 3 * 1/8 + \dots$$

subtracting , we get $1/2 * E(X) = 1 + 1/4 + 1/8 + 1/16 + \dots$

$$0.5 * E(X) = 1 + (1/4)/(1-0.5) = 1 + 1/2 = 3/2 \quad (a/1-r)$$

$$E(x) = 3$$

12 votes

-- Sandeep_Uniyal (5.5k points)

13.3**Conditional Probability** [top](#)**13.3.1 Conditional Probability: GATE 2016-2-05** [top](#)<http://gateoverflow.in/39541>

Suppose that a shop has an equal number of LED bulbs of two different types. The probability of an LED bulb lasting more than 100 hours given that it is of Type 1 is 0.7, and given that it is of Type 2 is 0.4. The probability that an LED bulb chosen uniformly at random lasts more than 100 hours is _____.

[gate2016-2](#) [probability](#) [conditional-probability](#) [normal](#)

Answer

13.3.2 Conditional Probability: TIFR2014-A-6 [top](#)<http://gateoverflow.in/25991>

Karan tells truth with probability $1/3$ and lies with probability $2/3$. Independently, Arjun tells truth with probability $3/4$ and lies with probability $1/4$. Both watch a cricket match. Arjun tells you that India won, Karan tells you that India lost. What probability will you assign to India's win?

- a. $1/2$
- b. $2/3$
- c. $3/4$
- d. $5/6$
- e. $6/7$

[tifr2014](#) [probability](#) [conditional-probability](#)

Answer

13.3.3 Conditional Probability: GATE1994_1.4 [top](#)<http://gateoverflow.in/2441>

Let A and B be any two arbitrary events, then, which one of the following is true?

- A. $P(A \cap B) = P(A)P(B)$
- B. $P(A \cup B) = P(A) + P(B)$
- C. $P(A | B) = P(A \cap B)P(B)$
- D. $P(A \cup B) \leq P(A) + P(B)$

[gate1994](#) [probability](#) [conditional-probability](#) [normal](#)

Answer

13.3.4 Conditional Probability: TIFR2012-A-1 [top](#)<http://gateoverflow.in/20938>

Amar and Akbar both tell the truth with probability $3/4$ and lie with probability $1/4$. Amar watches a test match and talks to Akbar about the outcome. Akbar, in turn, tells Anthony, "Amar told me that India won". What probability should Anthony assign to India's win?

- a. $9/16$
- b. $6/16$
- c. $7/16$
- d. $10/16$
- e. None of the above.

[tifr2012](#) [probability](#) [conditional-probability](#)

Answer

13.3.5 Conditional Probability: TIFR2010-A-19 top

<http://gateoverflow.in/18499>

Karan tells truth with probability $\frac{1}{3}$ and lies with probability $\frac{2}{3}$. Independently, Arjun tells truth with probability $\frac{3}{4}$ and lies with probability $\frac{1}{4}$. Both watch a cricket match. Arjun tells you that India won, Karan tells you that India lost. What probability will you assign to India's win?

- a. $\frac{1}{2}$
- b. $\frac{2}{3}$
- c. $\frac{3}{4}$
- d. $\frac{5}{6}$
- e. $\frac{6}{7}$

tifr2010 | probability | conditional-probability

Answer

Answers: Conditional Probability

13.3.1 Conditional Probability: GATE 2016-2-05 top

<http://gateoverflow.in/39541>



Selected Answer

Suppose that a shop has an equal number of LED bulbs of two different types. ==> Therefore

Probability of Taking Type 1 Bulb => 0.5

Probability of Taking Type 2 Bulb => 0.5

The probability of an LED bulb lasting more than 100 hours given that it is of Type 1 is 0.7, and given that it is of Type 2 is 0.4.

Prob(100+ | Type1) => 0.7

Prob(100+ | Type2) => 0.4

$$\text{Prob}(100+) = \text{Prob}(100+ | \text{Type1}) * \text{Prob}(\text{Type1}) + \text{Prob}(100+ | \text{Type2}) * \text{Prob}(\text{Type2})$$

$$= 0.7 * .5 + .4 * .5$$

$$= 0.55$$

9 votes

-- Akash (31.7k points)

13.3.2 Conditional Probability: TIFR2014-A-6 top

<http://gateoverflow.in/25991>



Selected Answer

Probability of India win = $\frac{1}{2}$

Probability of India lost = $\frac{1}{2}$

If really India wins, then Karan lies i.e. = $\frac{2}{3}$ and Arjun tells truth = $\frac{3}{4}$

Now prob. of Karan lies and Arjun tells truth = $\frac{2}{3} * \frac{3}{4} = \frac{1}{2}$

Now prob. of Arjun lies and Karan tells truth = $\frac{1}{4} * \frac{1}{3} = \frac{1}{12}$

so, by Bayes theorem $\frac{1/2 * 1/2}{1/2 * 1/2 + 1/4 * 1/3} = \frac{6}{7}$

$$\frac{1/2 * 1/2}{1/2 * 1/2 + 1/4 * 1/3} = \frac{6}{7}$$

so answer is (e)

3 votes

-- srestha (27.8k points)

13.3.3 Conditional Probability: GATE1994_1.4 [top](#)



Selected Answer

- (a) is true only if events are independent.
- (b) is true only if events are mutually exclusive i.e. $P(A \cap B) = 0$
- (c) is false everywhere
- (d) is always true as $P(A \cup B) = P(A) + P(B) - P(A \cap B)$

Since $P(A \cap B) \geq 0$, $P(A \cup B) \leq P(A) + P(B)$

10 votes

-- Happy Mittal (9.5k points)

13.3.4 Conditional Probability: TIFR2012-A-1 [top](#)



Selected Answer

Option D should be the correct answer.

Consider the following events,

W : India wins,

W^\neg : India does not win (India Lost/ Match Draw/ Match Tie/ Match Suspended etc.)

X : Akbar tells Anthony, "Amar told me that India won"

X^\neg : Akbar tells Anthony, "Amar told me that India did not win"

Given X , we have to find W , that is we have to calculate $P\left(\frac{W}{X}\right)$.

$P\left(\frac{W}{X}\right)$ can be calculated using Bayes's theorem as follows:

$$P\left(\frac{\text{India Wins}}{\text{Akbar tells Anthony "Amar told me that India won"}}\right) = \frac{P\left(\frac{\text{Akbar tells Anthony "Amar told me that India won"}}{\text{India Wins}}\right)}{P\left(\frac{\text{Akbar tells Anthony "Amar told me that India won"}}{\text{India Won}}\right) \cup P\left(\frac{\text{Akbar tells Anthony "Amar told me that India won}}{\text{India didn't win}}\right)}$$

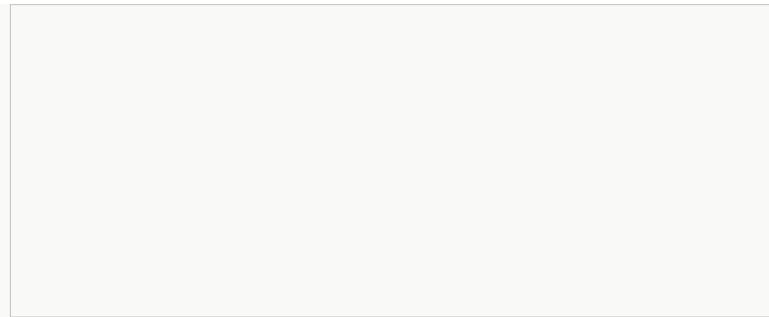
rewriting same equation using the events defined:

$$P\left(\frac{W}{X}\right) = \frac{P\left(\frac{X}{W}\right)}{P\left(\frac{X}{W}\right) + P\left(\frac{X}{W^\neg}\right)}$$

Calculation of

$P\left(\frac{X}{W}\right)$ and $P\left(\frac{X}{W^\neg}\right)$:

All the 8 possible events can be described using the following tree diagram:



$$P\left(\frac{X}{W}\right) = P\left(\frac{\text{Case 1}}{W}\right) \cup P\left(\frac{\text{Case 4}}{W}\right)$$

$$P\left(\frac{\text{Case 1}}{W}\right) = \frac{3}{4} \times \frac{3}{4} = \frac{9}{16}$$

$$P\left(\frac{\text{Case 4}}{W}\right) = \frac{1}{4} \times \frac{1}{4} = \frac{1}{16}$$

$$\text{So } P\left(\frac{X}{W}\right) = \frac{9}{16} + \frac{1}{16} = \frac{10}{16}$$

$$P\left(\frac{X}{W^\neg}\right) = P\left(\frac{\text{Case 6}}{W^\neg}\right) \cup P\left(\frac{\text{Case 7}}{W^\neg}\right)$$

$$P\left(\frac{\text{Case 6}}{W^\neg}\right) = \frac{3}{4} \times \frac{1}{4} = \frac{3}{16}$$

$$P\left(\frac{\text{Case 7}}{W^\neg}\right) = \frac{1}{4} \times \frac{3}{4} = \frac{3}{16}$$

$$\text{So } P\left(\frac{X}{W^\neg}\right) = \frac{3}{16} + \frac{3}{16} = \frac{6}{16}$$

$$\text{Hence } P\left(\frac{W}{X}\right) = \frac{\frac{10}{16}}{\frac{10}{16} + \frac{6}{16}} = \frac{10}{16}.$$

1 votes

-- Anurag Pandey (9.7k points)

there are two cases in which India win:

- 1) Akbar tells the truth and Amar tells the truth : $3/4 \times 3/4 = 9/16$
- 2) Akbar tells a lie that India loose and Amar tells lie to Anthony that "Akbar told me India win" : $1/4 \times 1/4 = 1/16$

So total probability of winning India would be $9/16 + 1/16 = 10/16$

Source : <http://www.careercup.com/question?id=13438685>

I felt this is easy to understand.

1 votes

-- Prasanna Ranganathan (2.5k points)

13.3.5 Conditional Probability: TIFR2010-A-19 [top](#)

<http://gateoverflow.in/18499>



Selected Answer

2/3 must be the correct answer.

Consider four events W, L, T, X

W: India wins.

L: India loses.

T: Match ties.

X: Arjun says India has won & Karan says India has lost.

We have to find the probability of India's win, given that Arjun says India has won & Karan says India has lost.

i.e. We have to find $P(W | X)$.

Now there are three cases:

1. India wins & Arjun says India has won and Karan says India has lost i.e. $P(X | W)$ or
2. India loses & Arjun says India has won and Karan says India has lost. $P(X | L)$ or
3. Match Ties & Arjun says India has won and Karan says India has lost. $P(X | T)$ or

$P(X | W) =$ Given that India has won, what is the probability that Arjun says India has won & Karan says India has lost.

= the probability that Arjun says truth and Karan lies.

$$= (3/4) \times (2/3) = (1/2)$$

$P(X | L) =$ Given that India has lost, what is the probability that Arjun says India has won & Karan says India has lost.

= the probability that Arjun lies & Karan says truth.

$$= (1 / 4) \times (1 / 3) = (1/12)$$

$P(X | T) =$ Given that match has been tied , what is the probability that Arjun says India has won & Karan says India has lost.

= the probability that Arjun lies & Karan lies.

$$= (1 / 4) \times (2 / 3) = (2/12)$$

Using Bayes's theorem,

$$P(W | X) = P(X | W) / \{P(X | W) + P(X | L) + P(X | T)\}$$

$$= (1 / 2) / \{(1/2) + (1/12) + (2/12)\}$$

$$= (6/12)/(9/12)$$

$$= 6/9 = 2/3.$$

Hence the probability of India's win, given that Arjun says India has won & Karan says India has lost is 2/3.

3 votes

-- Anurag Pandey (9.7k points)

13.4

Expectation top

13.4.1 Expectation: GATE2014-2_2 top

<http://gateoverflow.in/1954>

Each of the nine words in the sentence

"The quick brown fox jumps over the lazy dog" is written on a separate piece of paper. These nine pieces of paper are kept in a box. One of the pieces is drawn at random from the box. The *expected* length of the word drawn is _____. (The answer should be rounded to one decimal place.)

gate2014-2 probability expectation numerical-answers easy

Answer

13.4.2 Expectation: TIFR2015-A-6 top

<http://gateoverflow.in/29567>

Ram has a fair coin, i.e., a toss of the coin results in either head or tail and each event happens with probability exactly half ($1/2$). He repeatedly tosses the coin until he gets heads in two consecutive tosses. The expected number of coin tosses that Ram does is.

- A. 2
- B. 4
- C. 6
- D. 8
- E. None of the above.

tifr2015 expectation

Answer

13.4.3 Expectation: TIFR2014-A-17 [top](#)<http://gateoverflow.in/27111>

A fair dice (with faces numbered $1, \dots, 6$) is independently rolled repeatedly. Let X denote the number of rolls till an even number is seen and let Y denote the number of rolls till 3 is seen. Evaluate $E(Y|X = 2)$.

- A. $6\frac{5}{6}$
- B. 6
- C. $5\frac{1}{2}$
- D. $6\frac{1}{3}$
- E. $5\frac{2}{3}$

[tifr2014](#) [expectation](#)**Answer****13.4.4 Expectation: GATE2013_24** [top](#)<http://gateoverflow.in/1535>

Consider an undirected random graph of eight vertices. The probability that there is an edge between a pair of vertices is $1/2$. What is the expected number of unordered cycles of length three?

- (A) $1/8$
- (B) 1
- (C) 7
- (D) 8

[gate2013](#) [probability](#) [expectation](#) [normal](#)**Answer****13.4.5 Expectation: GATE2006_18** [top](#)<http://gateoverflow.in/979>

We are given a set $X = \{X_1, \dots, X_n\}$ where $X_i = 2^i$. A sample $S \subseteq X$ is drawn by selecting each X_i independently with probability $P_i = \frac{1}{2}$. The expected value of the smallest number in sample S is:

- (A) $\frac{1}{n}$
- (B) 2
- (C) \sqrt{n}
- (D) n

[gate2006](#) [probability](#) [expectation](#) [normal](#)**Answer****13.4.6 Expectation: TIFR2011-A-6** [top](#)<http://gateoverflow.in/20011>

Assume that you are flipping a fair coin, i.e. probability of heads or tails is equal. Then the expected number of coin flips required to obtain two consecutive heads for the first time is.

- a. 4
- b. 3
- c. 6
- d. 10
- e. 5

[tifr2011](#) [probability](#) [expectation](#)**Answer****13.4.7 Expectation: GATE2002_2.10** [top](#)<http://gateoverflow.in/840>

Consider the following algorithm for searching for a given number x in an unsorted array $A[1..n]$ having n distinct values:

1. Choose an i at random from $1..n$
2. If $A[i] = x$, then Stop else Goto 1;

Assuming that x is present in A , what is the expected number of comparisons made by the algorithm before it terminates?

- (A) n
- (B) $n - 1$
- (C) $2n$
- (D) $\frac{n}{2}$

[gate2002](#) [probability](#) [expectation](#) [normal](#)

[Answer](#)

13.4.8 Expectation: GATE2004_74 [top](#)

<http://gateoverflow.in/1068>

An examination paper has 150 multiple choice questions of one mark each, with each question having four choices. Each incorrect answer fetches -0.25 marks. Suppose 1000 students choose all their answers randomly with uniform probability. The sum total of the expected marks obtained by all these students is

- A. 0
- B. 2550
- C. 7525
- D. 9375

[gate2004](#) [probability](#) [expectation](#) [normal](#)

[Answer](#)

Answers: Expectation

13.4.1 Expectation: GATE2014-2_2 [top](#)

<http://gateoverflow.in/1954>



Selected Answer

Each of the nine words have equal probability. So, expected length
 $= 3 \times \frac{1}{9} + 5 \times \frac{1}{9} + 5 \times \frac{1}{9} + 3 \times \frac{1}{9} + 5 \times \frac{1}{9} + 4 \times \frac{1}{9} + 3 \times \frac{1}{9} + 4 \times \frac{1}{9} + 3 \times \frac{1}{9}$
 $= \frac{35}{9}$
 $= 3.9$

7 votes

-- Arjun Suresh (150k points)

13.4.2 Expectation: TIFR2015-A-6 [top](#)

<http://gateoverflow.in/2957>



Selected Answer

Let x be the Expected Number of tosses.

If we get a tail immediately (Probability $\frac{1}{2}$) then the Expected number = $(x+1)$

If we get a head then a tail (Probability $\frac{1}{4}$) then the Expected number = $(x+2)$

If first 2 tosses are head then the Expected number = 2

Thus

$$\begin{aligned} x &= \\ \frac{1}{2} (x+1) + \\ \frac{1}{4} (x+2) + \\ \frac{1}{4} 2 \end{aligned}$$

$$\begin{aligned} \frac{1}{4} x &= \\ \frac{3}{2} x \end{aligned}$$

$$x=6$$

Hence (c) 6 is the Answer.

5 votes

-- Leen Sharma (23k points)

13.4.3 Expectation: TIFR2014-A-17 [top](#)

<http://gateoverflow.in/27111>

X : The value of X denotes the number of rolls till an even number is seen.

Y: The value of Y denotes the number of rolls till a 3 is seen.

For example:

X = 2 implies an even number first time occurred on second roll, or outcome of the first roll is odd & outcome of the second roll is even.

Y = 4 implies 3 appeared for first time in the 4th die roll.

Ranges of Random Variables X & Y

X : { 1, 2, 3, ..., infinite}

Y: {1, 2, 3, ..., infinite}

E[Y| X = 2] :Expected number of rolls till a 3 is seen given that an even number appeared for the first time in the second roll.

It is sure that 3 can't appear on 2nd toss, i.e. P[Y = 2|X = 2] = 0 and henceforth E[Y = 2|X = 2] = 0 :

Now there are two cases possible

Case 1: 3 appears on the first toss given that outcome of first toss is odd.

i.e. E[Y = 1|X = 2]

here we need not to concern about outcomes of rolls other than the first roll.

Probability of getting 3 in first toss given that o/c of the first toss is odd=P(Y = 1| X = 2) = 1/3 = 0.33

So Expectation E[Y = 1| X = 2] = y* P(Y = 1| X = 2) = 1 * 0.33 = 0.33

Case 2: 3 appears on any toss after the second toss given that outcome of first toss is odd, & that of second toss is even

P[Y = y | X = 2] = given that 1st roll is an odd number and 2nd roll is an even number, Probability that out of y rolls,

None of the first (y - 1) roll's outcome is 3 &

Outcome of the yth roll is 3.

So P[Y = y | X = 2] = (2/3){ for first o/c odd but not 3} x (5/6)^{y-3} {for not getting a 3 from 3rd to (y - 1)th rolls}x(1/6){for yth o/c to be 3}.

$$P[Y = y | X = 2] = (2/3)x(5/6)^{y-3}x(1/6)$$

So $E[Y = y | X = 2] = \text{Summation from } y = 3 \text{ to infinity}(y * P(Y = y | X = 2)) = 5.33$ (where $y \geq 3$)

This summation will give sum of all the expectations from $Y = 3$ to infinity.

Now

Net Expectation is given as:

$$E[Y = y | X = 2] = E[Y = 1 | X = 2] + E[Y = 2 | X = 2] + E[Y = y' | X = 2] \text{ where } y' \geq 3.$$

Putting all the values,

$$E[Y = y | X = 2] = 0.33 + 0 + 5.33$$

$$\text{So } E[Y = y | X = 2] = 5.66 = 17/3.$$

5 votes

-- Anurag Pandey (9.7k points)

13.4.4 Expectation: GATE2013_24 [top](#)

<http://gateoverflow.in/1535>



Selected Answer

A cycle of length 3 requires 3 vertices.

Number of ways in which we can choose 3 vertices from 8 = ${}^8C_3 = 56$.

Probability that 3 vertices form a cycle = Probability of edge between vertices 1 and 2 * Probability of edge between vertices 2 and 3 * Probability of edge between vertices 1 and 3

$$= 1/2 * 1/2 * 1/2 = 1/8$$

So, expected number of cycles of length 3 = $56 * 1/8 = 7$

ref@ <http://stackoverflow.com/questions/14801072/number-of-cycles-in-a-random-graph>

17 votes

-- Arjun Suresh (150k points)

13.4.5 Expectation: GATE2006_18 [top](#)

<http://gateoverflow.in/979>



Selected Answer

The smallest element in sample S would be X_i for which i is smallest.

The given probability is for selection of each item of X . Independent selection means each item is selected with probability $\frac{1}{2}$.

Probability for X_1 to be smallest in $S = \frac{1}{2}$.

Value of $X_1 = 2$.

Probability for X_2 to be smallest in $S = \text{Probability of } X_1 \text{ not being in } S \times \text{Probability of } X_2 \text{ being in } S = \frac{1}{2} \cdot \frac{1}{2}$.

Value of $X_2 = 2^2 = 4$.

Similarly, Probability for X_i to be smallest in $S = (1/2)^i$.

Value of $X_i = 2^i$.

$$\text{Now Required Expectation} = \sum_{i=1}^n 2^i \times \left(\frac{1}{2}\right)^i = \sum_{i=1}^n 1 = n.$$

The answer is option D.

7 votes

-- Mari Ganesh Kumar (1.9k points)

13.4.6 Expectation: TIFR2011-A-6 [top](#)

<http://gateoverflow.in/20011>



Selected Answer

Let the expected number of coin flips be X . The case analysis goes as follows:

- a. If the first flip is a tails, then we have wasted one flip. The probability of this event is $\frac{1}{2}$ and the total number of flips required is $X + 1$.
- b. If the first flip is a heads and second flip is a tails, then we have wasted two flips. The probability of this event is $\frac{1}{4}$ and the total number of flips required is $X + 2$. as the same scenario as beginning is there even after 2 tosses.
- c. If the first flip is a heads and second flip is also heads, then we are done. The probability of this event is $\frac{1}{4}$ and the total number of flips required is 2.

Adding, the equation that we get is -

$$X = \frac{1}{2}(X + 1) + \frac{1}{4}(X + 2) + \frac{1}{4}2$$

Solving, we get $X = 6$.

Thus, the expected number of coin flips for getting two consecutive heads is 6.

5 votes

-- Avdhesh Singh Rana (1.7k points)

13.4.7 Expectation: GATE2002_2.10 [top](#)

<http://gateoverflow.in/840>

Selected Answer

Expected number of comparisons (E) = $1 * \text{Probability of find on first comparison} + 2 * \text{Probability of find on second comparison} + \dots + i * \text{Probability of find on } i^{\text{th}} \text{ comparison} + \dots$

$$= 1 \times \frac{1}{n} + 2 \times \frac{n-1}{n^2} + 3 \times \frac{(n-1)^2}{n^3} + \dots$$

$$= \frac{1/n}{1 - \frac{n-1}{n}} + \frac{(n-1)/n^2}{\left(1 - \frac{n-1}{n}\right)^2} \left(\text{Sum to infinity of aritmetico-geometric series with } a = \frac{1}{n}, r = \frac{n-1}{n} \text{ and } d = \frac{1}{n} \right) = 1 + n - 1 = n$$

Ref: https://en.wikipedia.org/wiki/Arithmetico-geometric_sequence

Or we can also do,

$$E = 1 \times \frac{1}{n} + 2 \times \frac{n-1}{n^2} + 3 \times \frac{(n-1)^2}{n^3} + \dots$$

$$E \frac{n-1}{n} = \frac{n-1}{n^2} + 2 \times \frac{(n-1)^2}{n^3} + 3 \times \frac{(n-1)^3}{n^4} + \dots$$

$$E - E \frac{n-1}{n} = \frac{1}{n} + \frac{n-1}{n^2} + \frac{(n-1)^2}{n^3} + \dots$$

$$E \cdot \frac{1}{n} = \frac{(1/n)}{1 - \frac{n-1}{n}} = 1 \left(\text{Sum to infinity of GP with } a = \frac{1}{n} \text{ and } r = \frac{n-1}{n} \right) \implies E = n$$

15 votes

-- Arjun Suresh (150k points)

13.4.8 Expectation: GATE2004_74 [top](#)

<http://gateoverflow.in/1068>

Selected Answer

answer = **option D**

Probability of choosing the correct option = $\frac{1}{4}$

Probability of choosing a wrong option =

$\frac{3}{4}$

So, expected mark for a question for a student = $\frac{1}{4} \times 1 + \frac{3}{4} \times (-0.25) = 0.0625$

Expected mark for a student for 150 questions = $0.0625 \times 150 = 9.375$

So, sum total of the expected marks obtained by all 1000 students = $9.375 \times 1000 = 9375$.

7 votes

-- Arjun Suresh (150k points)

13.5

Exponential Distribution [top](#)13.5.1 Exponential Distribution: GATE2004-IT_33 [top](#)<http://gateoverflow.in/3676>

Let X and Y be two exponentially distributed and independent random variables with mean α and β , respectively. If Z = min(X, Y), then the mean of Z is given by

- A) $(1/(\alpha + \beta))$
- B) $\min(\alpha, \beta)$
- C) $(\alpha\beta/(\alpha + \beta))$
- D) $\alpha + \beta$

[gate2004-it](#) [probability](#) [exponential-distribution](#) [random-variable](#) [normal](#)

Answer

Answers: Exponential Distribution

13.5.1 Exponential Distribution: GATE2004-IT_33 [top](#)<http://gateoverflow.in/3676>

Selected Answer

X is an exponential random variable of parameter λ when its probability distribution function is

$$f(x) = \begin{cases} \lambda e^{-\lambda x} & x \geq 0 \\ 0 & x < 0 \end{cases}$$

For $a > 0$, we have the cumulative distribution function

$$F_x(a) = \int_0^a f(x)dx = \int_0^a \lambda e^{-\lambda x} dx = -e^{-\lambda x} \Big|_0^a = 1 - e^{-\lambda a}$$

So,

$$P\{X < a\} = 1 - e^{-\lambda a}$$

and

$$P\{X > a\} = e^{-\lambda a}$$

Now, we use $P\{X > a\}$ for our problem because our concerned variable Z is **min** of X and Y.

For exponential distribution with parameter λ , mean is given by $\frac{1}{\lambda}$.

We have,

$$P\{X > a\} = e^{-\frac{1}{\lambda}a}$$

$$P\{Y > a\} = e^{-\frac{1}{\beta}a}$$

$$\begin{aligned} P\{Z > a\} &= P\{X > a\} P\{Y > a\} (\because X \text{ and } Y \text{ are independent events and } Z > \min(X, Y)) \\ &= e^{-\frac{1}{\alpha}a} e^{-\frac{1}{\beta}a} \\ \text{So,} \quad &= e^{-\left(\frac{1}{\alpha} + \frac{1}{\beta}\right)a} \\ &= e^{-\left(\frac{\alpha+\beta}{\alpha\beta}\right)a} \end{aligned}$$

This shows that Z is also exponentially distributed with parameter $\frac{\alpha+\beta}{\alpha\beta}$ and mean $\frac{\alpha\beta}{\alpha+\beta}$.

Reference : http://ocw.mit.edu/courses/mathematics/18-440-probability-and-random-variables-spring-2011/lecture-notes/MIT18_440S11_Lecture20.pdf

4 votes

-- Arjun Suresh (150k points)

13.6

Huffman Code top

13.6.1 Huffman Code: TIFR2012-B-7 top

<http://gateoverflow.in/25107>

A bag contains 16 balls of the following colors: 8 red, 4 blue, 2 green, 1 black, and 1 white. Anisha picks a ball randomly from the bag, and messages Babu its color using a string of zeros and ones. She replaces the ball in the bag, and repeats this experiment, many times. What is the minimum expected length of the message she has to convey to Babu per experiment?

- a. $3/2$
- b. $\log 5$
- c. $15/8$
- d. $31/16$
- e. 2

[tifr2012](#) [probability](#) [expectation](#) [huffman-code](#) [greedy-algorithm](#)

Answer

Answers: Huffman Code

13.6.1 Huffman Code: TIFR2012-B-7 top

<http://gateoverflow.in/25107>



Selected Answer

using static huffman compression you can encode the more common colours in fewer bits than the rare colours, that being the case one can expect that common colours will usually be chosen.

eg:

```
red    1
blue   01
green  001
white  0001
black  0000
```

on average from 16 draws there will be

```
8 reds  = 8 bits
4 blues = 8 bits
2 greens = 6 bits
1 white  = 4 bits
1 black  = 4 bits
```

for a total of $30/16 = 15/8$ bits on average

4 votes

-- sudipta roy (289 points)

13.7**Normal Distribution** [top](#)**13.7.1 Normal Distribution: GATE2008-29** [top](#)<http://gateoverflow.in/427>

Let X be a random variable following normal distribution with mean $+1$ and variance 4 . Let Y be another normal variable with mean -1 and variance unknown. If $P(X \leq -1) = P(Y \geq 2)$, the standard deviation of Y is

- A. 3
- B. 2
- C. $\sqrt{2}$
- D. 1

[gate2008](#) [random-variable](#) [normal-distribution](#) [probability](#) [normal](#)

[Answer](#)

Answers: Normal Distribution**13.7.1 Normal Distribution: GATE2008-29** [top](#)<http://gateoverflow.in/427>

Selected Answer

First lets convert both X and Y to Standard normal distribution.

$$Z = X - 1/2$$

$$Z = Y + 1/\sigma$$

Now replace X and Y in $P(X \leq -1) = P(Y \geq 2)$ we get $P(Z \leq -1) = P(Z \geq 3/\sigma)$

Since the Standard Normal Curve is symmetric about the mean(i.e, zero) $-(-1) = 3/\sigma \Rightarrow \sigma = 3$.

Answer is Option A

7 votes

-- Mari Ganesh Kumar (1.9k points)

13.8**Poisson Distribution** [top](#)**13.8.1 Poisson Distribution: GATE2007-IT_57** [top](#)<http://gateoverflow.in/349>

In a multi-user operating system on an average, 20 requests are made to use a particular resource per hour. The arrival of requests follows a Poisson distribution. The probability that either one, three or five requests are made in 45 minutes is given by :

- A. $6.9 \times 10^6 \times e^{-20}$
- B. $1.02 \times 10^6 \times e^{-20}$
- C. $6.9 \times 10^3 \times e^{-20}$
- D. $1.02 \times 10^3 \times e^{-20}$

[gate2007-it](#) [probability](#) [poisson-distribution](#) [normal](#)

[Answer](#)

13.8.2 Poisson Distribution: GATE2013_2 [top](#)<http://gateoverflow.in/62>

Suppose p is the number of cars per minute passing through a certain road junction between 5 PM and 6 PM, and p has a Poisson distribution with mean 3. What is the probability of observing fewer than 3 cars during any given minute in this interval?

- (A) $8/(2e^3)$
 (B) $9/(2e^3)$
 (C) $17/(2e^3)$
 (D) $26/(2e^3)$

gate2013 | probability | poisson-distribution | normal

[Answer](#)

Answers: Poisson Distribution

13.8.1 Poisson Distribution: GATE2007-IT_57 [top](#)

<http://gateoverflow.in/3499>



Selected Answer

20 request in 1 hour.. so we can expect 15 request in 45 minutes...

So, $\lambda = 15$.. (expected value)

poission distribution formula: $f(x, \lambda) = p(X = x) = (\lambda^x * e^{-\lambda}) / x!$

Therefore $p(\text{one request}) + p(3 \text{ request}) + p(5 \text{ request})$

$$= p(1; 15) + p(3; 15) + p(5; 15)$$

$$= 6.9 * 10^3 * e^{-15} ..$$

$$= 6.9 * 10^3 * e^{-15} = 6.9 * 10^3 * e^{5 * -20} = 1.02 * 10^6 * e^{-20} .. \text{ Ans is (B)}$$

6 votes

-- Vicky Bajoria (3.4k points)

13.8.2 Poisson Distribution: GATE2013_2 [top](#)

<http://gateoverflow.in/62>



Selected Answer

Poisson Probability Density Function (with mean λ) = $\lambda^k / (e^\lambda k!)$,

We have to sum the probability density function for $k = 0, 1$ and 2 and $\lambda = 3$ (thus finding the cumulative mass function)

$$= (1/e^3) + (3/e^3) + (9/2e^3)$$

$$= 17/(2e^3)$$

10 votes

-- Arjun Suresh (150k points)

13.9

Probability [top](#)

13.9.1 Probability: GATE1996_2.7 [top](#)

<http://gateoverflow.in/2736>

The probability that top and bottom cards of a randomly shuffled deck are both aces is

- A. $\frac{4}{52} \times \frac{4}{52}$
- B. $\frac{4}{52} \times \frac{3}{52}$
- C. $\frac{4}{52} \times \frac{3}{51}$

D. $\frac{4}{52} \times \frac{4}{51}$

gate1996 | probability | easy

Answer

13.9.2 Probability: TIFR2011-A-9 top

<http://gateoverflow.in/20020>

You have to play three games with opponents A and B in a specified sequence. You win the series if you win two consecutive games. A is a stronger player than B. Which sequence maximizes your chance of winning the series?

- a. AAB
- b. ABA
- c. BAB
- d. BAA
- e. All are the same.

tifr2011 | probability

Answer

13.9.3 Probability: GATE2015-1_29 top

<http://gateoverflow.in/8253>

Consider a LAN with four nodes S_1, S_2, S_3 and S_4 . Time is divided into fixed-size slots, and a node can begin its transmission only at the beginning of a slot. A collision is said to have occurred if more than one node transmit in the same slot. The probabilities of generation of a frame in a time slot by S_1, S_2, S_3 and S_4 are 0.1, 0.2, 0.3 and 0.4 respectively. The probability of sending a frame in the first slot without any collision by any of these four stations is_____.

gate2015-1 | probability | normal

Answer

13.9.4 Probability: GATE1998_1.1 top

<http://gateoverflow.in/1638>

A die is rolled three times. The probability that exactly one odd number turns up among the three outcomes is

- (a) $\frac{1}{6}$
- (b) $\frac{3}{8}$
- (c) $\frac{1}{8}$
- (d) $\frac{1}{2}$

gate1998 | probability | easy

Answer

13.9.5 Probability: GATE2004_78 top

<http://gateoverflow.in/1072>

Two n bit binary strings, S_1 and S_2 are chosen randomly with uniform probability. The probability that the Hamming distance between these strings (the number of bit positions where the two strings differ) is equal to d is

- A. ${}^n C_d / 2^n$
- B. ${}^n C_d / 2^d$
- C. $d / 2^n$
- D. $1 / 2^d$

[gate2004](#)
[probability](#)
[normal](#)
Answer**13.9.6 Probability: TIFR2010-A-6** [top](#)<http://gateoverflow.in/18222>

Given 10 tosses of a coin with probability of head = .4 = (1 - the probability of tail), the probability of at least one head is?

- a. $(.4)^{10}$
- b. $1 - (.4)^{10}$
- c. $1 - (.6)^{10}$
- d. $(.6)^{10}$
- e. $10(.4)(.6)^9$

[tifr2010](#)
[probability](#)
Answer**13.9.7 Probability: TIFR2010-A-10** [top](#)<http://gateoverflow.in/26481>

A drawer contains 2 Blue, 4 Red and 2 Yellow balls. No two balls have the same radius. If two balls are randomly selected from the drawer, what is the probability that they will be of the same colour?

- A. $2/7$
- B. $2/5$
- C. $3/7$
- D. $1/2$
- E. $3/5$

[tifr2010](#)
[probability](#)
Answer**13.9.8 Probability: TIFR2010-A-13** [top](#)<http://gateoverflow.in/18392>

A cube whose faces are colored is split into 1000 small cubes of equal size. The cubes thus obtained are mixed thoroughly. The probability that a cube drawn at random will have exactly two colored faces is:

- a. 0.096
- b. 0.12
- c. 0.104
- d. 0.24
- e. None of the above

[tifr2010](#)
[probability](#)
Answer**13.9.9 Probability: GATE2004_25** [top](#)<http://gateoverflow.in/1022>

If a fair coin is tossed four times. What is the probability that two heads and two tails will result?

- A. $\frac{3}{8}$
- B. $\frac{1}{2}$
- C. $\frac{5}{8}$
- D. $\frac{3}{4}$

gate2004 probability easy

Answer

13.9.10 Probability: TIFR2010-B-38 [top](#)<http://gateoverflow.in/19050>

Suppose three coins are lying on a table, two of them with heads facing up and one with tails facing up. One coin is chosen at random and flipped. What is the probability that after the flip the majority of the coins(i.e., at least two of them) will have heads facing up?

- a. $\frac{1}{3}$
- b. $\frac{1}{8}$
- c. $\frac{1}{4}$
- d. $\frac{1}{4} + \frac{1}{8}$
- e. $\frac{2}{3}$

tifr2010 probability

Answer

13.9.11 Probability: TIFR2011-A-3 [top](#)<http://gateoverflow.in/20000>

The probability of three consecutive heads in four tosses of a fair coin is.

- a. $\frac{1}{4}$
- b. $\frac{1}{8}$
- c. $\frac{1}{16}$
- d. $\frac{3}{16}$
- e. None of the above.

tifr2011 probability

Answer

13.9.12 Probability: GATE2003_60, ISRO2007-45 [top](#)<http://gateoverflow.in/948>

A program consists of two modules executed sequentially. Let $f_1(t)$ and $f_2(t)$ respectively denote the probability density functions of time taken to execute the two modules. The probability density function of the overall time taken to execute the program is given by

- A. $f_1(t) + f_2(t)$
- B. $\int_0^t f_1(x)f_2(x)dx$
- C. $\int_0^t f_1(x)f_2(t-x)dx$
- D. $\max\{f_1(t), f_2(t)\}$

gate2003 probability normal isro2007

Answer

13.9.13 Probability: GATE1995_1.18 [top](#)<http://gateoverflow.in/780>

The probability that a number selected at random between 100 and 999 (both inclusive) will not contain the digit 7 is:

(a) 16/25

(b) $(9/10)^3$

(c) 27/75

(d) 18/25

[gate1995](#) [probability](#) [normal](#)[Answer](#)**13.9.14 Probability: TIFR2011-A-19** [top](#)<http://gateoverflow.in/26479>

Three dice are rolled independently. What is the probability that the highest and the lowest value differ by 4?

- A. $\frac{1}{3}$
- B. $\frac{1}{6}$
- C. $\frac{1}{9}$
- D. $\frac{5}{18}$
- E. $\frac{2}{9}$

[tifr2011](#) [probability](#)[Answer](#)**13.9.15 Probability: GATE2010-26** [top](#)<http://gateoverflow.in/1152>

Consider a company that assembles computers. The probability of a faulty assembly of any computer is p . The company therefore subjects each computer to a testing process. This testing process gives the correct result for any computer with a probability of q . What is the probability of a computer being declared faulty?

- A. $pq + (1 - p)(1 - q)$
- B. $(1 - q)p$
- C. $(1 - q)p$
- D. pq

[gate2010](#) [probability](#) [easy](#)[Answer](#)**13.9.16 Probability: GATE2003_3** [top](#)<http://gateoverflow.in/894>

Let $P(E)$ denote the probability of the event E . Given $P(A) = 1$, $P(B) = 1/2$, the values of $P(A | B)$ and $P(B | A)$ respectively are

- (A) 1/4, 1/2
- (B) 1/2, 1/4
- (C) 1/2, 1
- (D) 1, 1/2

[gate2003](#) [probability](#) [easy](#)[Answer](#)**13.9.17 Probability: TIFR2012-A-9** [top](#)<http://gateoverflow.in/21008>

The probability of throwing six perfect dices and getting six different faces is

- a. $1 - 6!/6^6$
- b. $6!/6^6$

- c. 6^{-6}
d. $1 - 6^{-6}$
e. None of the above.

tifr2012 probability

Answer

13.9.18 Probability: TIFR2012-A-17 top

<http://gateoverflow.in/25042>

A spider is at the bottom of a cliff, and is n inches from the top. Every step it takes brings it one inch closer to the top with probability $1/3$, and one inch away from the top with probability $2/3$, unless it is at the bottom in which case, it always gets one inch closer. What is the expected number of steps for the spider to reach the top as a function of n ?

- a. It will never reach the top.
b. Linear in n .
c. Polynomial in n .
d. Exponential in n .
e. Double exponential in n .

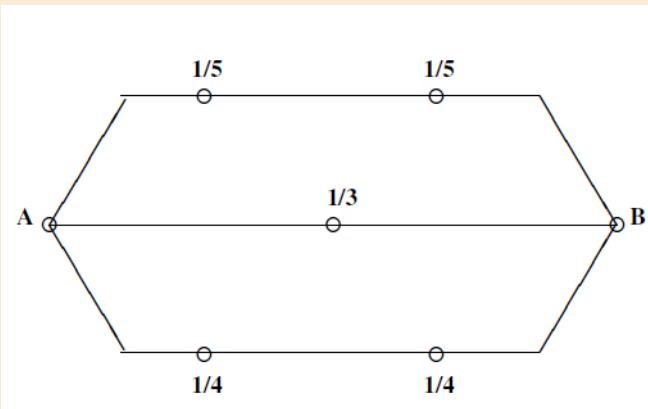
tifr2012 probability

Answer

13.9.19 Probability: TIFR2012-A-19 top

<http://gateoverflow.in/25044>

An electric circuit between two terminals A and B is shown in the figure below, where the numbers indicate the probabilities of failure for the various links, which are all independent.



What is the probability that A and B are connected?

- a. $\frac{6}{25}$
b. $\frac{379}{400}$
c. $\frac{1}{1200}$
d. $\frac{1199}{1200}$
e. $\frac{59}{60}$

tifr2012 probability

Answer

13.9.20 Probability: TIFR2012-A-20 top

<http://gateoverflow.in/25045>

There are 1000 balls in a bag, of which 900 are black and 100 are white. I randomly draw 100 balls from the bag. What is the probability that the 101st ball will be black?

- a. $9/10$
b. More than $9/10$ but less than 1.

- c. Less than $9/10$ but more than 0.
 d. 0
 e. 1

[tifr2012](#) [probability](#)

[Answer](#)

13.9.21 Probability: GATE2002_2.16 [top](#)

<http://gateoverflow.in/846>

Four fair coins are tossed simultaneously. The probability that at least one head and one tail turn up is

- A. $\frac{1}{16}$
 B. $\frac{1}{8}$
 C. $\frac{7}{8}$
 D. $\frac{15}{16}$

[gate2002](#) [probability](#) [easy](#)

[Answer](#)

13.9.22 Probability: TIFR2013-A-4 [top](#)

<http://gateoverflow.in/25386>

A biased coin is tossed repeatedly. Assume that the outcomes of different tosses are independent and probability of heads is $2/3$ in each toss. What is the probability of obtaining an even number of heads in 5 tosses, zero being treated as an even number?

- a. $121/243$
 b. $122/243$
 c. $124/243$
 d. $125/243$
 e. $128/243$

[tifr2013](#) [probability](#)

[Answer](#)

13.9.23 Probability: TIFR2013-A-6 [top](#)

<http://gateoverflow.in/25390>

You are lost in the National park of Kabrastan. The park population consists of tourists and Kabrastanis. Tourists comprise two-thirds of the population the park, and give a correct answer to requests for directions with probability $3/4$. The air of Kabrastan has an amnesiac quality however, and so the answers to repeated questions to tourists are independent, even if the question and the person are the same. If u ask a Kabrastani for directions, the answer is always wrong.

Suppose you ask a randomly chosen passer by whether the exit from the park is East or West. The answer is East. You then ask the same person again, and the reply is again East. What is the probability of East being correct?

- a. $1/4$
 b. $1/3$
 c. $1/2$
 d. $2/3$
 e. $3/4$

[tifr2013](#) [probability](#)

[Answer](#)

13.9.24 Probability: TIFR2013-A-13 [top](#)<http://gateoverflow.in/25435>

Doctors A and B perform surgery on patients in stages III and IV of a disease. Doctor A has performed a 100 surgeries (on 80 stage III and 20 stage IV patients) and 80 out of her 100 patients have survived (78 stage III and 2 stage IV survivors). Doctor B has also performed 100 surgeries (on 50 stage III and 50 stage IV patients). Her success rate is 60/100 (49 stage III survivors and 11 stage IV survivors). A patient has been advised that she is equally likely to be suffering from stage III or stage IV of this disease. Which doctor would you recommend to this patient and why?

- a. Doctor A since she has a higher success rate
- b. Doctor A since she specializes in stage III patients and the success of surgery in stage IV patients is anyway too low
- c. Doctor B since she has performed more stage IV surgeries
- d. Doctor B since she appears to be more successful
- e. There is not enough data since the choice depends on the stage of the disease the patient is suffering from.

[tifr2013](#) [probability](#)**Answer****13.9.25 Probability: TIFR2013-A-14** [top](#)<http://gateoverflow.in/25437>

An unbiased die is thrown n times. The probability that the product of numbers would be even is

- a. $1/(2n)$
- b. $1/[(6n)!]$
- c. $1 - 6^{-n}$
- d. 6^{-n}
- e. None of the above.

[tifr2013](#) [probability](#)**Answer****13.9.26 Probability: TIFR2013-A-17** [top](#)<http://gateoverflow.in/25497>

A stick of unit length is broken into two at a point chosen at random. Then, the larger part of the stick is further divided into two parts in the ratio $4 : 3$. What is the probability that the three sticks that are left CANNOT form a triangle?

- a. $1/4$
- b. $1/3$
- c. $5/6$
- d. $1/2$
- e. $\log_e(2)/2$

[tifr2013](#) [probability](#)**Answer****13.9.27 Probability: GATE2005-IT_1** [top](#)<http://gateoverflow.in/3745>

A bag contains 10 blue marbles, 20 green marbles and 30 red marbles. A marble is drawn from the bag, its colour recorded and it is put back in the bag. This process is repeated 3 times. The probability that no two of the marbles drawn have the same colour is

- | | |
|----|------|
| A) | 1/36 |
| B) | 1/6 |
| C) | 1/4 |
| D) | 1/3 |

[gate2005-it](#) [probability](#) [normal](#)**Answer****13.9.28 Probability: GATE2004-IT_1** [top](#)<http://gateoverflow.in/3642>

In a population of N families, 50% of the families have three children, 30% of the families have two children and the remaining families have one child. What is the probability that a randomly picked child belongs to a family with two children?

- A) $\frac{3}{23}$
- B) $\frac{6}{23}$
- C) $\frac{3}{10}$
- D) $\frac{3}{5}$

[gate2004-it](#) [probability](#) [normal](#)

[Answer](#)

13.9.29 Probability: GATE2009-21 [top](#)

<http://gateoverflow.in/798>

An unbalanced dice (with 6 faces, numbered from 1 to 6) is thrown. The probability that the face value is odd is 90% of the probability that the face value is even. The probability of getting any even numbered face is the same. If the probability that the face is even given that it is greater than 3 is 0.75, which one of the following options is closest to the probability that the face value exceeds 3?

- A. 0.453
- B. 0.468
- C. 0.485
- D. 0.492

[gate2009](#) [probability](#) [normal](#)

[Answer](#)

13.9.30 Probability: GATE1997_1.1 [top](#)

<http://gateoverflow.in/2217>

The probability that it will rain today is 0.5. The probability that it will rain tomorrow is 0.6. The probability that it will rain either today or tomorrow is 0.7. What is the probability that it will rain today and tomorrow?

- A. 0.3
- B. 0.25
- C. 0.35
- D. 0.4

[gate1997](#) [probability](#) [easy](#)

[Answer](#)

13.9.31 Probability: GATE1998_3a [top](#)

<http://gateoverflow.in/1694>

Two friends agree to meet at a park with the following conditions. Each will reach the park between 4:00 pm and 5:00 pm and will see if the other has already arrived. If not, they will wait for 10 minutes or the end of the hour whichever is earlier and leave. What is the probability that the two will not meet?

[gate1998](#) [probability](#) [normal](#)

[Answer](#)

13.9.32 Probability: GATE 2016-1-29 [top](#)

<http://gateoverflow.in/39709>

Consider the following experiment.

Step 1. Flip a fair coin twice.

Step 2. If the outcomes are (TAILS, HEADS) then output Y and stop.

Step 3. If the outcomes are either (HEADS, HEADS) or (HEADS, TAILS), then output N and stop.

Step 4. If the outcomes are (TAILS, TAILS), then go to Step 1.

The probability that the output of the experiment is Y is (up to two decimal places) _____.

gate2016-1 | probability | normal | numerical-answers

Answer

13.9.33 Probability: GATE1999_2.1 [top](#)

<http://gateoverflow.in/1479>

Consider two events E_1 and E_2 such that probability of E_1 , $P_r[E_1] = \frac{1}{2}$, probability of E_2 , $P_r[E_2] = \frac{1}{3}$, and probability of E_1 , and E_2 , $P_r[E_1 \text{ and } E_2] = \frac{1}{5}$. Which of the following statements is/are true?

- A. $P_r[E_1 \text{ or } E_2]$ is $\frac{2}{3}$
- B. Events E_1 and E_2 are independent
- C. Events E_1 and E_2 are not independent
- D. $P_r\left[\frac{E_1}{E_2}\right] = \frac{4}{5}$

gate1999 | probability | normal

Answer

13.9.34 Probability: GATE2014-1_48 [top](#)

<http://gateoverflow.in/1927>

Four fair six-sided dice are rolled. The probability that the sum of the results being 22 is $\frac{X}{1296}$. The value of X is _____.

gate2014-1 | probability | numerical-answers | normal

Answer

13.9.35 Probability: GATE-2014-2_1 [top](#)

<http://gateoverflow.in/1953>

The security system at an IT office is composed of 10 computers of which exactly four are working. To check whether the system is functional, the officials inspect four of the computers picked at random (without replacement). The system is deemed functional if at least three of the four computers inspected are working. Let the probability that the system is deemed functional be denoted by p . Then $100p =$ _____.

gate2014-2 | probability | numerical-answers | normal

Answer

13.9.36 Probability: GATE 2016-1-04 [top](#)

<http://gateoverflow.in/39661>

A probability density function on the interval $[a, 1]$ is given by $1/x^2$ and outside this interval the value of the function is zero. The value of a is _____.

gate2016-1 | probability | normal | numerical-ability

Answer

13.9.37 Probability: GATE2014-2_48 [top](#)

<http://gateoverflow.in/2014>

The probability that a given positive integer lying between 1 and 100 (both inclusive) is NOT divisible by 2, 3 or 5 is _____.

gate2014-2 | probability | numerical-answers | normal

[Answer](#)

13.9.38 Probability: GATE2014-3_48 [top](#)

<http://gateoverflow.in/2082>

Let S be a sample space and two mutually exclusive events A and B be such that $A \cup B = S$. If $P(\cdot)$ denotes the probability of the event, the maximum value of $P(A)P(B)$ is_____.

gate2014-3 | probability | numerical-answers | normal

[Answer](#)

13.9.39 Probability: GATE2011_3 [top](#)

<http://gateoverflow.in/2105>

If two fair coins are flipped and at least one of the outcomes is known to be a head, what is the probability that both outcomes are heads?

- (A) $1/3$
- (B) $1/4$
- (C) $1/2$
- (D) $2/3$

gate2011 | probability | easy

[Answer](#)

13.9.40 Probability: GATE2000-1.1 [top](#)

<http://gateoverflow.in/624>

The minimum number of cards to be dealt from an arbitrarily shuffled deck of 52 cards to guarantee that three cards are from same suit is

- A. 3
- B. 8
- C. 9
- D. 12

gate2000 | probability | easy

[Answer](#)

13.9.41 Probability: GATE2000-2.2 [top](#)

<http://gateoverflow.in/649>

E_1 and E_2 are events in a probability space satisfying the following constraints:

- $\Pr(E_1) = \Pr(E_2)$
- $\Pr(E_1 \cup E_2) = 1$
- E_1 and E_2 are independent

The value of $\Pr(E_1)$, the probability of the event E_1 , is

- A. 0
- B. $1/4$
- C. $1/2$
- D. 1

gate2000 | probability | easy

Answer**13.9.42 Probability: GATE2011_34** [top](#)<http://gateoverflow.in/2136>

A deck of 5 cards (each carrying a distinct number from 1 to 5) is shuffled thoroughly. Two cards are then removed one at a time from the deck. What is the probability that the two cards are selected with the number on the first card being one higher than the number on the second card?

- (A) $1/5$
- (B) $4/25$
- (C) $1/4$
- (D) $2/5$

[gate2011](#) [probability](#) [normal](#)**Answer****13.9.43 Probability: GATE2007-24** [top](#)<http://gateoverflow.in/1222>

Suppose we uniformly and randomly select a permutation from the $20!$ permutations of 1, 2, 3 ... ,20. What is the probability that 2 appears at an earlier position than any other even number in the selected permutation?

- A. $\frac{1}{2}$
- B. $\frac{1}{10}$
- C. $\frac{9!}{20!}$
- D. None of these

[gate2007](#) [probability](#) [easy](#)**Answer****13.9.44 Probability: TIFR2015-A-1** [top](#)<http://gateoverflow.in/29156>

Consider a 6-sided die with all sides not necessarily equally likely such that probability of an even number is $P(\{2, 4, 6\}) = 1/2$, probability of a multiple of 3 is $P(\{3, 6\}) = 1/3$ and probability of 1 is $P(\{1\}) = 1/6$. Given the above conditions, choose the strongest (most stringent) condition of the following that must always hold about $P(\{5\})$, the probability of 5.

- A. $P(\{5\}) = 1/6$
- B. $P(\{5\}) \geq 1/6$
- C. $P(\{5\}) \leq 1/6$
- D. $P(\{5\}) \leq 1/3$
- E. None of the above.

[tifr2015](#) [probability](#)**Answer****13.9.45 Probability: GATE1994_2.6** [top](#)<http://gateoverflow.in/2473>

The probability of an event B is P_1 . The probability that events A and B occur together is P_2 while the probability that A and \bar{B} occur together is P_3 . The probability of the event A in terms of P_1 , P_2 and P_3 is _____

[gate1994](#) [probability](#) [normal](#)**Answer****13.9.46 Probability: GATE1994_2.8** [top](#)<http://gateoverflow.in/2475>

Let A , B and C be independent events which occur with probabilities 0.8, 0.5 and 0.3 respectively. The probability of occurrence of at least one of the event is _____

[gate1994](#) [probability](#) [normal](#)
Answer**13.9.47 Probability: GATE1995_2.14** [top](#)<http://gateoverflow.in/2626>

A bag contains 10 white balls and 15 black balls. Two balls are drawn in succession. The probability that one of them is black and the other is white is:

- A. $\frac{2}{3}$
- B. $\frac{4}{5}$
- C. $\frac{1}{2}$
- D. $\frac{1}{3}$

[gate1995](#) [probability](#) [normal](#)
Answer**13.9.48 Probability: GATE1996_1.5** [top](#)<http://gateoverflow.in/2709>

Two dice are thrown simultaneously. The probability that at least one of them will have 6 facing up is

- A. $\frac{1}{36}$
- B. $\frac{1}{3}$
- C. $\frac{25}{36}$
- D. $\frac{11}{36}$

[gate1996](#) [probability](#) [easy](#)
Answer**13.9.49 Probability: GATE2008-27** [top](#)<http://gateoverflow.in/425>

Aishwarya studies either computer science or mathematics everyday. If she studies computer science on a day, then the probability that she studies mathematics the next day is 0.6. If she studies mathematics on a day, then the probability that she studies computer science the next day is 0.4. Given that Aishwarya studies computer science on Monday, what is the probability that she studies computer science on Wednesday?

- A. 0.24
- B. 0.36
- C. 0.4
- D. 0.6

[gate2008](#) [probability](#) [normal](#)
Answer**13.9.50 Probability: GATE2008-IT_2** [top](#)<http://gateoverflow.in/3224>

A sample space has two events A and B such that probabilities $P(A \cap B) = 1/2$, $P(A') = 1/3$, $P(B') = 1/3$. What is $P(A \cup B)$?

A)

11/12

- B) 10/12
 C) 9/12
 D) 8/12

gate2008-it probability easy

Answer

13.9.51 Probability: GATE2008-IT_23 [top](#)

<http://gateoverflow.in/3284>

What is the probability that in a randomly chosen group of r people at least three people have the same birthday?

- A) $1 - \frac{365 \cdot 364 \cdots (365 - r + 1)}{365^r}$
- B) $\frac{365 \cdot 364 \cdots (365 - r + 1)}{365^r} + \binom{r}{2} \frac{365 \cdot 364 \cdot 363 \cdots (364 - (r - 2) + 1)}{364^{r-2}}$
- C) $1 - \frac{365 \cdot 364 \cdots (365 - r + 1)}{365^r} + \binom{r}{2} \frac{365 \cdot 364 \cdot 363 \cdots (364 - (r - 2) + 1)}{364^{r-2}}$
- D) $\frac{365 \cdot 364 \cdots (365 - r + 1)}{365^r}$

gate2008-it probability normal

Answer

13.9.52 Probability: GATE2007-IT_1 [top](#)

<http://gateoverflow.in/3432>

Suppose there are two coins. The first coin gives heads with probability $5/8$ when tossed, while the second coin gives heads with probability $1/4$. One of the two coins is picked up at random with equal probability and tossed. What is the probability of obtaining heads?

- A) 7/8
 B) 1/2
 C) 7/16
 D) 5/32

gate2007-it probability normal

Answer

13.9.53 Probability: GATE2001-2.4 [top](#)

<http://gateoverflow.in/722>

Seven (distinct) car accidents occurred in a week. What is the probability that they all occurred on the same day?

- A. $\frac{1}{7^7}$
 B. $\frac{1}{7^6}$
 C. $\frac{1}{2^7}$
 D. $\frac{7}{2^7}$

gate2001 probability normal

Answer

13.9.54 Probability: GATE2006-IT_1 [top](#)<http://gateoverflow.in/3258>

In a certain town, the probability that it will rain in the afternoon is known to be 0.6. Moreover, meteorological data indicates that if the temperature at noon is less than or equal to 25°C , the probability that it will rain in the afternoon is 0.4. The temperature at noon is equally likely to be above 25°C , or at/below 25°C . What is the probability that it will rain in the afternoon on a day when the temperature at noon is above 25°C ?

- | | |
|----|-----|
| A) | 0.4 |
| B) | 0.6 |
| C) | 0.8 |
| D) | 0.9 |

[gate2006-it](#) [probability](#) [normal](#)**Answer****13.9.55 Probability: GATE2010-27** [top](#)<http://gateoverflow.in/1153>

What is the probability that divisor of 10^{99} is a multiple of 10^{96} ?

- A. $1/625$
- B. $4/625$
- C. $12/625$
- D. $16/625$

[gate2010](#) [probability](#) [normal](#)**Answer****13.9.56 Probability: TIFR2013-B-10** [top](#)<http://gateoverflow.in/25771>

Let m, n be positive integers with m a power of 2. Let $s = 100n^2 \log m$. Suppose S_1, S_2, \dots, S_m are subsets of $1, 2, \dots, s$ such that $|S_i| = 10n \log m$ and $|S_i \cap S_j| \leq \log m$ for all $1 \leq i < j \leq m$. Such a collection of sets S_1, \dots, S_m is an example of a so-called Nisan-Wigderson design. We now consider the set membership problem, where we have to store an arbitrary subset $T \subseteq \{1, 2, \dots, m\}$, $|T| = n$ as an array A of s bits so that given any integer x , $1 \leq x \leq m$, we can discover whether $x \in T$ by reading only one bit of A . Consider the following strategy to solve this problem. Array A is initialized to all zeroes. Given the set T to be stored, we put a one in all the locations of A indexed by the union $\bigcup_{t \in T} S_t$. Now, given the integer x , we read a random location in A from S_x and declare that $x \in T$ if the bit in that location is one. This strategy gives the correct answer with probability

- a. 1 if $x \in T$ and at most 0.1 if $x \notin T$.
- b. At least 0.9 if $x \in T$ and at most 0.1 if $x \notin T$.
- c. At least 0.9 if $x \in T$ and at least 0.9 if $x \notin T$.
- d. 1 if $x \in T$ and at least 0.9 if $x \notin T$.
- e. At least 0.9 if $x \in T$ and 1 if $x \notin T$.

[tifr2013](#) [probability](#)**Answer****Answers: Probability****13.9.1 Probability: GATE1996_2.7** [top](#)<http://gateoverflow.in/2736>

Selected Answer

There are 52 cards including 4 aces so the probability must be $4/52 * 3/51$

6 votes

-- Bhagirathi Nayak (11.3k points)

13.9.2 Probability: TIFR2011-A-9 [top](#)<http://gateoverflow.in/20020>



Selected Answer

Let the three games in a series be called G_1, G_2 and G_3 respectively, and the probability of winning the game x be denoted as $P(x)$

You can win the series if and only if: You win G_2 and you win atleast one of $\{G_1, G_3\}$.

$$P \left(\begin{array}{c} \text{winning} \\ \text{the series} \\ G_1 G_2 G_3 \end{array} \right) = P(G_2) \times \left(\left(P(G_1) + P(G_3) - P(G_1) \times P(G_3) \right) \right)$$

Let the probability of winning against player A be a and the probability of winning against player B be b .

Then,
 $a < b$. (
 A is a stronger player than B , so probability of winning against A is smaller compared to B)

Let $P(xyz)$ be the probability of winning the series in which the games played are against x, y and z in order.

- a. $P(AAB) = a(a + b - ab) = a^2 + ab - a^2b$
- b. $P(ABA) = b(a + a - aa) = 2ab - a^2b$
- c. $P(BAB) = a(b + b - b^2) = 2ab - ab^2$
- d. $P(BAA) = a(b + a - ba) = a^2 + ab - a^2b$

We can see that **not all probabilities are equal, so option E is not correct**

We can also see that options **A and D result in the same value, so they are not correct either**

Comparing option B and option C.

Since $a < b$ and $a, b \geq 0$, we have that $2ab - a^2b > 2ab - ab^2$

Hence, option B is the correct answer.

4 votes

-- Pragy Agarwal (14.4k points)

13.9.3 Probability: GATE2015-1_29 [top](#)

<http://gateoverflow.in/8253>



Selected Answer

$$P = P(S1) P(\sim S2) P(\sim S3) P(\sim S4) + P(\sim S1) P(S2) P(\sim S3) P(\sim S4) + P(\sim S1) P(\sim S2) P(S3) P(\sim S4) + P(\sim S1) P(\sim S2) P(S4)$$

$$\begin{aligned} &= 0.1 * 0.8 * 0.7 * 0.6 \\ &+ 0.9 * 0.2 * 0.7 * 0.6 \\ &+ 0.9 * 0.8 * 0.3 * 0.6 \\ &+ 0.9 * 0.8 * 0.7 * 0.4 \end{aligned}$$

$$= 0.4404$$

16 votes

-- Arjun Suresh (150k points)

13.9.4 Probability: GATE1998_1.1 [top](#)

<http://gateoverflow.in/1638>



Selected Answer

answer - B

There are 6 possible outcomes for a die roll. Out of these 3 are even and 3 are odd. So, when we consider odd/even a die roll has only 2 possible outcomes. So, for three rolls of the die we have 8 possible outcomes.

Out of them only 3 will have exactly one odd number {OEE, EOE, EEO}

probability = 3/8

7 votes

-- ankitrokdeonsns (8.4k points)

13.9.5 Probability: GATE2004_78 [top](#)

<http://gateoverflow.in/1072>



Selected Answer

answer - A

there n binary bits that can differ but only d should differ in this case

ways of choosing these d bits = nC_d

probability of d bits differ but, n - d bits do not differ = $(1/2)^d(1/2)^{n-d}$

no of ways = $nC_d/2^n$

7 votes

-- ankitrokdeonsns (8.4k points)

13.9.6 Probability: TIFR2010-A-6 [top](#)

<http://gateoverflow.in/18222>



Selected Answer

10 tosses of coin are there.

Probability of head = 0.4

Probability of tail = 0.6

Probability of at least one head = $1 - P_{\text{no head occur}} = 1 - (0.6)^{10}$

2 votes

-- Digvijay (35.8k points)

13.9.7 Probability: TIFR2010-A-10 [top](#)

<http://gateoverflow.in/26481>



Selected Answer

If any 2 balls selected from 8 balls then we can choose $8C2$ ways=28 ways

If selected 2 balls are same color then $2C2 + 4C2 + 2C2$ ways=1+6+1 ways=8 ways

So, required probability= $8/28 = 2/7$

Ans (A)

4 votes

-- srestha (27.8k points)

13.9.8 Probability: TIFR2010-A-13 [top](#)

<http://gateoverflow.in/18392>



Selected Answer

0.096 should be the correct answer, i.e. option a)

Suppose that the side of larger cube is 10m then volume of the larger cube will be $10 \times 10 \times 10 = 1000\text{m}^3$.

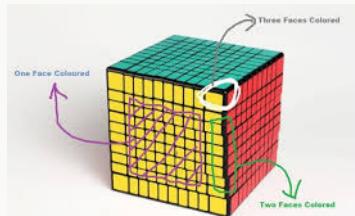
After dividing the cube into 1000 equal sized small cubes, volume of each smaller cube will be $((10 \times 10 \times 10)/1000) \text{ m}^3 = 1 \text{ m}^3$.

So the sides of the each of the smaller cube will be 1 m, which is 10 times less than the side length of larger cube.

so each EDGE of the larger larger cube will contain 10 smaller cube edges.

each FACE of the larger cube will contain $10 \times 10 = 100$ smaller cube faces.

each CORNER of the larger cube will contain 1 smaller cube corner.



Position of each of the smaller cube can be as follows:

A) It can be in the corners of the larger cube, In this case it would have three of its faces colored.

There are total $8(\text{number of corners}) \times 1(\text{number of smaller cubes per corner}) = 8$ such cubes.

B) It can be in the edges of the larger cube, In this case it would have two of its faces colored.

There are total $12(\text{number of edges}) \times 8(\text{number of smaller cubes per edge excluding corner cubes of the edge}) = 96$.

C) It can be on the face of the larger cube but not in the edges of a face, in this case it would have one face colored.

There are total $6(\text{number of faces}) \times 64(\text{number of smaller cubes per face excluding the edge & corner cubes}) = 384$.

D) It can be inside the core of the larger cube, in this case it will be uncolored.

There will be $512 (= 1000 - (384 + 96 + 8))$ cubes.

Now since there are 96 cubes out of 1000 which have 2 colored faces, so required probability = $96/1000 = 0.096$

Now, since total number of edges in the larger cube = 12, so total number of smaller cubes with two colored faces = $12 \times 8 = 96$.

5 votes

-- Anurag Pandey (9.7k points)

13.9.9 Probability: GATE2004_25 top

<http://gateoverflow.in/1022>



Selected Answer

answer - A

out of 4 times 2 times head should be present

ways of selecting these 2 places 4C_2

probability of getting 2 heads and 2 tails = $(1/2)^2(1/2)^2$

probability = ${}^4C_2/2^4 = 3/8$

3 votes

-- ankitrokdeonsns (8.4k points)

13.9.10 Probability: TIFR2010-B-38 top

<http://gateoverflow.in/19050>

(e) is correct

table has 3 coins with H,H,T facing up.

now, probability of choosing any coin is $1/3$, as we can choose any of three coins.

Case A: 1st coin : either H or T can come.
so, HHT THT possible. only HHT is favourable.
which gives $(1/3) \times (1/2) = 1/6$

Case B: 2nd coin : either H or T can come.
so, HHT HTT possible. only HHT is favourable.
which gives $(1/3) \times (1/2) = 1/6$

case C: 3rd coin : Table already contains two H's so, whatever comes is favourable.
which gives $(1/3) \times 1 = 1/3$

summing up total gives $1/6 + 1/6 + 1/3 = 2/3$

4 votes

-- Himanshu Agarwal (9.8k points)

13.9.11 Probability: TIFR2011-A-3 [top](#)

<http://gateoverflow.in/2000>



Selected Answer

Let the 4 tosses be named P, Q, R and S

To have 3 consecutive heads:

- Q, R must be both heads.
- At least one of $\{P, S\}$ must be a head.

Thus, the probability of getting 3 consecutive heads is given by:

$$\begin{aligned} P &= P_q \times P_r \times \underbrace{(P_p + P_s - P_p P_s)}_{\text{atleast one}} \\ &= \frac{1}{2} \times \frac{1}{2} \times \left(\frac{1}{2} + \frac{1}{2} - \frac{1}{2} \cdot \frac{1}{2} \right) \\ P &= \frac{3}{16} \end{aligned}$$

Hence, option D is the correct answer.

Another way of looking at it is:

$$P = P_{HHHT} + P_{THHH} + P_{HHHH} = \frac{1}{16} + \frac{1}{16} + \frac{1}{16} = \frac{3}{16}$$

1 votes

-- Pragy Agarwal (14.4k points)

13.9.12 Probability: GATE2003_60, ISRO2007-45 [top](#)

<http://gateoverflow.in/948>

Solution: C

Since the two modules execute sequentially. The total runtime of the program is the sum of runtime of the two modules. Probability mass function of sum of two random variable is given by the convolution in the option C.

[REFERENCE](#)

2 votes

-- Gowthaman Arumugam (1.1k points)

13.9.13 Probability: GATE1995_1.18 [top](#)<http://gateoverflow.in/780>

Selected Answer

First digit can be chosen in 8 ways from 1–9 excluding 7

Second digit can be chosen in 9 ways from 0–9 excluding 7 and similarly the third digit in 9 ways.

So, total no. of ways excluding 7 = $8 \times 9 \times 9$

Total no. of ways including 7 = $9 \times 10 \times 10$

So, ans = $(8 \times 9 \times 9) / (9 \times 10 \times 10) = 18/25$

11 votes

-- **gatecse** (10.7k points)**13.9.14 Probability: TIFR2011-A-19** [top](#)<http://gateoverflow.in/26479>

There will be 2 possibilities for highest and lowest differ by 4, i.e (1,5),(2,6) and they can arrange in $2!$ ways

Now among 3 dies 2 dice can be selected in $3C2$ ways

Case 1:

for (1,5) the 3rd dice value can be any value from 1 to 5, but it cannot be 6, Because in that case difference cannot be 4
so probability is $3C2 \times 2! \times 5 / (6^3)$

Case 2:

for (2,6) the 3rd dice value can be any value from 2 to 6, but it cannot be 1, Because in that case difference cannot be 4
so probability is $3C2 \times 2! \times 5 / (6^3)$

So, probability that the highest and the lowest value differ by 4

$$= 3C2 \times 2! \times 5 / (6^3) + 3C2 \times 2! \times 5 / (6^3) = 5/18$$

Ans is (D)

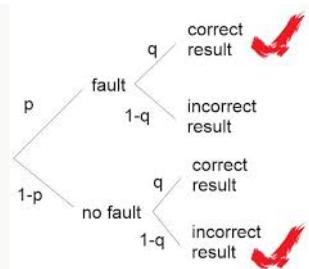
2 votes

-- **srestha** (27.8k points)**13.9.15 Probability: GATE2010-26** [top](#)<http://gateoverflow.in/1152>

Selected Answer

answer = **option A**

in image below the ticks shows those branch where the result is declared as faulty.



so required probability = sum of those two branches = $pq + (1-p)(1-q)$

8 votes

-- Amar Vashishth (20.7k points)

13.9.16 Probability: GATE2003_3 [top](#)

<http://gateoverflow.in/894>



Selected Answer

$P(A) = 1.$

So no matter what happens with B , A always happens.
If you check options there is no need to even think in this question.

Only Option D is correct. As happening or not happening of Even B does not reduce probability of Even A from 1 to 1/2 or 1/4.

4 votes

-- Akash (31.7k points)

13.9.17 Probability: TIFR2012-A-9 [top](#)

<http://gateoverflow.in/21008>



Selected Answer

B) for all the 6 different faces 1,2,3,4,5,6 the probability is $1/6^6$ and then for
6! different permutations :
 $6!/6^6$

2 votes

-- Shaun Patel (5.8k points)

13.9.18 Probability: TIFR2012-A-17 [top](#)

<http://gateoverflow.in/25042>

It will be linear to n

It will go $(n-1)$ inches in $(n-1)*3$ steps

last 1 inch goes in 1 step

so total $(n-1)*3+1$ steps

0 votes

-- srestha (27.8k points)

Let this be a bernoulli distribution in which the indicator random variable is $X_i=\{ 1 \text{ if step is taken in the front direction and } 0 \text{ otherwise.}$

We know that in Bernoulli Distribution, $E(X_i) = P(\text{step is taken in the front direction}) = 1/3$

Similarly let there be a bernoulli distribution in which the indicator random variable is $Y_i=\{ 1 \text{ if step is taken in the backward direction and } 0 \text{ otherwise. Hence } E(Y_i) = 2/3.$

Now according to linearity $E(X_i + Y_i) = E(X_i) + E(Y_i)$ even if X_i and Y_i are dependent variables.

If total number of front steps be $z+n$, then total number of back steps are z .

$$\begin{aligned} E(X + Y) &= (z+n)*E(X_i) + z*E(Y_i) \\ \text{or, } E(X + Y) &= 1/3*(z+n) + 2/3*z = \\ \frac{3z+n}{3} \end{aligned}$$

hence the equation is linear in terms of n .

0 votes

-- Sagnik Chatterjee (11 points)

13.9.19 Probability: TIFR2012-A-19 top

<http://gateoverflow.in/25044>



Selected Answer

Lets define the following events:

P : Uppermost link is working.

Q : Middle link is working.

R : Lowermost link is working.

W : Terminals A & B are connected.

From the given information, we can calculate the probabilities of events P , Q and R as follow:

(as I already consumed letter (capital) P denoting an event so here by I will use letter (small) p to denote probabilities, e.g. $p(X)$ denotes probability of happening of event X).

$$p(P) = \frac{4}{5} \times \frac{4}{5} = \frac{16}{25},$$

$$\Rightarrow p(\widehat{P}) = 1 - \frac{16}{25} = \frac{9}{25},$$

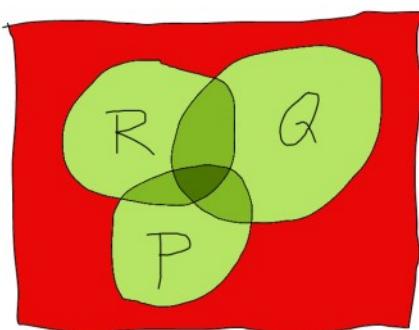
$$p(Q) = \frac{2}{3},$$

$$\Rightarrow p(\widehat{Q}) = \frac{1}{3},$$

$$p(R) = \frac{3}{4} \times \frac{3}{4} = \frac{9}{16},$$

$$\Rightarrow p(\widehat{R}) = 1 - \frac{9}{16} = \frac{7}{16}.$$

The situation here can be represented using the following Venn Diagram:



Here Red region denotes the event \widehat{W} in which A & B are disconnected.

Different gradients of Green colour represent the W in which terminals A & B are connected.

We have to find $p(W)$

Events W and \widehat{W} are mutually exclusive & totally exhaustive, since either terminals A and B will be connected or they will be disconnected.

So we can write $p(W)$ in terms of $p(\widehat{W})$ as follow:

$$p(W) = 1 - p(\widehat{W}).$$

Also it can be seen that

$$p(\widehat{W}) = p(\widehat{P}) \cap (\widehat{Q}) \cap (\widehat{R}) \text{ where } \widehat{P}, \widehat{Q} \text{ and } \widehat{R} \text{ are independent events.}$$

That is terminals A & B will be disconnected only when all of the links will fail simultaneously.

Using independence we can write,

$$p(\widehat{W}) = p(W) = p(\widehat{P}) \times (\widehat{Q}) \times (\widehat{R}),$$

$$\Rightarrow p(\widehat{W}) = \frac{9}{25} \times \frac{1}{3} \times \frac{7}{16} = \frac{21}{400}$$

$$\Rightarrow p(W) = 1 - \frac{21}{400} = \frac{379}{400}.$$

3 votes

-- Anurag Pandey (9.7k points)

If component are connected in **Series(Both working)** then we can say Probability of A connected to B

$$P(A \cap B) = P(A)P(B)$$

If component are connected in **Parallel(any one among two working)** then we can say Probability of A connected to B

$$P(A \cup B) = P(A) + P(B) - P(A \cap B)$$

$$\text{Probability of top wire success } P(A \cap B) = P(A)P(B) = \frac{4}{25}$$

$$\text{Probability of middle wire success } P(A) = \frac{2}{3}$$

$$\text{Probability of lowest wire success } P(A \cap B) = \frac{9}{16}$$

$$\begin{aligned} \text{Probability of circuit success} &= P(A \cup B \cup C) = P(A) + P(B) + P(C) - P(A \cap B) - P(A \cap C) - P(B \cap C) + P(A \cap B \cap C) \\ &= \frac{16}{25} + \frac{2}{3} + \frac{9}{16} - \frac{16}{25} * \frac{2}{3} - \frac{16}{25} * \frac{9}{16} - \frac{2}{3} * \frac{9}{16} + \frac{16}{25} * \frac{2}{3} * \frac{9}{16} \end{aligned}$$

=

$$\frac{379}{400} \text{ OPTION B}$$

3 votes

-- Umang Raman (11.3k points)

13.9.20 Probability: TIFR2012-A-20 [top](#)

<http://gateoverflow.in/25045>

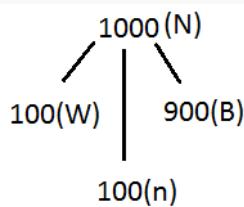


Selected Answer

Here we are having a **total** of **1000** Balls, out of which we firstly **draw 100 balls**, and then **101st ball..**

Firstly we have to **find expected number of white and black balls in drawn 100 balls**, as both can occur in 100 balls..

We have a situation like this:



Expected number of white balls = $n \cdot W/N = 100 \cdot (100/1000) = 10$

Expected number of black balls = $n \cdot B/N = 100 \cdot (900/1000) = 90$

So, we have drawn 100 balls(90 black, 10 white)

Left balls = (810 Black , 90 white) = 900 total

Now,

probability for 101st ball to be black = $810/900 = 9/10$

So, option (A) is Correct

4 votes

-- Himanshu Agarwal (9.8k points)

13.9.21 Probability: GATE2002_2.16 top

<http://gateoverflow.in/846>



Selected Answer

answer - C

probability of getting all heads = $1/16$

probability of getting all tails = $1/16$

probability of getting at least one head and one tail = $1 - 1/16 - 1/16 = 7/8$

6 votes

-- ankitrokdeonsns (8.4k points)

13.9.22 Probability: TIFR2013-A-4 top

<http://gateoverflow.in/25386>



Selected Answer

probability of obtaining an even number of heads in 5 tosses, zero being treated as an even number
number of event = 0 head or 2 head or 4 head

Probability of head = $2/3$

Probability of tail = $1/3$

$$\text{Probability} = 5C0\left(\frac{2}{3}\right)^0\left(\frac{1}{3}\right)^5 + 5C2\left(\frac{2}{3}\right)^2\left(\frac{1}{3}\right)^3 + 5C4\left(\frac{2}{3}\right)^4\left(\frac{1}{3}\right)^1$$

$$= \frac{121}{243}$$

Option A

4 votes

-- Umang Raman (11.3k points)

13.9.23 Probability: TIFR2013-A-6<http://gateoverflow.in/25390>

Ans should be 1/2

Tourists are 2/3 of population of the park

Among them probability of correct answer is 3/4

so, $2/3 * 3/4 = 1/2$

0 votes

-- srestha (27.8k points)

Let

E = East is the correct answer

S = Same person answers East 2 times.

We are asked to find $p(E|S)$:

$$= P(E \cap S) / P(S)$$

$$= P(\text{East is correct and same person is telling east 2 times}) / P(\text{same person saying east 2 times})$$

$$= P(\text{Same person is telling correct answer 2 times}) / P(\text{Same person saying east 2 times, no matter if East is correct or not})$$

$$= (2/3 * 3/4 * 3/4 + 1/3 * 0 * 0) / (2/3 * 3/4 * 3/4 + 2/3 * 1/4 * 1/4 + 1/3 * 1 * 1 + 1/3 * 0 * 0)$$

where 0 is showing that the kabristani person will tell correct answer with probability 0.

0 votes

-- redbloodpro (55 points)

13.9.24 Probability: TIFR2013-A-13<http://gateoverflow.in/25435>

Selected Answer

Ans will be d

As, % of Doctor A successful for stage III $78/80 * 100 = 97.5$

for stage IV $2/20 * 100 = 10$

As, % of Doctor B successful for stage III $49/50 * 100 = 98$

stage IV $11/50 * 100 = 22$

In both cases Doc B is more successful

5 votes

-- srestha (27.8k points)

13.9.25 Probability: TIFR2013-A-14<http://gateoverflow.in/25437>

Selected Answer

Even number = 2,4,6
 odd number = 1,3,5
 Product will come even when even one time even number comes
 odd product will be if every time odd comes

$$\text{so } P(\text{Even}) = 1 - P(\text{odd}) = 1 - nCn * \left(\frac{3}{6}\right)^0 * \left(\frac{3}{6}\right)^n \\ = 1 - \left(\frac{1}{2}\right)^n$$

So i think option E

6 votes

-- Umang Raman (11.3k points)

13.9.26 Probability: TIFR2013-A-17 [top](#)

<http://gateoverflow.in/25497>

let us assume we divide string at length x such that x is bigger part i.e $x > 1/2$ and smaller part is $1-x$, further we divide x into 2 parts of ratio 4:3 means 1 part is $4x/7$ and second part is $3x/7$ so far we have establish the value of each side (a,b,c) in term of x ($4x/7, 3x/7, 1-x$)

now for triangle to form following 2 property must satisfies $a+b>c$ and $|a-b|<c$ for any side (a,b,c) now we have to permute a b c as per above to find value of x

- 1)a=4x/7 b=3x/7,c=1-x ----- x belong to $(1/2, 7/8)$
 - 2)a=4x/7 b=1-x ,c=3x/7 ----- $x < 7/6$ futile because x cannot be greater than 1
 - 3)a=3x/7 b=1-x ,c=4x/7 ----- x belong to $(1/2, 7/6)$
 - 4)a=3x/7 b=4x/7 ,c=1-x ----- x belong to $(1/2, 7/8)$
 - 5)a=1-x b=4x/7 ,c=3x/7 ----- $x < 7/8$
 - 6)a=1-x b=3x/7 ,c=4x/7 ----- $x < 7/6$ futile because x cannot be greater than 1
- so finally x should be between $1/2$ and $7/8$ inorder to form triangle hence it can take $(7/8-1/2) = 3/8$ values therefore probability of forming a triangle is $3/8$ (favourable values)/ $1/2$ (total values)= $3/4$
 probability of not forming a triangle will be $1-3/4 = 1/4$

1 votes

-- Saurav Shrivastava (719 points)

13.9.27 Probability: GATE2005-IT_1 [top](#)

<http://gateoverflow.in/3745>



Selected Answer

No two marbles have the same color means, the final outcome of the three draws must be a permutation of

Blue, Green, Red

There are $3! = 6$ such permutations possible.

Now, probability of getting a Blue first, Green second and Red third = $10/60 * 20/60 * 30/60$

Required probability = $6 * 10/60 * 20/60 * 30/60 = 1/6$

5 votes

-- Arjun Suresh (150k points)

13.9.28 Probability: GATE2004-IT_1 [top](#)

<http://gateoverflow.in/3642>



Selected Answer

Answer is B) 6/23

Let N be the total number of families.

Number of children in a family of 3 children = $(N/2) * 3$

Number of children in a family of 2 children = $(3N/10) * 2$

Number of children in a family of 1 child = $(N/5) * 1$

Probability = Favorable case / Total cases

$$= ((3/10)*2) / ((1/2)*3 + (3/10)*2 + 1/5)$$

$$= 6/23$$

6 votes

-- Prateeksha Keshari (1.7k points)

13.9.29 Probability: GATE2009-21 [top](#)

<http://gateoverflow.in/798>



Selected Answer

$P(\{1, 3, 5\}) = 0.9P(\{2, 4, 6\})$ and their sum must be 1. So,

$$P(\{1, 3, 5\}) = \frac{0.9}{1.9} = 0.4736 \text{ and}$$

$$P(\{2, 4, 6\}) = \frac{1}{1.9} = 0.5263$$

Given that probability of getting 2 or 4 or 6 is same.

$$\text{So, } P(2) = P(4) = P(6) = \frac{0.5263}{3} = 0.1754$$

$$P(\{4, 6\} | x > 3) = 0.75 \implies P(5 | x > 3) = 0.25 \implies P(5) = \frac{1}{3}(P(4) + P(6)) \because x > 3 \implies x \in \{4, 5, 6\} \implies P(5) =$$

$$\text{So, } P(x > 3) = P(4) + P(5) + P(6) = \frac{8}{3} \times 0.1754 = 0.468$$

6 votes

-- Arjun Suresh (150k points)

13.9.30 Probability: GATE1997_1.1 [top](#)

<http://gateoverflow.in/2217>



Selected Answer

Answer: D

$P(\text{it will rain today either today or tomorrow}) = P(\text{it will rain today}) + P(\text{it will rain tomorrow}) - P(\text{it will rain today and tomorrow})$

So, $.7 = .5 + .6 - P(\text{it will rain today and tomorrow})$

$\Rightarrow P(\text{it will rain today and tomorrow}) = .4$

5 votes

-- Rajarshi Sarkar (29.7k points)

13.9.31 Probability: GATE1998_3a [top](#)

<http://gateoverflow.in/1694>



Selected Answer

We are given that both will be reaching the park between 4:00 and 5:00.

Probability that one friend arrives between 4:00 and 4:50 = $5/6$

Probability that one friend arrives between 4:00 and 4:50 and meets the other arriving in the next 10 minutes = $5/6 * 1/6 * 2 = 10/36 = 5/18$

(For any time of arrival between 4:00 and 4:50, we have a 10 minute interval possible for the second friend to arrive, and 2 cases as for choosing which friend arrives first)

Probability that both friend arrives between 4:50 and 5:00 = $1/6 * 1/6 = 1/36$

This covers all possibility of a meet. So, required probability of non-meet

$$\begin{aligned} &= 1 - (5/18 + 1/36) \\ &= 1 - 11/36 \\ &= 25/36 \end{aligned}$$

6 votes

-- Arjun Suresh (150k points)

13.9.32 Probability: GATE 2016-1-29 [top](#)

<http://gateoverflow.in/39709>



Selected Answer

Answer is 0.33

1st time it is 0.25(1/4), when tail tail comes, entire process gets repeated, so next time probability of Y to happen is 0.25*0.25 ((1/4)*(1/4)), likewise it goes on as infinite GP

Sum of infinite GP = $a/(1-r)$

here $a = 1/4$ and $r = 1/4$

so answer becomes $1/3$ i.e 0.33

10 votes

-- Sreyas S (1.6k points)

13.9.33 Probability: GATE1999_2.1 [top](#)

<http://gateoverflow.in/1479>



Selected Answer

answer - C

if events E1 and E2 are independent then $P[E1 \text{ and } E2] = P[E1] \times P[E2]$ which is not the case here.

4 votes

-- ankitrokdeonsns (8.4k points)

13.9.34 Probability: GATE2014-1_48 [top](#)

<http://gateoverflow.in/1927>



Selected Answer

There are only two possible sets whose elements sum to 22 : {6,6,6,4}, {6,6,5,5}

Number of permutations for 1st set : $4!/3! = 4$

Number of permutations for 2nd set : $4!/(2!*2!) = 6$

So total number of ways to sum 22 = 10

So X = 10.

11 votes

-- Happy Mittal (9.5k points)

13.9.35 Probability: GATE-2014-2_1 [top](#)

<http://gateoverflow.in/1953>



Selected Answer

Initially $P(\text{working computer}) = 4/10$, $P(\text{non-working computer}) = 6/10$.

Case 1 : three computers are functional : There are 4 sub-cases WWWN, WWNW, WNWW, NWWW, where W means working, N means non-working, but $P(WWWN) = P(WWNW) = P(WNWW) = P(NWWW)$, because for example

$$P(WWWN) = \frac{4}{10} * \frac{3}{9} * \frac{2}{8} * \frac{6}{7} = \frac{144}{5040}$$

In all other 3 sub-cases, we get same numerators and denominators (in different order), so total prob in this case is $4 * 144/5040 = 576/5040$.

Case 2 : all 4 are working

$$P(WWWW) = \frac{4}{10} * \frac{3}{9} * \frac{2}{8} * \frac{1}{7} = \frac{24}{5040}$$

P(atleast 3 are working) = 600/5040

So $100 * p = 11.90$

9 votes

-- Happy Mittal (9.5k points)

13.9.36 Probability: GATE 2016-1-04 [top](#)

<http://gateoverflow.in/39661>



Selected Answer

Integrate $1/x^2$ in the limits a to 1.. and equate it to 1..
solving we get $a=0.5$

17 votes

-- Abhilash Panicker (7k points)

13.9.37 Probability: GATE2014-2_48 [top](#)

<http://gateoverflow.in/2014>



Selected Answer

answer - 0.26

no of integers divisible by 2 = 50

no of integers divisible by 3 = 33

no of integers divisible by 5 = 20

no of integers divisible by 2 and 3 = 16

no of integers divisible by 2 and 5 = 10

no of integers divisible by 3 and 5 = 6

no of integers divisible by 2 and 3 and 5 = 3

total numbers divisible by 2 or 3 or 5 = $50 + 33 + 20 - 16 - 10 - 6 + 3 = 74$

total number not divisible by 2 or 3 or 5 = 26

probability = 0.26 [EDIT]

6 votes

-- ankitrokdeonsns (8.4k points)

13.9.38 Probability: GATE2014-3_48 [top](#)

<http://gateoverflow.in/2082>



Selected Answer

$$1/2 * 1/2 = 1/4$$

$P(A) + P(B) = 1$, since both are mutually exclusive and $A \cup B = S$.

When sum is a constant, product of two numbers becomes maximum when they are equal. So, $P(A) = P(B) = 1/2$

6 votes

-- Saumya (529 points)

13.9.39 Probability: GATE2011_3 [top](#)

<http://gateoverflow.in/2105>

Selected Answer

answer - A

$$\text{prob(at least one head)} = 3/4$$

$$\text{prob(both heads)} = 1/4$$

$$\text{using bayes' theorem} = (1/4)/(3/4) = 1/3$$

7 votes

-- ankitrokdeonsns (8.4k points)

13.9.40 Probability: GATE2000-1.1 [top](#)

<http://gateoverflow.in/624>

Selected Answer

There are 4 sets of cards. So, up till 8 cards there is a chance that no more than 2 cards are from a given set. But, once we pick the 9th one, it should make 3 cards from any one of the sets. So, (C) is the answer.

11 votes

-- gatecse (10.7k points)

13.9.41 Probability: GATE2000-2.2 [top](#)

<http://gateoverflow.in/649>

Selected Answer

answer - D

let probability of Event E1 = x = prob of E2

$$\text{prob}(E1 \cup E2) = \text{prob}(E1) + \text{prob}(E2) - \text{prob}(E1 \cap E2)$$

$$1 = x + x - x^2 \quad (\text{prob}(E1 \cap E2) = \text{prob}(E1) * \text{prob}(E2) \text{ as events are independent})$$

$$x = 1$$

8 votes

-- ankitrokdeonsns (8.4k points)

13.9.42 Probability: GATE2011_34 [top](#)

<http://gateoverflow.in/2136>

Selected Answer

The number on the first card needs to be **One higher** than that on the second card, so possibilities are :

| 1 st card | 2 nd card |
|----------------------|----------------------|
| 1 | — |
| 2 | 1 |
| 3 | 2 |
| 4 | 3 |
| 5 | 4 |
| — | 5 |

Total : 4 possibilities

Total possible ways of picking up the cards = $5 \times 4 = 20$

$$\text{Thus, the required Probability} = \frac{\text{favorable ways}}{\text{total possible ways}} = \frac{4}{20} = \frac{1}{5}$$

Option A is correct

8 votes

-- Amar Vashishth (20.7k points)

13.9.43 Probability: GATE2007-24 [top](#)

<http://gateoverflow.in/1222>



Selected Answer

There are 10 even numbers (2,4,...20) possible as the one in the earliest position and all of these are equally likely. So, the probability of 2 becoming the earliest is simply $\frac{1}{10}$.

16 votes

-- Arjun Suresh (150k points)

13.9.44 Probability: TIFR2015-A-1 [top](#)

<http://gateoverflow.in/29156>

Given,

$$P(2,4,6) = 1/2$$

$$P(3,6) = 1/3$$

$$P(1) = 1/6$$

So,

$$P(1,3,5) = 1/2$$

$$P(3,5) = P(1,3,5) - P(1)$$

$$= 1/2 - 1/6$$

$$= 1/3$$

$$P(3,5) = 1/3$$

For $P(5)$ to have the maximum probability, $P(3)$ should be 0

$$P(5) \leq 1/3$$

3 votes

-- admin (1.6k points)

13.9.45 Probability: GATE1994_2.6 [top](#)

<http://gateoverflow.in/2473>



Selected Answer

$$P(A \cap B') = P(A) - P(A \cap B)$$

$$\Rightarrow P(A) = P_2 + P_3$$

6 votes

-- Saumya (529 points)

13.9.46 Probability: GATE1994_2.8 [top](#)

<http://gateoverflow.in/2475>

Selected Answer

$$P(A) = 0.8 \implies P(A') = 1 - .8 = .2$$

$$P(B) = 0.5 \implies P(B') = 1 - .5 = .5$$

$$P(C) = 0.3 \implies P(C') = 1 - .3 = .7$$

$$P(\text{No event will occur}) = .2 \cdot .5 \cdot .7 = .07$$

$$P(\text{at least 1 event will occur}) = 1 - .07 = .93$$

5 votes

-- Manu Thakur (5.6k points)

13.9.47 Probability: GATE1995_2.14 [top](#)

<http://gateoverflow.in/2626>

Selected Answer

answer - C

probability of first ball white and second one black = $(10/25) \times (15/24)$

probability of first ball black and second one white = $(15/25) \times (10/24)$

probability = sum of above two probabilities = $1/2$

9 votes

-- ankitrokdeonsns (8.4k points)

13.9.48 Probability: GATE1996_1.5 [top](#)

<http://gateoverflow.in/2709>

Selected Answer

$$1 - (\text{no 6 in both the dice}) = 1 - (5/6 \times 5/6) = 11/36$$

7 votes

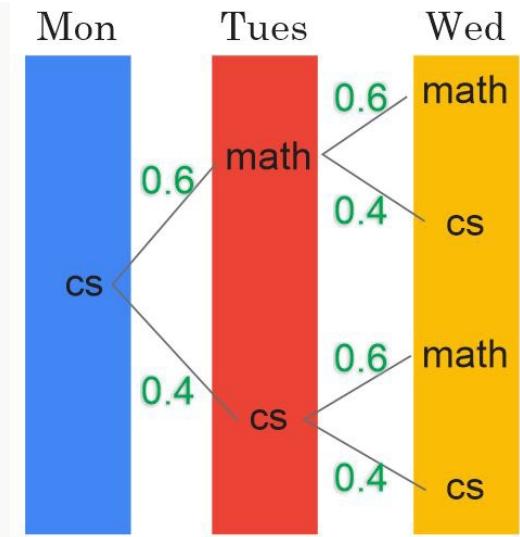
-- Bhagirathi Nayak (11.3k points)

13.9.49 Probability: GATE2008-27 [top](#)

<http://gateoverflow.in/425>

Selected Answer

on Wednesday we want cs



$$\text{required probability} = 0.6 \times 0.4 + 0.4 \times 0.4 = 0.4$$

answer = **option C**

9 votes

-- Amar Vashishth (20.7k points)

13.9.50 Probability: GATE2008-IT_2 [top](#)

<http://gateoverflow.in/3224>



Selected Answer

$$\begin{aligned}
 P(A \cup B) &= P(A) + P(B) - P(A \cap B) \\
 &= (1 - P(A')) + (1 - P(B')) - P(A \cap B) \\
 &= (1 - 1/3) + (1 - 1/3) - 1/2 \\
 &= 4/3 - 1/2 \\
 &= 5/6 = 10/12
 \end{aligned}$$

5 votes

-- Arjun Suresh (150k points)

13.9.51 Probability: GATE2008-IT_23 [top](#)

<http://gateoverflow.in/3284>

Answer: C

Case 1: Among 365 people If all r have birthdays on different days.
Then first one can have his birthday in 365 ways. Second one can have in 364 ways, and so on up to r'th person, who can have his birthday in (365-(r-1)) ways.

Case 2: Among 365 people If exactly 2 persons have birthdays on same day.
Then we can consider these 2 persons as single entity and Selecting these 2 persons in $C(r,2)$ ways. Then these two (assumed as first person) can have their birthday in 365 ways.
Second person can have in 364 ways, and so on up to rth person, who can have his birthday in (365-(r-2)) ways (since 1 person is less now).

As we know,
 $P(\text{at least 3 persons have same birthday}) = 1 - \{P(\text{no one has same birthday}) + P(\text{any 2 have same birthday})\}$
Hence,
 $P(\text{at least 3 persons have same birthday}) = 1 - [\{365 \cdot 364 \cdot \dots \cdot (365-(r-1))\} / (365^r) + C(r,2) \cdot 365 \cdot \{364 \cdot \dots \cdot (365-(r-2)) / (364^{(r-2)})\}]$

$$= 1 - \{365 \cdot 364 \cdot \dots \cdot (365-(r-1))\} / (365^r) - C(r,2) \cdot 365 \cdot \{364 \cdot \dots \cdot (365-(r-2)) / (364^{(r-2)})\}$$

PS: There is a typo in the question.

7 votes

-- Rajarshi Sarkar (29.7k points)

13.9.52 Probability: GATE2007-IT_1 top<http://gateoverflow.in/3432>

Selected Answer

Answer is C) 7/16

Probability of obtaining head= Probability of picking first coin * Probability of getting head on first coin + Probability of picking second coin * Probability of getting head on second coin = $(1/2)*(5/8) + (1/2)*(1/4) = 7/16$

9 votes

-- Prateeksha Keshari (1.7k points)

13.9.53 Probability: GATE2001-2.4 top<http://gateoverflow.in/722>

Selected Answer

answer - B [EDIT]

for every car accident we can pick a day in 7 ways

total number of ways in which accidents can be assigned to days = 7^7 probability of accidents happening on a particular day = $1/7^7$

we can choose a day in 7 ways

hence probability = $7/7^7 = 1/7^6$

8 votes

-- ankitrokdeonsns (8.4k points)

13.9.54 Probability: GATE2006-IT_1 top<http://gateoverflow.in/3538>

Selected Answer

Answer is C) 0.8

$P(\text{rain in afternoon}) = 0.5 * P(\text{rain when temp} \leq 25) + 0.5 * P(\text{rain when temp} > 25)$
 $0.6 = 0.5 * 0.4 + 0.5 * P(\text{rain when temp} > 25)$

so

 $P(\text{rain when temp} > 25) = 0.8$

(Answer courtesy- Pradeep Pandey sir - <https://gateetude.wordpress.com/category/gate-computer-science/information-technology-solutions/>)

7 votes

-- Prateeksha Keshari (1.7k points)

13.9.55 Probability: GATE2010-27 top<http://gateoverflow.in/1153>

Selected Answer

Prime factorization of $10 = 2 \times 5$.
So, $10^{99} = 2^{99} \times 5^{99}$ and

No. of possible factors for 10^{99} = No. of ways in which prime factors can be combined
 $= 100 \times 100$ (1 extra possibility for each prime number as prime factor raised to 0 is also possible for a factor)

$$10^{99} = 10^{96} \times 1000$$

So, no. of multiples of 10^{96} which divides 10^{99} = No. of possible factors of 1000

$$= 4 \times 4 (\because 1000 = 2^3 \times 5^3) \text{ (See below)}$$

$$= 16$$

$$\text{So, required probability} = \frac{16}{10000}$$

$$= \frac{1}{625}$$

How number of possible factors of 1000 = 16?

Here we can prime factorize 1000 as $2^3 \times 5^3$. Now, any factor of 1000 will be some combination of these prime factors. For 2, a factor has 4 options - $2^0, 2^1, 2^2$ or 2^4 . Similarly 4 options for 5 also. This is true for any number n , if n can be prime factorized as $a_1^{m_1} \cdot a_2^{m_2} \dots a_n^{m_n}$, number of factors of $n = (m_1 + 1) \times (m_2 + 1) \times \dots \times (m_n + 1)$,

the extra one in each factor term coming for power being 0.

16 votes

-- Arjun Suresh (150k points)

13.9.56 Probability: TIFR2013-B-10 [top](#)

<http://gateoverflow.in/25771>

OPTION d is correct

let m=4(2^2), n=2 then s=100*4*2=800 no's

let s1,s2,s3,s4 are subsets to s ,each have (10*2*2=40) elements.

special cond. is |s_i ∩ s_j| ≤ 2(i.e log m)

let

s1={1,2,---37,38,39,40}

s2={121,122,----160}

s3={37,38,41,42--- 78} here |s1 ∩ s2|=2

s4={39,40,81,82,----118} here also same.

and A is an array of 800 locations.initially 0.

and T is ⊂ (s1,s2,s3,s4) and |T|=2(i.e n)

case 1: let T=(s3,s4)

then A is like this

| | | |
|-----------|--------------------------|--------------------|
| 1 2 3 ... | 36 37 38 39 40 41 42 ... | 78 ... 118 ... 800 |
| 0 0 0 ... | 0 1 1 11 1 1 ... | 1 ... 0 |

case a: if input is 3 (i.e s3) belongs to T
it went to one of the 40 locations {37--78}
cmp bit.
 $P(s3 \text{ present}) = 40/40 = 1$

case b: if input is 1 (i.e s1) not belongs to T
it went to one of the 40 locations {1--40}
cmp bit.
 $P(s1 \text{ present}) = 4/40 = 1/10$ (wrong says)
 $P(s1 \text{ not present}) = 36/40$
 $= 9/10$
 $= 0.9$ (correct says)

you agree

//up vote if

0 votes

-- venky.victory35 (565 points)

13.10**Random Variable** top**13.10.1 Random Variable: TIFR2014-A-19** top<http://gateoverflow.in/27130>Consider the following random function of x

$$F(x) = 1 + Ux + Vx^2 \bmod 5,$$

where U and V are independent random variables uniformly distributed over $\{0, 1, 2, 3, 4\}$. Which of the following is FALSE?

- a. $F(1)$ is uniformly distributed over $\{0, 1, 2, 3, 4\}$.
- b. $F(1), F(2)$ are independent random variables and both are uniformly distributed over $\{0, 1, 2, 3, 4\}$.
- c. $F(1), F(2), F(3)$ are independent and identically distributed random variables.
- d. All of the above.
- e. None of the above.

[tifr2014](#) [probability](#) [random-variable](#)

Answer

13.10.2 Random Variable: GATE2012_21 top<http://gateoverflow.in/1577>Consider a random variable X that takes values $+1$ and -1 with probability 0.5 each. The values of the cumulative distribution function $F(x)$ at $x = -1$ and $+1$ are

- (A) 0 and 0.5
- (B) 0 and 1
- (C) 0.5 and 1
- (D) 0.25 and 0.75

[gate2012](#) [probability](#) [random-variable](#) [easy](#)

Answer

13.10.3 Random Variable: TIFR2011-A-7 top<http://gateoverflow.in/20012>Let X and Y be two independent and identically distributed random variables. Then $P(X > Y)$ is.

- a. $\frac{1}{2}$
- b. 1

- c. 0
- d. $\frac{1}{3}$
- e. Information is insufficient.

[tifr2011](#) [probability](#) [random-variable](#)

[Answer](#)

13.10.4 Random Variable: GATE2006-IT_58 [top](#)

<http://gateoverflow.in/3602>

A software program consists of two modules M_1 and M_2 that can fail independently, but never simultaneously. The program is considered to have failed if any of these modules fails. Both the modules are 'repairable' and so the program starts working again as soon as the repair is done. Assume that the mean time to failure (MTTF) of M_1 is T_1 with a mean time to repair (MTTR) of R_1 . The MTTF of M_2 is T_2 with an MTTR of R_2 . What is the availability of the overall program given that the failure and repair times are all exponentially distributed random variables?

- A) $((T_1 T_2) / (T_1 R_1 + T_2 R_2))$
- B) $((R_1 R_2) / (T_1 R_1 + T_2 R_2))$
- C) $((T_1 T_2) / (T_1 T_2 + T_1 R_1 + T_2 R_2))$
- D) $((T_1 T_2) / (T_1 T_2 + T_1 R_2 + T_2 R_1))$

[gate2006-it](#) [probability](#) [random-variable](#) [normal](#)

[Answer](#)

13.10.5 Random Variable: GATE2005-12, ISRO2009-64 [top](#)

<http://gateoverflow.in/1162>

Let $f(x)$ be the continuous probability density function of a random variable x , the probability that $a < x \leq b$, is :

- A. $f(b - a)$
- B. $f(b) - f(a)$
- C. $\int_a^b f(x) dx$
- D. $\int_a^b x f(x) dx$

[gate2005](#) [probability](#) [random-variable](#) [easy](#) [isro2009](#)

[Answer](#)

13.10.6 Random Variable: GATE2011_33 [top](#)

<http://gateoverflow.in/2135>

Consider a finite sequence of random values $X = [x_1, x_2, \dots, x_n]$. Let

μ_x be the mean and

σ_x be the standard deviation of

X . Let another finite sequence

Y of equal length be derived from this as

$y_i = a * x_i + b$, where

a and

b are positive constants. Let

μ_y be the mean and

σ_y be the standard deviation of this sequence. Which one of the following statements is **INCORRECT**?

- (A) Index position of mode of X in X is the same as the index position of mode of Y in Y

(B) Index position of median of X in
 X is the same as the index position of median of Y in
 Y

- (C)
 $\mu_y = a\mu_x + b$
- (D)
 $\sigma_y = a\sigma_x + b$

[gate2011](#) [probability](#) [random-variable](#) [normal](#)

[Answer](#)

13.10.7 Random Variable: GATE2011_18 [top](#)

<http://gateoverflow.in/2120>

If the difference between the expectation of the square of a random variable ($E[X^2]$) and the square of the expectation of the random variable ($E[X]$)² is denoted by R , then

- (A)
 $R = 0$
- (B)
 $R < 0$
- (C)
 $R \geq 0$
- (D)
 $R > 0$

[gate2011](#) [probability](#) [random-variable](#) [expectation](#) [normal](#)

[Answer](#)

13.10.8 Random Variable: GATE1999_1.1 [top](#)

<http://gateoverflow.in/1455>

Suppose that the expectation of a random variable X is 5. Which of the following statements is true?

- A. There is a sample point at which X has the value 5.
- B. There is a sample point at which X has value greater than 5.
- C. There is a sample point at which X has a value greater than equal to 5.
- D. None of the above

[gate1999](#) [probability](#) [random-variable](#) [expectation](#) [easy](#)

[Answer](#)

13.10.9 Random Variable: GATE2015-3_37 [top](#)

<http://gateoverflow.in/8496>

Suppose X_i for $i = 1, 2, 3$ are independent and identically distributed random variables whose probability mass functions are $Pr[X_i = 0] = Pr[X_i = 1] = \frac{1}{2}$ for $i = 1, 2, 3$. Define another random variable $Y = X_1 X_2 \oplus X_3$, where \oplus denotes XOR. Then $Pr[Y = 0 | X_3 = 0] = \text{_____}$.

[gate2015-3](#) [probability](#) [random-variable](#) [normal](#) [numerical-answers](#)

[Answer](#)

Answers: Random Variable

13.10.1 Random Variable: TIFR2014-A-19 [top](#)

<http://gateoverflow.in/27130>

Answer will be (B)

Firstly take $U=2, V=4, x=1$

$$F(x) = (1+2+4) \bmod 5 = 2$$

Now take $U=1, V=1, x=2$

$$F(x) = (1+2+4) \bmod 5 = 2$$

So, $F(1)$ and $F(2)$ not uniformly distributed over all points between $\{0,1,2,3,4\}$

0 votes

-- srestha (27.8k points)

Here

$$\begin{aligned} F(1) &= 1 + U + V \bmod 5 = 1 + 1/4 + 1/4 \bmod 5 \quad \text{for all } 0, 1, 2, 3, 4 \\ F(2) &= 1 + 2U + 4V \bmod 5 = 1 + 2/4 + 4/4 \bmod 5 \quad \text{for all } 0, 1, 2, 3, 4 \\ F(3) &= 1 + 3U + 9V \bmod 5 = 1 + 3/4 + 9/4 \bmod 5 \quad \text{for all } 0, 1, 2, 3, 4 \end{aligned}$$

so all three are uniformly distributed as they all same value for all points.

but not identical as they have values different from each other.

0 votes

-- redbloodpro (55 points)

13.10.2 Random Variable: GATE2012_21 [top](#)

<http://gateoverflow.in/1577>



Selected Answer

Given $P(-1) = 0.5$ and $P(1) = 0.5$. So, at all other points P must be zero as the sum of all probabilities must be 1.

So, $F(-1) = 0.5$ and

$$\begin{aligned} F(1) &= P(-1) + 0 + 0 + \dots + P(1) \\ &= 0.5 + 0.5 = 1 \end{aligned}$$

8 votes

-- Arjun Suresh (150k points)

13.10.3 Random Variable: TIFR2011-A-7 [top](#)

<http://gateoverflow.in/20012>



Selected Answer

Let the probability

$P(X = Y) > 0$. This can happen if

X and

Y are discrete random variables. Also, if

X and

Y are continuous random variables, it could be that some values have a non-zero probability of getting selected.

Then

$$P(X > Y) = P(Y > X) = \frac{1 - P(X = Y)}{2}$$

Since nothing is said about the value of $P(X=Y)$, the correct answer will be option e. Information is insufficient.

3 votes

-- Pragy Agarwal (14.4k points)

13.10.4 Random Variable: GATE2006-IT_58 [top](#)

<http://gateoverflow.in/3602>

Fraction of Time Available = Duration for which both are working / Duration in all 3 possible cases (pass-pass,fail-pass,pass-fail)

Duration for which both are working = both are in amidst of time period and going to fail = $T1*T2$

Duration for all 3 possible cases = $T1*T2 + T1*R2 + T1*R3$

1 votes

-- redbloodpro (55 points)

13.10.5 Random Variable: GATE2005-12, ISRO2009-64 [top](#)

<http://gateoverflow.in/1162>

C should be used if prob density function is given B should be used if prob distribution function is given D must be used to calculate expectation when pdf is given

5 votes

-- Bhagirathi Nayak (11.3k points)

13.10.6 Random Variable: GATE2011_33 [top](#)

<http://gateoverflow.in/2135>



Selected Answer

answer - D

mean, median and mode are linear functions over a random variable.

so multiplying by constants or adding constants wont change their relative position.

standard deviation is not a linear function over a random variable.

5 votes

-- ankitrokdeonsns (8.4k points)

13.10.7 Random Variable: GATE2011_18 [top](#)

<http://gateoverflow.in/2120>

answer - C

3 votes

-- ankitrokdeonsns (8.4k points)

13.10.8 Random Variable: GATE1999_1.1 [top](#)

<http://gateoverflow.in/1455>



Selected Answer

Expectation of discrete random variable (finite case)

$$E(X) = x_1 p_1 + x_2 p_2 + \dots + x_n p_n$$

$$E(X) = 5, 0 \leq p_i \leq 1$$

$$p_1 + p_2 + \dots + p_n = 1$$

Therefore, $E(X) = 5$ is possible only if at-least one of the $x_i \geq 5$

7 votes

-- suraj (3.7k points)

13.10.9 Random Variable: GATE2015-3_37 [top](#)<http://gateoverflow.in/8496>

Selected Answer

Answer is 0.75

As $X_3 = 0$ is given, to have $Y = 0$, $X_1 X_2$ should be 0, meaning (X_1, X_2) should be one of $\{(0,0)(0,1)(1,0)\}$

so, required probability $= 3 \times \frac{1}{2} \times \frac{1}{2} = 0.75$ ∵ we can choose any of the 3 possibilities in 3 ways and then probability of each set of two combination is $\frac{1}{2} \times \frac{1}{2}$.

We can also do like follows:

There are totally 4 possibilities - $\{(0,0)(0,1)(1,0), (1,1)\}$, out of which 3 are favourable cases. So, required probability $= \frac{3}{4} = 0.75$.

14 votes

-- Srijay Deshpande (361 points)

13.11**Uniform Distribution** [top](#)**13.11.1 Uniform Distribution: GATE2004_80** [top](#)<http://gateoverflow.in/1074>

A point is randomly selected with uniform probability in the X-Y plane within the rectangle with corners at $(0,0)$, $(1,0)$, $(1,2)$ and $(0,2)$. If p is the length of the position vector of the point, the expected value of p^2 is

- (A) $\frac{2}{3}$
- (B) 1
- (C) $\frac{4}{3}$
- (D) $\frac{5}{3}$

[gate2004](#) [probability](#) [uniform-distribution](#) [expectation](#) [normal](#)

Answer

13.11.2 Uniform Distribution: GATE2014-1_2 [top](#)<http://gateoverflow.in/177>

Suppose you break a stick of unit length at a point chosen uniformly at random. Then the expected length of the shorter stick is _____.

[gate2014-1](#) [probability](#) [uniform-distribution](#) [expectation](#) [numerical-answers](#) [normal](#)

Answer

Answers: Uniform Distribution**13.11.1 Uniform Distribution: GATE2004_80** [top](#)<http://gateoverflow.in/1074>

Selected Answer

See Q.80 here : http://www.cse.iitd.ac.in/~mittal/gate/gate_math_2004.html

9 votes

-- Happy Mittal (9,5k points)

13.11.2 Uniform Distribution: GATE2014-1_2 top<http://gateoverflow.in/1717>

Selected Answer

Length of shorter stick can be from 0 to 0.5 (because if it is greater than 0.5, it is no longer a shorter stick). This random variable L (length of shorter stick) follows a uniform distribution, and hence probability density function of L is $\frac{1}{0.5 - 0} = 2$ for all lengths in range 0 to 0.5.

$$\text{Now expected value of } L = \int_0^{0.5} L * p(L) dL = \int_0^{0.5} L * 2dL = 2 * \left[\frac{L^2}{2} \right]_0^{0.5} = 0.25$$

12 votes

-- Happy Mittal (9.5k points)

14

General Aptitude

Numerical Ability (195)

[top](#)

14.0.1 GATE2014-1_GA_5 [top](#)

<http://gateoverflow.in/770>

The roots of $ax^2+bx+c=0$ are real and positive. a , b and c are real. Then $ax^2+b|x|+c=0$ has

- A. no roots
- B. 2 real roots
- C. 3 real roots
- D. 4 real roots

[gate2014-1](#) [numerical-ability](#) [normal](#)

[Answer](#)

14.0.2 GATECE-2011 [top](#)

<http://gateoverflow.in/36295>

Q.64

A firm is selling its product at Rs. 60 per unit. The total cost of production is Rs. 100 and firm is earning total profit of Rs. 500. Later, the total cost increased by 30%. By what percentage should the price be increased to maintained the same profit level?

- A. 5
- B. 10
- C. 15
- D. 30

Here what does PROFIT LEVEL mean? Also, answer the question.

[gatece-2011](#) [numerical-ability](#)

[Answer](#)

14.0.3 GATE 2015 Aptitude Set 4 Q5 [top](#)

<http://gateoverflow.in/40170>

Q.5 Five teams have to compete in a league, with every team playing every other team exactly once, before going to the next round. How many matches will have to be held to complete the league round of matches?

- (A) 20 (B) 10 (C) 8 (D) 5

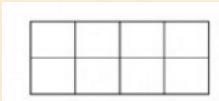
[gate2015aptiset4](#) [aptitude](#) [numerical-ability](#)

[Answer](#)

14.0.4 GATE 2016-2-GA-09 [top](#)

<http://gateoverflow.in/39537>

In a 2×4 rectangle grid shown below, each cell is rectangle. How many rectangles can be observed in the grid?



- A. 21
B. 27
C. 30
D. 36

[gate2016-2](#) [numerical-ability](#) [normal](#)

[Answer](#)

14.0.5 GATE 2015 Aptitude Set 3 Q9 [top](#)

<http://gateoverflow.in/39522>

Q.9 $\log \tan 1^\circ + \log \tan 2^\circ + \dots + \log \tan 89^\circ$ is....
(A) 1 (B) $1/\sqrt{2}$ (C) 0 (D) -1

[gate2015aptiset3](#) [gate2015](#) [aptitude](#)

[Answer](#)

14.0.6 GATE 2015 Aptitude Set 3 Q8 [top](#)

<http://gateoverflow.in/39511>

Q.8 From a circular sheet of paper of radius 30 cm, a sector of 10% area is removed. If the remaining part is used to make a conical surface, then the ratio of the radius and height of the cone is _____

[gate2015aptiset3](#) [gate2015](#) [aptitude](#)

[Answer](#)

14.0.7 GATE 2015 Aptitude Set 3 Q5 [top](#)

<http://gateoverflow.in/39518>

Q.5 If $x > y > 1$, which of the following must be true?
i. $\ln x > \ln y$ ii. $ex > ey$ iii. $yx > xy$ iv. $\cos x > \cos y$

- (A) (i) and (ii) (B) (i) and (iii)
(C) (iii) and (iv) (D) (ii) and (iv)

[gate2015aptiset3](#) [gate2015](#) [aptitude](#)

[Answer](#)

14.0.8 GATE 2015 Aptitude Set 3 Q4 [top](#)

<http://gateoverflow.in/39517>

Q.4 Find the missing sequence in the letter series below:
A, CD, GHI, ?, UVWXYZ
(A) LMN (B) MNO (C) MNOP (D) NOPQ

[gate2015aptiset3](#) [gate2015](#) [aptitude](#)

[Answer](#)

14.0.9 GATE 2015 Aptitude Set 2 Q9 [top](#)

<http://gateoverflow.in/39509>

Q.9 If $a^2 + b^2 + c^2 = 1$, then $ab + bc + ac$ lies in the interval
(A) $[1, 2/3]$
(B) $[-1/2, 1]$
(C) $[-1, 1/2]$
(D) $[2, -4]$

[gate2015](#) [gate2015aptiset2](#) [aptitude](#)

[Answer](#)

14.0.10 GATE 2015 Aptitude Set 2 Q 8 [top](#)

<http://gateoverflow.in/39509>

Q.8 A tiger is 50 leaps of its own behind a deer. The tiger takes 5 leaps per minute to the deer's 4. If the tiger and the deer cover 8 metre and 5metre per leap respectively, what distance in metres will the

tiger have to run before it catches the deer?

[gate2015](#) [gate2015aptiset2](#) [aptitude](#)

[Answer](#)

14.0.11 GATE2014-1_GA_4 [top](#)

<http://gateoverflow.in/773>

If $(z + 1/z)^2 = 98$, compute $(z^2 + 1/z^2)$.

[gate2014-1](#) [numerical-ability](#) [easy](#)

[Answer](#)

14.0.12 GATE 2015 Aptitude Set 1 Q9 [top](#)

<http://gateoverflow.in/39496>

Q.9 A cube of side 3 units is formed using a set of smaller cubes of side 1 unit. Find the proportion of the number of faces of the smaller cubes visible to those which are NOT visible.

(A) 1 : 4 (B) 1 : 3 (C) 1 : 2 (D) 2 : 3

[gate2015](#) [gate2015aptiset1](#) [aptitude](#)

[Answer](#)

14.0.13 GATE 2015 Aptitude Set 1 Q5 [top](#)

<http://gateoverflow.in/39493>

Q.5 If $\log_x(5/7) = -1/3$, then the value of x is

- (A) 343/125
- (B) 125/343
- (C) -25/49
- (D) -49/25

[gate2015](#) [gate2015aptiset1](#) [aptitude](#)

[Answer](#)

14.0.14 GATE 2015 Aptitude Set 1 Q4 [top](#)

<http://gateoverflow.in/39492>

Q.4 Operators \square , \diamond and \rightarrow are defined by: $a \square b = \frac{a-b}{a+b}$; $a \diamond b = \frac{a+b}{a-b}$; $a \rightarrow b = ab$.

Find the value of $(66 \square 6) \rightarrow (66 \diamond 6)$.

- (A) -2
- (B) -1
- (C) 1
- (D) 2

[gate2015](#) [gate2015aptiset1](#) [aptitude](#)

[Answer](#)

14.0.15 GATE_2011_MN_65 [top](#)

<http://gateoverflow.in/31545>

Q.65

Nimbus clouds are dark and ragged, stratus clouds appear dull in colour and cover the entire sky. Cirrus clouds are thin and delicate, whereas cumulus clouds look like cotton balls.

It can be inferred from the passage that

- (A) A cumulus cloud on the ground is called fog
- (B) It is easy to predict the weather by studying clouds

- (C) Clouds are generally of very different shapes, sizes and mass
 (D) There are four basic cloud types: stratus, nimbus, cumulus and cirrus

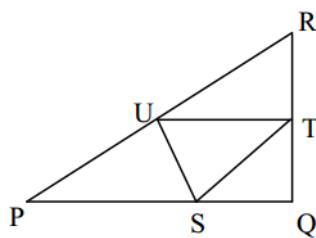
gate2011-mn verbal-ability

Answer

14.0.16 GATE 2015 Aptitude Set 4 Q8 [top](#)

<http://gateoverflow.in/40175>

Q.8 In the given figure angle Q is a right angle, PS:QS = 3:1, RT:QT = 5:2 and PU:UR = 1:1. If area of triangle QTS is 20 cm², then the area of triangle PQR in cm² is _____



gate2015aptiset4 aptitude

Answer

14.0.17 GATE_2011_MN_63 [top](#)

<http://gateoverflow.in/31543>

L, M and N are waiting in a queue meant for children to enter the zoo. There are 5 children between L and M, and 8 children between M and N. If there are 3 children ahead of N and 21 children behind L, then what is the minimum number of children in the queue?

- (A) 28 (B) 27 (C) 41 (D) 40

numerical-ability gate2011-mn

Answer

14.0.18 GATE_2011_MN_62 [top](#)

<http://gateoverflow.in/31540>

Q.62

A student attempted to solve a quadratic equation in x twice. However, in the first attempt, he incorrectly wrote the constant term and ended up with the roots as (4, 3). In the second attempt, he incorrectly wrote down the coefficient of x and got the roots as (3, 2). Based on the above information, the roots of the correct quadratic equation are

- (A) (-3, 4)
 (B) (3, -4)
 (C) (6, 1)
 (D) (4, 2)

numerical-ability gate2011-mn

Answer

14.0.19 GATE_MN_2011_61 [top](#)

<http://gateoverflow.in/31536>

Q.61

If $(2y+1)/(y+2) < 1$, then which of the following alternatives gives the CORRECT range of y ?

- (A) $-2 < y < 2$
- (B) $-2 < y < 1$
- (C) $-3 < y < 1$
- (D) $-4 < y < 1$

[numerical-ability](#) [gate2011-mn](#)

[Answer](#)

14.0.20 GATE_MN_2011_59 [top](#)

<http://gateoverflow.in/31531>

Q.59

In how many ways 3 scholarships can be awarded to 4 applicants, when each applicant can receive any number of scholarships?

- (A) 4
- (B) 12
- (C) 64
- (D) 81

[numerical-ability](#) [gate2011-mn](#)

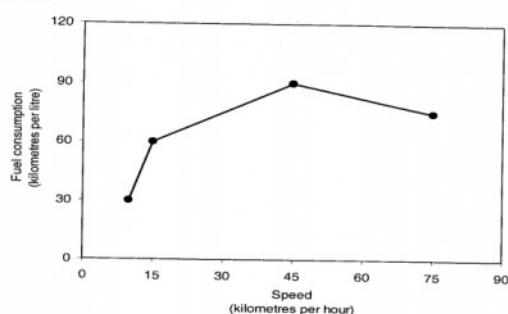
[Answer](#)

14.0.21 GATE_IN_61 [top](#)

<http://gateoverflow.in/31386>

2011 Q. 61 to Q. 65 carry two marks each.

Q.61 The fuel consumed by a motorcycle during a journey while traveling at various speeds is indicated in the graph below.



The distances covered during four laps of the journey are listed in the table below

| Lap | Distance (kilometres) | Average speed (kilometres per hour) |
|-----|-----------------------|-------------------------------------|
| P | 15 | 15 |
| Q | 75 | 45 |
| R | 40 | 75 |
| S | 10 | 10 |

From the given data, we can conclude that the fuel consumed per kilometre was least during the lap

- (A) P
- (B) Q
- (C) R
- (D) S

[gate-in-2011](#) [gate2011-in](#) [numerical-ability](#)

[Answer](#)

14.0.22 GATE IN 2011-65 [top](#)

<http://gateoverflow.in/31281>

65. Three friends, R, S and T shared toffee from a bowl. R took $\frac{1}{3}$ rd of the toffees, but returned four to the bowl. S took $\frac{1}{4}$ th of what was left but returned three toffees to the bowl. T took half of the remainder but returned two back into the bowl. If the bowl had 17 toffees left, how many toffees were originally there in the bowl?

(A) 38 (B) 31 (C) 48 (D) 41

gate-in-2011 numerical-ability

Answer

14.0.23 GATE IN 2011-56 [top](#)

<http://gateoverflow.in/31267>

56. There are two candidates P and Q in an election. During the campaign, 40% of the voters promised to vote for P, and rest for Q. However, on the day of election 15% of the voters went back on their promise to vote for P and instead voted for Q. 25% of the voters went back on their promise to vote for Q and instead voted for P. Suppose, P lost by 2 votes, then what was the total number of voters? (A) 100 (B) 110 (C) 90 (D) 95

gate-in-2011 numerical-ability

Answer

14.0.24 TIFR2015-B-12 [top](#)

<http://gateoverflow.in/30046>

Let t_n be the sum of the first n natural numbers, for $n > 0$. A number is called triangular if it is equal to t_n for some n . Which of the following statements are true:

- (i) There exists three successive triangular numbers whose product is a perfect square.
- (ii) If the triangular number t_n is a perfect square, then so is $t_{4n(n+1)}$.
- (iii) The sum of the reciprocals of the first n triangular numbers is less than 2, i.e.

$$\frac{1}{1} + \frac{1}{3} + \frac{1}{6} + \dots + \frac{1}{t_n} < 2$$

- a. (i) only.
- b. (ii) only.
- c. (iii) only.
- d. All of the above.
- e. None of the above.

tifr2015 numerical-ability normal

Answer

14.0.25 TIFR2015-A-13 [top](#)

<http://gateoverflow.in/29566>

Imagine the first quadrant of the real plane as consisting of unit squares. A typical square has 4 corners: $(i, j), (i+1, j), (i+1, j+1)$, and $(i, j+1)$, where (i, j) is a pair of non-negative integers. Suppose a line segment l connecting $(0, 0)$ to $(90, 1100)$ is drawn. We say that l passes through a unit square if it passes through a point in the interior of the square. How many unit squares does l pass through?

- a. 98,990
- b. 9,900
- c. 1,190
- d. 1,180
- e. 1,010

tifr2015 numerical-ability

Answer

14.0.26 TIFR2015-A-3 [top](#)

<http://gateoverflow.in/29159>

Let $|z| < 1$. Define $M_n(z) = \sum_{i=1}^{10} z^{10^n(i-1)}$? what is

$$\prod_{i=0}^{\infty} M_i(z) = M_0(z) \times M_1(z) \times M_2(z) \times \dots ?$$

- A. Can't be determined.
- B. $1/(1-z)$
- C. $1/(1+z)$
- D. $1-z^9$
- E. None of the above.

tifr2015

Answer

14.0.27 TIFR2013-B-9 top<http://gateoverflow.in/25675>

Suppose n straight lines are drawn on a plane. When these lines are removed, the plane falls apart into several connected components called regions. A region R is said to be convex if it has the following property: whenever two points are in R , then the entire line segment joining them is in R . Suppose no two of the n lines are parallel. Which of the following is true?

- a. $O(n)$ regions are produced, and each region is convex.
- b. $O(n^2)$ regions are produced but they need not all be convex.
- c. $O(n^2)$ regions are produced, and each region is convex.
- d. $O(n \log n)$ regions are produced, but they need not all be convex.
- e. All regions are convex but there may be exponentially many of them.

tifr2013 numerical-ability

Answer

14.0.28 TIFR2013-A-12 top<http://gateoverflow.in/25434>

Among numbers 1 to 1000 how many are divisible by 3 or 7?

- a. 333
- b. 142
- c. 475
- d. 428
- e. None of the above.

tifr2013 numerical-ability

Answer

14.0.29 GATE 2015 Aptitude Set 4 Q9 top<http://gateoverflow.in/40173>

Q.9 Right triangle PQR is to be constructed in the xy - plane so that the right angle is at P and line PR is parallel to the x-axis. The x and y coordinates of P, Q, and R are to be integers that satisfy the inequalities: $-4 \leq x \leq 5$ and $6 \leq y \leq 16$. How many different triangles could be constructed with these properties?

(A) 110 (B) 1,100 (C) 9,900 (D) 10,000

gate2015aptiset4 aptitude numerical-ability

Answer

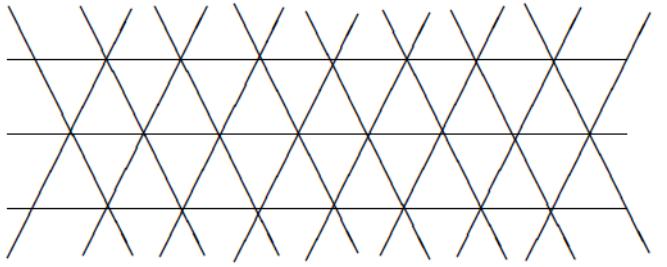
14.0.30 Gate 2015 Aptitude Set 8 Q4 top<http://gateoverflow.in/40179>

Q.4 Mr. Vivek walks 6 meters North-east, then turns and walks 6 meters South-east, both at 60 degrees to east. He further moves 2 meters South and 4 meters West. What is the straight distance in metres between the point he started from and the point he finally reached?

- (A) $2\sqrt{2}$
- (B) 2
- (C) $\sqrt{2}$
- (D) $1/\sqrt{2}$

[gate2015aptiset8](#) [aptitude](#) [numerical-ability](#)
Answer**14.0.31 TIFR2013-A-1** [top](#)<http://gateoverflow.in/25382>

An infinite two-dimensional pattern is indicated below.



The smallest closed figure made by the lines is called a unit triangle. Within every unit triangle, there is a mouse. At every vertex there is a laddoo. What is the average number of laddoos per mouse?

- a. 3
- b. 2
- c. 1
- d. $\frac{1}{2}$
- e. $\frac{1}{3}$

[tifr2013](#) [numerical-ability](#)
Answer**14.0.32 GATE-2013-AE-GA-8** [top](#)<http://gateoverflow.in/40249>

Q.64 If $| -2X + 9 | = 3$ then the possible value of $| -X | - X^2$ would be:

- (A) 30
- (B) -30
- (C) -42
- (D) 42

Q 64). If $| -2X + 9 | = 3$ then the possible value of $| -X | - X^2$ would be:

- A). 30
- B). -30
- C). -42
- D). 42

[gate2013-ae](#) [numerical-ability](#)
Answer**14.0.33 GATE2014-EC02-GA8** [top](#)<http://gateoverflow.in/41516>

The sum of eight consecutive odd numbers is 656. The average of four consecutive even numbers is 87. What is the sum of the smallest odd number and second largest even number?

[gate2014-ec02](#) [numerical-ability](#) [numerical-answers](#)
Answer**14.0.34 GATE2014-EC04-GA10** [top](#)<http://gateoverflow.in/41472>

A five digit number is formed using the digits 1, 3, 5, 7 and 9 without repeating any of them. What is the sum of all such possible five digit numbers?

- A. 6666660
- B. 6666600
- C. 6666666
- D. 6666606

gate2014-ec04 numerical-ability normal

[Answer](#)

14.0.35 GATE2014-EC04-GA4 [top](#)

<http://gateoverflow.in/41466>

Let $f(x, y) = x^n y^m = p$. If x is doubled and y is halved, the new value of f is

- A. $2^{n-m}P$
- B. $2^{m-n}P$
- C. $2(n-m)P$
- D. $2(m-n)P$

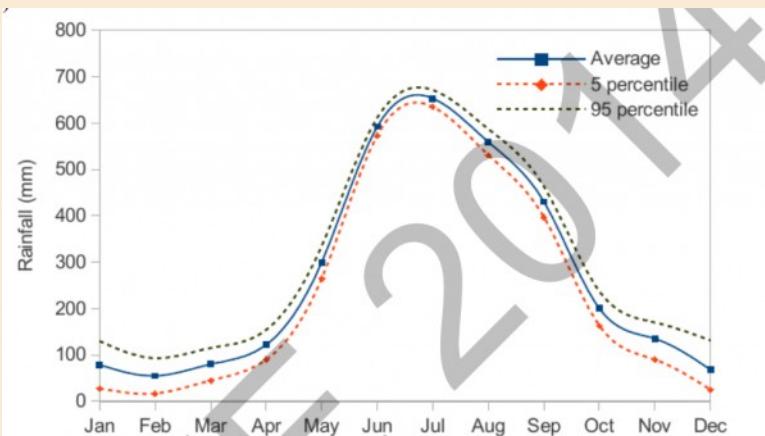
gate2014-ec04 numerical-ability easy

[Answer](#)

14.0.36 gate-2014-ae-10 [top](#)

<http://gateoverflow.in/40310>

The monthly rainfall chart based on 50 years of rainfall in Agra is shown in the following figure. Which of the following are true? (k percentile is the value such that k percent of the data fall below that value)



- (i) On average, it rains more in July than in December
 - (ii) Every year, the amount of rainfall in August is more than that in January
 - (iii) July rainfall can be estimated with better confidence than February rainfall
 - (iv) In August, there is at least 500 mm of rainfall
- (A) (i) and (ii) (B) (i) and (iii)
(C) (ii) and (iii) (D) (iii) and (iv)

gate-2014-ae numerical-ability

[Answer](#)

14.0.37 gate-2014-ae-8 [top](#)<http://gateoverflow.in/40308>

Q.8 The smallest angle of a triangle is equal to two thirds of the smallest angle of a quadrilateral. The ratio between the angles of the quadrilateral is 3:4:5:6. The largest angle of the triangle is twice its smallest angle. What is the sum, in degrees, of the second largest angle of the triangle and the largest angle of the quadrilateral?

[gate-2014-ae](#) [numerical-ability](#)
Answer**14.0.38 gate-2014-ae-4** [top](#)<http://gateoverflow.in/40303>

Q.4 If $y = 5x^2 + 3$, then the tangent at $x = 0, y = 3$

- (A) passes through $x = 0, y = 0$
- (B) has a slope of +1
- (C) is parallel to the x -axis
- (D) has a slope of -1

Q4). If $y = 5x^2 + 3$, then the tangent at $x = 0, y = 3$

- A). passes through $x = 0, y = 0$
- B). has a slope of +1
- C). is parallel to the x -axis
- D). has a slope of -1

[gate-2014-ae](#) [numerical-ability](#)
Answer**14.0.39 GATE2013-ee-8** [top](#)<http://gateoverflow.in/40295>

The set of values of p for which the roots of the equation $3x^2 + 2x + p(p-1) = 0$ are of opposite sign is

- (A) $(-\infty, 0)$
- (B) $(0, 1)$
- (C) $(1, \infty)$
- (D) $(0, \infty)$

[gate2013-ee](#) [numerical-ability](#)
Answer**14.0.40 gate-2013-ee-2** [top](#)<http://gateoverflow.in/40289>

Q.57 In the summer of 2012, in New Delhi, the mean temperature of Monday to Wednesday was 41°C and of Tuesday to Thursday was 43°C . If the temperature on Thursday was 15% higher than that of Monday, then the temperature in $^\circ\text{C}$ on Thursday was

- (A) 40 (B) 43 (C) 46 (D) 49

[gate2013-ee](#) [numerical-ability](#)
Answer**14.0.41 gate2013-ce-8** [top](#)<http://gateoverflow.in/40276>

Q.63 Following table provides figures (in rupees) on annual expenditure of a firm for two years - 2010 and 2011.

| Category | 2010 | 2011 |
|------------------------|-------|-------|
| Raw material | 5200 | 6240 |
| Power & fuel | 7000 | 9450 |
| Salary & wages | 9000 | 12600 |
| Plant & machinery | 20000 | 25000 |
| Advertising | 15000 | 19500 |
| Research & Development | 22000 | 26400 |

In 2011, which of the following two categories have registered increase by same percentage?

- (A) Raw material and Salary & wages
- (B) Salary & wages and Advertising
- (C) Power & fuel and Advertising
- (D) Raw material and Research & Development

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In 2011 , which of the two categories have registered increase by same percentage?

- A). Raw material and Salary & wages.
- B), Salary & wages and Advertising.
- C). Power & fuel and Advertising.
- D). Raw material and research & Development.

numerical-ability gate2013-ce

Answer

14.0.42 GATE2013-CE-7 top

<http://gateoverflow.in/40275>

If $|4X - 7| = 5$ then the values of $2|X| - |-X|$ is:

- A). $2, \frac{1}{3}$
- B). $\frac{1}{2}, 3$
- C). $\frac{3}{2}, 9$
- D). $\frac{2}{3}, 9$

gate2013-ce numerical-ability

Answer

14.0.43 gate2013-ce-6 top

<http://gateoverflow.in/40274>

Q.61 X and Y are two positive real numbers such that $2X + Y \leq 6$ and $X + 2Y \leq 8$. For which of the following values of (X, Y) the function $f(X, Y) = 3X + 6Y$ will give maximum value?

- (A) $(4/3, 10/3)$
- (B) $(8/3, 20/3)$
- (C) $(8/3, 10/3)$
- (D) $(4/3, 20/3)$

[gate2013-ce](#) [numerical-ability](#)

[Answer](#)

14.0.44 gate2013-ce-1 [top](#)

<http://gateoverflow.in/40268>

Q.56 A number is as much greater than 75 as it is smaller than 117. The number is:

- (A) 91 (B) 93 (C) 89 (D) 96

[gate2013-ce](#) [numerical-ability](#)

[Answer](#)

14.0.45 GATE-2013-AE-GA-7 [top](#)

<http://gateoverflow.in/40248>

Q.63 Following table gives data on tourists from different countries visiting India in the year 2011.

| Country | Number of Tourists |
|-----------|--------------------|
| USA | 2000 |
| England | 3500 |
| Germany | 1200 |
| Italy | 1100 |
| Japan | 2400 |
| Australia | 2300 |
| France | 1000 |

Which two countries contributed to the one third of the total number of tourists who visited India in 2011?

- (A) USA and Japan (B) USA and Australia (C) England and France (D) Japan and Australia

[gate2013-ae](#) [numerical-ability](#)

[Answer](#)

14.0.46 Gate 2015 Aptitude Set 8 Q7 [top](#)

<http://gateoverflow.in/40182>

Q.7 The given question is followed by two statements; select the most appropriate option that solves the question.

Capacity of a solution tank A is 70% of the capacity of tank B. How many gallons of solution are in tank A and tank B?

Statements:

- (I) Tank A is 80% full and tank B is 40% full.
- (II) Tank A if full contains 14,000 gallons of solution.
- (A) Statement I alone is sufficient.
- (B) Statement II alone is sufficient.
- (C) Either statement I or II alone is sufficient.
- (D) Both the statements I and II together are sufficient.

[gate2015aptiset8](#)
[aptitude](#)
[numerical-ability](#)
Answer**14.0.47 GATE2012-CY-GA-10** [top](#)<http://gateoverflow.in/40241>

Q.65 Raju has 14 currency notes in his pocket consisting of only Rs. 20 notes and Rs. 10 notes. The total money value of the notes is Rs. 230. The number of Rs. 10 notes that Raju has is
 (A) 5 (B) 6 (C) 9 (D) 10

[gate2012-cy](#)
[aptitude](#)
[numerical-ability](#)
Answer**14.0.48 GATE2012-CY-GA-9** [top](#)<http://gateoverflow.in/40240>

Q.64 There are eight bags of rice looking alike, seven of which have equal weight and one is slightly heavier. The weighing balance is of unlimited capacity. Using this balance, the minimum number of weighings required to identify the heavier bag is
 (A) 2 (B) 3 (C) 4 (D) 8

[gate2012-cy](#)
[aptitude](#)
[numerical-ability](#)
Answer**14.0.49 GATE2012-CY-GA-8** [top](#)<http://gateoverflow.in/40239>

The data given in the following table summarizes the monthly budget of an average household.

| Category | Amount (Rs) |
|----------------|-------------|
| Food | 4000 |
| Clothing | 1200 |
| Rent | 2000 |
| Savings | 1500 |
| Other expenses | 1800 |

The approximate percentage of the monthly budget **NOT** spent on savings is

1. 10%
2. 14%
3. 81%
4. 86%

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[gate2012-cy](#)
[aptitude](#)
[numerical-ability](#)
Answer

14.0.50 GATE2012-AR-9 top<http://gateoverflow.in/40230>

A smuggler has 10 capsules in which five are filled with narcotic drugs and the rest contain the original medicine. All the 10 capsules are mixed in a single box, from which the customs officials picked two capsules at random and tested for the presence of narcotic drugs. The probability that the smuggler will be caught is

- (A) 0.50 (B) 0.67 (C) 0.78 (D) 0.82

[gate2012-ar](#) [aptitude](#) [numerical-ability](#)

Answer

14.0.51 GATE2012-AR-6 top<http://gateoverflow.in/40227>

Q.61 A value of x that satisfies the equation $\log x + \log (x - 7) = \log (x + 11) + \log 2$ is
(A) 1 (B) 2 (C) 7 (D) 11

[gate2012-ar](#) [aptitude](#) [numerical-ability](#)

Answer

14.0.52 GATE2012-AR-5 top<http://gateoverflow.in/40226>

Ten teams participate in a tournament. Every team plays each of the other teams twice. The total number of matches to be played is

- (A) 20
(B) 45
(C) 60
(D) 90

[gate2012-ar](#) [aptitude](#) [numerical-ability](#)

Answer

14.0.53 GATE-2012-AE-9 top<http://gateoverflow.in/40220>

Q.64 Two points $(4, p)$ and $(0, q)$ lie on a straight line having a slope of $3/4$. The value of $(p - q)$ is
(A) -3 (B) 0 (C) 3 (D) 4

[gate2012-ae](#) [numerical-ability](#)

Answer

14.0.54 GATE-2012-AE-7 top<http://gateoverflow.in/40218>

Q.62 The total runs scored by four cricketers P, Q, R, and S in years 2009 and 2010 are given in the following table:

| Player | 2009 | 2010 |
|--------|------|------|
| P | 802 | 1008 |
| Q | 765 | 912 |
| R | 429 | 619 |
| S | 501 | 701 |

The player with the lowest percentage increase in total runs is

- (A) P (B) Q (C) R (D) S

Q 62). The total runs scored by four cricketers *P, Q, R and S* in years 2009 and 2010 are given in the following table;

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| R | 429 | 619 |
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The player with the lowest percentage increase in total runs is

- A). *P*
B). *Q*
C). *R*
D). *S*

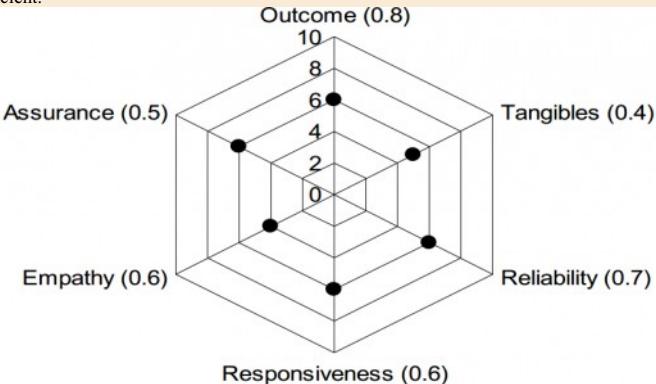
gate2012-ae aptitude numerical-ability

Answer

14.0.55 GATE2011_GG_GA_9 top

<http://gateoverflow.in/40210>

The quality of services delivered by a company consists of six factors as shown below in the radar diagram. The dots in the figure indicate the score for each factor on a scale of 0 to 10. The standardized coefficient for each factor is given in the parentheses. The contribution of each factor to the overall service quality is directly proportional to the factor score and its standardized coefficient.



The lowest contribution among all the above factors to the overall quality of services delivered by the company is (A) 10%
(B) 20% (C) 24% (D) 40%

gate2011-gg aptitude difficult

Answer**14.0.56 GATE2011_GG_GA_8** [top](#)<http://gateoverflow.in/40209>

Q.63 Three sisters (R, S, and T) received a total of 24 toys during Christmas. The toys were initially divided among them in a certain proportion. Subsequently, R gave some toys to S which doubled the share of S. Then S in turn gave some of her toys to T, which doubled T's share. Next, some of T's toys were given to R, which doubled the number of toys that R currently had. As a result of all such exchanges, the three sisters were left with equal number of toys. How many toys did R have originally?

- (A) 8 (B) 9 (C) 11 (D) 12

[gate2011_gg](#) [aptitude](#)**Answer****14.0.57 GATE2011_GG_GA_7** [top](#)<http://gateoverflow.in/40208>

In a class of 300 students in an M.Tech programme, each student is required to take at least one subject from the following three:

- M600: Advanced Engineering Mathematics
- C600: Computational Methods for Engineers
- E600: Experimental Techniques for Engineers

The registration data for the M.Tech class shows that 100 students have taken M600, 200 students have taken C600, and 60 students have taken E600. What is the maximum possible number of students in the class who have taken all the above three subjects?

- (A) 20 (B) 30 (C) 40 (D) 50

[gate2011_gg](#) [numerical-ability](#) [set-theory&algebra](#)**Answer****14.0.58 GATE2011_GG_GA_4** [top](#)<http://gateoverflow.in/40205>

If m students require a total of m pages of stationery in m days, then 100 students will require 100 pages of stationery in

- (A) 100 days (B) $m/100$ days (C) $100/m$ days (D) m days

[gate2011_gg](#) [numerical-ability](#)**Answer****14.0.59 Gate 2015 Aptitude Set 8 Q10** [top](#)<http://gateoverflow.in/40184>

Q.10 There are 16 teachers who can teach Thermodynamics (TD), 11 who can teach Electrical Sciences (ES), and 5 who can teach both TD and Engineering Mechanics (EM). There are a total of 40 teachers. 6 cannot teach any of the three subjects, i.e. EM, ES or TD. 6 can teach only ES. 4 can teach all three subjects, i.e. EM, ES and TD. 4 can teach ES and TD. How many can teach both ES and EM but not TD?

- (A) 1 (B) 2 (C) 3 (D) 4

[gate2015aptiset8](#) [aptitude](#) [set-theory&algebra](#)

Answer**14.0.60 TIFR2013-A-10** [top](#)<http://gateoverflow.in/25432>

Three men and three rakhsasas arrive together at a ferry crossing to find a boat with an oar, but no boatman. The boat can carry one or at the most two persons, for example, one man and one rakhsasas, and each man or rakhsasas can row. But if at any time, on any bank, (including those who maybe are in the boat as it touches the bank) rakhsasas outnumber men, the former will eat up the latter. If all have to go to the other side without any mishap, what is the minimum number of times that the boat must cross the river?

- a. 7
- b. 9
- c. 11
- d. 13
- e. 15

[tifr2013](#) [numerical-ability](#)**Answer****14.0.61 GATE 2015 Aptitude Set 2 Q 5** [top](#)<http://gateoverflow.in/39506>

Q.5 Ram and Ramesh appeared in an interview for two vacancies in the same department. The probability of Ram's selection is $1/6$ and that of Ramesh is $1/8$. What is the probability that only one of them will be selected?

- (A) $47/48$
- (B) $1/4$
- (C) $13/48$

[gate2015](#) [gate2015aptiset2](#) [aptitude](#)**Answer****14.0.62 GATE2011_65** [top](#)<http://gateoverflow.in/2175>

A container originally contains 10 litres of pure spirit. From this container 1 litre of spirit replaced with 1 litre of water. Subsequently, 1 litre of the mixture is again replaced with 1 litre of water and this process is repeated one more time. How much spirit is now left in the container?

- (A) 7.58 litres
- (B) 7.84 litres
- (C) 7 litres
- (D) 7.29 litres

[gate2011](#) [numerical-ability](#) [normal](#)**Answer****14.0.63 GATE2011_57** [top](#)<http://gateoverflow.in/2166>

If $\log(P) = (1/2)\log(Q) = (1/3)\log(R)$, then which of the following options is **TRUE**?

- (A) $P^2 = Q^3R^2$
- (B) $Q^2 = PR$
- (C) $Q^2 = R^3P$
- (D) $R = P^2Q^2$

[gate2011](#) [numerical-ability](#) [normal](#)[Answer](#)**14.0.64 TIFR2010-A-14** [top](#)<http://gateoverflow.in/18393>

A marine biologist wanted to estimate the number of fish in a large lake. He threw a net and found 30 fish in the net. He marked all these fish and released them into the lake. The next morning he again threw the net and these time caught 40 fish, of which two were found to be marked. The (approximate) number of fish in the lake is:

- a. 600
- b. 1200
- c. 68
- d. 800
- e. 120

[tifr2010](#) [numerical-ability](#)[Answer](#)**14.0.65 TIFR2010-A-9** [top](#)<http://gateoverflow.in/18385>

A table contains 287 entries. When anyone of the entries is requested, it is encoded into a binary string and transmitted. The number of bits required is.

- a. 8
- b. 9
- c. 10
- d. Cannot be determined from the given information.
- e. None of the above.

[tifr2010](#) [numerical-ability](#)[Answer](#)**14.0.66 TIFR2010-A-1** [top](#)<http://gateoverflow.in/18202>

A box contains 731 black balls and 2000 white balls. The following process is to be repeated as long as possible. Arbitrarily select two balls from the box. If they are of the same color, throw them out and put a black ball into the box (enough extra black balls are available to do this). If they are of different color, place the white ball back into the box and throw the black ball away. Which of the following is correct?

- 1. The process can be applied indefinitely without any prior bound
- 2. The process will stop with a single white ball in the box
- 3. The process will stop with a single black ball in the box
- 4. The process will stop with the box empty
- 5. None of the above

[tifr2010](#) [numerical-ability](#)[Answer](#)**14.0.67 GATE2014-3_GA_8** [top](#)<http://gateoverflow.in/2032>

The Gross Domestic Product (GDP) in Rupees grew at 7% during 2012-2013. For international comparison, the GDP is compared in US Dollars (USD) after conversion based on the market exchange rate. During the period 2012-2013 the exchange rate for the USD increased from Rs. 50/ USD to Rs. 60/ USD. India's GDP in USD during the period 2012-2013

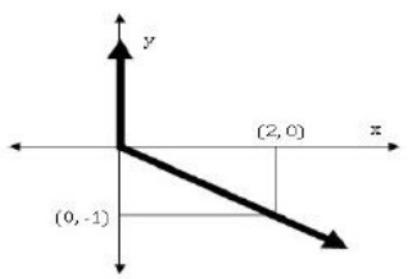
- (A) increased by 5 %
- (B) decreased by 13%
- (C) decreased by 20%
- (D) decreased by 11%

gate2014-3 numerical-ability normal

Answer

14.0.68 GATE2015-3_GA_8 top<http://gateoverflow.in/8385>

Choose the most appropriate equation for the function drawn as thick line, in the plot below.



- A. $x = y - |y|$
- B. $x = -(y - |y|)$
- C. $x = y + |y|$
- D. $x = -(y + |y|)$

gate2015-3 numerical-ability normal

Answer

14.0.69 GATE2015-3_GA_5 top<http://gateoverflow.in/8303>

A function $f(x)$ is linear and has a value of 29 at $x = -2$ and 39 at $x = 3$. Find its value at $x = 5$.

- A. 59
- B. 45
- C. 43
- D. 35

gate2015-3 numerical-ability normal

Answer

14.0.70 GATE2015-3_GA_1 top<http://gateoverflow.in/8098>

If ROAD is written as URDG, then SWAN should be written as:

- A. VXDQ
- B. VZDQ
- C. VZDP
- D. UXDQ

gate2015-3 numerical-ability easy

Answer

14.0.71 GATE2015-2_GA_7 top<http://gateoverflow.in/8036>

Four branches of a company are located at M, N, O and P. M is north of N at a distance of 4 km; P is south of O at a distance of 2 km; N is southeast of O by 1 km. What is the distance between M and P in km?

- A. 5.34
 B. 6.74
 C. 28.5
 D. 45.49

gate2015-2 numerical-ability normal

[Answer](#)

14.0.72 TIFR2010-A-20 [top](#)

<http://gateoverflow.in/18500>

How many integers from 1 to 1000 are divisible by 30 but not by 16?

- a. 29
 b. 31
 c. 32
 d. 33
 e. 25

tifr2010 numerical-ability

[Answer](#)

14.0.73 GATE2015-2_GA_6 [top](#)

<http://gateoverflow.in/8035>

If the list of letters, P, R, S, T, U is an arithmetic sequence, which of the following are also in arithmetic sequence?

- I. $2P, 2R, 2S, 2T, 2U$
 II. $P - 3, R - 3, S - 3, T - 3, U - 3$
 III. P^2, R^2, S^2, T^2, U^2

- A. I only
 B. I and II
 C. II and III
 D. I and III

gate2015-2 numerical-ability normal

[Answer](#)

14.0.74 GATE2015-2_GA_5 [top](#)

<http://gateoverflow.in/8033>

Based on the given statements, select the most appropriate option to solve the given question.

What will be the total weight of 10 poles each of same weight?

Statements:

- I. One fourth of the weight of the pole is 5 Kg.
 II. The total weight of these poles is 160 Kg more than the total weight of two poles.

- A. Statement I alone is not sufficient.
 B. Statement II alone is not sufficient.
 C. Either I or II alone is sufficient.
 D. Both statements I and II together are not sufficient.

gate2015-2 numerical-ability normal

[Answer](#)

14.0.75 GATE2011_64 [top](#)

<http://gateoverflow.in/2174>

A transporter receives the same number of orders each day. Currently, he has some pending orders (backlog) to be shipped. If he uses 7 trucks, then at the end of the 4th day he can clear all the orders. Alternatively, if he uses only 3 trucks, then all the orders are cleared at the end of the 10th day. What is the minimum number of trucks required so that there will be no pending order at the end of 5th day?

- (A) 4
- (B) 5
- (C) 6
- (D) 7

[gate2011](#) [numerical-ability](#) [normal](#)

[Answer](#)

14.0.76 GATE2012_62 [top](#)

<http://gateoverflow.in/2210>

A political party orders an arch for the entrance to the ground in which the annual convention is being held. The profile of the arch follows the equation $y = 2x - 0.1x^2$ where y is the height of the arch in meters. The maximum possible height of the arch is

- (A) 8 meters
- (B) 10 meters
- (C) 12 meters
- (D) 14 meters

[gate2012](#) [numerical-ability](#) [normal](#)

[Answer](#)

14.0.77 GATE2015-1_GA_6 [top](#)

<http://gateoverflow.in/8010>

The number of students in a class who have answered correctly, wrongly, or not attempted each question in an exam, are listed in the table below. The marks for each question are also listed. There is no negative or partial marking.

| Q No. | Marks | Answered Correctly | Answered Wrongly | Not Attempted |
|-------|-------|--------------------|------------------|---------------|
| 1 | 2 | 21 | 17 | 6 |
| 2 | 3 | 15 | 27 | 2 |
| 3 | 1 | 11 | 29 | 4 |
| 4 | 2 | 23 | 18 | 3 |
| 5 | 5 | 31 | 12 | 1 |

What is the average of the marks obtained by the class in the examination?

- A. 2.290
- B. 2.970
- C. 6.795
- D. 8.795

[gate2015-1](#) [numerical-ability](#) [easy](#)

[Answer](#)

14.0.78 GATE2015-1_GA_4 [top](#)

<http://gateoverflow.in/8006>

Based on the given statements, select the most appropriate option to solve the given question.

If two floors in a certain building are 9 feet apart, how many steps are there in a set of stairs that extends from the first floor to the second floor of the building?

Statements:

- (I) Each step is 3/4 foot high.

(II) Each step is 1 foot wide.

- A. Statements I alone is sufficient, but statement II alone is not sufficient.
- B. Statements II alone is sufficient, but statement I alone is not sufficient.
- C. Both statements together are sufficient, but neither statement alone is sufficient.
- D. Statements I and II together are not sufficient.

[gate2015-1](#) [numerical-ability](#) [easy](#)

[Answer](#)

14.0.79 GATE2010-59 [top](#)

<http://gateoverflow.in/2367>

25 persons are in a room. 15 of them play hockey, 17 of them play football and 10 of them play both hockey and football. Then the number of persons playing neither hockey nor football is:

- A. 2
- B. 17
- C. 13
- D. 3

[gate2010](#) [numerical-ability](#) [easy](#)

[Answer](#)

14.0.80 GATE2010-61 [top](#)

<http://gateoverflow.in/2369>

If $137 + 276 = 435$ how much is $731 + 672$?

- A. 534
- B. 1403
- C. 1623
- D. 1513

[gate2010](#) [numerical-ability](#) [normal](#)

[Answer](#)

14.0.81 GATE2010-65 [top](#)

<http://gateoverflow.in/2373>

Given digits 2, 2, 3, 3, 3, 4, 4, 4, 4 how many distinct 4 digit numbers greater than 3000 can be formed?

- A. 50
- B. 51
- C. 52
- D. 54

[gate2010](#) [numerical-ability](#) [combinatory](#) [normal](#)

[Answer](#)

14.0.82 GATE2014-3_GA_5 [top](#)

<http://gateoverflow.in/2028>

The table below has question-wise data on the performance of students in an examination. The marks for each question are also listed. There is no negative or partial marking in the examination.

| Q No. | Marks | Answered Correctly | Answered Wrongly | Not Attempted |
|-------|-------|--------------------|------------------|---------------|
| 1 | 2 | 21 | 17 | 6 |
| 2 | 3 | 15 | 27 | 2 |
| 3 | 2 | 23 | 18 | 3 |

What is the average of the marks obtained by the class in the examination?

- (A) 1.34
 (B) 1.74
 (C) 3.02
 (D) 3.91

gate2014-3 numerical-ability normal

[Answer](#)

14.0.83 GATE2014-2_GA_10 [top](#)

<http://gateoverflow.in/1952>

At what time between 6 a. m. and 7 a. m. will the minute hand and hour hand of a clock make an angle closest to 60° ?

- (A) 6: 22 a.m.
 (B) 6: 27 a.m.
 (C) 6: 38 a.m.
 (D) 6: 45 a.m.

gate2014-2 numerical-ability normal

[Answer](#)

14.0.84 TIFR2011-A-15 [top](#)

<http://gateoverflow.in/20226>

The exponent of 3 in the product $100!$ is

- a. 27
 b. 33
 c. 44
 d. 48
 e. None of the above.

tifr2011

[Answer](#)

14.0.85 GATE2014-1_GA_8 [top](#)

<http://gateoverflow.in/776>

Round-trip tickets to a tourist destination are eligible for a discount of 10% on the total fare. In addition, groups of 4 or more get a discount of 5% on the total fare. If the one way single person fare is Rs 100, a group of 5 tourists purchasing round-trip tickets will be charged Rs _____

gate2014-1 numerical-ability easy

[Answer](#)

14.0.86 GATE2014-1_GA_9 [top](#)

<http://gateoverflow.in/777>

In a survey, 300 respondents were asked whether they own a vehicle or not. If yes, they were further asked to mention whether they own a car or scooter or both. Their responses are tabulated below. What percent of respondents do not own a scooter?

| | | Men | Women |
|-------------|---------|-----|-------|
| Own vehicle | Car | 40 | 34 |
| | Scooter | 30 | 20 |
| | Both | 60 | 46 |

Do not own vehicle

20

50

gate2014-1 numerical-ability normal

Answer

14.0.87 GATE2013_58 [top](#)<http://gateoverflow.in/1562>

What will be the maximum sum of 44, 42, 40, ?

- (A) 502 (B) 504 (C) 506 (D) 500

gate2013 numerical-ability easy

Answer

14.0.88 TIFR2011-A-20 [top](#)<http://gateoverflow.in/20260>Let $n > 1$ be an odd integer. The number of zeros at the end of the number $99^n + 1$ is.

- a. 1
- b. 2
- c. 3
- d. 4
- e. None of the above.

tifr2011 numerical-ability

Answer

14.0.89 GATE2013_61 [top](#)<http://gateoverflow.in/1565>

Find the sum of the expression

$$\frac{1}{\sqrt{1}+\sqrt{2}} + \frac{1}{\sqrt{2}+\sqrt{3}} + \frac{1}{\sqrt{3}+\sqrt{4}} + \dots + \frac{1}{\sqrt{80}+\sqrt{81}}$$

- (A) 7 (B) 8 (C) 9 (D) 10

gate2013 numerical-ability normal

Answer

14.0.90 GATE2013_62 [top](#)<http://gateoverflow.in/1566>

Out of all the 2-digit integers between 1 and 100, a 2-digit number has to be selected at random. What is the probability that the selected number is not divisible by 7?

- (A) 13/90 (B) 12/90 (C) 78/90 (D) 77/90

gate2013 numerical-ability easy

Answer

14.0.91 GATE2013_64 [top](#)<http://gateoverflow.in/1568>

A tourist covers half of his journey by train at 60 km/h, half of the remainder by bus at 30 km/h and the rest by cycle at 10 km/h. The average speed of the tourist in km/h during his entire journey is

- (A) 36 (B) 30 (C) 24 (D) 18

gate2013 numerical-ability easy

Answer

14.0.92 GATE2013_65 [top](#)<http://gateoverflow.in/1569>

The current erection cost of a structure is Rs. 13,200. If the labour wages per day increase by 1/5 of the current wages and the working hours decrease by 1/24 of the current period, then the new cost of erection in Rs. is

- (A) 16,500 (B) 15,180 (C) 11,000 (D) 10,120

gate2013 | numerical-ability | normal

Answer

14.0.93 GATE2014-2_GA_4 [top](#)

<http://gateoverflow.in/1941>

What is the average of all multiples of 10 from 2 to 198?

- (A) 90
(B) 100
(C) 110
(D) 120

gate2014-2 | numerical-ability | easy

Answer

14.0.94 GATE2014-2_GA_5 [top](#)

<http://gateoverflow.in/1942>

The value of $\sqrt{12 + \sqrt{12 + \sqrt{12 + \dots}}}$ is

- (A) 3.464
(B) 3.932
(C) 4.000
(D) 4.444

gate2014-2 | numerical-ability | easy

Answer

14.0.95 GATE2014-2_GA_8 [top](#)

<http://gateoverflow.in/1950>

If x is real and $|x^2 - 2x + 3| = 11$, then possible values of $|-x^3 + x^2 - x|$ include

- (A) 2, 4
(B) 2, 14
(C) 4, 52
(D) 14, 52

gate2014-2 | numerical-ability | normal

Answer

14.0.96 GATE2010-64 [top](#)

<http://gateoverflow.in/2372>

5 skilled workers can build a wall in 20 days; 8 semi-skilled workers can build a wall in 25 days; 10 unskilled workers can build a wall in 30 days. If a team has 2 skilled, 6 semi-skilled and 5 unskilled workers, how long will it take to build the wall?

- A. 20 days
B. 18 days

- C. 16 days
D. 15 days

gate2010 | numerical-ability | normal

Answer

Answers:

14.0.1 GATE2014-1_GA_5 [top](#)

<http://gateoverflow.in/770>



Selected Answer

Let the positive roots be m and n. Now, -m and -n will also satisfy the equation $ax^2 + b|x| + c = 0$ and hence we have 4 roots.

9 votes

-- Arjun Suresh (150k points)

14.0.2 GATECE-2011 [top](#)

<http://gateoverflow.in/36295>

Selling price per unit = Rs. 60

Total Cost Price of production = Rs. 100

Total profit = Rs. 500

Total Selling Price = Total CP + Total profit = Rs. (500 + 100) = Rs. 600

Now, Number of units sold = Total SP / (SP of one unit) = 600 / 60 = 10 units

Now total cost increased by 30%

So, the new Total CP becomes 100 + 30% of 100 = Rs. 130

Now, I considered profit level as two possible meanings - same profit % or same total profit amount

Case (i) - Same profit percentage -

$$\text{Old profit percent} = \frac{500}{100} * 100 = 500 \%$$

New Total CP = Rs. 130

profit = 500 % of 130 = Rs. 650

Total price (SP) = Rs. (130 + 650) = Rs. 780

$$\begin{aligned} \text{percentage increase in price} &= \frac{\text{NewSP} - \text{OldSP}}{\text{OldSP}} * 100 \\ &= \frac{780 - 600}{600} * 100 \\ &= 30 \% \end{aligned}$$

Case(ii) - If I consider same profit amount -

Total CP(new) = Rs. 130

Total profit = Rs. 500

New Total SP = Rs. 630

$$\begin{aligned} \text{percentage increase in price(SP)} &= \frac{\text{NewSP} - \text{OldSP}}{\text{OldSP}} * 100 \\ &= \frac{630 - 600}{600} * 100 \end{aligned}$$

= 5 %

1 votes

-- Himanshu Agarwal (9.8k points)

14.0.3 GATE 2015 Aptitude Set 4 Q5 [top](#)

<http://gateoverflow.in/40170>

Ans.- (B) $5C_2 = 10$

1 votes

-- vijaycs (10.7k points)

1st team play with 2,3,4,5 so total 4 match played

2nd team play with 3,4,5 so total 3 match played

3rd team play with 4,5 so total 2 match played

4th team play with 5 so total 1 match played

so total match played to reach next round is $4+3+2+1=10$ is answer

1 votes

-- rajan (2.1k points)

14.0.4 GATE 2016-2-GA-09 [top](#)

<http://gateoverflow.in/39537>



Selected Answer

To form a rectangle, we must choose two horizontal sides and two vertical sides. Since there are three horizontal lines, we can choose the horizontal sides in $3C2$ ways. Similarly to choose 2 vertical lines out of 5 vertical lines is $5C2$ so answer is

$$\binom{5}{2} \times \binom{3}{2}$$

12 votes

-- rajan (2.1k points)

14.0.5 GATE 2015 Aptitude Set 3 Q9 [top](#)

<http://gateoverflow.in/39522>

$$(\tan 1 \cdot \tan 89) \cdot (\tan 2 \cdot \tan 88) \cdot \dots \cdot (\tan 44 \cdot \tan 46) \cdot \tan 45$$

$$= (\tan 1 \cdot \cot 1) \cdot (\tan 2 \cdot \cot 2) \dots \cdot (\tan 44 \cdot \cot 44) \cdot \tan 45$$

$$= 1 \cdot 1 \cdot 1 \dots \cdot 1 \cdot \tan 45$$

$$= 1$$

so given expression reduces to $\log 1 = 0$

thus correct option is (C) 0

1 votes

-- deandamontvd (165 points)

14.0.6 GATE 2015 Aptitude Set 3 Q8 [top](#)

<http://gateoverflow.in/39521>

Let radius of circular sheet of paper = R
 And radius of the cone = r
 Height of cone = H

$$\text{Perimeter of base of cone} = 0.9 * 2\pi R \\ 2\pi r = 0.9 * 2\pi R \\ r = 0.9R$$

$$\text{Now height of cone } H = \sqrt{R^2 - r^2} \\ H = r \cdot \sqrt{(R/r)^2 - 1} \\ H/r = \sqrt{(1/0.9)^2 - 1} \\ = 0.48$$

0 votes

-- vijaycs (10.7k points)

14.0.7 GATE 2015 Aptitude Set 3 Q5 [top](#)

<http://gateoverflow.in/39518>

Let $x=\Pi$ & $y=\Pi/2$ then $\cos x=-1$ & $\cos y=0$

i.e $\cos x < \cos y$

so (iv) is incorrect & option (C) & (D) are not possible

considering (ii) for the base e to be same & the value of exponent $x>y>1$, the value $e^x > e^y$ holds true

So option (A) is correct

0 votes

-- Vivek Srivastava (415 points)

14.0.8 GATE 2015 Aptitude Set 3 Q4 [top](#)

<http://gateoverflow.in/39517>

A --> increment 1 alphabet in position after A --> CD --> increment 2 alphabet in position after D --> GHI --> increment 3 alphabet in position after I --> MNOP-->increment 4 alphabet in position after P --> UVWXY So, option (C)

0 votes

-- Vivek Srivastava (415 points)

14.0.9 GATE 2015 Aptitude Set 2 Q9 [top](#)

<http://gateoverflow.in/39510>

Ans B)

$$(a+b+c)^2 \text{ should be } \geq 0 \\ \text{therefore } a^2 + b^2 + c^2 + 2ab + 2bc + 2ca \geq 0 \\ \text{given } a^2 + b^2 + c^2 = 1 \text{ therefore } 1 + 2(ab+bc+ca) \geq 0 \\ ab+bc+ca \geq -1/2$$

Now to find upper limit,
 $(a-b)^2 + (b-c)^2 + (c-a)^2 \geq 0$
 Expanding we get, $2(a^2 + b^2 + c^2) - 2(ab+bc+ca) \geq 0$
 $\Rightarrow 2-2(ab+bc+ca) \geq 0$
 $ab+bc+ca \leq 1$
Ans [-1/2, 1]

0 votes

-- Ganesh K (151 points)

14.0.10 GATE 2015 Aptitude Set 2 Q 8 [top](#)

<http://gateoverflow.in/39509>

Tiger covers 40m/min
 Deer covers 20m/min

Revt distnc 20m/min
Deer is ahead by $50 \times 8 = 400$ m
Time taken $400/20 = 20$
In 20 mints tiger covers $20 \times 40 = 800$

0 votes

-- **rajan** (2.1k points)

its 800 meters....

0 votes

-- **Manikant Kumar** (271 points)

14.0.11 GATE2014-1_GA_4 top

<http://gateoverflow.in/773>



Selected Answer

Ans: $(z+1/z)^2 = (z^2 + 2(z)(1/z) + (1/z)^2) = (z^2 + 1/z^2) + 2 = 98 \Rightarrow 98 - 2 = 96$ is answer..

8 votes

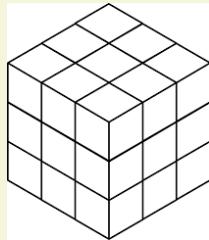
-- **Jay** (1.1k points)

14.0.12 GATE 2015 Aptitude Set 1 Q9 top

<http://gateoverflow.in/39496>

Option C

Total $27(3 \times 3 \times 3)$ small cubes of 1 unit will be required to form a bigger cube of side 3 units



No. of faces per cube = 6

Total number of cubes = $9 \times 3 = 27$

Total number of faces = $27 \times 6 = 162$

Total number of non visible faces = $162 - 54 = 108$

$$\frac{\text{No.ofvisiblefaces}}{\text{No.ofnonvisiblefaces}} = \frac{54}{108} = \frac{1}{2}$$

Ref:<https://www.quora.com/A-cube-with-sides-of-3-units-is-formed-using-a-set-of-smaller-cubes-with-sides-of-1-unit-How-do-you-find-the-proportion-of-the-number-of-faces-of-the-smaller-cubes-visible-to-those-which-are-not-visible>

0 votes

-- **Prasanna Ranganathan** (2.5k points)

14.0.13 GATE 2015 Aptitude Set 1 Q5 top

<http://gateoverflow.in/39493>

I think the question given is log of $5/7$ to base $x = -1/3$

then, $x^{-1/3} = 5/7$

implies, $1/(x^{1/3}) = 5/7$

$\text{so } x \wedge (1/3) = 7/5$

and $x = (7/5) \wedge 3$

$= 343/125$

Option A is answer

0 votes

-- Sreyas S (1.6k points)

14.0.14 GATE 2015 Aptitude Set 1 Q4 [top](#)

<http://gateoverflow.in/39492>

Answer is 1 . Option C

0 votes

-- Sreyas S (1.6k points)

14.0.15 GATE_2011_MN_65 [top](#)

<http://gateoverflow.in/31545>

Option A is wrong because nowhere 'fog' is referenced to any type of cloud in paragraph.

Option B is wrong because it is easy to predict whether from cloud but it is not referenced from given paragraph.

Option C is wrong because paragraph talks about the colour of all clouds but size of only ' stratus' cloud. So , whether size of all clouds are same or different , we can't conclude.

But one thing is sure that all clouds are different type because at least we can differentiate them based on their colours .

So we are left with option(D). Hence D is correct.

1 votes

-- Shashank Kumar (2.9k points)

14.0.16 GATE 2015 Aptitude Set 4 Q8 [top](#)

<http://gateoverflow.in/40175>

$$\frac{RT}{QT} = \frac{5x}{2x}$$

$$\Rightarrow RQ = 7x$$

$$\frac{PS}{QS} = \frac{3y}{1y} \Rightarrow PQ = 4y$$

Area of Triangle
 $QTS =$

$$\frac{1}{2} \times QS \times QT = 20\text{cm}^2$$

$$\frac{1}{2} \times 1y \times 2x = 20\text{cm}^2$$

$$\Rightarrow xy = 20\text{cm}^2$$

Area of Triangle

$$PQR =$$

$$\frac{1}{2} \times PQ \times RQ$$

$$\frac{1}{2} \times 4y \times 7x$$

$$= 14xy = 14 \times 20\text{cm}^2 = 280\text{cm}^2$$

2 votes

-- Praveen Saini (38.4k points)

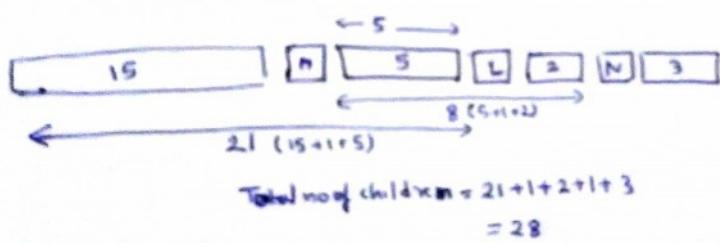
14.0.17 GATE_2011_MN_63 [top](#)

<http://gateoverflow.in/31543>



Selected Answer

L, M and N are waiting in queue that are meant for children, then L, M and N are also count in childs



6 votes

-- Praveen Saini (38.4k points)

14.0.18 GATE_2011_MN_62 top

<http://gateoverflow.in/31540>

Selected Answer

if equation is $ax^2 + bx + c = 0$ and roots of the equation are x_1 and x_2

then $x_1 + x_2 = -b/a$

and $x_1 \cdot x_2 = c/a$

in 1st attempt c is incorrect , So, we can say $x_1 + x_2 = 4+3=7$(i) [as here $-b/a$ is correct]

in 2nd attempt b is incorrect . So, we can say $x_1 \cdot x_2 = 3 \cdot 2 = 6$(ii) [as here c/a is correct]

Now solving (ii) we get

$$x_2 = 6 / x_1 \dots \text{(iii)}$$

putting it in eqn. (i)

$$x_1 + 6 / x_1 = 7$$

$$\text{or, } x_1^2 - 7x_1 + 6 = 0$$

$$\text{or, } x_1 = 1, 6$$

Answer is (c)

2 votes

-- srestha (27.8k points)

14.0.19 GATE_MN_2011_61 top

<http://gateoverflow.in/31536>

Selected Answer

$$\frac{2y+1}{y+2} < 1 \\ \Rightarrow y < 1.$$

1. For any value of $y < -2$, Numerator become greater than Denominator.

2. But since in LHS, denominator cannot be zero

i.e., $y > -2$.

Therefore, $-2 < y < 1$

Option B.

4 votes

-- Monanshi Jain (6.5k points)

14.0.20 GATE_MN_2011_59 top

<http://gateoverflow.in/31531>

One scholarship can be awarded to 4 applicant in 4 ways. Three scholarship can be awarded to 4 applicants in $4^3 = 64$ ways. (All scholarship are independent, any student can get any no of scholarship between 0 to 3)

1 votes

-- Akash (31.7k points)

14.0.21 GATE_IN_61 top

<http://gateoverflow.in/31386>



Selected Answer

This is not very hard question, You just got to do table like the below (IT is 2 mark question)

| Lap | Distance | Speed | Mileage | Total Petrol Used | Fuel Consumed Per KM |
|-----|----------|-------|---------|-------------------|----------------------|
| P | 15 | 15 | 60 | 250ml | 16.66ml |
| Q | 75 | 45 | 90 | 833ml | 11.11ml |
| R | 40 | 75 | 75 | 533ml | 13.33ml |
| S | 10 | 10 | 30 | 333ml | 33.33ml |
| | | | | | |

So ANswer = Q

You get speed, Mileage, Distance from given diagram. You can easily calculate

Total Petrol used in ltr = Distance / Mileage

Per Km => Petrol Used / Mileage.

2 votes

-- Akash (31.7k points)

14.0.22 GATE IN 2011-65 top

<http://gateoverflow.in/31281>



Selected Answer

Let x be no of toffees

no of toffee taken by R = $\frac{x}{3}$

R returned 4 to bowl

so no of toffees in bowl = $2(\frac{x}{3}) + 4$

S took $\frac{1}{4}$ of it

no of toffees taken by S = $\frac{1}{4}(\frac{2x}{3} + 4)$

S returns 3 to bowl

so no of toffees in bowl=
 $\frac{3}{4}(\frac{2x}{3} + 4) + 3 = \frac{x}{2} + 6$

T takes
 $\frac{1}{2}$ of it

no of toffees taken by T =
 $\frac{1}{2}(\frac{x}{2} + 6)$

T returns
 2 to bowl

no of toffees in bowl=
 $\frac{1}{2}(\frac{x}{2} + 6) + 2 = \frac{x}{4} + 5$

now its given
 17 toffees left in bowl

so
 $\frac{x}{4} + 5 = 17$

$x = 48$

ans is
 c

4 votes

-- Pooja (25.9k points)

14.0.23 GATE IN 2011-56 [top](#)

<http://gateoverflow.in/31267>

Ans a. 100

Exp:-

Suppose no. Of voters =100

So Promised to vote P =40

Promised to vote Q=60

Then 15% of the voter promised to vote p went back and voted for Q = 15% of 40= 6

Rest out of 40 voted for P=34

similarly, 25% of 60 voted for P= 15

Rest out of 60 voted for P=45

So voted for P= 49

So voted for Q=51 voters

Difference between votes 51-49=2

So, no of voters=100

2 votes

-- Khush Tak (3.3k points)

14.0.24 TIFR2015-B-12 [top](#)

<http://gateoverflow.in/30046>



Selected Answer

Triangular number,

$$t_n = \frac{n(n+1)}{2}$$

Product of three consecutive Triangular numbers ,
 $t_m \times t_{m+1} \times t_{m+2}$

$$= \frac{m(m+1)}{2} \times \frac{(m+1)(m+2)}{2} \times \frac{(m+2)(m+3)}{2}$$

$$= \left(\frac{m(m+1)}{2} \right)^2 \times \left(\frac{m(m+3)}{2} \right)$$

at m= 3,
 $t_3 \times t_4 \times t_5$ is a perfect square.

(i) is **True**.

$$t_{4n(n+1)} = t_{4n^2+4n} = \frac{(4n^2+4n)(4n^2+4n+1)}{2}$$

$$= 4 \times (2n+1)^2 \times \frac{n(n+1)}{2} = 2^2 \times (2n+1)^2 \times t_n$$

if
 t_n is a perfect square, then
 $t_{4n(n+1)}$ is also a perfect square

(ii) is **True**

$$\begin{aligned} & \frac{1}{1} + \frac{1}{3} + \frac{1}{6} + \frac{1}{10} + \dots + \frac{1}{t_n} \\ &= \frac{2}{1.(1+1)} + \frac{2}{2.(2+1)} + \frac{2}{3.(3+1)} + \frac{2}{4.(4+1)} + \dots + \frac{2}{n.(n+1)} \\ &= 2 \times \left(\frac{1}{1.(1+1)} + \frac{1}{2.(2+1)} + \frac{1}{3.(3+1)} + \frac{1}{4.(4+1)} + \dots + \frac{1}{n.(n+1)} \right) \\ &= 2 \times \left(\frac{1}{1.2} + \frac{1}{2.3} + \frac{1}{3.4} + \frac{1}{4.5} + \dots + \frac{1}{n.(n+1)} \right) \\ &= 2 \times \left(\left(\frac{1}{1} - \frac{1}{2} \right) + \left(\frac{1}{2} - \frac{1}{3} \right) + \left(\frac{1}{3} - \frac{1}{4} \right) + \left(\frac{1}{4} - \frac{1}{5} \right) + \dots + \left(\frac{1}{n} - \frac{1}{n+1} \right) \right) \\ &= 2 \times \left(1 - \frac{1}{n+1} \right) \\ &= 2 \times \frac{n}{n+1} \end{aligned}$$

for any
 $n > 0$,
 $\frac{n}{n+1}$ will be
 < 1 , so
 $2 \times \frac{n}{n+1}$ will be
 < 2 .

so

$$\frac{1}{1} + \frac{1}{3} + \frac{1}{6} + \frac{1}{10} + \dots + \frac{1}{t_n} < 2$$

(iii) is also **True**.

9 votes

-- Praveen Saini (38.4k points)

14.0.25 TIFR2015-A-13 top

<http://gateoverflow.in/29586>

Ans will be (d)1180

If a line segment passes through unit square from (0,0) to (i,j) the line intersects $(i+j-\gcd(i,j))$ no of squares = $(90+1100-10)=1180$

3 votes

-- srestha (27.8k points)

14.0.26 TIFR2015-A-3 [top](#)

<http://gateoverflow.in/29159>



Selected Answer

$$M_n(z) = \sum_{i=1}^{10} z^{10^n(i-1)}$$

$$= z^{0*10^n} + z^{1*10^n} + z^{2*10^n} + \dots + z^{9*10^n}$$

$$= 1 + z^{1*10^n} + z^{2*10^n} + \dots + z^{9*10^n}$$

$$= \frac{1 - (z^{10^n})^{10}}{1 - z^{10^n}} = \frac{1 - z^{10(n+1)}}{1 - z^{10^n}}$$

$$M_n(z) \\ = \frac{1 - z^{10(n+1)}}{1 - z^{10^n}}$$

Now,

$$\prod_{i=0}^{\infty} M_i(z) = M_0(z) \times M_1(z) \times M_2(z) \times \dots$$

$$= \left(\frac{1 - z^{10^1}}{1 - z^{10^0}} \right) \times \left(\frac{1 - z^{10^2}}{1 - z^{10^1}} \right) \times \left(\frac{1 - z^{10^3}}{1 - z^{10^2}} \right) \times \dots \times \left(\frac{1 - z^{10^k}}{1 - z^{10^{k-1}}} \right) \times \left(\frac{1 - z^{10^{k+1}}}{1 - z^{10^k}} \right) \times \dots$$

$$= \frac{1}{1-z}$$

for ending terms, As $|z| < 1$, z^∞ tends to 0, $1 - z^\infty$ tends to 1

3 votes

-- Praveen Saini (38.4k points)

14.0.27 TIFR2013-B-9 [top](#)

<http://gateoverflow.in/25675>

Option C must be correct.

Regions divided by n lines = $1 + 1 + 2 + 3 + 4 + \dots + n-1 = 1 + n(n-1)/2 = O(n^2)$

option B can be easily discarded as convex segments are obvious.

Hence C is correct.

1 votes

-- Nitesh Tripathi (79 points)

14.0.28 TIFR2013-A-12 [top](#)

<http://gateoverflow.in/25434>



Selected Answer

$$\text{Divisible by 3} = \frac{1000}{3} = 333 \\ \text{Divisible by 7} =$$

$$\frac{1000}{7} = 142$$

Divisible by both =

$$\frac{1000}{\text{LCM OF } 3 \& 7} =$$

$$\frac{1000}{21} = 47$$

$$\begin{aligned} P(A \cup B) &= P(A) + P(B) - P(A \cap B) \\ &= 333 + 142 - 47 = 428 \end{aligned}$$

2 votes

-- Umang Raman (11.3k points)

14.0.29 GATE 2015 Aptitude Set 4 Q9 top

<http://gateoverflow.in/40173>

Here PR is parallel to x-axis so y coordinate of vertex P and R would always be same.

For ex- If $P = (-1, 7)$ then $R = (2, 7)$ or $(5, 7)$

So total possible x- coordinate of P and R for a particular y ($-4 \leq x \leq 5$) = $10P_2 = 90$.

Similarly, for 11 different y coordinate, total coordinates of P and R = $11 * 90 = 990$.

Now since, its a right angle at P so vertex Q has same x-coordinate as P has. So total possible coordinates for vertex Q ($6 \leq y \leq 16$) = $10C_1 = 10$.

For ex- If $P = (-1, 7)$ then $Q = (-1, 8)$ or $(-1, 16)$ but not $(-1, 7)$.

Total number of triangles = $10 * 990 = 9900$

Ans- C

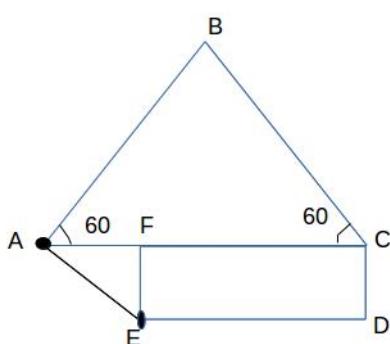
1 votes

-- vijaycs (10.7k points)

14.0.30 Gate 2015 Aptitude Set 8 Q4 top

<http://gateoverflow.in/40179>

option A $2\sqrt{2}$



AB=6m BC=6m CD= 2m ED=4m

Angle BAC=60 angle BCA=60
so angle ABC=(180 - 60 - 60) = 60
And AC= 6 (equilateral triangle)

A is starting point. Vivek walks 6 meters North-east to point B, then turns and walks 6 meters South-east to the point C. He further moves 2 meters South to the point D and 4 meters West to the point E and E is end point.

as mentioned in fig. AC=6m and ED= FC = 4m

then $AF = AC - FC = 6 - 4 = 2m$

and $EF = CD = 2m$ and angle AFC is right angle
by pythagoras theorem

$$AE^2 = EF^2 + AF^2$$

$$AE^2 = (4+4)$$

$$AE = 2\sqrt{2}$$

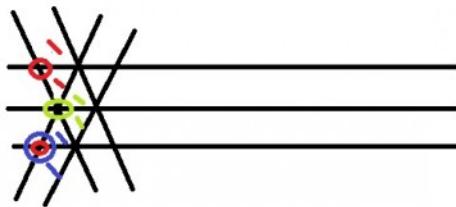
0 votes

-- Khush Tak (3.3k points)

14.0.31 TIFR2013-A-1 [top](#)

<http://gateoverflow.in/25382>

Ans will be $1/2$. Every Laddoo shared by 2 mouse



1 votes

-- srestha (27.8k points)

14.0.32 GATE-2013-AE-GA-8 [top](#)

<http://gateoverflow.in/40249>



Selected Answer

$$\text{Given } |-2X + 9| = 3,$$

$$\Rightarrow -2X + 9 = 3 \text{ or } -(-2X + 9) = 3,$$

$$\Rightarrow X = 3 \text{ or } X = 6,$$

$$\Rightarrow |-X| - X^2 = |-3| - 3^2 = -6 \text{ or } |-X| - X^2 = |-6| - 6^2 = -30,$$

Thus B is the correct option.

2 votes

-- Anurag Pandey (9.7k points)

14.0.33 GATE2014-EC02-GA8 [top](#)

<http://gateoverflow.in/41516>



Selected Answer

let eight consecutive odd numbers are
 $n, n+2, n+4, n+6, n+8, n+10, n+12$ and $n+14$

sum of these numbers is

656,

$$8n + 56 = 656, \text{ so, } n = 75$$

And four consecutive even numbers are

$m, m+2, m+4, \text{ and } m+6$

Average of these numbers is

$$87, \frac{(4m+12)}{4} = 87, \text{ so, } m = 84$$

Sum of smallest odd number and second largest even number is
 $n + (m+4) = 75 + 88 = 163$

4 votes

-- Praveen Saini (38.4k points)

14.0.34 GATE2014-EC04-GA10 [top](#)

<http://gateoverflow.in/41472>



Selected Answer

(B)

Consider the digits 1, 2, 3.

The possible numbers are {123, 132, 213, 231, 312, 321}, count = $3! = 6$.

- Consider the cases where the digit 3 is at the unit position. The number of such numbers (fix 3 at unit, permute the rest) will be $(3-1)! = 2!$. In all such cases, the 3 digit will contribute a 3 to the final sum. Total = $2! \times 3$
- Consider the cases where the digit 3 is at the decimal position. The number of such numbers (fix 3 at decimal, permute the rest) will be $(3-1)! = 2!$. In all such cases, the 3 digit will contribute a 30 to the final sum. Total = $2! \times 30$
- Consider the cases where the digit 3 is at the hundreds position. The number of such numbers (fix 3 at hundreds, permute the rest) will be $(3-1)! = 2!$. In all such cases, the 3 digit will contribute a 300 to the final sum. Total = $2! \times 300$

In total, the digit 3 contributes $2! \times (3 + 30 + 300) = 2! \times 333$ to the final sum.

The same happens for all other digits.

Hence, the net sum (for the original question) will be:

$$(5-1)! \times (11111 + 33333 + 55555 + 77777 + 99999)$$

Note: $(5-1)! =$ the number of permutations after fixing 1 digit. 11111... because the digit 1 contributes a 1, 10, 100, 1000, 10000 to the final sum.

Required Answer = 6666600.

Hence, option B is correct.

5 votes

-- Pragy Agarwal (14.4k points)

14.0.35 GATE2014-EC04-GA4 [top](#)

<http://gateoverflow.in/41466>



Selected Answer

$$f(x, y) = x^n y^m = P$$

Now, x is doubled so we substitute $2x$ for x AND
 y is halved so we substitute $y/2$ for y

$$f(x, y) = (2x)^n (\frac{y}{2})^m$$

We get

$$f(x, y) = (2)^n (x)^n (y)^m (2)^{-m}$$

$$f(x,y) = 2^{n-m}x^n y^m = 2^{n-m}P$$

Answer A) $2^{n-m}P$

1 votes

-- Abhilash Panicker (7k points)

14.0.36 gate-2014-ae-10 top

<http://gateoverflow.in/4030>

1st statement true since avg of july is more than that of dec

2nd statement - not true since, we have data till 95% only- notice--- 95 % as i understand---in all data of 50 years, amount of rainfall is below the value presented by graph in 95% cases . so we have 5% of years for which we dont have surely of which month had more rainfall.

3rd statement true- since difference between 5% correspoding y value and 95% corresponding y value indicates that this was range for 90% of years. in Feb this range is bigger.

4th - clearly false. refer 2

thus ans B.pinch me if i am wrong :P

1 votes

-- Pavan Dongare (27 points)

14.0.37 gate-2014-ae-8 top

<http://gateoverflow.in/4031>

Clearly, the angles of quadrilateral are 60, 80, 100, 120.

That makes smallest angle of triangle $60*(2/3) = 40$.

That makes largest angle of triangle $40*(2) = 80$.

so third angle of triangle = 60.

The required value is = $120 + 60 = 180$

0 votes

-- Akshay Patil (11 points)

14.0.38 gate-2014-ae-4 top

<http://gateoverflow.in/4033>



Selected Answer

given, $y=5x^2+3$

Slope $dy/dx = 10x$

given point $x=0, y=3 \dots (0,3)$

Now, at $(0,3)$ we have the slope as

$dy/dx = 10 * 0 = 0$

which means line is parallel to x axis

Option B, D eliminated as slope is 0

Option A eliminated as given the tangent is at point $(0,3)$ and we found slope=0, which means its parallel to x axis. The equation of line is nothing but $y=3$, which never passes through $(0,0)$. Hence A too eliminated.

Answer Option C)

3 votes

-- Abhilash Panicker (7k points)

14.0.39 GATE2013-ee-8 top

<http://gateoverflow.in/40295>



Selected Answer

Roots of equation are of opposite sign then for the equation,
 $ax^2 + bx + c = 0$, product of roots,
 $\frac{c}{a}$, should be (negative number) less than
0

$$\frac{p(p-1)}{3} < 0$$

$$p(p-1) < 0$$

so
 p must be less than
1 and greater than
0

Option B

5 votes

-- Praveen Saini (38.4k points)

14.0.40 gate-2013-ee-2 top

<http://gateoverflow.in/40289>

Let the temperatures on Monday, Tuesday, Wednesday and Thursday is x° , y° , z° and w° C respectively.

Given that,

$$x+y+z = 3 * 41$$

$$y+z+w = 3 * 43$$

Thursday temperature is 15% higher than Monday temperature.

$$w = 1.15x$$

After solving above equations, we'll get $w=46$

Therefore, correct answer is (c).

1 votes

-- suraj (3.7k points)

14.0.41 gate2013-ce-8 top

<http://gateoverflow.in/40276>



Selected Answer

Ans is D.

$$\% \text{ increase in Raw material} = \frac{6240 - 5200}{5200}$$

$$= 20\%$$

$$\% \text{ increase in Power \& fuel} = \frac{9450 - 7000}{7000}$$

$$= 35\%$$

$$\% \text{ increase in Salary \& wages} = \frac{9000 - 12600}{9000}$$

$$= 40\%$$

$$\% \text{ increase in Plant \& machinery} = \frac{20000 - 25000}{20000}$$

$$= 25\%$$

$$\% \text{ increase in Advertising} = \frac{19500 - 15000}{15000}$$

30%

% increase in Research & Developement= $26400 - 22000 / 22000$

20%

1 votes

-- richa07 (493 points)

14.0.42 GATE2013-CE-7 [top](#)<http://gateoverflow.in/40275>

Selected Answer

A). $|4X - 7| = 5$, since it is in absolute form the regular form of this equation is given as

$$(4X - 7) = 5$$

$$(4X - 7) = -5$$

By solving the above equations we get the following answer

$$X = \frac{1}{2}, X = 3$$

Now $2|X| - |-X| = 2|X| - |X| = |X|$.

So, our answer will be B.

2 votes

-- ibia (717 points)

14.0.43 gate2013-ce-6 [top](#)<http://gateoverflow.in/40274>I think ans is A as only A satisfy both conditions(i.e $2x+y \leq 6$ and $x+2y \leq 8$).

0 votes

-- richa07 (493 points)

$$f(x,y)=3x+6y=3(x+2y)$$

maximum value of $x+2y$ is given by equation 2 which is 8 ($x+2y \leq 8$)i.e maximum value of $f(x,y)=3*(8)=24$ $f(x,y)=24$ can be obtained by putting $x=4/3$ & $y=10/3$

So, answer is (A)

0 votes

-- Vivek Srivastava (415 points)

14.0.44 gate2013-ce-1 [top](#)<http://gateoverflow.in/40268>

Selected Answer

D. 96

Let the number be x . Writing equation,

$$x - 75 = 117 - x$$

$$2 \times x = 192$$

2 votes

-- Gaurav Sharma (1.8k points)

14.0.45 GATE-2013-AE-GA-7<http://gateoverflow.in/40248>

Ans (C)

Up 2 votes

-- srestha (27.8k points)

14.0.46 Gate 2015 Aptitude Set 8 Q7<http://gateoverflow.in/40182>

Let the total capacity of B be x

A=>0.7x B=>x

According to statement 1--->

A is 80% full i.e A=>0.8*0.7x=0.56x

B is 40 % full i.e. B=>0.4x

after statement 1 both A & B have variable x whose value is given in statement 2 i.e. x=14000

So, both statements together are necessary

SO, answer is (D)

Up 0 votes

-- Vivek Srivastava (415 points)

14.0.47 GATE2012-CY-GA-10<http://gateoverflow.in/40241>

Selected Answer

No. of Rs 20 notes - x

No. of Rs 10 notes - y

Given,

x+y=14

20x+10y=230

Solving the two equations, we get.

x=9, y=5

So, the number of Rs 10 notes is 5

Answer A)5

Up 4 votes

-- Abhilash Panicker (7k points)

14.0.48 GATE2012-CY-GA-9<http://gateoverflow.in/40240>

Selected Answer

answer is a) i.e 2

divide in to 3-3-2 and then take 3-3 pair and then if they are equal then weigh the remaining 1-1.

if out of 3-3 one is heavier then take the heavier group and divide it 1-1-1 take any two of these group and weigh again to get the heavier

Up 5 votes

-- Piyush Kapoor (595 points)

14.0.49 GATE2012-CY-GA-8<http://gateoverflow.in/40239>

$9000 / 10500 * 100 = 85.7\%$

1 vote

-- srestha (27.8k points)

14.0.50 GATE2012-AR-9 [top](#)

<http://gateoverflow.in/40230>



Selected Answer

The smuggler would be caught if any one or both the randomly picked capsule contains drugs..
M represents Medicine, D represents Drugs

- A - The smuggler will be caught
- B - The randomly picked capsules contains M, D
- C - The randomly picked capsules contains D, M
- D - The randomly picked capsules contains D, D

$$P(A) = P(B) + P(C) + P(D)$$

$$P(A) = (5/10)*(5/9) + (5/10)*(5/9) + (5/10)*(4/9)$$

$$P(A) = 0.278 + 0.278 + 0.222$$

$$P(A) = 0.778 = 0.78$$

Hence, Answer Option C) 0.78

1 vote

-- Abhilash Panicker (7k points)

14.0.51 GATE2012-AR-6 [top](#)

<http://gateoverflow.in/40227>



Selected Answer

$$\log m + \log n = \log mn$$

So,

$$\log x + \log(x - 7) = \log(x + 11) + \log 2$$

$$\Rightarrow \log x(x - 7) = \log 2(x + 11)$$

$$\Rightarrow x(x - 7) = 2(x + 11)$$

$$\Rightarrow x^2 - 9x - 22 = 0$$

$$\Rightarrow (x - 11)(x + 2) = 0$$

$$\therefore x = 11$$

$\because x \neq -2$, log is undefined for negative number.

4 votes

-- Praveen Saini (38.4k points)

14.0.52 GATE2012-AR-5 [top](#)

<http://gateoverflow.in/40226>

90...

let 1.2.3.4.5.6.7.8.9.10 be teams now

first team can play with any=9

similarly second can play with any =8 ...similarly 3rd team will play 7 games ...so

$9+8+7\dots+1=n(n-1)/2 == 10(9)/2=45$..we are said ..to have 2 matches= $45*2=90$

1 3 votes

-- Deepesh Kataria (1.4k points)

14.0.53 GATE-2012-AE-9 [top](#)

<http://gateoverflow.in/40220>



Selected Answer

For two points
 (x_1, y_1) and
 (x_2, y_2) on a line, Slope of line
 $= \frac{y_2 - y_1}{x_2 - x_1}$

so,
 $\frac{q-p}{0-4} = \frac{3}{4}$

$\therefore (p - q) = 3$

1 1 votes

-- Praveen Saini (38.4k points)

14.0.54 GATE-2012-AE-7 [top](#)

<http://gateoverflow.in/40218>



Selected Answer

//total number of runs ->

p->1810

q->1677

r->1048

s->1202//

now % increase is defined as..> $((\text{final value}-\text{initial value})/\text{initial value}) * 100$

p->(206/802)*100=25.68%

q->(147/765)*100=19.21

r->(190/429)*100=44.28

s->(200/501)*100=39.42

so the lowest increase is => Q so B is the answer

2 2 votes

-- Joker (735 points)

14.0.55 GATE2011_GG_GA_9 [top](#)

<http://gateoverflow.in/40210>

Ans should be A)

as given in question "The contribution of each factor to the overall service quality is directly proportional to the factor score and its standardized coefficient."

so contribution \propto factor score * standardized coefficient

1) contribution of outcome factor = $Q * \text{factor score} * \text{standardized coefficient} = Q * 6 * 0.8 = 4.8$ Q = 4.8

(Here let Q is proportional constant and assume it is 1 ..)

similar

2) contribution of tangibles = $5 * 0.4 = 2$

3) contribution of reliability = $6 \times 0.7 = 4.2$

4) contribution of responsiveness = $6 \times 0.6 = 3.6$

5) contribution of empathy = $4 \times 0.6 = 2.4$

6) contribution of assurance = $6 \times 0.5 = 3$

so we can see here lowest contribution is " 2" and total contribution is " $4.8 + 2 + 4.2 + 3.6 + 2.4 + 3 = 20$ "

so The lowest contribution among all the above factors to the overall quality of services delivered by

the company is = $(2/20) \times 100 = 10\%$ ans

0 votes

-- sonam vyas (8.1k points)

14.0.56 GATE2011_GG_GA_8 top

<http://gateoverflow.in/40209>



Selected Answer

R. S. T

11. 7. 6

(ORIGINAL SITUATION.... GOT AFTER SOME HIT AND TRIAL)

4. 14. 6

4. 8. 12

8. 8. 8.....R HAVE 11 ORIGINALLY

1 votes

-- Deepesh Kataria (1.4k points)

14.0.57 GATE2011_GG_GA_7 top

<http://gateoverflow.in/40208>



Selected Answer

Let the no. of students who took all courses be x .

Since every one must take at least 1 course, we have

$$200 - x + 100 - x + 60 - x \geq 300 - x \implies 360 - 2x \geq 300 \implies x \leq 30.$$

1 votes

-- Arjun Suresh (150k points)

14.0.58 GATE2011_GG_GA_4 top

<http://gateoverflow.in/40205>

Ans should be D)

as we know Men and days are inversely proportional and work and days are directly proportional

so we can write $M_1 D_1 / W_1 = M_2 D_2 / W_2$

According to given data in question

$$m * m = 100 * D_2 / 100$$

$D_2 = m$ days

2 votes

-- sonam vyas (8.1k points)

14.0.59 Gate 2015 Aptitude Set 8 Q10 [top](#)<http://gateoverflow.in/40184>

A total of 11 teachers can teach ES.
now the question says , **6** teachers can teach **only ES** so the number of teachers has to be less than or equal to (11-6) i.e **5**.
Also , **4** teachers can teach **all three subjects** .
The question asks for the number of teachers who **can teach ES and EM but not TD**.
Subtract 4 from the 5 derived earlier.
Ans 1 , Option A

0 votes

-- Ganesh K (151 points)

14.0.60 TIFR2013-A-10 [top](#)<http://gateoverflow.in/25432>

Selected Answer

Please correct me if I am wrong.

I am denoting M as men and R as rakshas.

Step 1 : Two rakshasas row the boat from one side to another. So , one rakshas will reach other side. and one rakshas will have to row back . So , first side now (3M + 2R) and second side (1R).

So , boat crosses 2 times.

Step 2 : 2 R row to other side. and leaves one R there and comes back to first side. So , now first side has (3M + 1R) and second side has (2R).

So , boat crosses 2 times.

Step 3: 2 M row to other side and gets down at other side. So , first side has (1R + 1M) and second side has (2M+2R).
So , boat crosses 1 time.

Step 4: Now , 1M and 1R will have to row back from second side , and they will take 1M + 1M to other side. So , in the first side , we have now 2R.

So , boat crosses 2 times.

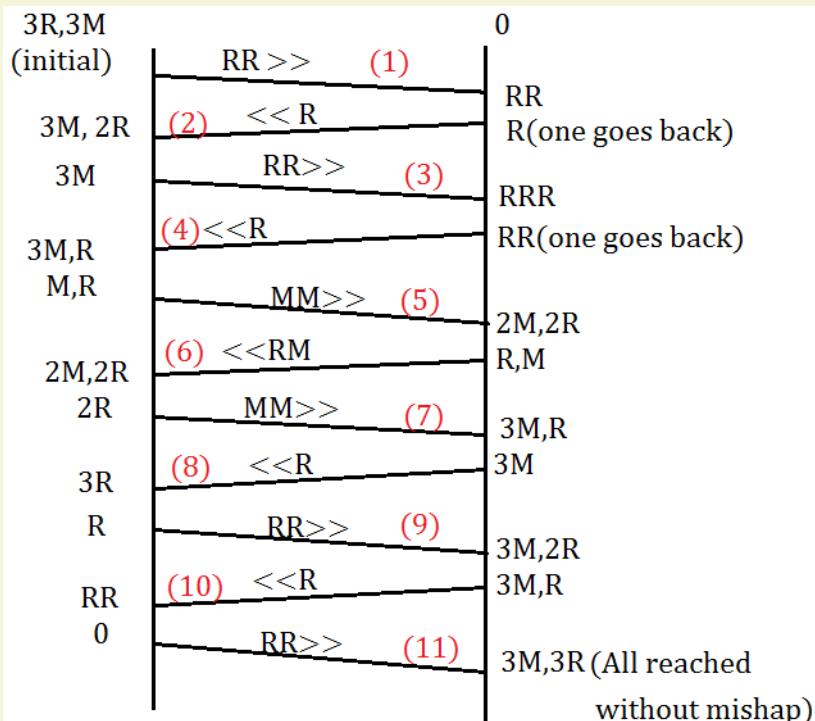
Step 5: Last step , 2R will row to other side.

So , boat crosses 1 time.

Total time boat crosses = 8 +1 = 9 times

1 votes

-- Shounak Kundu (4.1k points)



So, boat crosses river 11 times.. **Option (C)**

1 vote

-- Himanshu Agarwal (9.8k points)

14.0.61 GATE 2015 Aptitude Set 2 Q 5 top

<http://gateoverflow.in/39506>

selection of RAM and not Ramesh is $1/6 * 7/8$ and selection of Ramesh and not Ram is $1/8 * 5/6$ so, net probability is $12/48$ so $1/4$ is the ans. option b)

0 votes

-- Ritaban Basu (435 points)

14.0.62 GATE2011_65 top

<http://gateoverflow.in/2175>



Selected Answer

Quantity left after n operations = $x(1 - y/x)^n$
where x = initial quantity
y = amount of mixture withdrawn each time (this should be same every time)
n = no of times operation performed
 $= 10(1 - 1/10)^n = 10(9/10)^3 = 10 * .9 * .9 * .9 = 10 * .729 = 7.29$ liters
hence option D is correct.

Reference Video: <https://www.youtube.com/watch?v=YYg23Fm3qW0>

8 votes

-- Manu Thakur (5.6k points)

14.0.63 GATE2011_57 top

<http://gateoverflow.in/2166>



Selected Answer

B.

Following Log formula, we get :

$$P = Q^{1/2} = R^{1/3}$$

$$\text{so, } Q^2 = P^4 = P \cdot P^3 = PR.$$

Upvote 6 votes

-- shreya ghosh (2.9k points)

14.0.64 TIFR2010-A-14 top

<http://gateoverflow.in/18393>

Selected Answer

I guess answer should be 600, i.e option a)

The problem given is equivalent to the problem in which an urn contains some number of white balls in it. We take out 30 balls out of it, mark them and put them back into the urn. Now we randomly take out 40 balls out of the urn, 2 of them are found to be marked, what is the approximate number of balls that were present in the urn initially?

Solution: Suppose the urn contained X balls initially, then

If we take n ball out of urn, probably $n*(30/X)$ balls will be marked out of n balls.

Here $n = 40$,

so Probably $40*(30/X)$ out 40 balls will be marked.

But it is given that there are 2 marked balls,

$$\text{so } 2 = 40*(30/X), \text{ which gives } X = (40 * 30)/2 = 600.$$

Upvote 3 votes

-- Anurag Pandey (9.7k points)

14.0.65 TIFR2010-A-9 top

<http://gateoverflow.in/18385>

Selected Answer

D should be the correct answer.

Each Entry represents a row of table, in general.

In order to encode all the information of a row/entry, we must know what is the size of that information. But it is not mentioned in the question.

We can ADDRESS 287 entries by ceiling of $\log_2(287) = 9$ bits.

but we CAN NOT ENCODE an entry, without knowing the size of that entry

So I don't think it is possible to tell how many bits are required to encode & transmit an entry unless any information is given about the data contained in entries.

Upvote 2 votes

-- Anurag Pandey (9.7k points)

14.0.66 TIFR2010-A-1 top

<http://gateoverflow.in/18202>

The number of ball is 2371 and each time 1 ball is decreased. So after 2370 steps, we will have 1 ball in the box and we must stop.

Here, white balls are even and every time either it gets removed in even number or remains unchanged

The only possibility of white ball remaining in the box if it was odd.

Since at each step the number of black balls changes from odd to even or even to odd, so at the end only 1 black ball will be in the box.

Hence, option 3 is the correct answer.

1 votes

-- Umang Raman (11.3k points)

14.0.67 GATE2014-3_GA_8 [top](#)

<http://gateoverflow.in/2032>

D)

In such questions take "What we have to find" as 100 (easy way). i.e Let India's GDP be Rs 100.

When GDP was Rs 100 exchange rate was Rs 50/USD

1 USD = Rs 50

? = Rs 100

Rs 100 = 100/50 Dollars

GDP grew by 7% = $100 + 7\%(100) = 100 + 7 = \text{Rs } 107$

When GDP is Rs 107 exchange rate is Rs 60/USD

1 USD = Rs 60

? = Rs 107

Rs 107 = 107/60 Dollars

$((107/60)/(100/50)) * 100 = 89\%$ increase of USD. which means Indian GDP has decreased , and it has decreased to $(100 - 89) = 11\%$

7 votes

-- Srinath Sri (2.9k points)

14.0.68 GATE2015-3_GA_8 [top](#)

<http://gateoverflow.in/8385>



Selected Answer

When y is -1, x is 2.

When y is positive x is 0.

So, $x = -(y - |y|)$

11 votes

-- Arjun Suresh (150k points)

14.0.69 GATE2015-3_GA_5 [top](#)

<http://gateoverflow.in/8303>



Selected Answer

$f(x)$ is linear means it is of the form $ax+b$

given $f(-2)$ and $f(3)$

solve the equation and find out value for a and b. then find $f(5)$. it will be 43

8 votes

-- Sankaranarayanan P.N (9.8k points)

14.0.70 GATE2015-3_GA_1 [top](#)

<http://gateoverflow.in/8298>



Selected Answer

option B.. VZDQ

(every letter is replaced by third letter in alphabetical order)

9 votes

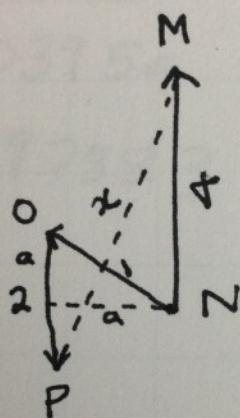
-- Anoop Sonkar (4.5k points)

14.0.71 GATE2015-2_GA_7 top

<http://gateoverflow.in/8036>



Selected Answer



$$\alpha = \frac{1}{\sqrt{2}}$$

$$x = \sqrt{[4 + (2 - \alpha)]^2 + \alpha^2}$$

Solving we get $x = 5.34$.

5 votes

-- Arjun Suresh (150k points)

14.0.72 TIFR2010-A-20 top

<http://gateoverflow.in/18500>



Selected Answer

Option A) i.e. 29 should be the answer.

Number of integers between 1 to 1000 that are divisible by 30 = floor of $1000/30 = 33$.

Now since LCM of 30 & 16 = 240, only the numbers that are divisible by 240 between 1 to 1000 will be divisible by both 30 & 16.

so number of integers between 1 to 1000 that are divisible by 240 (i.e divisible by both 30 & 16) = floor of $1000/240 = 4$.

So total number of integers that are divisible by 30 but not divisible by 16 = $33 - 4 = 29$.

2 votes

-- Anurag Pandey (9.7k points)

A: TOTAL NUMBERS DIVISIBLE BY 30
 B: TOTAL NUMBERS DIVISIBLE BY 16
 $P(A-B) = P(A) - P(A \cap B)$ (DIVISIBLE BY 30 BUT NOT BY 16)
 $= 33 - 4 = 29$ OPTION A

2 votes

-- Umang Raman (11.3k points)

14.0.73 GATE2015-2_GA_6 top

<http://gateoverflow.in/8035>

answer is B because if we multiply by any no to AP than difference between them will b same and if we subtract any no in AP with every no then also difference will b same but if we make square of AP element then difference will not b same.

2 votes

-- Anoop Sonkar (4.5k points)

14.0.74 GATE2015-2_GA_5 top

<http://gateoverflow.in/8033>



Selected Answer

Ans C

3 votes

-- Vikrant Singh (11k points)

14.0.75 GATE2011_64 top

<http://gateoverflow.in/2174>



Selected Answer

Let the amount of orders received per day be x and let the amount of pending orders be y and let the amount of orders carried by a truck each day be z .

$$7z * 4 = 4x + y \rightarrow (1)$$

$$3z * 10 = 10x + y \rightarrow (2)$$

$$(2) - (1) \Rightarrow 2z = 6x, z = 3x, y = 80x$$

We want to find the number of trucks to finish the orders in 5 days. Let it be A .

$$Az * 5 = 5x + y$$

$$15Ax = 5x + 80x$$

$$A = 85/15 = 17/3 = 5.67$$

So, minimum 6 trucks must be used.

9 votes

-- Arjun Suresh (150k points)

14.0.76 GATE2012_62 top

<http://gateoverflow.in/2210>



Selected Answer

B. 10

$$y = 2x - 0.1x^2$$

$dy/dx=2 - 2*0.1 x \Rightarrow dy/dx=0 \Rightarrow x=10$

so $y = 20-10=10$

Upvote 6 votes

-- shreya ghosh (2.9k points)

14.0.77 GATE2015-1_GA_6 [top](#)

<http://gateoverflow.in/8010>



Selected Answer

$$\begin{aligned} \text{Avg. mark} &= (21 * 2 + 15 * 3 + 11 * 1 + 23 * 2 + 31 * 5) / (21 + 17 + 6) \\ &= (42 + 45 + 11 + 46 + 155) / 44 \\ &= 299/44 \\ &= 6.795 \end{aligned}$$

Upvote 3 votes

-- Arjun Suresh (150k points)

14.0.78 GATE2015-1_GA_4 [top](#)

<http://gateoverflow.in/8006>



Selected Answer

A. Statements I alone is sufficient, but statement II alone is not sufficient.

Upvote 7 votes

-- Anoop Sonkar (4.5k points)

14.0.79 GATE2010-59 [top](#)

<http://gateoverflow.in/2367>



Selected Answer

D. 3

No. of persons who play either football or hockey = $15 + 17 - 10 = 22$

No. of persons playing neither hockey nor football = $25 - 22 = 3$

Upvote 7 votes

-- shreya ghosh (2.9k points)

14.0.80 GATE2010-61 [top](#)

<http://gateoverflow.in/2369>



Selected Answer

Answer. C.

$$(137)_8 + (276)_8 = (435)_8$$

So basically the numbers are given in Octal base.

Similarly, addition of 731,672 gives 1623 in octal.

Upvote 10 votes

-- shreya ghosh (2.9k points)

14.0.81 GATE2010-65 [top](#)

<http://gateoverflow.in/2373>



Selected Answer

first place should be occupied by either 3 or 4.

Case 1 : First place is occupied by the digit 4

4 _ _ _

now in the set from where we can pick numbers is left with = {2, 2, 3, 3, 3, 4, 4, 4}

if we got 3 of each digit(which are 2, 3 and 4) then number of ways by **each** of those blanks can be filled in are 3 coz we have 3 choices of digits: pick 2, 3 or 4.

But we do not have just enough 2's to fill all those 3 spaces with the digit 2.

∴ we need to subtract this case where number would be

4222.

So, total numbers obtained using the numbers in our current set

= $1 \times 3 \times 3 \times 3 - 1 = 26$. The first one is for the digit 4, coz its fixed for this case; the subtracted one is for the case 4222 that can't be made possible.

Case 2 : First place is occupied by the digit 3

3 _ _ _

now in the set from where we can pick numbers is left with = {2, 2, 3, 3, 4, 4, 4, 4}

we have enough 4's here but lack 3's and 2's

∴ the cases we need to subtract are

3222 and

3333

So, total numbers obtained using the numbers in our current set

= $1 \times 3 \times 3 \times 3 - 2 = 25$

both cases are independently capable of giving us the answer, we have = 26 + 25 = 51

answer = **option B**

10 votes

-- Amar Vashishth (20.7k points)

14.0.82 GATE2014-3_GA_5 [top](#)

<http://gateoverflow.in/2028>



Selected Answer

The question paper has only 3 questions. There are 3 ways a student can attempt a question.

1. Attempt correctly
2. Attempt wrongly
3. Not attempted

Each row lists number of students who attempted the question correctly , wrongly and who did not attempt.
Sum of these, of any row gives the total strength of class , $21+17+6 = 44$.

Average marks obtained by the class in the examination = (Total marks(Q1)+Total marks(Q2)+Total marks(Q3)) / Total strength of class
 $= ((2 \times 21) + (3 \times 15) + (2 \times 23)) / 44$
 $= 133/44 = 3.02$

Note : There is no negative or partial marking for the wrongly attempted and the non-attempted questions.

8 votes

-- Srinath Sri (2.9k points)

14.0.83 GATE2014-2_GA_10 [top](#)

<http://gateoverflow.in/1952>



Selected Answer

At 6 a.m. the hour hand and minute hand are separated by 180 degree. Now,

Speed of hour hand = 360 degree/12 hour (clock is 12 hrs as am/pm is given) = 30 degrees /hr = 0.5 degree per minute

Speed of minute hand = 360 degree per 60 minutes = 6 degrees per minute.

So, we want the relative distance between minute and hour hand to be 60 degree as per question which would mean a relative distance traversal of 180-60 = 120 degrees. This happens after x minutes such that

$$6x - 0.5x = 120 \implies x = \frac{120}{5.5} = 21.81$$

So, closest time is 6:22 a.m.

6 votes

-- Arjun Suresh (150k points)

14.0.84 TIFR2011-A-15 top

<http://gateoverflow.in/20226>



Selected Answer

Exponent of p in $n!$, where p is a prime number, and n is an integer greater than p is:

$$E_p(n!) = \left\lfloor \frac{n}{p} \right\rfloor + \left\lfloor \frac{n}{p^2} \right\rfloor + \left\lfloor \frac{n}{p^3} \right\rfloor + \cdots + \left\lfloor \frac{n}{p^S} \right\rfloor$$

where S is the largest positive integer such that $p^s \leq n \leq p^{s+1}$

So,

$$\begin{aligned} E_3(100!) &= \left\lfloor \frac{100}{3} \right\rfloor + \left\lfloor \frac{100}{3^2} \right\rfloor + \left\lfloor \frac{100}{3^3} \right\rfloor + \left\lfloor \frac{100}{3^4} \right\rfloor \\ &= 33 + 11 + 3 + 1 \\ &= 48 \end{aligned}$$

3 votes

-- sonu (1.5k points)

14.0.85 GATE2014-1_GA_8 top

<http://gateoverflow.in/776>



Selected Answer

For individual , Round-trip discount 10% on TOTAL fare . So for each person $(200 \times 10\%) = 20$.

So for 5 member 100 rupees .

For 5 member group they will get 5% discount on TOTAL fare i.e. $(5 \times 200 \times 5\%) = 50$ rupess.

Total discount is $(100+50)=150$. They have to pay 850 rupees

7 votes

-- Palash Nandi (1.4k points)

14.0.86 GATE2014-1_GA_9 top

<http://gateoverflow.in/777>



Selected Answer

Not having scooter from Men (40 (car owner) + 20 (nothing owns))=60

Not having scooter from Women (34 (car owner) + 50 (nothing owns))=84

percentage = $(60+84)/300 = .48$ i.e. 48%

8 votes

-- Palash Nandi (1.4k points)

14.0.87 GATE2013_58 [top](#)

<http://gateoverflow.in/1562>



Selected Answer

This is in AP.

Maximum sum means we do not need to consider negative numbers and can stop at 0.

First find number of terms using the formula $a_n = a + (n-1)d$

Here,

$a = 44$,

$d = 42-44 = -2$,

$a_n = 0$.

Therefore, $0 = 44 + (n-1)(-2)$
 $\Rightarrow n = 23$.

Now, sum of n terms of AP is given by: $S_n = n/2[a+a_n] = 23/2[44+0] = 506$
 Option C is correct!

4 votes

-- Monanshi Jain (6.5k points)

14.0.88 TIFR2011-A-20 [top](#)

<http://gateoverflow.in/20260>



Selected Answer

For odd
 n ,

$$99^n = (100 - 1)^n$$

$$= 100^n - \binom{n}{1} 100^{n-1} + \dots - \binom{n}{n-2} 100^2 + \binom{n}{n-1} 100^1 - 1$$

$$99^n + 1 = 100^n - \binom{n}{1} 100^{n-1} + \dots - \binom{n}{n-2} 100^2 + \binom{n}{n-1} 100^1 - 1 + 1$$

$$= 100 \left(\dots \right) 100^{n-1} - \binom{n}{1} 100^{n-2} + \dots - \binom{n}{n-1}$$

Since n is odd, it cannot end in a 0

Thus, $99^n + 1 = 100 \left(\dots \text{ doesn't end with 0} \right)$

Which means that $99^n + 1$ ends with exactly 2 zeros

Hence, option b) is correct.

Alternative way:

$$\begin{aligned}
 99 &\times 01 = 99 \\
 99 &\times 099 = 9801 \\
 99 &\times (...)801 = (...)299 \\
 99 &\times (...)299 = (...)601 \\
 99 &\times (...)601 = (...)499 \\
 99 &\times (...)499 = (...)401 \\
 99 &\times (...)401 = (...)699 \\
 99 &\times (...)699 = (...)201 \\
 99 &\times (...)201 = (...)899 \\
 99 &\times (...)899 = (...)001
 \end{aligned}$$

Thus, 99^n always ends in a 99 when n is odd, but never in a 999.

Hence, $99^n + 1$ will always end with exactly 2 zeros.

Note: We couldn't just say that $99^3 + 1$ ends with exactly 2 zeros, so **b** must be correct. This is because we also have an option **e** which says **None of the above**. Had it not been there, we could have marked b without having to prove that the pattern will continue.

4 votes

-- Pragy Agarwal (14.4k points)

14.0.89 GATE2013_61 [top](#)

<http://gateoverflow.in/1565>



Selected Answer

when you such overlapping expressions just rationalise it and add in most of the case you will be left with lesser number of terms ..in this case i am left with $\sqrt{81} - \sqrt{1} = 8$

$$\frac{1}{\sqrt{1}+\sqrt{2}} + \frac{1}{\sqrt{2}+\sqrt{3}} + \frac{1}{\sqrt{3}+\sqrt{4}} + \dots + \frac{1}{\sqrt{80}+\sqrt{81}}$$

$$= \frac{1}{\sqrt{1}+\sqrt{2}} \times \left(\frac{\sqrt{1}-\sqrt{2}}{\sqrt{1}-\sqrt{2}} \right) + \frac{1}{\sqrt{2}+\sqrt{3}} \times \left(\frac{\sqrt{2}-\sqrt{3}}{\sqrt{2}-\sqrt{3}} \right) + \frac{1}{\sqrt{3}+\sqrt{4}} \times \left(\frac{\sqrt{3}-\sqrt{4}}{\sqrt{3}-\sqrt{4}} \right) + \dots + \frac{1}{\sqrt{80}+\sqrt{81}} \times \left(\frac{\sqrt{80}-\sqrt{81}}{\sqrt{80}-\sqrt{81}} \right)$$

$$= \frac{\sqrt{1}-\sqrt{2}}{(\sqrt{1})^2-(\sqrt{2})^2} + \frac{\sqrt{2}-\sqrt{3}}{(\sqrt{2})^2-(\sqrt{3})^2} + \frac{\sqrt{3}-\sqrt{4}}{(\sqrt{3})^2-(\sqrt{4})^2} + \dots + \frac{\sqrt{80}-\sqrt{81}}{(\sqrt{80})^2-(\sqrt{81})^2}$$

$$= -(\sqrt{1} - \sqrt{2} + \sqrt{2} - \sqrt{3} + \sqrt{3} - \sqrt{4} + \dots + \sqrt{80} - \sqrt{81})$$

$$= \sqrt{81} - \sqrt{1}$$

$$= 8$$

11 votes

-- Bhagirathi Nayak (11.3k points)

14.0.90 GATE2013_62 [top](#)<http://gateoverflow.in/1566>

Selected Answer

The number of 2 digit multiples of 7 = 13

not divisible by 7=(90-13)/90=[77/90](#)

[Upvote](#) 7 votes

-- Bhagirathi Nayak (11.3k points)

14.0.91 GATE2013_64 [top](#)<http://gateoverflow.in/1568>

Selected Answer

let the total distance be D then

avg speed=D/total time taken

Total time taken=D/2*60+D/4*30+D/4*10

avg speed- $120/5=24$

[Upvote](#) 9 votes

-- Bhagirathi Nayak (11.3k points)

14.0.92 GATE2013_65 [top](#)<http://gateoverflow.in/1569>

Selected Answer

Since wages per day increase by 1/5 of current wages, new wages per day becomes $6/5$ of current wages.

Similarly new working hours are $23/24$ of current working hours.

So new erection cost becomes $13200 * 6/5 * 23/24 = 15180$.

So option (B) is correct.

[Upvote](#) 4 votes

-- Happy Mittal (9.5k points)

14.0.93 GATE2014-2_GA_4 [top](#)<http://gateoverflow.in/1941>

Selected Answer

$a=10, l=190$

$s=n(a+l)/2=19(200)/2=1900$

average= $1900/19=100$

ans. is 100

[Upvote](#) 5 votes

-- aditi (337 points)

14.0.94 GATE2014-2_GA_5 [top](#)<http://gateoverflow.in/1942>

Selected Answer

$$\begin{aligned}x &= \sqrt{12+x} \\ \implies x^2 &= 12+x \\ \implies x^2 - x - 12 &= 0 \\ \implies (x-4)(x+3) &= 0 \\ \implies x = 4 \text{ or } x &= -3\end{aligned}$$

7 votes

-- Arjun Suresh (150k points)

14.0.95 GATE2014-2_GA_8 top<http://gateoverflow.in/1950>

Selected Answer

$x^2 - 2x + 3 = 11$ Or $x^2 - 2x + 3 = -11$ (Any one of them can be correct because of Mod)

Lets take first one

$$x^2 - 2x + 3 = 11$$

$$x^2 - 2x - 8 = 0.$$

After solving

$$(x-4)(x+2) = 0,$$

$$x = 4 \text{ & } x = -2.$$

Now put the values of x in given equation $| -x^3 + x^2 - x |$

for $x = 4$, we will get $| -64 + 16 - 4 | = 52$

for $x = -2$, we will get $| 8 + 4 + 2 | = 14$.

So Answer => D.

3 votes

-- Akash (31.7k points)

14.0.96 GATE2010-64 top<http://gateoverflow.in/2372>

Selected Answer

D. 15 days

1 skilled person can do $1/100$ of work in 1 day, so 2 skilled person do $2/100$ of work in a day.

similarly, 6 semi-skilled and 5 unskilled person can do $6/200$ and $5/300$ respectively in 1 day.

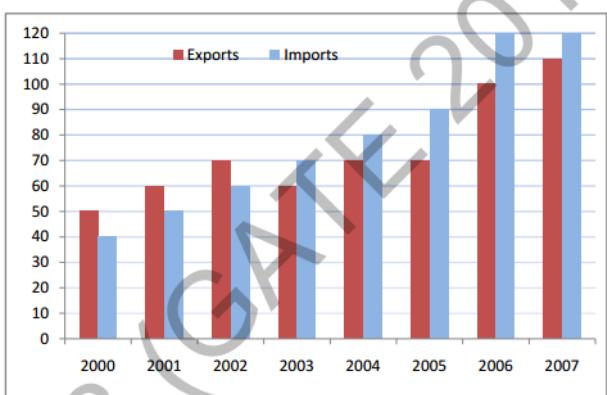
so they do $1/15$ of work together in 1 day, which gives required number of day to complete the work = 15 .

9 votes

-- shreya ghosh (2.9k points)

14.1**Bar Charts** top**14.1.1 Bar Charts: GATE2014-EC01-GA9** top<http://gateoverflow.in/41498>

The exports and imports (in crores of Rs.) of a country from 2000 to 2007 are given in the following bar chart. If the trade deficit is defined as excess of imports over exports, in which year is the trade deficit $1/5$ th of the exports?



- A. 2005
B. 2004
C. 2007
D. 2006

gate2014-ec01 numerical-ability data-interpretation bar-charts normal

Answer

Answers: Bar Charts

14.1.1 Bar Charts: GATE2014-EC01-GA9 [top](#)

<http://gateoverflow.in/41498>

I go with Option D 2006

1 votes

-- saif ahmed (1.5k points)

14.2

Bayes Theorem [top](#)

14.2.1 Bayes Theorem: GATE 2014 EC [top](#)

<http://gateoverflow.in/38256>

Q.10 You are given three coins: one has heads on both faces, the second has tails on both faces, and the third has a head on one face and a tail on the other. You choose a coin at random and toss it, and it comes up heads. The probability that the other face is tails is

- (A) 1/4 (B) 1/3 (C) 1/2 (D) 2/3

In this question they have given answer (B) as 1/3. We can get B if we take

$$P(C1) = 1/3, P(C2) = 1/3, P(C3) = 1/3$$

Where C1 has both head / tail & C2 has Head/Head, C3 has tail/tail.

Issue is that if we know that we have got heads , we can actually eliminate P(C3) , we can take it as 0.

Because it is given that we get Head when we toss it. (C3 can't generate head)

If we consider $P(C1) = 1/2, P(C2) = 1/2$ & $P(C3) = 0$ then answer I get is (D) 2/3 which is wrong as per GATE key. So please answer the question & Also let me know why should we consider C3 , if we know surely that coin is not C3.

conditional-probability bayes-theorem gate-aptitude aptitude

Answer

14.2.2 Bayes Theorem: GATE2013-AE-GA-10 [top](#)

<http://gateoverflow.in/40251>

In a factory, two machines M1 and M2 manufacture 60% and 40% of the autocomponents respectively. Out of the total production, 2% of M1 and 3% of M2 are found to be defective. If a randomly drawn autocomponent from the combined lot is found defective, what is the probability that it was manufactured by M2?

- (A) 0.35 (B) 0.45 (C) 0.5 (D) 0.4

gate2013-ae numerical-ability bayes-theorem

Answer

14.2.3 Bayes Theorem: GATE2012_63 top

<http://gateoverflow.in/2211>

An automobile plant contracted to buy shock absorbers from two suppliers X and Y . X supplies 60% and Y supplies 40% of the shock absorbers. All shock absorbers are subjected to a quality test. The ones that pass the quality test are considered reliable. Of X 's shock absorbers, 96% are reliable. Of Y 's shock absorbers, 72% are reliable.

The probability that a randomly chosen shock absorber, which is found to be reliable, is made by Y is

- (A) 0.288
 (B) 0.334
 (C) 0.667
 (D) 0.720

gate2012 numerical-ability probability normal bayes-theorem

Answer

Answers: Bayes Theorem

14.2.1 Bayes Theorem: GATE 2014 EC top

<http://gateoverflow.in/38256>



Selected Answer

We are given that head comes on one side. So, there are only two possibilities- the other side is head (HH coin) or the other side is tail (HT coin). Favorable case is only HT, and hence answer is $\frac{1}{2}$.

Well, the above explanation is wrong because it assumes uniform probability distribution for the two cases HH and HT. This is true initially as all 3 coins have equal probability of being chosen. But we are given that "head" comes in one face. HH coin has two head faces, and hence has twice the chance of being chosen over HT as we got a head face. i.e., for the two coins HH and HT, the respective probabilities are $\frac{2}{3}$ and $\frac{1}{3}$ respectively given that one side is a head. Now, our required probability is simply $P(\{\text{HT}\}) = \frac{1}{3}$.

We can also apply Bayes' theorem but I guess solving intuitively is more fun :)

2 votes

-- Arjun Suresh (150k points)

14.2.2 Bayes Theorem: GATE2013-AE-GA-10 top

<http://gateoverflow.in/40251>

C) 0.5

Let $P(M_i)$ denote the probability that the component is manufactured by machine M_i , and $P(\text{def})$ denote the probability that the component is defective.

We have to find $P(M_2|\text{def})$.

$$P(M_2|\text{def}) = P(M_2 \cap \text{def})/P(\text{def}) = \frac{0.4 \times 0.03}{(0.4 \times 0.03) + (0.6 \times 0.02)} = 0.5$$

Drawing *probability tree diagram* for such questions makes them easier to solve. Please refer [link1](#) and [link2](#) for more details.

2 votes

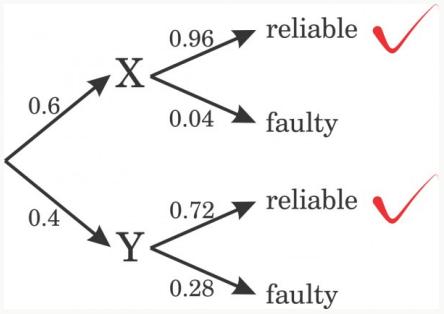
-- Gaurav Sharma (1.8k points)

14.2.3 Bayes Theorem: GATE2012_63 top

<http://gateoverflow.in/2211>

 Selected Answer

B.



Then by using Bayes' Theorem :

$$\text{Probability of Y given R} = \frac{\text{Probability of Y and R}}{\text{Probability of R}}$$

$$= \frac{0.4 \times 0.72}{0.4 \times 0.72 + 0.6 \times 0.96}$$

$$= \frac{1}{3} = 0.33$$

 8 votes -- shreya ghosh (2.9k points)

14.3**Circle** top**14.3.1 Circle: TIFR2011-A-18** top<http://gateoverflow.in/20255>

The equation of the tangent to the unit circle at point $(\cos \alpha, \sin \alpha)$ is.

- a. $x \cos \alpha - y \sin \alpha = 1$
- b. $x \sin \alpha - y \cos \alpha = 1$
- c. $x \cos \alpha + y \sin \alpha = 1$
- d. $x \sin \alpha - y \cos \alpha = 1$
- e. None of the above.

[tifr2011](#) [numerical-ability](#) [geometry](#) [circle](#)

Answer

Answers: Circle**14.3.1 Circle: TIFR2011-A-18** top<http://gateoverflow.in/20255>

Selected Answer

Assuming that the unit circle is centered at the origin, the equation of the unit circle is:

$$x^2 + y^2 = 1$$

The slope of the tangent to the unit circle at point (x, y) can be derived by implicit differentiation as follows:

$$x^2 + y^2 = 1$$

$$\frac{d}{dx}(x^2 + y^2) = \frac{d}{dx}1$$

$$2x + 2y \frac{dy}{dx} = 0$$

$$\frac{dy}{dx} = -\frac{x}{y}$$

Thus, the slope of the tangent at the point $(\cos \alpha, \sin \alpha)$ is
 $-\frac{\cos \alpha}{\sin \alpha}$

The equation of the tangent line then will be:

$$y - y_1 = m(x - x_1)$$

$$y - \sin \alpha = -\frac{\cos \alpha}{\sin \alpha}(x - \cos \alpha)$$

$$y \sin \alpha - \sin^2 \alpha = -x \cos \alpha + \cos^2 \alpha$$

$$y \sin \alpha + x \cos \alpha = \sin^2 \alpha + \cos^2 \alpha = 1$$

Hence, option c is correct.

2 votes

-- Pragy Agarwal (14.4k points)

14.4

Clock Time top

14.4.1 Clock Time: TIFR2013-A-20 top

<http://gateoverflow.in/25902>

Consider a well functioning clock where the hour, minute and the seconds needles are exactly at zero. How much time later will the minutes needle be exactly one minute ahead ($1/60$ th of the circumference) of the hours needle and the seconds needle again exactly at zero?

Hint: When the desired event happens both the hour needle and the minute needle have moved an integer multiple of $1/60$ th of the circumference.

- a. 144 minutes
- b. 66 minutes
- c. 96 minutes
- d. 72 minutes
- e. 132 minutes

[tifr2013](#) [numerical-ability](#) [clock-time](#)

Answer

14.4.2 Clock Time: TIFR2014-A-10 top

<http://gateoverflow.in/25998>

A person went out between 4pm and 5pm to chat with her friend and returned between 5pm and 6pm. On her return, she found that the hour-hand and the minute-hand of her (well-functioning) clock had just exchanged their positions with respect to their earlier positions at the time of her leaving. The person must have gone out to chat at

- a. Twenty five minutes past 4pm.
 b. Twenty six and $122/143$ minutes past 4pm.
 c. Twenty seven and $1/3$ minutes past 4pm.
 d. Twenty eight minutes past 4pm.
 e. None of the above.

[tifr2014](#) [numerical-ability](#) [clock-time](#)

[Answer](#)

14.4.3 Clock Time: TIFR2010-A-2 [top](#)

<http://gateoverflow.in/18206>

The hour hand and the minute hands of a clock meet at noon and again at mid-night. In between they meet N times, where N is.:

- a. 6
 b. 11
 c. 12
 d. 13
 e. None of the above.

[tifr2014](#) [numerical-ability](#) [clock-time](#)

[Answer](#)

Answers: Clock Time

14.4.1 Clock Time: TIFR2013-A-20 [top](#)

<http://gateoverflow.in/25502>

Please correct me if I am wrong. I think answer is (b) 66 min.

Reason :

Here it is given current time is 12:00 pm. After 66 min , time will be 1:06 p.m . So , hour's hand will be at 1 and minute's hand will be exactly 1 place ahead.

0 votes

-- Shounak Kundu (4.1k points)

Option (e) is correct ..

As minute hand progresses 6° in one minute & Hour hand progresses $1/2^\circ$ in one minute , And second Hand 360° in one minute ..So it is always at 0 for all options..

0 votes

-- Himanshu Agarwal (9.8k points)

14.4.2 Clock Time: TIFR2014-A-10 [top](#)

<http://gateoverflow.in/25998>



Selected Answer

Let the time of departure be $4 : x$ and time of arrival be $5 : y$.

$$\text{Angle made by hour hand during departure} = \frac{4}{12} \times 360 + x \frac{360}{12 \times 60} = 120 + \frac{x}{2} .$$

This angle is equal to the angle made by the minute hand on arrival which is $6y$. So,

$$240 + x = 12y \rightarrow (1)$$

Similarly, the angle made by the hour hand on arrival is equal to the angle made by the minute hand on departure, which

gives

$$\frac{5}{12} \times 360 + \frac{y}{2} = 6x \implies 300 + y = 12x \rightarrow (2).$$

Eliminating y from (1) and (2),

$$240 + x = 12(12x - 300) \implies 143x = 3840 \implies x = 26\frac{122}{143}$$

4 votes

-- Arjun Suresh (150k points)

14.4.3 Clock Time: TIFR2010-A-2 [top](#)

<http://gateoverflow.in/18206>

ANS : e)

10

between 11 and 1 , hour hand and minute hand meets only one time at 12:00 , we need to exclude this , as they asked in between noon and midnight.

1-2-3-4-5-6-7-8-9-10-11

between every hour they meet once

2 votes

-- pramod (2.3k points)

14.5

Complex Number [top](#)

14.5.1 Complex Number: TIFR2011-A-13 [top](#)

<http://gateoverflow.in/20223>

If $z = \frac{\sqrt{3}-i}{2}$ and $(z^{95} + i^{67})^{97} = z^n$, then the smallest value of n is?

- a. 1
- b. 10
- c. 11
- d. 12
- e. None of the above.

[tifr2011](#) [numerical-ability](#) [complex-number](#)

Answer

Answers: Complex Number

14.5.1 Complex Number: TIFR2011-A-13 [top](#)

<http://gateoverflow.in/20223>



Selected Answer

$$\begin{aligned}
 z &= \frac{1}{2}(\sqrt{3} - i) \\
 z^2 &= \frac{1}{4}(3 - 1 - 2\sqrt{3}i) = \frac{1}{2}(1 - \sqrt{3}i) \\
 z^4 &= \frac{1}{4}(1 - 3 - 2\sqrt{3}i) = \frac{1}{2}(-1 - \sqrt{3}i) \\
 z^8 &= \frac{1}{4}(1 - 3 + 2\sqrt{3}i) = \frac{1}{2}(-1 + \sqrt{3}i) \\
 z^{16} &= \frac{1}{4}(1 - 3 - 2\sqrt{3}i) = \frac{1}{2}(-1 - \sqrt{3}i) = \textcolor{red}{z^4} \\
 z^{32} &= z^{16} \times z^{16} = z^4 \times z^4 = z^8 \\
 z^{64} &= z^{32} \times z^{32} = z^8 \times z^8 = z^{16} = z^4
 \end{aligned}$$

$$\begin{aligned}
 z^{95} &= z^{64} \times z^{16} \times z^{15} \\
 &= z^4 \times z^4 \times z^{15} \\
 &= z^{16} \times z^7 \\
 &= z^4 \times z^7 \\
 &= z^8 \times z^2 \times z \\
 &= \frac{1}{2}(-1 + \sqrt{3}i) \times \frac{1}{2}(1 - \sqrt{3}i) \times \frac{1}{2}(\sqrt{3} - i) \\
 &= \frac{1}{2}(\sqrt{3} + i)
 \end{aligned}$$

$$\begin{aligned}
 i^{67} &= i^{64} \times i^3 \\
 &= 1 \times (-i) \\
 &= -i
 \end{aligned}$$

$$\begin{aligned}
 z^{95} + i^{67} &= \frac{1}{2}(\sqrt{3} + i) - i \\
 &= \frac{1}{2}(\sqrt{3} - i) \\
 &= z
 \end{aligned}$$

$$\begin{aligned}
 (z^{95} + i^{67})^{97} &= z^{97} = z^{95} \times z^2 \\
 &= \frac{1}{2}(\sqrt{3} + i) \times \frac{1}{2}(1 - \sqrt{3}i) \\
 &= \frac{1}{2}(\sqrt{3} - i) \\
 &= z
 \end{aligned}$$

Hence, option a is the correct answer.

6 votes

-- Pragy Agarwal (14.4k points)

14.6

Compound Interest top

14.6.1 Compound Interest: GATE2014-AG-GA5 top

<http://gateoverflow.in/41669>

The population of a new city is 5 million and is growing at 20% annually. How many years would it take to double at this growth rate?

- A. 3 – 4 years
- B. 4 – 5 years
- C. 5 – 6 years
- D. 6 – 7 years

[gate2014-ag](#) [numerical-ability](#) [growth-rate](#) [compound-interest](#) [normal](#)

[Answer](#)

Answers: Compound Interest

14.6.1 Compound Interest: GATE2014-AG-GA5 [top](#)

<http://gateoverflow.in/41669>

Initial population P=5m

After 1 year P=5m*1.2=6m

Now 2nd year Current P=6m

Now after inc=6m*1.2=7.2

After 3 year =8.65m

After 4 year=10.38m

So ans should be A.

1 votes

-- Manoj Kumar (23.1k points)

14.7

Conditional Probability [top](#)

14.7.1 Conditional Probability: GATE 2015 Aptitude Set 4 Q10 [top](#)

<http://gateoverflow.in/40174>

Q.10 A coin is tossed thrice. Let X be the event that head occurs in each of the first two tosses. Let Y be the event that a tail occurs on the third toss. Let Z be the event that two tails occur in three tosses.

Based on the above information, which one of the following statements is TRUE?

- (A) X and Y are not independent
- (B) Y and Z are dependent
- (C) Y and Z are independent
- (D) X and Z are independent

[gate2015aptiset4](#) [aptitude](#) [conditional-probability](#) [probability](#)

[Answer](#)

14.7.2 Conditional Probability: GATE2014-AG-GA10 [top](#)

<http://gateoverflow.in/41674>

10% of the population in a town is HIV⁺. A new diagnostic kit for HIV detection is available; this kit correctly identifies HIV⁺ individuals 95% of the time, and HIV⁻ individuals 89% of the time. A particular patient is tested using this kit and is found to be positive. The probability that the individual is actually positive is _____.

[gate2014-ag](#) [numerical-ability](#) [probability](#) [conditional-probability](#) [normal](#)

[Answer](#)

Answers: Conditional Probability

14.7.1 Conditional Probability: GATE 2015 Aptitude Set 4 Q10 [top](#)

<http://gateoverflow.in/40174>

choice A and D are out straight away they are false consider choice C and D the question is asked about 2 (exactly 2) tails occur in 3 tosses now if there is a tail in 3rd toss then we need only one tail in first 2 tosses else we need 2 tails hence they are dependent on each other

so and should be B

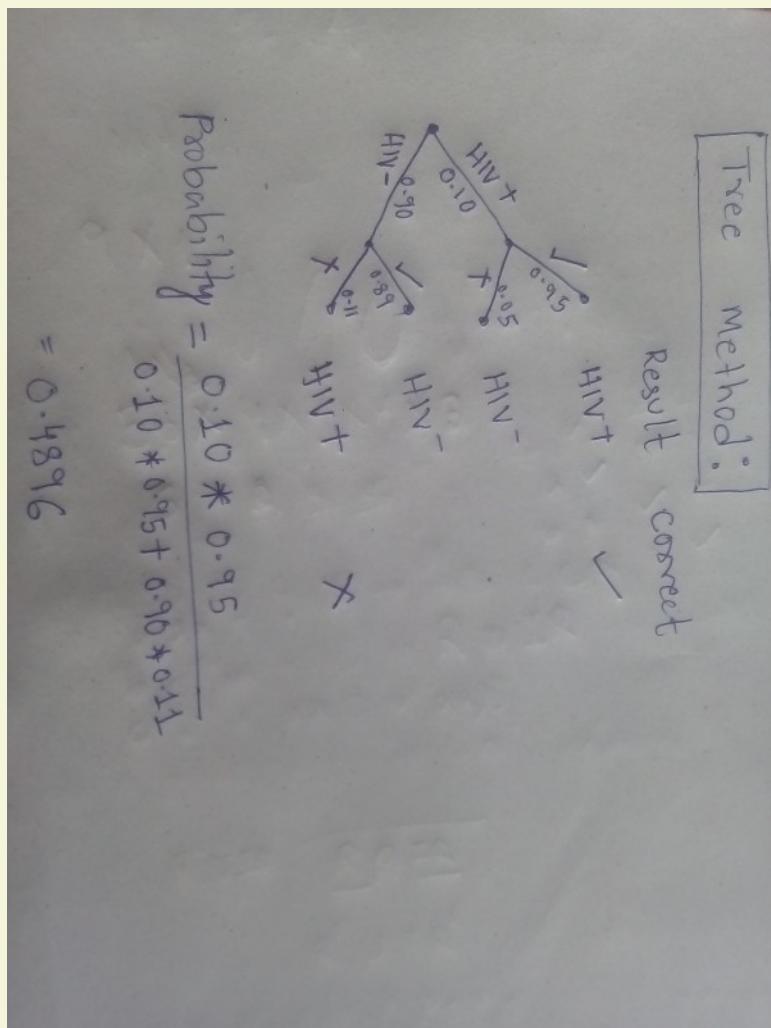
0 votes

-- Sanjay Sharma (29.8k points)

14.7.2 Conditional Probability: GATE2014-AG-GA10 [top](#)

<http://gateoverflow.in/41674>

If you dont like Bayes theorem then use this



$$\text{Probability} = \frac{0.10 * 0.95}{0.10 * 0.95 + 0.90 * 0.11} = 0.4896$$

2 votes

-- Bhagirathi Nayak (11.3k points)

14.8

Cost Market Price [top](#)

14.8.1 Cost Market Price: gate-2014-ae-5 [top](#)

<http://gateoverflow.in/40304>

A foundry has a fixed daily cost of Rs 50,000 whenever it operates and a variable cost of RS $800Q$, where Q is the daily production in tonnes. What is the cost of production in Rs per tonne for a daily production of 100 tonnes.

[gate2014-ae](#) [numerical-ability](#) [cost-market-price](#)

Answer

14.8.2 Cost Market Price: GATE2012_56 [top](#)<http://gateoverflow.in/2193>

The cost function for a product in a firm is given by $5q^2$, where q is the amount of production. The firm can sell the product at a market price of ₹ 50 per unit. The number of units to be produced by the firm such that the profit is maximized is

- (A) 5
- (B) 10
- (C) 15
- (D) 25

[gate2012](#) [numerical-ability](#) [cost-market-price](#) [normal](#)

[Answer](#)

14.8.3 Cost Market Price: TIFR2012-A-6 [top](#)<http://gateoverflow.in/2102>

A certain pair of used shoes can be repaired for *Rs.1250* and will last for 1 year. A pair of the same kind of shoes can be purchased new for *Rs.2800* and will last for 2 years. The average cost per year of the new shoes is what percent greater than the cost of repairing the used shoes?

- a. 5%
- b. 12%
- c. 15%
- d. 3%
- e. 24%

[tifr2012](#) [cost-market-price](#)

[Answer](#)

14.8.4 Cost Market Price: GATE2011_63 [top](#)<http://gateoverflow.in/2173>

The variable cost (V) of manufacturing a product varies according to the equation
 $V = 4q$, where

q is the quantity produced. The fixed cost (F) of production of same product reduces with q according to the equation
 $F = 100/q$. How many units should be produced to minimize the total cost ($V + F$)?

- (A) 5
- (B) 4
- (C) 7
- (D) 6

[gate2011](#) [numerical-ability](#) [cost-market-price](#) [normal](#)

[Answer](#)

Answers: Cost Market Price**14.8.1 Cost Market Price: gate-2014-ae-5** [top](#)<http://gateoverflow.in/40304>

Selected Answer

Answer: 1300

For a daily production of 100 tonnes, the daily cost of foundry would be Rs $50,000 + (800 \times 100) =$ Rs 130,000.

Hence cost of production in Rs per tonne = $\frac{130,000}{100} = \text{Rs } 1,300$.

1 votes

-- Anurag Pandey (9.7k points)

14.8.2 Cost Market Price: GATE2012_56 [top](#)

<http://gateoverflow.in/2193>



Selected Answer

Answer is A. The equation for profit is Profit=SP-CP, here SP=Q*50 and CP=5Q^2 so when a function attains its maximum value its first order differentiation is zero. Hence 50-5*2*Q=0. therefore Q=5.

6 votes

-- kireeti (1k points)

14.8.3 Cost Market Price: TIFR2012-A-6 [top](#)

<http://gateoverflow.in/2102>

repaired shoes lasts 1 year worth Rs. 1250

new shoes lasts 2 year worth Rs. 2800

so for one year new shoes costs Rs. 1400

% greater of new shoes cost than the cost of repaired shoes $(1400 - 1250 / 1250) = 12\% (\text{option b})$

0 votes

-- Khush Tak (3.3k points)

14.8.4 Cost Market Price: GATE2011_63 [top](#)

<http://gateoverflow.in/2173>



Selected Answer

Total Cost, $T = 4q + 100/q$

When total cost becomes minimum, first derivative of T becomes 0 and second derivative at the minimum point will be positive.

Differentiating T with respect to q and equating to 0,

$4 - 100/q^2 = 0 \Rightarrow q = +5 \text{ or } -5$. Since, we can't have negative number of product, $q = 5$.

Taking second derivative, at $q = 5$ gives $200/125 = 8/5 > 0$, and hence 5 is the minimum point.

6 votes

-- Arjun Suresh (150k points)

14.9

Counting [top](#)

14.9.1 Counting: Gate 2015 Aptitude Set 8 Q8 [top](#)

<http://gateoverflow.in/40183>

Q.8 How many four digit numbers can be formed with the 10 digits 0, 1, 2, ..., 9 if no number can start with 0 and if repetitions are not allowed?

[gate2015aptiset8](#) [aptitude](#) [counting](#)

Answer

Answers: Counting

14.9.1 Counting: Gate 2015 Aptitude Set 8 Q8 top

<http://gateoverflow.in/40183>



Selected Answer

so, since digits in number must be 4. it is possible only when number doesn't start with 0.

- - - -

at first place all number can appear except 0. so possibility is 9.

9 - - -

since repetition is not allowed so second place will be occupied by 8 different numbers but here 0 may appear so total possibilities are 9 here as well.

9 * 9 - -

similarly

$9*9*8*7 = 4536$

1 votes

-- ppateriya (125 points)

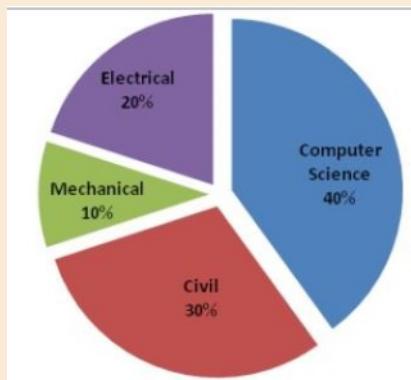
14.10

Data Interpretation top

14.10.1 Data Interpretation: GATE2015-1_GA_9 top

<http://gateoverflow.in/8013>

The pie chart below has the breakup of the number of students from different departments in an engineering college for the year 2012. The proportion of male to female students in each department is 5:4. There are 40 males in Electrical Engineering. What is the difference between the numbers of female students in the civil department and the female students in the Mechanical department?



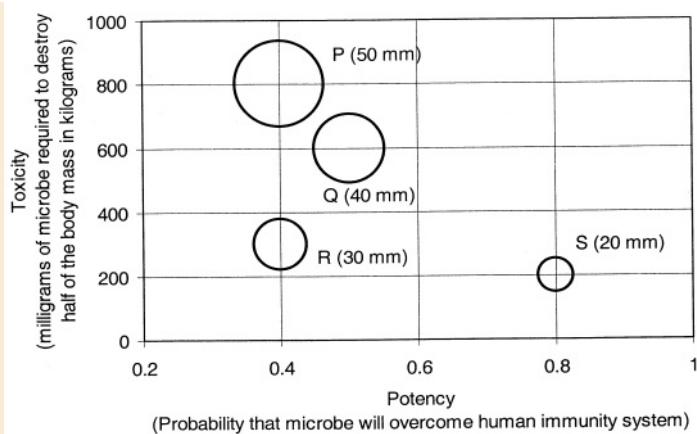
[gate2015-1](#) [numerical-ability](#) [data-interpretation](#)

Answer

14.10.2 Data Interpretation: GATE2011_62 top

<http://gateoverflow.in/2172>

P, Q, R and S are four types of dangerous microbes recently found in a human habitat. The area of each circle with its diameter printed in brackets represents the growth of a single microbe surviving human immunity system within 24 hours of entering the body. The danger to human beings varies proportionately with the toxicity, potency and growth attributed to a microbe shown in the figure below:



A pharmaceutical company is contemplating the development of a vaccine against the most dangerous microbe. Which microbe should the company target in its first attempt?

- (A) P
- (B) Q
- (C) R
- (D) S

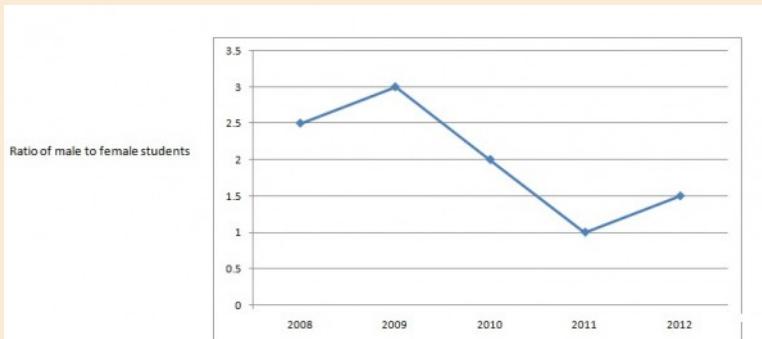
[gate2011](#) [numerical-ability](#) [data-interpretation](#) [normal](#)

[Answer](#)

14.10.3 Data Interpretation: GATE2014-2_GA_9 [top](#)

<http://gateoverflow.in/1951>

The ratio of male to female students in a college for five years is plotted in the following line graph. If the number of female students doubled in 2009, by what percent did the number of male students increase in 2009?

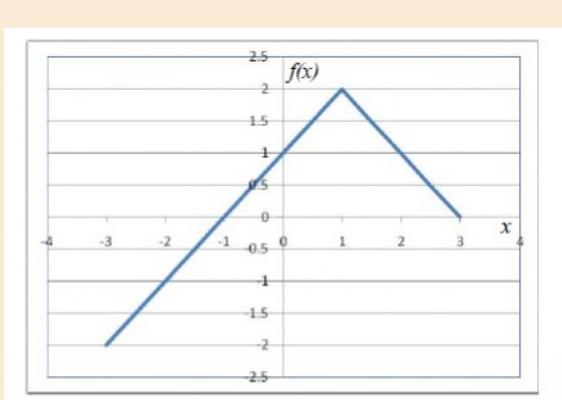


[gate2014-2](#) [numerical-ability](#) [data-interpretation](#) [numerical-answers](#) [normal](#)

[Answer](#)

14.10.4 Data Interpretation: GATE 2016-2-GA-10 [top](#)

<http://gateoverflow.in/39535>



- A. $f(x) = 1 - |x - 1|$
- B. $f(x) = 1 + |x - 1|$
- C. $f(x) = 2 - |x - 1|$
- D. $f(x) = 2 + |x - 1|$

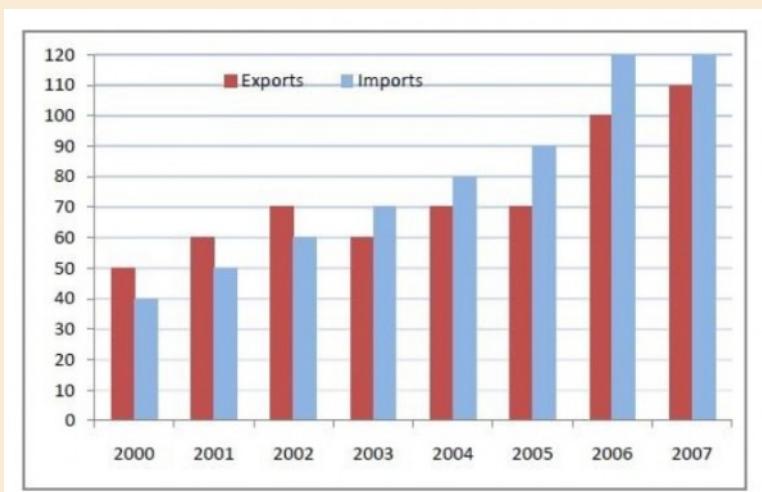
gate2016-2 numerical-ability data-interpretation normal

Answer

14.10.5 Data Interpretation: GATE2015-3_GA_10 [top](#)

<http://gateoverflow.in/8389>

The exports and imports (in crores of Rs.) of a country from the year 2000 to 2007 are given in the following bar chart. In which year is the combined percentage increase in imports and exports the highest?



gate2015-3 numerical-ability data-interpretation normal

Answer

14.10.6 Data Interpretation: GATE2016-1-GA06 [top](#)

<http://gateoverflow.in/39616>

A shaving set company sells 4 different types of razors- Elegance, Smooth, Soft and Executive.

Elegance sells at Rs. 48, Smooth at Rs. 63, Soft at Rs. 78 and Executive at

Rs. 173 per piece. The table below shows the numbers of each razor sold in each quarter of a year.

| Quarter / Product | Elegance | Smooth | Soft | Executive |
|-------------------|----------|--------|-------|-----------|
| Q1 | 27300 | 20009 | 17602 | 9999 |
| Q2 | 25222 | 19392 | 18445 | 8942 |
| Q3 | 28976 | 22429 | 19544 | 10234 |
| Q4 | 21012 | 18229 | 16595 | 10109 |

Which product contributes the greatest fraction to the revenue of the company in that year?

- A. Elegance
- B. Executive
- C. Smooth
- D. Soft

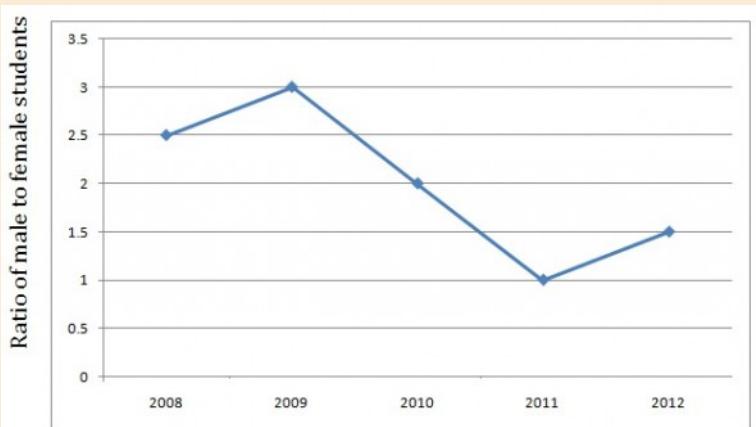
gate2016-1 numerical-ability data-interpretation easy

Answer

14.10.7 Data Interpretation: GATE2014-3_GA_9 [top](#)

<http://gateoverflow.in/2033>

The ratio of male to female students in a college for five years is plotted in the following line graph. If the number of female students in 2011 and 2012 is equal, what is the ratio of male students in 2012 to male students in 2011?



- (A) 1:1
- (B) 2:1
- (C) 1.5:1
- (D) 2.5:1

gate2014-3 numerical-ability data-interpretation normal

Answer

Answers: Data Interpretation

14.10.1 Data Interpretation: GATE2015-1_GA_9 [top](#)

<http://gateoverflow.in/8013>



Selected Answer

Number of female students in Electrical = $40 * 4/5 = 32$

Number of female students in Civil = $32 * 30/20 = 48$ (Since proportion of male students to female students is same, the breakup chart is the same for number of female students)

Number of female students in Mechanical = $32 * 10/20 = 16$

So, answer = $48 - 16 = 32$

6 votes

-- Arjun Suresh (150k points)

14.10.2 Data Interpretation: GATE2011_62 [top](#)



Selected Answer

Answer is D.

As per the question, it is quite clear that the danger of a microbe to human being will be directly proportional to potency and growth. At the same time it is inversely proportional to toxicity, defined as(more dangerous will a microbe be if lesser of its milligram is required).

So,

Level Of Danger (D) \propto Growth (G)

\propto Potency (P)

$1/\propto$ Toxicity (T)

$D = KGP/T$

where K is constant of proportionality.

So level of danger will be maximum for S.

Given by,

$$D_S = 0.8 * \pi(10)^2/200$$

$$= 1.256$$

Similar Calculations for D_P , D_Q , D_R can be done. Which will consequently lead to D_S being the most dangerous and hence will be targeted first.

10 votes

-- Gate Keeda (17.7k points)

14.10.3 Data Interpretation: GATE2014-2_GA_9 [top](#)



Selected Answer

In 2008 M/F ratio is 2.5.

Assume 250 Males, 100 Females.

In 2009 M/F ratio is 3. Also total no of females doubled

$$\text{Females} = 100 * 2 = 200.$$

So

$$M/F = 3$$

$$M / 200 = 3$$

$$M = 200 * 3 = 600.$$

$$\text{Increase in Male Students} = 600 - 250 = 450$$

% increase = (450 / 250) * 100 = 140%

3 votes

-- Akash (31.7k points)

14.10.4 Data Interpretation: GATE 2016-2-GA-10 [top](#)

<http://gateoverflow.in/39535>



Selected Answer

Answer is Option C

The equation of line, from coordinates
(1, 2) to
(3, 0), where
 $|x - 1| = (x - 1)$

$$(y - 2) = \frac{(0-2)}{(3-1)}(x - 1)$$

$$y = 2 - (x - 1)$$

$$y = 2 - |x - 1|$$

The equation of line, from coordinates
(-3, -2) to
(1, 2), where
 $|x - 1| = -(x - 1)$

$$(y - (-2)) = \frac{(2 - (-2))}{(1 - (-3))}(x - (-3))$$

$$y = x + 1$$

$$y = 2 - (-(x - 1))$$

$$y = 2 - |x - 1|$$

Note : Equation of line when two coordinates
(x_2, y_2) and
(x_1, y_1) are given is
 $(y - y_1) = \frac{(y_2 - y_1)}{(x_2 - x_1)}(x - x_1)$

5 votes

-- Praveen Saini (38.4k points)

Here we can cancel options easily !

See that $F(0) = 1$

A) $F(0) => 1 - |x-1| = 1 - |-1| = 1 - 1 = 0 \neq 1$. So A is not answer !

B) $F(0) => 1 + |x-1| = 1 + |-1| = 1 + 1 = 2 \neq 1$ So B is not answer !

D) $F(0) => 2 + |x-1| = 2 + |-1| = 2 + 1 = 3 \neq 1$ So D is not answer !

Remaining option C is answer !

5 votes

-- Akash (31.7k points)

14.10.5 Data Interpretation: GATE2015-3_GA_10 [top](#)

<http://gateoverflow.in/8389>



Selected Answer

Ans is 2006

No need to do any calculations ,just observe the bar chart.

Here %increase is asked, so just check for previous year & next year pair, where you can find maximum positive change.

Consider year 2006.

Red Bar is above 3 steps than 2005 AND Blue Bar is 3 steps more than 2005, total = $3+3=6$, it's maximum.

9 votes

-- Rohan Mundhey (1.1k points)

14.10.6 Data Interpretation: GATE2016-1-GA06 [top](#)

<http://gateoverflow.in/39816>



Selected Answer

b executive

We have to find the product x which has $\max \left(\sum_{i=1}^4 n_{x_i} \times P_x \right)$, where P_x is the selling price of x and n_{x_i} is the number of items of type x sold in quarter i .

12 votes

-- Pooja (25.9k points)

14.10.7 Data Interpretation: GATE2014-3_GA_9 [top](#)

<http://gateoverflow.in/2033>



Selected Answer

C) 1.5 : 1

2011

m_1 = no of male students

f_1 = no of female students

$m_1/f_1=1$

2012

m_2 = no of male students

f_2 = no of female students

$m_2/f_2=1.5$

Given : $f_1=f_2=f$

So , $m_1/f_1=1$ and $m_2/f_2=1.5$

$f=m_1/1$ and $f=m_2/1.5$

Both the equations can be equated..

$m_1/1 = m_2/1.5$

Ratio of male students in 2012 to male students in 2011 => $m_2/m_1 = 1.5/1 = 1.5 : 1$

4 votes

-- Srinath Sri (2.9k points)

14.11

Directions [top](#)

14.11.1 Directions: GATE2014-AG-GA9 [top](#)

<http://gateoverflow.in/41673>

X is 1 km northeast of Y . Y is 1 km southeast of Z . W is 1 km west of Z . P is 1 km south of W . Q is 1 km east of P . What is the distance between X and Q in km?

- A. 1
- B. $\sqrt{2}$
- C. $\sqrt{3}$

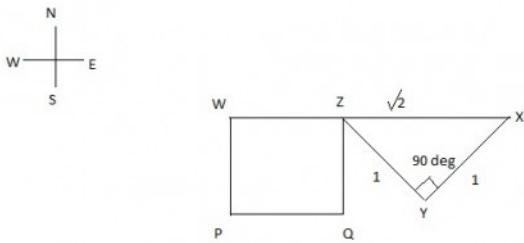
D. 2

gate2014-ag numerical-ability directions normal

Answer

Answers: Directions**14.11.1 Directions: GATE2014-AG-GA9** [top](#)<http://gateoverflow.in/41673>

Selected Answer

distance between XQ is $\sqrt{(1^2 + (\sqrt{2})^2)} = \sqrt{3}$

1 votes

-- srestha (27.8k points)

14.12**Distance Time** [top](#)**14.12.1 Distance Time: GATE2014-EC02-GA10** [top](#)<http://gateoverflow.in/41518>

It takes 30 minutes to empty a half-full tank by draining it at a constant rate. It is decided to simultaneously pump water into the half-full tank while draining it. What is the rate at which water has to be pumped in so that it gets fully filled in 10 minutes?

- A. 4 times the draining rate
- B. 3 times the draining rate
- C. 2.5 times the draining rate
- D. 2 times the draining rate

gate2014-ec02 numerical-ability distance-time normal

Answer

14.12.2 Distance Time: TIFR2012-A-16 [top](#)<http://gateoverflow.in/25041>

Walking at $4/5$ is normal speed a man is 10 minute too late. Find his usual time in minutes.

- a. 81
- b. 64
- c. 52
- d. 40
- e. It is not possible to determine the usual time from given data.

tifr2012 numerical-ability distance-time

Answer

14.12.3 Distance Time: GATE2014-EC03-GA8 [top](#)<http://gateoverflow.in/41460>

A man can row at 8 km per hour in still water. If it takes him thrice as long to row upstream, as to row downstream, then find the stream velocity in km per hour.

gate2014-ec03 numerical-ability distance-time normal

Answer

14.12.4 Distance Time: GATE2014-EC01-GA8 [top](#)

<http://gateoverflow.in/41497>

A train that is 280 metres long, travelling at a uniform speed, crosses a platform in 60 seconds and passes a man standing on the platform in 20 seconds. What is the length of the platform in metres?

gate2014-ec01 numerical-ability distance-time normal numerical-answers

Answer

Answers: Distance Time

14.12.1 Distance Time: GATE2014-EC02-GA10 [top](#)

<http://gateoverflow.in/41518>

A 4 times the draining rate .

0 votes

-- Afzal Ahmad (11 points)

A. 4 times the draining rate

0 votes

-- Harsukh Chandak (11 points)

14.12.2 Distance Time: TIFR2012-A-16 [top](#)

<http://gateoverflow.in/25041>



Selected Answer

Let man travel distance d with speed s in time t

$$d=st \quad \text{----- eqn 1}$$

Acc to que we get second equation

$$d=4/5s(t+10) \quad \text{----- eqn 2}$$

$$5/4t - t = 10$$

$$\text{So } t=40$$

$$\text{So ans is } d$$

2 votes

-- Pooja (25.9k points)

14.12.3 Distance Time: GATE2014-EC03-GA8 [top](#)

<http://gateoverflow.in/41460>



Selected Answer

Speed of man (m) = 8km/h

Speed of stream (s)

According to the question

speed of man upstream = $S_1 = m-s$
 speed of man downstream = $S_2 = m+s$
 Speed = Distance/Time
 Here since the distance D are same.
 $D = S_1 * T_1$
 $D = S_2 * T_2$
 $S_1 * T_1 = S_2 * T_2$

$$\frac{S_1}{S_2} = \frac{T_2}{T_1} = 3$$

$$m+s = 3(m-s)$$

$$\text{or, } 8+s=3(8-s)$$

$$\text{or, } s=4\text{km/h}$$

1 votes

-- srestha (27.8k points)

14.12.4 Distance Time: GATE2014-EC01-GA8 [top](#)

<http://gateoverflow.in/41497>



Selected Answer

Speed of train=280/20=14m/s

let L be length of platform

280+L covered in 60s

$$280+L/14=60$$

$$280+L=840$$

$$L=840-280$$

$$L=560\text{m}$$

4 votes

-- Pooja (25.9k points)

14.13

First Order Logic [top](#)

14.13.1 First Order Logic: GATE 2015 Aptitude Set 4 Q7 [top](#)

<http://gateoverflow.in/40172>

Q.7 Given below are two statements followed by two conclusions. Assuming these statements to be true, decide which one logically follows.

Statements:

- I. No manager is a leader.
- II. All leaders are executives.

Conclusions:

- I. No manager is an executive.
 - II. No executive is a manager.
- (A) Only conclusion I follows.
 (B) Only conclusion II follows.
 (C) Neither conclusion I nor II follows.
 (D) Both conclusions I and II follow.

[gate2015aptiset4](#) [aptitude](#) [mathematical-logic](#) [logical-reasoning](#) [first-order-logic](#)

Answer

Answers: First Order Logic

14.13.1 First Order Logic: GATE 2015 Aptitude Set 4 Q7 [top](#)<http://gateoverflow.in/40172>

Answer is C, we can check by venn diagram.

2 votes

-- Aditya Sharma (719 points)

14.14**Fraction** [top](#)**14.14.1 Fraction: TIFR2014-A-11** [top](#)<http://gateoverflow.in/26329>

A large community practices birth control in the following peculiar fashion. Each set of parents continues having children until a son is born; then they stop. What is the ratio of boys to girls in the community if, in the absence of birth control, 51% of the babies are born male?

- a. 51 : 49
- b. 1 : 1
- c. 49 : 51
- d. 51 : 98
- e. 98 : 51

[tifr2014](#) [numerical-ability](#) [fraction](#)

[Answer](#)

Answers: Fraction**14.14.1 Fraction: TIFR2014-A-11** [top](#)<http://gateoverflow.in/26329>

Selected Answer

A) should be the correct choice.

In the community we know that each set of parents will have exactly 1 boy.

The number of girls might differ.

To find the ratio of boys to girls in the community, we are going to find the expected number of girls that each parent set can have.

Henceforth in this question we are going to use the word "family" to denote a "parent set".

Calculation of expected number of girls in any family

Let X be a random variable that denotes the number of girls that any family has. Each family will have exactly 1 boy.

$P(X = 0)$ will denote : Probability that a family has 0 girls and 1 boy.

$$P(X = 0) = (0.49)^0 (0.51)$$

$P(X = 3)$ will denote : Probability that a family has 3 girls and 1 boy.

$$P(X = 3) = (0.49)^3 (0.51)$$

and so on.

In general we can say that

$P(X = i)$ will denote the probability that a family has i girls and 1 boy, and

$$P(X = i) = (0.49)^i (0.51)$$

Now the expected number of girls in any family will be denoted by $E[X]$.

Here

$$E[X] = \sum_{i=0}^{\infty} i \cdot P(X = i)$$

but

$$P(X = i) = (0.49)^i (0.51) \text{ . so we get,}$$

$$E[X] = \sum_{i=0}^{\infty} i \cdot (0.49)^i (0.51)$$

This implies

$$E[X] = (0.51) \sum_{i=0}^{\infty} i \cdot (0.49)^i$$

The formula for summation of series of type $\sum_{k=0}^{\infty} k \cdot x^k$ can be found by differentiating

$\sum_{k=0}^{\infty} x^k$ with respect to x . (See the reference below).

This gives

$$\sum_{k=0}^{\infty} k \cdot x^k = \frac{x}{(x-1)^2}$$

$$\text{So } \sum_{i=0}^{\infty} i \cdot (0.49)^i = \frac{0.49}{(0.49-1)^2}$$

Hence

$$E[X] = (0.51) \cdot \frac{0.49}{(0.51)^2} = \frac{0.49}{0.51}$$

Now the ratio of boys to girls can be given by number of boys in each family/expected number of girls in each family.

$$\text{that is } \text{Ratio (B to G)} = \frac{1}{E[X]}$$

$$\text{So } \text{Ratio (B to G)} = \frac{\frac{0.49}{0.51}}{\frac{0.49}{0.51}} = \frac{51}{49}$$

Reference for series summation:

<http://math.stackexchange.com/questions/629589/converge-of-the-sum-sum-k-1n-k-xk>

4 votes

-- Anurag Pandey (9.7k points)

14.15

Functions

14.15.1 Functions: GATE2012-AR-7

<http://gateoverflow.in/40228>

- Let $f(x) = x - [x]$, where $x \geq 0$ and $[x]$ is the greatest integer not larger than x . Then $f(x)$ is a
- (A) monotonically increasing function
 - (B) monotonically decreasing function
 - (C) linearly increasing function between two integers
 - (D) linearly decreasing function between two integers

gate2012-ar aptitude numerical-ability functions

Answer

Answers: Functions

14.15.1 Functions: GATE2012-AR-7<http://gateoverflow.in/40228>

$$f(x) = x - [x]$$

$f(x)$ gives nothing but the fractional part of x .

Now, as we move up the number line between two consecutive integers say a and $a+1$..

The value of $f(a)$ starts from 0 and grows linearly till the consecutive integer and just before $x=a+1$ (left neighbourhood of $a+1$) it tends to the value 1. Between a and $a+1$, the graph grows linearly from 0 to 1..

But, when at $x=a+1$, the value comes back to 0 and same linear graph continues between the next two consecutive integers and so on..

So, answer C)linearly increasing function between two integers

3 votes

-- Abhilash Panicker (7k points)

14.16**Geometry****14.16.1 Geometry: TIFR2015-A-9**<http://gateoverflow.in/29575>

Consider a square of side length 2. We throw five points into the square. Consider the following statements:

- (i) There will always be three points that lie on a straight line.
- (ii) There will always be a line connecting a pair of points such that two points lie on one side of the line and one point on the other.
- (iii) There will always be a pair of points which are at distance at most $\sqrt{2}$ from each other.

Which of the above is true:

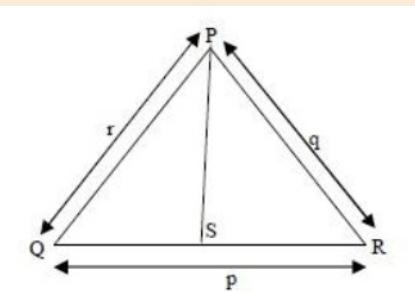
- A. (i) only.
- B. (ii) only.
- C. (iii) only.
- D. (ii) and (iii).
- E. None of the above.

tifr2015 geometry

Answer

14.16.2 Geometry: GATE2015-2_GA_8<http://gateoverflow.in/8039>

In a triangle PQR, PS is the angle bisector of $\angle QPR$ and $\angle QPS = 60^\circ$. What is the length of PS?



- A. $\frac{(q+r)}{qr}$
- B. $\frac{qr}{q+r}$
- C. $\sqrt{(q^2 + r^2)}$
- D. $\frac{(q+r)^2}{qr}$

[gate2015-2](#)
[numerical-ability](#)
[geometry](#)
[difficult](#)
[Answer](#)

14.16.3 Geometry: TIFR2015-A-2 [top](#)

<http://gateoverflow.in/29158>

Consider a circle with a circumference of one unit length. Let $d < 1/6$. Suppose that we independently throw two arcs, each of length d , randomly on this circumference so that each arc is uniformly distributed along the circle circumference. The arc attaches itself exactly to the circumference so that arc of length d exactly covers length d of the circumference. What can be said about the probability that the two arcs do not intersect each other?

- It equals $(1 - d)$
- It equals $(1 - 3d)$
- It equals $(1 - 2d)$
- It equals 1
- It equals $(1 - d)(1 - d)$

[tifr2015](#)
[geometry](#)
[Answer](#)

14.16.4 Geometry: TIFR2010-A-17 [top](#)

<http://gateoverflow.in/18493>

Suppose there is a sphere with diameter **at least** 6 inches. Through this sphere we drill a hole along a diameter. The part of the sphere lost in the process of drilling the hole looks like two caps joined to a cylinder, where the cylindrical part has length 6 inches. It turns out that the volume of the remaining portion of the sphere does not depend on the diameter of the sphere. Using this fact, determine the volume of the remaining part.

- 24π cu. inches
- 36π cu. inches
- 27π cu. inches
- 32π cu. inches
- 35π cu. inches

[tifr2010](#)
[numerical-ability](#)
[geometry](#)
[Answer](#)

14.16.5 Geometry: TIFR2012-A-5 [top](#)

<http://gateoverflow.in/21001>

What is the maximum number of points of intersection between the diagonals of a convex octagon (8-vertex planar polygon)? Note that a polygon is said to be convex if the line segment joining any two points in its interior lies wholly in the interior of the polygon. Only points of intersection between diagonals that lie in the interior of the octagon are to be considered for this problem.

- 55
- 60
- 65
- 70
- 75

[tifr2012](#)
[numerical-ability](#)
[geometry](#)
[Answer](#)

14.16.6 Geometry: GATE2014-1_GA_10 [top](#)

<http://gateoverflow.in/778>

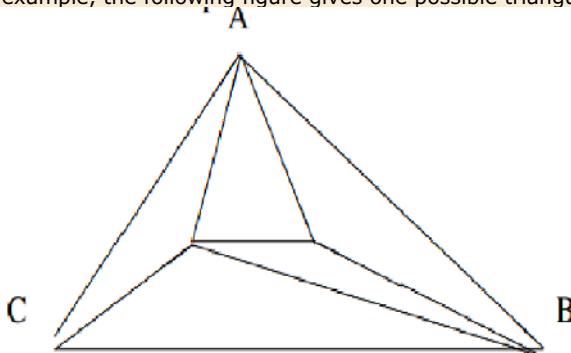
When a point inside of a tetrahedron (a solid with four triangular surfaces) is connected by straight lines to its corners, how many (new) internal planes are created with these lines?

[gate2014-1](#)
[numerical-ability](#)
[geometry](#)
[combinatory](#)
[normal](#)
[Answer](#)

14.16.7 Geometry: TIFR2012-A-4 [top](#)

<http://gateoverflow.in/20984>

Let ABC be a triangle with n distinct points inside. A triangulation of ABC with respect to the n points is obtained by connecting as many points as possible, such that no more line segments can be added without intersecting other line segments. In other words ABC has been partitioned into triangles with end points at the n points or at the vertices A, B, C . For example, the following figure gives one possible triangulation of ABC with two points inside it.



Although there are many different ways to triangulate ABC with the n points inside, the number of triangles depends only on n . In the above figure it is five. How many triangles are there in a triangulation of ABC with n points inside it?

- a). $3n - 1$
- b). $n^2 + 1$
- c). $n + 3$
- d). $2n + 1$
- e). $4n - 3$

[tifr2012](#) [numerical-ability](#) [geometry](#)

[Answer](#)

14.16.8 Geometry: GATE 2016-1-GA05 [top](#)

<http://gateoverflow.in/39610>

A cube is built using 64 cubic blocks of side one unit. After it is built, one cubic block is removed from every corner of the cube. The resulting surface area of the body (in square units) after the removal is _____.

- a. 56
- b. 64
- c. 72
- d. 96

[gate2016-1](#) [numerical-ability](#) [geometry](#) [normal](#)

[Answer](#)

Answers: Geometry

14.16.1 Geometry: TIFR2015-A-9 [top](#)

<http://gateoverflow.in/29575>

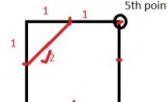
(i) Not necessarily true. There will be a line connecting a pair of points such that two points lie on one side of the line and one point on the other.

(ii) There will be a line connecting a pair of points such that two points lie on one side of the line and one point on the other.

But It is not always true because There can be three points that lie on a straight line

- (iii) There will always be a pair of points which are at distance at most $\sqrt{2}$ from each other.

$\sqrt{2}$ is the case when the point in middle .But as there are 1 extra point , the



max among minimum distance will must be less than $\sqrt{2}$

for 5th point min distance among a pair of vertices must be less than or equal to 1

So, only (iii) is true

Ans will be (C)

1 votes

-- srestha (27.8k points)

14.16.2 Geometry: GATE2015-2_GA_8 [top](#)

<http://gateoverflow.in/8039>

Area of a $\Delta = 1/2 * ac \sin B = 1/2 * bc \sin A = 1/2 ab \sin C$

so, Here area (ΔPQR) = area (ΔPQS) + area (ΔPRS)

$$\begin{aligned} 1/2 rq \sin 120 &= 1/2 PS * r \sin 60 + 1/2 PS * q \sin 60 \\ \Rightarrow PS &= rq/(r+q) \end{aligned}$$

so, choice (B) is correct..

8 votes

-- Himanshu Agarwal (9.8k points)

14.16.3 Geometry: TIFR2015-A-2 [top](#)

<http://gateoverflow.in/29158>

$(1 - 2d)$ will be the correct answer.

Two points on the circumference of any circle divides the circle in two arcs, the length of smaller arc must be less than or equal to half of the circumference, & length of the larger arc must be greater than or equal to half the circumference.

but since here given length of the arc under consideration is strictly less than $\frac{1}{2}$, so henceforth in this answer, whenever I will use the term "arc", I'll be referring to the smaller of those two arcs.

Process of Arc drawing: I am going to follow a specific procedure for drawing any arc of length d , which is as follows:

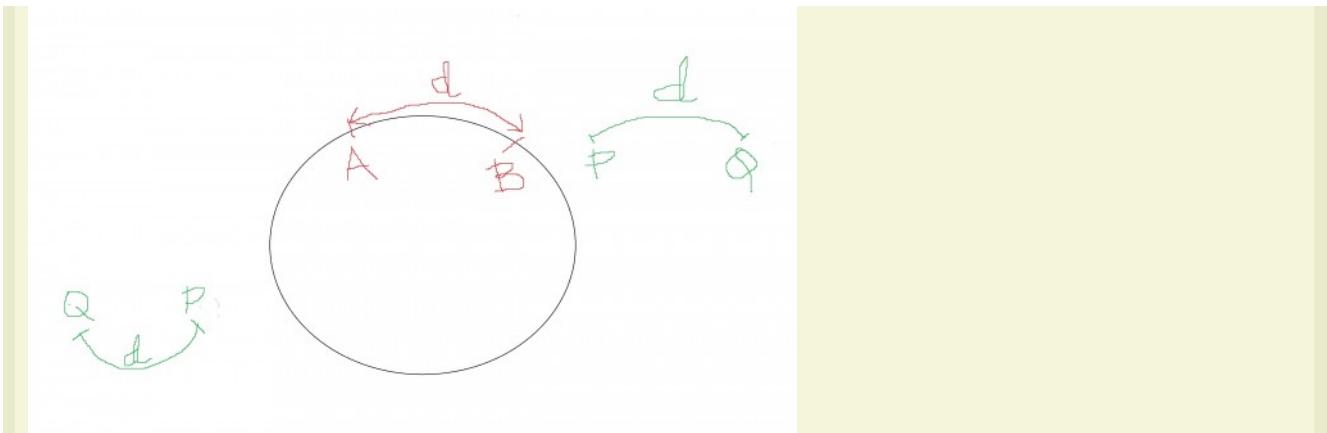
1) Pick any point on the circumference of the circle, this will be the starting point.

2) Move

d units CLOCKWISE on the circumference of the circle & mark that point as the finishing point.

Suppose we choose our first arc AB of length d , randomly anywhere on the circumference on the circle.

Here A is the starting point & B is the end point.



After drawing the arc AB , we have to draw another arc PQ on the circle of length d , where P will be the starting point & Q will be the end point.

Now if we have to make sure that arc PQ does not intersect with arc AB , we have to keep following things in mind while choosing our starting point P :

- 1) P can not lie within arc AB , otherwise AB and PQ will intersect each other.
- 2) P can not lie anywhere within the anticlockwise distance d from the point A otherwise, end part of arc PQ will intersect with starting part of arc AB .

So we can conclude that **If
 P lies anywhere on the circumference of the circle within a distance
 d from
 A then the arc
 PQ &
 AB will intersect.**

So $\text{Probability}(\text{Arc } PQ \text{ does not intersect with Arc } AB) = \frac{\text{P lies atleast } d \text{ distance away from } A}{\text{P lies anywhere in the circumference}}$
 $\Rightarrow \text{Probability}(\text{Arc } PQ \text{ does not intersect with Arc } AB) = \frac{1-2d}{1} = (1-2d).$

拇指 3 votes

-- Anurag Pandey (9.7k points)

14.16.4 Geometry: TIFR2010-A-17 [top](#)

<http://gateoverflow.in/1843>

This is the napkin ring problem.

The volume of the remaining part is $\pi * h^3 / 6$

Here $h=6$

Hence the answer is 36π

拇指 0 votes

-- admin (1.6k points)

14.16.5 Geometry: TIFR2012-A-5 [top](#)

<http://gateoverflow.in/21001>

nc4 is direct formulae to calculate no intersection made by polygon therefore Answer is D for more on this

ref :<http://www-math.mit.edu/~poonen/papers/ngon.pdf>

拇指 0 votes

-- Saurav Shrivastava (719 points)

14.16.6 Geometry: GATE2014-1_GA_10 [top](#)

<http://gateoverflow.in/778>



Selected Answer

It is 6.

Tetrahedron has 4 corner points. So, it forms 4 planes. Now, we add an internal point making a total of 5 points. Any three combination of points leads to a plane and thus we can get ${}^5C_3 = 10$ planes. So, newly created planes = $10 - 4 = 6$.

1 like 8 votes

-- Palash Nandi (1.4k points)

14.16.7 Geometry: TIFR2012-A-4 top

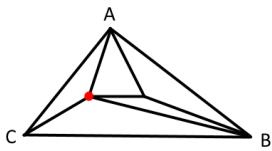
<http://gateoverflow.in/20984>

Selected Answer

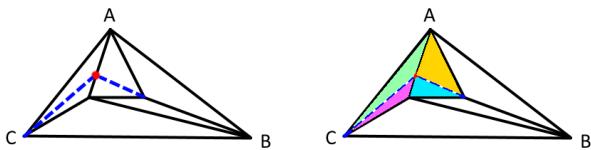
Any polygon can be split into triangles, so any n -triangulate for any n will always be composed of triangles.

Given an $(n - 1)$ triangulate, we can add the point in the following three ways:

- I. **The point lies on a point that is already there.** In this case, the point has already been connected to all possible vertices that it can be connected to (since we started with a $(n - 1)$ triangulate). Example:

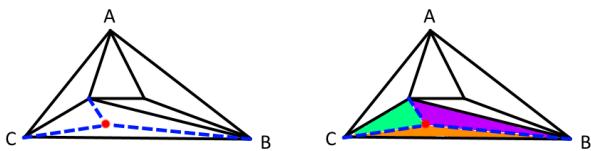


- II. **The point lies on a line that is already there, but not on a point.** In this case, since the line is the common edge of at most 2 triangles, the point can only be connected to 2 vertices (the opposite ends of the triangles). For example:



This creates 4 new triangles, but destroys the original 2 triangles. Thus, the number of triangles increase by 2. This is an optimal case.

- III. **The point lies inside of a triangle.** The new point can then be connected to exactly 3 vertices of the bounding triangle. Example:



This creates 3 new triangles, but destroys the original triangle. So, the number of triangles increase by 2. So, this is also an optimal case.

We can see that the n^{th} triangulate has exactly 2 more triangles than the $(n - 1)^{th}$ triangulate.

This gives us the following recurrence:

$$T(n) = T(n - 1) + 2, T(2) = 5$$

Which solves to:

$$T(n) = 2n + 1$$

Hence, option d is the correct answer.

1 like 1 votes

-- Pragy Agarwal (14.4k points)

14.16.8 Geometry: GATE 2016-1-GA05 [top](#)<http://gateoverflow.in/39610>

Selected Answer

(D). 96

Removal of blocks won't cause any change in surface area.

13 votes

-- The_cake (247 points)

14.17**Inference** [top](#)**14.17.1 Inference: GATE2010-62** [top](#)<http://gateoverflow.in/2370>

Hari(H), Gita(G), Irfan(I) and Saira(S) are siblings (i.e., brothers and sisters). All were born on 1st January. The age difference between any two successive siblings (that is born one after another) is less than three years. Given the following facts:

- i. Hari's age + Gita's age > Irfan's age + Saira's age
- ii. The age difference between Gita and Saira is one year. However Gita is not the oldest and Saira is not the youngest.
- iii. There are no twins.

In what order they were born (oldest first)?

- A. HSIG
- B. SGHI
- C. IGSH
- D. IHSG

[gate2010](#) [numerical-ability](#) [inference](#) [normal](#)

Answer

Answers: Inference**14.17.1 Inference: GATE2010-62** [top](#)<http://gateoverflow.in/2370>

Selected Answer

Correct answer is B. Though, its a hit-n-trial method.

option A: There is no such possibility, as it is given that there are no twins, so S and G must be consecutive.

option B: For some combination of ages of SGHI we can satisfy (1) condition like taking ages as, S=5 G=5 H=3 I=1, (2) and (3) are also satisfied. So, all the 3 conditions are satisfied.

option C: IGSH, so I > G and S > H (as there are no twins) and so I + S > G + H - violates condition 1.

option D: IHSG, so I > H and S > G and so I + S > H + G - violates condition 1.

4 votes

-- ujjwal saini (331 points)

14.18**Logical Reasoning** [top](#)**14.18.1 Logical Reasoning: GATE2014-AE-GA-7** [top](#)<http://gateoverflow.in/40307>

Anuj, Bhola, Chandan, Dilip, Eswar and Faisal live on different floors in a six-storeyed building (the ground floor is numbered 1, the floor above it 2, and so on) Anuj lives on an even-numbered floor, Bhola does not live on an odd numbered floor. Chandan does not live on any of the floors below Faisal's floor. Dilip does not live on floor number 2. Eswar does not live on a floor immediately above or immediately below Bhola. Faisal lives three floors above Dilip. Which of the following floor-person

combinations is correct?

| | Anuj | Bhola | Chandan | Dilip | Eswar | Faisal |
|-----|------|-------|---------|-------|-------|--------|
| (A) | 6 | 2 | 5 | 1 | 3 | 4 |
| (B) | 2 | 6 | 5 | 1 | 3 | 4 |
| (C) | 4 | 2 | 6 | 3 | 1 | 5 |
| (D) | 2 | 4 | 6 | 1 | 3 | 5 |

gate-2014-ae logical-reasoning numerical-ability

Answer

14.18.2 Logical Reasoning: TIFR2013-A-11 [top](#)

<http://gateoverflow.in/25433>

Let there be a pack of 100 cards numbered 1 to 100. The i^{th} card states: "There are at most $i - 1$ true cards in this pack". Then how many cards of the pack contain TRUE statements?

- a. 0
- b. 1
- c. 100
- d. 50
- e. None of the above.

tifr2013 logical-reasoning

Answer

14.18.3 Logical Reasoning: GATE2014-AG-GA6 [top](#)

<http://gateoverflow.in/41670>

In a group of four children, Som is younger to Riaz. Shiv is elder to Ansu. Ansu is youngest in the group. Which of the following statements is/are required to find the eldest child in the group?

Statements

- 1. Shiv is younger to Riaz.
- 2. Shiv is elder to Som.
- A. Statement 1 by itself determines the eldest child.
- B. Statement 2 by itself determines the eldest child.
- C. Statements 1 and 2 are both required to determine the eldest child.
- D. Statements 1 and 2 are not sufficient to determine the eldest child.

gate2014-ag numerical-ability logical-reasoning normal

Answer

14.18.4 Logical Reasoning: GATE2014-EC02-GA7 [top](#)

<http://gateoverflow.in/41515>

Lights of four colors (red, blue, green, yellow) are hung on a ladder. On every step of the ladder there are two lights. If one of the lights is red, the other light on that step will always be blue. If one of the lights on a step is green, the other light on that step will always be yellow. Which of the following statements is not necessarily correct?

- A. The number of red lights is equal to the number of blue lights
- B. The number of green lights is equal to the number of yellow lights
- C. The sum of the red and green lights is equal to the sum of the yellow and blue lights
- D. The sum of the red and blue lights is equal to the sum of the green and yellow lights

gate2014-ec02 numerical-ability logical-reasoning normal

Answer

14.18.5 Logical Reasoning: GATE2014-EC03-GA5 [top](#)

<http://gateoverflow.in/41144>

In which of the following options will the expression $P < M$ be definitely true?

- A. $M < R > P > S$
- B. $M > S < P < F$
- C. $Q < M < F = P$
- D. $P = A < R < M$

[gate2014-ec03](#) [logical-reasoning](#)

[Answer](#)

14.18.6 Logical Reasoning: TIFR2013-A-2 [top](#)

<http://gateoverflow.in/25383>

Consider the following two types of elections to determine which of two parties A and B forms the next government in the 2014 Indian elections. Assume for simplicity an Indian population of size 545545 ($= 545 * 1001$). There are only two parties A and B and every citizen votes.

TYPE C: The country is divided into 545 constituencies and each constituency has 1001 voters. Elections are held for each constituency and a party is said to win a constituency if it receives a majority of the vote in that constituency. The party that wins the most constituencies forms the next government.

TYPE P: There are no constituencies in this model. Elections are held throughout the country and the party that wins the most votes (among 545545 voters) forms the government.

Which of the following is true?

- a. If the party forms the govt. by election TYPE C winning at least two-third of the constituencies, then it will also form the govt. by election TYPE P.
- b. If a party forms govt. by election TYPE C, then it will also form the govt. by election TYPE P.
- c. If a party forms govt. by election TYPE P, then it will also form the govt. by election TYPE C.
- d. All of the above
- e. None of the above.

[tifr2013](#) [logical-reasoning](#)

[Answer](#)

14.18.7 Logical Reasoning: GATE2014-EC01-GA7 [top](#)

<http://gateoverflow.in/41496>

For submitting tax returns, all resident males with annual income below Rs 10 lakh should fill up Form P and all resident females with income below Rs 8 lakh should fill up Form Q . All people with incomes above Rs 10 lakh should fill up Form R , except non residents with income above Rs 15 lakhs, who should fill up Form S . All others should fill Form T . An example of a person who should fill Form T is

- A. A resident male with annual income Rs 9 lakh
- B. A resident female with annual income Rs 9 lakh
- C. A non-resident male with annual income Rs 16 lakh
- D. A non-resident female with annual income Rs 16 lakh

[gate2014-ec01](#) [numerical-ability](#) [logical-reasoning](#) [normal](#)

[Answer](#)

Answers: Logical Reasoning

14.18.1 Logical Reasoning: GATE2014-AE-GA-7 [top](#)

<http://gateoverflow.in/40307>



Selected Answer

Time is less hence, calculating and applying permutations and combinations would be a layman's choice.

Question says that

Eswar does not live on a floor immediately above or immediately below Bhola

Option (A) Bhola's floor number-2 and Eswar's floor number-3

Option (B) Bhola's floor number-6 and Eswar's floor number-3

Option (C) Bhola's floor number-2 and Eswar's floor number-1

Option (D) Bhola's floor number-4 and Eswar's floor number-3

here we can clearly see that in options A, C and D the statement is not followed.

therefore, the answer is option(B).

1 votes

-- sumit patel (107 points)

the key point of the question is eswar and bhola never be adjecnt so only B option satisfied otherwise all are wrong

1 votes

-- rajan (2.1k points)

14.18.2 Logical Reasoning: TIFR2013-A-11 [top](#)

<http://gateoverflow.in/25433>



Selected Answer

Option D should be the correct one.

that is 50 cards of the pack contain true statements.

Why?

Because if the statement written on card number x is true then all the statements written in card numbers $x + 1$ to 100 must be true.

For Example if Card number 3 is true, then according to the statement written in this card, "There are at most $3 - 1 (= 2)$ true cards in the pack".

This implies number of true cards must be less than 3.

Now the statement on card number 4 will imply that the number of true cards must be less than 4.

similarly the statement on card number 100 will imply that the number of true cards must be less than 100.

So if statement written on card number 3 is true then all the statements written on the card numbers 4 to 100 will vacuously be true.

But now the the number of true cards will be 98 (from card number 3 to 100) hence the statement on the card number 3 must be false.

Clearly this is inconsistent so card number 3 can not be a true card.

Conclusion:

If card number x is a true card then:

1. There are at least $(100 - x) + 1$ true cards. and

2. Total Number of true cards must be less then or equal to $x - 1$

(where x belongs to Integers between 1 and 100).

For any value of $x \leq 50$ both of the above statements can not be true simultaneously, so none of the cards from 1 to 50 is a true card.

For any value of $x \geq 51$ both of the above statements can be true at the same time, so all of the cards from 51 to 100 must be true cards & the total number of true cards will be 50.

It can be observed that comparing one of the boundary cases of each of the above two statements will give us of the boundary cases of our answer.

that is, on solving:

$$(100 - x) + 1 = x - 1$$

we get $x = 51$ which indeed is our smallest true card.

6 votes

-- Anurag Pandey (9.7k points)

14.18.3 Logical Reasoning: GATE2014-AG-GA6 [top](#)

<http://gateoverflow.in/41670>



Selected Answer

I think answer should be A. GIVEN

- Som is younger to Riaz .
- Shiv is elder to Ansu.
- Ansu is youngest.

First Statement :

Shiv is younger to RIAZ, SOM is also younger to RIAZ, ANSU is the youngest. **So RIAZ would be the eldest.**

3 votes

-- richa07 (493 points)

14.18.4 Logical Reasoning: GATE2014-EC02-GA7 [top](#)

<http://gateoverflow.in/41515>

The answer should be D.

1 votes

-- Yogesh900 (21 points)

14.18.5 Logical Reasoning: GATE2014-EC03-GA5 [top](#)

<http://gateoverflow.in/41144>



Selected Answer

Answer D)

Here clearly P < M

as P = A

and A < R and R < M => A < M => P < M

1 votes

-- Abhilash Panicker (7k points)

14.18.6 Logical Reasoning: TIFR2013-A-2 [top](#)

<http://gateoverflow.in/25383>



Selected Answer

Minimum condition for Type C winning : if any wins 273 constituencies out of 545 and with vote 501 out of 1001 for each.

Minimum condition for Type P winning : if any wins 272773 votes out of 545545

**option A : Type C : let A wins 2/3 of constituencies i.e 364 wins by 1 vote and 181 loss by all vote
 $364*501 + 181*0 = 182364$**

**Type P : If A wins it should have more than half of vote i.e. 272773
so its false since A got only 182364 votes**

Option B : similar to option A

Option C: Type P: Let A wins by 272773 votes

**Type C: If A wins 272 constituencies with 1001 votes and loss 272 with 1001 and 1 with 1000 votes
then**

**$272*1001 + 272*0 + 1*1 = 272773$
so it loose the election since A won only 272 constituencies out of 545**

so i think option e

1 3 votes

-- Umang Raman (11.3k points)

14.18.7 Logical Reasoning: GATE2014-EC01-GA7 [top](#)

<http://gateoverflow.in/41496>

I think its Option B

1 1 votes

-- saif ahmed (1.5k points)

14.19

Mean [top](#)

14.19.1 Mean: GATE-2012-AE-5 [top](#)

<http://gateoverflow.in/40216>

The arithmetic mean of five different natural numbers is 12. The largest possible value among the numbers is

- (A) 12 (B) 40 (C) 50 (D) 60

[gate2012-ae](#) [aptitude](#) [mean](#) [numerical-ability](#)

Answer

Answers: Mean

14.19.1 Mean: GATE-2012-AE-5 [top](#)

<http://gateoverflow.in/40216>



Selected Answer

It is 50 obviously.

Total sum of 5 natural numbers = $12 \times 5 = 60$

If 60 is one natural number, then the other 4 numbers must be 0. As 0 is not a natural number (it is a whole number), 60 is not right, so next option remaining is 50.

and also in question they have told as different natural numbers. so 50, 1, 2, 3, 4 are the numbers.

Answer 50 option C

1 2 votes

-- Sreyas S (1.6k points)

14.20

Modular Arithmetic [top](#)

14.20.1 Modular Arithmetic: GATE2012-CY-GA-1 [top](#)

<http://gateoverflow.in/40232>

If $(1.001)^{1259} = 3.52$ and $(1.001)^{2062} = 7.85$, then $(1.001)^{3321} =$
(A) 2.23 (B) 4.33 (C) 11.37 (D) 27.64

[gate2012-cy](#) [aptitude](#) [numerical-ability](#) [modular-arithmetic](#)

Answer

Answers: Modular Arithmetic

14.20.1 Modular Arithmetic: GATE2012-CY-GA-1 top

<http://gateoverflow.in/40232>

$$1259 + 2062 = 3321$$

So, Answer is $3.52 * 7.85 = 27.64$ (Ans)

Option (d) is correct.

Up 2 votes

-- Himanshu Agarwal (9.8k points)

14.21

Most Appropriate Word top

14.21.1 Most Appropriate Word: GATE-2012-AE-3 top

<http://gateoverflow.in/40214>

Choose the most appropriate alternative from the options given below to complete the following sentence:

The administrators went on to implement yet another unreasonable measure, arguing that the measures were already ___ and one more would hardly make a difference.

- (A) reflective (B) utopian (C) luxuriant (D) unpopular

[gate2012-ae](#) [aptitude](#) [most-appropriate-word](#) [verbal-ability](#)

Answer

Answers: Most Appropriate Word

14.21.1 Most Appropriate Word: GATE-2012-AE-3 top

<http://gateoverflow.in/40214>

(D)

unpopular seems to be the most suitable alternative to unreasonable

Up 1 votes

-- Sourav Mishra (2.7k points)

14.22

Number Representation top

14.22.1 Number Representation: TIFR2012-A-11 top

<http://gateoverflow.in/25015>

Let N be the sum of all numbers from 1 to 1023 except the five prime numbers: 2, 3, 11, 17, 31. Suppose all numbers are represented using two bytes (sixteen bits). What is the value of the least significant byte (the least significant eight bits) of N ?

- a. 00000000
- b. 10101110
- c. 01000000
- d. 10000000
- e. 11000000

[tifr2012](#) [numerical-ability](#) [number-representation](#)

Answer

14.22.2 Number Representation: GATE2014-3_GA_10 [top](#)

<http://gateoverflow.in/2034>

Consider the equation:
 $(7526)_8 - (Y)_8 = (4364)_8$, where
 $(X)_N$ stands for

X to the base
 N . Find

Y .

- (A) 1634
- (B) 1737
- (C) 3142
- (D) 3162

[gate2014-3](#) [numerical-ability](#) [number-representation](#) [normal](#) [digital-logic](#)

[Answer](#)

Answers: Number Representation

14.22.1 Number Representation: TIFR2012-A-11 [top](#)

<http://gateoverflow.in/25015>



Selected Answer

This is another way of saying , what will be the remainder when N is divided by $2^8=256$?

$$\begin{aligned} \text{Here } N &= 1023*1024/2 - (2+3+11+17+31) \\ &= 1023*512 - 64 \\ &= 1022*512 + (512-64) \\ &= 1022*512 + 448 \end{aligned}$$

Now $448\%256 = 192 = 11000000$

So e. is correct.

3 votes

-- sudipta roy (289 points)

14.22.2 Number Representation: GATE2014-3_GA_10 [top](#)

<http://gateoverflow.in/2034>



Selected Answer

C)

The given numbers are in octal representation. Digits range from 0 to 7.
 $Y=7526-4364$

$$\begin{array}{r} 7526 \\ -4364 \\ \hline \end{array}$$

3142

steps : 1. $(6-4) = 2$
 2. $(2-6)$, borrow a 8. Now $(8+2-6)=4$
 3. $(5-1-3) = 1$ (Subtracted by 1 because ONE 8 was borrowed)
 4. $(7-4) = 3$

11 votes

-- Srinath Sri (2.9k points)

14.23**Number Series** top**14.23.1 Number Series: GATE2014-EC02-GA5** top<http://gateoverflow.in/41152>

Fill in the missing number in the series.

2 3 6 15 ____ 157.5 630

[gate2014-ec02](#) [number-series](#)[Answer](#)**14.23.2 Number Series: GATE2014-EC03-GA6** top<http://gateoverflow.in/41145>Find the next term in the sequence: $7G, 11K, 13M, \dots$.

- A. 15Q
- B. 17Q
- C. 15P
- D. 17P

[gate2014-ec03](#) [number-series](#) [logical-reasoning](#)[Answer](#)**14.23.3 Number Series: TIFR2013-A-15** top<http://gateoverflow.in/25438>

Let $\text{sgn}(x) = \begin{cases} +1 & \text{if } x \geq 0 \\ -1 & \text{if } x < 0 \end{cases}$

What is the value of the following summation?

$$\sum_{i=0}^{50} \text{sgn} \quad (\quad ((2i-1)(2i-3)\dots(2i-99))$$

- a. 0
- b. -1
- c. +1
- d. 25
- e. 50

[tifr2013](#) [numerical-ability](#) [number-series](#)[Answer](#)**14.23.4 Number Series: GATE2014-EC03-GA4** top<http://gateoverflow.in/41143>

The next term in the series 81, 54, 36, 24, ... is _____.

[gate2014-ec03](#) [number-series](#)[Answer](#)**14.23.5 Number Series: TIFR2013-A-8** top<http://gateoverflow.in/25430>

Find the sum of the infinite series

$$\frac{1}{1 \times 3 \times 5} + \frac{1}{3 \times 5 \times 7} + \frac{1}{5 \times 7 \times 9} + \frac{1}{7 \times 9 \times 11} + \dots$$

- a. ∞
- b. $\frac{1}{2}$
- c. $\frac{1}{6}$
- d. $\frac{1}{12}$
- e. $\frac{1}{14}$

[tifr2013](#) [numerical-ability](#) [number-series](#)

[Answer](#)

14.23.6 Number Series: GATE2014-EC01-GA5 [top](#)

<http://gateoverflow.in/41494>

What is the next number in the series?

12 35 81 173 357 _____.

[gate2014-ec01](#) [number-series](#)

[Answer](#)

14.23.7 Number Series: TIFR2014-A-7 [top](#)

<http://gateoverflow.in/25992>

Consider a sequence of non-negative numbers $x_n : n = 1, 2, \dots$. Which of the following statements cannot be true?

- a. $\sum_{n=1}^{\infty} x_n = \infty$ and $\sum_{n=1}^{\infty} x_n^2 = \infty$.
- b. $\sum_{n=1}^{\infty} x_n = \infty$ and $\sum_{n=1}^{\infty} x_n^2 < \infty$.
- c. $\sum_{n=1}^{\infty} x_n < \infty$ and $\sum_{n=1}^{\infty} x_n^2 < \infty$.
- d. $\sum_{n=1}^{\infty} x_n \leq 5$ and $\sum_{n=1}^{\infty} x_n^2 \geq 25$.
- e. $\sum_{n=1}^{\infty} x_n < \infty$ and $\sum_{n=1}^{\infty} x_n^2 = \infty$.

[tifr2014](#) [numerical-ability](#) [number-series](#)

[Answer](#)

14.23.8 Number Series: GATE2013-ee-10 [top](#)

<http://gateoverflow.in/40297>

Find the sum to 'n' terms of the series

$10 + 84 + 734 + \dots$

- A). $\frac{9(9^n+1)}{10} + 1$
- B). $\frac{9(9^n-1)}{8} + 1$
- C). $\frac{9(9^n-1)}{8} + n$
- D). $\frac{9(9^n-1)}{8} + n^2$

[gate2013-ee](#) [numerical-ability](#) [number-series](#)

[Answer](#)

14.23.9 Number Series: TIFR2011-A-8 [top](#)

<http://gateoverflow.in/20014>

The sum of the first n terms of the series $1, 11, 111, 1111, \dots$, is.

- a. $\frac{1}{81}(10^{n+1} - 9n - 10)$
- b. $\frac{1}{81}(10^n - 9n)$

- c. $\frac{1}{9}(10^{n+1} - 1)$
d. $\frac{1}{9}(10^{n+1} - n10^n)$
e. None of the above.

tifr2011 numerical-ability number-series

Answer

14.23.10 Number Series: GATE2014-3_GA_4 top

<http://gateoverflow.in/2027>

Which number does not belong in the series below?

2, 5, 10, 17, 26, 37, 50, 64

- (A) 17
(B) 37
(C) 64
(D) 26

gate2014-3 numerical-ability number-series easy

Answer

Answers: Number Series

14.23.1 Number Series: GATE2014-EC02-GA5 top

<http://gateoverflow.in/41512>



Selected Answer

2*1.5=3
3*2=6
6*2.5=15
15*3=45 is answer
45*3.5=157.5 means each time increase multiplication factor by 0.5

3 votes

-- rajan (2.1k points)

14.23.2 Number Series: GATE2014-EC03-GA6 top

<http://gateoverflow.in/41145>



Selected Answer

7G - G is the 7th alphabet
11K - K is the 11th alphabet
13M - M is the 13th alphabet
15th alphabet is O
17th alphabet is Q
Therefore A,C,D eliminated
Also, 7,11,13 are prime numbers, next prime in the sequence would be 17
Answer **Option B) 17Q**

3 votes

-- Abhilash Panicker (7k points)

14.23.3 Number Series: TIFR2013-A-15 [top](#)<http://gateoverflow.in/25438>

i=50 sgn((2i-1)(2i-3)...(2i-99))=+1 as x>=0
 i=48 sgn((2i-1)...(2i-99))=+1 as here we get -ve value for (2i-97) and (2i-99), and two -ve gives +ve value

 similarly, i=0 sgn((2i-1)...(2i-99))=+1
 so, 26 number of +1 we get value1=26....i
 i=49 sgn((2i-1)(2i-3)...(2i-99))=-1
 i=47 sgn((2i-1)(2i-3)...(2i-99))=-1
 i=45 sgn((2i-1)(2i-3)...(2i-99))=-1

 i=1 sgn((2i-1)...(2i-99))=-1
 here we get 25 no of -1, so value2=-25.....ii
 value1+value2=26-25=1

so answer will be +1

1 votes

-- srestha (27.8k points)

14.23.4 Number Series: GATE2014-EC03-GA4 [top](#)<http://gateoverflow.in/41143>

Selected Answer

We get next term in sequence by $(X/3)*2$
 $81/3 = 27*2 = 54$
 $54/3 = 18*2 = 36$
 $36/3 = 12*2 = 24$
 $24/3 = 8*2 = 16$

Answer)16

3 votes

-- Abhilash Panicker (7k points)

14.23.5 Number Series: TIFR2013-A-8 [top](#)<http://gateoverflow.in/25430>

Selected Answer

We note that:

$$\begin{aligned} \frac{1}{1 \times 3 \times 5} &= \frac{1}{4} \cdot \left(\frac{5-1}{1 \times 3 \times 5} \right) \\ &= \frac{1}{4} \cdot \left(\frac{1}{1 \times 3} - \frac{1}{3 \times 5} \right) \end{aligned}$$

Now, we can rewrite the original series as a Telescoping series and simplify as follows:

$$\begin{aligned}
 & \left(\frac{1}{1 \times 3 \times 5} + \frac{1}{3 \times 5 \times 7} + \frac{1}{5 \times 7 \times 9} + \dots \right) \\
 = & \frac{1}{4} \cdot \left(\frac{1}{1 \times 3} - \frac{1}{3 \times 5} + \frac{1}{3 \times 5} - \frac{1}{5 \times 7} + \frac{1}{5 \times 7} - \frac{1}{7 \times 9} + \dots \right) \\
 = & \frac{1}{4} \cdot \left(\frac{1}{1 \times 3} - \cancel{\frac{1}{3 \times 5}} + \cancel{\frac{1}{3 \times 5}} - \cancel{\frac{1}{5 \times 7}} + \cancel{\frac{1}{5 \times 7}} - \cancel{\frac{1}{7 \times 9}} + \dots \right) \\
 = & \frac{1}{4} \cdot \left(\frac{1}{1 \times 3} \right) \\
 = & \frac{1}{12}
 \end{aligned}$$

Hence (D) is the Answer.

9 votes

-- Leen Sharma (23k points)

14.23.6 Number Series: GATE2014-EC01-GA5 [top](#)

<http://gateoverflow.in/41494>



Selected Answer

answer is 725 bcz their diffrence is each time double

1 votes

-- rajan (2.1k points)

14.23.7 Number Series: TIFR2014-A-7 [top](#)

<http://gateoverflow.in/2592>

I think (b) could be the answer, because if summation of X_n =infinite,then summation of X_n^2 cannot be less than X_n value

0 votes

-- srestha (27.8k points)

14.23.8 Number Series: GATE2013-ee-10 [top](#)

<http://gateoverflow.in/40297>



Selected Answer

Ans). This is a arithmetico -geometric series . and the break down of each number in the sequence is as follows

$9^1 + 1, 9^2 + 3, 9^3 + 5, \dots$

Now if we use substitution method we can find the right summation formula for the above sequence.

Take for example the first two terms of the sequence and add them we will get the sum as $10 + 84 = 94$

Now consider the option D ,here we have $n = 2$, So ,we are trying to find the sum for first two numbers of the sequence.

$\frac{9(9^2-1)}{8} + 2^2 = 94$. Same procedure can used to find the sum of first three numbers in the sequence

The answer is option D

3 votes

-- ibia (717 points)

14.23.9 Number Series: TIFR2011-A-8 [top](#)

<http://gateoverflow.in/20014>



Selected Answer

$$\begin{aligned}
 S &= (1 + 11 + 111 + \dots n \text{ terms}) \\
 &= \frac{1}{9} \times (9 + 99 + 999 + \dots n \text{ terms}) \\
 &= \frac{1}{9} \quad \left(\begin{array}{l} ((10 - 1) + (100 - 1) + (\textcolor{blue}{1000} - 1) + \dots + (10^n - 1)) \\ = \frac{1}{9} \left(\frac{10^{n+1} - 10}{10 - 1} - n \right) \\ = \frac{1}{9} \left(\frac{10^{n+1} - 10 - 9n}{9} \right) \\ = \frac{10^{n+1} - 9n - 10}{81} \end{array} \right)
 \end{aligned}$$

So, the correct answer is option A.

3 votes

-- Pooja (25.9k points)

14.23.10 Number Series: GATE2014-3_GA_4 [top](#)

<http://gateoverflow.in/2027>



Selected Answer

If $a_1, a_2, a_3 \dots a_n$ is the series and $i = 1$ to n , then the series is defined as $a_i = i^2 + 1$.
i.e the i th term is 1 plus the square of i .

Series will be as follows : $1^2 + 1, 2^2 + 1, 3^2 + 1, 4^2 + 1 \dots n^2 + 1$
 $2, 5, 10, 17, 26, 37, 50, 65$

Hence 64 does not belong to the series.

4 votes

-- Srinath Sri (2.9k points)

14.24

Numerical Methods [top](#)

14.24.1 Numerical Methods: GATE-2012-AE-8 [top](#)

<http://gateoverflow.in/40219>

If a prime number on division by 4 gives a remainder of 1, then that number can be expressed as
 (A) sum of squares of two natural numbers
 (B) sum of cubes of two natural numbers
 (C) sum of square roots of two natural numbers
 (D) sum of cube roots of two natural numbers

[gate2012-ae](#) [aptitude](#) [numerical-methods](#)

Answer

Answers: Numerical Methods

14.24.1 Numerical Methods: GATE-2012-AE-8 [top](#)

<http://gateoverflow.in/40219>

we can express them as sum of square roots of 2 natural numbers definitely.

eg: 17,29,41 etc..

$17 = 9 + 8 = \text{Sq root of } 81 + \text{ Sq root of } 64$

like that we can express.

Option C is answer i guess

0 votes

-- Sreyas S (1.6k points)

$x \bmod 4 = 1$..13 can be one such number and it is also prime ..can be expressed as $2^2 + 3^2 = > 13..$

so option A seems to be the correct one

can be applied on $17 -> 4^2 + 1^2 ...$ and so on..

0 votes

-- Joker (735 points)

14.25

Odd One top

14.25.1 Odd One: gate-2014-ae-6 top

<http://gateoverflow.in/40306>

- Q.6 Find the odd one in the following group: ALRVX, EPVZB, ITZDF, OYEIK
 (A) ALRVX (B) EPVZB (C) ITZDF (D) OYEIK

Q6). Find the odd one in the following group: *ALRVX,EPVZB,ITZDF,OYEIK*

- A). *ALRVX*
- B). *EPVZB*
- C). *ITZDF*
- D). *OYEIK*

[gate-2014-ae](#) [odd-one](#)

[Answer](#)

14.25.2 Odd One: GATE 2016-2-GA-04 top

<http://gateoverflow.in/39528>

Pick the odd one from the following options.

- (A) CADBE (B) JHKIL (C) XVYWZ (D) ONPMQ

[gate2016-2](#) [verbal-ability](#) [odd-one](#) [normal](#)

[Answer](#)

Answers: Odd One

14.25.1 Odd One: gate-2014-ae-6 top

<http://gateoverflow.in/40306>

HERE OPTION D IS DIFFERENT ..

option D is the only word which consists of 2 vowels!!

So option D i guess

0 votes

-- Uddipto (4.8k points)

14.25.2 Odd One: GATE 2016-2-GA-04 [top](#)<http://gateoverflow.in/39528>

Selected Answer

Option D.

A)
 $\overbrace{C A D B E}^{3 \ 1 \ 4 \ 2 \ 5}$

B)
 $\overbrace{J H K I L}^{3 \ 1 \ 4 \ 2 \ 5}$

C)
 $\overbrace{X V Y W Z}^{3 \ 1 \ 4 \ 2 \ 5}$

They are all making sequence of 1-2-3-4-5 and as in alphabetical order

12 votes

-- Praveen Saini (38.4k points)

14.26**Passage Reading** [top](#)**14.26.1 Passage Reading: GATE 2016-2-GA-07** [top](#)<http://gateoverflow.in/39533>

Computers were invented for performing only high-end useful computations. However, it is no understatement that they have taken over our world today. The internet, for example, is ubiquitous. Many believe that the internet itself is an unintended consequence of the original invention. With the advent of mobile computing on our phones, a whole new dimension is now enabled. One is left wondering if all these developments are good or, more importantly, required.

Which of the statement(s) below is/are logically valid and can be inferred from the above paragraph?

- (i) The author believes that computers are not good for us.
- (ii) Mobile computers and the internet are both intended inventions.
- A. (i) only
- B. (ii) only
- C. Both (i) and (ii)
- D. Neither (i) nor (ii)

[gate2016-2](#) [verbal-ability](#) [passage-reading](#) [normal](#)

Answer

Answers: Passage Reading**14.26.1 Passage Reading: GATE 2016-2-GA-07** [top](#)<http://gateoverflow.in/39533>

Selected Answer

"Many believe that the internet itself is an unintended consequence of the original invention. So (ii) statement does not follow from the passage."

The author has nowhere said that the computers are bad, authoring is talking about the way computers are being used today and the author questions this way. So, (i) statement does not follow.

Hence, option (d) is the answer.

5 votes

-- Ashish Deshmukh (1.4k points)

14.27

Percent top

14.27.1 Percent: GATE2014-EC04-GA8 top

<http://gateoverflow.in/41470>

Industrial consumption of power doubled from 2000 – 2001 to 2010 – 2011. Find the annual rate of increase in percent assuming it to be uniform over the years.

- A. 5.6
- B. 7.2
- C. 10.0
- D. 12.2

[gate2014-ec04](#) [percent](#) [normal](#)

Answer

14.27.2 Percent: gate-2014-ae-9 top

<http://gateoverflow.in/40309>

Q.9 One percent of the people of country X are taller than 6 ft. Two percent of the people of country Y are taller than 6 ft. There are thrice as many people in country X as in country Y. Taking both countries together, what is the percentage of people taller than 6 ft?

- (A) 3.0 (B) 2.5 (C) 1.5 (D) 1.25

[gate-2014-ae](#) [percent](#)

Answer

Answers: Percent

14.27.1 Percent: GATE2014-EC04-GA8 top

<http://gateoverflow.in/41470>

Total price = X rs.

X rs. in 10 years rate of interest rs.X

1 rs. " 10 " " " rs $X/X=1$

1 rs. " 1 " " " rs. $1/10 \times 100 = 10$

Ans will be (C)

0 votes

-- srestha (27.8k points)

14.27.2 Percent: gate-2014-ae-9 top

<http://gateoverflow.in/40309>

people in Y=a total people in Y >6 ft=2a/100

people in X=3a total people in X >6 ft=3a/100

total people >6 ft=2a/100+3a/100=5a/100

total=a+3a=4a

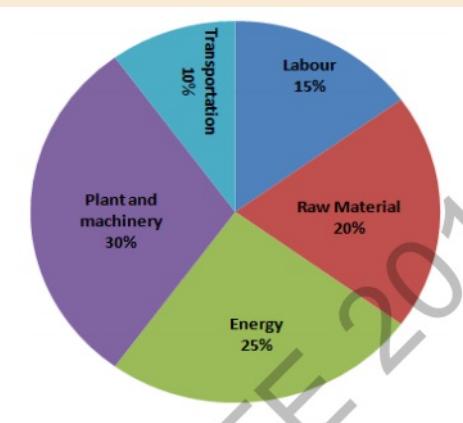
total people in (X+Y)>6 ft=(5a/100)*(100/4a)=1.25%

2 votes

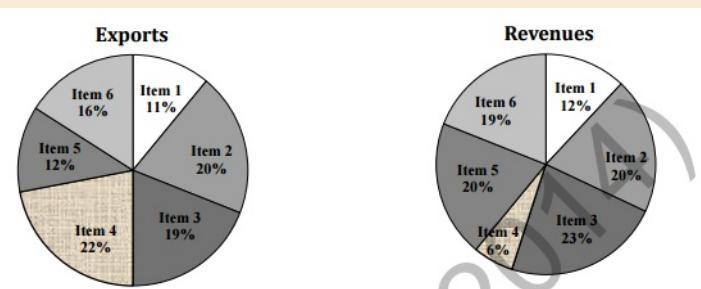
-- Sandip Shaw (821 points)

14.28**Pie Chart** top**14.28.1 Pie Chart: GATE2014-EC03-GA9** top<http://gateoverflow.in/41461>

A firm producing air purifiers sold 200 units in 2012. The following pie chart presents the share of raw material, labour, energy, plant & machinery, and transportation costs in the total manufacturing cost of the firm in 2012. The expenditure on labour in 2012 is Rs.4,50,000. In 2013, the raw material expenses increased by 30% and all other expenses increased by 20%. If the company registered a profit of Rs. 10 lakhs in 2012, at what price (in Rs) was each air purifier sold?


[gate2014-ec03](#) [numerical-ability](#) [data-interpretation](#) [pie-chart](#)
Answer**14.28.2 Pie Chart: GATE2014-EC02-GA9** top<http://gateoverflow.in/41471>

The total exports and revenues from the exports of a country are given in the two charts shown below. The pie chart for exports shows the quantity of each item exported as a percentage of the total quantity of exports. The pie chart for the revenues shows the percentage of the total revenue generated through export of each item. The total quantity of exports of all the items is 500 thousand tonnes and the total revenues are 250 crore rupees. Which item among the following has generated the maximum revenue per kg?

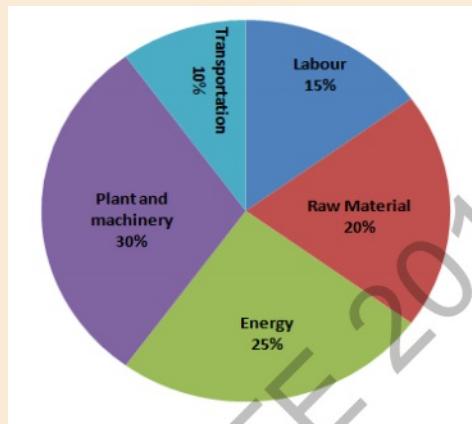


- A. Item 2
- B. Item 3
- C. Item 6
- D. Item 5

[gate2014-ec02](#) [numerical-ability](#) [data-interpretation](#) [pie-chart](#) [normal](#)
Answer**14.28.3 Pie Chart: GATE2014-EC04-GA9** top<http://gateoverflow.in/41471>

A firm producing air purifiers sold 200 units in 2012. The following pie chart presents the share of raw material, labour,

energy, plant & machinery, and transportation costs in the total manufacturing cost of the firm in 2012. The expenditure on labour in 2012 is Rs. 4,50,000. In 2013, the raw material expenses increased by 30% and all other expenses increased by 20%. What is the percentage increase in total cost for the company in 2013?



[gate2014-ec04](#) [numerical-ability](#) [data-interpretation](#) [pie-chart](#)

Answer

14.28.4 Pie Chart: GATE2014-EC03-GA7 [top](#)

<http://gateoverflow.in/41459>

The multi-level hierarchical pie chart shows the population of animals in a reserve forest. The correct conclusions from this information are:



- (i) Butterflies are birds
 - (ii) There are more tigers in this forest than red ants
 - (iii) All reptiles in this forest are either snakes or crocodiles
 - (iv) Elephants are the largest mammals in this forest
- A. (i) and (ii) only
B. (i), (ii), (iii) and (iv)
C. (i), (iii) and (iv) only
D. (i), (ii) and (iii) only

[gate2014-ec03](#) [numerical-ability](#) [data-interpretation](#) [pie-chart](#) [normal](#)

Answer

14.28.5 Pie Chart: GATE2014-EC03-GA7 [top](#)

<http://gateoverflow.in/41146>

The multi-level hierarchical pie chart shows the population of animals in a reserve forest. The correct conclusions from this information are:



- (i) Butterflies are birds
 - (ii) There are more tigers in this forest than red ants
 - (iii) All reptiles in this forest are either snakes or crocodiles
 - (iv) Elephants are the largest mammals in this forest
- A. (i) and (ii) only
 B. (i), (ii), (iii) and (iv)
 C. (i), (iii) and (iv) only
 D. (i), (ii) and (iii) only

[gate2014-ec03](#) [data-interpretation](#) [pie-chart](#)

[Answer](#)

Answers: Pie Chart

14.28.1 Pie Chart: GATE2014-EC03-GA9 [top](#)

<http://gateoverflow.in/41461>

expenditure of labour Rs.4,50,000

15% expenditure is Rs.4,50,000

then, 100% " " $Rs. 4,50,000 \times 100\% / 15\% = Rs.30,00,000$

Now, Profit Rs.10,00,000

Total selling cost $Rs.30,00,000 + 10,00,000 = Rs.40,00,000$

200 air purifier selling cost Rs.40,00,000

1 " " " " Rs.20,000

0 votes

-- srestha (27.8k points)

14.28.2 Pie Chart: GATE2014-EC02-GA9 [top](#)

<http://gateoverflow.in/41517>

D. Is true option because less export making more revenue

0 votes

-- muzaffar husain khan (37 points)

14.28.3 Pie Chart: GATE2014-EC04-GA9 [top](#)

<http://gateoverflow.in/41471>



Selected Answer

2012:

Given Expenditure on Labour is 450000, which is 15% of total cost(From Pie Chart). then

$$\text{Total Cost (X)} \Rightarrow 15\% \text{ of } X = 450000 \Rightarrow X = 3000000$$

So, Expenditure on Transportation will be 10 % of X = 300000

Expenditure on plan and Machinery will be 30% of X = 900000

Expenditure on Energy will be 25% of X = 750000

Expenditure on raw material will be 20% of X = 600000

2013:

New Expense in Raw Material will be 30% more than last year expense : $600000 + (30\% \text{ of } 600000) = 780000$

New Expense in Labour will be 20% more than last year expense : $450000 + (20\% \text{ of } 450000) = 540000$

New Expense in Transportation will be 20% more than last year expense : $300000 + (20\% \text{ of } 300000) = 360000$

New Expense in Plant and Machinery will be 20% more than last year expense : $900000 + (20\% \text{ of } 900000) = 1080000$

New Expense in Energy will be 20% more than last year expense : $750000 + (20\% \text{ of } 750000) = 900000$

Total Cost in 2013 = $(7.8 \text{ L} + 5.4 \text{ L} + 3.6 \text{ L} + 10.8 \text{ L} + 9 \text{ L}) = 3660000$

Total Increase in cost = $(3660000 - 3000000) = 660000$

Total % increase in cost = $((660000)/3000000)*100 = 22\%$.

Answer will be 22%.

Upvote 3 votes

-- Rude Maverick (22.6k points)

14.28.4 Pie Chart: GATE2014-EC03-GA7 [top](#)

<http://gateoverflow.in/41149>



Selected Answer

Ans will be (D)

pie chart is about population of animals, not about size of animals

So, (iv) is not true

(i) is true as butterfly comes under the pie birds.

(ii) is true as the pie chart portion of tigers is more than that of red ants.

(iii) is true as the pie portion corresponding to reptiles consists of only snakes and crocodiles.

Upvote 2 votes

-- srestha (27.8k points)

14.28.5 Pie Chart: GATE2014-EC03-GA7 [top](#)

<http://gateoverflow.in/41146>



Selected Answer

The ivth statement cannot be inferred from the pie chart. Rest all can be
Answer Option D) i, ii, iii only

Upvote 3 votes

-- Abhilash Panicker (7k points)

14.29

Polynomials top**14.29.1 Polynomials: GATE2016-1-GA09** top<http://gateoverflow.in/39611>

If $f(x) = 2x^7 + 3x - 5$, which of the following is a factor of $f(x)$?

- A. $(x^3 + 8)$
- B. $(x - 1)$
- C. $(2x - 5)$
- D. $(x + 1)$

[gate2016-1](#) [numerical-ability](#) [polynomials](#) [normal](#)
Answer**Answers: Polynomials****14.29.1 Polynomials: GATE2016-1-GA09** top<http://gateoverflow.in/39611>

Selected Answer

for
 $x = 1$,

$$f(1) = 2(1)^7 + 3(1) - 5 = 0$$

so
 $x = 1$ is a root for
 $f(x)$

so $(x - 1)$ is factor

12 votes

-- Pooja (25.9k points)

14.30

Probability top**14.30.1 Probability: GATE2014-EC02-GA4** top<http://gateoverflow.in/41511>

A regular die has six sides with numbers 1 to 6 marked on its sides. If a very large number of throws show the following frequencies of occurrence: 1 → 0.167; 2 → 0.167; 3 → 0.152; 4 → 0.166; 5 → 0.168; 6 → 0.180. We call this die:

- A. Irregular
- B. Biased
- C. Gaussian
- D. Insufficient

[gate2014-ec02](#) [numerical-ability](#) [probability](#) [normal](#)
Answer**14.30.2 Probability: GATE2014-EC03-GA10** top<http://gateoverflow.in/41462>

A batch of one hundred bulbs is inspected by testing four randomly chosen bulbs. The batch is rejected if even one of the bulbs is defective. A batch typically has five defective bulbs. The probability that the current batch is accepted is_____.

[gate2014-ec03](#) [numerical-ability](#) [probability](#) [numerical-answers](#) [normal](#)
Answer

14.30.3 Probability: GATE2015-1_GA_10 [top](#)

<http://gateoverflow.in/8014>

The probabilities that a student passes in mathematics, physics and chemistry are m, p and c respectively. Of these subjects, the student has 75% chance of passing in at least one, a 50% chance of passing in at least two and a 40% chance of passing in exactly two. Following relations are drawn in m, p, c :

- I. $p + m + c = 27/20$
- II. $p + m + c = 13/20$
- III. $(p) \times (m) \times (c) = 1/10$

- A. Only relation I is true.
- B. Only relation II is true.
- C. Relations II and III are true.
- D. Relations I and III are true.

[gate2015-1](#) [numerical-ability](#) [probability](#)
Answer

14.30.4 Probability: gate2013-ee-6 [top](#)

<http://gateoverflow.in/40293>

Q.61 What is the chance that a leap year, selected at random, will contain 53 Saturdays?
 (A) 2/7 (B) 3/7 (C) 1/7 (D) 5/7

[gate2013-ee](#) [numerical-ability](#) [probability](#)
Answer

14.30.5 Probability: GATE2012-CY-GA-7 [top](#)

<http://gateoverflow.in/4173>

A and B are friends. They decide to meet between 1:00 pm and 2:00 pm on a given day. There is a condition that whoever arrives first will not wait for the other for more than 15 minutes. The probability that they will meet on that day is

- A. 1/4
- B. 1/16
- C. 7/16
- D. 9/16

[gate2012-cy](#) [aptitude](#) [numerical-ability](#) [probability](#)
Answer

14.30.6 Probability: GATE2014-AG-GA4 [top](#)

<http://gateoverflow.in/41668>

In any given year, the probability of an earthquake greater than Magnitude 6 occurring in the Garhwal Himalayas is 0.04. The average time between successive occurrences of such earthquakes is ____ years.

[gate2014-ag](#) [numerical-ability](#) [probability](#) [numerical-answers](#) [normal](#)
Answer

14.30.7 Probability: GATE-2012-AE-6 [top](#)

<http://gateoverflow.in/40217>

Two policemen, A and B, fire once each at the same time at an escaping convict. The probability that A hits the convict is three times the probability that B hits the convict. If the probability of the convict not getting injured is 0.5, the probability that B hits the convict is

- (A) 0.14 (B) 0.22 (C) 0.33 (D) 0.40

gate2012-ae aptitude numerical-ability probability

[Answer](#)

14.30.8 Probability: Gate 2015 Aptitude Set 8 Q5 [top](#)

<http://gateoverflow.in/40180>

Four cards are randomly selected from a pack of 52 cards. If the first two cards are kings, what is the probability that the third card is a king?

- (A) 4/52 (B) 2/50 (C) (1/52)×(1/52) (D) (1/52)×(1/51) ×(1/50)

gate2015aptiset8 numerical-ability probability easy

[Answer](#)

14.30.9 Probability: GATE2015-1_GA_3 [top](#)

<http://gateoverflow.in/8004>

Given Set A= {2, 3, 4, 5} and Set B= { 11, 12, 13, 14, 15}, two numbers are randomly selected, one from each set. What is the probability that the sum of the two numbers equals 16?

- A. 0.20
- B. 0.25
- C. 0.30
- D. 0.33

gate2015-1 numerical-ability probability normal

[Answer](#)

Answers: Probability

14.30.1 Probability: GATE2014-EC02-GA4 [top](#)

<http://gateoverflow.in/41511>



Selected Answer

For a very large number of throws, the frequency should be same for an unbiased die.

But given frequencies are not same, hence the die is biased.Hence, option B.

1 votes

-- Ashish Gupta (671 points)

14.30.2 Probability: GATE2014-EC03-GA10 [top](#)

<http://gateoverflow.in/41462>



Selected Answer

In a batch there are total 100 bulbs of which
95 are working
5 are defective.

$$P(\text{Selecting 4 working bulbs}) = \frac{95}{100} * \frac{94}{99} * \frac{93}{98} * \frac{92}{97} = 0.81$$

1 votes

-- Abhilash Panicker (7k points)

14.30.3 Probability: GATE2015-1_GA_10 [top](#)

<http://gateoverflow.in/8014>



Selected Answer

Probability of non pass = 1 - Probability of at least one pass = 1 - 0.75 = 0.25

$$(1-m)(1-p)(1-c) = 0.25$$

$$(1 + mp - m - p)(1-c) = 0.25$$

$$1 + mp - m - p - c - mpc + mc + pc = 0.25$$

$$\mathbf{m + p + c - mp - pc - mc + mpc = 0.75 \text{ -- (1)}}$$

Probability of exactly 2 pass = 0.4

$$mp(1-c) + pc(1-m) + mc(1-p) = 0.4$$

$$mp + pc + mc - 3mpc = 0.4$$

mp + pc + mc - 2mpc = 0.5 -- (2) (Adding the probability of all pass to probability of exactly 2 pass gives probability of at least 2 pass)

So, **mpc = 0.1, -- (3)**

From (2) and (3),

$$\mathbf{mp + pc + mc - mpc = 0.6 \text{ -- (4)}}$$

From (1) and (4)

$$m + p + c = 0.75 + 0.6$$

$$m + p + c = 1.35 = 135/100 = 27/20$$

So, D option

4 votes

-- Arjun Suresh (150k points)

14.30.4 Probability: gate2013-ee-6 top

<http://gateoverflow.in/40293>



Selected Answer

sample space is S : {Monday-Tuesday, Tuesday-Wednesday, Wednesday-Thursday,..., Sunday-Monday}

Number of elements in S = n(S) = 7

What we want is a set A (say) that comprises of the elements Saturday-Sunday and Friday-Saturday

Number of elements in set A = n(A) = 2

By definition, probability of occurrence of A = n(A)/n(S) = 2/7

Therefore, probability that a leap year has 53 Saturdays is 2/7.

3 votes

-- Pooja (25.9k points)

14.30.5 Probability: GATE2012-CY-GA-7 top

<http://gateoverflow.in/41173>



Selected Answer

Meeting occurs if the first person arrives between 1:00 and 1:45 and the second person arrives in the next 15 minutes or if both the persons arrive between 1:45 and 2:00.

Case 1:

- 45/60 are favourable cases and hence probability of first person arriving between 1:00 and 1:45 is 3/4.
- Probability of second person arriving in the next 15 minutes = 15/60 = 1/4
- So, probability of one person arriving between 1:00 and 1:45 and meeting the other = $3/4 * 1/4 * 2 = 3/8$ (2 for choosing the first arriving friend)

Case 2:

- Both friends must arrive between 1:45 and 2:00. So, probability = $1/4 * 1/4 = 1/16$

So, probability of a meet = $3/8 + 1/16 = 7/16$

5 votes

-- Arjun Suresh (150k points)

14.30.6 Probability: GATE2014-AG-GA4 [top](#)

<http://gateoverflow.in/41668>



Selected Answer

probability of an earthquake greater than Magnitude 6 is 0.04.

This means 4 out of 100 years will face an earthquake greater than Magnitude 6. So average time between successive earthquakes will be $100/4=25$ years

1 votes

-- Aditya Sharma (719 points)

14.30.7 Probability: GATE-2012-AE-6 [top](#)

<http://gateoverflow.in/40277>



Selected Answer

X - A hits the convict

Y - B hits the convict

Given, $P(X) = 3 * P(Y)$

Z - Convict is injured

Z' - Convict is not injured

Given, $P(Z') = 0.5$

$P(Z) = 1 - P(Z')$

$P(Z) = 1 - 0.5 = 0.5$

Now,

$$P(Z) = P(X) * P(Y') + P(X') * P(Y) + P(X) * P(Y)$$

Let

$$P(Y) = t$$

$$P(X) = 3t$$

$$P(Y') = 1-t$$

$$P(X') = 1-3t$$

Substituting in above equation,

$$0.5 = (3t * (1-t)) + ((1-3t) * t) + (t * 3t)$$

$$\Rightarrow 3t - 3t^2 + t - 3t^2 + 3t^2 = 0.5$$

$$\Rightarrow 3t^2 - 4t + 0.5 = 0$$

$$\Rightarrow 6t^2 - 8t + 1 = 0$$

Solving, we get

$t=1.193$ (eliminated as probability cannot be greater than 1) OR $t=0.1396$

Therefore. $P(Y) = t = 0.1396$

Answer A) 0.14

Alternative Method: by Joker :P

$$P(Z')=0.5$$

Now,

$$P(Z') = (P(X') * P(Y'))$$

$$\Rightarrow 0.5 = (1-t) * (1-3t)$$

Solving this gives the same equation as above.

$$6t^2 - 8t + 1 = 0$$

and the same answer

3 votes

-- Abhilash Panicker (7k points)

14.30.8 Probability: Gate 2015 Aptitude Set 8 Q5 top<http://gateoverflow.in/40180>

Selected Answer

There are 4 kings in a pack of 52 cards.
If 2 cards are selected and both are kings, remaining cards will be 50 out of which 2 will be kings.

so ans is b

2 votes

-- Pooja (25.9k points)

14.30.9 Probability: GATE2015-1_GA_3 top<http://gateoverflow.in/8004>

Selected Answer

option A because total combination is $5*4=20$ and out 20 we have only 4 combination of which have sum 16
 2,14
 3,13
 4,12
 5,11

4 votes

-- Anoop Sonkar (4.5k points)

14.31**Proportions** top**14.31.1 Proportions: GATE2016-1-GA10** top<http://gateoverflow.in/39612>

In a process, the number of cycles to failure decreases exponentially with an increase in load. At a load of 80 units, it takes 100 cycles for failure. When the load is halved, it takes 10000 cycles for failure. The load for which the failure will happen in 5000 cycles is _____.

- A. 40.00
- B. 46.02
- C. 60.01
- D. 92.02

[gate2016-1](#) [numerical-ability](#) [proportions](#) [normal](#)

Answer

Answers: Proportions**14.31.1 Proportions: GATE2016-1-GA10** top<http://gateoverflow.in/39612>

Selected Answer

The number of cycles to failure decrease exponentially with an increase in load.
so we have general equation

$$y = ae^{-bx}$$

where

y is number of cycles to failure, and
 x is load.

At load of 80 units , it takes 100 cycles for failure.

$$100 = ae^{-80b} \quad \text{---(1)}$$

when load is halved it takes
10000 cycles for failure.

$$10000 = ae^{-40b} \quad \text{---(2)}$$

Divide (2) by (1)

$$e^{40b} = 100$$

$$b = \frac{\log_e 100}{40} \quad \text{--- (3)}$$

At

5000 cycles to failure

$$5000 = ae^{-xb} \quad \text{---(4)}$$

divide (2) by (4)

$$e^{b(x-40)} = 2$$

$$b(x - 40) = \log_e 2$$

$$\frac{\log_e 100}{40} \times (x - 40) = \log_e 2 \quad \dots\dots (\text{using (3)})$$

$$x = 40 \times \frac{(\log_e 2 + \log_e 100)}{\log_e 100}$$

$$x = 40 \times \frac{\log_e 200}{\log_e 100}$$

$$x = 46.02$$

16 votes

-- Praveen Saini (38.4k points)

14.32

Quadratic Equations top

14.32.1 Quadratic Equations: GATE 2016-2-GA-05 top

<http://gateoverflow.in/39532>

In a quadratic function, the value of the product of the roots (α, β) is 4. Find the value of

$$\frac{\alpha^n + \beta^n}{\alpha^{-n} + \beta^{-n}}$$

- A. n^4
- B. 4^n
- C. 2^{2n-1}
- D. 4^{n-1}

gate2016-2 numerical-ability quadratic-equations normal

Answer

Answers: Quadratic Equations

14.32.1 Quadratic Equations: GATE 2016-2-GA-05 top

<http://gateoverflow.in/39532>



Selected Answer

$$\begin{aligned} & \frac{\alpha^n + \beta^n}{\alpha^{-n} + \beta^{-n}} \\ &= \frac{\alpha^n + \beta^n}{\left(\frac{1}{\alpha^n} + \frac{1}{\beta^n}\right)} \\ &= \frac{\alpha^n + \beta^n}{\left(\frac{\alpha^n + \beta^n}{\alpha^n \beta^n}\right)} \\ &= (\alpha \beta)^n \\ &= 4^n \end{aligned}$$

as product of roots,
 $\alpha \beta = 4$

11 votes

-- Praveen Saini (38.4k points)

14.33

Ratios top

14.33.1 Ratios: TIFR2014-A-2 top

<http://gateoverflow.in/25987>

A body at a temperature of 30 Celsius is immersed into a heat bath at 0 Celsius at time $t = 0$. The body starts cooling at a rate proportional to the temperature difference. Assuming that the heat bath does not change in temperature throughout the process, calculate the ratio of the time taken for the body to reach 1 Celsius divided by the time taken for the body to reach 5 Celsius.

- a. $\log 5$.
- b. $\frac{\log 29}{\log 25}$.
- c. e^5 .
- d. $1 + \log_6 5$.
- e. None of the above.

[tifr2014](#) [numerical-ability](#) [ratios](#)

Answer

14.33.2 Ratios: GATE2013-AE-GA-1 top

<http://gateoverflow.in/40242>

If $3 \leq X \leq 5$ and $8 \leq Y \leq 11$ then which of the following options is TRUE?

- A. $\frac{3}{5} \leq \frac{X}{Y} \leq \frac{8}{5}$
- B. $\frac{3}{11} \leq \frac{X}{Y} \leq \frac{5}{8}$
- C. $\frac{3}{11} \leq \frac{X}{Y} \leq \frac{8}{5}$
- D. $\frac{3}{5} \leq \frac{X}{Y} \leq \frac{8}{11}$

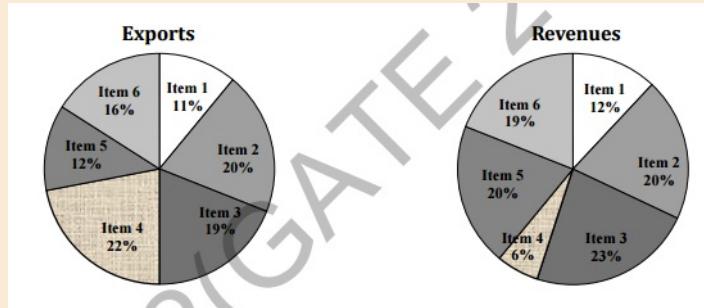
[gate2013-ae](#) [numerical-ability](#) [ratios](#) [normal](#)

Answer

14.33.3 Ratios: GATE2014-AG-GA8 top

<http://gateoverflow.in/41672>

The total exports and revenues from the exports of a country are given in the two pie charts below. The pie chart for exports shows the quantity of each item as a percentage of the total quantity of exports. The pie chart for the revenues shows the percentage of the total revenue generated through export of each item. The total quantity of exports of all the items is 5 lakh tonnes and the total revenues are 250 crore rupees. What is the ratio of the revenue generated through export of Item 1 per kilogram to the revenue generated through export of Item 4 per kilogram?



- A. 1 : 2
- B. 2 : 1
- C. 1 : 4
- D. 4 : 1

gate2014-ag numerical-ability data-interpretation pie-chart ratios normal

[Answer](#)

Answers: Ratios

14.33.1 Ratios: TIFR2014-A-2 [top](#)

<http://gateoverflow.in/25987>



Selected Answer

Let's say the Temperature of body at time t be T_t , which means $T_0 = 30$.

Now let the time at which temperature is 5 be t_1 , which means $T_{t_1} = 5$

and the time at which temperature is 1 be t_2 , which means $T_{t_2} = 1$.

Question Asks us to find t_2/t_1 ..

Now, Temperature decrease(D) at time $t \propto$ Body Temperature - Bath Temperature

$$D \propto T_t \quad \{ \text{As Bath Temp. is } 0 \text{ & Body Temp. is } T_t \}$$

$$D = k * T_t \quad \{ \text{where } k \text{ is proportionality constant} \}$$

$$\text{now, it gives } T_{t+1} = T_t - D = T_t - k * T_t = (1-k) T_t$$

$$T_0 = 30$$

$$T_1 = 30(1-k)$$

$$T_2 = 30(1-k)^2$$

$$T_{t_1} = 30(1-k)^{t_1} \quad \& \quad T_{t_2} = 30(1-k)^{t_2}$$

$$\Rightarrow 30(1-k)^{t_1} = 5 \Rightarrow t_1 * \log(1-k) = \log(5/30) = \log(1/6)$$

$$\text{Similarly } \Rightarrow t_2 * \log(1-k) = \log(1/30)$$

$$\Rightarrow t_2 / t_1 = \log(1/30) / \log(1/6) = \log(30^{-1}) / \log(6^{-1}) = \log(30) / \log(6) = \log_6 30$$

$= \log_6 (6*5) = \log_6 6 + \log_6 5 = 1 + \log_6 5$ which is **OPTION (D)** ..

2 votes

-- Himanshu Agarwal (9,8k points)

14.33.2 Ratios: GATE2013-AE-GA-1 [top](#)



Selected Answer

$x/y = \text{minimum}$ for the given range if x is minimum possible & y is maximum possible i.e. $3/11$

$x/y = \text{maximum}$ for the given range if x is maximum possible & y is minimum possible i.e. $5/8$

So, answer is (B)

4 votes

-- Vivek Srivastava (415 points)

14.33.3 Ratios: GATE2014-AG-GA8 [top](#)

<http://gateoverflow.in/41672>

for item1

exports $500000 \times 11/100 = 55000$

revenues $2500000000 \times 12/100 = 300000000$

When export 55 kg revenue 30,00,00,000

1 " " **5454545.4545**

for item 4

export $500000 \times 22/100 = 110000$

revenues $2500000000 \times 6/100 = 15,00,00,000$

110 kg then revenue 15,00,00,000

1 " " **1363636.36364**

item1 revenue/kg : item4 revenue/kg = 4:1

0 votes

-- srestha (27,8k points)

14.34

Sequence [top](#)

14.34.1 Sequence: GATE2012_65 [top](#)

<http://gateoverflow.in/2213>

Given the sequence of terms, AD CG FK JP, the next term is

- (A) OV
- (B) OW
- (C) PV
- (D) PW

[gate2012](#) [numerical-ability](#) [sequence](#) [easy](#)

Answer

14.34.2 Sequence: TIFR2013-A-19 [top](#)

<http://gateoverflow.in/25500>

Consider a sequence of numbers $(\epsilon_n : n = 1, 2, \dots)$, such that $\epsilon_1 = 10$ and

$$\epsilon_{n+1} = \frac{20\epsilon_n}{20 + \epsilon_n}$$

for $n \geq 1$. Which of the following statements is true?

Hint: Consider the sequence of reciprocals.

- a. The sequence $(\epsilon_n : n = 1, 2, \dots)$ converges to zero.
- b. $\epsilon_n \geq 1$ for all n
- c. The sequence $(\epsilon_n : n = 1, 2, \dots)$ is decreasing and converges to 1.
- d. The sequence $(\epsilon_n : n = 1, 2, \dots)$ is decreasing and then increasing. Finally it converges to 1.
- e. None of the above.

[tifr2013](#) [numerical-ability](#) [sequence](#)

[Answer](#)

14.34.3 Sequence: GATE2014-EC04-GA6 [top](#)

<http://gateoverflow.in/41468>

Find the next term in the sequence: 13M, 17Q, 19S, _____.

- A. 21W
- B. 21V
- C. 23W
- D. 23V

[gate2014-ec04](#) [numerical-ability](#) [sequence](#) [normal](#)

[Answer](#)

14.34.4 Sequence: GATE2014-EC04-GA5 [top](#)

<http://gateoverflow.in/41467>

In a sequence of 12 consecutive odd numbers, the sum of the first 5 numbers is 425. What is the sum of the last 5 numbers in the sequence?

[gate2014-ec04](#) [numerical-ability](#) [sequence](#) [normal](#)

[Answer](#)

Answers: Sequence

14.34.1 Sequence: GATE2012_65 [top](#)

<http://gateoverflow.in/2213>



Selected Answer

- A. OV
- AD - difference 2 (B,C)
- CG - difference 3 (D,E,F)
- FK - difference 4 and JP - difference 5
- so next term will have 6 difference
- again each term starts with preceding term's 2nd last letter
- so JKLMNOP , next term will start with O and having 6 difference it will be OV

7 votes

-- shreya ghosh (2.9k points)

14.34.2 Sequence: TIFR2013-A-19 [top](#)<http://gateoverflow.in/25500>

Selected Answer

ε_1 is positive.

In the formula for ε_{n+1} , we only add, multiply and divide positive numbers. Thus, all ε_n are positive.

Also, $\varepsilon_{n+1} < \varepsilon_n$

Proof:

$$\begin{aligned}\varepsilon_{n+1} - \varepsilon_n &= \frac{20 \cdot \varepsilon_n}{20 + \varepsilon_n} - \varepsilon_n \\ &= \frac{20 \cdot \varepsilon_n - 20 \cdot \varepsilon_n - (\varepsilon_n)^2}{20 + \varepsilon_n} \\ &= \frac{-(\varepsilon_n)^2}{20 + \varepsilon_n} \\ &< 0 \\ \hline \varepsilon_{n+1} - \varepsilon_n &< 0 \\ \varepsilon_{n+1} &< \varepsilon_n\end{aligned}$$

Thus, the sequence is decreasing.

Since the sequence is decreasing and is bounded below by 0, we know that the sequence converges (Monotone Convergence Theorem).

The only fixed point of the sequence can be found as follows:

$$\begin{aligned}\varepsilon_f &= \frac{20 \cdot \varepsilon_f}{20 + \varepsilon_f} \\ 20 \cdot \varepsilon_f + (\varepsilon_f)^2 &= 20 \cdot \varepsilon_f \\ (\varepsilon_f)^2 &= 0 \\ \varepsilon_f &= 0\end{aligned}$$

Hence, the sequence converges to 0.

Option a is correct.

1 votes

-- Pragy Agarwal (14.4k points)

14.34.3 Sequence: GATE2014-EC04-GA6 [top](#)<http://gateoverflow.in/41468>

Selected Answer

13,17,19, 23 All are prime numbers

13th alphabet M

17th alphabet Q

19th alphabet S

23th alphabet W

Answer C) 23W

1 votes

-- Abhilash Panicker (7k points)

14.34.4 Sequence: GATE2014-EC04-GA5 [top](#)

<http://gateoverflow.in/41467>



Selected Answer

Let a be the first odd number..
So the terms of sequence would be

$$a, a+2, a+4, a+6, \dots, a+20, a+22$$

Sum of first 5 terms = $a + a+2 + a+4 + a+6 + a+8 = 5a+20 = 425$
We get, $5a = 405$
 $a = 81$

$$\text{Sum of last 5 terms is } = a+22 + a+20 + a+18 + a+16 + a+14 \\ = 5a + 90$$

now we have $a = 81$. Substituting it we get.
Answer as $5*81 + 90 = 405 + 90 = 495$

Answer) 495

2 votes

-- Abhilash Panicker (7k points)

14.35

Sets [top](#)

14.35.1 Sets: GATE 2016-2-GA-06 [top](#)

<http://gateoverflow.in/39536>

Among 150 faculty members in an institute, 55 are connected with each other through Facebook and 85 are connected through Whatsapp. 30 faculty members do not have Facebook or Whatsapp accounts. The numbers of faculty members connected only through Facebook accounts is _____.

- A. 35
- B. 45
- C. 65
- D. 90

[gate2016-2](#) [numerical-ability](#) [sets](#) [easy](#)

Answer

Answers: Sets

14.35.1 Sets: GATE 2016-2-GA-06 [top](#)

<http://gateoverflow.in/39536>



Selected Answer

Let
 F denotes Facebook users,
 W denotes Whatsapp users ,
 F' denotes those not using Facebook, and
 W' denotes those not using Whatsapp.
 U denotes universal set.

Total faculties in institute,
 $n(U) = 150$

Facebook users,
 $n(F) = 55$

Whatsapp users,
 $n(W) = 85$

Faculty members not using Facebook or Whatsapp
 $n(F' \cap W') = 30$

Faculty members using either Facebook or Whatsapp

$$n(F \cup W) = n(U) - n(F' \cap W') = 150 - 30 = 120$$

Faculty members using both Facebook and Whatsapp

$$n(F \cap W) = n(F) + n(W) - n(F \cup W) = 55 + 85 - 120 = 20$$

Faculty members using Facebook only

$$n(F \cap W') = n(F) - n(F \cap W) = 55 - 20 = 35$$

12 votes

-- Praveen Saini (38.4k points)

14.36

Speed top

14.36.1 Speed: GATE-2013-AE-GA-6 top

<http://gateoverflow.in/40247>

Q.61 Velocity of an object fired directly in upward direction is given by

$$V=80$$

$$-32$$

t , where

t (time) is in seconds. When will the velocity be between 32 m/sec and 64 m/sec?

- (A) (1, 3/2) (B) (1/2, 1)
- (C) (1/2, 3/2) (D) (1, 3)

[gate2013-ae](#) [numerical-ability](#) [speed](#)

[Answer](#)

14.36.2 Speed: gate2013-ee-9 top

<http://gateoverflow.in/40296>

A car travels 8 km in the first quarter of an hour, 6 km in the second quarter and 16 km in the third quarter. The average speed of the car in km per hour over the entire journey is

- (A) 30 (B) 36 (C) 40 (D) 24

[gate2013-ee](#) [speed](#) [distance-time](#) [numerical-ability](#)

[Answer](#)

Answers: Speed

14.36.1 Speed: GATE-2013-AE-GA-6 top

<http://gateoverflow.in/40247>



Selected Answer

Given $32 < 80 - 32t < 64$

$$-48 < -32t < -16$$

$48 > 32 \ t > 16$

$3/2 > t > 1/2$

so ans (1
/2 , 3
/2) option c)

1 votes

-- sonam vyas (8.1k points)

14.36.2 Speed: gate2013-ee-9 top

<http://gateoverflow.in/40296>



Selected Answer

40km/hr

2 votes

-- khamer (407 points)

14.37

Statistics top

14.37.1 Statistics: GATE2012_64 top

<http://gateoverflow.in/2212>

Which of the following assertions are **CORRECT**?

P: Adding 7 to each entry in a list adds 7 to the mean of the list

Q: Adding 7 to each entry in a list adds 7 to the standard deviation of the list

R: Doubling each entry in a list doubles the mean of the list

S: Doubling each entry in a list leaves the standard deviation of the list unchanged

- (A) P, Q
- (B) Q, R
- (C) P, R
- (D) R, S

[gate2012](#) [numerical-ability](#) [statistics](#) [normal](#)

[Answer](#)

Answers: Statistics

14.37.1 Statistics: GATE2012_64 top

<http://gateoverflow.in/2212>



Selected Answer

Suppose we double each entry of a list

$$\text{Initial Mean } (M_I) = \frac{\sum_{i=1}^n x_i}{n}$$

$$\text{New Mean } (M_N) = \frac{\sum_{i=1}^n 2 \times x_i}{n}$$

$$= \frac{2}{n} \sum_{i=1}^n x_i$$

So, when each entry in the list is doubled, mean also gets doubled.

$$\text{Standard Deviation } \sigma_I = \sqrt{\sum_{i=1}^n (M_I - x_i)^2}$$

$$\begin{aligned}\text{New Standard Deviation } \sigma_N &= \sqrt{\sum_{i=1}^n (M_N - 2 \times x_i)^2} \\ &= \sqrt{\sum_{i=1}^n (2 \times (M_I - x_i))^2} \\ &= 2\sigma_I\end{aligned}$$

So, when each entry is doubled, standard deviation also gets doubled.

When we add a constant to each element of the list, it gets added to the mean as well. This can be seen from the formula of mean.

When we add a constant to each element of the list, the standard deviation (or variance) remains unchanged. This is because, the mean also gets added by the same constant and hence the deviation from the mean remains the same for each element.

So, here P and R are correct.

12 votes

-- Arjun Suresh (150k points)

14.38

System Of Equations

14.38.1 System Of Equations: GATE2011_GG_GA_6

<http://gateoverflow.in/40207>

Q.61 The number of solutions for the following system of inequalities is
 $X_1 \geq 0$
 $X_2 \geq 0$
 $X_1 + X_2 \leq 10$
 $2X_1 + 2X_2 \geq 22$

- (A) 0 (B) infinite (C) 1 (D) 2

gate2011_gg numerical-ability system-of-equations

Answer

Answers: System Of Equations

14.38.1 System Of Equations: GATE2011_GG_GA_6

<http://gateoverflow.in/40207>

$$\begin{array}{ll} X_1 \geq 0 & \dots[1] \\ X_2 \geq 0 & \dots[2] \\ X_1 + X_2 \leq 10 & \dots[3] \\ 2X_1 + 2X_2 \geq 22 & \dots[4] \end{array}$$

Now the equation [4] can be written as

$$X_1 + X_2 \geq 11 \quad \dots[5]$$

Now equation [3] and [5] cannot hold true together since $X_1 \geq 0$ and $X_2 \geq 0$.

Hence system of inequalities can never be satisfied.
Hence **Answer A)0**

14.39

Variance top

14.39.1 Variance: GATE2014-EC01-GA4 top

<http://gateoverflow.in/41493>

The statistics of runs scored in a series by four batsmen are provided in the following table. Who is the most consistent batsman of these four?

| Batsman | Average | Standard deviation |
|---------|---------|--------------------|
| K | 31.2 | 5.21 |
| L | 46.0 | 6.35 |
| M | 54.4 | 6.22 |
| N | 17.9 | 5.90 |

- A. K
- B. L
- C. M
- D. N

[gate2014-ec01](#) [statistics](#) [variance](#)

Answer

Answers: Variance

14.39.1 Variance: GATE2014-EC01-GA4 top

<http://gateoverflow.in/41493>

I think the answer is A. K

Average only gives the mean value, Standard Deviation gives how close to mean value (consistency) of a sample population distribution.

A standard deviation close to 0 means very close to mean value of a distribution.

Here K has the lowest SD (5.21)

14.39

-- Sourav Mishra (2.7k points)

15 General Aptitude Verbal Ability (155) top

15.0.1 Gate 2015 Aptitude Set 8 Q9 top

<http://gateoverflow.in/40185>

Q.9 Read the following table giving sales data of five types of batteries for years 2006 to 2012:

| Year | Type I | Type II | Type III | Type IV | Type V |
|------|--------|---------|----------|---------|--------|
| 2006 | 75 | 144 | 114 | 102 | 108 |
| 2007 | 90 | 126 | 102 | 84 | 126 |
| 2008 | 96 | 114 | 75 | 105 | 135 |
| 2009 | 105 | 90 | 150 | 90 | 75 |
| 2010 | 90 | 75 | 135 | 75 | 90 |
| 2011 | 105 | 60 | 165 | 45 | 120 |
| 2012 | 115 | 85 | 160 | 100 | 145 |

Out of the following, which type of battery achieved highest growth between the years 2006 and 2012?

- (A) Type V
- (B) Type III
- (C) Type II
- (D) Type I

Q.9). Read the following table giving sales data of five types of batteries for years 2006 to 2012:

| Year | Type I | Type II | Type III | Type IV | Type V |
|------|--------|---------|----------|---------|--------|
| 2006 | 75 | 144 | 114 | 102 | 108 |
| 2007 | 90 | 126 | 102 | 84 | 126 |
| 2008 | 96 | 114 | 75 | 105 | 135 |
| 2009 | 105 | 90 | 150 | 90 | 75 |
| 2010 | 90 | 75 | 135 | 75 | 90 |
| 2011 | 105 | 60 | 165 | 45 | 120 |
| 2012 | 115 | 85 | 160 | 100 | 145 |

Out of the following , which type of battery achieved highest growth between the years 2006 and 2012?

- A). Type V
- B). Type III
- C). Type II
- D), Type I

gate2015aptiset8 aptitude

Answer

15.0.2 GATE2015-2_GA_10 top

<http://gateoverflow.in/8041>

Out of the following 4 sentences, select the most suitable sentence with respect to grammar and usage:

- A. Since the report lacked needed information, it was of no use to them.
- B. The report was useless to them because there were no needed information in it.
- C. Since the report did not contain the needed information, it was not real useful to them.
- D. Since the report lacked needed information, it would not had been useful to them.

[gate2015-2](#) [verbal-ability](#) [normal](#)**Answer****15.0.3 GATE 2012 CY Q 57** [top](#)<http://gateoverflow.in/32298>

Q.60 Choose the most appropriate alternative from the options given below to complete the following sentence:

If the tired soldier wanted to lie down, he ____ the mattress out on the balcony.

- (A) should take
- (B) shall take
- (C) should have taken
- (D) will have taken

[gate-cy-2012](#) [verbal-ability](#)**Answer****15.0.4 GATE2012-AR-1** [top](#)<http://gateoverflow.in/40222>

Which one of the following options is the closest in meaning to the word given below?

Pacify

- (A) Excite
- (B) Soothe
- (C) Deplete
- (D) Tire

[gate2012-ar](#) [aptitude](#) [verbal-ability](#)**Answer****15.0.5 GATE2011_GG_GA_2** [top](#)<http://gateoverflow.in/40203>

Q.57 Choose the word from the options given below that is most nearly opposite in meaning to the given word:

Polemical

- (A) imitative
- (B) conciliatory
- (C) truthful
- (D) ideological

[gate2011_gg](#) [verbal-ability](#)**Answer****15.0.6 GATE2015-1_GA_1** [top](#)<http://gateoverflow.in/7995>

Didn't you buy ____ when you went shopping?

- A. any paper
- B. much paper
- C. no paper
- D. a few paper

[gate2015-1](#) [verbal-ability](#) [easy](#)**Answer**

15.0.7 GATE2015-1_GA_2 [top](#)<http://gateoverflow.in/8003>

Which of the following options is the closest in meaning of the sentence below?

She enjoyed herself immensely at the party.

- A. She had a terrible time at the party
- B. She had a horrible time at the party
- C. She had a terrific time at the party
- D. She had a terrifying time at the party

[gate2015-1](#) [verbal-ability](#) [easy](#)

Answer

15.0.8 GATE2015-1_GA_5 [top](#)<http://gateoverflow.in/8008>

Which one of the following combinations is incorrect?

- A. Acquiescence - Submission
- B. Wheedle - Roundabout
- C. Flippancy - Lightness
- D. Profligate - Extravagant

[gate2015-1](#) [verbal-ability](#) [difficult](#)

Answer

15.0.9 GATE2011_GG_GA_1 [top](#)<http://gateoverflow.in/40202>

Q.56 Choose the most appropriate word or phrase from the options given below to complete the following sentence.

The environmentalists hope _____ the lake to its pristine condition.

- (A) in restoring
- (B) in the restoration of
- (C) to restore
- (D) restoring

[gate2011_gg](#) [verbal-ability](#)

Answer

15.0.10 GATE2015-1_GA_8 [top](#)<http://gateoverflow.in/8012>

The given statement is followed by some courses of action. Assuming the statement to be true, decide the correct option.

Statement:

There has been a significant drop in the water level in the lakes supplying water to the city.

Course of action:

- I. The water supply authority should impose a partial cut in supply to tackle the situation.
- II. The government should appeal to all the residents through mass media for minimal use of water.
- III. The government should ban the water supply in lower areas.

- A. Statements I and II follow.
- B. Statements I and III follow.
- C. Statements II and III follow.
- D. All the statements follow.

[gate2015-1](#) [verbal-ability](#) [normal](#)

[Answer](#)

15.0.11 GATE2015-2_GA_1 [top](#)

<http://gateoverflow.in/8028>

We _____ our friend's birthday and we _____ how to make it up to him.

- A. completely forgot --- don't just know
- B. forgot completely --- don't just know
- C. completely forgot --- just don't know
- D. forgot completely --- just don't know

[gate2015-2](#) [verbal-ability](#) [easy](#)

[Answer](#)

15.0.12 GATE_2011_MN_60 [top](#)

<http://gateoverflow.in/31533>

Q.60

Choose the most appropriate word from the options given below to complete the following sentence. The _____ of evidence was on the side of the plaintiff since all but one witness testified that his story was correct.

- (A) paucity
- (B) propensity
- (C) preponderance
- (D) accuracy

[verbal-ability](#) [gate2011-mn](#)

[Answer](#)

15.0.13 GATE2015-2_GA_4 [top](#)

<http://gateoverflow.in/8022>

A generic term that includes various items of clothing such as a skirt, a pair of trousers and a shirt is

- A. fabric
- B. textile
- C. fibre
- D. apparel

[gate2015-2](#) [verbal-ability](#) [easy](#)

[Answer](#)

15.0.14 GATE2015-3_GA_2 [top](#)

<http://gateoverflow.in/8300>

The Tamil version of _____ John Abraham-starrer *Madras Cafe* _____ cleared by the Censor Board with no cuts last week, but the film's distributor _____ no takers among the exhibitors for a release in Tamilnadu _____ this Friday.

- A. Mr., was, found, on
- B. a, was, found, at
- C. the, was, found, on
- D. a, being, find at

[gate2015-3](#) [verbal-ability](#) [normal](#)

[Answer](#)

15.0.15 Gate 2015 Aptitude Set 8 Q2 [top](#)<http://gateoverflow.in/40177>

Choose the statement where underlined word is used correctly.

- A. The minister insured the victims that everything would be all right.
- B. He ensured that the company will not have to bear any loss.
- C. The actor got himself ensured against any accident.
- D. The teacher insured students of good results.

[gate2015aptiset8](#) [aptitude](#) [verbal-ability](#)

Answer

15.0.16 GATE2015-3_GA_3 [top](#)<http://gateoverflow.in/8301>

Extreme focus on syllabus and studying for tests has become such a dominant concern of Indian student that they close their minds to anything _____ to the requirements of the exam.

- A. related
- B. extraneous
- C. outside
- D. useful

[gate2015-3](#) [verbal-ability](#) [normal](#)

Answer

15.0.17 GATE2015-3_GA_4 [top](#)<http://gateoverflow.in/8302>

Select the pair of best expresses a relationship similar to that expressed in the pair:

Children : Pediatrician

- A. Adult : Orthopaedist
- B. Females : Gynaecologist
- C. Kidney : Nephrologist
- D. Skin : Dermatologist

[gate2015-3](#) [verbal-ability](#) [easy](#)

Answer

15.0.18 GATE2015-3_GA_6 [top](#)<http://gateoverflow.in/8306>

Alexander turned his attention towards India, since he had conquered Persia.

Which one of the statements below is logically valid and can be inferred from the above sentence?

- A. Alexander would not have turned his attention towards India had he not conquered Persia.
- B. Alexander was not ready to rest on his laurels, and wanted to march to India.
- C. Alexander was not completely in control of his army and could command it to move towards India.
- D. Since Alexander's kingdom extended to Indian borders after the conquest of Persia, he was keen to move further.

[gate2015-3](#) [verbal-ability](#) [normal](#)

Answer

15.0.19 GATE2015-3_GA_7 [top](#)<http://gateoverflow.in/8308>

The head of newly formed government desires to appoint five of the six selected members P, Q, R, S, T and U to portfolios of Home, Power, Defense, Telecom, and Finance. U does not want any portfolio if S gets one of the five. R wants either Home or Finance or no portfolio. Q says that if S gets Power or Telecom, then she must get the other one. T insists on a portfolio if P gets one.

Which is the valid distribution of portfolios?

- A. P-Home, Q-Power, R-Defense, S-Telecom, T-Finance
- B. R-Home, S-Power, P-Defense, Q-Telecom, T-Finance
- C. P-Home, Q-Power, T-Defense, S-Telecom, U-Finance
- D. Q-Home, U-Power, T-Defense, R-Telecom, P-Finance

[gate2015-3](#) [verbal-ability](#) [normal](#)

[Answer](#)

15.0.20 GATE2015-3_GA_9 [top](#)

<http://gateoverflow.in/8388>

Most experts feel that in spite of possessing all the technical skills required to be a batsman of the highest order, he is unlikely to be so due to lack of requisite temperament. He was guilty of throwing away his wicket several time after working hard to lay a strong foundation. His critics pointed out that until he addressed his problem, success at the highest level will continue to elude him.

Which of the statement(s) below is/are logically valid and can be inferred from the above passage?

- i. He was already a successful batsman at the highest level.
- ii. He was to improve his temperament in order to become a great batsman.
- iii. He failed to make many of his good starts count.
- iv. Improving his technical skills will guarantee success.

- A. iii and iv
- B. ii and iii
- C. i, ii and iii
- D. ii only

[gate2015-3](#) [verbal-ability](#) [normal](#)

[Answer](#)

15.0.21 GATE IN 2011-57 [top](#)

<http://gateoverflow.in/3120>

57. The question below consists of a pair of related words followed by four pairs of words. Select the pair that best expresses the relation in the original pair:

Gladiator: Arena

(A) dancer: stage (B) commuter: train

(C) teacher: classroom (D) lawyer: courtroom

[gate-in-2011](#) [verbal-ability](#)

[Answer](#)

15.0.22 GATE IN 2011-58 [top](#)

<http://gateoverflow.in/3123>

58. Choose the most appropriate word from the options given below to complete-the following sentence: Under ethical guidelines recently adopted by the Indian Medical Association, human genes are to be manipulated only to correct diseases for which _____ treatments are unsatisfactory. (A) similar (B) most (C) uncommon (D) available

[gate-in-2011](#) [verbal-ability](#)

[Answer](#)

15.0.23 GATE IN 2011-59 [top](#)<http://gateoverflow.in/31276>

59. Choose the word from the options given below that is most nearly opposite in meaning to the given word:

Frequency

- (A) periodicity (B) rarity (C) gradualness (D) persistency

[gate-in-2011](#) [verbal-ability](#)

Answer

15.0.24 GATE IN 2011-60 [top](#)<http://gateoverflow.in/31278>

60. Choose the most appropriate word from the options given below to complete the following sentence:

It was her view that the country's problems had been _____ by foreign technocrats, so that to invite them to come back would be counter-productive

- (A) identified (B) ascertained (C) exacerbated (D) analyzed

[gate-in-2011](#) [verbal-ability](#)

Answer

15.0.25 GATE IN 2011-62 [top](#)<http://gateoverflow.in/31280>

62. The horse has played a little known but very important role in the field of medicine. Horses were injected with toxins of diseases until their blood built up immunities. Then a serum was made from their blood. Serums to fight with diphtheria and tetanus were developed this way.

It can be inferred from the passage, that horses were

- (A) given immunity to diseases
(B) generally quite immune to diseases
(C) given medicines to fight toxins
(D) given diphtheria and tetanus serums

[gate-in-2011](#) [verbal-ability](#)

Answer

15.0.26 GATE_MN_2011_01 [top](#)<http://gateoverflow.in/31519>

Q.56 Choose the word from the options given below that is most nearly opposite in meaning to the given word:

Deference

- (A) aversion
(B) resignation
(C) suspicion
(D) contempt

[verbal-ability](#) [gate2011-mn](#)

Answer

15.0.27 Gate 2015 Aptitude Set 8 Q [top](#)<http://gateoverflow.in/40178>

Q.3 Which word is not a synonym for the word ***vernacular***?
 (A) regional (B) indigenous (C) indigent (D) colloquial

gate2015aptiset8 aptitude verbal-ability

Answer

15.0.28 Gate 2015 Aptitude Set 8 Q1 [top](#)

<http://gateoverflow.in/40176>

Q.1 Choose the most appropriate word from the options given below to complete the following sentence.

The official answered _____ that the complaints of the citizen would be looked into.
 (A) respectably (B) respectfully (C) reputably (D) respectively

gate2015aptiset8 aptitude verbal-ability

Answer

15.0.29 GATE_MN_2011_58 [top](#)

<http://gateoverflow.in/31529>

Q.58 Choose the word or phrase that best completes the sentence below.

_____ in the frozen wastes of Arctic takes special equipment.

- (A) To survive
- (B) Surviving
- (C) Survival
- (D) That survival

verbal-ability gate2011-mn

Answer

15.0.30 GATE 2015 Aptitude Set 3 Q1 [top](#)

<http://gateoverflow.in/39544>

Q.1 Choose the most appropriate word from the options given below to complete the following sentence.

If the athlete had wanted to come first in the race, he _____ several hours every day.
 (A) should practise (B) should have practised
 (C) practised (D) should be practising

gate2015aptiset3 gate2015 aptitude

Answer

15.0.31 GATE2014-1_GA_3 [top](#)

<http://gateoverflow.in/772>

In a press meet on the recent scam, the minister said, "The buck stops here". What did the minister convey by the statement?

- A. He wants all the money
- B. He will return the money
- C. He will assume final responsibility
- D. He will resist all enquiries

gate2014-1 verbal-ability normal

Answer

15.0.32 GATE2016-1-GA03 [top](#)

<http://gateoverflow.in/39606>

Archimedes said, "Give me a lever long enough and a fulcrum on which to place it, and I will move the world."

The sentence above is an example of a _____ statement.

- A. figurative
- B. collateral
- C. literal
- D. figurine

[gate2016-1](#) [verbal-ability](#) [normal](#)

[Answer](#)

15.0.33 GATE 2015 Aptitude Set 4 Q1 [top](#)

<http://gateoverflow.in/40166>

Q.1 Choose the appropriate word/phrase, out of the four options given below, to complete the following sentence:

Apparent lifelessness _____ dormant life.

- (A) harbours
- (B) leads to
- (C) supports
- (D) affects

[gate2015aptiset4](#) [aptitude](#) [verbal-ability](#)

[Answer](#)

15.0.34 GATE 2015 Aptitude Set 4 Q2 [top](#)

<http://gateoverflow.in/40167>

Q.2 Fill in the blank with the correct idiom/phrase.

That boy from the town was a _____ in the sleepy village.

- (A) dog out of herd
- (B) sheep from the heap
- (C) fish out of water
- (D) bird from the flock

[gate2015aptiset4](#) [aptitude](#) [verbal-ability](#)

[Answer](#)

15.0.35 GATE2013_57 [top](#)

<http://gateoverflow.in/1560>

Complete the sentence:

Universalism is to particularism as diffuseness is to _____.

- (A) specificity
- (B) neutrality
- (C) generality
- (D) adaptation

[gate2013](#) [verbal-ability](#) [normal](#)

[Answer](#)

15.0.36 GATE 2015 Aptitude Set 3 Q10 [top](#)

<http://gateoverflow.in/39523>

Q.10 Ms. X will be in Bagdogra from 01/05/2014 to 20/05/2014 and from 22/05/2014 to 31/05/2014. On the morning of 21/05/2014, she will reach Kochi via Mumbai.

Which one of the statements below is logically valid and can be inferred from the above sentences?

- (A) Ms. X will be in Kochi for one day, only in May.
- (B) Ms. X will be in Kochi for only one day in May.
- (C) Ms. X will be only in Kochi for one day in May.
- (D) Only Ms. X will be in Kochi for one day in May.

[gate2015aptiset3](#) [gate2015](#) [aptitude](#)

[Answer](#)

15.0.37 GATE 2015 Aptitude Set 3 Q6 [top](#)

<http://gateoverflow.in/39519>

If she _____ how to calibrate the instrument, she _____ done the experiment.

- (A) knows, will have
- (B) knew, had
- (C) had known, could have
- (D) should have known, would have

[gate2014-3](#) [verbal-ability](#) [easy](#)

[Answer](#)

15.0.43 GATE 2015 Aptitude Set 4 Q3 [top](#)

<http://gateoverflow.in/40278>

Q.3 Choose the statement where underlined word is used correctly.

- (A) When the teacher eludes to different authors, he is being elusive.
- (B) When the thief keeps eluding the police, he is being elusive.
- (C) Matters that are difficult to understand, identify or remember are allusive.
- (D) Mirages can be allusive, but a better way to express them is illusory.

[gate2015aptiset4](#) [aptitude](#) [verbal-ability](#)

[Answer](#)

15.0.44 gate2013-ce-9 [top](#)

<http://gateoverflow.in/40278>

Q.64 A firm is selling its product at Rs. 60 per unit. The total cost of production is Rs. 100 and firm is earning total profit of Rs. 500. Later, the total cost increased by 30%. By what percentage the price should be increased to maintained the same profit level.

- (A) 5
- (B) 10
- (C) 15
- (D) 30

[numerical-ability](#) [gate2013-ce](#)

[Answer](#)

15.0.45 GATE 2015 Aptitude Set 2 Q 7 [top](#)

<http://gateoverflow.in/39508>

Q.7 Given below are two statements followed by two conclusions. Assuming these statements to be true, decide which one logically follows.

Statements:

- I. All film stars are playback singers.
- II. All film directors are film stars.

Conclusions:

- I. All film directors are playback singers.
 - II. Some film stars are film directors.
- (A) Only conclusion I follows.
 - (B) Only conclusion II follows.
 - (C) Neither conclusion I nor II follows.
 - (D) Both conclusions I and II follow.

[gate2015](#) [gate2015aptiset2](#) [aptitude](#)

[Answer](#)

15.0.46 GATE 2015 Aptitude Set 2 Q 6 [top](#)

<http://gateoverflow.in/39507>

Q.6 In the following sentence certain parts are underlined and marked P, Q, and R. One of the parts may contain certain error or may not be acceptable in standard written communication. Select the part containing an error. Choose D as your answer if there is no error.

The student corrected all the errors that the instructor marked on the answer book.

P Q R
(A) P (B) Q (C) R (D) No Error

gate2015 | gate2015aptiset2 | aptitude

Answer

15.0.47 GATE 2015 Aptitude Set 2 Q 3 [top](#)

<http://gateoverflow.in/39504>

Q.3 What is the adverb for the given word below?
Misogynous
(A) Misogynousness (B) Misogyny (C) Misogynously (D) Misogynous

gate2015 | gate2015aptiset2 | aptitude

Answer

15.0.48 GATE 2015 Aptitude Set 2 Q 2 [top](#)

<http://gateoverflow.in/39503>

Q.2 Choose the word most similar in meaning to the given word:
Awkward
(A) Inept (B) Graceful (C) Suitable (D) Dreadful

gate2015 | gate2015aptiset2 | aptitude

Answer

15.0.49 GATE 2015 Aptitude Set 4 Q6 [top](#)

<http://gateoverflow.in/40171>

Q.6 Select the appropriate option in place of underlined part of the sentence.
Increased productivity necessary reflects greater efforts made by the employees.
(A) Increase in productivity necessary
(B) Increase productivity is necessary
(C) Increase in productivity necessarily
(D) No improvement required

gate2015aptiset4 | aptitude | verbal-ability

Answer

15.0.50 GATE2012_57 [top](#)

<http://gateoverflow.in/2195>

Choose the most appropriate alternative from the options given below to complete the following sentence:

Despite several ----- the mission succeeded in its attempt to resolve the conflict.

- (A) attempts
- (B) setbacks
- (C) meetings
- (D) delegations

gate2012 | verbal-ability | easy

Answer

15.0.51 GATE2012-CY-GA-3 [top](#)

<http://gateoverflow.in/40234>

Q.58 Which one of the following options is the closest in meaning to the word given below?
Latitude

- (A) Eligibility (B) Freedom (C) Coercion (D) Meticulousness

[gate2012-cy](#)
[aptitude](#)
[verbal-ability](#)
[Answer](#)

15.0.52 Gate 2015 Aptitude Set 8 Q6 [top](#)

<http://gateoverflow.in/40181>

The word similar in meaning to 'dreary' is

- (A) cheerful
- (B) dreamy
- (C) hard
- (D) dismal

[gate2015aptiset8](#)
[verbal-ability](#)
[Answer](#)

Answers:

15.0.1 Gate 2015 Aptitude Set 8 Q9 [top](#)

<http://gateoverflow.in/40185>

Answer (B)

Type I = $696/7 = 96.57$

Type II = $694/7 = 99.14$

Type III = $901/7 = 128.71$

Type IV = $601/7 = 85.85$

Type V = $799/7 = 114.14$

0 votes

-- srestha (27.8k points)

growth rate = (growth rate in 2012- growth rate in 2006) / 2006 yr

so for type 1 is $(115-75)/75 * 100 = 40 * 75/100 = 30\%$

for type 2 is $(144-85)/144 * 100 = 5900/144 = 40.02\%$

for type 3 is $(160-114)/114 * 100 = 4600/114 = 40.35$

for type 5 is $(145-108)/108 * 100 = 3700/108 = 34.25\%$ so **highest growth rate will be 40.35 that means type 3 is answer**

0 votes

-- rajan (2.1k points)

15.0.2 GATE2015-2_GA_10 [top](#)

<http://gateoverflow.in/8041>


Selected Answer

A.

Correct versions of other 3:

B. The report was useless to them because there **was** no needed information in it.

C. Since the report did not contain the needed information, it was not **really** useful to them.

D. Since the report lacked needed information, it would not **have** been useful to them.

Another copied question.

<https://books.google.co.in/books?id=pEs8BAAQBAJ&pg=PA456&lpg=PA456&dq=The+report+was+useless+to+them+because+there+was+no+needed+information+in+it>

C. She had a terrific time at the party

Upvote 3 votes

-- Kathleen Bankson (47.9k points)

15.0.8 GATE2015-1_GA_5 top

<http://gateoverflow.in/8008>



Selected Answer

B Wheedle - Roundabout

Upvote 5 votes

-- Kathleen Bankson (47.9k points)

15.0.9 GATE2011_GG_GA_1 top

<http://gateoverflow.in/40202>

(C)

The environmentalists hope to restore the lake to its pristine condition.

Pristine means original condition.

Upvote 2 votes

-- Sourav Mishra (2.7k points)

15.0.10 GATE2015-1_GA_8 top

<http://gateoverflow.in/8012>



Selected Answer

Statements I and II are correct measures. Option A,

Upvote 4 votes

-- Arjun Suresh (150k points)

15.0.11 GATE2015-2_GA_1 top

<http://gateoverflow.in/8028>



Selected Answer

answer is option c

Upvote 5 votes

-- naresh1845 (1.3k points)

15.0.12 GATE_2011_MN_60 top

<http://gateoverflow.in/31533>

Ans => (C)

preponderance => the quality or fact of being greater in number, quantity, or importance.

"the preponderance of women among older people" C is correct option.

Here plaintiff => a person who brings a case against another in a court of law.

"the plaintiff commenced an action for damages"

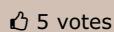
Upvote 2 votes

-- Akash (31.7k points)

15.0.13 GATE2015-2_GA_4 top<http://gateoverflow.in/8032>

Selected Answer

its 'D' apparel



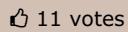
5 votes

-- Anoop Sonkar (4.5k points)

15.0.14 GATE2015-3_GA_2 top<http://gateoverflow.in/8300>

Selected Answer

answer is c



11 votes

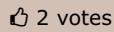
-- naresh1845 (1.3k points)

15.0.15 Gate 2015 Aptitude Set 8 Q2 top<http://gateoverflow.in/40177>

Selected Answer

Ans **B**)ensured: , make something certain in future
insured: , covered by some policy/ insurance

For everything other than B, the words have to be interchanged :)



2 votes

-- Ganesh K (151 points)

15.0.16 GATE2015-3_GA_3 top<http://gateoverflow.in/8301>

Selected Answer

answer is b



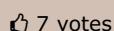
7 votes

-- naresh1845 (1.3k points)

15.0.17 GATE2015-3_GA_4 top<http://gateoverflow.in/8302>

Selected Answer

its BFemales : Gynaecologist



7 votes

-- Anoop Sonkar (4.5k points)

15.0.18 GATE2015-3_GA_6 top<http://gateoverflow.in/8306>

Selected Answer

Answer should be A.....as other options required more information

Let
P be " Alexander turned his attention towards India " and
Q be "he had conquered Persia"

P since Q = ~Q implies ~P.

~P is "Alexander would not have turned his attention towards India"

~Q is "he had not conquered Persia"

14 votes

-- Srijay Deshpande (361 points)

15.0.19 GATE2015-3_GA_7 [top](#)

<http://gateoverflow.in/8308>



Selected Answer

"U does not want any portfolio if S gets one of the five"

So, S and U cannot come together. Option C eliminated.

"R wants either Home or Finance or no portfolio"

So, options A and D eliminated.

So, answer is B.

Just to confirm:

Q says that if S gets Power or Telecom, then she must get the other one

In B, S gets Power and Q gets Telecom

"T insists on a portfolio if P gets one"

In B, T is getting a portfolio.

9 votes

-- Arjun Suresh (150k points)

15.0.20 GATE2015-3_GA_9 [top](#)

<http://gateoverflow.in/8388>



Selected Answer

"possessing all the technical skills" - iv is false

"throwing away his wicket several time after working hard to lay a strong foundation" - iii is true

"he is unlikely to be so due to lack of requisite temperament" - ii is true

"success at the highest level will continue to elude him" - i is false

So, B.

8 votes

-- Arjun Suresh (150k points)

15.0.21 GATE IN 2011-57 [top](#)

<http://gateoverflow.in/31270>



Selected Answer

Gladiator : a man trained to fight with weapons against other men or wild animals in an arena

the most suitable pair will be option D

3 votes

-- Sandip Shaw (821 points)

15.0.22 GATE IN 2011-58 [top](#)

<http://gateoverflow.in/31273>

Answer (D) Available !

2 votes

-- Akash (31.7k points)

15.0.23 GATE IN 2011-59 [top](#)

<http://gateoverflow.in/31276>



Selected Answer

Ans -> (B) rarity

is opposite of "the fact or state of being frequent or happening often." Meaning of frequency is "frequentness" here, which is one of synonyms.

<http://www.merriam-webster.com/dictionary/infrequency> -> Another Antonym of Frequency

the rate at which something occurs over a particular period of time or in a given sample.
"an increase in the frequency of accidents due to increased overtime"

the fact or state of being frequent or happening often.

rate of occurrence, commonness, frequentness, [prevalence](#), [incidence](#), [amount](#); rate of repetition, recurrence,
synonyms: [repetition](#), [persistence](#), [regularity](#); [distribution](#)
"the frequency of errors"

2 votes

-- Akash (31.7k points)

15.0.24 GATE IN 2011-60 [top](#)

<http://gateoverflow.in/31280>

Ans -> (C) exacerbated

2 votes

-- Akash (31.7k points)

15.0.25 GATE IN 2011-62 [top](#)

<http://gateoverflow.in/31280>

Option B should be it. Otherwise no reason to try on horse.

5 votes

-- Arjun Suresh (150k points)

15.0.26 GATE_MN_2011_01 [top](#)

<http://gateoverflow.in/31519>

Ans => D. Contempt

Deference => polite submission and respect.

A) aversion => Plain Dislike

B) resignation => Act of resigning

C) suspicion => a feeling or thought that something is possible, likely, or true.

D) contempt => the feeling that a person or a thing is worthless or beneath consideration.

"Pam stared at the girl with total contempt" synonyms: scorn, disdain, disrespect, depreciation, disparagement,

denigration, opprobrium, odium, obloquy, scornfulness;
 More derision, mockery, ridicule; disgust, loathing, detestation, abhorrence, hatred; archaiccontumely
 "she was showing little but contempt for him"
 antonyms:=> respect

1 votes

-- Akash (31.7k points)

15.0.27 Gate 2015 Aptitude Set 8 Q1 [top](#)

<http://gateoverflow.in/40178>



Selected Answer

vernacular means the language spoken by the ordinary people of a country or region
 and option C is indigent which means poor or needy for example we do charity for indigent person
 so it is not a synonym for the word vernacular
 and option A also relates in some sense bcz it means relating to a region. and same for colloquial means language used informally in particular region
 and same thing for B also so CORRECT ANSWER IS C

2 votes

-- rajan (2.1k points)

15.0.28 Gate 2015 Aptitude Set 8 Q1 [top](#)

<http://gateoverflow.in/40176>

answer should be B ie respectfully

2 votes

-- Pooja (25.9k points)

15.0.29 GATE_MN_2011_58 [top](#)

<http://gateoverflow.in/31529>

Official Answer Directly from GATE 2011 Key => A) To survive

1 votes

-- Akash (31.7k points)

15.0.30 GATE 2015 Aptitude Set 3 Q1 [top](#)

<http://gateoverflow.in/39514>

B) Its easy,should have practised. Its given in perfect tense so I think B) is the correct ans..

1 votes

-- Ritaban Basu (435 points)

15.0.31 GATE2014-1_GA_3 [top](#)

<http://gateoverflow.in/772>



Selected Answer

C. The buck stops here is a term meaning to put an end to something, not continue, stop it.

(idiomatic) A statement that no excuses will be made, that the speaker is going to take direct responsibility for matters, rather than pass the responsibility to higher authorities.

9 votes

-- Kathleen Bankson (47.9k points)

15.0.32 GATE2016-1-GA03 [top](#)<http://gateoverflow.in/39606>

A) Figurative

9 votes

-- Abhilash Panicker (7k points)

15.0.33 GATE 2015 Aptitude Set 4 Q1 [top](#)<http://gateoverflow.in/40166>

Ans : [B]

Apparent lifelessness leads to dormant life.

0 votes

-- Desert_Warrior (6.6k points)

15.0.34 GATE 2015 Aptitude Set 4 Q2 [top](#)<http://gateoverflow.in/40167>Ans : That boy from the town was a dog out of herd in the sleepy village.

a] dog out of herd :

b] sheep from the heap :

c] fish out of water : someone who is uncomfortable in a particular situation

d] bird from the flock :

0 votes

-- Desert_Warrior (6.6k points)

15.0.35 GATE2013_57 [top](#)<http://gateoverflow.in/1560>

Selected Answer

A...Specificity. This is asking for opposites.

Specificity**Diffuseness**

Direct, to the point, purposeful in Indirect, circuitous, seemingly relating "aimless" forms of relating
 Precise, blunt, definitive and Evasive, tactful, ambiguous, even transparent opaque
 Principles and consistent moral stands Highly situational morality depending independent of the person being upon the person and context addressed encountered

8 votes

-- Kathleen Bankson (47.9k points)

15.0.36 GATE 2015 Aptitude Set 3 Q10 [top](#)<http://gateoverflow.in/39523>

Most probably Option B will be the answer.

1 votes

-- Sreyas S (1.6k points)

15.0.37 GATE 2015 Aptitude Set 3 Q6 [top](#)<http://gateoverflow.in/39519>

a) is the right ans.

check for other options ,option d) is incorrect because the secret is between them nd not solely with Ram so its contradicting with the original statement.

Option b and c are false because "I " is incorrect usage ,it should be "me"

1 votes

-- Ritaban Basu (435 points)

15.0.38 GATE 2015 Aptitude Set 3 Q3 top

<http://gateoverflow.in/39516>

B) alternate.. The other three doesnt make any sense ..

1 votes

-- Ritaban Basu (435 points)

15.0.39 GATE2014-EC03-GA3 top

<http://gateoverflow.in/41142>



Selected Answer

Answer B) Noun
Advice - Noun
Advise - Verb

2 votes

-- Abhilash Panicker (7k points)

15.0.40 GATE 2015 Apti Set 2 Q 2 top

<http://gateoverflow.in/39515>

Connotation of road or way :

an idea or feeling which a word invokes for road or way

A] pertinacious : holding firmly to an opinion or a course of action. (persistent) (related to human)

B] viaticum : the Eucharist as given to a person near or in danger of death. (related to human)

C] clandestine : confidential (related to way)

D] ravenous : extremely hungry. (related to human)

0 votes

-- Desert_Warrior (6.6k points)

15.0.41 GATE2014-3_GA_1 top

<http://gateoverflow.in/2024>



Selected Answer

Answer D)

While trying to collect an envelope from under the table, Mr. X fell down and was losing consciousness.

A :Mr. X is trying to collect an envelope from under the table (Present continuous tense)

B :Mr. X fell down (Simple past tense)

C :Mr. X was losing consciousness. (Past continuous tense)

While A, B and C

What is wrong is the usage of sentences B and C together.

"We use the **past continuous tense** with the **simple past tense** when we want to show that one thing happened in the middle of another thing."
eg-I was taking a bath and the telephone rang.

Here it says..

"Mr. X fell down and was losing consciousness."

i.e B is done.. and C starts. Where as the usage says.. C should have happened in the middle of B.

It should have been Mr. X fell down and lost consciousness.

Source - <http://www.5minuteenglish.com/nov12.htm>

5 votes

-- Srinath Sri (2.9k points)

15.0.42 GATE2014-3_GA_2 [top](#)



Selected Answer

To answer these i normally use the language(even english itself) i am fluent in.
Option C) makes perfect sense , rest do not relate to each other.

7 votes

-- Srinath Sri (2.9k points)

15.0.43 GATE 2015 Aptitude Set 4 Q3 [top](#)

<http://gateoverflow.in/40168>

Ans : [B] When the thief keeps eluding the police, he is being **elusive**.

elusive - Difficult to find, catch or achieve.

allusive - Using or containing suggestion rather than explicit mention.

The correct alternatives for the incorrect answers are :

- A. When the teacher eludes to different authors, he is being **allusive**.
- C. Matters that are difficult to understand, identify or remember are **elusive**.
- D. Mirages can be **elusive**, but a better way to express them is illusory.

1 votes

-- Sharath George M (21 points)

15.0.44 gate2013-ce-9 [top](#)

<http://gateoverflow.in/40278>

5%.....

let N units are made ...and sold for RS 60

let X be the cost related to each unit ..we are given

$500(\text{as profit}) = 60-X + 60-X + 60-X + 60-X \dots \text{Nimes}$

$N(60-X) = 500 \Rightarrow 60N-NX = 500$

total cost is $100 . 60N - 100 = 500 \Rightarrow N = 10$

now the cost has increased 30% ..NEW cost 130 now 30 has to be divided among 10 ...to maintain same profit level..

SO,,,, $60+3 + 60+3 \dots 10\text{times} \dots \text{SO } 3 \text{ is } 5\% \text{ of } 60$

1 votes

-- Deepesh Kataria (1.4k points)

15.0.45 GATE 2015 Aptitude Set 2 Q 7 [top](#)

<http://gateoverflow.in/39508>

Both the conclusions follow. You can verify it by drawing venn diagram representation.

Option D

2 votes

-- Sreyas S (1.6k points)

15.0.46 GATE 2015 Aptitude Set 2 Q 6 top<http://gateoverflow.in/39507>**see below for missing underline part of question's**

The student corrected all the errors that the instructor marked on the answer book.
 P Q R

- (A) P (B) Q (C) R (D) No Error

answer :- B

it should be " the instructor had marked"

0 votes

-- Prateek kumar (1.1k points)

15.0.47 GATE 2015 Aptitude Set 2 Q 3 top<http://gateoverflow.in/39504>

Option C

1 votes

-- Sreyas S (1.6k points)

15.0.48 GATE 2015 Aptitude Set 2 Q 2 top<http://gateoverflow.in/39503>

Option A

2 votes

-- Sreyas S (1.6k points)

15.0.49 GATE 2015 Aptitude Set 4 Q6 top<http://gateoverflow.in/40171>

Selected Answer

- (C) Increase in productivity necessarily

4 votes

-- Monanshi Jain (6.5k points)

15.0.50 GATE2012_57 top<http://gateoverflow.in/2195>

Selected Answer

- B...setbacks

5 votes

-- Kathleen Bankson (47.9k points)

15.0.51 GATE2012-CY-GA-3 top<http://gateoverflow.in/40234>

Selected Answer

Latitude means scope for freedom of action or thought.
 Option B.

1 votes

-- Monanshi Jain (6.5k points)

Latitude means freedom of action, choice or space.

So, B is correct.

1 votes

-- Prateek Banra (75 points)

15.0.52 Gate 2015 Aptitude Set 8 Q6 [top](#)



Selected Answer

depressingly dull and bleak or repetitive or gloomy or upset

option A is wrong bcz cheerful means happy and option B and C are not related to depression or upset

and remaining option D which is dismal which means mood of gloom or depression.

2 votes

-- rajan (2.1k points)

15.1

Closest Word [top](#)

15.1.1 Closest Word: gate-2013-ee-1 [top](#)

<http://gateoverflow.in/40288>

Q.56 They were requested not to **quarrel** with others.

Which one of the following options is the closest in meaning to the word **quarrel**?

(A) make out (B) call out (C) dig out (D) fall out

[gate2013-ee](#) [verbal-ability](#) [closest-word](#)

Answer

15.1.2 Closest Word: gate-2014-ae-1 [top](#)

<http://gateoverflow.in/40270>

Q.1 A student is required to demonstrate a high level of comprehension of the subject, especially in the social sciences.

The word closest in meaning to comprehension is

(A) understanding (B) meaning (C) concentration (D) stability

[gate-2014-ae](#) [closest-word](#)

Answer

15.1.3 Closest Word: GATE2013-CE-3 [top](#)

<http://gateoverflow.in/40270>

Which of the following options is the closest in meaning to the word given below: Primeval

(A) Modern (B) Historic (C) Primitive (D) Antique

[gate2013-ce](#) [closest-word](#) [most-appropriate-word](#)

Answer

Answers: Closest Word

15.1.1 Closest Word: gate-2013-ee-1 [top](#)<http://gateoverflow.in/40288>

Selected Answer

quarrel means having an argument.
option D) **fall out** means the same.

4 votes

-- Monanshi Jain (6.5k points)

15.1.2 Closest Word: gate-2014-ae-1 [top](#)<http://gateoverflow.in/40300>

Selected Answer

comprehension means understanding.
option A.

3 votes

-- Monanshi Jain (6.5k points)

15.1.3 Closest Word: GATE2013-CE-3 [top](#)<http://gateoverflow.in/40270>

Selected Answer

Ans C--> Primitive, its synonym for Primeval

1 votes

-- UK (1.5k points)

15.2**English Grammar** [top](#)**15.2.1 English Grammar: GATE 2015 Aptitude Set 1 Q6** [top](#)<http://gateoverflow.in/39494>

The following question presents a sentence, part of which is underlined. Beneath the sentence you find four ways of phrasing the underlined part. Following the requirements of the standard written English, select the answer that produces the most effective sentence.

Tuberculosis, together with its effects, ranks one of the leading causes of death in India.

- (A) ranks as one of the leading causes of death
- (B) rank as one of the leading causes of death
- (C) has the rank of one of the leading causes of death
- (D) are one of the leading causes of death

[gate2015aptiset1](#) | [english-grammar](#)**Answer****15.2.2 English Grammar: GATE 2015 Set 2 Q 1** [top](#)<http://gateoverflow.in/38935>

Choose the appropriate word/phrase, out of the four options given below, to complete the following sentence:

Dhoni, as well as the other team members of Indian team, _____ present on the occasion.

- (A) were
- (B) was
- (C) has
- (D) have

[gate2015aptiset2](#) | [aptitude](#) | [verbal-ability](#) | [english-grammar](#)

[Answer](#)

15.2.3 English Grammar: GATE 2016-2-GA-01 [top](#)

<http://gateoverflow.in/39529>

The man who is now Municipal Commissioner worked as _____.

- (A) the security guard at a university
- (B) a security guard at the university
- (C) a security guard at university
- (D) the security guard at the university

The man who is now Municipal Commissioner worked as _____.

- (A) the security guard at a university
- (B) a security guard at the university
- (C) a security guard at university
- (D) the security guard at the university

[gate2016-2](#) | [verbal-ability](#) | [english-grammar](#) | [normal](#)

[Answer](#)

15.2.4 English Grammar: GATE2016-1-GA01 [top](#)

<http://gateoverflow.in/39608>

Out of the following four sentences, select the most suitable sentence with respect to grammar and usage.

- A. I will not leave the place until the minister does not meet me.
- B. I will not leave the place until the minister doesn't meet me.
- C. I will not leave the place until the minister meet me.
- D. I will not leave the place until the minister meets me.

[gate2016-1](#) | [verbal-ability](#) | [english-grammar](#) | [easy](#)

[Answer](#)

15.2.5 English Grammar: GATE-2013-AE-GA-2 [top](#)

<http://gateoverflow.in/40243>

Q.57 The Headmaster _____ to speak to you. Which of the following options is incorrect to complete the above sentence?

- (A) is wanting
- (B) wants
- (C) want
- (D) was wanting

[gate2013-ae](#) | [verbal-ability](#) | [english-grammar](#)

[Answer](#)

15.2.6 English Grammar: GATE2014-EC02-GA2 [top](#)

<http://gateoverflow.in/41509>

Which of the options given below best completes the following sentence?

She will feel much better if she _____.

- A. Will get some rest
 B. Gets some rest
 C. Will be getting some rest
 D. Is getting some rest

gate2014-ec02 | verbal-ability | english-grammar | normal

[Answer](#)

15.2.7 English Grammar: gate-2013-ee-4 [top](#)

<http://gateoverflow.in/40291>

Q.59 Choose the grammatically **CORRECT** sentence:

- (A) Two and two add four.
 (B) Two and two become four.
 (C) Two and two are four.
 (D) Two and two make four.

gate2013-ee | english-grammar

[Answer](#)

15.2.8 English Grammar: GATE2012-AR-3 [top](#)

<http://gateoverflow.in/40224>

Choose the grammatically **CORRECT** sentence:

- A. He laid in bed till 8 o'clock in the morning.
 B. He layed in bed till 8 o'clock in the morning.
 C. He lain in bed till 8 o'clock in the morning.
 D. He lay in bed till 8 o'clock in the morning.

gate2012-ar | aptitude | verbal-ability | english-grammar | easy

[Answer](#)

15.2.9 English Grammar: GATE-2013-AE-GA-4 [top](#)

<http://gateoverflow.in/40245>

All engineering students should learn mechanics, mathematics and how to do computation.

I

II

III

IV

Which of the above underlined parts of the sentence is not appropriate?

- a. I
 b. II
 c. III
 d. IV

Q.59 All engineering students should learn mechanics, mathematics and how to do computation.

I II III IV

Which of the above underlined parts of the sentence is not appropriate?

- (A) I (B) II (C) III (D) IV

gate2013-ae | english-grammar | verbal-ability

[Answer](#)

15.2.10 English Grammar: GATE2013-CE-2 [top](#)

<http://gateoverflow.in/40269>

The professor ordered to the students to go out of the class.

I II III IV

Which of the above underlined parts of the sentence is grammatically incorrect?

- A. I
- B. II
- C. III
- D. IV

[gate2013-ce](#) [english-grammar](#)
[Answer](#)

15.2.11 English Grammar: GATE2012-AR-4 [top](#)

<http://gateoverflow.in/40225>

Which one of the parts (A, B, C, D) in the sentence contains an **ERROR**?

No sooner had the doctor seen the results of the blood test, than he suggested the patient to see the specialist.

- (A) no sooner had
- (B) results of the blood test
- (C) suggested the patient
- (D) see the specialist

[gate2012-ar](#) [aptitude](#) [verbal-ability](#) [english-grammar](#)
[Answer](#)

15.2.12 English Grammar: GATE2012-CY-GA-2 [top](#)

<http://gateoverflow.in/40233>

Q.57 One of the parts (A, B, C, D) in the sentence given below contains an ERROR. Which one of the following is **INCORRECT**?

I requested that he should be given the driving test today instead of tomorrow.

- (A) requested that
- (B) should be given
- (C) the driving test
- (D) instead of tomorrow

[gate2012-cy](#) [aptitude](#) [verbal-ability](#) [english-grammar](#)
[Answer](#)

Answers: English Grammar

15.2.1 English Grammar: GATE 2015 Aptitude Set 1 Q6 [top](#)

<http://gateoverflow.in/39494>

Selected Answer

Tuberculosis, together with its effects,
A) ranks as one of the leading causes of death

<http://dictionary.cambridge.org/dictionary/english/rank>

4 votes

-- srestha (27.8k points)

15.2.2 English Grammar: GATE 2015 Set 2 Q 1 [top](#)

<http://gateoverflow.in/38935>



Selected Answer

Words joined to a singular subject by WITH, AS WELL AS, takes a singular verb...So it will be WAS

5 votes

-- Shalini (157 points)

15.2.3 English Grammar: GATE 2016-2-GA-01 [top](#)

<http://gateoverflow.in/39529>



Selected Answer

option b

6 votes

-- Mohit Kumar Gupta (237 points)

15.2.4 English Grammar: GATE2016-1-GA01 [top](#)

<http://gateoverflow.in/39608>



Selected Answer

ans will be d

15 votes

-- Pooja (25.9k points)

15.2.5 English Grammar: GATE-2013-AE-GA-2 [top](#)

<http://gateoverflow.in/40243>

Answer B: The headmaster WANTS to speak to you.

Best explanation I found...

I look at this from an old English point of view. I dismiss that time dictates what is proper or not. As in old English, if you were found "wanting" it was used in a negative context, meaning you lacked a skill to do something you attempted. You would not say "I am wanting to learn to" whatever. You would say "I want to learn to". Yet you could be found wanting if you failed an attempt at something you did not have the skill for. Also for consideration is the premise of saying the most with the least. What takes less to say but conveys the most? "I want ..." or "I am wanting ..."? The use of "want" reduces confusion without using more than is needed to convey the message. Unfortunately as mentioned about the McDonald's ad, we've taught our children via marketing that incorrect use of English is ok. Most people have lost the skill or were never taught to speak English efficiently.

2 votes

-- Kathleen Bankson (47.9k points)

15.2.6 English Grammar: GATE2014-EC02-GA2 [top](#)

<http://gateoverflow.in/41509>

Answer will be (B)

5 votes

-- srestha (27.8k points)

15.2.7 English Grammar: gate-2013-ee-4 [top](#)

<http://gateoverflow.in/40291>



Selected Answer

D) seems to be correct ans.

5 votes

-- Manashi Sarkar (193 points)

15.2.8 English Grammar: GATE2012-AR-3 [top](#)

<http://gateoverflow.in/40224>

(A) He laid in bed till 8'o clock in the morning.

1 2 votes

-- Sourav Mishra (2.7k points)

15.2.9 English Grammar: GATE-2013-AE-GA-4 [top](#)

<http://gateoverflow.in/40245>

I will have to go with D on this one.

All engineering students should learn mechanics, mathematics and computation.

or possibly

All engineering students should learn how to do mechanics, mathematics and computation.

1 5 votes

-- Kathleen Bankson (47.9k points)

15.2.10 English Grammar: GATE2013-CE-2 [top](#)

<http://gateoverflow.in/40269>

B) II

The correct phrase is **ordered**.

This [link](#) explains the correct use of the verb *order*.

1 2 votes

-- Gaurav Sharma (1.8k points)

15.2.11 English Grammar: GATE2012-AR-4 [top](#)

<http://gateoverflow.in/40225>

"**to see the specialist**"

Who is the specialist here? Not clear- it must be one of the specialist for that particular disease. So, "to see a specialist" is correct.

Rest all are fine in the sentence. "No sooner had- than" means the first part happened and the second part followed immediately. The first part uses past perfect tense and the second part uses simple past tense - which is as required.

<http://www.englishgrammar.org/rewrite-sooner/>

1 1 votes

-- Arjun Suresh (150k points)

15.2.12 English Grammar: GATE2012-CY-GA-2 [top](#)

<http://gateoverflow.in/40233>

Answer A:

I requested he should be given the driving test today instead of tomorrow .

1 0 votes

-- Kathleen Bankson (47.9k points)

15.3

Grammatically Incorrect Sentence [top](#)

15.3.1 Grammatically Incorrect Sentence: GATE2012_59 [top](#)

<http://gateoverflow.in/2198>

Choose the grammatically **INCORRECT** sentence:

- (A) They gave us the money back less the service charges of Three Hundred rupees.
 (B) This country's expenditure is not less than that of Bangladesh.
 (C) The committee initially asked for a funding of Fifty Lakh rupees, but later settled for a lesser sum.
 (D) This country's expenditure on educational reforms is very less.

gate2012 | verbal-ability | grammatically-incorrect-sentence | normal

Answer

15.3.2 Grammatically Incorrect Sentence: GATE2013_60 [top](#)

<http://gateoverflow.in/1564>

Choose the grammatically **INCORRECT** sentence:

- (A) He is of Asian origin.
 (B) They belonged to Africa.
 (C) She is an European.
 (D) They migrated from India to Australia.

gate2013 | verbal-ability | grammatically-incorrect-sentence | normal

Answer

Answers: Grammatically Incorrect Sentence

15.3.1 Grammatically Incorrect Sentence: GATE2012_59 [top](#)

<http://gateoverflow.in/2198>



Selected Answer

D...."is very less" should be "is much less".

1 upvote

-- Kathleen Bankson (47.9k points)

15.3.2 Grammatically Incorrect Sentence: GATE2013_60 [top](#)

<http://gateoverflow.in/1564>



Selected Answer

C. Should be... She is a European

"The **sound** of a word's first letter determines which to use. If the word starts with a **vowel sound**, you should use *an*. If it starts with a **consonant sound**, you should use *a*."

The word "European" does not start with a vowel sound, it starts with the syllable "you". The "y"-sound is in this case a consonant (or at least a half-consonant), so the indefinite article is "a".

1 upvote

-- Kathleen Bankson (47.9k points)

15.4

Inference [top](#)

15.4.1 Inference: GATE2012_61 [top](#)

<http://gateoverflow.in/2209>

Wanted Temporary, Part-time persons for the post of Field Interviewer to conduct personal interviews to collect and collate economic data. Requirements: High School-pass, must be available for Day, Evening and Saturday work. Transportation paid, expenses reimbursed.

Which one of the following is the best inference from the above advertisement?

- (A) Gender-discriminatory
 (B) Xenophobic

- (C) Not designed to make the post attractive
 (D) Not gender-discriminatory

gate2012 | verbal-ability | inference | normal

Answer

15.4.2 Inference: GATE2014-1_GA_7 [top](#)

<http://gateoverflow.in/775>

Geneticists say that they are very close to confirming the genetic roots of psychiatric illnesses such as depression and schizophrenia, and consequently, that doctors will be able to eradicate these diseases through early identification and gene therapy.

On which of the following assumptions does the statement above rely?

Select one:

- A. Strategies are now available for eliminating psychiatric illnesses
- B. Certain psychiatric illnesses have a genetic basis
- C. All human diseases can be traced back to genes and how they are expressed
- D. In the future, genetics will become the only relevant field for identifying psychiatric illnesses

gate2014-1 | verbal-ability | inference | normal

Answer

Answers: Inference

15.4.1 Inference: GATE2012_61 [top](#)

<http://gateoverflow.in/2209>



Selected Answer

D. Not gender_discriminatory. The post mentions "persons" meaning any gender.

Xenophobic means having or showing an intense or irrational dislike or fear of people from other countries, so does not apply.

C and A do not apply.

👍 7 votes

-- Kathleen Bankson (47.9k points)

15.4.2 Inference: GATE2014-1_GA_7 [top](#)

<http://gateoverflow.in/775>



Selected Answer

B is correct, The first sentence mentions two specific illnesses, (depression and schizophrenia). B is the only one that mentions certain illnesses.

A states strategies are now available. The statement says they are very close so its not yet available.

C states that ALL human diseases can be traced back. The statement only mentions two specific illnesses.

D the statement does not mention at all that it is the only relevant field.

👍 9 votes

-- Kathleen Bankson (47.9k points)

15.5**Logical Reasoning** [top](#)**15.5.1 Logical Reasoning: GATE 2016-2-GA-08** [top](#)<http://gateoverflow.in/39534>

All hill-stations have a lake. Ooty has two lakes.

Which of the statement(s) below is/are logically valid and can be inferred from the above sentences?

- (i) Ooty is not a hill-station.
- (ii) No hill-station can have more than one lake.
- A. (i) only.
- B. (ii) only.
- C. Both (i) and (ii)
- D. Neither (i) nor (ii)

[gate2016-2](#) | [verbal-ability](#) | [logical-reasoning](#) | [easy](#)

[Answer](#)

15.5.2 Logical Reasoning: GATE2016-1-GA08 [top](#)<http://gateoverflow.in/39617>

Consider the following statements relating to the level of poker play of four players P, Q, R and S .

- I. P always beats Q
- II. R always beats S
- III. S loses to P only sometimes.
- IV. R always loses to Q

Which of the following can be logically inferred from the above statements?

- i. P is likely to beat all the three other players
- ii. S is the absolute worst player in the set
- A. (i). only
- B. (ii) only
- C. (i) and (ii) only
- D. neither (i) nor (ii)

[gate2016-1](#) | [numerical-ability](#) | [logical-reasoning](#) | [normal](#)

[Answer](#)

15.5.3 Logical Reasoning: GATE2016-1-GA04 [top](#)<http://gateoverflow.in/39609>

If 'reftaga' means carefree, 'otaga' means careful and 'fertaga' means careless, which of the following could mean 'aftercare'?

- A. zentaga
- B. tagafer.
- C. tagazen.
- D. refffer.

[gate2016-1](#) | [verbal-ability](#) | [logical-reasoning](#) | [normal](#)

[Answer](#)

15.5.4 Logical Reasoning: GATE 2015 Aptitude Set 4 Q4 [top](#)<http://gateoverflow.in/40169>

Q.4 Tanya is older than Eric.
 Cliff is older than Tanya.
 Eric is older than Cliff.
 If the first two statements are true, then the third statement is:
 (A) True
 (B) False
 (C) Uncertain
 (D) Data insufficient

[gate2015aptiset4](#) aptitude logical-reasoning

Answer

15.5.5 Logical Reasoning: gate2013-ee-5 [top](#)

<http://gateoverflow.in/40292>

Q.60 **Statement:** You can always give me a ring whenever you need.
 Which one of the following is the best inference from the above statement?
 (A) Because I have a nice caller tune.
 (B) Because I have a better telephone facility.
 (C) Because a friend in need is a friend indeed.
 (D) Because you need not pay towards the telephone bills when you give me a ring.

[gate2013-ee](#) logical-reasoning

Answer

15.5.6 Logical Reasoning: GATE2012-AR-8 [top](#)

<http://gateoverflow.in/40229>

Ravi is taller than Arun but shorter than Iqbal. Sam is shorter than Ravi. Mohan is shorter than Arun. Balu is taller than Mohan and Sam. The tallest person can be

- (A) Mohan (B) Ravi (C) Balu (D) Arun

[gate2012-ar](#) aptitude logical-reasoning verbal-ability

Answer

15.5.7 Logical Reasoning: gate2013-ce-10 [top](#)

<http://gateoverflow.in/40280>

Q.65 Abhishek is elder to Savar. Savar is younger to Anshul. Which of the given conclusions is logically valid and is inferred from the above statements?
 (A) Abhishek is elder to Anshul
 (B) Anshul is elder to Abhishek
 (C) Abhishek and Anshul are of the same age
 (D) No conclusion follows

[gate2013-ce](#) logical-reasoning

Answer

15.5.8 Logical Reasoning: GATE-2013-AE-GA-9 [top](#)

<http://gateoverflow.in/40250>

Q.65 All professors are researchers Some scientists are professors Which of the given conclusions is logically valid and is inferred from the above arguments:

- (A) All scientists are researchers
- (B) All professors are scientists
- (C) Some researchers are scientists
- (D) No conclusion follows

[gate2013-ae](#) [verbal-ability](#) [logical-reasoning](#)

[Answer](#)

15.5.9 Logical Reasoning: GATE-2013-AE-GA-3 [top](#)

<http://gateoverflow.in/40244>

Q.58 Mahatama Gandhi was known for his humility as

- (A) he played an important role in humiliating exit of British from India.
- (B) he worked for humanitarian causes.
- (C) he displayed modesty in his interactions.
- (D) he was a fine human being

[gate2013-ae](#) [verbal-ability](#) [logical-reasoning](#)

[Answer](#)

Answers: Logical Reasoning

15.5.1 Logical Reasoning: GATE 2016-2-GA-08 [top](#)

<http://gateoverflow.in/39534>



Selected Answer

All hill stations have a lake. \implies For all x ($h(x) \implies (\exists y, l(y) \wedge \text{has}(x,y))$)

Ooty has two lakes \implies There exist x ($o(x) \wedge \exists y,z$ ($\text{has}(x,y,z) \wedge l(y) \wedge l(z) \wedge (z \neq y)$))

Here $h(x) \implies x$ is hill station

$l(x) \implies x$ is lake

$\text{has}(x,y) \implies x$ has y

$\text{has}(x,y,z) \implies x$ has y, z

$o(x) \implies x$ is ooty

(i)

Ooty is not a hill station. \implies we can not derive this above arguments, Ooty has two lakes already, if Ooty had 0 lakes only then this can become true.

(ii)

No hill station can have more than one lake

All arguments here are saying are if we have hill station, it can have lake. It is nowhere told that how many lakes it has ! So this is false .

Answer \Rightarrow (D) neither (i) nor (ii)

9 votes

-- Akash (31.7k points)

15.5.2 Logical Reasoning: GATE2016-1-GA08 [top](#)

<http://gateoverflow.in/39617>



Selected Answer

i think answer is d because

i) p is not likely to beat s because s only loses sometimes to p

ii) s is not worst player because he is likely to beat p

23 votes

-- Vaibhav Singh (521 points)

15.5.3 Logical Reasoning: GATE2016-1-GA04 [top](#)



Selected Answer

relf taga = care free

o taga = care full

fer taga = care less

Hence taga means care, and if present in the second part, care comes in the first part in English translation.

For after care, "taga-fer" and "taga-zen" are the options. But "fer" means less.

Hence **answer is C**

15 votes

-- ryan sequeira (1.6k points)

15.5.4 Logical Reasoning: GATE 2015 Aptitude Set 4 Q4 [top](#)

OPTION (B)
CLIFF < TANYA < ERIC

1 votes -- Shah Himadri Satishbhai (181 points)

15.5.5 Logical Reasoning: gate2013-ee-5 [top](#)



Selected Answer

C) seems to be an appropriate option.

2 votes

-- Monanshi Jain (6.5k points)

15.5.6 Logical Reasoning: GATE2012-AR-8 [top](#)

BALU IS TALLEST.

Ravi can't be the answer since its clearly mentioned that ravi < iqbal.

Iqbal and balu could be tallest as no comparison is provided where these two are smaller than anyone.

Since Iqbal is not mentioned in options. 😊

Hence we may conclude that Balu is tallest.

3 votes -- Govind Krishna Tewari (179 points)

15.5.7 Logical Reasoning: gate2013-ce-10 [top](#)

<http://gateoverflow.in/40220>



Selected Answer

D) No conclusion follows as we cannot derive any relationship between Abhishek and Anshul with the given data.

5 votes

-- vamsi2376 (2.5k points)

15.5.8 Logical Reasoning: GATE-2013-AE-GA-9 [top](#)

<http://gateoverflow.in/40250>



Selected Answer

Answer C: If some scientists are professors and all professors are researchers, then that means that some scientists are researchers.

2 votes

-- Kathleen Bankson (47.9k points)

15.5.9 Logical Reasoning: GATE-2013-AE-GA-3 [top](#)

<http://gateoverflow.in/40244>

Answer C: He displayed modesty in his interactions.

hu·mil·i·ty

(h)yoo'milədē/

noun

a modest or low view of one's own importance; humbleness.

synonyms: [modesty](#), humbleness, [meekness](#), [diffidence](#), unassertiveness; [More](#)

2 votes

-- Kathleen Bankson (47.9k points)

15.6

Meaning [top](#)

15.6.1 Meaning: GATE2014-EC04-GA2 [top](#)

<http://gateoverflow.in/41464>

After the discussion, Tom said to me, 'Please revert!'. He expects me to _____.

- A. Retract
- B. Get back to him
- C. Move in reverse
- D. Retreat

[gate2014-ec04](#) [verbal-ability](#) [meaning](#) [easy](#)

Answer

15.6.2 Meaning: GATE2014-EC04-GA3 [top](#)

<http://gateoverflow.in/41465>

While receiving the award, the scientist said, "I feel vindicated". Which of the following is closest in meaning to the word 'vindicated'?

- A. Punished
- B. Substantiated
- C. Appreciated
- D. Chastened

[gate2014-ec04](#) [verbal-ability](#) [meaning](#) [normal](#)

Answer

15.6.3 Meaning: GATE2014-EC04-GA1 [top](#)

<http://gateoverflow.in/41463>

Which of the following options is the closest in meaning to the word underlined in the sentence below?

In a democracy, everybody has the freedom to **disagree** with the government.

- A. Dissent
- B. Descent
- C. Decent
- D. Decadent

[gate2014-ec04](#) [verbal-ability](#) [meaning](#) [normal](#)

Answer

15.6.4 Meaning: GATE2014-1_GA_1 [top](#)

<http://gateoverflow.in/56>

Which of the following options is the closest in meaning to the phrase in bold in the sentence below?

It is fascinating to see life forms **cope with** varied environmental conditions.

- (A) Adopt to
- (B) Adapt to
- (C) Adept in
- (D) Accept with

[verbal-ability](#) [gate2014-1](#) [meaning](#) [easy](#)

Answer

15.6.5 Meaning: GATE2016-1-GA02 [top](#)

<http://gateoverflow.in/39607>

A rewording of something written or spoken is a _____.

- A. paraphrase
- B. paradox
- C. paradigm
- D. paraffin

[gate2016-1](#) [verbal-ability](#) [meaning](#) [normal](#)

Answer

15.6.6 Meaning: GATE2013_56 [top](#)

<http://gateoverflow.in/1559>

Which one of the following options is the closest in meaning to the word given below?

Nadir

- (A) Highest
- (B) Lowest
- (C) Medium
- (D) Integration

[gate2013](#) [verbal-ability](#) [meaning](#) [normal](#)

Answer

15.6.7 Meaning: GATE2012_58 [top](#)

<http://gateoverflow.in/2197>

Which one of the following options is the closest in meaning to the word given below?

Mitigate

- (A) Diminish
- (B) Divulge
- (C) Dedicate
- (D) Denote

[gate2012](#) [verbal-ability](#) [meaning](#) [easy](#)
[Answer](#)**15.6.8 Meaning: GATE2011_56** [top](#)<http://gateoverflow.in/2165>

Which of the following options is the closest in the meaning to the word below:

Inexplicable

- (A) Incomprehensible
- (B) Indelible
- (C) Inextricable
- (D) Infallible

[gate2011](#) [verbal-ability](#) [meaning](#) [normal](#)
[Answer](#)**15.6.9 Meaning: GATE2014-2_GA_3** [top](#)<http://gateoverflow.in/1940>

Match the columns.

Column 1 Column 2

- | | |
|--------------|--------------------|
| 1) eradicate | P) misrepresent |
| 2) distort | Q) soak completely |
| 3) saturate | R) use |
| 4) utilize | S) destroy utterly |

- (A) 1:S, 2:P, 3:Q, 4:R
- (B) 1:P, 2:Q, 3:R, 4:S
- (C) 1:Q, 2:R, 3:S, 4:P
- (D) 1:S, 2:P, 3:R, 4:Q

[gate2014-2](#) [verbal-ability](#) [meaning](#) [normal](#)
[Answer](#)**15.6.10 Meaning: GATE2015-2_GA_2** [top](#)<http://gateoverflow.in/8029>

Choose the statement where underlined word is used correctly.

- A. The industrialist had a personnel jet.
- B. I write my experience in my personnel diary.
- C. All personnel are being given the day off.
- D. Being religious is a personnel aspect.

[gate2015-2](#) [verbal-ability](#) [meaning](#) [normal](#)
[Answer](#)**15.6.11 Meaning: GATE2015-1_GA_7** [top](#)<http://gateoverflow.in/8011>

Select the alternative meaning of the underlined part of the sentence.

The chain snatchers took to their heels when the police party arrived.

- A. Took shelter in a thick jungle
 B. Open indiscriminate fire
 C. Took to flight
 D. Unconditionally surrendered

gate2015-1 | verbal-ability | meaning | easy

[Answer](#)

15.6.12 Meaning: GATE2010-57 [top](#)

<http://gateoverflow.in/2365>

Which of the following options is the closest in meaning to the word given below:

Circuitous

- A. cyclic
 B. indirect
 C. confusing
 D. crooked

gate2010 | verbal-ability | meaning | normal

[Answer](#)

15.6.13 Meaning: GATE 2016-2-GA-02 [top](#)

<http://gateoverflow.in/3951>

Nobody knows how the Indian cricket team is going to cope with the difficult and seamer-friendly wickets in Australia.

Choose the option which is closest in meaning to the underlined phrase in the above sentence.

- A. Put up with.
 B. Put in with.
 C. Put down to.
 D. Put up against.

gate2016-2 | verbal-ability | meaning | normal

[Answer](#)

Answers: Meaning

15.6.1 Meaning: GATE2014-EC04-GA2 [top](#)

<http://gateoverflow.in/41464>

Revert means to get back..
 Answer B) Get back to him

3 votes

-- Abhilash Panicker (7k points)

15.6.2 Meaning: GATE2014-EC04-GA3 [top](#)

<http://gateoverflow.in/41465>

option B

Vindicated means to free from allegation(unproved) and substantiate means prove the truth of.

1 votes

-- Prateek Banra (75 points)

15.6.3 Meaning: GATE2014-EC04-GA1 [top](#)<http://gateoverflow.in/41463>

Selected Answer

Ans will be (A) Dissent , which means disagree

Upvote 2 votes

-- srestha (27.8k points)

15.6.4 Meaning: GATE2014-1_GA_1 [top](#)<http://gateoverflow.in/56>

Selected Answer

Answer is Adapt to. Often seen in newspaper "Indian players couldn't adapt to foreign conditions".

Adopt - means legally take care of. Also means to take up and use as in "He adopted my point of view."

Adept in - means smart in. Example- "Sachin is adept in batting."

Upvote 8 votes

-- Arjun Suresh (150k points)

15.6.5 Meaning: GATE2016-1-GA02 [top](#)<http://gateoverflow.in/39607>

Selected Answer

paraphrase

paradox: a statement that apparently contradicts itself and yet might be true

paradigm: a typical example or pattern of something

paraffin: a white or colorless, tasteless, odorless, water-insoluble, solid substance not easily acted upon by reagents

Upvote 11 votes

-- Pooja (25.9k points)

15.6.6 Meaning: GATE2013_56 [top](#)<http://gateoverflow.in/1559>

Selected Answer

B, the lowest point

Upvote 5 votes

-- Kathleen Bankson (47.9k points)

15.6.7 Meaning: GATE2012_58 [top](#)<http://gateoverflow.in/2197>

Selected Answer

A. Diminish

Upvote 4 votes

-- Kathleen Bankson (47.9k points)

15.6.8 Meaning: GATE2011_56 [top](#)<http://gateoverflow.in/2165>

Selected Answer

answer is (a)

Inexplicable => difficult or impossible to explain

Incomprehensible => difficult or impossible to understand or comprehend => Most appropriate

Indelible => impossible to remove, erase or wash away => Not appropriate

Inextricable => unavoidable , inescapable => Not appropriate

Infallible => completely dependable or trustworthy => irrelevant

Upvote 7 votes

-- Kalpana Bhargav (3k points)

15.6.9 Meaning: GATE2014-2_GA_3 [top](#)

<http://gateoverflow.in/7940>



Selected Answer

Answer is A

Upvote 6 votes

-- Poshita Shrivastava (1k points)

15.6.10 Meaning: GATE2015-2_GA_2 [top](#)

<http://gateoverflow.in/8029>



Selected Answer

Answer: C

Personnel: People employed in an organization or engaged in an organized undertaking such as military service.

Option A,B,D should use the word personal.

Upvote 5 votes

-- Rajarshi Sarkar (29.7k points)

15.6.11 Meaning: GATE2015-1_GA_7 [top](#)

<http://gateoverflow.in/8011>



Selected Answer

C Took to flight

Upvote 5 votes

-- Kathleen Bankson (47.9k points)

15.6.12 Meaning: GATE2010-57 [top](#)

<http://gateoverflow.in/2365>



Selected Answer

B Indirect

Synonyms for circuitous

adj going around, indirect

Upvote 5 votes

-- Kathleen Bankson (47.9k points)

15.6.13 Meaning: GATE 2016-2-GA-02 [top](#)<http://gateoverflow.in/39531>

Selected Answer

but the closest meaning to cope with is put up with which means to tolerate. Cope with does not mean to place someone into competition with someone else.

8 votes

-- UK (1.5k points)

15.7**Most Appropriate Alternative** [top](#)**15.7.1 Most Appropriate Alternative: GATE 2015 Aptitude Set 1 Q3** [top](#) <http://gateoverflow.in/39491>

Choose the word most similar in meaning to the given word:

Educe

- (A) Exert (B) Educate (C) Extract (D) Extend

[gate2015aptiset1](#) [meaning](#) [most-appropriate-alternative](#)

Answer

15.7.2 Most Appropriate Alternative: GATE2012-CY-GA-5 [top](#)<http://gateoverflow.in/40236>

Q.60 Choose the most appropriate alternative from the options given below to complete the following sentence:

If the tired soldier wanted to lie down, he ___ the mattress out on the balcony.

- (A) should take
 (B) shall take
 (C) should have taken
 (D) will have taken

[gate2012-cy](#) [aptitude](#) [most-appropriate-alternative](#) [english-grammar](#) [verbal-ability](#)

Answer

15.7.3 Most Appropriate Alternative: GATE-2012-AE-2 [top](#)<http://gateoverflow.in/40213>

Choose the most appropriate alternative from the options given below to complete the following sentence:

Food prices ___ again this month.

- (A) have raised (B) have been raising
 (C) have been rising (D) have arose

[gate2012-ae](#) [aptitude](#) [verbal-ability](#) [most-appropriate-alternative](#)

Answer

15.7.4 Most Appropriate Alternative: GATE-2012-AE-1 [top](#)<http://gateoverflow.in/40212>

Choose the most appropriate alternative from the options given below to complete the following sentence:

I ___ to have bought a diamond ring.

- (A) have a liking (B) should have liked

(C) would like (D) may like

gate2012-ae aptitude most-appropriate-alternative verbal-ability

Answer

Answers: Most Appropriate Alternative

15.7.1 Most Appropriate Alternative: GATE 2015 Aptitude Set 1 Q3 [top](#) <http://gateoverflow.in/39491>

Ans : [B]

Educe : bring out or develop (something latent or potential).

(a)Exert : make a physical or mental effort.

(b)Educate : give (someone) training in or information on a particular field.

(c)Extract : remove or take out, especially by effort or force.

(d)Extend : to extend

Hence ,ans is Option B

1 votes

-- Desert_Warrior (6.6k points)

15.7.2 Most Appropriate Alternative: GATE2012-CY-GA-5 [top](#) <http://gateoverflow.in/40236>

Answer C: If the tired soldier wanted to lie down, he should have taken the mattress out on the balcony.

2 votes

-- Kathleen Bankson (47.9k points)

15.7.3 Most Appropriate Alternative: GATE-2012-AE-2 [top](#) <http://gateoverflow.in/40233>



Selected Answer

Food price **have been rising** again this month.
Answer C.

- A) wrong - have risen
- B) wrong
- D)wrong - have risen

0 votes

-- Abhilash Panicker (7k points)

A->have raised

0 votes

-- Joker (735 points)

15.7.4 Most Appropriate Alternative: GATE-2012-AE-1 [top](#) <http://gateoverflow.in/40212>



Selected Answer

Ans C

I would like to have bought a diamond ring.

1 votes

-- Abhilash Panicker (7k points)

15.8

Most Appropriate Word [top](#)

15.8.1 Most Appropriate Word: GATE2012-CY-GA-4 [top](#)

<http://gateoverflow.in/40235>

Q.59 Choose the most appropriate word from the options given below to complete the following sentence:

Given the seriousness of the situation that he had to face, his ____ was impressive.

- (A) beggary
- (B) nomenclature
- (C) jealousy
- (D) nonchalance

[gate2012-cy](#) [aptitude](#) [most-appropriate-word](#)

[Answer](#)

15.8.2 Most Appropriate Word: GATE2011_58 [top](#)

<http://gateoverflow.in/2167>

Choose the most appropriate word(s) from the options given below to complete the following sentence.

I contemplated _____ Singapore for my vacation but decided against it.

- (A) to visit
- (B) having to visit
- (C) visiting
- (D) for a visit

[gate2011](#) [verbal-ability](#) [most-appropriate-word](#) [easy](#)

[Answer](#)

15.8.3 Most Appropriate Word: GATE2014-AG-GA2 [top](#)

<http://gateoverflow.in/41665>

Choose the most appropriate word from the options given below to complete the following sentence. _____ is the key to their happiness; they are satisfied with what they have.

- A. Contentment
- B. Ambition
- C. Perseverance
- D. Hunger

[gate2014-ag](#) [verbal-ability](#) [most-appropriate-word](#) [easy](#)

[Answer](#)

15.8.4 Most Appropriate Word: GATE2014-EC01-GA1 [top](#)

<http://gateoverflow.in/41490>

Choose the most appropriate phrase from the options given below to complete the following sentence.

The aircraft _____ take off as soon as its flight plan was filed.

- A. Is allowed to
- B. Will be allowed to
- C. Was allowed to
- D. Has been allowed to

[gate2014-ec01](#) [verbal-ability](#) [most-appropriate-word](#) [easy](#)

[Answer](#)

15.8.5 Most Appropriate Word: gate2013-ce-4 [top](#)

<http://gateoverflow.in/40271>

Friendship, no matter how _____ it is, has its limitations.

- A. cordial
- B. intimate
- C. secret
- D. pleasant

[gate2013-ce](#) [most-appropriate-word](#)[Answer](#)

15.8.6 Most Appropriate Word: GATE2014-AG-GA1 [top](#)

<http://gateoverflow.in/41660>

Choose the most appropriate word from the options given below to complete the following sentence. A person suffering from Alzheimer's disease _____ short-term memory loss.

- A. Experienced
- B. Has experienced
- C. Is experiencing
- D. Experiences

[gate2014-ag](#) [verbal-ability](#) [most-appropriate-word](#) [normal](#)[Answer](#)

15.8.7 Most Appropriate Word: gate-2014-ae-2 [top](#)

<http://gateoverflow.in/40301>

Q.2 Choose the most appropriate word from the options given below to complete the following sentence.

One of his biggest _____ was his ability to forgive.
(A) vice (B) virtues (C) choices (D) strength

[gate-2014-ae](#) [most-appropriate-word](#)[Answer](#)

15.8.8 Most Appropriate Word: GATE2012_60 [top](#)

<http://gateoverflow.in/2200>

Choose the most appropriate alternative from the options given below to complete the following sentence:

Suresh's dog is the one ----- was hurt in the stampede.

- (A) that
- (B) which
- (C) who
- (D) whom

[gate2012](#) [verbal-ability](#) [most-appropriate-word](#) [normal](#)[Answer](#)

15.8.9 Most Appropriate Word: GATE2014-EC02-GA3 [top](#)

<http://gateoverflow.in/41510>

Choose the most appropriate pair of words from the options given below to complete the following sentence.

She could not _____ the thought of _____ the election to her bitter rival.

- A. Bear, loosing
- B. Bare, loosing
- C. Bear, losing
- D. Bare, losing

[gate2014-ec02](#) | [most-appropriate-word](#)

Answer

15.8.10 Most Appropriate Word: GATE2014-EC03-GA2 [top](#)

<http://gateoverflow.in/41141>

The value of one U.S. dollar is 65 Indian Rupees today, compared to 60 last year. The Indian Rupee has _____.

- A. Depressed
- B. Depreciated
- C. Appreciated
- D. Stabilized

[gate2014-ec03](#) | [most-appropriate-word](#)

Answer

15.8.11 Most Appropriate Word: GATE2014-2_GA_1 [top](#)

<http://gateoverflow.in/1938>

Choose the most appropriate phrase from the options given below to complete the following sentence.

India is a post-colonial country because

- (A) it was a former British colony
- (B) Indian Information Technology professionals have colonized the world
- (C) India does not follow any colonial practices
- (D) India has helped other countries gain freedom

[gate2014-2](#) | [verbal-ability](#) | [most-appropriate-word](#) | [easy](#)

Answer

15.8.12 Most Appropriate Word: GATE2014-EC01-GA3 [top](#)

<http://gateoverflow.in/41492>

Choose the most appropriate word from the options given below to complete the following sentence.

Many ancient cultures attributed disease to supernatural causes. However, modern science has largely helped _____ such notions.

- A. Impel
- B. Dispel
- C. Propel
- D. Repel

[gate2014-ec01](#) | [most-appropriate-word](#)

Answer

15.8.13 Most Appropriate Word: GATE 2013-ee-3 [top](#)

<http://gateoverflow.in/40290>

Complete the sentence:

Dare _____ mistakes.

- (A) commit
- (B) to commit
- (C) committed
- (D) committing

[gate2013-ee](#) | [most-appropriate-word](#) | [easy](#)

Answer**15.8.14 Most Appropriate Word: GATE2011_59 [top](#)**<http://gateoverflow.in/2169>

Choose the most appropriate word from the options given below to complete the following sentence.

If you are trying to make a strong impression on your audience, you cannot do so by being understated, tentative or _____.

- (A) hyperbolic
- (B) restrained
- (C) argumentative
- (D) indifferent

[gate2011](#) [verbal-ability](#) [most-appropriate-word](#) [normal](#)
Answer**15.8.15 Most Appropriate Word: GATE2011_GG_GA_5 [top](#)**<http://gateoverflow.in/40206>

Choose the most appropriate words from the options given below to complete the following sentence.

Because she had a reputation for _____ we were surprised and pleased when she greeted us so _____.

- (A) insolence irately
- (B) insouciance curtly
- (C) graciousness amiably
- (D) querulousness affably

[gate2011_gg](#) [most-appropriate-word](#) [verbal-ability](#)
Answer**15.8.16 Most Appropriate Word: GATE-2012-AE-4 [top](#)**<http://gateoverflow.in/40215>

Choose the most appropriate alternative from the options given below to complete the following sentence:

To those of us who had always thought him timid, his ___ came as a surprise.

- (A) intrepidity
- (B) inevitability
- (C) inability
- (D) inertness

[gate2012-ae](#) [aptitude](#) [verbal-ability](#) [most-appropriate-word](#)
Answer**15.8.17 Most Appropriate Word: GATE2010-58 [top](#)**<http://gateoverflow.in/2366>

Choose the most appropriate word from the options given below to complete the following sentence:

If we manage to _____ our natural resources, we would leave a better planet for our children.

- A. uphold
- B. restrain
- C. cherish
- D. conserve

[gate2010](#) [verbal-ability](#) [most-appropriate-word](#) [easy](#)

Answer**15.8.18 Most Appropriate Word: GATE2012-AR-2** [top](#)<http://gateoverflow.in/40223>

Choose the most appropriate pair of words from the options given below to complete the following sentence:

The high level of ___ of the questions in the test was ___ by an increase in the period of time allotted for answering them.

- A. difficulty, compensated
- B. exactitude, magnified
- C. aptitude, decreased
- D. attitude, mitigated

[gate2012-ar](#) [aptitude](#) [most-appropriate-word](#) [verbal-ability](#) [normal](#)
Answer**15.8.19 Most Appropriate Word: GATE2010-56** [top](#)<http://gateoverflow.in/2364>

Choose the most appropriate word from the options given below to complete the following sentence:

His rather casual remarks on politics _____ his lack of seriousness about the subject.

- A. masked
- B. belied
- C. betrayed
- D. suppressed

[gate2010](#) [verbal-ability](#) [most-appropriate-word](#) [normal](#)
Answer**15.8.20 Most Appropriate Word: GATE 2015 Aptitude Set 1 Q1** [top](#)<http://gateoverflow.in/39489>

Choose the most appropriate word from the options given below to complete the following sentence.

The principal presented the chief guest with a _____, as token of appreciation.

- (A) momento (B) memento (C) momentum (D) moment

[gate2015aptiset1](#) [most-appropriate-word](#)
Answer**15.8.21 Most Appropriate Word: GATE_2011_MN_57** [top](#)<http://gateoverflow.in/31522>

Q.57 Choose the most appropriate word(s) from the options given below to complete the following sentence.

We lost confidence in him because he never _____ the grandiose promises he had made.

- (A) delivered
- (B) delivered on
- (C) forgot
- (D) reneged on

[gate2011-mn](#) [verbal-ability](#) [most-appropriate-word](#)
Answer**15.8.22 Most Appropriate Word: GATE 2015 Aptitude Set 1 Q2** [top](#)<http://gateoverflow.in/39490>

Choose the appropriate word/phrase, out of the four options given below, to complete the following sentence:

Frogs _____.

(A) croak (B) roar (C) hiss (D) patter

gate2015aptiset1 | most-appropriate-word

Answer

15.8.23 Most Appropriate Word: GATE2014-1_GA_2 top

<http://gateoverflow.in/771>

Choose the most appropriate word from the options given below to complete the following sentence.

He could not understand the judges awarding her the first prize, because he thought that her performance was quite _____.

- A. superb
- B. medium
- C. mediocre
- D. exhilarating

gate2014-1 | verbal-ability | most-appropriate-word | easy

Answer

15.8.24 Most Appropriate Word: GATE2011_GG_GA_3 top

<http://gateoverflow.in/40204>

"> Q.58 Choose the most appropriate word from the options given below to complete the following sentence.

Despite the mixture's _____ nature, we found that by lowering its temperature in the laboratory we could dramatically reduce its tendency to vaporize.

- (A) acerbic
- (B) resilient
- (C) volatile
- (D) heterogeneous

gate2011_gg | verbal-ability | most-appropriate-word

Answer

Answers: Most Appropriate Word

15.8.1 Most Appropriate Word: GATE2012-CY-GA-4 top

<http://gateoverflow.in/40235>

**Beggary is poverty which seems wrong
Nomenclature is choosing names for things which also seems wrong
jealousy Wrong
So The Correction Option is D
Nonchalance which means casualness or the state of being relaxed...**

2 votes

-- saif ahmed (1.5k points)

15.8.2 Most Appropriate Word: GATE2011_58 top

<http://gateoverflow.in/2167>

C) visiting

4 votes

-- Poshita Shrivastava (1k points)

15.8.3 Most Appropriate Word: GATE2014-AG-GA2 [top](#)<http://gateoverflow.in/41665>

Selected Answer

Ans : A

contentment means a state of happiness and satisfaction.

7 votes

-- Marylyn Joseph (205 points)

15.8.4 Most Appropriate Word: GATE2014-EC01-GA1 [top](#)<http://gateoverflow.in/41490>

Option C

2 votes

-- saif ahmed (1.5k points)

15.8.5 Most Appropriate Word: gate2013-ce-4 [top](#)<http://gateoverflow.in/40271>

Selected Answer

B) Intimate

Statement says about limitations of friendship and our required word follows "no matter how" meaning it should be something which increases the friendship bond.

3 votes

-- vamsi2376 (2.5k points)

15.8.6 Most Appropriate Word: GATE2014-AG-GA1 [top](#)<http://gateoverflow.in/41660>**I am assuming blank space is after the word "disease" because it makes sense***A person suffering from Alzheimer's disease short-term memory loss***So the answer should be option D**

4 votes

-- saif ahmed (1.5k points)

15.8.7 Most Appropriate Word: gate-2014-ae-2 [top](#)<http://gateoverflow.in/40301>

Selected Answer

B) Virtues

Virtues is related to moral standards while strength is related to physical ability.

3 votes

-- Monanshi Jain (6.5k points)

15.8.8 Most Appropriate Word: GATE2012_60 [top](#)<http://gateoverflow.in/2200>

Selected Answer

A....that

Who and whom are people, not dogs.

Regarding that and which...

Restrictive Clause—That

A [restrictive clause](#) is just part of a sentence that you can't get rid of because it specifically restricts some other part of the sentence. Here's an example:

- Gems that sparkle often elicit forgiveness.

The words *that sparkle* restrict the kind of gems you're talking about. Without them, the meaning of the sentence would change. Without them, you'd be saying that all gems elicit forgiveness, not just the gems that sparkle. (And note that you don't need [commas](#) around the words *that sparkle*.)

Nonrestrictive Clause—Which

A [nonrestrictive clause](#) is something that can be left off without changing the meaning of the sentence. You can think of a nonrestrictive clause as simply additional information. Here's an example:

- Diamonds, which are expensive, often elicit forgiveness.

7 votes

-- Kathleen Bankson (47.9k points)

15.8.9 Most Appropriate Word: GATE2014-EC02-GA3 [top](#)

<http://gateoverflow.in/41510>



Selected Answer

Ans : Option C

bear means to carry (*in this context*)

losing OR loosing ?

loose is opposite of tight. Hence losing

4 votes

-- Desert_Warrior (6.6k points)

15.8.10 Most Appropriate Word: GATE2014-EC03-GA2 [top](#)

<http://gateoverflow.in/41141>



Selected Answer

Ans: B) **Depreciated** meaning diminish in value over a period of time.

2 votes

-- biranchi (1k points)

15.8.11 Most Appropriate Word: GATE2014-2_GA_1 [top](#)

<http://gateoverflow.in/1938>



Selected Answer

Ans is A

2 votes

-- Keith Kr (6k points)

15.8.12 Most Appropriate Word: GATE2014-EC01-GA3 [top](#)

<http://gateoverflow.in/41492>

dispel is best suitable word bcz dispel means do away

2 votes

-- **rajan** (2.1k points)

15.8.13 Most Appropriate Word: GATE 2013-ee-3 [top](#)



Selected Answer

commit

Dare commit mistakes. Option A

2 votes

-- **Sreyas S** (1.6k points)

Answer : [B]

Dare to commit mistakes.

2 votes

-- **Desert_Warrior** (6.6k points)

15.8.14 Most Appropriate Word: GATE2011_59 [top](#)

B) restrained

3 votes

-- **Poshita Shrivastava** (1k points)

15.8.15 Most Appropriate Word: GATE2011_GG_GA_5 [top](#)

(D)

Explanation : As the sentence reveals both the words should be contrasting in nature.

Among the options given (querulous,affable) is the only contrasting pair.

2 votes

-- **Sourav Mishra** (2.7k points)

15.8.16 Most Appropriate Word: GATE-2012-AE-4 [top](#)

(A)

Explanation : Timid means fearful and Intrepid means fearless which is the most suitable contrast.

2 votes

-- **Sourav Mishra** (2.7k points)

15.8.17 Most Appropriate Word: GATE2010-58 [top](#)



Selected Answer

answer is (d)

Uphold : cause to remain => **Not appropriate**

Restrain : keep under control => **Not appropriate**

Cherish : be fond of => **Not related**

Conserve : keep in safety and protect from harm , decay, loss or destruction => **most appropriate**

6 votes

-- Kalpana Bhargav (3k points)

15.8.18 Most Appropriate Word: GATE2012-AR-2 [top](#)

<http://gateoverflow.in/40223>



Selected Answer

(A) difficulty, compensated

3 votes

-- Sourav Mishra (2.7k points)

15.8.19 Most Appropriate Word: GATE2010-56 [top](#)

<http://gateoverflow.in/2364>



Selected Answer

answer is option (c)

- (a) Masked : Hide under a false appearance => **opposite**
- (b) Belied : Be in contradiction with => **not appropriate**
- (c) Betrayed : Reveal unintentionally => **most appropriate**
- (d) Suppressed: To put down by force or authority => **irrelevant**

6 votes

-- Kalpana Bhargav (3k points)

15.8.20 Most Appropriate Word: GATE 2015 Aptitude Set 1 Q1 [top](#)

<http://gateoverflow.in/39489>



Selected Answer

I think the ans is memento. :) option B) nd it is correct.. there is no such word as momento ,memento is spelled as "momento "

2 votes

-- Ritaban Basu (435 points)

15.8.21 Most Appropriate Word: GATE_2011_MN_57 [top](#)

<http://gateoverflow.in/31522>

Ans => B

B) Delivered on is most appropriate.

A) Delivered this is not correct because of "The" in next part. Does not sound appropriate.

(C) forgot Does not fit properly

(D) reneged on => This does not seem appropriate, As he never go back on a promise then we should not loose confidence !

2 votes

-- Akash (31.7k points)

15.8.22 Most Appropriate Word: GATE 2015 Aptitude Set 1 Q2 [top](#)<http://gateoverflow.in/39490>

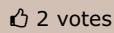
Selected Answer

Ans : [A] Frogs croak

here are the links: experience it... :)

<https://youtu.be/GUcfvd0X9rg>https://youtu.be/p7_kJXNytnw

Also more info :

Lion roarcat hissmice patter

2 votes

-- Desert_Warrior (6.6k points)

15.8.23 Most Appropriate Word: GATE2014-1_GA_2 [top](#)<http://gateoverflow.in/771>

Selected Answer

C. Mediocre meaning not very good, not up to par, average. Her performance was average and not worthy of 1st prize.



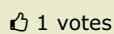
7 votes

-- Kathleen Bankson (47.9k points)

15.8.24 Most Appropriate Word: GATE2011_GG_GA_3 [top](#)<http://gateoverflow.in/40204>

(C)

Explanation : Tendency to vaporize is the nature of volatile substances.



1 votes

-- Sourav Mishra (2.7k points)

15.9**Odd One** [top](#)**15.9.1 Odd One: GATE2014-EC02-GA6** [top](#)<http://gateoverflow.in/41513>

Find the odd one in the following group

Q,W,Z,B B,H,K,M W,C,G,J M,S,V,X

- A. Q,W,Z,B
- B. B,H,K,M
- C. W,C,G,J
- D. M,S,V,X

[gate2014-ec02](#) [verbal-ability](#) [verbal-reasoning](#) [odd-one](#) [normal](#)

Answer

15.9.2 Odd One: GATE 2016-2-GA-03 [top](#)<http://gateoverflow.in/39530>

Find the odd one in the following group of words.

mock, deride, praise, jeer

- A. Mock
B. Deride
C. Praise
D. Jeer

gate2016-2 | verbal-ability | odd-one | easy

[Answer](#)

Answers: Odd One

15.9.1 Odd One: GATE2014-EC02-GA6 [top](#)

<http://gateoverflow.in/41513>



Selected Answer

Here in each option

1st letter and 2nd letter difference = 6 letters

2nd and 3rd letter diff = 3 letters

3rd and 4th letter diff = 2 letters

but option (C) is not matching these all criteria

So,

Ans is (C)

6 votes

-- srestha (27.8k points)

15.9.2 Odd One: GATE 2016-2-GA-03 [top](#)

<http://gateoverflow.in/39530>



Selected Answer

Ans C , praise. Rest all have same meaning.

6 votes

-- UK (1.5k points)

15.10

Opposite [top](#)

15.10.1 Opposite: GATE2011_60 [top](#)

<http://gateoverflow.in/2170>

Choose the word from the options given below that is most nearly opposite in the meaning to the given word

Amalgamate

- (A) merge
- (B) split
- (C) collect
- (D) separate

gate2011 | verbal-ability | opposite | normal

[Answer](#)

15.10.2 Opposite: GATE2014-3_GA_3 [top](#)<http://gateoverflow.in/2026>

Choose the word that is opposite in meaning to the word " coherent".

- (A) sticky
- (B) well-connected
- (C) rambling
- (D) friendly

[gate2014-3](#) [verbal-ability](#) [opposite](#) [easy](#)

Answer

Answers: Opposite**15.10.1 Opposite: GATE2011_60** [top](#)<http://gateoverflow.in/2170>

Selected Answer

- (D) separate

amalgamate

/ə'malɡəmeɪt/

verb

verb: amalgamate; 3rd person present: amalgamates; past tense: amalgamated; past participle: amalgamated; gerund or present participle: amalgamating

combine or unite to form one organization or structure.

"he amalgamated his company with another"

synonyms: combine, merge, unite, integrate, fuse, blend, mingle, coalesce, consolidate, meld, intermingle, mix, intermix, incorporate, affiliate, join (together), join forces, band (together), club together, get together, link (up), team up, go into partnership, pool resources; unify; informal gang up, gang together, literary commingle

"the two departments were amalgamated"

antonyms: separate

- [CHEMISTRY](#)

alloy (a metal) with mercury.
"amalgamated zinc"

Origin

early 17th century: from medieval Latin *amalgam-* 'formed into a soft mass', from the verb *amalgamare*, from *amalgama* (see *amalgam*).

reg@https://www.google.co.in/search?

q=Amalgamate&rlz=1C1GIWA_enIN597IN597&oq=Amalgamate&aqs=chrome..69i57&sourceid=chrome&es_sm=93&ie=UTF-8

4 votes

-- Kathleen Bankson (47.9k points)

15.10.2 Opposite: GATE2014-3_GA_3 [top](#)<http://gateoverflow.in/2026>

Selected Answer

C) Rambling

coherent = Logical and clear
Rambling = Confused

4 votes

-- Srinath Sri (2.9k points)

15.11

Passage Reading top15.11.1 Passage Reading: GATE 2015 Aptitude Set 1 Q7 top

<http://gateoverflow.in/3945>

Read the following paragraph and choose the correct statement.

Climate change has reduced human security and threatened human well being. An ignored reality of human progress is that human security largely depends upon environmental security. But on the contrary, human progress seems contradictory to environmental security. To keep up both at the required level is a challenge to be addressed by one and all. One of the ways to curb the climate change may be suitable scientific innovations, while the other may be the Gandhian perspective on small scale progress with focus on sustainability.

- (A) Human progress and security are positively associated with environmental security.
- (B) Human progress is contradictory to environmental security.
- (C) Human security is contradictory to environmental security.
- (D) Human progress depends upon environmental security

[gate2015aptiset1](#) [passage-reading](#)

Answer

15.11.2 Passage Reading: GATE2014-ae-3 top

<http://gateoverflow.in/40302>

Rajan was not happy that Sajan decided to do the project on his own. On observing his unhappiness, Sajan explained to Rajan that he preferred to work independently.

Which one of the statements below is logically valid and can be inferred from the above sentences?

- A). Rajan has decided to work only in a group.
- B). Rajan and Sajan were formed into a group against their wishes.
- C). Sajan had decided to give in to Rajan's request to work with him.
- D). Rajan had believed that Sajan and he would be working together.

[gate-2014-ae](#) [passage-reading](#) [logical-reasoning](#)

Answer

15.11.3 Passage Reading: GATE2010-63 top

<http://gateoverflow.in/2371>

Modern warfare has changed from large scale clashes of armies to suppression of civilian populations. Chemical agents that do their work silently appear to be suited to such warfare; and regrettably, there exist people in military establishments who think that chemical agents are useful tools for their cause.

Which of the following statements best sums up the meaning of the above passage:

- A. Modern warfare has resulted in civil strife.
- B. Chemical agents are useful in modern warfare.
- C. Use of chemical agents in warfare would be undesirable.
- D. People in military establishments like to use chemical agents in war.

[gate2010](#) [verbal-ability](#) [passage-reading](#) [normal](#)

Answer

15.11.4 Passage Reading: GATE 2013-ee-7 [top](#)

<http://gateoverflow.in/40294>

Statement: There were different streams of freedom movements in colonial India carried out by the moderates, liberals, radicals, socialists, and so on.

Which one of the following is the best inference from the above statement?

- (A) The emergence of nationalism in colonial India led to our Independence.
- (B) Nationalism in India emerged in the context of colonialism.
- (C) Nationalism in India is homogeneous.
- (D) Nationalism in India is heterogeneous

[gate2013-ee](#) [passage-reading](#)

[Answer](#)

15.11.5 Passage Reading: GATE2012-AR-10 [top](#)

<http://gateoverflow.in/40231>

The documents expose the cynicism of the government officials – and yet as the media website reflects, not a single newspaper has reported on their existence.

Which one of the following inferences may be drawn with the greatest accuracy from the above passage?

- (A) Nobody other than the government officials knew about the existence of the documents.
- (B) Newspapers did report about the documents but nobody cared.
- (C) Media reports did not show the existence of the documents.
- (D) The documents reveal the attitude of the government officials.

[gate2012-ar](#) [aptitude](#) [verbal-ability](#) [passage-reading](#)

[Answer](#)

15.11.6 Passage Reading: GATE2014-1_GA_6 [top](#)

<http://gateoverflow.in/774>

The Palghat Gap (or Palakkad Gap) , a region about 30 km wide in the southern part of the Western Ghats in India, is lower than the hilly terrain to its north and south. The exact reasons for the formation of this gap are not clear. It results in the neighbouring regions of Tamil Nadu getting more rainfall from the South West monsoon and the neighbouring regions of Kerala having higher summer temperatures.

What can be inferred from this passage?

Select one:

- A. The Palghat gap is caused by high rainfall and high temperatures in southern Tamil Nadu and Kerala
- B. The regions in Tamil Nadu and Kerala that are near the Palghat Gap are low-lying
- C. The low terrain of the Palghat Gap has a significant impact on weather patterns in neighbouring parts of Tamil Nadu and Kerala
- D. Higher summer temperatures result in higher rainfall near the Palghat Gap area

[gate2014-1](#) [verbal-ability](#) [passage-reading](#) [normal](#)

[Answer](#)

15.11.7 Passage Reading: GATE2014-2_GA_6 [top](#)

<http://gateoverflow.in/1943>

The old city of Koenigsberg, which had a German majority population before World War 2, is now called Kaliningrad. After the events of the war, Kaliningrad is now a Russian territory and has a predominantly Russian population. It is bordered by the Baltic Sea on the north and the countries of Poland to the south and west and Lithuania to the east respectively. Which of the statements below can be inferred from this passage?

- (A) Kaliningrad was historically Russian in its ethnic make up
- (B) Kaliningrad is a part of Russia despite it not being contiguous with the rest of Russia
- (C) Koenigsberg was renamed Kaliningrad, as that was its original Russian name

(D) Poland and Lithuania are on the route from Kaliningrad to the rest of Russia

gate2014-2 | verbal-ability | passage-reading | normal

Answer

15.11.8 Passage Reading: GATE2014-2_GA_7 [top](#)

<http://gateoverflow.in/1944>

The number of people diagnosed with dengue fever (contracted from the bite of a mosquito) in north India is twice the number diagnosed last year. Municipal authorities have concluded that measures to control the mosquito population have failed in this region.

Which one of the following statements, if true, does not contradict this conclusion?

- (A) A high proportion of the affected population has returned from neighbouring countries where dengue is prevalent
- (B) More cases of dengue are now reported because of an increase in the Municipal Office's administrative efficiency
- (C) Many more cases of dengue are being diagnosed this year since the introduction of a new and effective diagnostic test
- (D) The number of people with malarial fever (also contracted from mosquito bites) has increased this year

gate2014-2 | verbal-ability | passage-reading | normal

Answer

15.11.9 Passage Reading: GATE2014-3_GA_6 [top](#)

<http://gateoverflow.in/2029>

A dance programme is scheduled for 10.00 a.m. Some students are participating in the programme and they need to come an hour earlier than the start of the event. These students should be accompanied by a parent. Other students and parents should come in time for the programme. The instruction you think that is appropriate for this is

- (A) Students should come at 9.00 a.m. and parents should come at 10.00 a.m.
- (B) Participating students should come at 9.00 a.m. accompanied by a parent, and other parents and students should come by 10.00 a.m.
- (C) Students who are not participating should come by 10.00 a.m. and they should not bring their parents. Participating students should come at 9.00 a.m.
- (D) Participating students should come before 9.00 a.m. Parents who accompany them should come at 9.00 a.m. All others should come at 10.00 a.m.

gate2014-3 | verbal-ability | passage-reading | easy

Answer

15.11.10 Passage Reading: GATE2011_GG_GA_10 [top](#)

<http://gateoverflow.in/40211>

In order to develop to full potential, a baby needs to be physically able to respond to the environment.

It can be inferred from the passage that

- (A) Full physical potential is needed in order for a baby to be able to respond to the environment.
- (B) It is necessary for a baby to be able to physically respond to the environment for it to develop its full potential.
- (C) Response to the environment of physically able babies needs to be developed to its full potential.
- (D) A physically able baby needs to develop its full potential in order to respond to its environment.

gate2011-gg | aptitude | logical-reasoning | passage-reading

Answer

15.11.11 Passage Reading: GATE2014-3_GA_7 [top](#)

<http://gateoverflow.in/2031>

By the beginning of the 20th century, several hypotheses were being proposed, suggesting a paradigm shift in our

understanding of the universe. However, the clinching evidence was provided by experimental measurements of the position of a star which was directly behind our sun.

Which of the following inference(s) may be drawn from the above passage?

- i. Our understanding of the universe changes based on the positions of stars
- ii. Paradigm shifts usually occur at the beginning of centuries
- iii. Stars are important objects in the universe
- iv. Experimental evidence was important in confirming this paradigm shift

(A) (i), (ii) and (iv)

(B) (iii) only

(C) (i) and (iv)

(D) (iv) only

[gate2014-3](#) [verbal-ability](#) [passage-reading](#) [easy](#)

[Answer](#)

15.11.12 Passage Reading: GATE-2012-AE-10 [top](#)

<http://gateoverflow.in/40221>

In the early nineteenth century, theories of social evolution were inspired less by Biology than by the conviction of social scientists that there was a growing improvement in social institutions. Progress was taken for granted and social scientists attempted to discover its laws and phases.

Which one of the following inferences may be drawn with the greatest accuracy from the above passage?

Social scientists

- (A) did not question that progress was a fact.
- (B) did not approve of Biology.
- (C) framed the laws of progress.
- (D) emphasized Biology over Social Sciences.

[gate2012-ae](#) [verbal-ability](#) [passage-reading](#)

[Answer](#)

15.11.13 Passage Reading: GATE2011_61 [top](#)

<http://gateoverflow.in/2171>

Few school curricula include a unit on how to deal with bereavement and grief, and yet all students at some point in their lives suffer from losses through death and parting.

Based on the above passage which topic would not be included in a unit on bereavement?

- (A) how to write a letter of condolence
- (B) what emotional stages are passed through in the healing process
- (C) what the leading causes of death are
- (D) how to give support to a grieving friend

[gate2011](#) [verbal-ability](#) [passage-reading](#) [normal](#)

[Answer](#)

15.11.14 Passage Reading: GATE2012-CY-GA-6 [top](#)

<http://gateoverflow.in/40237>

Q.61 One of the legacies of the Roman legions was discipline. In the legions, military law prevailed and discipline was brutal. Discipline on the battlefield kept units obedient, intact and fighting, even when the odds and conditions were against them.

Which one of the following statements best sums up the meaning of the above passage?

- (A) Thorough regimentation was the main reason for the efficiency of the Roman legions even in adverse circumstances.

- (B) The legions were treated inhumanly as if the men were animals.
 (C) Discipline was the armies' inheritance from their seniors.
 (D) The harsh discipline to which the legions were subjected led to the odds and conditions being against them.

gate2012-cy aptitude verbal-ability passage-reading

[Answer](#)

15.11.15 Passage Reading: GATE2013_63 [top](#)

<http://gateoverflow.in/1567>

After several defeats in wars, Robert Bruce went in exile and wanted to commit suicide. Just before committing suicide, he came across a spider attempting tirelessly to have its net. Time and again, the spider failed but that did not deter it to refrain from making attempts. Such attempts by the spider made Bruce curious. Thus, Bruce started observing the near-impossible goal of the spider to have the net. Ultimately, the spider succeeded in having its net despite several failures. Such act of the spider encouraged Bruce not to commit suicide. And then, Bruce went back again and won many a battle, and the rest is history.

Which one of the following assertions is best supported by the above information?

- (A) Failure is the pillar of success.
 (B) Honesty is the best policy.
 (C) Life begins and ends with adventures.
 (D) No adversity justifies giving up hope.

gate2013 verbal-ability passage-reading normal

[Answer](#)

Answers: Passage Reading

15.11.1 Passage Reading: GATE 2015 Aptitude Set 1 Q7 [top](#)

<http://gateoverflow.in/3945>



Selected Answer

human security largely depends upon environmental security. But on the contrary, human progress seems contradictory to environmental security

From the passage its clear that only B option is correct.

1 vote

-- Anurag Semwal (5.5k points)

15.11.2 Passage Reading: GATE2014-ae-3 [top](#)

<http://gateoverflow.in/40302>



Selected Answer

Answer : [D]

Read passage again. you will get my point.

1 vote

-- Desert_Warrior (6.6k points)

15.11.3 Passage Reading: GATE2010-63 [top](#)

<http://gateoverflow.in/2371>



Selected Answer

D. People in military establishments like to use chemical agents in war.

8 votes

-- Kathleen Bankson (47.9k points)

15.11.4 Passage Reading: GATE 2013-ee-7 [top](#)



Selected Answer

Option D. Hetero means different.

It's clearly mentioned that the movement comprised of moderates, liberals, radicals, socialists and so on.

1 votes

-- Mojo Jojo (3.2k points)

15.11.5 Passage Reading: GATE2012-AR-10 [top](#)

<http://gateoverflow.in/40231>

(A)

Explanation : The documents were known only to the government officials till the time of its publication on the media website but until then none of the newspapers has reported anything on their existence. Nothing is known of what the document reveals.

0 votes

-- Sourav Mishra (2.7k points)

answer must be D according to me bcz if i check options A is wrong bcz in the passage they did not mention who knows or who does not know about the existence of document so A will be wrong . B totally irrelevant from passage and C is wrong bcz after reading the passage you got an idea media is waiting once they got the information about existence of document then they will expose them .. then remaining is **D which is related to passage so D will be answer according to me**

0 votes

-- rajan (2.1k points)

15.11.6 Passage Reading: GATE2014-1_GA_6 [top](#)

<http://gateoverflow.in/774>



Selected Answer

The answer is C. The primary statement is about the Palghat Gap being low lying which is mentioned in the first sentence. The second part mentions the results of that causing lots of rain and unusual temperatures in the other areas. (Tamil Nadu and Kerala)

8 votes

-- Kathleen Bankson (47.9k points)

15.11.7 Passage Reading: GATE2014-2_GA_6 [top](#)

<http://gateoverflow.in/1943>



Selected Answer

Answer is B.

3 votes

-- chetna (471 points)

15.11.8 Passage Reading: GATE2014-2_GA_7 [top](#)

<http://gateoverflow.in/1944>



Selected Answer

Answer should be D)

4 votes

-- Poshita Shrivastava (1k points)

15.11.9 Passage Reading: GATE2014-3_GA_6 [top](#)<http://gateoverflow.in/2029>

Selected Answer

It will be B.

7 votes

-- Gate Keeda (17.7k points)

15.11.10 Passage Reading: GATE2011_GG_GA_10 [top](#)<http://gateoverflow.in/40211>

(B)

This is the best possible explanation.

2 votes

-- Sourav Mishra (2.7k points)

15.11.11 Passage Reading: GATE2014-3_GA_7 [top](#)<http://gateoverflow.in/2031>

Selected Answer

A paradigm shift means a fundamental change in approach or underlying assumptions.

And a change in paradigm happens only when we have an experimented evidence. It is crucial to have an evidence.

In this para the evidence was provided by the experimental measurements of the position of a star which was directly behind our sun.

Option D suits well for the given para.

5 votes

-- Srinath Sri (2.9k points)

15.11.12 Passage Reading: GATE-2012-AE-10 [top](#)<http://gateoverflow.in/40221>A : Did not question that progress was a fact. **True** They took progress for granted.B: Did not approve of Biology : **False** . No mention regarding this in paragraph. It's mention that it was not inspired from biology and that's a different thing.C: Framed the laws of progress : **False** They attempted to discover its laws. Frame and dicover are different things.

D: Clearly false.

2 votes

-- Mojo Jojo (3.2k points)

15.11.13 Passage Reading: GATE2011_61 [top](#)<http://gateoverflow.in/2171>

Selected Answer

(C) what the leading causes of death are

4 votes

-- Kathleen Bankson (47.9k points)

15.11.14 Passage Reading: GATE2012-CY-GA-6 [top](#)<http://gateoverflow.in/40237>

(A)

This is the best possible option.

2 votes

-- Sourav Mishra (2.7k points)

15.11.15 Passage Reading: GATE2013_63 [top](#)<http://gateoverflow.in/1567>

Selected Answer

D is my answer. He gave up hope and wanted to commit suicide until he saw the spider in his struggles so no struggle or difficulty is worth giving up hope. Continue on!

11 votes

-- Kathleen Bankson (47.9k points)

15.12**Tense** [top](#)**15.12.1 Tense: GATE2014-2_GA_2** [top](#)<http://gateoverflow.in/1939>

Who _____ was coming to see us this evening?

- (A) you said
- (B) did you say
- (C) did you say that
- (D) had you said

[gate2014-2](#) [verbal-ability](#) [tense](#) [normal](#)

Answer

15.12.2 Tense: GATE2013_59 [top](#)<http://gateoverflow.in/1563>

Were you a bird, you _____ in the sky.

- (A) would fly
- (B) shall fly
- (C) should fly
- (D) shall have flown

[gate2013](#) [verbal-ability](#) [tense](#) [normal](#)

Answer

Answers: Tense**15.12.1 Tense: GATE2014-2_GA_2** [top](#)<http://gateoverflow.in/1939>**Answer should be B)**

3 votes

-- Poshita Shrivastava (1k points)

15.12.2 Tense: GATE2013_59 [top](#)<http://gateoverflow.in/1563>



Selected Answer

A...would fly

6 votes

-- Kathleen Bankson (47.9k points)

15.13

Verbal Reasoning top15.13.1 Verbal Reasoning: GATE2014-EC04-GA7 top<http://gateoverflow.in/41469>

If 'KCLFTSB' stands for 'best of luck' and 'SHSWDG' stands for 'good wishes', which of the following indicates 'ace the exam'?

- A. MCHTX
- B. MXHTC
- C. XMHCT
- D. XMHTC

[gate2014-ec04](#) [verbal-ability](#) [verbal-reasoning](#) [normal](#)

Answer

15.13.2 Verbal Reasoning: GATE2014-EC03-GA1 top<http://gateoverflow.in/41140>

"India is a country of rich heritage and cultural diversity." Which one of the following facts best supports the claim made in the above sentence?

- A. India is a union of 28 states and 7 union territories.
- B. India has a population of over 1.1 billion.
- C. India is home to 22 official languages and thousands of dialects.
- D. The Indian cricket team draws players from over ten states.

[gate2014-ec03](#) [verbal-reasoning](#)

Answer

15.13.3 Verbal Reasoning: GATE2014-EC01-GA2 top<http://gateoverflow.in/41491>

Read the statements:

All women are entrepreneurs.

Some women are doctors.

Which of the following conclusions can be logically inferred from the above statements?

- A. All women are doctors
- B. All doctors are entrepreneurs
- C. All entrepreneurs are women
- D. Some entrepreneurs are doctors

[gate2014-ec01](#) [verbal-ability](#) [mathematical-logic](#) [verbal-reasoning](#) [easy](#)

Answer

15.13.4 Verbal Reasoning: GATE 2015 Aptitude Set 1 Q10 top<http://gateoverflow.in/39497>

Humpty Dumpty sits on a wall every day while having lunch. The wall sometimes breaks. A person sitting on the wall falls if the wall breaks.

Which one of the statements below is logically valid and can be inferred from the above sentences?

- (A) Humpty Dumpty always falls while having lunch
- (B) Humpty Dumpty does not fall sometimes while having lunch
- (C) Humpty Dumpty never falls during dinner

(D) When Humpty Dumpty does not sit on the wall, the wall does not break

[gate2015aptiset1](#) [verbal-reasoning](#)

Answer

15.13.5 Verbal Reasoning: GATE2014-EC01-GA6 [top](#)

<http://gateoverflow.in/41495>

Find the odd one from the following group:

W,E,K,O I,Q,W,A F,N,T,X N,V,B,D

- A. W,E,K,O
- B. I,Q,W,A
- C. F,N,T,X
- D. N,V,B,D

[gate2014-ec01](#) [verbal-ability](#) [verbal-reasoning](#) [normal](#)

Answer

15.13.6 Verbal Reasoning: GATE2014-EC02-GA1 [top](#)

<http://gateoverflow.in/41507>

Choose the most appropriate word from the options given below to complete the following sentence.

Communication and interpersonal skills are _____ important in their own ways.

- A. Each
- B. Both
- C. All
- D. Either

[gate2014-ec02](#) [verbal-ability](#) [verbal-reasoning](#) [most-appropriate-word](#) [normal](#)

Answer

15.13.7 Verbal Reasoning: GATE 2015 Aptitude Set 2 Q10 [top](#)

<http://gateoverflow.in/39511>

Lamenting the gradual sidelining of the arts in school curricula, a group of prominent artists wrote to the Chief Minister last year, asking him to allocate more funds to support arts education in schools. However, no such increase has been announced in this year's Budget. The artists expressed their deep anguish at their request not being approved, but many of them remain optimistic about funding in the future.

Which of the statement(s) below is/are logically valid and can be inferred from the above statements?

- (i) The artists expected funding for the arts to increase this year.
- (ii) The Chief Minister was receptive to the idea of increasing funding for the arts.
- (iii) The Chief Minister is a prominent artist.
- (iv) Schools are giving less importance to arts education nowadays.

(A) (iii) and (iv) (B) (i) and (iv) (C) (i), (ii) and (iv) (D) (i) and (iii)

[gate2015aptiset2](#) [aptitude](#) [passage-reading](#) [verbal-reasoning](#)

Answer

15.13.8 Verbal Reasoning: GATE2016-1-GA07 [top](#)

<http://gateoverflow.in/39613>

Indian currency notes show the denomination indicated in at least seventeen languages. If this is not an indication of the nation's diversity, nothing else is.

Which of the following can be logically inferred from the above sentences?

- A. India is a country of exactly seventeen languages.
- B. Linguistic pluralism is the only indicator of a nation's diversity.
- C. Indian currency notes have sufficient space for all the Indian languages.
- D. Linguistic pluralism is strong evidence of India's diversity.

[gate2016-1](#) [verbal-ability](#) [verbal-reasoning](#) [normal](#)
Answer

15.13.9 Verbal Reasoning: GATE2014-AG-GA3 [top](#)

<http://gateoverflow.in/41667>

Which of the following options is the closest in meaning to the sentence below?

"As a woman, I have no country."

- A. Women have no country.
- B. Women are not citizens of any country.
- C. Women's solidarity knows no national boundaries.
- D. Women of all countries have equal legal rights.

[gate2014-ag](#) [verbal-ability](#) [verbal-reasoning](#) [normal](#)
Answer

15.13.10 Verbal Reasoning: GATE2014-AG-GA7 [top](#)

<http://gateoverflow.in/41671>

Moving into a world of big data will require us to change our thinking about the merits of exactitude. To apply the conventional mindset of measurement to the digital, connected world of the twenty-first century is to miss a crucial point. As mentioned earlier, the obsession with exactness is an artefact of the information-deprived analog era. When data was sparse, every data point was critical, and thus great care was taken to avoid letting any point bias the analysis. From "BIG DATA" Viktor Mayer-Schonberger and Kenneth Cukier. The main point of the paragraph is:

- A. The twenty-first century is a digital world
- B. Big data is obsessed with exactness
- C. Exactitude is not critical in dealing with big data
- D. Sparse data leads to a bias in the analysis

[gate2014-ag](#) [verbal-ability](#) [verbal-reasoning](#) [passage-reading](#) [normal](#)
Answer

Answers: Verbal Reasoning

15.13.1 Verbal Reasoning: GATE2014-EC04-GA7 [top](#)

<http://gateoverflow.in/41469>

Selected Answer

Best of luck - KCLFTSB
If we read it backwards BSTFLCK

Good wishes SHSWDG
If we read it backwards GDWSHS

Similarly, for
Ace the exam
It should be
MXHTC
which when read backward CTHXM

Answer B) MXHTC

Edit: added by Sonam Vyas
Just remove the vowels and read from backward to get the answer :)

3 votes

-- Abhilash Panicker (7k points)

15.13.2 Verbal Reasoning: GATE2014-EC03-GA1 [top](#)

<http://gateoverflow.in/41140>

Answer C) India is home to 22 official languages and thousands of dialects.

It talks about 22 languages and 1000s of dialects, which clearly show existence of rich heritage and cultural diversity. Other options A,B and D only show there are many states, which does not necessarily imply the rich heritage and diversity,

3 votes

-- Abhilash Panicker (7k points)

15.13.3 Verbal Reasoning: GATE2014-EC01-GA2 top



Selected Answer

Option D is correct.

"Some Entrepreneurs are Doctor".

6 votes

-- Rude Maverick (22.6k points)

15.13.4 Verbal Reasoning: GATE 2015 Aptitude Set 1 Q10 top



Selected Answer

Option B is the answer. The wall sometimes breaks. Sometimes it wont break. So Humpty Dumpty does not fall sometimes, while having lunch. This can be inferred.

3 votes

-- Sreyas S (1.6k points)

15.13.5 Verbal Reasoning: GATE2014-EC01-GA6 top



Selected Answer

Ans is (D)

the no of alphabet between B,D in N,V,B,D is 1 while in other 3 sets, it is 4. Alphabet sequence in all the sets are obtained by adding 8,6,4 respectively to the previous one in sequence.

4 votes

-- srestha (27.8k points)

15.13.6 Verbal Reasoning: GATE2014-EC02-GA1 top

Answer will be (B)

5 votes

-- srestha (27.8k points)

15.13.7 Verbal Reasoning: GATE 2015 Aptitude Set 2 Q10 top



Selected Answer

Ans: (B)

From first line in para its clear that schools are giving less importance to arts education. hence (iv)

However, no such increase has been announced in this year's Budget.

From this line we can infer that artists are expected funding for arts to increase this year.

2 votes

-- Desert_Warrior (6.6k points)

15.13.8 Verbal Reasoning: GATE2016-1-GA07 [top](#)<http://gateoverflow.in/39613>

Selected Answer

Answer is (D) Linguistic pluralism is strong evidence of India's diversity.

18 votes

-- sushma nayak (181 points)

15.13.9 Verbal Reasoning: GATE2014-AG-GA3 [top](#)<http://gateoverflow.in/41667>

Selected Answer

You can surely go with option (3). That Woman's solidarity knows no national boundaries.

Because option (1) and (2) are surely not correct & option (4) is not suitable, in my views.

Thx. All the best.

6 votes

-- Rude Maverick (22.6k points)

15.13.10 Verbal Reasoning: GATE2014-AG-GA7 [top](#)<http://gateoverflow.in/41671>

Selected Answer

Option C :

Exactitude is not critical in dealing with big data

3 votes

-- Pratik Agrawal (153 points)

15.14**Word Pairs** [top](#)**15.14.1 Word Pairs: gate2013-ce-5** [top](#)<http://gateoverflow.in/40272>

Q.60 Select the pair that best expresses a relationship similar to that expressed in the pair:

Medicine: Health

- (A) Science: Experiment
- (B) Wealth: Peace
- (C) Education: Knowledge
- (D) Money: Happiness

[gate2013-ce](#) [word-pairs](#)

Answer

15.14.2 Word Pairs: GATE-2013-AE-GA-5 [top](#)<http://gateoverflow.in/40246>

Q.60 Select the pair that best expresses a relationship similar to that expressed in the pair:

water: pipe:

- (A) cart: road
- (B) electricity: wire
- (C) sea: beach
- (D) music: instrument

[gate2013-ae](#) [verbal-ability](#) [word-pairs](#)[Answer](#)

15.14.3 Word Pairs: GATE2010-60 [top](#)

<http://gateoverflow.in/2368>

The question below consists of a pair of related words followed by four pairs of words. Select the pair that best expresses the relation in the original pair.

Unemployed : Worker

- A. fallow : land
- B. unaware : sleeper
- C. wit : jester
- D. renovated : house

[gate2010](#) [verbal-ability](#) [word-pairs](#) [normal](#)[Answer](#)

Answers: Word Pairs

15.14.1 Word Pairs: gate2013-ce-5 [top](#)

<http://gateoverflow.in/40272>

Selected Answer

c as medicine improves health similarly education improves knowlege

1 5 votes

-- Rahul Singla (199 points)

15.14.2 Word Pairs: GATE-2013-AE-GA-5 [top](#)

<http://gateoverflow.in/40246>

Answer B: Water runs through a pipe like electricity runs through a wire.

1 3 votes

-- Kathleen Bankson (47.9k points)

15.14.3 Word Pairs: GATE2010-60 [top](#)

<http://gateoverflow.in/2368>

Selected Answer

A. Fallow: Land

Fallow is **land** that is uncultivated

Unemployed is a **worker** without a job

1 9 votes

-- Kathleen Bankson (47.9k points)

16 Operating System (264) [top](#)

16.0.1 GATE2012_8 [top](#)

<http://gateoverflow.in/40>

A process executes the code

```
fork();  
fork();  
fork();
```

The total number of **child** processes created is

- (A) 3
- (B) 4
- (C) 7
- (D) 8

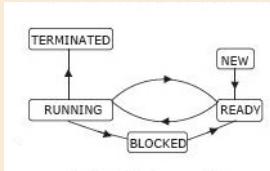
[gate2012](#) [operating-system](#) [easy](#)

[Answer](#)

16.0.2 GATE1996_1.18 [top](#)

<http://gateoverflow.in/2722>

The process state transition diagram in the below figure is representative of



- A. a batch operating system
- B. an operating system with a preemptive scheduler
- C. an operating system with a non-preemptive scheduler
- D. a uni-programmed operating system

[gate1996](#) [operating-system](#) [normal](#)

[Answer](#)

16.0.3 GATE2001-1.20 [top](#)

<http://gateoverflow.in/713>

Where does the swap space reside?

- A. RAM
- B. Disk
- C. ROM
- D. On-chip cache

[gate2001](#) [operating-system](#) [easy](#)

[Answer](#)

16.0.4 GATE2001-2.20 [top](#)

<http://gateoverflow.in/738>

Which of the following does not interrupt a running process?

- A. A device
 B. Timer
 C. Scheduled process
 D. Power failure

gate2001 | operating-system | easy

[Answer](#)

16.0.5 GATE2004-IT_14 [top](#)

<http://gateoverflow.in/3655>

Which one of the following is NOT shared by the threads of the same process ?

- A) Stack
 B) Address Space
 C) File Descriptor Table
 D) Message Queue

gate2004-it | operating-system | easy

[Answer](#)

16.0.6 GATE2002_2.21 [top](#)

<http://gateoverflow.in/851>

Which combination of the following features will suffice to characterize an OS as a multi-programmed OS?

- (A) More than one program may be loaded into main memory at the same time for execution.
 (B) If a program waits for certain events such as I/O, another program is immediately scheduled for execution.
 (C) If the execution of a program terminates, another program is immediately scheduled for execution.

- A. A
 B. A and B
 C. A and C
 D. A, B and C

gate2002 | operating-system | normal

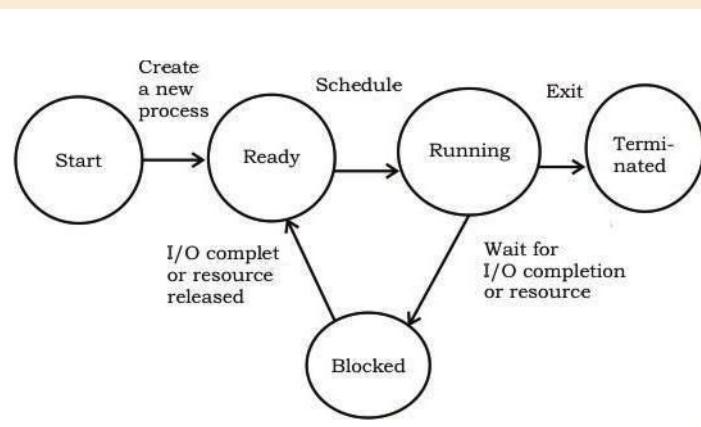
[Answer](#)

16.0.7 GATE2006-IT_13 [top](#)

<http://gateoverflow.in/3552>

The process state transition diagram of an operating system is as given below.

Which of the following must be FALSE about the above operating system?



- A) It is a multiprogrammed operating system
 B) It uses preemptive scheduling
 C) It uses non-preemptive scheduling
 D) It is a multi-user operating system

[gate2006-it](#) [operating-system](#) [normal](#)

[Answer](#)

16.0.8 GATE1996_2.17 [top](#)

<http://gateoverflow.in/2746>

The correct matching for the following pairs is

- | | |
|------------------------|------------------------|
| (A) Activation record | (1) Linking loader |
| (B) Location counter | (2) Garbage collection |
| (C) Reference counts | (3) Subroutine call |
| (D) Address relocation | (4) Assembler |

- A. A-3 B-4 C-1 D-2
- B. A-4 B-3 C-1 D-2
- C. A-4 B-3 C-2 D-1
- D. A-3 B-4 C-2 D-1

[gate1996](#) [operating-system](#) [easy](#)

[Answer](#)

16.0.9 GATE1994_1.21 [top](#)

<http://gateoverflow.in/2464>

Which one of the following statements is true?

- A. Macro definitions cannot appear within other macro definitions in assembly language programs
- B. Overlaying is used to run a program which is longer than the address space of a computer
- C. Virtual memory can be used to accommodate a program which is longer than the address space of a computer
- D. It is not possible to write interrupt service routines in a high level language

[gate1994](#) [operating-system](#) [normal](#)

[Answer](#)

16.0.10 GATE2000-2.22 [top](#)

<http://gateoverflow.in/669>

Suppose the time to service a page fault is on the average 10 milliseconds, while a memory access takes 1 microsecond. Then a 99.99% hit ratio results in average memory access time of

- A. 1.9999 milliseconds
- B. 1 millisecond
- C. 9.999 microseconds
- D. 1.9999 microseconds

[gate2000](#) [operating-system](#) [easy](#)

[Answer](#)

16.0.11 GATE1997_3.7 [top](#)

<http://gateoverflow.in/2238>

I/O redirection

- A. implies changing the name of a file
- B. can be employed to use an existing file as input file for a program
- C. implies connecting 2 programs through a pipe
- D. None of the above

[gate1997](#) [operating-system](#) [normal](#)

[Answer](#)

16.0.12 GATE1997_3.6 [top](#)

<http://gateoverflow.in/2237>

The correct matching for the following pairs is:

- | | |
|--------------------------|-----------------|
| (A) Disk Scheduling | (1) Round robin |
| (B) Batch Processing | (2) SCAN |
| (C) Time sharing | (3) LIFO |
| (D) Interrupt processing | (4) FIFO |
- A. A-3 B-4 C-2 D-1
 - B. A-4 B-3 C-2 D-1
 - C. A-2 B-4 C-1 D-3
 - D. A-3 B-4 C-3 D-2

[gate1997](#) [operating-system](#) [normal](#)

[Answer](#)

16.0.13 GATE1999_1.9 [top](#)

<http://gateoverflow.in/1462>

Listed below are some operating system abstractions (in the left column) and the hardware components (in the right column)?

- | | |
|---------------------------|--------------|
| (A) Thread | 1. Interrupt |
| (B) Virtual address space | 2. Memory |
| (C) File system | 3. CPU |
| (D) Signal | 4. Disk |
- A. (A) - 2 (B) - 4 (C) - 3 (D) - 1
 - B. (A) - 1 (B) - 2 (C) - 3 (D) - 4
 - C. (A) - 3 (B) - 2 (C) - 4 (D) - 1
 - D. (A) - 4 (B) - 1 (C) - 2 (D) - 3

[gate1999](#) [operating-system](#) [easy](#)

[Answer](#)

16.0.14 GATE1999-1.11, UGCNET-Dec2015-II-44 [top](#)

<http://gateoverflow.in/1464>

System calls are usually invoked by using

- A. a software interrupt
- B. polling

- C. an indirect jump
- D. a privileged instruction

[gate1999](#) [operating-system](#) [normal](#) [ugcnetdec2015ii](#)

[Answer](#)

16.0.15 GATE1999_2.10 [top](#)

<http://gateoverflow.in/1488>

A multi-user, multi-processing operating system cannot be implemented on hardware that does not support

- A. Address translation
- B. DMA for disk transfer
- C. At least two modes of CPU execution (privileged and non-privileged)
- D. Demand paging

[gate1999](#) [operating-system](#) [normal](#)

[Answer](#)

16.0.16 GATE1998_1.30 [top](#)

<http://gateoverflow.in/1667>

When the result of a computation depends on the speed of the processes involved, there is said to be

- (a) cycle stealing
- (b) race condition
- (a) a time lock
- (d) a deadlock

[gate1998](#) [operating-system](#) [easy](#)

[Answer](#)

16.0.17 GATE2001-1.13 [top](#)

<http://gateoverflow.in/706>

A CPU has two modes -- privileged and non-privileged. In order to change the mode from privileged to non-privileged

- A. a hardware interrupt is needed
- B. a software interrupt is needed
- C. a privileged instruction (which does not generate an interrupt) is needed
- D. a non-privileged instruction (which does not generate an interrupt) is needed

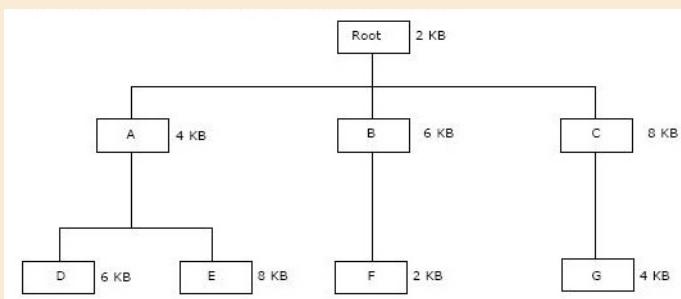
[gate2001](#) [operating-system](#) [normal](#)

[Answer](#)

16.0.18 GATE1998_2.16 [top](#)

<http://gateoverflow.in/1689>

The overlay tree for a program is as shown below:



What will be the size of the partition (in physical memory) required to load (and run) this program?

- A. 12 KB
- B. 14 KB
- C. 10 KB
- D. 8 KB

[gate1998](#) [operating-system](#) [normal](#)

[Answer](#)

16.0.19 GATE2000-2.13 [top](#)

<http://gateoverflow.in/660>

A graphics card has on board memory of 1 MB. Which of the following modes can the card not support?

- A. 1600 x 400 resolution with 256 colors on a 17 inch monitor
- B. 1600 x 400 resolution with 16 million colors on a 14 inch monitor
- C. 800 x 400 resolution with 16 million colors on a 17 inch monitor
- D. 800 x 800 resolution with 256 colors on a 14 inch monitor

[gate2000](#) [operating-system](#) [normal](#)

[Answer](#)

16.0.20 GATE1991_02,iii [top](#)

<http://gateoverflow.in/513>

Match the pairs in the following questions by writing the corresponding letters only.

- (a). Buddy system
- (b). Interpretation
- (c). Pointer type
- (d). Virtual memory

- (p). Run time type specification
- (q). Segmentation
- (r). Memory allocation
- (s). Garbage collection

[gate1991](#) [operating-system](#) [normal](#)

[Answer](#)

16.0.21 GATE1991_01,xii [top](#)

<http://gateoverflow.in/508>

A given set of processes can be implemented by using only **parbegin/parend** statement, if the precedence graph of these processes is _____

[gate1991](#) [operating-system](#) [normal](#)

[Answer](#)

16.0.22 GATE2000-1.20, ISRO2008-47 [top](#)<http://gateoverflow.in/644>

Which of the following need not necessarily be saved on a context switch between processes?

- A. General purpose registers
- B. Translation look-aside buffer
- C. Program counter
- D. All of the above

[gate2000](#) [operating-system](#) [easy](#) [isro2008](#)

Answer

16.0.23 GATE1992-12a [top](#)<http://gateoverflow.in/591>

Draw the precedence graph for the concurrent program given below

```
S1
parbegin
    begin
        S2:S4
    end;
    begin
        S3;
        parbegin
            S5;
            begin
                S6:S8
            end
        parend
    end;
    S7
parend;
S9
```

[gate1992](#) [operating-system](#) [normal](#)

Answer

Answers:**16.0.1 GATE2012_8** [top](#)<http://gateoverflow.in/40>

Selected Answer

At each fork() the no. of processes becomes doubled. So, after 3 fork calls, the total no. of processes will be 8. Out of this 1 is the parent process and 7 are child processes. So, total number of child processes created is 7.

9 votes

-- Arjun Suresh (150k points)

16.0.2 GATE1996_1.18 [top](#)<http://gateoverflow.in/2722>

Selected Answer

Answer is B. The transition from running to ready indicates that the process in the running state can be preempted and brought back to ready state.

5 votes

-- kireeti (1k points)

16.0.3 GATE2001-1.20 [top](#)<http://gateoverflow.in/713>

Selected Answer

Option B is correct.

Swap space is the area on a hard disk which is part of the Virtual Memory of your machine, which is a combination of accessible physical memory (RAM) and the swap space. Swap space temporarily holds memory pages that are inactive. Swap space is used when your system decides that it needs physical memory for active processes and there is insufficient unused physical memory available. If the system happens to need more memory resources or space, inactive pages in physical memory are then moved to the swap space therefore freeing up that physical memory for other uses. Note that the access time for swap is slower therefore do not consider it to be a complete replacement for the physical memory. Swap space can be a dedicated swap partition (recommended), a swap file, or a combination of swap partitions and swap files.

6 votes

-- Manoj Kumar (23.1k points)

16.0.4 GATE2001-2.20 [top](#)

<http://gateoverflow.in/738>



Selected Answer

ans is C.

timer and disk both makes interrupt and power failure will interrupt the system. only a scheduled process will not interrupt the running process.

4 votes

-- jayendra (6.6k points)

16.0.5 GATE2004-IT_14 [top](#)

<http://gateoverflow.in/3655>



Selected Answer

Stack is not shared

5 votes

-- Sankaranarayanan P.N (9.8k points)

16.0.6 GATE2002_2.21 [top](#)

<http://gateoverflow.in/851>



Selected Answer

A and B suffice multi programming concept. For multi programming more than one program should be in memory and if any program goes for Io another can be scheduled to use CPU so ans is b

10 votes

-- Pooja (25.9k points)

16.0.7 GATE2006-IT_13 [top](#)

<http://gateoverflow.in/352>



Selected Answer

Answer B

Explanation :-

A) It is a multiprogrammed operating system

Correct, it has ready state. We can have multiple processes in ready state here so this is Multiprogrammed OS.

B) It uses preemptive scheduling

False :- There is no arrow transition from running to read state. So this is non preemptive.

C) It uses non-preemptive scheduling

True.

D) It is a multi-user operating system

We can have multiple user processes in ready state. So this is also correct.

2 votes

-- Akash (31.7k points)

16.0.8 GATE1996_2.17 top

<http://gateoverflow.in/2746>



Selected Answer

ans is d

3 votes

-- neha pawar (3.8k points)

16.0.9 GATE1994_1.21 top

<http://gateoverflow.in/2464>



Selected Answer

1. Is TRUE.

2. False. Overlaying is used to increase the address space usage when physical memory is limited on systems where virtual memory is absent. But it cannot increase the address space (logical) of a computer.

3. False. Like above is true for physical memory but here it is specified address space which should mean logical address space.

4. Is false. We can write in high level language just that the performance will be bad.

3 votes

-- Arjun Suresh (150k points)

16.0.10 GATE2000-2.22 top

<http://gateoverflow.in/669>



Selected Answer

Since nothing is told about page tables, we can assume page table access time is included in memory access time.

So, average memory access time

$$\begin{aligned} &= .9999 * 1 + 0.0001 * 10,000 \\ &= 0.9999 + 1 \\ &= 1.9999 \text{ microseconds} \end{aligned}$$

13 votes

-- Arjun Suresh (150k points)

16.0.11 GATE1997_3.7 top

<http://gateoverflow.in/2238>



Selected Answer

Answer: B

Typically, the syntax of these characters is as follows, using < to redirect input, and > to redirect output.

command1 > file1

executes command1, placing the output in file1, as opposed to displaying it at the terminal, which is the usual destination

for standard output. This will clobber any existing data in file1.

Using,

```
command1 < file1
```

executes command1, with file1 as the source of input, as opposed to the keyboard, which is the usual source for standard input.

```
command1 < infile > outfile
```

combines the two capabilities: command1 reads from infile and writes to outfile.

1 votes

-- Rajarshi Sarkar (29.7k points)

16.0.12 GATE1997_3.6 [top](#)

<http://gateoverflow.in/2237>



Selected Answer

Answer: C

2 votes

-- Rajarshi Sarkar (29.7k points)

16.0.13 GATE1999_1.9 [top](#)

<http://gateoverflow.in/1462>



Selected Answer

Answer: C

4 votes

-- Rajarshi Sarkar (29.7k points)

16.0.14 GATE1999-1.11, UGCNET-Dec2015-II-44 [top](#)

<http://gateoverflow.in/1464>



Selected Answer

Ans) A Software interrupt

https://en.wikipedia.org/wiki/System_call#Typical_implementations

7 votes

-- Prasanna Ranganathan (2.5k points)

16.0.15 GATE1999_2.10 [top](#)

<http://gateoverflow.in/1488>



Selected Answer

Answer should be both A and C (Earlier GATE questions had multiple answers and marks were given only if all correct answers were selected).

Address translation is needed to provide memory protection so that a given process does not interfere with another.

We also need at least 2 modes of execution to ensure user processes share resources properly and OS maintains control. This is not required for a single user OS like early version of MS-DOS.

Demand paging and DMA enhances the performances- not a strict necessity.

Ref: Hardware protection section in Galvin

<http://www.examrace.com/d/pdf/f54efd26/GATE-Computer-Science-1999.pdf>

7 votes

-- Arjun Suresh (150k points)

16.0.16 GATE1998_1.30 top

<http://gateoverflow.in/1667>



Selected Answer

When final result depends on ordering of processes it is called [Race condition](#). Speed of processes corresponds to ordering of processes.

5 votes

-- Digvijay (35.8k points)

16.0.17 GATE2001-1.13 top

<http://gateoverflow.in/706>



Selected Answer

Answer should be D. Changing from privileged to non-privileged doesn't require an interrupt unlike from non-privileged to privileged. Also, to loose a privilege we don't need a privileged instruction though a privileged instruction does no harm.

http://web.cse.ohio-state.edu/~teodores/download/teaching/cse675.au08/CSE675.02_MIPS-ISA_part3.pdf

14 votes

-- Arjun Suresh (150k points)

16.0.18 GATE1998_2.16 top

<http://gateoverflow.in/1689>

"To enable a process to be larger than the amount of memory allocated to it, we can use overlays. The idea of overlays is to keep in memory only those instructions and data that are needed at any given time. When other instructions are needed, they are loaded into space occupied previously by instructions that are no longer needed." For the above program, maximum memory will be required when running code portion present at leaves. Max requirement=(max of requirements of D,E,F, and G. = $\text{MAX}(12,14,10,14) =14$ (Ans)

2 votes

-- learncp (877 points)

16.0.19 GATE2000-2.13 top

<http://gateoverflow.in/660>

Just measure the memory required for the given resolution. The screen size has nothing to do with the memory required and is given just for the sake of it. Each pixel is represented using a color. So, we need to find the number of pixels and multiply by the amount of storage required for color.

A. 256 colors means 8 bits for color representation meaning 1 byte. So, $1600 * 400$ resolution requires 640 kB . We have 1 MB , so fine.

B. 16 million colors require 24 bits or 3 bytes. So, $1600 * 400$ resolution requires $640 \text{ k} * 3 = 1920 \text{ kB}$ which is over our on board memory. So, not possible.

C. Again 3 bytes for a color. $800 * 400$ resolution requires $320 \text{ k} * 3 = 960 \text{ kB}$ which is fine as we have 1 MB on board.

D. 256 colors require 1 byte. $800 * 800$ resolution requires $640 \text{ k} * 1 = 640 \text{ kB}$ which is again fine.

So, answer is B.

3 votes

-- Arjun Suresh (150k points)

16.0.20 GATE1991_02,iii [top](#)<http://gateoverflow.in/513>

Selected Answer

A-R

B-P

C-S

D-Q

7 votes

-- Gate Keeda (17.7k points)

16.0.21 GATE1991_01,xii [top](#)<http://gateoverflow.in/508>

Selected Answer

A given set of processes can be implemented by using only **parbegin/parendstatement**, if the precedence graph of these processes is **properly nested**

ref :<http://nob.cs.ucdavis.edu/classes/ecs150-2008-04/handouts/sync.pdf>

1. it should be closed under par begin and par end ...

2. process execute concurrently

http://gateoverflow.in/1739/gate1998_24#viewbutton

in this question precedence graph is nested

1) all the process execute concurrently ..closed under par begin and par end ..

2) if you see all the serial execution come then signal the resource and parallel process down the value (resource) similar all the process which are dependent to other one , other one release the resource then it will be got that with down ..and after release the its own resource .. in the sense all the process are executing concurrently ...

3 votes

-- sonam vyas (8.1k points)

16.0.22 GATE2000-1.20, ISRO2008-47 [top](#)<http://gateoverflow.in/644>

Selected Answer

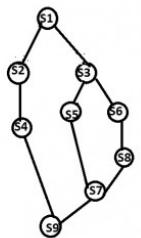
Answer: B

We don't need to save TLB or cache to ensure correct program resumption. They are just bonus for ensuring better performance. But PC, stack and registers must be saved as otherwise program cannot resume.

10 votes

-- Rajarshi Sarkar (29.7k points)

16.0.23 GATE1992-12a [top](#)<http://gateoverflow.in/591>



12.a) picture will be like above. Here perbegin-perend creates when there are more than one child processes, and begin-end creates a process

1 votes

-- srestha (27.8k points)

16.1

Cache Memory top

16.1.1 Cache Memory: GATE2001-1.7, ISRO2008-18 top

<http://gateoverflow.in/700>

More than one word are put in one cache block to

- A. exploit the temporal locality of reference in a program
- B. exploit the spatial locality of reference in a program
- C. reduce the miss penalty
- D. none of the above

[gate2001](#) [operating-system](#) [easy](#) [cache-memory](#) [isro2008](#)

[Answer](#)

Answers: Cache Memory

16.1.1 Cache Memory: GATE2001-1.7, ISRO2008-18 top

<http://gateoverflow.in/700>



Selected Answer

exploit the spatial locality of reference in a program as, if the next locality is addressed immediately, it will already be in the cache.

Consider the scenario similar to cooking, where when an ingredient is taken from cupboard, you also take the near by ingredients along with it- hoping that they will be needed in near future.

16 votes

-- Arjun Suresh (150k points)

16.2

Computer Peripherals top

16.2.1 Computer Peripherals: GATE1992_02,xii top

<http://gateoverflow.in/569>

Choose the correct alternatives (more than one may be correct) and write the corresponding letters only:

Which of the following is an example of a spooled device?

- (a). The terminal used to input data for a program being executed.
- (b). The secondary memory device in a virtual memory system
- (c). A line printer used to print the output of a number of jobs.

(d). None of the above.

gate1992 operating-system computer-peripherals easy

Answer

Answers: Computer Peripherals

16.2.1 Computer Peripherals: GATE1992_02,xii [top](#)

<http://gateoverflow.in/569>



Selected Answer

Answer: C

Spool stands for simultaneous peripheral operations on-line.

14 votes

-- Rajarshi Sarkar (29.7k points)

16.3

Concurrency [top](#)

16.3.1 Concurrency: GATE2015-1_9 [top](#)

<http://gateoverflow.in/8121>

The following two functions P1 and P2 that share a variable B with an initial value of 2 execute concurrently.

```
P1 () {
    C = B - 1;
    B = 2 * C;
}
```

```
P2 () {
    D = 2 * B;
    B = D - 1;
}
```

The number of distinct values that B can possibly take after the execution is _____.

gate2015-1 operating-system concurrency normal

Answer

Answers: Concurrency

16.3.1 Concurrency: GATE2015-1_9 [top](#)

<http://gateoverflow.in/8121>



Selected Answer

3 distinct value (2,3,4)

P1-P2: B = 3
P2-P1: B = 4
P1-P2-P1: B = 2

14 votes

-- Anoop Sonkar (4.5k points)

16.4

Context Switch [top](#)

16.4.1 Context Switch: GATE2011-6, UGCNET-June2013-III-62 [top](#)

<http://gateoverflow.in/2108>

Let the time taken to switch from user mode to kernel mode of execution be T1 while time taken to switch between two user processes be T2. Which of the following is correct?

- A. $T_1 < T_2$
 B. $T_1 > T_2$
 C. $T_1 = T_2$
 D. Nothing can be said about the relation between T_1 and T_2

gate2011 | operating-system | context-switch | easy | ugcnetjune2013iii

Answer

16.4.2 Context Switch: GATE1999_2.12 [top](#)

<http://gateoverflow.in/1490>

Which of the following actions is/are typically not performed by the operating system when switching context from process A to process B?

- A. Saving current register values and restoring saved register values for process B.
 B. Changing address translation tables.
 C. Swapping out the memory image of process A to the disk.
 D. Invalidating the translation look-aside buffer.

gate1999 | operating-system | context-switch | normal

Answer

Answers: Context Switch

16.4.1 Context Switch: GATE2011-6, UGCNET-June2013-III-62 [top](#)

<http://gateoverflow.in/2108>



Selected Answer

Time taken to switch two processes is very large as compared to time taken to switch between kernel and user mode of execution because :

When you switch processes, you have to do a context switch, save the PCB of previous process (note that the PCB of a process in Linux has over 95 entries), then save registers and then load the PCB of new process and load its registers etc.

When you switch between kernel and user mode of execution, OS has to just **change a single bit** at hardware level which is very fast operation.

So answer is : C

17 votes

-- Mojo Jojo (3,2k points)

16.4.2 Context Switch: GATE1999_2.12 [top](#)

<http://gateoverflow.in/1490>



Selected Answer

option C) because swapping out of the memory image of a process to disk is not done on every context switch as it would cause a huge overhead but can solve problems like thrashing.

12 votes

-- GateMaster Prime (1,3k points)

16.5

Dining Philosopher [top](#)

16.5.1 Dining Philosopher: TIFR2011-B-26 [top](#)

<http://gateoverflow.in/20572>

Consider the following two scenarios in the dining philosophers problem:

- First a philosopher has to enter a room with the table that restricts the number of philosophers to four.

- ii. There is no restriction on the number of philosophers entering the room.

Which of the following is true?

- a. Deadlock is possible in (i) and (ii).
- b. Deadlock is possible in (i).
- c. Starvation is possible in (i).
- d. Deadlock is not possible in (ii).
- e. Starvation is not possible in (ii)

[tifr2011](#) [operating-system](#) [process-synchronization](#) [dining-philosopher](#)

Answer

Answers: Dining Philosopher

16.5.1 Dining Philosopher: TIFR2011-B-26 [top](#)

<http://gateoverflow.in/20572>

First of all, In Dining Philosopher two things are definitely going to happen:

1. Starvation, as one philosopher always has to wait for every other philosophers to finish.
2. No deadlock, since resource/s of the waiting philosopher is/are always available.

Above Point 2 eliminates every probability of a deadlock in Dining Philosopher problem so option a,b,e are out except d. Examining closely Option d, we find that the number of philosophers keep on increasing but the rate at which philosopher is done with its job leads to a deadlock.

Therefore, option c is the answer, with absolute starvation in (i).

0 votes

-- Harsh Patil (31 points)

In dining phyloshoper problem , if the number of phyloshoper is 4 and number of fork is 5, then atleast one fork which is extra , that place 2 philoshoper is not sharing any fork.

So, circular wait violating. and deadlock not possible. But yes **starvation** always possible. As each philoshoper have atleast one fork sharing with other.

Now for (ii) unrestricted number of philosopher is there. and there are only 5 forks. So, each phyloshoper must share their forks. So, **Deadlock** is obvious there.

0 votes

-- srestha (27.8k points)

16.6

Disk [top](#)

16.6.1 Disk: GATE1999_2.18, ISRO2008-46 [top](#)

<http://gateoverflow.in/1496>

Raid configurations of the disks are used to provide

- A. Fault-tolerance
- B. High speed
- C. High data density
- D. A & B

[gate1999](#) [operating-system](#) [disk](#) [easy](#) [isro2008](#)

Answer

16.6.2 Disk: GATE1993_7.8 [top](#)<http://gateoverflow.in/2296>

The root directory of a disk should be placed

- (A) at a fixed address in main memory
- (B) at a fixed location on the disk
- (C) anywhere on the disk
- (D) at a fixed location on the system disk
- (E) anywhere on the system disk

[gate1993](#) [operating-system](#) [disk](#) [normal](#)

[Answer](#)

16.6.3 Disk: GATE2004_49 [top](#)<http://gateoverflow.in/1045>

A unix-style I-nodes has 10 direct pointers and one single, one double and one triple indirect pointers. Disk block size is 1 Kbyte, disk block address is 32 bits, and 48-bit integers are used. What is the maximum possible file size?

- A. 2^{24} bytes
- B. 2^{32} bytes
- C. 2^{34} bytes
- D. 2^{48} bytes

[gate2004](#) [operating-system](#) [disk](#) [normal](#)

[Answer](#)

16.6.4 Disk: GATE2004_68 [top](#)<http://gateoverflow.in/1062>

A hard disk with a transfer rate of 10 Mbytes/second is constantly transferring data to memory using DMA. The processor runs at 600 MHz, and takes 300 and 900 clock cycles to initiate and complete DMA transfer respectively. If the size of the transfer is 20 Kbytes, what is the percentage of processor time consumed for the transfer operation?

- A. 5.0%
- B. 1.0%
- C. 0.5%
- D. 0.1%

[gate2004](#) [operating-system](#) [disk](#) [normal](#) [computer-organization](#)

[Answer](#)

16.6.5 Disk: GATE2007-11, ISRO2009-36, ISRO2016-21 [top](#)<http://gateoverflow.in/1209>

Consider a disk pack with 16 surfaces, 128 tracks per surface and 256 sectors per track. 512 bytes of data are stored in a bit serial manner in a sector. The capacity of the disk pack and the number of bits required to specify a particular sector in the disk are respectively:

- A. 256 Mbyte, 19 bits
- B. 256 Mbyte, 28 bits
- C. 512 Mbyte, 20 bits
- D. 64 Gbyte, 28 bits

[gate2007](#) [operating-system](#) [disk](#) [normal](#) [isro2016](#)

[Answer](#)

16.6.6 Disk: GATE1998-25a [top](#)

<http://gateoverflow.in/1740>

Free disk space can be used to keep track of using a free list or a bit map. Disk addresses require d bits. For a disk with B blocks, F of which are free, state the condition under which the tree list uses less space than the bit map.

gate1998 | operating-system | disk | descriptive

Answer

16.6.7 Disk: GATE1995_14 [top](#)

<http://gateoverflow.in/2650>

If the overhead for formatting a disk is 96 bytes for a 4000 byte sector,

- a. Compute the unformatted capacity of the disk for the following parameters:

Number of surfaces: 8
 Outer diameter of the disk: 12 cm
 Inner diameter of the disk: 4 cm
 Inner track space: 0.1 mm
 Number of sectors per track: 20

- b. If the disk in (a) is rotating at 360 rpm, determine the effective data transfer rate which is defined as the number of bytes transferred per second between disk and memory.

gate1995 | operating-system | disk | normal

Answer

16.6.8 Disk: GATE2013_29 [top](#)

<http://gateoverflow.in/1540>

Consider a hard disk with 16 recording surfaces (0-15) having 16384 cylinders (0-16383) and each cylinder contains 64 sectors (0-63). Data storage capacity in each sector is 512 bytes. Data are organized cylinder-wise and the addressing format is <cylinder no., surface no., sector no.> . A file of size 42797 KB is stored in the disk and the starting disk location of the file is <1200, 9, 40>. What is the cylinder number of the last sector of the file, if it is stored in a contiguous manner?

- (A) 1281 (B) 1282 (C) 1283 (D) 1284

gate2013 | operating-system | disk | normal

Answer

16.6.9 Disk: GATE1993_6.7 [top](#)

<http://gateoverflow.in/2289>

A certain moving arm disk storage, with one head, has the following specifications:

Number of tracks/recording surface = 200
 Disk rotation speed = 2400 rpm
 Track storage capacity = 62,500 bits

The average latency of this device is P ms and the data transfer rate is Q bits/sec. Write the values of P and Q.

gate1993 | operating-system | disk | normal

Answer

16.6.10 Disk: GATE2008-32 [top](#)

<http://gateoverflow.in/443>

For a magnetic disk with concentric circular tracks, the seek latency is not linearly proportional to the seek distance due to

- A. non-uniform distribution of requests
- B. arm starting and stopping inertia
- C. higher capacity of tracks on the periphery of the platter

- D. use of unfair arm scheduling policies

gate2008 operating-system disk normal

Answer

16.6.11 Disk: GATE2009-51 [top](#)

<http://gateoverflow.in/1337>

A hard disk has 63 sectors per track, 10 platters each with 2 recording surfaces and 1000 cylinders. The address of a sector is given as a triple $\langle c, h, s \rangle$, where c is the cylinder number, h is the surface number and s is the sector number. Thus, the 0^{th} sector is addressed as $\langle 0, 0, 0 \rangle$, the 1^{st} sector as $\langle 0, 0, 1 \rangle$, and so on

51. The address $\langle 400, 16, 29 \rangle$ corresponds to sector number:

- A. 505035
- B. 505036
- C. 505037
- D. 505038

gate2009 operating-system disk normal

Answer

16.6.12 Disk: GATE2005_21 [top](#)

<http://gateoverflow.in/1357>

What is the swap space in the disk used for?

- A. Saving temporary html pages
- B. Saving process data
- C. Storing the super-block
- D. Storing device drivers

gate2005 operating-system disk easy

Answer

16.6.13 Disk: GATE2012_41 [top](#)

<http://gateoverflow.in/2149>

A file system with 300 GByte disk uses a file descriptor with 8 direct block addresses, 1 indirect block address and 1 doubly indirect block address. The size of each disk block is 128 Bytes and the size of each disk block address is 8 Bytes. The maximum possible file size in this file system is

- (A) 3 KBytes
- (B) 35 KBytes
- (C) 280 KBytes
- (D) dependent on the size of the disk

gate2012 operating-system disk normal

Answer

16.6.14 Disk: GATE2011_44 [top](#)

<http://gateoverflow.in/2146>

An application loads 100 libraries at startup. Loading each library requires exactly one disk access. The seek time of the disk to a random location is given as 10 ms. Rotational speed of disk is 6000 rpm. If all 100 libraries are loaded from random locations on the disk, how long does it take to load all libraries? (The time to transfer data from the disk block once the head has been positioned at the start of the block may be neglected.)

- (A) 0.50 s
- (B) 1.50 s

- (C) 1.25 s
(D) 1.00 s

[gate2011](#) [operating-system](#) [disk](#) [normal](#)

[Answer](#)

16.6.15 Disk: GATE1998_2.9 [top](#)

<http://gateoverflow.in/1681>

Formatting for a floppy disk refers to

- arranging the data on the disk in contiguous fashion
- writing the directory
- erasing the system data
- writing identification information on all tracks and sectors

[gate1998](#) [operating-system](#) [disk](#) [normal](#)

[Answer](#)

16.6.16 Disk: GATE2009-52 [top](#)

<http://gateoverflow.in/43477>

A hard disk has 63 sectors per track, 10 platters each with 2 recording surfaces and 1000 cylinders. The address of a sector is given as a triple $\langle c, h, s \rangle$, where c is the cylinder number, h is the surface number and s is the sector number. Thus, the 0^{th} sector is addressed as $\langle 0, 0, 0 \rangle$, the 1^{st} sector as $\langle 0, 0, 1 \rangle$, and so on

The address of the 1039^{th} sector is

- $\langle 0, 15, 31 \rangle$
- $\langle 0, 16, 30 \rangle$
- $\langle 0, 16, 31 \rangle$
- $\langle 0, 17, 31 \rangle$

[gate2009](#) [operating-system](#) [disk](#) [normal](#)

[Answer](#)

16.6.17 Disk: GATE1998-25b [top](#)

<http://gateoverflow.in/41055>

Consider a disk with c cylinders, t tracks per cylinder, s sectors per track and a sector length s_l . A logical file d_l with fixed record length r_l is stored continuously on this disk starting at location (c_L, t_L, s_L) , where c_L, t_L and s_L are the cylinder, track and sector numbers, respectively. Derive the formula to calculate the disk address (i.e. cylinder, track and sector) of a logical record n assuming that $r_l = s_l$.

[gate1998](#) [operating-system](#) [disk](#) [descriptive](#)

[Answer](#)

16.6.18 Disk: GATE2007-IT-44, ISRO2015-34 [top](#)

<http://gateoverflow.in/3479>

A hard disk system has the following parameters :

- Number of tracks = 500
- Number of sectors/track = 100
- Number of bytes /sector = 500
- Time taken by the head to move from one track to adjacent track = 1 ms
- Rotation speed = 600 rpm.

What is the average time taken for transferring 250 bytes from the disk ?

- 300.5 ms

- B. 255.5 ms
 C. 255 ms
 D. 300 ms

[gate2007-it](#) [operating-system](#) [disk](#) [normal](#) [isro2015](#)

[Answer](#)

16.6.19 Disk: GATE2015-2_49 [top](#)

<http://gateoverflow.in/8251>

Consider a typical disk that rotates at 15000 rotations per minute (RPM) and has a transfer rate of 50×10^6 bytes/sec. If the average seek time of the disk is twice the average rotational delay and the controller's transfer time is 10 times the disk transfer time, the average time (in milliseconds) to read or write a 512-byte sector of the disk is _____.

[gate2015-2](#) [operating-system](#) [disk](#) [normal](#)

[Answer](#)

16.6.20 Disk: GATE2015-1_48 [top](#)

<http://gateoverflow.in/8344>

Consider a disk pack with a seek time of 4 milliseconds and rotational speed of 10000 rotations per minute (RPM). It has 600 sectors per track and each sector can store 512 bytes of data. Consider a file stored in the disk. The file contains 2000 sectors. Assume that every sector access necessitates a seek, and the average rotational latency for accessing each sector is half of the time for one complete rotation. The total time (in milliseconds) needed to read the entire file is _____.

[gate2015-1](#) [operating-system](#) [disk](#) [normal](#)

[Answer](#)

16.6.21 Disk: GATE2005-IT_81b [top](#)

<http://gateoverflow.in/3846>

A disk has 8 equidistant tracks. The diameters of the innermost and outermost tracks are 1 cm and 8 cm respectively. The innermost track has a storage capacity of 10 MB.

If the disk has 20 sectors per track and is currently at the end of the 5th sector of the inner-most track and the head can move at a speed of 10 meters/sec and it is rotating at constant angular velocity of 6000 RPM, how much time will it take to read 1 MB contiguous data starting from the sector 4 of the outer-most track?

- | | |
|----|---------|
| A) | 13.5 ms |
| B) | 10 ms |
| C) | 9.5 ms |
| D) | 20 ms |

[gate2005-it](#) [operating-system](#) [disk](#) [normal](#)

[Answer](#)

16.6.22 Disk: GATE2005-IT_81a [top](#)

<http://gateoverflow.in/3845>

A disk has 8 equidistant tracks. The diameters of the innermost and outermost tracks are 1 cm and 8 cm respectively. The innermost track has a storage capacity of 10 MB.

What is the total amount of data that can be stored on the disk if it is used with a drive that rotates it with (i) Constant Linear Velocity (ii) Constant Angular Velocity?

- | | |
|----|------------------------|
| A) | (i) 80 MB (ii) 2040 MB |
| B) | (i) 2040 MB (ii) 80 MB |
| C) | (i) 80 MB (ii) 360 MB |
| D) | (i) 360 MB (ii) 80 MB |

[gate2005-it](#) [operating-system](#) [disk](#) [normal](#)

[Answer](#)

16.6.23 Disk: GATE2001-1.22 [top](#)<http://gateoverflow.in/715>

Which of the following requires a device driver?

- A. Register
- B. Cache
- C. Main memory
- D. Disk

[gate2001](#) [operating-system](#) [disk](#) [easy](#)

[Answer](#)

16.6.24 Disk: GATE2003_25, ISRO2009-12 [top](#)<http://gateoverflow.in/915>

Using a larger block size in a fixed block size file system leads to

- A. better disk throughput but poorer disk space utilization
- B. better disk throughput and better disk space utilization
- C. poorer disk throughput but better disk space utilization
- D. poorer disk throughput and poorer disk space utilization

[gate2003](#) [operating-system](#) [disk](#) [normal](#) [isro2009](#)

[Answer](#)

16.6.25 Disk: GATE2005-IT_63 [top](#)<http://gateoverflow.in/3824>

In a computer system, four files of size 11050 bytes, 4990 bytes, 5170 bytes and 12640 bytes need to be stored. For storing these files on disk, we can use either 100 byte disk blocks or 200 byte disk blocks (but can't mix block sizes). For each block used to store a file, 4 bytes of bookkeeping information also needs to be stored on the disk. Thus, the total space used to store a file is the sum of the space taken to store the file and the space taken to store the book keeping information for the blocks allocated for storing the file. A disk block can store either bookkeeping information for a file or data from a file, but not both.

What is the total space required for storing the files using 100 byte disk blocks and 200 byte disk blocks respectively?

- A) 35400 and 35800 bytes
- B) 35800 and 35400 bytes
- C) 35600 and 35400 bytes
- D) 35400 and 35600 bytes

[gate2005-it](#) [operating-system](#) [disk](#) [normal](#)

[Answer](#)

16.6.26 Disk: GATE1997_74 [top](#)<http://gateoverflow.in/19704>

A program P reads and processes 1000 consecutive records from a sequential file F stored on device D without using any file system facilities. Given the following

Size of each record = 3200 bytes

Access time of D = 10 msec

Data transfer rate of D = 800×10^3 bytes/second

CPU time to process each record = 3 msec

What is the elapsed time of P if

- a. F contains unblocked records and P does not use buffering?
- b. F contains unblocked records and P uses one buffer (i.e., it always reads ahead into the buffer)?
- c. records of F are organized using a blocking factor of 2 (i.e., each block on D contains two records of F) and P uses one

buffer?

gate1997 operating-system disk

Answer

16.6.27 Disk: GATE2004-IT_51 [top](#)

<http://gateoverflow.in/3694>

The storage area of a disk has innermost diameter of 10 cm and outermost diameter of 20 cm. The maximum storage density of the disk is 1400 bits/cm. The disk rotates at a speed of 4200 RPM. The main memory of a computer has 64-bit word length and $1\mu s$ cycle time. If cycle stealing is used for data transfer from the disk, the percentage of memory cycles stolen for transferring one word is

- | | |
|----|------|
| A) | 0.5% |
| B) | 1% |
| C) | 5% |
| D) | 10% |

gate2004-it operating-system disk normal

Answer

16.6.28 Disk: GATE2001-8 [top](#)

<http://gateoverflow.in/749>

Consider a disk with following specifications: 20 surface, 1000 tracks/surface, 16 sectors/track, data density 1 KB/sector, rotation speed 3000 rpm. The operating system initiates the transfer between the disk and the memory sector-wise. Once the head has been placed on the right track, the disk reads a sector in a single scan. It reads bits from the sector while the head is passing over the sector. The read bits are formed into bytes in a serial-in-parallel-out buffer and each byte is then transferred to memory. The disk writing is exactly a complementary process.

For parts (C) and (D) below, assume memory read-write time = 0.1 microsecond/byte, interrupt driven transfer has an interrupt overhead = 0.4 microseconds, the DMA initialization and termination overhead is negligible compared to the total sector transfer time. DMA requests are always granted.

- What is the total capacity of the disk?
- What is the data transfer rate?
- What is the percentage of time the CPU is required for this disk I/O for bite-wise interrupts driven transfer?
- What is the maximum percentage of time the CPU is held up for this disk I/O for cycle-stealing DMA transfer?

gate2001 operating-system disk normal

Answer

16.6.29 Disk: GATE2001-20 [top](#)

<http://gateoverflow.in/761>

Consider a disk with the 100 tracks numbered from 0 to 99 rotating at 3000 rpm. The number of sectors per track is 100 and the time to move the head between two successive tracks is 0.2 millisecond.

- Consider a set of disk requests to read data from tracks 32, 7, 45, 5 and 10. Assuming that the elevator algorithm is used to schedule disk requests, and the head is initially at track 25 moving up (towards larger track numbers), what is the total seek time for servicing the requests?
- Consider an initial set of 100 arbitrary disk requests and assume that no new disk requests arrive while servicing these requests. If the head is initially at track 0 and the elevator algorithm is used to schedule disk requests, what is the worse case time to complete all the requests?

gate2001 operating-system disk normal

Answer

Answers: Disk

16.6.1 Disk: GATE1999_2.18, ISRO2008-46 [top](#)

<http://gateoverflow.in/1496>



Selected Answer

- A) Fault tolerance and
B) High Speed

4 votes

-- GateMaster Prime (1.3k points)

16.6.2 Disk: GATE1993_7.8 [top](#)<http://gateoverflow.in/2296>

Selected Answer

file system uses directories which are the files containing the name and location of other file in the file system. unlike other file, directory does not store the user data. Directories are the file that can point to other directories. Root directory point to various user directory so they will be stored in such a way that user cannot easily modify them. They should be placed at fixed location on the disk.

5 votes

-- neha pawar (3.8k points)

16.6.3 Disk: GATE2004_49 [top](#)<http://gateoverflow.in/1045>

Selected Answer

no of address in one block = $2^{10}/2^2 = 2^8$ as triple pointer used max possible size = $2^8 \times 2^8 \times 2^8 \times 2^{10} = 2^{34}$ Bytes

ans is C

3 votes

-- Pooja (25.9k points)

Size of Disk Block = 1024Byte

Disk Blocks address = 4B

No of addresses per block $1024/4 = 256 = 2^8$ addresses

we Have

10 Direct

1 SI = 2^8 Indirect * $2^{10} = 2^{18}$ Byte

1 DI = 2^8 SI = $(2^8)^2$ Direct = 2^{16} Direct ** $2^{10} = 2^{26}$ Byte

1 TI = 2^8 DI = $(2^8)^2$ SI = $(2^8)^3 = 2^{24}$ Direct = $2^{24} * 2^{10} = 2^{34}$ Byte.

So total size = $2^{18} + 2^{26} + 2^{34}$ Byte + 10240 Byte. Which is nearly 2^{34} Bytes. (We don't have exact option available. Choose approximate one)

Answer -> C

3 votes

-- Akash (31.7k points)

16.6.4 Disk: GATE2004_68 [top](#)<http://gateoverflow.in/1062>

Selected Answer

Clock cycle time = $(1/600) \times 10^6$

For DMA initiation and completion = $(900+300)/(600 \times 10^6) = 2$ microsec .

Disk Transfer rate = 10 Mbytes/sec

1 byte = $1/10^7$ sec

20 Kbytes = 2 milisec = 2000 micro sec

Percentage = $(2/2000 + 2)*100 = 0.0999 \approx 0.1\%$

% of cpu time consume= $x/x+y$

x= cpu busy

y= cpu block

10 votes

-- Anirudh Pratap Singh (17.7k points)

16.6.5 Disk: GATE2007-11, ISRO2009-36, ISRO2016-21 [top](#)

<http://gateoverflow.in/1209>



Selected Answer

ans is A.

16 surfaces= 4 bits, 128 tracks= 7 bits, 256 sectors= 8 bits, sector size 512 bytes = 9 bits

capacity of disk = $2^{(4+7+8+9)} = 2^{28} = 256MB$

to specify a particular sector we do not need sector size, so bits required = $4+7+8 = 19$

10 votes

-- jayendra (6.6k points)

16.6.6 Disk: GATE1998-25a [top](#)

<http://gateoverflow.in/1740>

Solution for Part a :-

Assume that size of each block is S bits.

Then no of bits required for free list is = Fd, No of blocks required = Fd/S

No of bits required for Bit map = B (No of blocks) , No of block required is = B /S

Condition under which free list uses less space than the bit map.

$Fd / S < B / S$

3 votes

-- Akash (31.7k points)

16.6.7 Disk: GATE1995_14 [top](#)

<http://gateoverflow.in/2650>



Selected Answer

For A part :

No of track = Recording width/ inner space between track

Recording width= $(OuterDiameter - Inner Diameter)/2 = (12-4)/2 = 4\text{ cm}$

therefore no of track = $4\text{cm} / 0.1\text{ mm} = 400\text{ track}$

Since they have ask capacity of unformatted disk , so no 96 bytes in 4000 bytes would be wasted for non data purpose

Whole 4000 is used

So total capacity = $400 * 8 * 20 * 4000 = 256 * 10^6$ Bytes = **256 MB**

For B part :

its is given 360 rotations in 60 seconds

that is 360 rotations = $60 * 10^3$ sec

therefore 1 rotations will take $(1/6)$ sec

In $(1/6)$ sec - we can read one track= $20 * (4000-96)$ B = $20 * 3904$ B

then in 1 sec it will be = $20 * 3904 * 6$ bytes = Data transfer rate = **468.480 KBps**

6 votes

-- spriti1991 (1.3k points)

16.6.8 Disk: GATE2013_29 [top](#)

<http://gateoverflow.in/1540>



Selected Answer

I think there is an easy method:

First convert <1200,9,40> into sector address.

$$(1200 * \underline{16} * \underline{64}) + (9 * \underline{64}) + 40 = 1229416$$

number of sectors to store file = $(42797 \text{ KB}) / 512 = 85594$

last sector to store file = $1229416 + 85594 = 1315010$

Now do reverse engineering,

$1315010 / (\underline{16} * \underline{64}) = 1284.189453$ // 1284 will be cylinder number and remaining sectors = 194.

$194 / \underline{64} = 3.03125$ // 3 is surface number and remaining sectors are 2.

$\therefore <1284, 3, 2>$ is last sector address.

28 votes

-- Laxmi (743 points)

16.6.9 Disk: GATE1993_6.7 [top](#)

<http://gateoverflow.in/2289>



Selected Answer

RPM = 2400

So, in 60 s, the disk rotates 2400 times.

Average latency is the time for half a rotation = $0.5 * 60 / 2400 \text{ s} = 3/240 \text{ s} = 12.5 \text{ ms}$.

In one full rotation, entire data in a track can be transferred. Track storage capacity = 62500 bits.

So, disk transfer rate = $62500 * 2400 / 60 \text{ s} = 2.5 * 10^6 \text{ bps}$.

10 votes

-- Arjun Suresh (150k points)

16.6.10 Disk: GATE2008-32 [top](#)

<http://gateoverflow.in/443>



Selected Answer

According to wiki http://en.wikipedia.org/wiki/Hard_disk_drive_performance_characteristics#Seek_time
answer should be B.

Upvote 6 votes

-- Vikrant Singh (11k points)

16.6.11 Disk: GATE2009-51 [top](#)

<http://gateoverflow.in/137>



Selected Answer

The data on a disk is ordered in the following way. It is first stored on the first sector of the first surface of the first cylinder. Then in the next sector, and next, until all the sectors on the first track are exhausted. Then it moves on to the first sector of the second surface (remains at the same cylinder), then next sector and so on. It exhausts all available surfaces for the first cylinder in this way. After that, it moves on to repeat the process for the next cylinder.

So, to reach to the cylinder numbered 400 (401th cylinder) we need to skip $400 * (10*2) * 63 = 504,000$ sectors.

Then, to skip to the 16th surface of the cylinder numbered 400, we need to skip another $16*63 = 1,008$ sectors.

Finally, to find the 29 sector, we need to move another 29 sectors.

In total, we moved $504,000 + 1,008 + 29 = 505,037$ sectors.

Hence, the answer to 51 is option C.

Upvote 20 votes

-- Pragy Agarwal (14.4k points)

16.6.12 Disk: GATE2005_21 [top](#)

<http://gateoverflow.in/137>



Selected Answer

Answer is b.

Upvote 5 votes

-- anshu (2.5k points)

16.6.13 Disk: GATE2012_41 [top](#)

<http://gateoverflow.in/2149>



Selected Answer

direct block addressing will point to 8 disk blocks = $8*128$ B = 1 KB

Singly Indirect block addressing will point to 1 disk block which has $128/8$ disc block addresses = $(128/8)*128$ B = 2 KB

Doubly indirect block addressing will point to 1 disk block which has $128/8$ addresses to disk blocks which in turn has $128/8$ addresses to disk blocks = $16*16*128$ B= 32 KB

Total = 35 KB

Ans B

Upvote 8 votes

-- Vikrant Singh (11k points)

16.6.14 Disk: GATE2011_44 [top](#)

<http://gateoverflow.in/2146>



Selected Answer

disk access time = seek time + rotational latency + transfer time (given that transfer time is neglected)

here seek time=10msec

rotational speed=6000rpm
 60sec ----- 6000 rotation
 1 rotation-----60/6000 sec
 rotational latency--- $1/2 * 60/6000$ sec=5msec
 total time to transfer one library=10+5=15 msec
 total time to transfer 100 libraries=100*15msec=1.5 sec

15 votes

-- neha pawar (3.8k points)

16.6.15 Disk: GATE1998_2.9 [top](#)

<http://gateoverflow.in/1681>



Selected Answer

Ans is D .

When a soft-sectorized disk is low-level "formatted", each track is written with a number of bytes calculated to fit within 360 degrees at the highest expected motor speed; identification data showing where each sector should start is written at this time. The system of punched holes used by hard-sectorized disks is not needed; a single hole is retained to indicate the start of the track (3 1/2-inch disks use an alignment pin rather than a hole). If the motor is spinning any slower than the highest acceptable speed, which is usually the case, the data will fit in fewer than 360 degrees, resulting in a gap at the end of the track. Additionally, if a sector were to be rewritten on a drive running faster than the drive was running when the track was formatted, the new data would be larger (occupy more degrees of rotation) than the original sector. Therefore, during formatting a gap must be left between sectors to allow a rewritten sector to be larger without overwriting the following sector.

Reference :-https://en.wikipedia.org/wiki/Floppy_disk_format

3 votes

-- Akash (31.7k points)

16.6.16 Disk: GATE2009-52 [top](#)

<http://gateoverflow.in/43477>



Selected Answer

1039th sector will be stored in track number $(1039 + 1)/63 = 16.5$ (as counting starts from 0 as given in question) and each track has 63 sectors. So, we need to go to 17th track which will be numbered 16 and each cylinder has 20 tracks (10 platters * 2 recording surface each) . Number of extra sectors needed = $1040 - 16 * 63 = 32$ and hence the sector number will be 31. So, option C.

8 votes

-- Pragy Agarwal (14.4k points)

16.6.17 Disk: GATE1998-25b [top](#)

<http://gateoverflow.in/41055>

disk address= cL(C)+tL(t)+SL(s)

we must know the cylinder number and track number in advance then only we can calculate the address of record

0 votes

-- Tauhin Gangwar (5k points)

Here logical file size d1

Now , d1 has n records of size r1

So, d1= n r1

No of sectors for the file say (sec)=n r1 % s [Now, r1=s1, then sec=0]

No of tracks say (track) = sec % t

No. of cylinder say (cyl)= sec / t

Now, disk address of the logical record is $\langle c_L, t_L, s_L \rangle + \langle cyl, track, sec \rangle$

0 votes

-- srestha (27.8k points)

16.6.18 Disk: GATE2007-IT-44, ISRO2015-34 [top](#)

<http://gateoverflow.in/3479>



Selected Answer

option D

Explanation

Avg. time to transfer = Avg. seek time + Avg. rotational delay + Data transfer time

Avg Seek Time

given that : time to move between successive tracks is 1 ms

time to move from track 1 to track 1 : 0ms
 time to move from track 1 to track 2 : 1ms
 time to move from track 1 to track 3 : 2ms

..

..

time to move from track 1 to track 500 : 499 ms

$$\text{Avg Seek time} = \frac{\sum_{i=1}^{500} i}{500} = 249.5 \text{ ms}$$

Avg Rotational Delay

RMP : 600

600 rotations in 60 sec
 one Rotation takes $60/600$ sec = 0.1 sec

$$\begin{aligned} \text{Avg Rotational Delay} &= \frac{0.1}{2} \left\{ \text{usually } \frac{\text{Rotation time}}{2} \text{ is taken as Avg Rotational Delay} \right\} \\ &= .05 \text{ sec} \\ &= 50 \text{ ms} \end{aligned}$$

Data Transfer Time

One 1 Roatation we can read data on one complete track .

$= 100 * 500 = 50,000$ B data is read in one complete rotation

one complete rotation takes 0.1 s (we seen above)

0.1 --- > 50,000 bytes.

$$250 \text{ bytes} \rightarrow 0.1 * 250 / 50,000 = 0.5 \text{ ms}$$

Avg. time to transfer = Avg. seek time + Avg. rotational delay + Data transfer time

$$= 295.5 + 50 + 0.5$$

$$= 300 \text{ ms}$$

14 votes

-- Akhil Nadh Pullolikkal Chandran (6.9k points)

16.6.19 Disk: GATE2015-2_49 [top](#)

<http://gateoverflow.in/8251>



Selected Answer

Average time to read/write = Avg. seek time + Avg. rotational delay + Effective transfer time

Rotational delay = $60/15 = 4 \text{ ms}$

Avg. rotational delay = $1/2 * 4 = 2 \text{ ms}$

Avg. seek time = $2 * 2 = 4 \text{ ms}$

Disk transfer time = $512/(50 * 10^3) = 0.0102 \text{ ms}$

Effective transfer time = $10 * \text{disk transfer time} = 0.102 \text{ ms}$

So, avg. time to read/write = $4 + 2 + 0.1 = 6.1 \text{ ms}$

Ref: <http://www.csc.villanova.edu/~japaridz/8400/sld012.htm>

17 votes

-- Arjun Suresh (150k points)

16.6.20 Disk: GATE2015-1_48 top

<http://gateoverflow.in/8354>



Selected Answer

Since each sector requires a seek,

Total time = $2000 * (\text{seek time} + \text{avg. rotational latency} + \text{data transfer time})$

Since data transfer rate is not given, we can take that in 1 rotation, all data in a track is read. i.e., in $60/10000 = 6\text{ms}$, $600 * 512$ bytes are read. So, time to read 512 bytes = $6/600 \text{ ms} = 0.01 \text{ ms}$

= $2000 * (4 \text{ ms} + 60 * 1000 / 2 * 10000 + 0.01)$

= $2000 * (7.01 \text{ ms})$

= 14020 ms .

<http://www.csee.umbc.edu/~olano/611s06/storage-io.pdf>

21 votes

-- Arjun Suresh (150k points)

16.6.21 Disk: GATE2005-IT_81b top

<http://gateoverflow.in/3846>

Radius of inner track is 0.5 cm (where the head is standing) and the radius of outermost track is 4 cm.

So the header has to seek $(4-0.5)=3.5 \text{ cm}$. It will take $(3.5 \times 1000 / 1000) = 3.5 \text{ ms}$.

now angular velocity is constant and header is now end of 5th sector . To start from front of 4th sector it must rotate upto 18 sector.

6000 rotation in 60000ms

1 rotation in 10 ms.(same time to traverse 20 sector)

So to traverse sector 18 it takes 9 ms.

in 10 ms 10 MB data is read.

1 MB can be read in 1 ms.

So total time is $=(1+9+3.5) \text{ ms} = 13.5 \text{ ms}$

10 votes

-- Palash Nandi (1.4k points)

16.6.22 Disk: GATE2005-IT_81a [top](#)<http://gateoverflow.in/3845>

Selected Answer

- With **Constant Linear Velocity, CLV**, the density of bits is uniform from cylinder to cylinder. Because there are more sectors in outer cylinders, the disk spins slower when reading those cylinders, causing the rate of bits passing under the read-write head to remain constant. This is the approach used by modern CDs and DVDs.
- With **Constant Angular Velocity, CAV**, the disk rotates at a constant angular speed, with the bit density decreasing on outer cylinders. (These disks would have a constant number of sectors per track on all cylinders.)
- $CLV = 10 + 20 + 30 + 40 + \dots + 80 = 360$
- $CAV = 10 * 8 = 80$ so answer should be d

6 votes

-- spriti1991 (1.3k points)

16.6.23 Disk: GATE2001-1.22 [top](#)<http://gateoverflow.in/715>

Selected Answer

A disk driver is a device driver that allows a specific disk drive to communicate with the remainder of the computer. A good example of this driver is a floppy disk driver.

12 votes

-- Bhagirathi Nayak (11.3k points)

16.6.24 Disk: GATE2003_25, ISRO2009-12 [top](#)<http://gateoverflow.in/915>

Selected Answer

Answer is A. Larger block size means less number of blocks to fetch and hence better throughput. But larger block size also means space is wasted when only small size is required.

12 votes

-- Arjun Suresh (150k points)

16.6.25 Disk: GATE2005-IT_63 [top](#)<http://gateoverflow.in/3824>

Selected Answer

for 100 bytes block:

$11050 = 111$ blocks requiring $111 * 4 = 444$ bytes of bookkeeping info which requires another 5 disk blocks. So, totally

$111 + 5 = 116$ disk blocks. Similarly,

$4990 = 50 + (50*4)/100 = 52$

$5170 = 52 + (52*4)/100 = 55$

$12640 = 127 + (127*4/100) = 133$

$356 \times 100 = 35600$ bytes

For 200 bytes block:

$56 + (56*4/200) = 58$

$25 + (25 * 4 / 200) = 26$

$26 + (26 * 4 / 200) = 27$

$64 + (64 * 4 / 200) = 66$

$177 \times 200 = 35400$

So, C option.

10 votes

-- Viral Kapoor (1.8k points)

16.6.26 Disk: GATE1997_74 <http://gateoverflow.in/1974>

here Access time = 10ms
 Process each Record = 3ms
 Transfer time = $3200/800 \times 10^3 = 4\text{ms}$

A) Elapsed time = (Access time + Transfer time + processing time)* number of records
 $(10+4+3) \times 1000 = 17000 \text{ ms} = 17\text{sec}$

B) In this case P uses one ' Read ahead' buffer the processing and transferring of records can be overlapped
 "Processing time is less than transfer time."
 Elapsed time = (Access time + Transfer time)*number of records

$$= (10+4) \times 1000 = 14\text{sec}$$

C) In this case each block contain two records so we can access 500 time to transfer 1000 records.
 Elapsed time = (Access time + Transfer time)*number of records
 $= (10+4+4+3+3) \times 500 = 12 \text{ sec}$

1 votes

-- Umang Raman (11.3k points)

16.6.27 Disk: GATE2004-IT_51 <http://gateoverflow.in/3694>

Selected Answer

As the max density is given so we take the inner most diameter as it is denser there(2Rp). The capacity of each track is $\pi D \times \text{Density} = 3.14 \times 10^3 \times 1400 \text{ bits} = 14000\pi \text{ bits}$
 Now rotational latency is $60/\text{RPM} = 60/4200 = 1/70 \text{ s}$.

So in $1/70 \text{ sec}$ the disk can traverse one entire track and can read total $14000\pi \text{ bits}$. Now this is done by the cpu. Now the data transfer is done by the DMA controller which will be operated in memory cycle time i.e 1 micro sec and it has 64 bit word length. So in 1 cycle it is able to transfer total of 64 bits. In 1 sec it can transfer 64×10^6 bits.(1sec memory cycle)

In 1 sec the disk can read total of $14000\pi \times 70 = 3.08 \times 10^6 \text{ bits}$ (considering $\pi = 22/7$)
 So total memory cycle stolen is $3.08 \times 10^6 / (64 \times 10^6) \% = 5\%(\text{approx})$

9 votes

-- Shaun Patel (5.8k points)

16.6.28 Disk: GATE2001-8 <http://gateoverflow.in/749>

Selected Answer

Q.a) $20 \times 1000 \times 16 \times 1KB = 3,20,000KB$

Q.b)

$$\begin{aligned} 3000 \text{ rotations} &= 60 \text{ seconds} \\ 1 \text{ rotation} &= \frac{60}{3000} \text{ seconds} \\ 1 \text{ rotation} = 1 \text{ track} &= \frac{1}{50} \text{ seconds} \\ 1 \text{ track} = 16 \times 1KB &= \frac{1}{50} \text{ seconds} \\ 800KB &= 1 \text{ second} \end{aligned}$$

Hence, transfer rate = 800 KB/sec

Q.c) Data is transferred Byte wise; given in the question.

CPU read/write time for a Byte = $0.1 \mu\text{s}$

Interrupt overhead (counted in CPU utilization time only) = $0.4 \mu\text{s}$

μs

transfer time for 1 Byte data which took place at the rate of 800 KB/sec = $1.25 \mu\text{s}$

μs

Percentage of CPU time required for this job =

$$\frac{0.1+0.4}{0.5+1.25} \times 100 = 28.57\%$$

Q.d)

Percentage of CPU time required for this job =

$$\frac{0.1+0}{0.1+1.25} \times 100 = 7.407\%$$

5 votes

-- Amar Vashishth (20.7k points)

16.6.29 Disk: GATE2001-20 <http://gateoverflow.in/761>

Selected Answer

Answer A)

We are using SCAN - Elevator algorithms.

We will need to go from 25->99->5. (As we will move up all the way to 99, servicing all request, then come back to 5.)

So total seeks = $74+94= 168$

Total time = $168*0.2 = 33.60000$

Answer for B)

We need to consider rotational latency too - >

3000 rpm

i.e. 50 rps

$1 \text{ r} = 1000 / 50 \text{ msec} = 20 \text{ msec}$

So rotational latency = $20/2 = 10 \text{ msec per access.}$

In worst case we need to go from tracks 0-99. I.e. 99 seeks

Total time = $99 * 0.2 + 10*100 = 1019.8\text{msec} = 1.019 \text{ sec}$

6 votes

-- Akash (31.7k points)

16.7**Disk Scheduling** **16.7.1 Disk Scheduling: GATE2009-31** <http://gateoverflow.in/1317>

Consider a disk system with 100 cylinders. The requests to access the cylinders occur in following sequence:

4, 34, 10, 7, 19, 73, 2, 15, 6, 20

Assuming that the head is currently at cylinder 50, what is the time taken to satisfy all requests if it takes 1ms to move from one cylinder to adjacent one and shortest seek time first policy is used?

- A. 95 ms
- B. 119 ms
- C. 233 ms
- D. 276 ms

[gate2009](#) [operating-system](#) [disk-scheduling](#) [normal](#)

Answer

16.7.2 Disk Scheduling: GATE 2016-1-48 <http://gateoverflow.in/39716>

Cylinder a disk queue with requests for I/O to blocks on cylinders 47, 38, 121, 191, 87, 11, 92, 10. The C-LOOK scheduling algorithm is used. The head is initially at cylinder number 63, moving towards larger cylinder numbers on its servicing pass. The cylinders are numbered from 0 to 199. The total head movement (in number of cylinders) incurred while servicing these requests is _____.

[gate2016-1](#) [operating-system](#) [disk-scheduling](#) [normal](#) [numerical-answers](#)

Answer

16.7.3 Disk Scheduling: GATE2007-IT_82 [top](#)

<http://gateoverflow.in/3534>

The head of a hard disk serves requests following the shortest seek time first (SSTF) policy. The head is initially positioned at track number 180.

Which of the request sets will cause the head to change its direction after servicing every request assuming that the head does not change direction if there is a tie in SSTF and all the requests arrive before the servicing starts?

- A) 11, 139, 170, 178, 181, 184, 201, 265
- B) 10, 138, 170, 178, 181, 185, 201, 265
- C) 10, 139, 169, 178, 181, 184, 201, 265
- D) 10, 138, 170, 178, 181, 185, 200, 265

[gate2007-it](#) [operating-system](#) [disk-scheduling](#) [normal](#)

[Answer](#)

16.7.4 Disk Scheduling: GATE2007-IT-83 [top](#)

<http://gateoverflow.in/3535>

The head of a hard disk serves requests following the shortest seek time first (SSTF) policy. The head is initially positioned at track number 180.

What is the maximum cardinality of the request set, so that the head changes its direction after servicing every request if the total number of tracks are 2048 and the head can start from any track?

- A. 9
- B. 10
- C. 11
- D. 12

[gate2007-it](#) [operating-system](#) [disk-scheduling](#) [normal](#)

[Answer](#)

16.7.5 Disk Scheduling: GATE2010-24 [top](#)

<http://gateoverflow.in/2203>

A system uses FIFO policy for system replacement. It has 4 page frames with no pages loaded to begin with. The system first accesses 100 distinct pages in some order and then accesses the same 100 pages but now in the reverse order. How many page faults will occur?

- A. 196
- B. 192
- C. 197
- D. 195

[gate2010](#) [operating-system](#) [disk-scheduling](#) [normal](#)

[Answer](#)

16.7.6 Disk Scheduling: GATE2014-1_19 [top](#)

<http://gateoverflow.in/1786>

Suppose a disk has 201 cylinders, numbered from 0 to 200. At some time the disk arm is at cylinder 100, and there is a queue of disk access requests for cylinders 30, 85, 90, 100, 105, 110, 135 and 145. If Shortest-Seek Time First (SSTF) is being used for scheduling the disk access, the request for cylinder 90 is serviced after servicing _____ number of requests.

[gate2014-1](#) [operating-system](#) [disk-scheduling](#) [numerical-answers](#) [normal](#)

[Answer](#)

16.7.7 Disk Scheduling: GATE1999_1.10 [top](#)

<http://gateoverflow.in/1463>

Which of the following disk scheduling strategies is likely to give the best throughput?

- A. Farthest cylinder next
- B. Nearest cylinder next
- C. First come first served
- D. Elevator algorithm

gate1999 | operating-system | disk-scheduling | normal

[Answer](#)

16.7.8 Disk Scheduling: GATE2004-IT_62 [top](#)

<http://gateoverflow.in/3705>

A disk has 200 tracks (numbered 0 through 199). At a given time, it was servicing the request of reading data from track 120, and at the previous request, service was for track 90. The pending requests (in order of their arrival) are for track numbers.

30 70 115 130 110 80 20 25.

How many times will the head change its direction for the disk scheduling policies SSTF(Shortest Seek Time First) and FCFS (First Come Fist Serve)?

- A. 2 and 3
- B. 3 and 3
- C. 3 and 4
- D. 4 and 4

gate2004-it | operating-system | disk-scheduling | normal

[Answer](#)

16.7.9 Disk Scheduling: GATE1995_20 [top](#)

<http://gateoverflow.in/2658>

The head of a moving head disk with 100 tracks numbered 0 to 99 is currently serving a request at track 55. If the queue of requests kept in FIFO order is

10, 70, 75, 23, 65

which of the two disk scheduling algorithms FCFS (First Come First Served) and SSTF (Shortest Seek Time First) will require less head movement? Find the head movement for each of the algorithms.

gate1995 | operating-system | disk-scheduling | normal

[Answer](#)

16.7.10 Disk Scheduling: GATE2015-1_30 [top](#)

<http://gateoverflow.in/8227>

Suppose the following disk request sequence (track numbers) for a disk with 100 tracks is given:

45, 20, 90, 10, 50, 60, 80, 25, 70.

Assume that the initial position of the R/W head is on track 50. The additional distance that will be traversed by the R/W head when the Shortest Seek Time First (SSTF) algorithm is used compared to the SCAN (Elevator) algorithm (assuming that SCAN algorithm moves towards 100 when it starts execution) is _____ tracks.

gate2015-1 | operating-system | disk-scheduling | normal

[Answer](#)

16.7.11 Disk Scheduling: GATE2004_12 [top](#)

<http://gateoverflow.in/1009>

Consider an operating system capable of loading and executing a single sequential user process at a time. The disk head scheduling algorithm used is First Come First Served (FCFS). If FCFS is replaced by Shortest Seek Time First (SSTF), claimed by the vendor to give 50% better benchmark results, what is the expected improvement in the I/O performance of user programs?

- A. 50%
- B. 40%
- C. 25%
- D. 0%

gate2004 | operating-system | disk-scheduling | normal

[Answer](#)

Answers: Disk Scheduling

16.7.1 Disk Scheduling: GATE2009-31 [top](#)

<http://gateoverflow.in/137>



Selected Answer

Answer is **B.**

$$\begin{aligned}
 &= (50 - 34) + (34 - 20) + (20 - 19) + (19 - 15) + (15 - 10) + (10 - 7) + \\
 &(7 - 6) + (6 - 4) + (4 - 2) + (73 - 2) \\
 &= 16 + 14 + 1 + 4 + 5 + 3 + 1 + 2 + 2 + 71 \\
 &= 119 \text{ ms.}
 \end{aligned}$$

1 votes

-- Sona Praneeth Akula (3.8k points)

16.7.2 Disk Scheduling: GATE 2016-1-48 [top](#)

<http://gateoverflow.in/3976>



Selected Answer

$$\begin{aligned}
 63->191 &= 128 \\
 191->10 &= 181 \\
 10->47 &= 37 \\
 \text{Total} &= 346
 \end{aligned}$$

10 votes

-- Abhilash Panicker (7k points)

16.7.3 Disk Scheduling: GATE2007-IT_82 [top](#)

<http://gateoverflow.in/354>



Selected Answer

It should be B.

When the head starts from 180... it seeks the nearest track.. which is 181. Then from 181 it seeks the nearest one which is 178 and 184. But the difference in both from 181 is same and as given in the question... if there is a tie then the head wont change its direction, and therefore to change the direction we need to consider 178. and thus we can eliminate option A and C.

Coming next to option B and D.. following the above procedure you'll see that option D is eliminated on similar ground. And thus you can say option B is correct.

3 votes

-- Gate Keeda (17.7k points)

Nearest cylinder next but it can lead to starvation

1 2 votes

-- Bhagirathi Nayak (11.3k points)

16.7.8 Disk Scheduling: GATE2004-IT_62 [top](#)

<http://gateoverflow.in/3705>



Selected Answer

Answer is (C)

SSTF: (90) 120 115 110 130 80 70 30 25 20

Direction changes at 120,110,130

FCFS: (90) 120 30 70 115 130 110 80 20 25

direction changes at 120,30,130,20

1 5 votes

-- Sandeep_Uniyal (5.5k points)

16.7.9 Disk Scheduling: GATE1995_20 [top](#)

<http://gateoverflow.in/2658>



Selected Answer

FCS: 55->10->70->75->23->65 => 45+60+5+52+42=204.

SSTE: 55->65->70->75->23->10 => 10+5+5+52+13=85

Hence SSTF.

1 6 votes

-- kireeti (1k points)

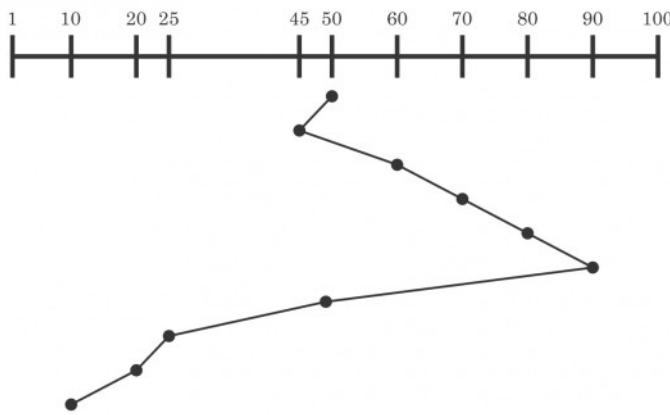
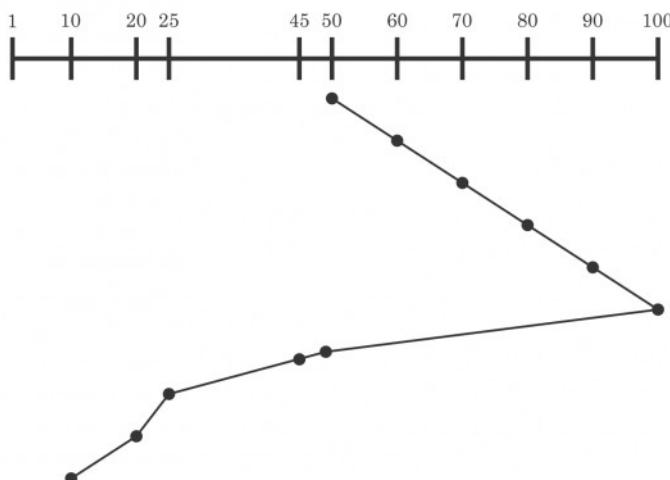
16.7.10 Disk Scheduling: GATE2015-1_30 [top](#)

<http://gateoverflow.in/8227>



Selected Answer

check : <http://www.cs.iit.edu/~cs561/cs450/disksched/disksched.html>

SSTF:**Scan:**

So, for SSTF it takes 130 head movements and for SCAN it takes 140 head movements.

Hence, not additional but $140 - 130 = 10$ less head movements SSTF takes.

10 votes

-- Amar Vashishth (20.7k points)

16.7.11 Disk Scheduling: GATE2004_12 top

<http://gateoverflow.in/109>



Selected Answer

Question says "single sequential user process". So, all the requests to disk scheduler will be in sequence and each one will be blocking the execution and hence there is no use of any disk scheduling algorithm. Any disk scheduling algorithm gives the same input sequence and hence the improvement will be 0% for SSTF over FCFS.

13 votes

-- Arjun Suresh (150k points)

16.8

Dma top

16.8.1 Dma: GATE2005_70 top

<http://gateoverflow.in/1393>

Consider a disk drive with the following specifications:

16 surfaces, 512 tracks/surface, 512 sectors/track, 1 KB/sector, rotation speed 3000 rpm. The disk is operated in cycle stealing mode whereby whenever one 4 byte word is ready it is sent to memory; similarly, for writing, the disk interface reads a 4 byte word from the memory in each DMA cycle. Memory cycle time is 40 nsec. The maximum percentage of time that the CPU gets blocked during DMA operation is:

- A. 10
- B. 25
- C. 40
- D. 50

gate2005 | operating-system | disk | normal | dma

[Answer](#)

Answers: Dma

16.8.1 Dma: GATE2005_70 [top](#)

<http://gateoverflow.in/1393>



Selected Answer

B. 25

Does 3000 rotations in 60 seconds

⇒ 1 rotation in 20 ms

In 1 rotation covers data in 1 track which is = 512×1 KB

20 ms

↔ 512 KB

1 sec

↔ 25600 KB

⇒ Transfer rate = 25600 KBps

Transfer Rate means we can perform read or write operations(one at a time) with this speed.

In one DMA cycle of 40 ns we are able to transfer 4 Bytes to disk.

CPU Idle Time = 40 ns

Data Preparation Time =

$$\frac{4\text{Bytes}}{25600\text{KB}} = 156.25\text{ ns}$$

% Time CPU Blocked =

$$\frac{40\text{ns}}{40\text{ns}+156.25\text{ns}} \times 100 = \mathbf{20.382}$$

10 votes

-- Amar Vashishth (20.7k points)

16.9

File [top](#)

16.9.1 File: GATE2014-2_20 [top](#)

<http://gateoverflow.in/1977>

A FAT (file allocation table) based file system is being used and the total overhead of each entry in the FAT is 4 bytes in size. Given a 100×10^6 bytes disk on which the file system is stored and data block size is 10^3 bytes, the maximum size of a file that can be stored on this disk in units of 10^6 bytes is _____.

gate2014-2 | operating-system | disk | numerical-answers | normal | file | file-system

[Answer](#)

Answers: File

16.9.1 File: GATE2014-2_20 [top](#)<http://gateoverflow.in/1977>

Selected Answer

Each datablock will have its entry.

$$\text{So, Total Number of entries in the FAT} = \frac{\text{Disk Capacity}}{\text{Block size}} = \frac{100MB}{1KB} = 100K$$

each entry takes up $4B$ as overhead

$$\text{so space occupied by overhead} = 100K \times 4B = 400KB = 0.4MB$$

We have to give space to Overheads on the same file system and at the rest available space we can store data.

$$\text{so, assuming that we use all available storage space to store a single file} = \text{Maximum file size} = \text{Total File System size} - \text{Overhead} = 100MB - 0.4MB = 99.6MB$$

11 votes

-- Kalpish Singh (1.7k points)

16.10**File System** [top](#)**16.10.1 File System: GATE2004-IT_67** [top](#)<http://gateoverflow.in/3710>

In a particular Unix OS, each data block is of size 1024 bytes, each node has 10 direct data block addresses and three additional addresses: one for single indirect block, one for double indirect block and one for triple indirect block. Also, each block can contain addresses for 128 blocks. Which one of the following is approximately the maximum size of a file in the file system?

- A) 512 MB
- B) 2 GB
- C) 8 GB
- D) 16 GB

[gate2004-it](#) [operating-system](#) [file-system](#) [normal](#)

Answer

16.10.2 File System: GATE2008-20 [top](#)<http://gateoverflow.in/418>

The data blocks of a very large file in the Unix file system are allocated using

- A. continuous allocation
- B. linked allocation
- C. indexed allocation
- D. an extension of indexed allocation

[gate2008](#) [file-system](#) [operating-system](#) [normal](#)

Answer

16.10.3 File System: GATE1996_23 [top](#)<http://gateoverflow.in/2775>

A file system with a one-level directory structure is implemented on a disk with disk block size of $4K$ bytes. The disk is used as follows:

Disk-block 0 File Allocation Table, consisting of one 8-bit entry per data block, representing the data block address of the next data block in the file

Disk-block 1 Directory, with one 32 bit entry per file:

Disk-block 2 Data-block 1;
 Disk-block 3 Data-block 2; etc.

- a. What is the maximum possible number of files?
- b. What is the maximum possible file size in blocks

[gate1996](#) | [operating-system](#) | [disk](#) | [normal](#) | [file-system](#)

[Answer](#)

Answers: File System

16.10.1 File System: GATE2004-IT_67 [top](#)

<http://gateoverflow.in/3710>



Selected Answer

Answer: B

Maximum file size = 10×1024 Bytes + $1 \times 128 \times 1024$ Bytes + $1 \times 128 \times 128 \times 1024$ Bytes + $1 \times 128 \times 128 \times 128 \times 1024$ Bytes = approx 2 GB.

6 votes

-- Rajarshi Sarkar (29.7k points)

16.10.2 File System: GATE2008-20 [top](#)

<http://gateoverflow.in/418>



Selected Answer

The data blocks of a very large file in the unix file system are allocated using an extension of indexed allocation or EXT2 file system. Hence option (d) is the right answer.

13 votes

-- Kalpana Bhargav (3k points)

16.10.3 File System: GATE1996_23 [top](#)

<http://gateoverflow.in/2775>

a) Maximum possible number of files...

As per question, 32 bits (or 4 Bytes) are required per file. And there is only one block to store this, ie the Disk block 1, which is of size 4KB. So number of files possible is $4\text{ KB}/4\text{ Bytes} = 1\text{ K}$ files possible...

b) Max file size..

As per question the Disk Block Address (FAT entry gives DBA) is of 8 bits.. So ideally the max file size should be $2^8=256$ Block size.. But question makes it clear that two blocks , DB0 and DB1, stores control information. So effectively we have $256-2=254$ blocks with us.. and the max file size shud be $=254 * \text{size of one block} = 254 * 4\text{ KB}= 1016\text{ KB}..$

8 votes

-- Hunain (441 points)

16.11

Fork [top](#)

16.11.1 Fork: GATE2004-IT_64 [top](#)

<http://gateoverflow.in/3707>

A process executes the following segment of code :

```
for(i = 1; i <= n; i++)
    fork();
```

The number of new processes created is

- A) n
- B) $((n(n + 1))/2)$
- C) $2^n - 1$
- D) $3^n - 1$

[gate2004-it](#) [operating-system](#) [fork](#) [easy](#)

[Answer](#)

16.11.2 Fork: GATE2005_72 [top](#)

<http://gateoverflow.in/765>

```
Consider the following code fragment:
if (fork() == 0)
{
    a = a + 5;
    printf("%d, %p\n", a, &a);
}
else
{
    a = a - 5;
    printf ("%d, %p\n", a,& a);
}
```

Let u, v be the values printed by the parent process and x, y be the values printed by the child process. Which one of the following is **TRUE**?

- A. $u = x + 10$ and $v = y$
- B. $u = x + 10$ and $v \neq y$
- C. $u + 10 = x$ and $v = y$
- D. $u + 10 = x$ and $v \neq y$

[gate2005](#) [operating-system](#) [fork](#) [normal](#)

[Answer](#)

16.11.3 Fork: GATE2008-66 [top](#)

<http://gateoverflow.in/489>

A process executes the following code

```
for(i=0; i<n; i++) fork();
```

The total number of child processes created is

- A. n
- B. $2^n - 1$
- C. 2^n
- D. $2^{n+1} - 1$

[gate2008](#) [operating-system](#) [fork](#) [normal](#)

[Answer](#)

Answers: Fork

16.11.1 Fork: GATE2004-IT_64 [top](#)

<http://gateoverflow.in/3707>



Selected Answer

option C.

At each fork, the number of processes doubles like from 1 - 2 - 4 - 8 ... 2^n . Of these except 1, all are child processes.

12 votes

-- prakash (255 points)

16.11.2 Fork: GATE2005_72 [top](#)

<http://gateoverflow.in/765>

(d) is the answer. Child is incrementing a by 5 and parent is decrementing a by 5. So, $x = u + 10$.

During fork(), address space of parent is copied for the child. So, any modifications to child variable won't affect the parent variable or vice-versa. But this copy is for physical pages of memory. The logical addresses remains the same between the parent and child processes.

12 votes

-- gatecse (10.7k points)

16.11.3 Fork: GATE2008-66 [top](#)

<http://gateoverflow.in/489>



Selected Answer

Each fork() creates a child which start executing from that point onward. So, number of child processes created will be $2^n - 1$.

At each fork, the number of processes doubles like from 1 - 2- 4 - 8 ... 2^n . Of these except 1, all are child processes.

http://gateoverflow.in/3707/gate2004-it_64

11 votes

-- Arjun Suresh (150k points)

16.12

Interrupts [top](#)

16.12.1 Interrupts: GATE1998_1.18 [top](#)

<http://gateoverflow.in/165>

Which of the following devices should get higher priority in assigning interrupts?

- A. Hard disk
- B. Printer
- C. Keyboard
- D. Floppy disk

[gate1998](#) [operating-system](#) [interrupts](#) [normal](#)

Answer

16.12.2 Interrupts: GATE2011_11 [top](#)

<http://gateoverflow.in/213>

A computer handles several interrupt sources of which of the following are relevant for this question.

- Interrupt from CPU temperature sensor (raises interrupt if CPU temperature is too high)
- Interrupt from Mouse (raises Interrupt if the mouse is moved or a button is pressed)
- Interrupt from Keyboard (raises Interrupt if a key is pressed or released)
- Interrupt from Hard Disk (raises Interrupt when a disk read is completed)

Which one of these will be handled at the **HIGHEST** priority?

- (A) Interrupt from Hard Disk
- (B) Interrupt from Mouse
- (C) Interrupt from Keyboard
- (D) Interrupt from CPU temperature sensor

[gate2011](#) [operating-system](#) [interrupts](#) [normal](#)

Answer**16.12.3 Interrupts: GATE1997_3.8** [top](#)<http://gateoverflow.in/2239>

When an interrupt occurs, an operating system

- A. ignores the interrupt
- B. always changes state of interrupted process after processing the interrupt
- C. always resumes execution of interrupted process after processing the interrupt
- D. may change state of interrupted process to 'blocked' and schedule another process.

[gate1997](#) [operating-system](#) [interrupts](#) [normal](#)
Answer**16.12.4 Interrupts: GATE2001-1.12** [top](#)<http://gateoverflow.in/705>

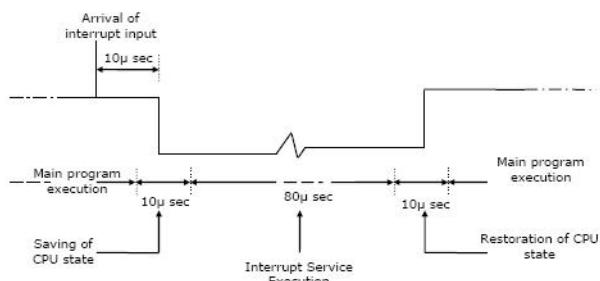
A processor needs software interrupt to

- A. test the interrupt system of the processor
- B. implement co-routines
- C. obtain system services which need execution of privileged instructions
- D. return from subroutine

[gate2001](#) [operating-system](#) [interrupts](#) [easy](#)
Answer**16.12.5 Interrupts: GATE1993_6.8** [top](#)<http://gateoverflow.in/2290>

The details of an interrupt cycle are shown in figure.

6.8. The details of an interrupt cycle are shown in figure.



Given that an interrupt input arrives every 1 msec, what is the percentage of the total time that the CPU devotes for the main program execution?

Given that an interrupt input arrives every 1 msec, what is the percentage of the total time that the CPU devotes for the main program execution.

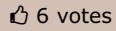
[gate1993](#) [operating-system](#) [interrupts](#) [normal](#)
Answer**Answers: Interrupts****16.12.1 Interrupts: GATE1998_1.18** [top](#)<http://gateoverflow.in/1655>



Selected Answer

It should be a Hard disk. I don't think there is a rule like that. But hard disk makes sense compared to others here.

<http://www.ibm1130.net/functional/IOInterrupts.html>



6 votes

-- Arjun Suresh (150k points)

16.12.2 Interrupts: GATE2011_11 [top](#)

<http://gateoverflow.in/2113>

Selected Answer

Answer should be (D) Higher priority interrupt levels are assigned to requests which, if delayed or interrupted, could have serious consequences. Devices with high speed transfer such as magnetic disks are given high priority, and slow devices such as keyboard receive low priority. We know that mouse pointer movements are more frequent than keyboard ticks. So its obvious that its data transfer rate is higher than keyboard. Delaying a CPU temperature sensor could have serious consequences, overheat can damage CPU circuitry. From the above information we can conclude that priorities are-

CPU temperature sensor > Hard Disk > Mouse > Keyboard



14 votes

-- Tejas Jaiswal (511 points)

16.12.3 Interrupts: GATE1997_3.8 [top](#)

<http://gateoverflow.in/2239>

Selected Answer

- A. Depends on the priority.
- B. Not always.
- C. Not always. If some high priority interrupt comes during execution of current interrupt, then?
- D. Seems to be correct.



6 votes

-- Monanshi Jain (6.5k points)

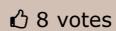
16.12.4 Interrupts: GATE2001-1.12 [top](#)

<http://gateoverflow.in/705>

Selected Answer

ans is C.

A and B are obviously incorrect. In D no need to change mode while returning from any subroutine. therefore software interrupt is not needed for that. But in C to execute any privileged instruction processor needs software interrupt while changing mode.



8 votes

-- jayendra (6.6k points)

16.12.5 Interrupts: GATE1993_6.8 [top](#)

<http://gateoverflow.in/2290>

Selected Answer

CPU overhead will be saving context + serving interrupt + restoration .
out of 1ms these things are overhead for CPU.

$$\text{OVERHEAD \%} = (10 + 80 + 10) * 10^{-6} / 1 * 10^{-3} * 100$$

$$= 10\%$$

% of time CPU devoted to main program = 90%



4 votes

-- Digvijay (35.8k points)

16.13

Io Handling [top](#)

16.13.1 Io Handling: GATE1998_1.29 [top](#)

<http://gateoverflow.in/1666>

Which of the following is an example of a spooled device?

- A. The terminal used to enter the input data for the C program being executed
- B. An output device used to print the output of a number of jobs
- C. The secondary memory device in a virtual storage system
- D. The swapping area on a disk used by the swapper

gate1998 | operating-system | io-handling | easy

Answer

16.13.2 Io Handling: GATE1996-1.20, ISRO2008-56 [top](#)

<http://gateoverflow.in/2724>

Which of the following is an example of spooled device?

- A. A line printer used to print the output of a number of jobs
- B. A terminal used to enter input data to a running program
- C. A secondary storage device in a virtual memory system
- D. A graphic display device

gate1996 | operating-system | io-handling | normal | isro2008

Answer

16.13.3 Io Handling: GATE2006-IT_8 [top](#)

<http://gateoverflow.in/3547>

Which of the following DMA transfer modes and interrupt handling mechanisms will enable the highest I/O band-width?

- A) Transparent DMA and Polling interrupts
- B) Cycle-stealing and Vectored interrupts
- C) Block transfer and Vectored interrupts
- D) Block transfer and Polling interrupts

gate2006-it | operating-system | io-handling | dma | normal

Answer

16.13.4 Io Handling: GATE2004-IT-11, ISRO2011-33 [top](#)

<http://gateoverflow.in/352>

What is the bit rate of a video terminal unit with 80 characters/line, 8 bits/character and horizontal sweep time of 100 μ s (including 20 μ s of retrace time)?

- A. 8 Mbps
- B. 6.4 Mbps
- C. 0.8 Mbps
- D. 0.64 Mbps

gate2004-it | operating-system | io-handling | easy | isro2011

Answer

16.13.5 Io Handling: GATE2005_20 [top](#)

<http://gateoverflow.in/1356>

Normally user programs are prevented from handling I/O directly by I/O instructions in them. For CPUs having explicit I/O

instructions, such I/O protection is ensured by having the I/O instruction privileged. In a CPU with memory mapped I/O, there is no explicit I/O instruction. Which one of the following is true for a CPU with memory mapped I/O?

- A. I/O protection is ensured by operating system routine(s)
- B. I/O protection is ensured by a hardware trap
- C. I/O protection is ensured during system configuration
- D. I/O protection is not possible

[gate2005](#) [operating-system](#) [io-handling](#) [normal](#)

[Answer](#)

16.13.6 Io Handling: GATE2005_19 [top](#)

<http://gateoverflow.in/1355>

Which one of the following is true for a CPU having a single interrupt request line and a single interrupt grant line?

- A. Neither vectored interrupt nor multiple interrupting devices are possible
- B. Vectored interrupts are not possible but multiple interrupting devices are possible
- C. Vectored interrupts and multiple interrupting devices are both possible
- D. Vectored interrupts are possible but multiple interrupting devices are not possible

[gate2005](#) [operating-system](#) [io-handling](#) [normal](#)

[Answer](#)

16.13.7 Io Handling: GATE1995_17 [top](#)

<http://gateoverflow.in/2653>

- a. An asynchronous serial communication controller that uses a start-stop scheme for controlling the serial I/O of a system is programmed for a string of length seven bits, one parity bit (odd parity) and one stop bit. The transmission rate is 1200 bits/second.
 - i. What is the complete bit stream that is transmitted for the string '0110101'?
 - ii. How many such strings can be transmitted per second?
- b. Consider a CRT display that has a text mode display format of 80×25 characters with a 9×12 character cell. What is the size of the video buffer RAM for the display to be used in monochrome (1 bit per pixel) graphics mode?

[gate1995](#) [operating-system](#) [io-handling](#) [normal](#)

[Answer](#)

Answers: Io Handling

16.13.1 Io Handling: GATE1998_1.29 [top](#)

<http://gateoverflow.in/1666>



Selected Answer

Ans B

<http://en.wikipedia.org/wiki/Spooling>

4 votes

-- Keith Kr (6k points)

16.13.2 Io Handling: GATE1996-1.20, ISRO2008-56 [top](#)<http://gateoverflow.in/2724>

Selected Answer

ans is A

spooling(simultaneous peripheral operations online) is a technique in which an intermediate device such as disk is interposed between process and low speed i/o device.for ex. in printer if a process attempt to print a document but printer is busy printing another document ,the process,instead of waiting for printer to become available,write its output to disk.when the printer become available the data on disk is printed.spooling allows process to request operation from peripheral device without requiring that the device be ready to service the request.

6 votes

-- neha pawar (3.8k points)

16.13.3 Io Handling: GATE2006-IT_8 [top](#)<http://gateoverflow.in/3547>

Selected Answer

The answer is c ryt ?

In block transfer the entire block of data is transferred then only CPU again becomes the bus master

And in vectored Interrupts . I/o device along with interrupts send vector address of Interrupt Service routine which guides CPU to execute for a specific I/O device

Hence in both case BW will be required in a good amount !

2 votes

-- spriti1991 (1.3k points)

16.13.4 Io Handling: GATE2004-IT-11, ISRO2011-33 [top](#)<http://gateoverflow.in/3652>

Selected Answer

Answer: B

Bit rate of a video terminal unit = $80*8 \text{ bits}/100 \mu\text{s} = 6.4 \text{ Mbps}$

7 votes

-- Rajarshi Sarkar (29.7k points)

16.13.5 Io Handling: GATE2005_20 [top](#)<http://gateoverflow.in/1356>

Selected Answer

option A. User applications are not allowed to perform I/O in user mode - All I/O requests are handled through system calls that must be performed in kernel mode

10 votes

-- Vikrant Singh (11k points)

16.13.6 Io Handling: GATE2005_19 [top](#)<http://gateoverflow.in/1355>

C. is the right option.

Daisy chain can be used.

4 votes

-- shreya ghosh (2.9k points)

16.13.7 Io Handling: GATE1995_17 [top](#)<http://gateoverflow.in/2653>

Answer for a)

- i)The complete bit stream will be 1011010111[1st bit is Start bit]
- ii)And Bandwidth is give as 1200bits/sec
so one complete bit stream is of length 10bit(1Start bit,7bit String,1ParityBit,1StopBit)
so in 1sec you can send $1200/10=120$ Strings.

0 votes

-- Abhishek Mitra (15 points)

16.14**Linking** [top](#)**16.14.1 Linking: GATE2002_2.20** [top](#)<http://gateoverflow.in/850>

Dynamic linking can cause security concerns because

- A. Security is dynamic
- B. The path for searching dynamic libraries is not known till runtime
- C. Linking is insecure
- D. Cryptographic procedures are not available for dynamic linking

[gate2002](#) [operating-system](#) [linking](#) [easy](#)

[Answer](#)

Answers: Linking**16.14.1 Linking: GATE2002_2.20** [top](#)<http://gateoverflow.in/850>

Selected Answer

- A) Nonsense option, No idea why it is here.
- D) There is no relation between Cryptographic procedures & Dynamic linking.
- C) This is not true. Linking in itself not insecure.
- B) The path for searching dynamic libraries is not known till runtime -> This seems most correct answer.

7 votes

-- Akash (31.7k points)

16.15**Memory Allocation** [top](#)**16.15.1 Memory Allocation: GATE2015-2_30** [top](#)<http://gateoverflow.in/8145>

Consider 6 memory partitions of sizes 200 KB, 400 KB, 600 KB, 500 KB, 300 KB and 250 KB, where KB refers to kilobyte. These partitions need to be allotted to four processes of sizes 357 KB, 210 KB, 468 KB, 491 KB in that order. If the best fit algorithm is used, which partitions are NOT allotted to any process?

- A. 200 KB and 300 KB

- B. 200 KB and 250 KB
 C. 250 KB and 300 KB
 D. 300 KB and 400 KB

gate2015-2 operating-system memory-allocation easy

[Answer](#)

Answers: Memory Allocation

16.15.1 Memory Allocation: GATE2015-2_30 [top](#)



Selected Answer

option A is correct because we have 6 memory partitions of sizes 200 KB, 400 KB, 600 KB, 500 KB, 300 KB and 250 KB and the partition allotted to the process using best fit is given below-
 357 KB process allotted at partition 400 KB.
 210 KB process allotted at partition 250 KB
 468 KB process allotted at partition 500 KB
 491 KB process allotted at partition 600 KB
 so we have left only two partitions 200 KB and 300 KB

8 votes

-- Anoop Sonkar (4.5k points)

16.16

Memory Management [top](#)

16.16.1 Memory Management: GATE1996_2.18 [top](#)

<http://gateoverflow.in/2747>

A 1000 Kbyte memory is managed using variable partitions but no compaction. It currently has two partitions of sizes 200 Kbytes and 260 Kbytes respectively. The smallest allocation request in Kbytes that could be denied is for

- A. 151
 B. 181
 C. 231
 D. 541

gate1996 operating-system memory-management normal

[Answer](#)

16.16.2 Memory Management: GATE2014-2_55 [top](#)

<http://gateoverflow.in/2022>

Consider a main memory system that consists of 8 memory modules attached to the system bus, which is one word wide. When a write request is made, the bus is occupied for 100 nanoseconds (ns) by the data, address, and control signals. During the same 100 ns, and for 500 ns thereafter, the addressed memory module executes one cycle accepting and storing the data. The (internal) operation of different memory modules may overlap in time, but only one request can be on the bus at any time. The maximum number of stores (of one word each) that can be initiated in 1 millisecond is _____

gate2014-2 operating-system memory-management numerical-answers normal

[Answer](#)

16.16.3 Memory Management: GATE2007-IT_11 [top](#)

<http://gateoverflow.in/3444>

Let a memory have four free blocks of sizes 4k, 8k, 20k, 2k. These blocks are allocated following the best-fit strategy. The allocation requests are stored in a queue as shown below.

| Request No | J1 | J2 | J3 | J4 | J5 | J6 | J7 | J8 |
|---------------|----|-----|----|----|----|-----|----|-----|
| Request Sizes | 2k | 14k | 3k | 6k | 6k | 10k | 7k | 20k |
| Usage Time | 4 | 10 | 2 | 8 | 4 | 1 | 8 | 6 |

The time at which the request for J7 will be completed will be

- A) 16
- B) 19
- C) 20
- D) 37

gate2007-it operating-system memory-management normal

Answer

16.16.4 Memory Management: GATE1995_5 [top](#)

<http://gateoverflow.in/2641>

A computer installation has 1000k of main memory. The jobs arrive and finish in the following sequences.

```
Job 1 requiring 200k arrives
Job 2 requiring 350k arrives
Job 3 requiring 300k arrives
Job 1 finishes
Job 4 requiring 120k arrives
Job 5 requiring 150k arrives
Job 6 requiring 80k arrives
```

- a. Draw the memory allocation table using Best Fit and First Fit algorithms
- b. Which algorithm performs better for this sequence?

gate1995 operating-system memory-management normal

Answer

16.16.5 Memory Management: GATE2006-IT_56 [top](#)

<http://gateoverflow.in/3600>

For each of the four processes P₁, P₂, P₃ and P₄. The total size in kilobytes (KB) and the number of segments are given below.

| Process | Total size (in KB) | Number of segments |
|----------------|--------------------|--------------------|
| P ₁ | 195 | 4 |
| P ₂ | 254 | 5 |
| P ₃ | 45 | 3 |
| P ₄ | 364 | 8 |

The page size is 1 KB. The size of an entry in the page table is 4 bytes. The size of an entry in the segment table is 8 bytes. The maximum size of a segment is 256 KB. The paging method for memory management uses two-level paging, and its storage overhead is P. The storage overhead for the segmentation method is S. The storage overhead for the segmentation and paging method is T. What is the relation among the overheads for the different methods of memory management in the concurrent execution of the above four processes ?

- A) P < S < T
- B) S < P < T
- C) S < T < P

D)

 $T < S < P$

gate2006-it

operating-system

memory-management

normal

Answer

16.16.6 Memory Management: GATE1992-12b [top](#)<http://gateoverflow.in/43582>

Let the page reference and the working set window be $c c d b c e c e a d$ and 4, respectively. The initial working set at time $t = 0$ contains the pages $\{a, d, e\}$, where a was referenced at time $t = 0$, d was referenced at time $t = -1$, and e was referenced at time $t = -2$. Determine the total number of page faults and the average number of page frames used by computing the working set at each reference.

gate1992

operating-system

memory-management

normal

Answer

Answers: Memory Management**16.16.1 Memory Management: GATE1996_2.18** [top](#)<http://gateoverflow.in/2747>

Selected Answer

Answer is B. Since the total size of the memory is 1000KB, lets assume that the partitioning for the current allocation is done in such a way that it will leave minimum free space.

Partitioning the 1000kB as below will allow gaps of 180KB each and hence a request of 181kB will not be met.

[180Kb-200kb-180kb-260kb-180kb]. The reasoning is more of an intuition rather than any formula.

12 votes

-- kireeti (1k points)

16.16.2 Memory Management: GATE2014-2_55 [top](#)<http://gateoverflow.in/2022>

Selected Answer

When a write request is made, the bus is occupied for 100 ns. So, between 2 writes at least 100 ns interval must be there.

Now, after a write request, for $100 + 500 = 600$ ns, the corresponding memory module is busy storing the data. But, assuming the next stores are to a different memory module (we have totally 8 modules in question), we can have consecutive stores at intervals of 100 ns. So, maximum number of stores in 1 ms

$$= 10^{-3} * 1/(100 * 10^{-9}) = 10,000$$

18 votes

-- Arjun Suresh (150k points)

16.16.3 Memory Management: GATE2007-IT_11 [top](#)<http://gateoverflow.in/3444>

Selected Answer

At t = 0

| Memory Block | Size | Job |
|--------------|------|-------------------------|
| A | 4k | J3 (finishes at t = 2) |
| B | 8k | J4 (finishes at t = 8) |
| C | 20k | J2 (finishes at t = 10) |
| D | 2k | J1 (finishes at t = 4) |

At t = 8

| Memory Block | Size | Job |
|--------------|------|-------------------------|
| A | 4k | |
| B | 8k | J5 (finishes at t = 14) |
| C | 20k | J2 (finishes at t = 10) |
| D | 2k | |

At t = 10

| Memory Block | Size | Job |
|--------------|------|-------------------------|
| A | 4k | |
| B | 8k | J5 (finishes at t = 14) |
| C | 20k | J6 (finishes at t = 11) |
| D | 2k | |

At t = 11

| Memory Block | Size | Job |
|--------------|------|-------------------------|
| A | 4k | |
| B | 8k | J5 (finishes at t = 14) |
| C | 20k | J7 (finishes at t = 19) |
| D | 2k | |

So, J7 finishes at t = 19.

Ref: <http://thumpsup2life.blogspot.fr/2011/02/best-fit-first-fit-and-worst-fit-memory.html>

✍ 5 votes

-- Arjun Suresh (150k points)

16.16.4 Memory Management: GATE1995_5 [top](#)

<http://gateoverflow.in/2641>

initial there is 1000k main memory available ...

then job 1 arrive ..and occupied 200k, then job 2 arrive ,occupy 350k,, after that job3 arrive and occupy 300k (assume continuous allocation) now free memory is $1000 - 850(200+350+300) = 150k$...till these jobs first fit and best fit are same)

now job1 is finished ...so that space is also free... so here 200k slot and 150k slot are free

now job 4 arrive which is 120k ..

case 1: first fit , so it will be in 200 k slot (free slot) and now free is = $200-120=80k$,

now 150k arrive which will be in 150 k slot ...

then 80k arrive which will occupy in 80k slot (200-120) so all jobs will be allocated successfully ...

case 2: best fit : , 120 k job will occupy best fit free space which is 150k so now remaining $150-120=30k$,

then 150k job arrive it will be occupied in 200k slot ..which is best fit for this job ...so free space = $200-150=50$,

now job 80k arrive , but there is no continuous 80k memory free ...so it will not be allocated successfully ...

so first fit is better .

✍ 6 votes

-- sonam vyas (8.1k points)

16.16.5 Memory Management: GATE2006-IT_56 [top](#)

<http://gateoverflow.in/3600>

For 2-level paging.

Page size is 1KB. So, no. of pages required for $P_1 = 195$. An entry in page table is of size 4 bytes and assuming an inner level page table takes the size of a page (this information is not given in question), we can have up to 256 entries in a second level page table and we require only 195 for P_1 . Thus only 1 second level page table is enough. So, memory overhead = 1KB (for first level) (again assumed as page size as not explicitly told in question) + 1KB for second level = 2KB.

For P_2 and P_3 also, we get 2KB each and for P_4 we get $1 + 2 = 3$ KB as it requires 1 first level page table and 2 second level page tables ($364 > 256$). So, total overhead for their concurrent execution = $2 \times 3 + 3 = 9$ KB .

Thus $P = 9$ KB .

For Segmentation method

<http://people.csail.mit.edu/rinard/osnotes/h15.html>

P_1 uses 4 segments -> 4 entries in segment table = $4 \times 8 = 32$ bytes.

Similarly, for P_2, P_3 and P_4 we get $5 \times 8, 3 \times 8$ and 8×8 bytes respectively and the total overhead will be $32 + 40 + 24 + 64 = 160$ bytes.

So, $S = 160B$.

For Segmentation with Paging

Here we segment first and then page. So, we need the page table size. We are given maximum size of a segment is 256 KB and page size is 1KB and thus we require 256 entries in the page table. So, total size of page table = $256 \times 4 = 1024$ bytes (exactly 1 page size).

So, now for P_1 we require 1 segment table of size 32 bytes plus 1 page table of size 1KB. Similarly,

P_2 – 40 bytes and 1KB

P_3 – 24 bytes and 1KB

P_4 – 64 bytes and 1KB.

Thus total overhead = 160 bytes + 4KB = $4096 + 160 = 4256$ bytes.

So, $T = 4256B$.

So, answer would be C- $S < T < P$.

4 votes

-- Arjun Suresh (150k points)

16.16.6 Memory Management: GATE1992-12b [top](#)

<http://gateoverflow.in/43582>



Selected Answer

Window size of working set = 4

Initial pages in the working set window = { e, d, a }

when page c comes at t=1, working set window = { e, d, a, c } - miss - current window size= 4

when page c comes,at t= 2, working set window = { d, a, c } - hit - current window size = 3

when page d comes,at t= 3, working set window = { a, c, d } - hit - current window size = 3

when page b comes,at t= 4, working set window = { c, d, b } - miss - current window size = 3

when page c comes,at t= 5, working set window = { d, b, c } - hit - current window size = 3

when page e comes,at t= 6, working set window = { d, b, c, e } - miss - current window size = 4

when page c comes,at t= 7, working set window = { b, c,e } - hit - current window size = 3

when page e comes,at t= 8, working set window = { c, e} - hit - current window size = 2

when page a comes,at t= 9, working set window = { c, e, a } - miss - current window size = 3

when page d comes,at t=10, working set window = { c, e, a, d} - miss - current window size = 4.

Total number of page faults = **5**.

Average no. of page frames used by window set = $(4 + 3 + 3 + 3 + 3 + 4 + 3 + 2 + 3 + 4) / 10 = 32/10 = \mathbf{3.2}$

4 votes

-- vijaycs (10.7k points)

Average number of page frames => 3.2

Total Page Faults => 5

4 votes

-- Akash (31.7k points)

16.17

Page Replacement [top](#)

16.17.1 Page Replacement: GATE2012_42 [top](#)

<http://gateoverflow.in/2150>

Consider the virtual page reference string

1, 2, 3, 2, 4, 1, 3, 2, 4, 1

on a demand paged virtual memory system running on a computer system that has main memory size of 3 page frames which are initially empty. Let *LRU*, *FIFO* and *OPTIMAL* denote the number of page faults under the corresponding page replacement policy. Then

- (A) *OPTIMAL* < *LRU* < *FIFO*
- (B) *OPTIMAL* < *FIFO* < *LRU*
- (C) *OPTIMAL* = *LRU*
- (D) *OPTIMAL* = *FIFO*

[gate2012](#) [operating-system](#) [page-replacement](#) [normal](#)

[Answer](#)

16.17.2 Page Replacement: GATE1994_1.13 [top](#)

<http://gateoverflow.in/2454>

A memory page containing a heavily used variable that was initialized very early and is in constant use is removed then

- A. LRU page replacement algorithm is used
- B. FIFO page replacement algorithm is used
- C. LFU page replacement algorithm is used
- D. None of the above

[gate1994](#) [operating-system](#) [page-replacement](#) [easy](#)

[Answer](#)

16.17.3 Page Replacement: TIFR2013-B-14 [top](#)

<http://gateoverflow.in/25794>

Assume a demand paged memory system where ONLY THREE pages can reside in the memory at a time. The following sequence gives the order in which the program references the pages.

1, 3, 1, 3, 4, 2, 2, 4

Assume that least frequently used page is replaced when necessary. If there is more than one least frequently used pages then the least recently used page among them is replaced. During the program's execution, how many times will the pages 1, 2, 3 and 4 be brought to the memory?

- a. 2, 2, 2, 2 times, respectively
- b. 1, 1, 1, 2 times, respectively
- c. 1, 1, 1, 1 times, respectively
- d. 2, 1, 2, 2 times, respectively
- e. None of the above

[tifr2013](#) [operating-system](#) [page-replacement](#)
Answer

16.17.4 Page Replacement: GATE1997_3.5 [top](#)

<http://gateoverflow.in/2236>

Locality of reference implies that the page reference being made by a process

- A. will always be to the page used in the previous page reference
- B. is likely to be to one of the pages used in the last few page references
- C. will always be to one of the pages existing in memory
- D. will always lead to a page fault

[gate1997](#) [operating-system](#) [page-replacement](#) [easy](#)
Answer

16.17.5 Page Replacement: GATE2007-IT-12 [top](#)

<http://gateoverflow.in/3445>

The address sequence generated by tracing a particular program executing in a pure demand paging system with 100 bytes per page is

0100, 0200, 0430, 0499, 0510, 0530, 0560, 0120, 0220, 0240, 0260, 0320, 0410.

Suppose that the memory can store only one page and if x is the address which causes a page fault then the bytes from addresses x to x + 99 are loaded on to the memory.

How many page faults will occur ?

- A. 0
- B. 4
- C. 7
- D. 8

[gate2007-it](#) [operating-system](#) [virtual-memory](#) [page-replacement](#) [normal](#)
Answer

16.17.6 Page Replacement: GATE 2016-2-20 [top](#)

<http://gateoverflow.in/39559>

In which one of the following page replacement algorithms it is possible for the page fault rate to increase even when the number of allocated frames increases?

- A. LRU (Least Recently Used)
- B. OPT (Optimal Page Replacement)
- C. MRU (Most Recently Used)
- D. FIFO (First In First Out)

[gate2016-2](#) [operating-system](#) [page-replacement](#) [easy](#)
Answer

16.17.7 Page Replacement: GATE2007-IT-58 [top](#)

<http://gateoverflow.in/3500>

A demand paging system takes 100 time units to service a page fault and 300 time units to replace a dirty page. Memory access time is 1 time unit. The probability of a page fault is p. In case of a page fault, the probability of page being dirty is also p. It is observed that the average access time is 3 time units. Then the value of p is

- A. 0.194
- B. 0.233
- C. 0.514
- D. 0.981

[gate2007-it](#)
[operating-system](#)
[page-replacement](#)
[probability](#)
[normal](#)
[Answer](#)

16.17.8 Page Replacement: GATE1997_3.9 [top](#)

<http://gateoverflow.in/2240>

Thrashing

- A. reduces page I/O
- B. decreases the degree of multiprogramming
- C. implies excessive page I/O
- D. improve the system performance

[gate1997](#)
[operating-system](#)
[page-replacement](#)
[easy](#)
[Answer](#)

16.17.9 Page Replacement: GATE1997-3.10, ISRO2008-57, ISRO2015-64 [top](#)

<http://gateoverflow.in/2241>

Dirty bit for a page in a page table

- A. helps avoid unnecessary writes on a paging device
- B. helps maintain LRU information
- C. allows only read on a page
- D. None of the above

[gate1997](#)
[operating-system](#)
[page-replacement](#)
[easy](#)
[isro2008](#)
[isro2015](#)
[Answer](#)

16.17.10 Page Replacement: GATE 2016-1-49 [top](#)

<http://gateoverflow.in/39711>

Consider a computer system with ten physical page frames. The system is provided with an access sequence $(a_1, a_2, \dots, a_{20}, a_1, a_2, \dots, a_{20})$, where each a_i is a distinct virtual page number. The difference in the number of page faults between the last-in-first-out page replacement policy and the optimal page replacement policy is _____.

[gate2016-1](#)
[operating-system](#)
[page-replacement](#)
[normal](#)
[numerical-answers](#)
[Answer](#)

16.17.11 Page Replacement: GATE2014-3_20 [top](#)

<http://gateoverflow.in/2054>

A system uses 3 page frames for storing process pages in main memory. It uses the Least Recently Used (**LRU**) page replacement policy. Assume that all the page frames are initially empty. What is the total number of page faults that will occur while processing the page reference string given below?

4, 7, 6, 1, 7, 6, 1, 2, 7, 2

[gate2014-3](#)
[operating-system](#)
[page-replacement](#)
[numerical-answers](#)
[normal](#)
[Answer](#)

16.17.12 Page Replacement: GATE2004_21, ISRO2007-44 [top](#)

<http://gateoverflow.in/1018>

The number of page frames that must be allocated to a running process in a virtual memory environment is determined by

- A. the instruction set architecture
- B. page size
- C. number of processes in memory
- D. physical memory size

[gate2004](#)
[operating-system](#)
[virtual-memory](#)
[page-replacement](#)
[normal](#)
[isro2007](#)

Answer**16.17.13 Page Replacement: GATE2014-2_33** [top](#)<http://gateoverflow.in/1992>

A computer has twenty physical page frames which contain pages numbered 101 through 120. Now a program accesses the pages numbered 1, 2, ..., 100 in that order, and repeats the access sequence **THREE**. Which one of the following page replacement policies experiences the same number of page faults as the optimal page replacement policy for this program?

- (A) Least-recently-used
- (B) First-in-first-out
- (C) Last-in-first-out
- (D) Most-recently-used

[gate2014-2](#) | [operating-system](#) | [page-replacement](#) | [easy](#)
Answer**16.17.14 Page Replacement: GATE1993_21** [top](#)<http://gateoverflow.in/2318>

The following page addresses, in the given sequence, were generated by a program:

1 2 3 4 1 3 5 2 1 5 4 3 2 3

This program is run on a demand paged virtual memory system, with main memory size equal to 4 pages. Indicate the page references for which page faults occur for the following page replacement algorithms.

- LRU
- FIFO

Assume that the main memory is initially empty

[gate1993](#) | [operating-system](#) | [page-replacement](#) | [normal](#)
Answer**16.17.15 Page Replacement: GATE2005-22, ISRO2015-36** [top](#)<http://gateoverflow.in/1358>

Increasing the RAM of a computer typically improves performance because:

- Virtual Memory increases
- Larger RAMs are faster
- Fewer page faults occur
- Fewer segmentation faults occur

[gate2005](#) | [operating-system](#) | [page-replacement](#) | [easy](#) | [isro2015](#)
Answer**16.17.16 Page Replacement: GATE2015-1_47** [top](#)<http://gateoverflow.in/8353>

Consider a main memory with five page frames and the following sequence of page references: 3, 8, 2, 3, 9, 1, 6, 3, 8, 9, 3, 6, 2, 1, 3. Which one of the following is true with respect to page replacement policies First In First Out (FIFO) and Least Recently Used (LRU)?

- Both incur the same number of page faults
- FIFO incurs 2 more page faults than LRU
- LRU incurs 2 more page faults than FIFO
- FIFO incurs 1 more page faults than LRU

[gate2015-1](#) | [operating-system](#) | [page-replacement](#) | [normal](#)

Answer**16.17.17 Page Replacement: GATE2007-82** [top](#)<http://gateoverflow.in/1274>

A process, has been allocated 3 page frames. Assume that none of the pages of the process are available in the memory initially. The process makes the following sequence of page references (reference string): **1, 2, 1, 3, 7, 4, 5, 6, 3, 1**

If optimal page replacement policy is used, how many page faults occur for the above reference string?

- A. 7
- B. 8
- C. 9
- D. 10

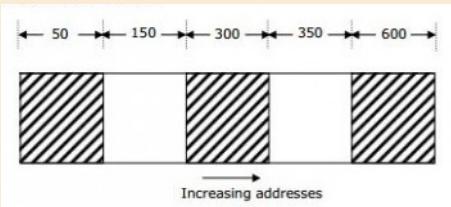
[gate2007](#) [operating-system](#) [page-replacement](#) [normal](#)
Answer**16.17.18 Page Replacement: GATE2002_1.23** [top](#)<http://gateoverflow.in/828>

The optimal page replacement algorithm will select the page that

- A. Has not been used for the longest time in the past
- B. Will not be used for the longest time in the future
- C. Has been used least number of times
- D. Has been used most number of times

[gate2002](#) [operating-system](#) [page-replacement](#) [easy](#)
Answer**16.17.19 Page Replacement: GATE1994_1.24** [top](#)<http://gateoverflow.in/2467>

Consider the following heap (figure) in which blank regions are not in use and hatched region are in use.



The sequence of requests for blocks of sizes 300, 25, 125, 50 can be satisfied if we use

- A. either first fit or best fit policy (any one)
- B. first fit but not best fit policy
- C. best fit but not first fit policy
- D. None of the above

[gate1994](#) [operating-system](#) [page-replacement](#) [normal](#)
Answer**16.17.20 Page Replacement: GATE2007-83** [top](#)<http://gateoverflow.in/43510>

A process, has been allocated 3 page frames. Assume that none of the pages of the process are available in the memory initially. The process makes the following sequence of page references (reference string): **1, 2, 1, 3, 7, 4, 5, 6, 3, 1**

Least Recently Used (LRU) page replacement policy is a practical approximation to optimal page replacement. For the above reference string, how many more page faults occur with LRU than with the optimal page replacement policy?

- A. 0
- B. 1
- C. 2
- D. 3

gate2007 | normal | operating-system | page-replacement

Answer

16.17.21 Page Replacement: GATE2007_56 [top](#)

<http://gateoverflow.in/1254>

A virtual memory system uses First In First Out (FIFO) page replacement policy and allocates a fixed number of frames to a process. Consider the following statements:

P: Increasing the number of page frames allocated to a process sometimes increases the page fault rate.

Q: Some programs do not exhibit locality of reference.

Which one of the following is TRUE?

- A. Both P and Q are true, and Q is the reason for P
- B. Both P and Q are true, but Q is not the reason for P.
- C. P is false but Q is true
- D. Both P and Q are false.

gate2007 | operating-system | page-replacement | normal

Answer

16.17.22 Page Replacement: GATE2014-1_33 [top](#)

<http://gateoverflow.in/1805>

Assume that there are 3 page frames which are initially empty. If the page reference string is 1, 2, 3, 4, 2, 1, 5, 3, 2, 4, 6, the number of page faults using the optimal replacement policy is_____.

gate2014-1 | operating-system | page-replacement | numerical-answers

Answer

16.17.23 Page Replacement: GATE1995_1.8 [top](#)

<http://gateoverflow.in/2595>

Which of the following page replacement algorithms suffers from Belady's anomaly?

- A. Optimal replacement
- B. LRU
- C. FIFO
- D. Both (A) and (C)

gate1995 | operating-system | page-replacement | normal

Answer

16.17.24 Page Replacement: GATE1995_2.7 [top](#)

<http://gateoverflow.in/2619>

The address sequence generated by tracing a particular program executing in a pure demand based paging system with 100 records per page with 1 free main memory frame is recorded as follows. What is the number of page faults?

0100, 0200, 0430, 0499, 0510, 0530, 0560, 0120, 0220, 0240, 0260, 0320, 0370

- A. 13
- B. 8
- C. 7
- D. 10

gate1995 operating-system page-replacement normal

[Answer](#)

Answers: Page Replacement

16.17.1 Page Replacement: GATE2012_42 [top](#)

<http://gateoverflow.in/2150>



Selected Answer

Page fault for LRU=9, FIFO=6, OPTIMAL=5

Ans (B)

2 votes

-- Keith Kr (6k points)

16.17.2 Page Replacement: GATE1994_1.13 [top](#)

<http://gateoverflow.in/2454>



Selected Answer

FIFO replaces a page which was brought into memory first will be removed first so since variable was initialized very early. it is in the set of first in pages. so it will be removed answer: b if you use LRU - since it is used constantly it is a recently used item always. so cannot be removed. If you use LFU - the frequency of the page is more since it is in constant use. So cannot be replaced

6 votes

-- Sankaranarayanan P.N (9.8k points)

16.17.3 Page Replacement: TIFR2013-B-14 [top](#)

<http://gateoverflow.in/25794>



Selected Answer

Page reference order: 1,3,1,3, 4,2,2,4

First 2 pages causes page fault...ie 1 and 3

Next 2 pages no fault

Next page ie 4 fault occurs

Now for page no 2 we have fault..we will replace less frequently used ie 4

Next page is again 2 so no page fault

Now page no 1 2 and 3 all are used 2 times so we will replace page 1 to accomodate page 4(least recently used is 1)

So page 1 2 3 are brought once in memory and page 4 is brought two times so ans is b

8 votes

-- Pooja (25.9k points)

16.17.4 Page Replacement: GATE1997_3.5 top<http://gateoverflow.in/2236>

Selected Answer

Answer: B

4 votes

-- Rajarshi Sarkar (29.7k points)

16.17.5 Page Replacement: GATE2007-IT-12 top<http://gateoverflow.in/3445>

Selected Answer

0100 - page fault, addresses till 199 in memory

0200 - page fault, addresses till 299 in memory

0430 - page fault, addresses till 529 in memory

0499 - no page fault

0510 - no page fault

0530 - page fault, addresses till 629 in memory

0560 - no page fault

0120 - page fault, addresses till 219 in memory

0220 - page fault, addresses till 319 in memory

0240 - no page fault

0260 - no page fault

0320 - page fault, addresses till 419 in memory

0410 - no page fault

So, 7 is the answer- (C)

11 votes

-- Arjun Suresh (150k points)

16.17.6 Page Replacement: GATE 2016-2-20 top<http://gateoverflow.in/3959>

Selected Answer

Option D.FIFO suffers from Belady's anomaly.

:D check this out

http://gateoverflow.in/1301/gate2009_9http://gateoverflow.in/1254/gate2007_56http://gateoverflow.in/2595/gate1995_1-8

5 votes

-- Shashank Chavan (2.6k points)

16.17.7 Page Replacement: GATE2007-IT-58 top<http://gateoverflow.in/3500>

Selected Answer

$$p(p * 300 + (1-p) * 100) + (1-p) * 1 = 3$$

$$p(300p + 100 - 100p) + 1-p=3$$

$$200p^2 + 99p - 2=0$$

$$p \approx 0.0194$$

8 votes

-- Laxmi (743 points)

16.17.8 Page Replacement: GATE1997_3.9 [top](#)

<http://gateoverflow.in/2240>



Selected Answer

C. implies excessive page i/o

http://en.wikipedia.org/wiki/Thrashing_%28computer_science%29

9 votes

-- Sankaranarayanan P.N (9.8k points)

16.17.9 Page Replacement: GATE1997-3.10, ISRO2008-57, ISRO2015-64 [top](#)

<http://gateoverflow.in/2241>



Selected Answer

The dirty bit allows for a performance optimization. A page on disk that is paged in to physical memory, then read from, and subsequently paged out again does not need to be written back to disk, since the page hasn't changed. However, if the page was written to after it's paged in, its dirty bit will be set, indicating that the page must be written back to the backing store answer: a

11 votes

-- Sankaranarayanan P.N (9.8k points)

16.17.10 Page Replacement: GATE 2016-1-49 [top](#)

<http://gateoverflow.in/39711>



Selected Answer

Ans is 1

In LIFO first 20 are page faults followed by next 9 hits then next 11 page faults. (After a_{10}, a_{11} replaces a_{10}, a_{12} replaces a_{11} and so on)

In optimal first 20 are page faults followed by next 9 hits then next 10 page faults followed by last page hit.

19 votes

-- Krishna murthy (421 points)

16.17.11 Page Replacement: GATE2014-3_20 [top](#)

<http://gateoverflow.in/2044>

total : 6

4 votes

-- Partha (509 points)

16.17.12 Page Replacement: GATE2004_21, ISRO2007-44 [top](#)

<http://gateoverflow.in/1018>



Selected Answer

A is the answer of this question, b,c,d options don't make a sense

https://www.cs.uic.edu/~jbell/CourseNotes/OperatingSystems/9_VirtualMemory.html

7 votes

-- Manu Thakur (5.6k points)

16.17.13 Page Replacement: GATE2014-2_33 [top](#)

<http://gateoverflow.in/1992>



Selected Answer

It will be D i.e Most-recently-used.

To be clear "repeats the access sequence THRICe" means totally the sequence of page numbers are accessed 4 times though this is not important for the answer here.

If we go optimal page replacement algorithm it replaces the page which will be least used in near future.

Now we have frame size 20 and reference string is

1, 2, ..., 100, 1, 2, ..., 100, 1, 2, ..., 100, 1, 2, ..., 100

First 20 accesses will cause page faults - the initial pages are no longer used and hence optimal page replacement replaces them first. Now, for page 21, according to reference string page 1 will be used again after 100 and similarly 2 will be used after 1 so on and so the least likely to be used page in future is page 20. So for 21st reference Page 20 will be replaced and then for

22nd page reference, page 21 will be replaced and so on which is MOST RECENTLY USED page replacement policy.

PS: Even for Most Recently Used page replacement at first all empty (invalid) pages frames are replaced and then only most recently used ones are replaced.

7 votes

-- Kalpish Singhal (1.7k points)

16.17.14 Page Replacement: GATE1993_21 [top](#)

<http://gateoverflow.in/2318>

LRU : 1,2,3,4,5,2,4,3,2
FIFO : 1,2,3,4,5,1,2,3

2 votes

-- Digvijay (35.8k points)

16.17.15 Page Replacement: GATE2005-22, ISRO2015-36 [top](#)

<http://gateoverflow.in/1358>



Selected Answer

So Answer -> C

1. Virtual Memory increases -> This option is false. Because Virtual Memory of Computer do not depend on RAM. Virtual Memory concept itself was introduced so Programs larger than RAM can be executed.
2. Larger RAMs are faster -> No This option is false. Size of ram does not determine its speed, Type of ram does, SRAM is faster, DRAM is slower.
3. Fewer page faults occur -> This is true, more pages can be in Main memory .
4. Fewer segmentation faults occur -> "Segementation Fault"-> A **segmentation fault** (aka segfault) is a common condition that causes programs to crash; they are often associated with a file named core . Segfaults are caused by a program trying to read or write an illegal memory location. It is clear that segmentation fault is not related to size of main memory. This is false.

8 votes

-- Akash (31.7k points)

16.17.16 Page Replacement: GATE2015-1_47 [top](#)<http://gateoverflow.in/8353>

Selected Answer

Requested Page references 3, 8, 2, 3, 9, 1, 6, 3, 8, 9, 3, 6, 2, 1, 3

and no. of page frame size is 5.

In FIFO Page replacement will take place in sequence in pattern First In first Out, as following

| Request | 3 | 8 | 2 | 3 | 9 | 1 | 6 | 3 | 8 | 9 | 3 | 6 | 2 | 1 | 3 |
|----------|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Frame 5 | | | | | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Frame 4 | | | | | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 2 |
| Frame 3 | | | 2 | 2 | 2 | 2 | 2 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 |
| Frame 2 | | 8 | 8 | 8 | 8 | 8 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| Frame 1 | 3 | 3 | 3 | 3 | 3 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 |
| Miss/Hit | F | F | F | H | F | F | F | H | H | H | H | H | F | H | |

No. of Faults = 9 No. of Hits = 6

Using Least Recently Used (LRU) page replacement will be the page which is visited least recently (which is not used by long time), as following

| Request | 3 | 8 | 2 | 3 | 9 | 1 | 6 | 3 | 8 | 9 | 3 | 6 | 2 | 1 | 3 |
|----------|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Frame 5 | | | | | | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 2 |
| Frame 4 | | | | | | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 |
| Frame 3 | | | 2 | 2 | 2 | 2 | 2 | 2 | 8 | 8 | 8 | 8 | 8 | 1 | 1 |
| Frame 2 | | 8 | 8 | 8 | 8 | 8 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 |
| Frame 1 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| Hit/Miss | F | F | F | H | F | F | F | H | F | H | H | H | F | F | H |

No. of Faults = 9 No. of Hits = 6

So, both incur the same number of page faults.

8 votes

-- Raghuveer Dhakad (969 points)

16.17.17 Page Replacement: GATE2007-82 [top](#)<http://gateoverflow.in/1274>

Selected Answer

Optimal replacement policy

| | | | | |
|---|---|---|---|---|
| 1 | 1 | 1 | 1 | 1 |
| 2 | 7 | 4 | 5 | 6 |
| 3 | 3 | 3 | 3 | 3 |

For Pages 1 2 3 6 4 5 6 bpage fault occur so ans for 82 is a

3 votes

-- Pooja (25.9k points)

16.17.18 Page Replacement: GATE2002_1.23 [top](#)<http://gateoverflow.in/828>



Selected Answer

Optimal page replacement algorithm will always select the page that will not be used for the longest time in the future for replacement, and that is why it is called optimal page replacement algorithm. Hence, (B) choice.

7 votes

-- Arjun Suresh (150k points)

16.17.19 Page Replacement: GATE1994_1.24 [top](#)

<http://gateoverflow.in/2467>

Selected Answer

In first fit, block request will be satisfied from the first free block that fits it.

So, request for 300 will be satisfied by 350 size block reducing the free size to 50.

Request for 25, satisfied by 125 size block, reducing it to 125.

Request for 125 satisfied by 125 size block.

And request for 50 satisfied by the 50 size block.

So, all requests can be satisfied.

In best fit strategy, a block request is satisfied by the smallest block in that can fit it.

So, request for 200 will be satisfied by 350 size block reducing the free size to 50.

Request for 25, satisfied by 50 size block as its the smallest size that fits 25, reducing it to 25.

Request for 125, satisfied by 150 size block, reducing it to 25.

Now, request for 50 cannot be satisfied as the two 25 size blocks are not contiguous.

So, answer (b)

6 votes

-- Arjun Suresh (150k points)

16.17.20 Page Replacement: GATE2007-83 [top](#)

<http://gateoverflow.in/43510>

Selected Answer

Using LRU = 9 Page Fault

| 1 | 2 | 1 | 3 | 7 | 4 | 5 | 6 | 3 | 1 |
|---|---|---|---|---|---|---|---|---|---|
| 3 | 3 | 3 | 5 | 5 | 5 | 5 | 1 | | |
| 2 | 2 | 2 | 7 | 7 | 7 | 6 | 6 | 6 | |
| 1 | 1 | 1 | 1 | 1 | 4 | 4 | 4 | 3 | 3 |

Using Optimal= 7 Page Fault

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 1 | 3 | 7 | 4 | 5 | 6 | 3 | 1 |
| | | | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| 2 | 2 | 2 | 7 | 4 | 5 | 6 | 6 | 6 | |
| 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| F | F | F | F | F | F | F | F | F | |

So LRU-OPTIMAL =2

option B

3 votes

-- Manoj Kumar (23.1k points)

16.17.21 Page Replacement: GATE2007_56 [top](#)

<http://gateoverflow.in/1254>



Selected Answer

P: Increasing the number of page frames allocated to a process sometimes increases the page fault rate.

This is true,
example :- FIFO suffers from [Bélády's anomaly](#) which means that on Increasing the number of page frames allocated to a process it may sometimes increase the total number of page faults.

Q: Some programs do not exhibit locality of reference.

This is true :- it is easy to write a program which jumps around a lot & which do not exhibit locality of reference.

Example :- Assume that array is stored in Row Major order & We are accessing it in column major order !

So answer = **option B** (As there is no relation between P & Q. As it is clear from example, they are independent.)

10 votes

-- Akash (31.7k points)

16.17.22 Page Replacement: GATE2014-1_33 [top](#)

<http://gateoverflow.in/1805>



Selected Answer

Ans : initially all empty frames fill by 1,2,3 so all time page fault which is 3 .

then next 4 was not available in frame set so we look at ahead of request which was coming last we replace 4 with that so 3 will be replaced by 4 and like wise next 2 and 1 is present already so no page fault and then next 5 is not present so replace with 1 and then 3 was not present and replace with 5 and then 2 and 4 are present already so no page fault and then last 6th was not already there so page fault.

So total page fault at : 1 , 2 , 3 , 4 , 5 , 3 , 6 . so, total 7 page fault occur ...

6 votes

-- Jay (1.1k points)

16.17.23 Page Replacement: GATE1995_1.8 [top](#)

<http://gateoverflow.in/2595>



Selected Answer

ans is C

FIFO suffers from Belady's anomaly. Optimal replacement never suffers from Belady's anomaly.

1 upvotes

-- jayendra (6.6k points)

16.17.24 Page Replacement: GATE1995_2.7 top<http://gateoverflow.in/2619>

Selected Answer

0100 - 1 page fault. Records 0100-0199 in memory
 0200 - 2 page faults. Records 0200-0299 in memory
 0430 - 3 page faults. Records 0400-0499 in memory
 0499 - 3 page faults. Records 0400-0499 in memory
 0510 - 4 page faults. Records 0500-0599 in memory
 0530 - 4 page faults. Records 0500-0599 in memory
 0560 - 4 page faults. Records 0500-0599 in memory
 0120 - 5 page faults. Records 0100-0199 in memory
 0220 - 6 page faults. Records 0200-0299 in memory
 0240 - 6 page faults. Records 0200-0299 in memory
 0260 - 6 page faults. Records 0200-0299 in memory
 0320 - 7 page faults. Records 0300-0399 in memory
 0370 - 7 page faults. Records 0300-0399 in memory
 So, C - 7 page faults.

1 upvotes

-- Arjun Suresh (150k points)

16.18**Process Schedule** top**16.18.1 Process Schedule: GATE2010-25** top<http://gateoverflow.in/2204>

Which of the following statements are true?

- I. Shortest remaining time first scheduling may cause starvation
- II. Preemptive scheduling may cause starvation
- III. Round robin is better than FCFS in terms of response time
 - A. I only
 - B. I and III only
 - C. II and III only
 - D. I, II and III

[gate2010](#) [operating-system](#) [process-schedule](#) [easy](#)

Answer

16.18.2 Process Schedule: GATE2015-3_1 top<http://gateoverflow.in/8390>The maximum number of processes that can be in ready Ready state for a computer system with n CPUs is

- A. n
 B. n^2
 C. 2^n
 D. Independent of n

gate2015-3 | operating-system | process-schedule | easy

Answer

16.18.3 Process Schedule: GATE2007_16 [top](#)

<http://gateoverflow.in/1214>

Group 1 contains some CPU scheduling algorithms and Group 2 contains some applications. Match entries in Group 1 to entries in Group 2.

Group I

- (P) Gang Scheduling (1) Guaranteed Scheduling
 (Q) Rate Monotonic Scheduling (2) Real-time Scheduling
 (R) Fair Share Scheduling (3) Thread Scheduling

Group II

- A. P-3; Q-2; R-1
 B. P-1; Q-2; R-3
 C. P-2; Q-3; R-1
 D. P-1; Q-3; R-2

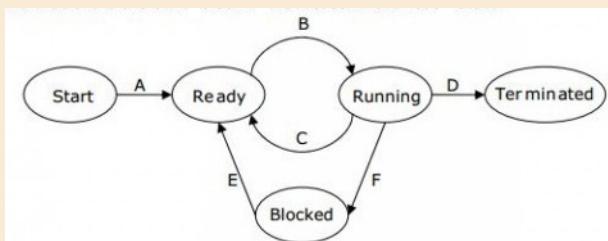
gate2007 | operating-system | process-schedule | normal

Answer

16.18.4 Process Schedule: GATE2009-32 [top](#)

<http://gateoverflow.in/1318>

In the following process state transition diagram for a uniprocessor system, assume that there are always some processes in the ready state:



Now consider the following statements:

- If a process makes a transition D, it would result in another process making transition A immediately.
- A process P_2 in blocked state can make transition E while another process P_1 is in running state.
- The OS uses preemptive scheduling.
- The OS uses non-preemptive scheduling.

Which of the above statements are TRUE?

- A. I and II
 B. I and III
 C. II and III
 D. II and IV

[gate2009](#) [operating-system](#) [process-schedule](#) [normal](#)
Answer

16.18.5 Process Schedule: GATE2008-IT_55 [top](#)

<http://gateoverflow.in/3365>

If the time-slice used in the round-robin scheduling policy is more than the maximum time required to execute any process, then the policy will

- A) degenerate to shortest job first
- B) degenerate to priority scheduling
- C) degenerate to first come first serve
- D) none of the above

[gate2008-it](#) [operating-system](#) [process-schedule](#) [easy](#)
Answer

16.18.6 Process Schedule: GATE1995_2.6 [top](#)

<http://gateoverflow.in/2618>

The sequence is an optimal non-preemptive scheduling sequence for the following jobs which leaves the CPU idle for unit(s) of time.

| Job | Arrival Time | Burst Time |
|-----|--------------|------------|
| 1 | 0.0 | 9 |
| 2 | 0.6 | 5 |
| 3 | 1.0 | 1 |

- A. {3, 2, 1}, 1
- B. {2, 1, 3}, 0
- C. {3, 2, 1}, 0
- D. {1, 2, 3}, 5

[gate1995](#) [operating-system](#) [process-schedule](#) [normal](#)
Answer

16.18.7 Process Schedule: GATE1995_1.15 [top](#)

<http://gateoverflow.in/2602>

Which scheduling policy is most suitable for a time shared operating system?

- A. Shortest Job First
- B. Round Robin
- C. First Come First Serve
- D. Elevator

[gate1995](#) [operating-system](#) [process-schedule](#) [easy](#)
Answer

16.18.8 Process Schedule: GATE1998_7b [top](#)

<http://gateoverflow.in/12963>

- a. In a computer system where the 'best-fit' algorithm is used for allocating 'jobs' to 'memory partitions', the following situation was encountered:

| | |
|-----------------------|----------------------------|
| Partitions size in KB | 4K 8K 20K 2K |
| Job sizes in KB | 2K 14K 3K 6K 6K 10K 20K 2K |
| Time for execution | 4 10 2 1 4 1 8 6 |

When will the 20K job complete?

[gate1998](#) [operating-system](#) [process-schedule](#) [normal](#)
Answer**16.18.9 Process Schedule: GATE2015-3_34** [top](#)<http://gateoverflow.in/8492>

For the processes listed in the following table, which of the following scheduling schemes will give the lowest average turnaround time?

| Process | Arrival Time | Process Time |
|---------|--------------|--------------|
| A | 0 | 3 |
| B | 1 | 6 |
| C | 4 | 4 |
| D | 6 | 2 |

- A. First Come First Serve
- B. Non-preemptive Shortest job first
- C. Shortest Remaining Time
- D. Round Robin with Quantum value two

[gate2015-3](#) [operating-system](#) [process-schedule](#) [normal](#)
Answer**16.18.10 Process Schedule: GATE2004_46** [top](#)<http://gateoverflow.in/1043>

Consider the following set of processes, with the arrival times and the CPU-burst times given in milliseconds.

| Process | Arrival Time | Burst Time |
|---------|--------------|------------|
| P1 | 0 | 5 |
| P2 | 1 | 3 |
| P3 | 2 | 3 |
| P4 | 4 | 1 |

What is the average turnaround time for these processes with the preemptive shortest remaining processing time first (SRPT) algorithm?

- A. 5.50
- B. 5.75
- C. 6.00
- D. 6.25

[gate2004](#) [operating-system](#) [process-schedule](#) [normal](#)
Answer**16.18.11 Process Schedule: GATE1993_7.10** [top](#)<http://gateoverflow.in/2298>

Assume that the following jobs are to be executed on a single processor system

| Job Id | CPU Burst Time |
|--------|----------------|
| p | 4 |
| q | 1 |
| r | 8 |
| s | 1 |
| t | 2 |

The jobs are assumed to have arrived at time 0^+ and in the order p, q, r, s, t . Calculate the departure time (completion time) for job p if scheduling is round robin with time slice 1

- (a). 4
- (b). 10
- (c). 11
- (d). 12
- (e). None of the above

[gate1993](#) [operating-system](#) [process-schedule](#) [normal](#)

[Answer](#)

16.18.12 Process Schedule: GATE2015-1_46 [top](#)

<http://gateoverflow.in/8330>

Consider a uniprocessor system executing three tasks T_1, T_2 and T_3 each of which is composed of an infinite sequence of jobs (or instances) which arrive periodically at intervals of 3, 7 and 20 milliseconds, respectively. The priority of each task is the inverse of its period, and the available tasks are scheduled in order of priority, which is the highest priority task scheduled first. Each instance of T_1, T_2 and T_3 requires an execution time of 1, 2 and 4 milliseconds, respectively. Given that all tasks initially arrive at the beginning of the 1st millisecond and task preemptions are allowed, the first instance of T_3 completes its execution at the end of _____ milliseconds.

[gate2015-1](#) [operating-system](#) [process-schedule](#) [normal](#)

[Answer](#)

16.18.13 Process Schedule: GATE1996-2.20, ISRO2008-15 [top](#)

<http://gateoverflow.in/2749>

Four jobs to be executed on a single processor system arrive at time 0 in the order A, B, C, D . Their burst CPU time requirements are 4, 1, 8, 1 time units respectively. The completion time of A under round robin scheduling with time slice of one time unit is

- A. 10
- B. 4
- C. 8
- D. 9

[gate1996](#) [operating-system](#) [process-schedule](#) [normal](#) [isro2008](#)

[Answer](#)

16.18.14 Process Schedule: GATE2007-IT-26 [top](#)

<http://gateoverflow.in/3459>

Consider n jobs $J_1, J_2 \dots J_n$ such that job J_i has execution time t_i and a non-negative integer weight w_i . The weighted mean completion time of the jobs is defined to be $\frac{\sum_{i=1}^n w_i T_i}{\sum_{i=1}^n w_i}$, where T_i is the completion time of job J_i . Assuming that there is only one processor available, in what order must the jobs be executed in order to minimize the weighted mean completion time of the jobs?

- A. Non-decreasing order of t_i
- B. Non-increasing order of w_i
- C. Non-increasing order of $w_i t_i$
- D. None-increasing order of w_i/t_i

[gate2007-it](#) [operating-system](#) [process-schedule](#) [normal](#)

[Answer](#)

16.18.15 Process Schedule: GATE2007_55 [top](#)

<http://gateoverflow.in/1253>

An operating system used Shortest Remaining System Time first (SRT) process scheduling algorithm. Consider the arrival times and execution times for the following processes:

| Process | Execution Time | Arrival time |
|---------|----------------|--------------|
| P1 | 20 | 0 |
| P2 | 25 | 15 |
| P3 | 10 | 30 |
| P4 | 15 | 45 |

What is the total waiting time for process P2?

- A. 5
- B. 15
- C. 40
- D. 55

[gate2007](#) [operating-system](#) [process-schedule](#) [normal](#)

Answer

16.18.16 Process Schedule: GATE2014-1_32 [top](#)

<http://gateoverflow.in/1803>

Consider the following set of processes that need to be scheduled on a single CPU. All the times are given in milliseconds.

| Process Name | Arrival Time | Execution Time |
|--------------|--------------|----------------|
| A | 0 | 6 |
| B | 3 | 2 |
| C | 5 | 4 |
| D | 7 | 6 |
| E | 10 | 3 |

Using the *shortest remaining time first* scheduling algorithm, the average process turnaround time (in msec) is _____.

[gate2014-1](#) [operating-system](#) [process-schedule](#) [numerical-answers](#) [normal](#)

Answer

16.18.17 Process Schedule: GATE2006-IT_54 [top](#)

<http://gateoverflow.in/3597>

The arrival time, priority, and duration of the CPU and I/O bursts for each of three processes P₁, P₂ and P₃ are given in the table below. Each process has a CPU burst followed by an I/O burst followed by another CPU burst. Assume that each process has its own I/O resource.

| Process | Arrival time | Priority | Burst duration, CPU, I/O |
|----------------|--------------|----------------|--------------------------|
| P ₁ | 0 | 2 | 1, 5, 3 |
| P ₂ | 2 | 3 (lowest) | 3, 3, 1 |
| P ₃ | 3 | 1 (highest) | 2, 3, 1 |

The multi-programmed operating system uses preemptive priority scheduling. What are the finish times of the processes P₁, P₂ and P₃?

- A) 11, 15, 9
- B) 10, 15, 9
- C) 11, 16, 10

D) 12, 17, 11

gate2006-it operating-system process-schedule normal

[Answer](#)

16.18.18 Process Schedule: GATE2006_64 [top](#)

<http://gateoverflow.in/1842>

Consider three processes (process id 0, 1, 2 respectively) with compute time bursts 2, 4 and 8 time units. All processes arrive at time zero. Consider the longest remaining time first (LRTF) scheduling algorithm. In LRTF ties are broken by giving priority to the process with the lowest process id. The average turn around time is:

- (A) 13 units
- (B) 14 units
- (C) 15 units
- (D) 16 units

gate2006 operating-system process-schedule normal

[Answer](#)

16.18.19 Process Schedule: GATE2006_65 [top](#)

<http://gateoverflow.in/1843>

Consider three processes, all arriving at time zero, with total execution time of 10, 20 and 30 units, respectively. Each process spends the first 20% of execution time doing I/O, the next 70% of time doing computation, and the last 10% of time doing I/O again. The operating system uses a shortest remaining compute time first scheduling algorithm and schedules a new process either when the running process gets blocked on I/O or when the running process finishes its compute burst. Assume that all I/O operations can be overlapped as much as possible. For what percentage of time does the CPU remain idle?

- (A) 0%
- (B) 10.6%
- (C) 30.0%
- (D) 89.4%

gate2006 operating-system process-schedule normal

[Answer](#)

16.18.20 Process Schedule: GATE2013_10 [top](#)

<http://gateoverflow.in/1419>

A scheduling algorithm assigns priority proportional to the waiting time of a process. Every process starts with zero (the lowest priority). The scheduler re-evaluates the process priorities every T time units and decides the next process to schedule. Which one of the following is **TRUE** if the processes have no I/O operations and all arrive at time zero?

- (A) This algorithm is equivalent to the first-come-first-serve algorithm.
- (B) This algorithm is equivalent to the round-robin algorithm.
- (C) This algorithm is equivalent to the shortest-job-first algorithm.
- (D) This algorithm is equivalent to the shortest-remaining-time-first algorithm.

gate2013 operating-system process-schedule normal

[Answer](#)

16.18.21 Process Schedule: GATE2006-06, ISRO2009-14 [top](#)

<http://gateoverflow.in/885>

Consider three CPU-intensive processes, which require 10, 20 and 30 time units and arrive at times 0, 2 and 6, respectively. How many context switches are needed if the operating system implements a shortest remaining time first scheduling algorithm? Do not count the context switches at time zero and at the end.

- A. 1
- B. 2
- C. 3
- D. 4

gate2006 operating-system process-schedule normal isro2009

Answer**16.18.22 Process Schedule: GATE2005-IT_60** [top](#)<http://gateoverflow.in/3821>

We wish to schedule three processes P1, P2 and P3 on a uniprocessor system. The priorities, CPU time requirements and arrival times of the processes are as shown below.

| Process | Priority | CPU time required | Arrival time (hh:mm:ss) |
|---------|-------------|-------------------|-------------------------|
| P1 | 10(highest) | 20 sec | 00:00:05 |
| P2 | 9 | 10 sec | 00:00:03 |
| P3 | 8 (lowest) | 15 sec | 00:00:00 |

We have a choice of preemptive or non-preemptive scheduling. In preemptive scheduling, a late-arriving higher priority process can preempt a currently running process with lower priority. In non-preemptive scheduling, a late-arriving higher priority process must wait for the currently executing process to complete before it can be scheduled on the processor. What are the turnaround times (time from arrival till completion) of P2 using preemptive and non-preemptive scheduling respectively?

- A) 30 sec, 30 sec
- B) 30 sec, 10 sec
- C) 42 sec, 42 sec
- D) 30 sec, 42 sec

[gate2005-it](#) [operating-system](#) [process-schedule](#) [normal](#)
Answer**16.18.23 Process Schedule: GATE2014-2_32** [top](#)<http://gateoverflow.in/1991>

Three processes A, B and C each execute a loop of 100 iterations. In each iteration of the loop, a process performs a single computation that requires t_c CPU milliseconds and then initiates a single I/O operation that lasts for t_{io} milliseconds. It is assumed that the computer where the processes execute has sufficient number of I/O devices and the OS of the computer assigns different I/O devices to each process. Also, the scheduling overhead of the OS is negligible. The processes have the following characteristics:

| Process id | t_c | t_{io} |
|------------|--------|----------|
| A | 100 ms | 500 ms |
| B | 350 ms | 500 ms |
| C | 200 ms | 500 ms |

The processes A, B, and C are started at times 0, 5 and 10 milliseconds respectively, in a pure time sharing system (round robin scheduling) that uses a time slice of 50 milliseconds. The time in milliseconds at which process C would **complete** its first I/O operation is _____.

[gate2014-2](#) [operating-system](#) [process-schedule](#) [numerical-answers](#) [normal](#)
Answer**16.18.24 Process Schedule: GATE2012_31** [top](#)<http://gateoverflow.in/1749>

Consider the 3 processes, P1, P2 and P3 shown in the table.

| Process | Arrival time | Time Units Required |
|---------|--------------|---------------------|
| P1 | 0 | 5 |
| P2 | 1 | 7 |
| P3 | 3 | 4 |

The completion order of the 3 processes under the policies FCFS and RR2 (round robin scheduling with CPU quantum of 2 time units) are

- (A) **FCFS:** P1, P2, P3 **RR2:** P1, P2, P3
- (B) **FCFS:** P1, P3, P2 **RR2:** P1, P3, P2
- (C) **FCFS:** P1, P2, P3 **RR2:** P1, P3, P2
- (D) **FCFS:** P1, P3, P2 **RR2:** P1, P2, P3

[gate2012](#) [operating-system](#) [process-schedule](#) [normal](#)

[Answer](#)

16.18.25 Process Schedule: GATE2003_77 [top](#)

<http://gateoverflow.in/963>

A uni-processor computer system only has two processes, both of which alternate 10 ms CPU bursts with 90 ms I/O bursts. Both the processes were created at nearly the same time. The I/O of both processes can proceed in parallel. Which of the following scheduling strategies will result in the *least* CPU utilization (over a long period of time) for this system?

- A. First come first served scheduling
- B. Shortest remaining time first scheduling
- C. Static priority scheduling with different priorities for the two processes
- D. Round robin scheduling with a time quantum of 5 ms

[gate2003](#) [operating-system](#) [process-schedule](#) [normal](#)

[Answer](#)

16.18.26 Process Schedule: GATE2002_1.22 [top](#)

<http://gateoverflow.in/827>

Which of the following scheduling algorithms is non-preemptive?

- A. Round Robin
- B. First-In First-Out
- C. Multilevel Queue Scheduling
- D. Multilevel Queue Scheduling with Feedback

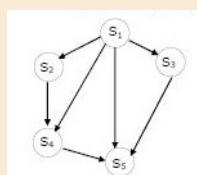
[gate2002](#) [operating-system](#) [process-schedule](#) [easy](#)

[Answer](#)

16.18.27 Process Schedule: GATE1998_24 [top](#)

<http://gateoverflow.in/1739>

- a. Four jobs are waiting to be run. Their expected run times are 6, 3, 5 and x. In what order should they be run to minimize the average response time?
- b. Write a concurrent program using par begin-par end to represent the precedence graph shown below.



[gate1998](#) [operating-system](#) [process-schedule](#) [descriptive](#)
Answer**16.18.28 Process Schedule: GATE2014-3_32** [top](#)<http://gateoverflow.in/2066>

An operating system uses *shortest remaining time first* scheduling algorithm for pre-emptive scheduling of processes. Consider the following set of processes with their arrival times and CPU burst times (in milliseconds):

| Process | Arrival Time | Burst Time |
|---------|--------------|------------|
| P1 | 0 | 12 |
| P2 | 2 | 4 |
| P3 | 3 | 6 |
| P4 | 8 | 5 |

The average waiting time (in milliseconds) of the processes is _____.

[gate2014-3](#) [operating-system](#) [process-schedule](#) [numerical-answers](#) [normal](#)
Answer**16.18.29 Process Schedule: GATE 2016-1-20** [top](#)<http://gateoverflow.in/39655>

Consider an arbitrary set of CPU-bound processes with unequal CPU burst lengths submitted at the same time to a computer system. Which one of the following process scheduling algorithms would minimize the average waiting time in the ready queue?

- A. Shortest remaining time first
- B. Round-robin with the time quantum less than the shortest CPU burst
- C. Uniform random
- D. Highest priority first with priority proportional to CPU burst length

[gate2016-1](#) [operating-system](#) [process-schedule](#) [normal](#)
Answer**16.18.30 Process Schedule: GATE2016-2-47** [top](#)<http://gateoverflow.in/39625>

Consider the following processes, with the arrival time and the length of the CPU burst given in milliseconds. The scheduling algorithm used is preemptive shortest remaining-time first.

| Process | Arrival Time | Burst Time |
|---------|--------------|------------|
| P_1 | 0 | 10 |
| P_2 | 3 | 6 |
| P_3 | 7 | 1 |
| P_4 | 8 | 3 |

The average turn around time of these processes is _____ milliseconds.

[gate2016-2](#) [operating-system](#) [process-schedule](#) [normal](#) [numerical-answers](#)
Answer**16.18.31 Process Schedule: GATE1998-2.17, UGCNET-Dec2012-III-43** [top](#) [http://gateoverflow.in/1690](#)

Consider n processes sharing the CPU in a round-robin fashion. Assuming that each process switch takes s seconds, what must be the quantum size q such that the overhead resulting from process switching is minimized but at the same time each process is guaranteed to get its turn at the CPU at least every t seconds?

- A. $q \leq \frac{t-ns}{n-1}$
- B. $q \geq \frac{t-ns}{n-1}$
- C. $q \leq \frac{t-ns}{n+1}$
- D. $q \geq \frac{t-ns}{n+1}$

[gate1998](#) [operating-system](#) [process-schedule](#) [normal](#) [ugcnetdec2012iii](#)

Answer

16.18.32 Process Schedule: GATE2011_35 [top](#)

<http://gateoverflow.in/2137>

Consider the following table of arrival time and burst time for three processes P0, P1 and P2.

| Process | Arrival Time | Burst Time |
|---------|--------------|------------|
| P0 | 0 ms | 9 ms |
| P1 | 1 ms | 4 ms |
| P2 | 2 ms | 9 ms |

The pre-emptive shortest job first scheduling algorithm is used. Scheduling is carried out only at arrival or completion of processes. What is the average waiting time for the three processes?

- (A) 5.0 ms
- (B) 4.33 ms
- (C) 6.33 ms
- (D) 7.33 ms

[gate2011](#) [operating-system](#) [process-schedule](#) [normal](#)

Answer

Answers: Process Schedule

16.18.1 Process Schedule: GATE2010-25 [top](#)

<http://gateoverflow.in/2204>



Selected Answer

ans is D

i)In SRTF ,job with the shorest CPU burst will be scheduled first bcz of this process with large CPU burst may suffer from starvation

ii)In preemptive scheduling , suppose process P1 is executing in CPU and after some time process P2 with high priority then P1 will arrive in ready queue then p1 is preempted and p2 will brought into CPU for execution.in this way if process which is arriving in ready queue is of higher priority than p1 ,then p1 is always preempted and it may possible that it suffer from starvation.

iii)round robin will give better response time than FCFS ,in FCFS when process is executing ,it executed upto its complete burst time,but in round robin it will execute upto time quantum.

10 votes

-- neha pawar (3.8k points)

16.18.2 Process Schedule: GATE2015-3_1 [top](#)<http://gateoverflow.in/8390>

Selected Answer

D. independent of n.

The number of processes that can be in READY state depends on the Ready Queue size and is independent of the number of CPU's.

14 votes

-- Arjun Suresh (150k points)

16.18.3 Process Schedule: GATE2007_16 [top](#)<http://gateoverflow.in/1214>

Selected Answer

A is the answer.

http://en.wikipedia.org/wiki/Rate-monotonic_scheduling

http://en.wikipedia.org/wiki/Gang_scheduling

http://en.wikipedia.org/wiki/Fair-share_scheduling

5 votes

-- Arjun Suresh (150k points)

16.18.4 Process Schedule: GATE2009-32 [top](#)<http://gateoverflow.in/1318>

Selected Answer

1. If a process makes a transition D, it would result in another process making transition A immediately. - This is false. It is not said anywhere that one process terminates, another process immediately come into Ready state. It depends on availability of process to run & Long term Scheduler.
2. A process P2 in blocked state can make transition E while another process P2 is in running state. - This is correct. There is no dependency between running process & Process getting out of blocked state.
3. The OS uses preemptive scheduling. :- This is true because we got transition C from Running to Ready.
4. The OS uses non-preemptive scheduling. Well as previous statement is true, this becomes false.

So answer is C) II and III .

9 votes

-- Akash (31.7k points)

16.18.5 Process Schedule: GATE2008-IT_55 [top](#)<http://gateoverflow.in/3365>

Selected Answer

ans is c

8 votes

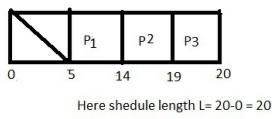
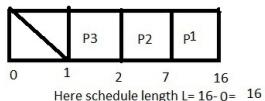
-- Sanjay Sharma (29.8k points)

16.18.6 Process Schedule: GATE1995_2.6 [top](#)<http://gateoverflow.in/2618>

Selected Answer

ans is A

here, in option B and C they have given CPU idle time is 0 which is not possible as per schedule B and C. so B and C will be eliminated. now in A and D:



schedule length = max(completion time) - min(arrival time)

therefore optimal is 16 and ans is A

1 votes

-- jayendra (6.6k points)

Answer is A, CPU will be idle for first 1 unit

1 votes

-- Saumya (529 points)

16.18.7 Process Schedule: GATE1995_1.15 [top](#)

<http://gateoverflow.in/2602>



Selected Answer

B. Round Robin.

8 votes

-- Sankaranarayanan P.N (9.8k points)

16.18.8 Process Schedule: GATE1998_7b [top](#)

<http://gateoverflow.in/12963>



Selected Answer

partitions are 4k , 8k, 20k, 2k, now due to best fit algo ,,

- 1.size of 2k job will fit in 2k partition and execute for 4 unit
- 2.size of 14k job will fit in 20k partition and execute for 10 unit
3. size of 3k job will fit in 4k partition and execute for 2 unit ...
- 4.size of 6k job will fit in 8k partition now execute for 1 unit..all partition are full....

and next job size of 10 k (5) wait for the partition of 20k .. and after completion of no 2 job .job no 5 will be executed for 1 unit (10 to 11)..now 20 k is also waiting for partition of 20k.. becoz it is best fit for it... so after completion of job 5 .. it will be fit . so it will execute for 8 unit which is 11 to 19 . so at 19 unit 20k job will be completed .

answer should be 19 units

12 votes

-- sonam vyas (8.1k points)

16.18.9 Process Schedule: GATE2015-3_34 [top](#)

<http://gateoverflow.in/8492>

FCFS

Average turn around time = [3 for A + (2 + 6) for B + (5 + 4) for C + (7 + 2) for D] / 4 = 7.25

Non-preemptive Shortest Job First

Average turn around time = [3 for A + (2 + 6) for B + (3 + 2) for D + (7 + 4) for C] = 6.75

Shortest Remaining Time

Average turn around time = [3 for A + (2 + 1) for B + (0 + 4) for C + (2 + 2) for D + (6 + 5) for remaining B]/4 = 6.25

Round Robin

Average turn around time = [2 for A + (1 + 2) for B {C comes} + (2+1) for A + (1+2) for C {D comes} + (3+2) for B + (3+2) for D + (4+2) for C + (4+2) for B]/4 = 8.25

Upvote 5 votes

-- Arjun Suresh (150k points)

16.18.10 Process Schedule: GATE2004_46 [top](#)

<http://gateoverflow.in/1043>



Selected Answer

0---p1---1---p2---4---p4---5---p3---8---p1---12

| Process | waiting time | turnaround time |
|---------|--------------|-----------------|
| P1 | 8 | 12 |
| P2 | 0 | 3 |
| P3 | 3 | 6 |
| P4 | 0 | 1 |

Avg turnaround time=12+3+6+1/4=22/4=5.5

Upvote 5 votes

-- Pooja (25.9k points)

16.18.11 Process Schedule: GATE1993_7.10 [top](#)

<http://gateoverflow.in/2298>



Selected Answer

Answer: C

Execution order: pqrstptrprprrrrr

Upvote 1 votes

-- Rajarshi Sarkar (29.7k points)

16.18.12 Process Schedule: GATE2015-1_46 [top](#)

<http://gateoverflow.in/8330>



Selected Answer

There are ∞ instances of Tasks $\{T_1, T_2, T_3\}$ which arrives at regular intervals, intervals starts from time 0.

so here's how processes arrives:

(3)

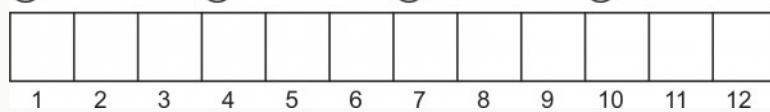
(2)

(1)

(1)

(1)

(1)



and here's the Gantt Chart:

| | | | | | | | | | | | |
|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| (1) | (2) | (2) | (1) | (3) | (3) | (1) | (2) | (2) | (1) | (3) | (3) |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |

answer = T_3 completes at the end of 12th millisecond

7 votes

-- Amar Vashishth (20.7k points)

16.18.13 Process Schedule: GATE1996-2.20, ISRO2008-15 [top](#)



Selected Answer

here all process arrive at time 0.so there order of execution will be A B C D, in this manner completion time for A is 9

5 votes

-- neha pawar (3.8k points)

The Completion time of A will be 9 Unit.

Hence Option D is correct.

Here is the sequence

| A | B | C | D | A | C | A | C | A | {Consider each block takes one time unit}

Completion time of A will be 9.

5 votes

-- Rude Maverick (22.6k points)

16.18.14 Process Schedule: GATE2007-IT-26 [top](#)



Selected Answer

take an example for

| Process | weight | execution time |
|---------|--------|----------------|
| p1 | 1 | 3 |
| p2 | 2 | 5 |
| p3 | 3 | 2 |
| p4 | 4 | 4 |

for option 1 non decreasing t_i

$$= (3 \times 2 + 1 \times 5 + 4 \times 9 + 2 \times 14) / 10 = (6 + 5 + 36 + 28) / 10 = 7.5$$

option 2 non increasing w_i

$$= (4 \times 4 + 3 \times 6 + 2 \times 11 + 1 \times 14) / 10 = (16 + 18 + 22 + 14) / 10 = 7$$

option 3 non increasing $w_i t_i$

$$= (16 + 2 \times 9 + 3 \times 11 + 1 \times 14) / 10 = (16 + 18 + 33 + 14) / 10 = 8.1$$

option 4 non increasing w_i / t_i

$$= (3 \times 2 + 4 \times 6 + 2 \times 11 + 1 \times 14) / 10 = (6 + 10 + 22 + 14) / 10 = 5.2$$

minimum weighted mean obtained from non increasing w_i / t_i (**option D**)

The solution above is a classical example of greedy algorithm - that is at every point we choose the best available option

and this leads to a global optimal solution. In this problem, we require to minimize the weighted mean completion time and the denominator in it is independent of the order of execution of the jobs. So, we just need to focus on the numerator and try to reduce it. Numerator here is a factor of the job weight and its completion time and since both are multiplied, our greedy solution must be

- to execute the shorter jobs first (so that remaining jobs have smaller completion time) and
- to execute highest weighted jobs first (so that it is multiplied by smaller completion time)

So, combining both we can use w_i/t_i to determine the execution order of processes - which must then be executed in non-increasing order.

9 votes

-- Khush Tak (3.3k points)

16.18.15 Process Schedule: GATE2007_55 [top](#)

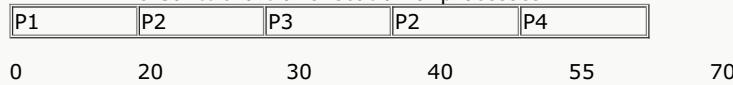
<http://gateoverflow.in/1253>



Selected Answer

The answer is B.

The Gantt chart of execution of processes



$$\text{Waiting time for process P2} = \text{Completion time} - \text{Arrival time} - \text{burst time} = 55 - 15 - 25 = 15$$

6 votes

-- Gate Keeda (17.7k points)

16.18.16 Process Schedule: GATE2014-1_32 [top](#)

<http://gateoverflow.in/1803>



Selected Answer

| | | | | | |
|---|---|---|---|----|-------|
| A | B | A | C | E | D |
| 0 | 3 | 5 | 8 | 12 | 15 21 |

$$\begin{aligned} \text{Average turn around time} &= \frac{(8-0)+(5-3)+(12-5)+(21-7)+(15-10)}{5} \\ &= \frac{36}{5} \Rightarrow 7.2 \text{ ms} \end{aligned}$$

So, answer is 7.2 msec..

7 votes

-- Jay (1.1k points)

16.18.17 Process Schedule: GATE2006-IT_54 [top](#)

<http://gateoverflow.in/3597>



Selected Answer

0---p1----1--- no process---2---p2---3---p3---5---p2---6---p2---8---p3---9---p1---10---p2---11---no process---14---p2---15

From time 1 to 6 p1 is doing i/o

From time 5 to 8 p3 is doing i/o

P2 is doing i/o from 11 to 14

So finishing time of p1 p2 p3 are 10 15 9

Ans is b

5 votes

-- Pooja (25.9k points)

16.18.18 Process Schedule: GATE2006_64 [top](#)

<http://gateoverflow.in/1842>



Selected Answer

A.

Gantt Chart is as follows.

Gantt Chart

| Scheduling Table | | | | | |
|------------------|------|------|------|--------|------|
| P.ID | A.T. | B.T. | C.T. | T.A.T. | W.T. |
| P0 | 0 | 2 | 12 | 12 | 10 |
| P1 | 0 | 4 | 13 | 13 | 9 |
| P2 | 0 | 8 | 14 | 14 | 6 |
| TOTAL | | | | 39 | 25 |

A.T.= Arrival Time

B.T.= Burst Time

C.T= Completion Time.

T.A.T.= Turn Around Time

W.T= Waiting Time.

Average TAT = $39/3 = 13$ units.

9 votes

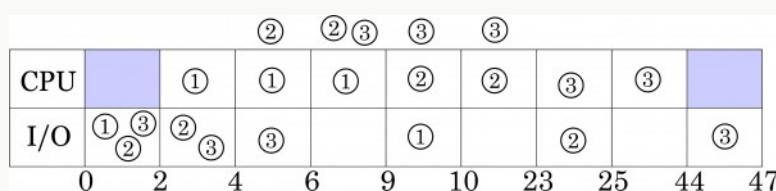
-- Gate Keeda (17.7k points)

16.18.19 Process Schedule: GATE2006_65 [top](#)

<http://gateoverflow.in/1843>



Selected Answer



$$\text{CPU Idle time} = \frac{2+3}{47} \times 100 = 10.6383\%$$

answer = **option B**

15 votes

-- Amar Vashishth (20.7k points)

16.18.20 Process Schedule: GATE2013_10 [top](#)

<http://gateoverflow.in/1419>

B.....because here the quanta for round robin is T units..after a process is scheduled it gets executed for T time units and waiting time becomes least and it again gets chance when every other process has completed T time units

10 votes

-- debanjan sarkar (2.6k points)

16.18.21 Process Schedule: GATE2006-06, ISRO2009-14 [top](#)<http://gateoverflow.in/885>

Selected Answer

process execute in this way ...

0 ---- p1---- 10 (switching)-----p2----30(switching)-----p3----60

so here only 2 switching possible (when we did not consider the starting and ending switching)

now here might be confusion that at t= 2 p1 is preempted and check that available process have shortest job time or not ...but he did not get anyone so it should not be consider as context switching ..(same happened at t=6)

ref :<http://stackoverflow.com/questions/8997616/does-a-context-switch-occur-in-a-system-whose-ready-queue-has-only-one-process-a>(thanks to anurag_s)

answer is B)

12 votes

-- sonam vyas (8.1k points)

16.18.22 Process Schedule: GATE2005-IT_60 [top](#)<http://gateoverflow.in/3821>

Selected Answer

Answer will be D.

TAT = Completion Time - Arrival Time.

The Gantt Chart for Non Preemptive scheduling will be (0)P3,(15)P1,(35)P2(45).

from above this can be inferred easily that completion time for P2 is 45, for P1 is 35 and P3 is 15. .

Gantt Chart for Preemptive- (0)P3,(1)P3,(2)P3,(3)P2,(4)P2,(5)P1,(25)P2,(33)P3(45).

Similarly take completion time from above for individual processes and subtract it from the Arrival time to get TAT.

6 votes

-- Gate Keeda (17.7k points)

16.18.23 Process Schedule: GATE2014-2_32 [top](#)<http://gateoverflow.in/1991>

Selected Answer

Gantt chart : ABCABCBC
C completes its CPU burst at= 500 millisecond.
IO time = 500 millisecond
C completes 1st IO burst at t = 500 + 500 = 1000ms

8 votes

-- Digvijay (35.8k points)

16.18.24 Process Schedule: GATE2012_31 [top](#)<http://gateoverflow.in/1749>

FCFS :- First come first serve.

Here arrival times of all processes are different, So for completion time just order them according of their arrival time. We get P1,P2,P3. So this eliminates option B & D.

Round Robin - Here when you run round robin algorithm on this 3 processes. completion sequence is P1, P3, P2. As Burst Time for P2 is big, P3 completes before P2.

So answer is (C)

Reference :-

https://en.wikipedia.org/wiki/Round-robin_scheduling

https://en.wikibooks.org/wiki/Operating_System_Design/Scheduling_Processes/FCFS

6 votes

-- Akash (31.7k points)

16.18.25 Process Schedule: GATE2003_77 [top](#)

<http://gateoverflow.in/963>



Selected Answer

CPU utilization = CPU burst time/Total time.

FCFS:

from 0-10: process 1
from 10-20: process 2
from 100-110: process 1
from 110-120: process 2

....

So, in every 100 ms, CPU is utilized for 20 ms, CPU utilization = 20%

SRTF:

same as FCFS as CPU burst time is same for all processes

Static priority scheduling:

Suppose process 1 is having higher priority. Now, the scheduling will be same as FCFS. If process 2 is having higher priority, then the scheduling will be as FCFS with process 1 and process 2 interchanged. So, CPU utilization remains at 20%

Round Robin:

Time quantum given as 5 ms.
from 0-5: process 1
from 5-10: process 2
from 10-15: process 1
from 15-20: process 2
from 105-110: process 1
from 110-115: process 2

...

So, in 105 ms, 20 ms of CPU burst is there. So, utilization = 20/105 = 19.05%

19.05 is less than 20, so answer is D.

(Round robin with time quantum 10ms would have made the CPU utilization same for all the schedules)

22 votes

-- Arjun Suresh (150k points)

16.18.26 Process Schedule: GATE2002_1.22 [top](#)

<http://gateoverflow.in/827>



Selected Answer

A) Here we preempt when Time quantum is expired.

C) Here we preempt when process of higher priority arrives.

D) Here we preempt when process of higher priority arrives or when time slice of higher level finishes & we need to move process to lower priority.

B) We never preempt, so answer is B) FIFO

8 votes

-- Akash (31.7k points)

16.18.27 Process Schedule: GATE1998_24 [top](#)<http://gateoverflow.in/1739>

Selected Answer

Part a

Here all we need to do for minimizing response time is to run jobs in increasing order of burst time.

6, 3, 5 and x.

If $X < 3 < 5 < 6$ then order should be x,3,5,6

If $3 < 5 < 6 < x$ then order is 3,5,6,x.

If $3 < x < 5 < 6$ then order is 3,x,5,6.

Part b :-

Idea is that if you have $S1 \rightarrow S2$ then you create new semaphore a , assume that initial value of all semaphores is 0. Then $S2$ thread will invoke $P(a)$ & will get blocked. When $S1$ get executed , after that it'll do $V(a)$ which will enable $S2$ to run. Do like this for all edges in graph.

Let me write program for it

Begin

Semaphores a,b,c,d,e,f,g

ParBegin S1 V(a) V(b) V(c) V(d) ParenD

ParBegin P(a) S2 V(e) ParenD

ParBegin P(b) S3 V(f) ParenD

ParBegin P(c) P(e) S4 V(g) ParenD

ParBegin P(d) P(f) P(g) S5 ParenD

End

IF you reverse engineer this program you can get how this diagram came.

Parbegin ParenD – Parallel execution

P Down V Up

5 votes

-- Akash (31.7k points)

16.18.28 Process Schedule: GATE2014-3_32 [top](#)<http://gateoverflow.in/2066>

Selected Answer

| | Arrival Time | Burst Time | Completion Time | Turn Around Time | Waiting Time = CT - BT - AT |
|----|--------------|------------|-----------------|------------------|-----------------------------|
| p1 | 0 | 12 | 27 | 27 | 15 |
| p2 | 2 | 4 | 6 | 4 | 0 |
| p3 | 3 | 6 | 12 | 9 | 3 |
| p4 | 8 | 5 | 17 | 9 | 4 |

$$(15 + 0 + 3 + 4)/4 = 5.5 \text{ msec}$$

p1 p2 p2 p3 p3 p4 p1

0 2 3 6 8 12 17 27

6 votes

-- Sourav Roy (2.7k points)

16.18.29 Process Schedule: GATE 2016-1-20 [top](#)<http://gateoverflow.in/39655>

Selected Answer

Answer should be A) SRTF

SJF minimizes average waiting time.. provably optimal..

Now here as all processes arrive at the same time, SRTF would be same as SJF.. and hence the answer

Reference: <http://www.cs.columbia.edu/~junfeng/10sp-w4118/lectures/l13-sched.pdf> See Slide 16,17 and 23

11 votes

-- Abhilash Panicker (7k points)

16.18.30 Process Schedule: GATE2016-2-47 [top](#)<http://gateoverflow.in/39625>

Selected Answer

SRTF Preemptive hence,

| | | | | | |
|----|----|----|----|----|-------|
| P1 | P2 | P3 | P2 | P4 | P1 |
| 0 | 3 | 7 | 8 | 10 | 13 20 |

Process TAT=Completion time- Arrival time

| | |
|----|----|
| P1 | 20 |
| P2 | 7 |
| P3 | 1 |
| P4 | 5 |

AvgTAT= $33/4 = 8.25$

16 votes

-- Shashank Chavan (2.6k points)

16.18.31 Process Schedule: GATE1998-2.17, UGCNET-Dec2012-III-43 [top](#) <http://gateoverflow.in/1690>

Selected Answer

Answer: A

Each process runs for q period and if there are n process: $p_1, p_2, p_3, \dots, p_n$.Then p_1 's turn comes again when it has completed time quanta for remaining process p_2 to p_n , i.e, it would take at most $(n-1)q$ time.So, each process in round robin gets its turn after $(n-1)q$ time when we don't consider overheads but if we consider overheads then it would be $ns + (n-1)q$ So we have $ns + (n-1)q \leq t$

10 votes

-- Rajarshi Sarkar (29.7k points)

16.18.32 Process Schedule: GATE2011_35 [top](#)<http://gateoverflow.in/2137>

Selected Answer

Answer is **A. 5ms**

Gantt Chart

| | | | | |
|----------------|----------------|----------------|----------------|----------------|
| P ₀ | P ₁ | P ₁ | P ₀ | P ₂ |
|----------------|----------------|----------------|----------------|----------------|

| | | | | | |
|---|---|---|---|----|----|
| 0 | 1 | 2 | 5 | 13 | 22 |
|---|---|---|---|----|----|

$$\text{Average Waiting Time} = \frac{(0+4)+(0)+(11)}{3} = 5\text{ms.}$$

2 votes

-- Sona Praneeth Akula (3.8k points)

16.19

Process Synchronization top

16.19.1 Process Synchronization: GATE2004_48 top

<http://gateoverflow.in/1044>

Consider two processes P_1 and P_2 accessing the shared variables X and Y protected by two binary semaphores S_X and S_Y respectively, both initialized to 1. P and V denote the usual semaphore operators, where P decrements the semaphore value, and V increments the semaphore value. The pseudo-code of P_1 and P_2 is as follows:

| P_1 : | P_2 : |
|-----------------|-----------------|
| While true do { | While true do { |
| L_1 :..... | L_3 :..... |
| L_2 :..... | L_4 :..... |
| $X = X + 1;$ | $Y = Y + 1;$ |
| $Y = Y - 1;$ | $X = Y - 1;$ |
| $V(S_X);$ | $V(S_Y);$ |
| $V(S_Y);$ | $V(S_X);$ |

In order to avoid deadlock, the correct operators at L_1 , L_2 , L_3 and L_4 are respectively.

- A. $P(S_Y), P(S_X); P(S_X), P(S_Y)$
- B. $P(S_X), P(S_Y); P(S_Y), P(S_X)$
- C. $P(S_X), P(S_X); P(S_Y), P(S_Y)$
- D. $P(S_X), P(S_Y); P(S_X), P(S_Y)$

[gate2004](#) [operating-system](#) [process-synchronization](#) [normal](#)

Answer

16.19.2 Process Synchronization: GATE2002_18 top

<http://gateoverflow.in/871>

- a. Draw the process state transition diagram of an OS in which (i) each process is in one of the five states: created, ready, running, blocked (i.e., sleep or wait), or terminated, and (ii) only non-preemptive scheduling is used by the OS. Label the transitions appropriately.
- b. The functionality of atomic TEST-AND-SET assembly language instruction is given by the following C function

```
int TEST-AND-SET (int *x)
{
    int y;
    A1: y=*x;
    A2: *x=1;
    A3: return y;
}
```

- i. Complete the following C functions for implementing code for entering and leaving critical sections on the above TEST-

AND-SET instruction.

ii.

```
int mutex=0;
void enter-cs ()
{
    while(.....);
}

void leave-cs ()
{
    .....
}
```

- iii. Is the above solution to the critical section problem deadlock free and starvation-free?
 iv. For the above solution, show by an example that mutual exclusion is not ensured if TEST-AND-SET instruction is not atomic?

[gate2002](#) [operating-system](#) [process-synchronization](#) [normal](#)

[Answer](#)

16.19.3 Process Synchronization: GATE1996-1.19, ISRO2008-61 [top](#)

<http://gateoverflow.in/2723>

A critical section is a program segment

- A. which should run in a certain amount of time
- B. which avoids deadlocks
- C. where shared resources are accessed
- D. which must be enclosed by a pair of semaphore operations, P and V

[gate1996](#) [operating-system](#) [process-synchronization](#) [easy](#) [isro2008](#)

[Answer](#)

16.19.4 Process Synchronization: GATE2001-2.22 [top](#)

<http://gateoverflow.in/740>

Consider Peterson's algorithm for mutual exclusion between two concurrent processes i and j. The program executed by process is shown below.

```
repeat
    flag[i] = true;
    turn = j;
    while (P) do no-op;
    Enter critical section, perform actions, then
    exit critical section
    Flag[i] = false;
    Perform other non-critical section actions.
Until false;
```

For the program to guarantee mutual exclusion, the predicate P in the while loop should be

- A. $\text{flag}[j] = \text{true}$ and $\text{turn} = i$
- B. $\text{flag}[j] = \text{true}$ and $\text{turn} = j$
- C. $\text{flag}[i] = \text{true}$ and $\text{turn} = j$
- D. $\text{flag}[i] = \text{true}$ and $\text{turn} = i$

[gate2001](#) [operating-system](#) [process-synchronization](#) [normal](#)

[Answer](#)

16.19.5 Process Synchronization: GATE2005-IT_41 [top](#)

<http://gateoverflow.in/3788>

Given below is a program which when executed spawns two concurrent processes :
 $\text{semaphore X} := 0;$

$/* \text{Process now forks into concurrent processes P1 \& P2 */}$

P1

P2

```
repeat forever
V (X) ;
Compute ;
P(X) ;
```

```
repeat forever
P(X) ;
Compute ;
V(X) ;
```

Consider the following statements about processes P1 and P2:

- It is possible for process P1 to starve.
- It is possible for process P2 to starve.

Which of the following holds?

- A) Both I and II are true.
- B) I is true but II is false.
- C) II is true but I is false
- D) Both I and II are false.

[gate2005-it](#) [operating-system](#) [process-synchronization](#) [normal](#)

[Answer](#)

16.19.6 Process Synchronization: GATE2003-80 [top](#)

<http://gateoverflow.in/964>

Suppose we want to synchronize two concurrent processes P and Q using binary semaphores S and T. The code for the processes P and Q is shown below.

| | |
|------------|------------|
| Process P: | Process Q: |
| while(1) { | while(1) { |
| W: | Y: |
| print '0'; | print '1'; |
| print '0'; | print '1'; |
| X: | Z: |
| } | } |

Synchronization statements can be inserted only at points W, X, Y, and Z

Which of the following will always lead to an output starting with '001100110011'?

- P(S) at W, V(S) at X, P(T) at Y, V(T) at Z, S and T initially 1
- P(S) at W, V(T) at X, P(T) at Y, V(S) at Z, S initially 1, and T initially 0
- P(S) at W, V(T) at X, P(T) at Y, V(S) at Z, S and T initially 1
- P(S) at W, V(S) at X, P(T) at Y, V(T) at Z, S initially 1 , and T initially 0

[gate2003](#) [operating-system](#) [process-synchronization](#) [normal](#)

[Answer](#)

16.19.7 Process Synchronization: GATE2006-IT_55 [top](#)

<http://gateoverflow.in/3598>

Consider the solution to the bounded buffer producer/consumer problem by using general semaphores S, F, and E. The semaphore S is the mutual exclusion semaphore initialized to 1. The semaphore F corresponds to the number of free slots in the buffer and is initialized to N. The semaphore E corresponds to the number of elements in the buffer and is initialized to 0.

| Producer Process | Consumer Process |
|--------------------------------|---------------------------------|
| Produce an item; | Wait(E); |
| Wait(F); | Wait(S); |
| Wait(S); | Remove an item from the buffer; |
| Append the item to the buffer; | Signal(S); |
| Signal(S); | Signal(F); |
| Signal(E); | Consume the item; |

Which of the following interchange operations may result in a deadlock?

- I. Interchanging Wait (F) and Wait (S) in the Producer process
- II. Interchanging Signal (S) and Signal (F) in the Consumer process

- A) I only
- B) II only
- C) Neither I nor II
- D) Both I and II

[gate2006-it](#) [operating-system](#) [process-synchronization](#) [normal](#)

[Answer](#)

16.19.8 Process Synchronization: GATE1996_2.19 [top](#)

<http://gateoverflow.in/2748>

A solution to the Dining Philosophers Problem which avoids deadlock is to

- A. ensure that all philosophers pick up the left fork before the right fork
- B. ensure that all philosophers pick up the right fork before the left fork
- C. ensure that one particular philosopher picks up the left fork before the right fork, and that all other philosophers pick up the right fork before the left fork
- D. None of the above

[gate1996](#) [operating-system](#) [process-synchronization](#) [normal](#)

[Answer](#)

16.19.9 Process Synchronization: GATE2005-IT_42 [top](#)

<http://gateoverflow.in/3789>

Two concurrent processes P1 and P2 use four shared resources R1, R2, R3 and R4, as shown below.

P1
Compute:
Use R1;
Use R2;
Use R3;
Use R4;

P2
Compute;
Use R1;
Use R2;
Use R3;
Use R4;

Both processes are started at the same time, and each resource can be accessed by only one process at a time. The following scheduling constraints exist between the access of resources by the processes:

- P2 must complete use of R1 before P1 gets access to R1.
- P1 must complete use of R2 before P2 gets access to R2.
- P2 must complete use of R3 before P1 gets access to R3.
- P1 must complete use of R4 before P2 gets access to R4.

There are no other scheduling constraints between the processes. If only binary semaphores are used to enforce the above scheduling constraints, what is the minimum number of binary semaphores needed?

- | | |
|----|---|
| A) | 1 |
| B) | 2 |
| C) | 3 |
| D) | 4 |

[gate2005-it](#) [operating-system](#) [process-synchronization](#) [normal](#)

[Answer](#)

16.19.10 Process Synchronization: GATE1996_21 [top](#)

<http://gateoverflow.in/2773>

The concurrent programming constructs fork and join are as below:

fork <label> which creates a new process executing from the specified label

join <variable> which decrements the specified synchronization variable (by 1) and terminates the process if the new value is not 0.

Show the precedence graph for S1, S2, S3, S4, and S5 of the concurrent program below.

21. The concurrent programming constructs fork and join are as below:
 fork <label> which creates a new process executing from the specified label
 join <variable> which decrements the specified synchronization variable (by 1) and terminates the process if the new value is not 0.
 Show the precedence graph for S1, S2, S3, S4 and S5 of the concurrent program below.
 N = 2
 M = 2
 fork L3
 fork L4
 S1
 L1 : join N
 S3
 L2: join M
 S5
 L3:S2
 goto L1
 L4:S4
 goto L2
 next:

[gate1996](#) [operating-system](#) [process-synchronization](#) [normal](#)

Answer

16.19.11 Process Synchronization: GATE2000-1.21 [top](#)

<http://gateoverflow.in/645>

Let m[0]....m[4] be mutexes (binary semaphores) and P[0].....P[4] be processes.
 Suppose each process P[i] executes the following:

```
wait (m[i]);
.....
release (m[i]); release (m(i+1) mod 4);
```

This could cause

- A. Thrashing
- B. Deadlock
- C. Starvation, but not deadlock
- D. None of the above

[gate2000](#) [operating-system](#) [process-synchronization](#) [normal](#)

Answer

16.19.12 Process Synchronization: GATE2008-IT_53 [top](#)

<http://gateoverflow.in/3363>

The following is a code with two threads, producer and consumer, that can run in parallel. Further, S and Q are binary semaphores equipped with the standard P and V operations.

```
semaphore S = 1, Q = 0;
integer x;

producer:           consumer:
while (true) do      while (true) do
  P(S);
  x = produce ();
  V(Q);
done                  done
```

Which of the following is TRUE about the program above?

- A) The process can deadlock
 B) One of the threads can starve
 C) Some of the items produced by the producer may be lost
 D) Values generated and stored in 'x' by the producer will always be consumed before the producer can generate a new value

gate2008-it operating-system process-synchronization normal

Answer

16.19.13 Process Synchronization: GATE2000-20 [top](#)

<http://gateoverflow.in/691>

(a) Fill in the boxes below to get a solution for the reader-writer problem, using a single binary semaphore, mutex (initialized to 1) and busy waiting. Write the box numbers (1, 2 and 3), and their contents in your answer book.

```
int R = 0, W = 0;

Reader () {
    wait (mutex);
    if (W == 0) {
        R = R + 1;
        □ _____ (1)
    }
    else {
        □ _____ (2)
        goto L1;
    }
    ..../* do the read*/
    wait (mutex);
    R = R - 1;
    signal (mutex);
}
```

L1:

```
Writer () {
    wait (mutex);
    if (W) {
        signal (mutex);
        goto L2;
    }
    W=1;
    signal (mutex);
    ..../*do the write*/
    wait( mutex);
    W=0;
    signal (mutex);
}
```

(b) Can the above solution lead to starvation of writers?

gate2000 operating-system process-synchronization normal

Answer

16.19.14 Process Synchronization: GATE2007-IT_56 [top](#)

<http://gateoverflow.in/3498>

Synchronization in the classical readers and writers problem can be achieved through use of semaphores. In the following incomplete code for readers-writers problem, two binary semaphores mutex and wrt are used to obtain synchronization

```
wait (wrt)
writing is performed
signal (wrt)
wait (mutex)
readcount = readcount + 1
if readcount = 1 then S1
S2
reading is performed
S3
readcount = readcount - 1
if readcount = 0 then S4
signal (mutex)
```

The values of S1, S2, S3, S4, (in that order) are

- A) signal (mutex), wait (wrt), signal (wrt), wait (mutex)
 B) signal (wrt), signal (mutex), wait (mutex), wait (wrt)
 C) wait (wrt), signal (mutex), wait (mutex), signal (wrt)
 D) signal (mutex), wait (mutex), signal (mutex), wait (mutex)

gate2007-it operating-system process-synchronization normal

[Answer](#)

16.19.15 Process Synchronization: GATE2007-IT_10 [top](#)

<http://gateoverflow.in/3443>

Processes P1 and P2 use critical_flag in the following routine to achieve mutual exclusion. Assume that critical_flag is initialized to FALSE in the main program.

```
get_exclusive_access ( )
{
    if (critical_flag == FALSE) {
        critical_flag = TRUE ;
        critical_region () ;
        critical_flag = FALSE;
    }
}
```

Consider the following statements.

- i. It is possible for both P1 and P2 to access critical_region concurrently.
- ii. This may lead to a deadlock.

Which of the following holds?

- A) (i) is false and (ii) is true
 B) Both (i) and (ii) are false
 C) (i) is true and (ii) is false
 D) Both (i) and (ii) are true

gate2007-it operating-system process-synchronization normal

[Answer](#)

16.19.16 Process Synchronization: GATE2002_20 [top](#)

<http://gateoverflow.in/873>

The following solution to the single producer single consumer problem uses semaphores for synchronization.

```
#define BUFFSIZE 100
buffer buf[BUFFSIZE];
int first = last = 0;
semaphore b_full = 0;
semaphore b_empty = BUFFSIZE

void producer()
{
while(1) {
    produce an item;
    p1:....;
    put the item into buf (first);
    first = (first+1)%BUFFSIZE;
    p2: ....;
}
}

void consumer()
{
while(1) {
    c1:.....
    take the item from buf[last];
    last = (last+1)%BUFFSIZE;
    c2:....;
    consume the item;
}
}
```

- a. Complete the dotted part of the above solution.
- b. Using another semaphore variable, insert one line statement each immediately after p1, immediately before p2, immediately after c1 and immediately before c2 so that the program works correctly for multiple producers and

consumers

gate2002 operating-system process-synchronization normal

Answer

16.19.17 Process Synchronization: GATE2010-45 [top](#)<http://gateoverflow.in/2347>

The following program consists of 3 concurrent processes and 3 binary semaphores. The semaphores are initialized as $S_0=1$, $S_1=0$ and $S_2=0$.

| Process P0 | Process P1 | Process P2 |
|---|-------------------------------------|-------------------------------------|
| <pre>while (true) { wait (S0); print '0'; release (S1); release (S2); }</pre> | <pre>wait (S1); release (S0);</pre> | <pre>wait (S2); release (S0);</pre> |

How many times will process P0 print '0'?

- A. At least twice
- B. Exactly twice
- C. Exactly thrice
- D. Exactly once

gate2010 operating-system process-synchronization normal

Answer

16.19.18 Process Synchronization: GATE1995_19 [top](#)<http://gateoverflow.in/2656>

Consider the following program segment for concurrent processing using semaphore operators P and V for synchronization. Draw the precedence graph for the statements S1 to S9.

```
var
a,b,c,d,e,f,g,h,i,j,k : semaphore;
begin
cobegin
begin S1; V(a); V(b) end;
begin P(a); S2; V(c); V(d) end;
begin P(c); S4; V(e) end;
begin P(d); S5; V(f) end;
begin P(e); P(f); S7; V(k) end
begin P(b); S3; V(g); V(h) end;
begin P(g); S6; V(i) end;
begin P(h); P(i); S8; V(j) end;
begin P(j); P(k); S9 end;
coend
end;
```

gate1995 operating-system process-synchronization normal

Answer

16.19.19 Process Synchronization: GATE2007-58 [top](#)<http://gateoverflow.in/1256>

Two processes, P1 and P2, need to access a critical section of code. Consider the following synchronization construct used by the processes:

| | |
|--|--|
| <pre>/* P1 */ while (true) { wants1 = true; while (wants2 == true); /* Critical Section */ wants1 = false; }</pre> | <pre>/* P2 */ while (true) { wants2 = true; while (wants1 == true); /* Critical Section */ wants2=false; }</pre> |
|--|--|

```
/* Remainder section */           /* Remainder section */
```

Here, wants1 and wants2 are shared variables, which are initialized to false.

Which one of the following statements is TRUE about the construct?

- A. It does not ensure mutual exclusion.
- B. It does not ensure bounded waiting.
- C. It requires that processes enter the critical section in strict alternation.
- D. It does not prevent deadlocks, but ensures mutual exclusion.

gate2007 operating-system process-synchronization normal

Answer

16.19.20 Process Synchronization: GATE2013_39 [top](#)

<http://gateoverflow.in/1550>

A certain computation generates two arrays a and b such that $a[i] = f(i)$ for $0 \leq i < n$ and $b[i] = g(a[i])$ for $0 \leq i < n$. Suppose this computation is decomposed into two concurrent processes X and Y such that X computes the array a and Y computes the array b. The processes employ two binary semaphores R and S, both initialized to zero. The array a is shared by the two processes. The structures of the processes are shown below.

Process X:

```
private i;
for (i=0; i< n; i++) {
    a[i] = f(i);
    ExitX(R, S);
}
```

Process Y:

```
private i;
for (i=0; i< n; i++) {
    EntryY(R, S);
    b[i] = g(a[i]);
}
```

Which one of the following represents the **CORRECT** implementations of ExitX and EntryY?

(A) ExitX(R, S) {

```
P(R);
```

```
V(S);
```

```
}
```

```
EntryY(R, S) {
```

```
P(S);
```

```
V(R);
```

```
}
```

(B) ExitX(R, S) {

```
V(R);
```

```
V(S);
```

```
}
```

```
EntryY(R, S) {
```

```
P(R);
```

```
P(S);
```

```
}
```

```

(C) ExitX(R, S) {
    P(S);
    V(R);
}

EntryY(R, S) {
    V(S);
    P(R);
}

(D) ExitX(R, S) {
    V(R);
    P(S);
}

EntryY(R, S) {
    V(S);
    P(R);
}

```

[gate2013](#) [operating-system](#) [process-synchronization](#) [normal](#)

[Answer](#)

16.19.21 Process Synchronization: GATE2012_32 [top](#)

<http://gateoverflow.in/1750>

Fetch_And_Add(X,i) is an atomic Read-Modify-Write instruction that reads the value of memory location X, increments it by the value i, and returns the old value of X. It is used in the pseudocode shown below to implement a busy-wait lock. L is an unsigned integer shared variable initialized to 0. The value of 0 corresponds to lock being available, while any non-zero value corresponds to the lock being not available.

```

AcquireLock(L) {
    while (Fetch_And_Add(L, 1))
        L = 1;
}

ReleaseLock(L) {
    L = 0;
}

```

This implementation

- (A) fails as L can overflow
- (B) fails as L can take on a non-zero value when the lock is actually available
- (C) works correctly but may starve some processes
- (D) works correctly without starvation

[gate2012](#) [operating-system](#) [process-synchronization](#) [normal](#)

[Answer](#)

16.19.22 Process Synchronization: GATE2013_34 [top](#)

<http://gateoverflow.in/1545>

A shared variable x, initialized to zero, is operated on by four concurrent processes W, X, Y, Z as follows. Each of the processes W and X reads x from memory, increments by one, stores it to memory, and then terminates. Each of the processes Y and Z reads x from memory, decrements by two, stores it to memory, and then terminates. Each process before reading x invokes the P operation (i.e., wait) on a counting semaphore S and invokes the V operation (i.e., signal) on the semaphore S after storing x to memory. Semaphore S is initialized to two. What is the maximum possible value of x after all processes complete execution?

- (A) -2
- (B) -1
- (C) 1
- (D) 2

[gate2013](#) [operating-system](#) [process-synchronization](#) [normal](#)

[Answer](#)

16.19.23 Process Synchronization: GATE2003-81 [top](#)

<http://gateoverflow.in/43574>

Suppose we want to synchronize two concurrent processes P and Q using binary semaphores S and T. The code for the processes P and Q is shown below.

| Process P: | Process Q: |
|------------|------------|
| while(1) { | while(1) { |
| W: | Y: |
| print '0'; | print '1'; |
| print '0'; | print '1'; |
| X: | Z: |
| } | } |

Synchronization statements can be inserted only at points W, X, Y, and Z

Which of the following will ensure that the output string never contains a substring of the form 01^n0 and 10^n1 where n is odd?

- A. P(S) at W, V(S) at X, P(T) at Y, V(T) at Z, S and T initially 1
- B. P(S) at W, V(T) at X, P(T) at Y, V(S) at Z, S and T initially 1
- C. P(S) at W, V(S) at X, P(S) at Y, V(S) at Z, S initially 1
- D. V(S) at W, V(T) at X, P(S) at Y, P(T) at Z, S and T initially 1

gate2003 operating-system process-synchronization normal

Answer

16.19.24 Process Synchronization: GATE2006-79 [top](#)

<http://gateoverflow.in/43564>

Barrier is a synchronization construct where a set of processes synchronizes globally i.e., each process in the set arrives at the barrier and waits for all others to arrive and then all processes leave the barrier. Let the number of processes in the set be three and S be a binary semaphore with the usual P and V functions. Consider the following C implementation of a barrier with line numbers shown on left.

```
void barrier (void) {
    P(S);
    process_arrived++;
    V(S);
    while (process_arrived != 3);
    P(S);
    process_left++;
    if (process_left == 3) {
        process_arrived = 0;
        process_left = 0;
    }
    V(S);
}
```

The variables process_arrived and process_left are shared among all processes and are initialized to zero. In a concurrent program all the three processes call the barrier function when they need to synchronize globally.

Which one of the following rectifies the problem in the implementation?

- A. Lines 6 to 10 are simply replaced by `process_arrived--`
- B. At the beginning of the barrier the first process to enter the barrier waits until `process_arrived` becomes zero before proceeding to execute `P(S)`.
- C. Context switch is disabled at the beginning of the barrier and re-enabled at the end.
- D. The variable `process_left` is made private instead of shared

gate2006 operating-system process-synchronization normal

Answer

16.19.25 Process Synchronization: GATE2006_61 [top](#)<http://gateoverflow.in/1839>

The atomic *fetch-and-set* x, y instruction unconditionally sets the memory location x to 1 and fetches the old value of x in y without allowing any intervening access to the memory location x . Consider the following implementation of P and V functions on a binary semaphore S.

```
void P (binary_semaphore *s) {
    unsigned y;
    unsigned *x = &(s->value);
    do {
        fetch-and-set x, y;
    } while (y);
}

void V (binary_semaphore *s) {
    S->value = 0;
}
```

Which one of the following is true?

- (A) The implementation may not work if context switching is disabled in P
- (B) Instead of using *fetch-and-set*, a pair of normal load/store can be used
- (C) The implementation of V is wrong
- (D) The code does not implement a binary semaphore

[gate2006](#) [operating-system](#) [process-synchronization](#) [normal](#)

Answer

16.19.26 Process Synchronization: GATE1991-11,b [top](#)<http://gateoverflow.in/43000>

Consider the following scheme for implementing a critical section in a situation with three processes P_i, P_j and P_k .

P_i :

```
repeat
    flag[i] := true;
    while flag [j] or flag[k] do
        case turn of
            j: if flag [j] then
                begin
                    flag [i] := false;
                    while turn != i do skip;
                    flag [i] := true;
                end;
            k: if flag [k] then
                begin
                    flag [i] := false;
                    while turn != i do skip;
                    flag [i] := true
                end
        end;
        critical section
        if turn = i then turn := j;
        flag [i] := false
    non-critical section
until false;
```

Is there a situation in which a waiting process can never enter the critical section? If so, explain and suggest modifications to the code to solve this problem

[gate1991](#) [process-synchronization](#) [normal](#) [operating-system](#)

Answer

16.19.27 Process Synchronization: GATE2006-78 [top](#)<http://gateoverflow.in/1853>

Barrier is a synchronization construct where a set of processes synchronizes globally i.e., each process in the set arrives at the barrier and waits for all others to arrive and then all processes leave the barrier. Let the number of processes in the set be three and S be a binary semaphore with the usual P and V functions. Consider the following C implementation of a barrier with line numbers shown on left.

```
void barrier (void) {
```

```

P(S);
process_arrived++;
V(S);
while (process_arrived !=3);
P(S);
process_left++;
if (process_left==3) {
    process_arrived = 0;
    process_left = 0;
}
V(S);
}

```

The variables *process_arrived* and *process_left* are shared among all processes and are initialized to zero. In a concurrent program all the three processes call the barrier function when they need to synchronize globally.

The above implementation of barrier is incorrect. Which one of the following is true?

- A. The barrier implementation is wrong due to the use of binary semaphore S
- B. The barrier implementation may lead to a deadlock if two barrier invocations are used in immediate succession.
- C. Lines 6 to 10 need not be inside a critical section
- D. The barrier implementation is correct if there are only two processes instead of three.

[gate2006](#) | [operating-system](#) | [process-synchronization](#) | [normal](#)

Answer

16.19.28 Process Synchronization: GATE1999_20 [top](#)

<http://gateoverflow.in/1519>

(a) A certain processor provides a 'test and set' instruction that is used as follows:

```
TSET register, flag
```

This instruction atomically copies flag to register and sets flag to 1. Give pseudo-code for implementing the entry and exit code to a critical region using this instruction.

(b) Consider the following solution to the producer-consumer problem using a buffer of size 1. Assume that the initial value of count is 0. Also assume that the testing of count and assignment to count are atomic operations.

```

Producer:
Repeat
    Produce an item;
    if count = 1 then sleep;
    place item in buffer.
    count = 1;
    Wakeup(Consumer);
Forever

Consumer:
Repeat
    if count = 0 then sleep;
    Remove item from buffer;
    count = 0;
    Wakeup(Producer);
    Consume item;
Forever;

```

Show that in this solution it is possible that both the processes are sleeping at the same time.

[gate1999](#) | [operating-system](#) | [process-synchronization](#) | [normal](#)

Answer

16.19.29 Process Synchronization: GATE2014-2_31 [top](#)

<http://gateoverflow.in/1990>

Consider the procedure below for the *Producer-Consumer* problem which uses semaphores:

```

semaphore n = 0;
semaphore s = 1;

void producer()
{
    while(true)
    {
        produce();
        semWait(s);
        addToBuffer();
        semSignal(s);
        semSignal(n);
    }
}

```

```

    }
}

void consumer()
{
    while(true)
    {
        semWait(s);
        semWait(n);
        removeFromBuffer();
        semSignal(s);
        consume();
    }
}

```

Which one of the following is **TRUE**?

- (A) The producer will be able to add an item to the buffer, but the consumer can never consume it.
- (B) The consumer will remove no more than one item from the buffer.
- (C) Deadlock occurs if the consumer succeeds in acquiring semaphore s when the buffer is empty.
- (D) The starting value for the semaphore n must be 1 and not 0 for deadlock-free operation.

[gate2014-2](#) | [operating-system](#) | [process-synchronization](#) | [normal](#)

Answer

16.19.30 Process Synchronization: GATE 2016-2-48 [top](#)

<http://gateoverflow.in/39600>

Q). Consider the following two-process synchronization solution.

| | |
|---|--|
| PROCESS 0 | Process 1 |
| Entry: loop while (turn ==1); (critical section) Exit: turn=1; | Entry: loop while (turn==0); (critical section) Exit turn =0; |

The shared variable turn is initialized to zero . Which one of the following is TRUE?

- A). This is a correct two- process synchronization solution.
- B). This solution violates mutual exclusion requirement.
- C). This solution violates progress requirement.
- D). This solution violates bounded wait requirement.

[gate2016-2](#) | [operating-system](#) | [process-synchronization](#) | [normal](#)

Answer

16.19.31 Process Synchronization: TIFR2015-B-14 [top](#)

<http://gateoverflow.in/30077>

Consider the following concurrent program (where statements separated by || with-in cobegin-coend are executed concurrently).

```

x:=1
cobegin
    x:= x + 1 ||    x:= x + 1 ||    x:= x + 1
coend

```

Reading and writing of variables is atomic but evaluation of expressions is not atomic. The set of possible values of x at the end of execution of the program is

- a. {4}
- b. {2, 3, 4}
- c. {2, 4}
- d. {2, 3}
- e. {2}

tifr2011 process-synchronization

Answer

16.19.32 Process Synchronization: TIFR2011-B-34 [top](#)<http://gateoverflow.in/20838>

Consider the class of synchronization primitives. Which of the following is false?

- Test and set primitives are as powerful as semaphores.
- There are various synchronizations that can be implemented using an array of semaphores but not by binary semaphores.
- Split binary semaphores and binary semaphores are equivalent.
- All statements a - c are false.
- Petri nets with and without inhibitor arcs have the same power.

tifr2011 operating-system process-synchronization

Answer

16.19.33 Process Synchronization: GATE2010-23 [top](#)<http://gateoverflow.in/2202>

Consider the methods used by processes P1 and P2 for accessing their critical sections whenever needed, as given below. The initial values of shared boolean variables S1 and S2 are randomly assigned.

| Method used by P1 | Method used by P2 |
|--|--|
| <pre>while (S1==S2); Critical Section S1=S2;</pre> | <pre>while (S1!=S2); Critical Section S2 = not(S1)</pre> |

Which one of the following statements describes the properties achieved?

- Mutual exclusion but not progress
- Progress but not mutual exclusion
- Neither mutual exclusion nor progress
- Both mutual exclusion and progress

gate2010 operating-system process-synchronization normal

Answer

16.19.34 Process Synchronization: TIFR2011-B-28 [top](#)<http://gateoverflow.in/20575>

Consider a basic block:

```
x:= a[i]; a[j]:= y; z:= a[j]
```

optimized by removing common sub expression a[i] as follows:

```
x:= a[i]; z:= x; a[j]:= y.
```

Which of the following is true?

- Both are equivalent.
- The values computed by both are exactly the same.
- Both give exactly the same values only if i is not equal to j .
- They will be equivalent in concurrent programming languages with shared memory.
- None of the above.

tifr2011 process-synchronization

Answer

16.19.35 Process Synchronization: GATE2004-IT_65 [top](#)<http://gateoverflow.in/3708>

The semaphore variables full, empty and mutex are initialized to 0, n and 1, respectively. Process P₁ repeatedly adds one

item at a time to a buffer of size n , and process P_2 repeatedly removes one item at a time from the same buffer using the programs given below. In the programs, K, L, M and N are unspecified statements.

P_1

```
while (1) {
    K;
    P(mutex);
    Add an item to the buffer;
    V(mutex);
    L;
}
```

P_2

```
while (1) {
    M;
    P(mutex);
    Remove an item from the buffer;
    V(mutex);
    N;
}
```

The statements K, L, M and N are respectively

- A. P(full), V(empty), P(full), V(empty)
- B. P(full), V(empty), P(empty), V(full)
- C. P(empty), V(full), P(empty), V(full)
- D. P(empty), V(full), P(full), V(empty)

gate2004-it | operating-system | process-synchronization | normal

Answer

16.19.36 Process Synchronization: GATE1991_11,a [top](#)

<http://gateoverflow.in/538>

Consider the following scheme for implementing a critical section in a situation with three processes P_i, P_j and P_k .

```
Pi;
repeat
    flag[i] := true;
    while flag [j] or flag[k] do
        case turn of
            j: if flag [j] then
                begin
                    flag [i] := false;
                    while turn != i do skip;
                    flag [i] := true;
                end;
            k: if flag [k] then
                begin
                    flag [i] := false;
                    while turn != i do skip;
                    flag [i] := true
                end
        end
        critical section
        if turn = i then turn := j;
        flag [i] := false
    non-critical section
until false;
```

- Does the scheme ensure mutual exclusion in the critical section? Briefly explain.

gate1991 | process-synchronization | normal | operating-system

Answer

16.19.37 Process Synchronization: GATE2015-3_10 [top](#)

<http://gateoverflow.in/8405>

Two processes X and Y need to access a critical section. Consider the following synchronization construct used by both the processes

| Process X | Process Y |
|---|--|
| <pre>/* other code for process x*/ while (true) { varP = true; while (varQ == true) { /* Critical Section */ varP = false; } } /* other code for process X */</pre> | <pre>/* other code for process Y */ while (true) { varQ = true; while (varP == true) { /* Critical Section */ varQ = false; } } /* other code for process Y */</pre> |

Here *varP* and *varQ* are shared variables and both are initialized to false. Which one of the following statements is true?

- A. The proposed solution prevents deadlock but fails to guarantee mutual exclusion
- B. The proposed solution guarantees mutual exclusion but fails to prevent deadlock
- C. The proposed solution guarantees mutual exclusion and prevents deadlock
- D. The proposed solution fails to prevent deadlock and fails to guarantee mutual exclusion

gate2015-3 operating-system process-synchronization normal

Answer

16.19.38 Process Synchronization: GATE1994_27 [top](#)

<http://gateoverflow.in/2523>

- a. Draw a precedence graph for the following sequential code. The statements are numbered from S_1 to S_6

S_1 read n
 S_2 $i := 1$
 S_3 if $i > n$ next
 S_4 $a(i) := i+1$
 S_5 $i := i+1$
 S_6 next : write $a(i)$

- b. Can this graph be converted to a concurrent program using parbegin-parend construct only?

gate1994 operating-system process-synchronization normal

Answer

16.19.39 Process Synchronization: GATE1993_22 [top](#)

<http://gateoverflow.in/2319>

Write a concurrent program using parbegin-parend and semaphores to represent the precedence constraints of the statements S_1 to S_6 , as shown in figure below.

□

gate1993 operating-system process-synchronization normal

Answer

16.19.40 Process Synchronization: TIFR2010-B-28 [top](#)

<http://gateoverflow.in/18751>

Consider the **concurrent** program:

```
x: 1;
cobegin
    x:= x + 3 || x := x + x + 2
coend
```

Reading and writing of variables is atomic, but the evaluation of an expression is not atomic.

The set of possible values of variable x at the end of the execution of the program is:

- A. $\{4\}$
- B. $\{8\}$
- C. $\{4, 7, 10\}$
- D. $\{4, 7, 8, 10\}$
- E. $\{4, 7, 8\}$

[tifr2010](#) [process-synchronization](#)

[Answer](#)

16.19.41 Process Synchronization: GATE2009-33 [top](#)

<http://gateoverflow.in/1319>

The **enter_CS()** and **leave_CS()** functions to implement critical section of a process are realized using test-and-set instruction as follows:

```
void enter_CS(X)
{
    while(test-and-set(X));
}

void leave_CS(X)
{
    X = 0;
}
```

In the above solution, X is a memory location associated with the CS and is initialized to 0. Now consider the following statements:

- I. The above solution to CS problem is deadlock-free
- II. The solution is starvation free
- III. The processes enter CS in FIFO order
- IV. More than one process can enter CS at the same time

Which of the above statements are TRUE?

- A. I only
- B. I and II
- C. II and III
- D. IV only

[gate2009](#) [operating-system](#) [process-synchronization](#) [normal](#)

[Answer](#)

16.19.42 Process Synchronization: TIFR2010-B-32 [top](#)

<http://gateoverflow.in/19244>

Consider the following solution (expressed in Dijkstra's guarded command notation) to the mutual exclusion problem.

```
process P1 is
begin
    loop
        Non_critical_section;
        while not (Turn=1) do
            skip od;
            Critical_section_1;
            Turn=2;
        end loop
    end
```

||

```
process P2 is
begin
    loop
        Non_critical_section;
```

```

while not (turn=2) do
    skip od;
    Critical_section_2;
    Turn=1;
end loop
end

```

Initially, Turn=1, Assume that the two process run forever and that no process stays in its critical and non-critical section infinitely. A mutual exclusion program is correct if it satisfies the following requirements.

- 1) Only one process can be in a critical region at a time.
- 2) Program is a dead-lock free, i.e., if both processes are trying to enter the critical region then at least one of them does enter the critical region.
- 3) Program is starvation-free; i.e, a process trying to enter the critical region eventually manages to do so.

The above mutual exclusion solution.

- a. Does not satisfy the requirement (1).
- b. Satisfy the requirement (1) but does not satisfy the requirement (2).
- c. Satisfies the requirements (1) and (2), but does not satisfies the requirement (3).
- d. Satisfies the requirement (1) and (3), but does not satisfies the requirement (2).
- e. Satisfies all the requirement (1), (2), and (3).

[tifr2010](#) [operating-system](#) [process-synchronization](#)

[Answer](#)

16.19.43 Process Synchronization: GATE1997_6.8 [top](#)

<http://gateoverflow.in/2264>

Each Process P_i , $i = 1 \dots 9$ is coded as follows

```

repeat
    P(mutex)
    {Critical section}
    V(mutex)
forever

```

The code for P_{10} is identical except it uses V(mutex) in place of P(mutex). What is the largest number of processes that can be inside the critical section at any moment?

- A. 1
- B. 2
- C. 3
- D. None

[gate1997](#) [operating-system](#) [process-synchronization](#) [normal](#)

[Answer](#)

16.19.44 Process Synchronization: TIFR2011-B-22 [top](#)

<http://gateoverflow.in/20330>

Consider the program

```
P:: x:=1; y:=1; z:=1; u:=0
```

And the program

```
Q:: x, y, z, u := 1, 1, 1, 1; u:= 0
```

Which of the following is true?

- a. P and Q are equivalent for sequential processors.
- b. P and Q are equivalent for all multi-processor models.
- c. P and Q are equivalent for all multi-core machines.
- d. P and Q are equivalent for all networks of computers.
- e. None of the above

[tifr2011](#) [operating-system](#) [process-synchronization](#)

Answer

Answers: Process Synchronization

16.19.1 Process Synchronization: GATE2004_48 top

<http://gateoverflow.in/1044>


Selected Answer

option A) deadlock p1 : line1|p2:line3| p1: line2(block) |p2 :line4(block)

so here p1 want s(x) which is held by p2 and p2 want s(y) which is held by p1 ...

so its **circular wait (hold and wait condition)** .. so there is **deadlock**

option B) deadlock p1 : line 1| p2 line 3|p1: line 2(block) |p2 : line 4(block)

so here p1 wants sy which is held by p2 and p2 wants sx which is held by p1...so its **circular wait (hold and wait) so deadlock**

option c) p1 :line 1|p2 :line 3| p2 line 4(block) |p1 line 2 (block) here p1 wants sx and p2 wants sy .. but both will not be release by its process p1 and p2 because there is no way to release them ...so stuck in **deadlock** ..

option d) p1 :line 1 |p2 : line 3(block because need sx) |p1 line 2 |p2 : still block |p1 : execute cs then up the value of sx |p2 :line 3 line 4(block need sy)| p1 up the sy |p2 :lin4 4 and easily get cs ..

we can start from p2 also ... as I answered according only p1 ... but we get same answer

so **option D)** is correct

Upvote 7 votes

-- sonam vyas (8.1k points)

16.19.2 Process Synchronization: GATE2002_18 top

<http://gateoverflow.in/871>

B.

i- 1st blank- TestandSet(mutex).
2nd blank- mutext=0;

ii - no.

iii- say given procedure is not atomic. 1st execute process p1. After A1 p1 is preempted. 2nd process p2 now executes full code and enters critical section. P1 resumes and completes the code and enters critical section. So 2 processes are now in critical section.

Upvote 2 votes

-- Avinash MV (63 points)

16.19.3 Process Synchronization: GATE1996-1.19, ISRO2008-61 top

<http://gateoverflow.in/2723>


Selected Answer

C. is the answer

http://en.wikipedia.org/wiki/Critical_section

A - there is no time guarantee for critical section

B - critical section by default doesn't avoid deadlock. While using critical section, programmer must ensure deadlock is avoided.

D - This is not a requirement of critical section. Only when semaphore is used for critical section management, this becomes a necessity. But, semaphore is just ONE of the ways for managing critical section.

Upvote 6 votes

-- Gate Keeda (17.7k points)

16.19.4 Process Synchronization: GATE2001-2.22 [top](#)<http://gateoverflow.in/740>

Selected Answer

ans is B. suppose two processes p1 and p2. to guarantee mutual exclusion only 1 process must be in CS at a time. now, shared variable is turn P1 P2 f[1]=true f[2]=true turn=2 p1 will now check for condition while(f[2]=true and turn=2) then it will go for busy wait... then p2 will execute and it will update turn=1 p2 will now check condition while(f[1]=true and turn=1) then it will go for busy wait, but here as the value of turn is updated by p2; p1 will be able to enter into CS as the condition will become false therefore p1 will enter CS and p2 will be in busy wai until the p1 will come out and make f[1]=false hence, no two process can enter into CS at a time so predicate p is option B.

6 votes

-- jayendra (6.6k points)

16.19.5 Process Synchronization: GATE2005-IT_41 [top](#)<http://gateoverflow.in/3788>

Selected Answer

Check : [What is Starvation?](#)

Here P_2 can go in infinite waiting while process P_1 executes infinitely long.

Also, it can be the case that the Process P_1 starves for ∞ long time on the semaphore S, after it has successfully executed its critical section once, while P_2 executes infinitely long.

Both P_1 and P_2 can starve for ∞ long period of time.

answer = **option A**

10 votes

-- Amar Vashishth (20.7k points)

16.19.6 Process Synchronization: GATE2003-80 [top](#)<http://gateoverflow.in/964>

Selected Answer

To get pattern 001100110011

Process P should be executed first then **Process Q** should b executed

So at Process P : **W P(S) X V(T)**

and at Process Q :**Y V(T) Z V(S)**

with **S=1 and T=0** initially (only **P** has to be run first then only **Q** is run , both process run on alternet way start with **P**)

So ans is B

6 votes

-- Pooja (25.9k points)

16.19.7 Process Synchronization: GATE2006-IT_55 [top](#)<http://gateoverflow.in/3598>

Selected Answer

Suppose the slots are full -> $F = 0$. Now, if $\text{Wait}(F)$ and $\text{Wait}(S)$ are interchanged and $\text{Wait}(S)$ succeeds, The producer will wait for $\text{Wait}(F)$ which is never going to succeed as Consumer would be waiting for $\text{Wait}(S)$. So, deadlock can happen.

If $\text{Signal}(S)$ and $\text{Signal}(F)$ are interchanged in Consumer, deadlock won't happen. It will just give priority to a producer compared to the next consumer waiting.

So, answer (A)

9 votes

-- Arjun Suresh (150k points)

16.19.8 Process Synchronization: GATE1996_2.19 [top](#)

<http://gateoverflow.in/2748>



Selected Answer

acc. to me it should be c) because.. according to condition.. out of all , one philosopher will get both the forks.. so deadlock should not be there.

10 votes

-- Sneha Goel (1k points)

16.19.9 Process Synchronization: GATE2005-IT_42 [top](#)

<http://gateoverflow.in/3789>



Selected Answer

Answer is (B)

It needs two semaphores. $x=0, y=0$

P1 P2

P(X)

R1 R1

V(X)

P(Y)

R2 R2

V(Y)

P(X)

R3 R3

V(X)

P(Y)

R4 R4

V(Y)

9 votes

-- Sandeep_Uniyal (5.5k points)

16.19.10 Process Synchronization: GATE1996_21 [top](#)

<http://gateoverflow.in/2773>

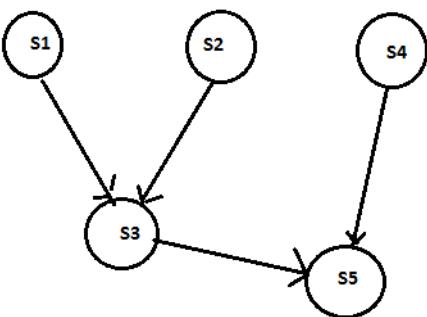


Selected Answer

Reference Link:

www.csc.lsu.edu/~rkannan/Fork_Cobegin_Creationtime.docx

<http://www.cis.temple.edu/~giorgio/old/cis307s96/readings/precedence.html>



(Precedence Graph)

2 votes

-- Manu Thakur (5.6k points)

16.19.11 Process Synchronization: GATE2000-1.21 [top](#)<http://gateoverflow.in/645>

Selected Answer

P0:m[0] m[1]
 P1:m[1] m[2]
 P2:m[2] m[3]
 P3:m[3] m[4]
 P4:m[4] m[0]
 p0 holding m0 waiting for m1
 p1 holding m1 waiting for m2
 p2 holding m2 waiting for m3
 p3 holding m3 waiting for m4
 p4 holding m4 waiting for m0
 So its circular wait and hence
 Answer: B) Deadlock.

11 votes

-- Sourav Roy (2.7k points)

16.19.12 Process Synchronization: GATE2008-IT_53 [top](#)<http://gateoverflow.in/3363>

Selected Answer

D Consumer can consume only once the producer has produced the item, and producer can produce(except the first time) only once the consumer has consumed the item.

8 votes

-- Shaun Patel (5.8k points)

16.19.13 Process Synchronization: GATE2000-20 [top](#)<http://gateoverflow.in/691>

1. signal mutex
2. signal mutex
3. R || W (binary OR operator)

3 votes

-- Digvijay (35.8k points)

16.19.14 Process Synchronization: GATE2007-IT_56 [top](#)<http://gateoverflow.in/3498>

Selected Answer

Answer is (C)

S1: if readcount is 1 i.e some reader is reading, DOWN on wrt so that no writer can write.

S2: After readcount has been updated , UP on mutex.

S3: DOWN on mutex to update readcount

S4: If readcount is zero i.e no reader is reading ,UP on wrt .Allow writer to Write

4 votes

-- Sandeep_Uniyal (5.5k points)

16.19.15 Process Synchronization: GATE2007-IT_10 [top](#)

<http://gateoverflow.in/3443>



Selected Answer

(C).. both process can run the critical section concurrently.. lets say p1 starts and it enters inside if clause.. and just after its entrance and before execution of critical_flag = TRUE, a context switch happens and p2 also gets entrance since the flag is still false.. so now both process are in critical section!! so (i) is true.. (ii) is false there is no way that flat is true and no process' are inside the if clause, if someone enters the critical section, it will definitely make flag = false.. so no deadlock

14 votes

-- Vicky Bajoria (3.4k points)

16.19.16 Process Synchronization: GATE2002_20 [top](#)

<http://gateoverflow.in/873>



Selected Answer

a) In Producer Consumer problem Producer produce item and makes the buffer full and after that Consumer consumes that item and makes the buffer empty

Here b_empty and b_full are two semaphore values

p1: P(Empty)

means, Producer have to wait only if buffer is full and it waits for consumer to remove at least one item. (See, Empty being initialized to BUFFSIZE)

p2: V(Full)

buffer is filled, now it gives signal to consumer that it can start consuming

c1: P(Full)

means here consumer have to wait only if buffer is empty, and it waits for Producer to fill the buffer

c2: V(Empty)

Now buffer is empty and Empty semaphore gives signal to the producer that it can start filling

It is same as giving water to a thirsty man.

Here u are giving water in a glass to that thirsty man, so u are producer here
and the man drinks and makes the glass empty, so he is consumer here

b) If there are multiple user we can use mutex semaphore, so that exclusively one could enter in Critical section at a time. i.e.

```
p1:P(Empty)
P(mutex)

p2:V(mutex)
V(Full)

c1:P(Full)
P(mutex)

c2: V(mutex)
V(Empty)
```

PS: One thing to see is P(mutex) is after P(Full) and P(empty)- otherwise deadlock can happen when buffer is full and a producer gets mutex or if buffer is empty and a consumer gets mutex.

5 votes

-- srestha (27.8k points)

16.19.17 Process Synchronization: GATE2010-45 [top](#)

<http://gateoverflow.in/2347>

First P0 will enter the while loop as S0 is 1. Now, it releases both S1 and S2 and one of them must execute next. Let that be P1. Now, P0 will be waiting for P1 to finish. But in the mean time P2 can also start execution. So, there is a chance that before P0 enters the second iteration both P1 and P2 would have done release (S0) which would make S1 1 only (as it is a binary semaphore). So, P0 can do only 1 more iteration printing '0' two times.

If P2 does release (S0) only after P0 starts its second iteration, then P0 would do three iterations printing '0' three times.

If the semaphore had 3 values possible (an integer semaphore and not a binary one), exactly three '0's would have been printed.

6 votes

-- Arjun Suresh (150k points)

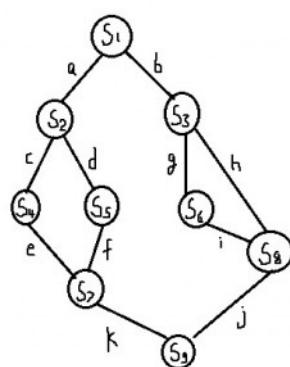
16.19.18 Process Synchronization: GATE1995_19 [top](#)

<http://gateoverflow.in/2656>



Selected Answer

Precedence graph will be formed as



10 votes

-- neha pawar (3.8k points)

16.19.19 Process Synchronization: GATE2007-58 [top](#)

<http://gateoverflow.in/1256>



Selected Answer

P1 can do wants1 = true and then P2 can do wants2 = true. Now, both P1 and P2 will be waiting in the while loop indefinitely without any progress of the system - deadlock.

When P1 is entering critical section it is guaranteed that wants1 = true (wants2 can be either true or false). So, this ensures P2 won't be entering the critical section at the same time. In the same way, when P2 is in critical section, P1 won't be able to enter critical section. So, mutual exclusion condition satisfied.

So, D is the correct choice

Suppose P1 first enters critical section. Now suppose P2 comes and waits for CS by making wants2 = true. Now, P1 cannot get access to CS before P2 gets and similarly if P1 is in wait, P2 cannot continue more than once getting access to CS. Thus there is a bound (of 1) on the number of times another process gets access to CS after a process requests access to it and hence bounded waiting condition is satisfied.

9 votes

-- Arjun Suresh (150k points)

16.19.20 Process Synchronization: GATE2013_39 [top](#)

<http://gateoverflow.in/1550>



Selected Answer

A choice:

X is waiting on R and Y is waiting on X. So, both cannot proceed.

B choice:

Process X is doing Signal operation on R and S without any wait and hence multiple signal operations can happen on the binary semaphore so Process Y won't be able to get exactly n successful wait operations. i.e., Process Y may not be able to complete all the iterations.

C choice:

Process X does Wait(S) followed by Signal(R) while Process Y does Signal(S) followed by Wait(R). So, this ensures that no two iterations of either X or Y can proceed without an iteration of the other being executed in between. i.e., this ensures that all n iterations of X and Y succeeds and hence the answer.

D choice:

Process X does Signal(R) followed by Wait(S) while Process Y does Signal(S) followed by Wait(R). There is a problem here that X can do two Signal(R) operation without a Wait(R) being done in between by Y. This happens in the following scenario:

Process Y: Does Signal (S); Wait(R) fails; goes to sleep.

Process X: Does Signal(R); Wait(S) succeeds; In next iteration Signal(R) again happens;

So, this can result in some Signal operations getting lost as the semaphore is a binary one and thus Process Y may not be able to complete all the iterations. If we change the order of Signal(S) and Wait(R) in EntryY, then D option also can work.

20 votes

-- Arjun Suresh (150k points)

16.19.21 Process Synchronization: GATE2012_32 [top](#)

<http://gateoverflow.in/1750>



Selected Answer

A process acquires a lock only when L = 0. When L is 1, the process repeats in the while loop- there is no overflow because after each increment to L, L is again made equal to 1. So, the only chance of overflow is if a large number of processes (larger than sizeof(int)) execute the check condition of while loop but not L = 1, which is highly improbable.

Acquire Lock gets success only when Fetch_And_Add gets executed with L = 0. Now suppose P1 acquires lock and make L = 1. P2 waits for a lock iterating the value of L between 1 and 2 (assume no other process waiting for lock). Suppose when P1 releases lock by making L = 0, the next statement P2 executes is L = 1. So, value of L becomes 1 and no process is in critical section ensuring L can never be 0 again. Thus B choice.

To correct the implementation we have to replace Fetch_And_Add with Fetch_And_Make_Equal_1 and remove L=1 in AcquireLock(L).

20 votes

-- Arjun Suresh (150k points)

16.19.22 Process Synchronization: GATE2013_34 [top](#)<http://gateoverflow.in/1545>

Selected Answer

Since initial value of semaphore is 2, two processes can enter critical section at a time- this is bad and we can see why.

Say, X and Y be the processes. X increments x by 1 and Z decrements x by 2. Now, Z stores back and after this X stores back. So, final value of x is 1 and not -1 and two Signal operations make the semaphore value 2 again. So, now W and Z can also execute like this and the value of x can be **2 which is the maximum possible** in any order of execution of the processes.

(If the semaphore is initialized to 1, processes would execute correctly and we get the final value of x as -2.)

14 votes

-- Arjun Suresh (150k points)

16.19.23 Process Synchronization: GATE2003-81 [top](#)<http://gateoverflow.in/4354>

output shouldn't contain substring of given form means no concurrent execution process P as well as Q. one semaphore is enough

So ans is c

2 votes

-- Pooja (25.9k points)

16.19.24 Process Synchronization: GATE2006-79 [top](#)<http://gateoverflow.in/4354>

The implementation is incorrect because if two barrier invocations are used in immediate succession the system will fall into a DEADLOCK.

Here's how: Let all three processes make `process_arrived` variable to the value

3, as soon as it becomes

3 previously stuck processes at the while loop are now free, to move out of the while loop.

But for instance let say one process moves out and has bypassed the next `if` statement & moves out of the `barrier` function and The SAME process is invoked again(its second invocation) while other processes are preempted still.

That process on its second invocation makes the `process_arrived` variable to 4 and gets stuck forever in the while loop with other processes.

At this point of time they are in DEADLOCK. as only 3 processes were in the system and all are now stuck in while loop.

Q.79 answer = **option B**

option A here is false as there will always be a need for some process to help some other process to move out of that while loop waiting. Not all processes together can be said to be completed at a time.

option C is false. If context switch is disabled then the process who was stuck in while loop will remain there forever and no other process can play a role in bringing it out of there as Context Switch will be required to bring that other process in the system to do the job.

option D is false. everyone will be in a loop forever, if that happens.

option B is TRUE. at the beginning of the barrier the 1st process to enter Critical section should wait until `process_arrived` becomes zero(i.e. before starting its second invocation). this is to prevent it from making `process_arrived` value greater than 3 i.e. rectifying the flaw observed in Q.78

3 votes

-- Amar Vashishth (20.7k points)

16.19.25 Process Synchronization: GATE2006_61 [top](#)<http://gateoverflow.in/1839>



Selected Answer

Option (B) :- If we use normal load & Store instead of Fetch & Set there is good chance that more than one Process sees S.value as 0 & then mutual exclusion wont be satisfied. So this option is wrong.

Option (C) :- Here we are setting S->value to 0, which is correct. (As in fetch & Set we wait if value of S-> value is 1. So implementation is correct. This option is wrong.

Option (D) :- I don't see why this code does not implement binary semaphore, only one Process can be in critical section here at a time. So this is binary semaphore & Option D is wrong

Answer :- Option A. This is correct because the implementation may not work if context switching is disabled in P , then process which is currently blocked may never give control to the process which might eventually execute V. So Context switching is must !

13 votes

-- Akash (31.7k points)

16.19.26 Process Synchronization: GATE1991-11,b [top](#)

<http://gateoverflow.in/43000>

Here 3 processes are there.

Now, at least 2 processes are ready to enter into CS at the same time

Here, as **flag[i]=false** // means flag[i] not ready to enter CS

So, P_j enters in CS

But CS depends on turn=i and turn=j and not on turn=k

So, if there is a situation turn=j is always false ,then P_k never go inside CS

0 votes

-- srestha (27.8k points)

16.19.27 Process Synchronization: GATE2006-78 [top](#)

<http://gateoverflow.in/1853>

Selected Answer

B is the correct answer.

Let 3 processes p1, p2 , p3 arrives at the barrier and after 4th step *process_arrived=3*. and the processes enters the barrier. Now suppose process p1 executes the complete code and makes *process_left=1*, and tries to re-enter the barrier. Now, when it executes 4th step, *process_arrived=4*. p1 is now stuck. At this point all other processes p2 and p3 also executes their section of code and resets *process_arrived=0* and *process_left=0*. Now, p2 and p3 also tries to re-enter the barrier making *process_arrived=2*. At this point all processes have arrived, but *process_arrived!=3*. Hence no process can re-enter into the barrier, therefore DEADLOCK!!

Let me know, if i'm right..?

14 votes

-- GateMaster Prime (1.3k points)

16.19.28 Process Synchronization: GATE1999_20 [top](#)

<http://gateoverflow.in/1519>

Q-2)

for consumer part

if (count==0)

consumer understands that buffer is full,But before consumer going to sleep It got preempted and went to the Ready

Queue

when producer produce an item and make Count=1,it will think consumer is blocked and try to wake up the consumer.

But actually Consumer is not Blocked it is in ready queue

After Some time Consumer come and Go to sleep[as before preemption it had seen that buffer is empty]

producer think that he has woken up consumer and consumer is busy in consuming its produced item and consumer is waiting for producer wakeup call

After sometime when buffer is full,producer went to sleep thinking that when buffer is empty consumer will wake him up .And consumer is still waiting for producer wakeup call

So now Both are sleeping nd deadlock happens.

After some

1 votes

-- Himani Srivastava (283 points)

16.19.29 Process Synchronization: GATE2014-2_31 [top](#)

<http://gateoverflow.in/1990>



Selected Answer

option A) False :

producer =P (let) , consumer = C(let) , once producer produce the item and put into the buffer .. it will up the s and n to 1 , so consumer can easily consume the item ...so option A Is false ...

code can be execute in this way : P :1 2 3 4 5| C: 1 2 3 4 5... so consumer can consume item after adding the item to buffer.

option B) Is also False , becoz whenever item is added to buffer means after producing the item . consumer can consume the item or we can say remove the item ... if here statement is like The consumer will remove no more than one item from the buffer just after the removing one then it will be true(due n=0 then it will be blocked) ... but here only asking about The consumer will remove no more than one item from the buffer so its false ...

option C) is true, statement says if consumer execute first means buffer is empty ...then execution will be like this

C:1 (wait on s , s=0 now) 2(BLOCK n ==1) |P : 1 2(wait on s which is already 0 so it now block) .. so c wants n which is held by producer or we can say up by only producer and P wants s , which will be up by only consumer ..(circular wait) surely there is deadlock.

option D) is false if n=1 then also it will not free from deadlock

for the given execution .. C: 1 2 3 4 5 1 2(BLOCK) | P: 1 2(BLOCK) so deadlock ...

(here 1 2 3 4 5 are the lines of the given code)

hence **answer is C**)

8 votes

-- sonam vyas (8.1k points)

16.19.30 Process Synchronization: GATE 2016-2-48 [top](#)

<http://gateoverflow.in/39600>



Selected Answer

There is strict alternation i.e. after completion of process 0 if it wants to start again.It will have to wait until process 1 gives the lock.

This violates progress requirement which is, that no other process outside critical section can stop any other interested process from entering the critical section.

Hence the answer, is that it violates the progress requirement.

The given solution does not violate bounded waiting requirement.

Bounded waiting is : *There exists a bound, or limit, on the number of times other processes are allowed to enter their critical sections after a process has made request to enter its critical section and before that request is granted.*

Here there are only two processes and when process 0 enters CS, next entry is reserved for process 1 and vice-versa (strict alternation). So, bounded waiting condition is satisfied here.

16 votes

-- bahirNaik (2.6k points)

16.19.31 Process Synchronization: TIFR2015-B-14 [top](#)



Selected Answer

Reading and writing is atomic but evaluation not atomic

So,

- 1) read 1, evaluate 1 time, write 2
- 2) read 1, evaluate 2 time, write 3
- 3) read 1, evaluate 3 time, write 4

Answer will be (B)2,3,4

2 votes

-- srestha (27.8k points)

16.19.32 Process Synchronization: TIFR2011-B-34 [top](#)



- (a) True. A test and set primitive can be used in place of a semaphore
- (b) True (Example: multiple process synchronization to a critical section access)
- (c) False. A split binary semaphore is essentially an array of binary semaphores (<http://bluehawk.monmouth.edu/rclayton/web-pages/u03-598/us.html>)
- (d) False as (a) and (b) are true
- (e) False as seen from the definition of inhibitor arc here (https://en.wikipedia.org/wiki/Petri_net)

0 votes

-- Arjun Suresh (150k points)

16.19.33 Process Synchronization: GATE2010-23 [top](#)



Selected Answer

ans is A ..in this mutual exclusion is satisfied,only one process can access the critical section at particular time but here progress will not satisfied because suppose when $s_1=1$ and $s_2=0$ and process p1 is not interested to enter into critical section but p2 want to enter critical section. P2 is not able to enter critical section in this as only when p1 finishes execution, then only p2 can enter (then only $s_1 = s_2$ condition be satisfied). Progress will not be satisfied when any process which is not interested to enter into the critical section will not allow other interested process to enter into the critical section.

11 votes

-- neha pawar (3.8k points)

16.19.34 Process Synchronization: TIFR2011-B-28 [top](#)<http://gateoverflow.in/20575>

e)
as in 1st $z = a[j] = y$

whereas in 2nd $z = x$;

so z is getting different values

(Also there's typo in question , expression $a[j]$ has been removed)

1 votes

-- Vertika Srivastava (283 points)

16.19.35 Process Synchronization: GATE2004-IT_65 [top](#)<http://gateoverflow.in/3708>

Selected Answer

P_1 is the producer. So, it must wait for full condition. But semaphore $full$ is initialized to 0 and semaphore $empty$ is initialized to n , meaning $full = 0$ implies no item and $empty = n$ implies space for n items is available. So, P_1 must wait for semaphore $empty - K - P(empty)$ and similarly P_2 must wait for semaphore $full - M - P(full)$. After accessing the critical section (producing/consuming item) they do their respective V operation. Thus option D.

11 votes

-- Arjun Suresh (150k points)

16.19.36 Process Synchronization: GATE1991_11,a [top](#)<http://gateoverflow.in/538>

Assume all 3 process has same implementation of code except flag variable indices changes accordingly for P_j and P_k and turn is shared variable among 3 process.

Initially $Flag[i]=F, Flag[j]=F, Flag[k]=F$ and assume $turn = i$

1) Let P_i and P_k want to enter CS then set $Flag[i] = T$ and $Flag[k] = T$

2) P_i will enter CS while P_k will wait because case $turn = j$ is true and $flag[i]=T$, it will wait till $turn = k$ therefore Mutual exclusion is satisfied other process agree to wait

3) here if initially $turn = j$ then both P_i and P_k will wait even when no process in CS.

1 votes

-- Saurav Shrivastava (719 points)

16.19.37 Process Synchronization: GATE2015-3_10 [top](#)<http://gateoverflow.in/8405>

Selected Answer

When both processes try to enter critical section simultaneously, both are allowed to do so since both shared variables $varP$ and $varQ$ are true. So, clearly there is **NO mutual exclusion**. Also, **deadlock is prevented** because mutual exclusion is one of the conditions for deadlock to happen. Hence, answer is **A**.

23 votes

-- tanaya (195 points)

16.19.38 Process Synchronization: GATE1994_27 [top](#)<http://gateoverflow.in/2523>

The precedence graph is as follows

precedence graph

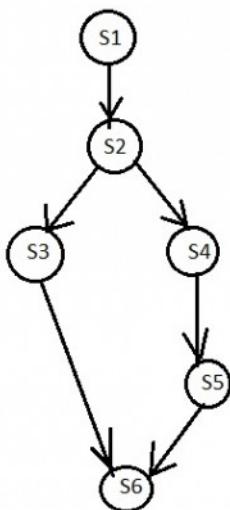
i feel parbegin .parend can be used between s1 and s2 and then be serialized but some solutions are showing they cant be used.

someone please rectify me if i am wrong and please make me understand my mistake

0 votes

-- ANI (513 points)

precedence graph



0 votes

-- srestha (27.8k points)

16.19.39 Process Synchronization: GATE1993_22 [top](#)

<http://gateoverflow.in/2319>

parbegin

| | | | |
|-------|---------|-----------|-----|
| begin | s1 | V(a) V(b) | end |
| begin | P(a) s2 | P(c) | |

| | | | | |
|--|-------|------|------|------|
| | P(e) | end | | |
| | begin | P(b) | s3 | P(d) |
| | end | | | |
| | begin | P(f) | P(c) | s4 |
| | end | | | |
| | begin | P(g) | P(d) | P(e) |
| | end | | | s5 |
| | begin | s6 | P(f) | P(g) |
| | end | | | |

par end

here the statement between parbegin and paren end can execute in any order. But the precedence graph shows the order in which the statements should be executed. This strict ordering is achieved using the semaphores.

Initially all the semaphores are 0.

For s1 there is no need of semaphore because it is the first one to execute.

next s2 can execute only when s1 finishes. For this we have a semaphore a on which signal is executed by s1 , which makes value of a =1. So that S2 can execute after executing wait on a.making a=0;

Likewise this is followed for all other statements.

2 votes

-- Sourav Roy (2.7k points)

16.19.40 Process Synchronization: TIFR2010-B-28 top

<http://gateoverflow.in/18751>

i think ans is (4,7,8,10)

0 votes

-- Ravi Raaja (165 points)

Well as it is given , "Reading and writing of variables is atomic, but the evaluation of an expression is not atomic."

We can convert above program into assembly language

Expression 1 :- $x = x + 1$

Load x,R1; (Atomic Read)

R1 = R1 + 3;

store R1,x; (Atomic Write)

Expression 2 :- $x = x + x + 2$

read x,R2 ;

$x = R2 + R2 + 2;$

store R2,x;

This 2 code will execute giving us answer as 4,7,10 C, depending on order of execution of instructions, we can not reorder inside any expression, but we can intermix statements in both expressions. (Same we can change relative order of statements in two different transactions, but we can no reorder statement in single transaction)

0 votes

-- Akash (31.7k points)

16.19.41 Process Synchronization: GATE2009-33[top](#)<http://gateoverflow.in/1319>

Selected Answer

The answer is A only.

The solution satisfies:

- 1) Mutual Exclusion as test-and-set is an indivisible (atomic) instruction (makes option IV wrong)
- 2) Progress as at initially X is 0 and at least one process can enter critical section at any time.

But no guarantee that a process eventually will enter CS and hence option IV is false. Also, no ordering of processes is maintained and hence III is also false.

So eliminating all the 3 choices remains A.

9 votes

-- Gate Keeda (17.7k points)

16.19.42 Process Synchronization: TIFR2010-B-32[top](#)<http://gateoverflow.in/19244>

Selected Answer

Process P1 while loop says : while NOT (turn = 1) do ... so it will not enter the while loop until Turn = 2 which will make Turn=1 false and thus NOT (Turn =1) as true.

Process P2 for the same reason will enter the while loop.

as process P2 has statement Turn = 1 at the end of the while loop so the value of Turn will always remain 1 ... So process P1 will never enter the while loop and So this will result in starvation of Process P1

Hence answer is (C) ... hopefully !!!

2 votes

-- Danish (2.4k points)

16.19.43 Process Synchronization: GATE1997_6.8[top](#)<http://gateoverflow.in/2264>

Selected Answer

Answer is D

If initial value is 1//execute P1 or P10 first

If initial value is 0, P_10 can execute and make the value 1.

since the both code (ie p1 to p9 and p10)can be executed any number of times and code for p10 is

```
repeat
{
    v(mutex)
    C.S.
    V(mutex)
}
forever
```

now let me say P1 is in c.s

then p10 comes executes the CS(up on mutex)

now P2 comes (down on mutex)

now P10 moves out of CS (again binary semaphore will be 1)

now P3 comes (down on mutex)

now P10 come (up on mutex)

now P4 comes (down on mutex)

so if we take p10 in out of CS recursively all 10 process can be in CS

using Binary semaphore only

9 votes

-- Kalpish Singh (1.7k points)

16.19.44 Process Synchronization: TIFR2011-B-22 [top](#)<http://gateoverflow.in/2030>

Both the programs are equivalent in the sense that the output will be the same at the end of execution. Q just writes 1 to u but this will be overwritten by the following write of 0. So, in any computer both P and Q should produce the same result at the end of execution.

2 votes

-- Arjun Suresh (150k points)

16.20**Resource Allocation** [top](#)**16.20.1 Resource Allocation: GATE2000-2.23** [top](#)<http://gateoverflow.in/670>

Which of the following is not a valid deadlock prevention scheme?

- A. Release all resources before requesting a new resource.
- B. Number the resources uniquely and never request a lower numbered resource than the last one requested.
- C. Never request a resource after releasing any resource.
- D. Request and all required resources be allocated before execution.

[gate2000](#) [operating-system](#) [resource-allocation](#) [normal](#)

Answer

16.20.2 Resource Allocation: GATE 2016-1-50 [top](#)<http://gateoverflow.in/3979>

Consider the following proposed solution for the critical section problem. There are n processes :

$P_0 \dots P_{n-1}$. In the code, function pmax returns an integer not smaller than any of its arguments .For all $i, t[i]$ is initialized to zero.

Code for P_i ;

```
do {
    c[i]=1; t[i]= pmax (t[0],...,t[n-1])+1; c[i]=0;
    for every j != i in {0,...,n-1} {
        while (c[j]);
        while (t[j] != 0 && t[j] <=t[i]);
    }
    Critical Section;
    t[i]=0;

    Remainder Section;
} while (true);
```

Which of the following is TRUE about the above solution?

- A. At most one process can be in the critical section at any time
- B. The bounded wait condition is satisfied
- C. The progress condition is satisfied
- D. It cannot cause a deadlock

[gate2016-1](#) [operating-system](#) [resource-allocation](#) [difficult](#) [ambiguous](#)

Answer

16.20.3 Resource Allocation: GATE2008-65 [top](#)<http://gateoverflow.in/488>

Which of the following is NOT true of deadlock prevention and deadlock avoidance schemes?

- A. In deadlock prevention, the request for resources is always granted if the resulting state is safe
- B. In deadlock avoidance, the request for resources is always granted if the resulting state is safe

- C. Deadlock avoidance is less restrictive than deadlock prevention
 D. Deadlock avoidance requires knowledge of resource requirements *a priority*

gate2008 | operating-system | easy | resource-allocation

[Answer](#)

16.20.4 Resource Allocation: GATE1992_02,xi [top](#)

<http://gateoverflow.in/568>

02. Choose the correct alternatives (more than one may be correct) and write the corresponding letters only:

(xi) A computer system has 6 tape devices, with n processes competing for them. Each process may need 3 tape drives. The maximum value of n for which the system is guaranteed to be deadlock free is:

- a. 2
- b. 3
- c. 4
- d. 1

gate1992 | operating-system | resource-allocation | normal

[Answer](#)

16.20.5 Resource Allocation: GATE1997_75 [top](#)

<http://gateoverflow.in/19705>

An operating system handles requests to resources as follows.

A process (which asks for some resources, uses them for some time and then exits the system) is assigned a unique timestamp when it starts. The timestamps are monotonically increasing with time. Let us denote the timestamp of a process P by TS(P).

When a process P requests for a resource the OS does the following:

- i. If no other process is currently holding the resource, the OS awards the resource to P.
- ii. If some process Q with TS(Q)
- iii. If some process Q with TS(Q)>TS(P) is holding the resource, the OS restarts Q and awards the resources to P. (Restarting means taking back the resources held by a process, killing it and starting it again with the same timestamp)

When a process releases a resource, the process with the smallest timestamp (if any) amongst those waiting for the resource is awarded the resource.

- a. Can a deadlock ever arise? If yes, show how. If not prove it.
- b. Can a process P ever starve? If yes, show how. If not prove it.

gate1997 | operating-system | resource-allocation

[Answer](#)

16.20.6 Resource Allocation: GATE2001-19 [top](#)

<http://gateoverflow.in/760>

Two concurrent processes P1 and P2 want to use resources R1 and R2 in a mutually exclusive manner. Initially, R1 and R2 are free. The programs executed by the two processes are given below.

Program for P1:

- ```
S1: While (R1 is busy) do no-op;
S2: Set R1 ← busy;
S3: While R2 is busy do no-op;
S4: Set R2 ← busy;
S5: Use R1 and R2;
S6: Set R1 ← free;
S7: Set R2 ← free;
```

*Program for P2:*

- Q1: While R1 is busy do no-op
- Q2: Set R1  $\leftarrow$  busy
- Q3: While (R1 is busy) do no-op;
- Q4: Set R1  $\leftarrow$  busy
- Q5: Use R1 and R2
- Q6: Set R2  $\leftarrow$  free
- Q7: Set R2  $\leftarrow$  free

- a. Is mutual exclusion guaranteed for R1 and R2? If not show a possible interleaving of the statements of P1 and P2 such mutual exclusion is violated (i.e., both P1 and P2 use R1 and R2 at the same time).
- b. Can deadlock occur in the above program? If yes, show a possible interleaving of the statements of P1 and P2 leading to deadlock.
- c. Exchange the statements Q1 and Q3 and statements Q2 and Q4. Is mutual exclusion guaranteed now? Can deadlock occur?

gate2001 | operating-system | resource-allocation | normal

Answer

### 16.20.7 Resource Allocation: GATE2015-3\_52 [top](#)

<http://gateoverflow.in/3561>

Consider the following policies for preventing deadlock in a system with mutually exclusive resources.

- I. Process should acquire all their resources at the beginning of execution. If any resource is not available, all resources acquired so far are released.
- II. The resources are numbered uniquely, and processes are allowed to request for resources only in increasing resource numbers
- III. The resources are numbered uniquely, and processes are allowed to request for resources only in decreasing resource numbers
- IV. The resources are numbered uniquely. A processes is allowed to request for resources only for a resource with resource number larger than its currently held resources

Which of the above policies can be used for preventing deadlock?

- A. Any one of I and III but not II or IV
- B. Any one of I, III and IV but not II
- C. Any one of II and III but not I or IV
- D. Any one of I, II, III and IV

gate2015-3 | operating-system | resource-allocation | normal

Answer

### 16.20.8 Resource Allocation: GATE2015-2\_23 [top](#)

<http://gateoverflow.in/3114>

A system has 6 identical resources and  $N$  processes competing for them. Each process can request atmost 2 requests. Which one of the following values of  $N$  could lead to a deadlock?

- A. 1
- B. 2
- C. 3
- D. 4

gate2015-2 | operating-system | resource-allocation | easy

Answer

### 16.20.9 Resource Allocation: GATE2005-IT\_62 [top](#)

<http://gateoverflow.in/3823>

Two shared resources  $R_1$  and  $R_2$  are used by processes  $P_1$  and  $P_2$ . Each process has a certain priority for accessing each resource. Let  $T_{ij}$  denote the priority of  $P_i$  for accessing  $R_j$ . A process  $P_i$  can snatch a resource  $R_h$  from process  $P_j$  if  $T_{ik} > T_{jk}$ .

Given the following :

- I.  $T_{11} > T_{21}$
- II.  $T_{12} > T_{22}$
- III.  $T_{11} < T_{21}$
- IV.  $T_{12} < T_{22}$

Which of the following conditions ensures that  $P_1$  and  $P_2$  can never deadlock?

- A) (I) and (IV)
- B) (II) and (III)
- C) (I) and (II)
- D) None of the above

[gate2005-it](#) [operating-system](#) [resource-allocation](#) [normal](#)

[Answer](#)

### 16.20.10 Resource Allocation: GATE1998\_1.32 [top](#)

<http://gateoverflow.in/1669>

A computer has six tape drives, with  $n$  processes competing for them. Each process may need two drives. What is the maximum value of  $n$  for the system to be deadlock free?

- a. 6
- b. 5
- c. 4
- d. 3

[gate1998](#) [operating-system](#) [resource-allocation](#) [normal](#)

[Answer](#)

### 16.20.11 Resource Allocation: GATE2004-IT\_63 [top](#)

<http://gateoverflow.in/3706>

In a certain operating system, deadlock prevention is attempted using the following scheme. Each process is assigned a unique timestamp, and is restarted with the same timestamp if killed. Let  $P_h$  be the process holding a resource  $R$ ,  $P_r$  be a process requesting for the same resource  $R$ , and  $T(P_h)$  and  $T(P_r)$  be their timestamps respectively. The decision to wait or preempt one of the processes is based on the following algorithm.

```
if T(Pr) < T(Ph) then
 kill Pr
else wait
```

Which one of the following is TRUE?

- A. The scheme is deadlock-free, but not starvation-free
- B. The scheme is not deadlock-free, but starvation-free
- C. The scheme is neither deadlock-free nor starvation-free
- D. The scheme is both deadlock-free and starvation-free

[gate2004-it](#) [operating-system](#) [resource-allocation](#) [normal](#)

[Answer](#)

### 16.20.12 Resource Allocation: GATE2008-IT\_54 [top](#)

<http://gateoverflow.in/3364>

An operating system implements a policy that requires a process to release all resources before making a request for another resource. Select the TRUE statement from the following:

- A) Both starvation and deadlock can occur
- B) Starvation can occur but deadlock cannot occur
- C) Starvation cannot occur but deadlock can occur
- D) Neither starvation nor deadlock can occur

[gate2008-it](#) [operating-system](#) [resource-allocation](#) [normal](#)

**Answer**

### 16.20.13 Resource Allocation: GATE2014-1\_31 [top](#)

<http://gateoverflow.in/1800>

An operating system uses the *Banker's algorithm* for deadlock avoidance when managing the allocation of three resource types X, Y, and Z to three processes P0, P1, and P2. The table given below presents the current system state. Here, the *Allocation matrix* shows the current number of resources of each type allocated to each process and the *Max matrix* shows the maximum number of resources of each type required by each process during its execution.

|    | Allocation |   |   | Max |   |   |
|----|------------|---|---|-----|---|---|
|    | X          | Y | Z | X   | Y | Z |
| P0 | 0          | 0 | 1 | 8   | 4 | 3 |
| P1 | 3          | 2 | 0 | 6   | 2 | 0 |
| P2 | 2          | 1 | 1 | 3   | 3 | 3 |

There are 3 units of type X, 2 units of type Y and 2 units of type Z still available. The system is currently in a **safe** state. Consider the following independent requests for additional resources in the current state:

**REQ1:** P0 requests 0 units of X, 0 units of Y and 2 units of Z

**REQ2:** P1 requests 2 units of X, 0 units of Y and 0 units of Z

Which one of the following is **TRUE**?

- (A) Only REQ1 can be permitted.
- (B) Only REQ2 can be permitted.
- (C) Both REQ1 and REQ2 can be permitted.
- (D) Neither REQ1 nor REQ2 can be permitted.

[gate2014-1](#) [operating-system](#) [resource-allocation](#) [normal](#)

**Answer**

### 16.20.14 Resource Allocation: GATE2006\_66 [top](#)

<http://gateoverflow.in/1844>

Consider the following snapshot of a system running  $n$  processes. Process  $i$  is holding  $x_i$  instances of a resource  $R$ ,  $1 \leq i \leq n$ . Currently, all instances of  $R$  are occupied. Further, for all  $i$ , process  $i$  has placed a request for an additional  $y_i$  instances while holding the  $x_i$  instances it already has. There are exactly two processes  $p$  and  $q$  and such that  $Y_p = Y_q = 0$ . Which one of the following can serve as a necessary condition to guarantee that the system is not approaching a deadlock?

- (A)  $\min(x_p, x_q) < \max_{k \neq p, q} y_k$
- (B)  $x_p + x_q \geq \min_{k \neq p, q} y_k$
- (C)  $\max(x_p, x_q) > 1$
- (D)  $\min(x_p, x_q) > 1$

[gate2006](#) [operating-system](#) [resource-allocation](#) [normal](#)

**Answer**

**16.20.15 Resource Allocation: GATE2014-3\_31** [top](#)<http://gateoverflow.in/2065>

A system contains three programs and each requires three tape units for its operation. The minimum number of tape units which the system must have such that deadlocks never arise is \_\_\_\_\_.

[gate2014-3](#) [operating-system](#) [resource-allocation](#) [numerical-answers](#) [easy](#)

**Answer****16.20.16 Resource Allocation: GATE2013\_16** [top](#)<http://gateoverflow.in/1438>

Three concurrent processes  $X$ ,  $Y$ , and  $Z$  execute three different code segments that access and update certain shared variables. Process  $X$  executes the  $P$  operation (i.e., *wait*) on semaphores  $a$ ,  $b$  and  $c$ ; process  $Y$  executes the  $P$  operation on semaphores  $b$ ,  $c$  and  $d$ ; process  $Z$  executes the  $P$  operation on semaphores  $c$ ,  $d$ , and  $a$  before entering the respective code segments. After completing the execution of its code segment, each process invokes the  $V$  operation (i.e., *signal*) on its three semaphores. All semaphores are binary semaphores initialized to one. Which one of the following represents a deadlock-free order of invoking the  $P$  operations by the processes?

- (A)  $X : P(a)P(b)P(c)$   $Y : P(b)P(c)P(d)$   $Z : P(c)P(d)P(a)$
- (B)  $X : P(b)P(a)P(c)$   $Y : P(b)P(c)P(d)$   $Z : P(a)P(c)P(d)$
- (C)  $X : P(b)P(a)P(c)$   $Y : P(c)P(b)P(d)$   $Z : P(a)P(c)P(d)$
- (D)  $X : P(a)P(b)P(c)$   $Y : P(c)P(b)P(d)$   $Z : P(c)P(d)P(a)$

[gate2013](#) [operating-system](#) [resource-allocation](#) [normal](#)

**Answer****16.20.17 Resource Allocation: GATE2005\_71** [top](#)<http://gateoverflow.in/1394>

Suppose  $n$  processes,  $P_1, \dots, P_n$  share  $m$  identical resource units, which can be reserved and released one at a time. The maximum resource requirement of process  $P_i$  is  $s_i$ , where  $s_i > 0$ . Which one of the following is a sufficient condition for ensuring that deadlock does not occur?

- A.  $\forall i, s_i < m$
- B.  $\forall i, s_i < n$
- C.  $\sum_{i=1}^n s_i < (m + n)$
- D.  $\sum_{i=1}^n s_i < (m \times n)$

[gate2005](#) [operating-system](#) [resource-allocation](#) [normal](#)

**Answer****16.20.18 Resource Allocation: GATE1997\_6.7** [top](#)<http://gateoverflow.in/2263>

An operating system contains 3 user processes each requiring 2 units of resource  $R$ . The minimum number of units of  $R$  such that no deadlocks will ever arise is

- A. 3
- B. 5
- C. 4
- D. 6

[gate1997](#) [operating-system](#) [resource-allocation](#) [normal](#)

**Answer**

### 16.20.19 Resource Allocation: GATE2009-30 [top](#)

<http://gateoverflow.in/1316>

Consider a system with 4 types of resources R1 (3 units), R2 (2 units), R3 (3 units), R4 (2 units). A non-preemptive resource allocation policy is used. At any given instance, a request is not entertained if it cannot be completely satisfied. Three processes P1, P2, P3 request the resources as follows if executed independently.

| Process P1:                                  | Process P2:                 | Process P3:                 |
|----------------------------------------------|-----------------------------|-----------------------------|
| t=0: requests 2 units of R2                  |                             | t=0: requests 1 unit of R4  |
| t=1: requests 1 unit of R3                   | t=0: requests 2 units of R3 | t=2: requests 2 units of R1 |
| t=3: requests 2 units of R1                  | t=2: requests 1 unit of R4  | t=5: releases 2 units of R1 |
| t=5: releases 1 unit of R2 and 1 unit of R1. | t=4: requests 1 unit of R1  | t=7: requests 1 unit of R2  |
| t=7: releases 1 unit of R3                   | t=6: releases 1 unit of R3  | t=8: requests 1 unit of R3  |
| t=8: requests 2 units of R4                  | t=8: Finishes               | t=9: Finishes               |
| t=10: Finishes                               |                             |                             |

Which one of the following statements is TRUE if all three processes run concurrently starting at time t = 0?

- A. All processes will finish without any deadlock
- B. Only P1 and P2 will be in deadlock
- C. Only P1 and P3 will be in deadlock
- D. All three processes will be in deadlock

[gate2009](#) [operating-system](#) [resource-allocation](#) [normal](#)

**Answer**

### 16.20.20 Resource Allocation: GATE2010-46 [top](#)

<http://gateoverflow.in/2348>

A system has  $n$  resources  $R_0, \dots, R_{n-1}$ , and  $k$  processes  $P_0, \dots, P_{k-1}$ . The implementation of the resource request logic of each process  $P_i$  is as follows:

```
if (i%2==0) {
 if (i<n) request Ri;
 if (i+2 < n) request Ri+2
}

else {
 if (i<n) request Rn-i;
 if (i+2 < n) request Rn-i-2;
}
```

In which of the following situations is a deadlock possible?

- A.  $n = 40, k = 26$
- B.  $n = 21, k = 12$
- C.  $n = 20, k = 10$
- D.  $n = 41, k = 19$

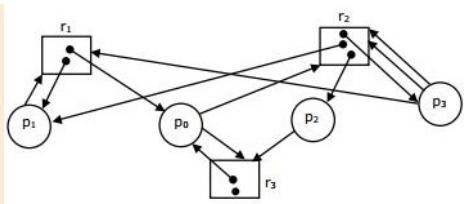
[gate2010](#) [operating-system](#) [resource-allocation](#) [normal](#)

**Answer**

### 16.20.21 Resource Allocation: GATE1994\_28 [top](#)

<http://gateoverflow.in/2524>

Consider the resource allocation graph in the figure.



- Find if the system is in a deadlock state
- Otherwise, find a safe sequence

gate1994 operating-system resource-allocation normal

**Answer**

### 16.20.22 Resource Allocation: GATE2007\_57 [top](#)

<http://gateoverflow.in/1255>

A single processor system has three resource types X, Y and Z, which are shared by three processes. There are 5 units of each resource type. Consider the following scenario, where the column **alloc** denotes the number of units of each resource type allocated to each process, and the column **request** denotes the number of units of each resource type requested by a process in order to complete execution. Which of these processes will finish **LAST**?

|    | alloc |   |   | request |   |   |
|----|-------|---|---|---------|---|---|
|    | X     | Y | Z | X       | Y | Z |
| P0 | 1     | 2 | 1 | 1       | 0 | 3 |
| P1 | 2     | 0 | 1 | 0       | 1 | 2 |
| P2 | 2     | 2 | 1 | 1       | 2 | 0 |

- A. P0
- B. P1
- C. P2
- D. None of the above, since the system is in a deadlock

gate2007 operating-system resource-allocation normal

**Answer**

### 16.20.23 Resource Allocation: GATE1996\_22 [top](#)

<http://gateoverflow.in/2774>

A computer system uses the Banker's Algorithm to deal with deadlocks. Its current state is shown in the table below, where P0, P1, P2 are processes, and R0, R1, R2 are resources types.

|    | Maximum Need |    |    | Current Allocation |    |    | Available |    |    |
|----|--------------|----|----|--------------------|----|----|-----------|----|----|
|    | R0           | R1 | R2 | R0                 | R1 | R2 | R0        | R1 | R2 |
| P0 | 4            | 1  | 2  | P0                 | 1  | 0  | 2         | 2  | 0  |
| P1 | 1            | 5  | 1  | P1                 | 0  | 3  | 1         | 0  | 0  |
| P2 | 1            | 2  | 3  | P2                 | 1  | 0  | 2         | 0  | 0  |

- Show that the system can be in this state
- What will the system do on a request by process P0 for one unit of resource type R1?

gate1996 operating-system resource-allocation normal

**Answer**

### 16.20.24 Resource Allocation: GATE1993-7.9, UGCNET-Dec2012-III-41 [top](#)

<http://gateoverflow.in/2297>

Consider a system having  $m$  resources of the same type. These resources are shared by 3 processes A, B and C which have peak demands of 3, 4 and 6 respectively. For what value of  $m$  deadlock will not occur?

- A. 7
- B. 9
- C. 10
- D. 13
- E. 15

[gate1993](#) [operating-system](#) [resource-allocation](#) [normal](#) [ugcnetdec2012iii](#)

[Answer](#)

### Answers: Resource Allocation

### 16.20.1 Resource Allocation: GATE2000-2.23 [top](#)

<http://gateoverflow.in/670>



Selected Answer

The answer is C.

A is valid. Which dissatisfies Hold and Wait but ends up in starvation.

B is valid. Which is used to dissatisfy circular wait.

C is invalid.

D is valid and is used to dissatisfy Hold and Wait.

11 votes

-- Gate Keeda (17.7k points)

### 16.20.2 Resource Allocation: GATE 2016-1-50 [top](#)

<http://gateoverflow.in/39719>

Answer is A.

```
while (t[j] != 0 && t[j] <= t[i]);
```

This ensures that when a process

$i$  reaches Critical Section, all processes

$j$  which started before it must have its

$t[j] = 0$ . This means no two process can be in critical section at same time as one of them must be started earlier.

returns an integer not smaller

is the issue here for deadlock. This means two processes can have same  $t$  value and hence

```
while (t[j] != 0 && t[j] <= t[i]);
```

can go to infinite wait. ( $t[j] == t[i]$ ). Starvation is also possible as there is nothing to ensure that a request is granted in a timed manner. But bounded waiting (as defined in Galvin) is guaranteed here as when a process  $i$  starts and gets  $t[i]$  value, no new process can enter critical section before  $i$  (as their  $t$  value will be higher) and this ensures that access to critical section is granted only to a finite number of processes (those which started before) before eventually process  $i$  gets access.

But in some places bounded waiting is defined as finite waiting (see one [here](#) from CMU) and since deadlock is possible here, bounded waiting is not guaranteed as per that definition.

9 votes

-- Arjun Suresh (150k points)

### 16.20.3 Resource Allocation: GATE2008-65 [top](#)

<http://gateoverflow.in/488>



Selected Answer

**A.** In deadlock prevention, we just need to ensure one of the four necessary conditions of deadlock doesn't occur. So, it may be the case that a resource request might be rejected even if the resulting state is safe. (One example, is when we impose a strict ordering for the processes to request resources).

Deadlock avoidance is less restrictive than deadlock prevention. Deadlock avoidance is like a police man and deadlock prevention is like a traffic light. The former is less restrictive and allows more concurrency.

Ref: <http://www.cs.jhu.edu/~yairamir/cs418/os4/tsld010.htm>

Upvote (11 votes)

-- Arjun Suresh (150k points)

#### 16.20.4 Resource Allocation: GATE1992\_02,xi [top](#)

<http://gateoverflow.in/568>



Selected Answer

Answer: A

For n=3, 2-2-2 combination of resources leads to deadlock.

For n=2, 3 - 3 is the maximum need and that can always be satisfied.

Upvote (8 votes)

-- Rajarshi Sarkar (29.7k points)

#### 16.20.5 Resource Allocation: GATE1997\_75 [top](#)

<http://gateoverflow.in/19705>

**a) Can Deadlock occur. No, because every time Older Process who wants some resources which are already acquired by some younger process. In this condition Younger will be killed and release its resources which is now taken by now older process. So never more than one process will wait for some resources indefinitely. Timestamp will also be unique.**

**b) Can a process Starve. No, because every time when Younger process is getting killed, it is restarted with same timestamp which he had at time of killing. So it will act as an elder even after killing for all those who came after it..**

Upvote (0 votes)

-- SONU (1.5k points)

any deadlock? no

but I Think the process will starve, imagine the one with the highest time stamp,it gets killed by a younger process,it has to start with the same time stamp, even though it gets hold of a resource it is always killed.secondly whenever any process releases a resource,the one with the smallest time stamp is awarded the resource, so the one with the highest time stamp in the entire system will starve provided new processes with lower time stamps keep coming.

Upvote (0 votes)

-- resilientknight (1.2k points)

#### 16.20.6 Resource Allocation: GATE2001-19 [top](#)

<http://gateoverflow.in/760>

in question program for P2 should be like this:

*Program for P2:*

Q1: While R1 is busy do no-op

Q2: Set R1 ← busy

Q3: While (R2 is busy) do no-op;

Q4: Set R2  $\leftarrow$  busy

Q5: Use R1 and R2

Q6: Set R2  $\leftarrow$  free

Q7: Set R2  $\leftarrow$  free

a) Mutual exclusion is not guaranteed;

initially both R1=free and R2=free

now consider the scenario,

P1 will start and check the condition (R1==busy) it will be evaluated as false and P1 will be preempted

then P2 will start and check the condition (R1==busy) it will be evaluated as false and P2 will be preempted

now again P1 will start execution and set R1=busy then preempted again

then P2 will start execution and set R1=busy which was already updated by P1 and now P2 will be preempted

after that P1 will start execution and same scenario happen again with both P1 and P2

both set R2=busy and enter into critical section together.

hence Mutual exclusion is not guaranteed.

b)

here deadlock is not possible, because atleast one process is able to proceed and enter into critical section.

c)

if Q1 and Q3 ; Q2 and Q4 will be interchanged then Mutual exclusion is guaranteed but deadlock is possible.

here, both process will not be able to enter critical section together.

for deadlock:

if P1 sets R1=busy and then preempted, and P2 sets R2=busy then preempted...

in this scenario no process can proceed further, as both holding the resource that is required by other to enter into CS.

hence deadlock will be there.

 5 votes

-- jayendra (6.6k points)

## 16.20.7 Resource Allocation: GATE2015-3\_52 top

<http://gateoverflow.in/8561>



Selected Answer

a deadlock will not occur if any one of the below four conditions are prevented :

**1> hold and wait**

**2> mutual exclusion**

**3> circular wait**

**4> no-preemption**

**now**

**option-1 if implemented violates 1 so deadlock cannot occur.**

**option-2 if implemented violates circular wait(making the dependency graph acyclic)**

**option-3 if implemented violates circular wait(making the dependency graph acyclic)**

**option-4 it is equivalent to the other options 2 and 3**

**so the correct option is 4 as all of them are methods to avoid deadlock.**

[http://www.cs.uic.edu/~jbell/CourseNotes/OperatingSystems/7\\_Deadlocks.html](http://www.cs.uic.edu/~jbell/CourseNotes/OperatingSystems/7_Deadlocks.html)

13 votes

-- Tamojit Chatterjee (1.9k points)

### 16.20.8 Resource Allocation: GATE2015-2\_23 [top](#)

<http://gateoverflow.in/8114>



Selected Answer

$$3 * 2 = 6$$

$$4 * 2 = 8.$$

I guess a question can't get easier than this- D choice. (Also, we can simply take the greatest value among choice for this question)

[There are 6 resources and all of them must be in use for deadlock. If the system has no other resource dependence, N=4 cannot lead to a deadlock. But if N=4, the system can be in deadlock in presence of other dependencies.

Why N=3 cannot cause deadlock? It can cause deadlock, only if the system is already in deadlock and so the deadlock is independent of the considered resource. Till N=3, all requests for considered resource will always be satisfied and hence there won't be a waiting and hence no deadlock with respect to the considered resource.]

7 votes

-- Arjun Suresh (150k points)

### 16.20.9 Resource Allocation: GATE2005-IT\_62 [top](#)

<http://gateoverflow.in/3823>



Selected Answer

The answer is (c)

If  $R_1$  and  $R_2$  are allocated to the Process  $P_1$ , then it will complete its job and release it. After that process  $P_2$  will get both the resources and complete its Job.

7 votes

-- zabiullah shiekh (163 points)

### 16.20.10 Resource Allocation: GATE1998\_1.32 [top](#)

<http://gateoverflow.in/1669>



Selected Answer

Each process needs 2 drives

Consider this scenario

**P1 P2 P3 P4 P5 P6**

1 1 1 1 1 1

This is scenario when a deadlock would happen, as each of the process is waiting for 1 more process to run to completion. And there are no more Resources available as max 6 reached. If we could have provided one more R to any of the process, any of the process could have executed to completion, then released its resources, which further when assigned to other and then other would have broken the deadlock situation.

In case of processes, if there are less than 6 processes, then no deadlock occurs.

Consider the maximum case of 5 processes.

P1 P2 P3 P4 P5

1 1 1 1 1

In this case system has 6 resources max, and hence we still have 1 more R left which can be given to any of the processes, which in turn runs to completion, releases its resources and in turn others can run to completion too.

**Ans b) 5**

👍 7 votes

-- Sourav Roy (2.7k points)

**16.20.11 Resource Allocation: GATE2004-IT\_63** top<http://gateoverflow.in/3706>

Selected Answer

**Answer is (A)**

When the process wakes up again after it has been killed once or twice IT WILL HAVE SAME TIME-STAMP as it had WHEN IT WAS KILLED FIRST TIME. And that time stamp can never be greater than a process that was killed after that or a NEW process that may have arrived.

So every time when the killed process wakes up it MIGHT ALWAYS find a new process that will say "your time stamp is less than me and I take this resource", which of course is as we know, and that process will again be killed.

This may happen indefinitely if processes keep coming and killing that "INNOCENT" process every time it try to access.

So **STARVATION is possible. Deadlock is not possible.**

👍 7 votes

-- Sandeep\_Uniyal (5.5k points)

**16.20.12 Resource Allocation: GATE2008-IT\_54** top<http://gateoverflow.in/3364>

Selected Answer

Answer: B

Starvation can occur as each time a process requests a resource it has to release all its resources. Now, maybe the process has not used the resources properly yet. This will happen again when the process requests another resource. So, the process starves for proper utilisation of resources.

Deadlock will not occur as it is similar to a deadlock prevention scheme.

👍 6 votes

-- Rajarshi Sarkar (29.7k points)

**16.20.13 Resource Allocation: GATE2014-1\_31** top<http://gateoverflow.in/1800>

Selected Answer

Option B

Request 1 if permitted does not lead to a safe state.

After allowing Req 1,

Allocated : Max : Requirement :

P0 0 0 3    8 4 3    8 4 0

P1 3 2 0    6 2 0    3 0 0

P2 2 1 1    3 3 3    1 2 2

Available : X=3 Y=2 Z=0

Now we can satisfy P1's requirement completely. So Available becomes : X=6, Y=4, Z=0.

Since Z is not available now, neither P0 nor P2's requirement can be satisfied. So its an unsafe state.

7 votes

-- Poulami Das (177 points)

**16.20.14 Resource Allocation: GATE2006\_66** <http://gateoverflow.in/1844>

Selected Answer

$$B. x_p + x_q \geq \min_{k \neq p,q} y_k$$

The question asks for "necessary" condition to guarantee no deadlock. i.e., without satisfying this condition "no deadlock" is not possible.

Both the processes  $p$  and  $q$  have no additional requirements and can be finished releasing  $x_p + x_q$  resources. Using this we can finish one more process only if condition B is satisfied.

PS: Condition B just ensures that the system can proceed from the current state. it does not guarantee that there won't be a deadlock before all processes are finished.

10 votes

-- Arjun Suresh (150k points)

**16.20.15 Resource Allocation: GATE2014-3\_31** <http://gateoverflow.in/2065>

Selected Answer

for this types of problems in which every process is making same number of request,use the formula  $n.(m-1)+1 \leq r$

where  $n$ =no. of processes

$m$ =resource request made by processes

$r$ =no. of resources

so above problem can be solved as  $3.(3-1)+1 \leq r$  i.e.  $7 \leq r$

min number of resource required are 7

8 votes

-- neha pawar (3.8k points)

**16.20.16 Resource Allocation: GATE2013\_16** <http://gateoverflow.in/1438>

Selected Answer

For deadlock-free invocation, X, Y and Z must access the semaphores in the same order so that there won't be a case where one process is waiting for a semaphore while holding some other semaphore. This is satisfied only by option B.

In option A, X can hold a and wait for c while Z can hold c and wait for a  
 In option C, X can hold b and wait for c, while Y can hold c and wait for b  
 In option D, X can hold a and wait for c while Z can hold c and wait for a

So, a deadlock is possible for all choices except B.

<http://www.eee.metu.edu.tr/~halici/courses/442/Ch5%20Deadlocks.pdf>

11 votes

-- Arjun Suresh (150k points)

**16.20.17 Resource Allocation: GATE2005\_71** <http://gateoverflow.in/1394>

Selected Answer

to ensure deadlock never happens allocate resource to each process in following manner..  
 allocation will be (max requirement -1) i.e.  $S_i - 1$  for each  $i$ .

now  $\sum(S_i - 1) + 1$  ( to prevent deadlock)  $\leq m$  ( available resources)

$$\sum S_i - \sum 1 + 1 \leq m$$

$$\sum S_i - n + 1 \leq m$$

$$\sum S_i + 1 \leq m + n$$

$$\sum S_i < m + n$$

17 votes

-- Digvijay (35.8k points)

### 16.20.18 Resource Allocation: GATE1997\_6.7 [top](#)

<http://gateoverflow.in/2263>



Selected Answer

Answer: C

(a) 1-1-1 allocation of resources can cause a deadlock.

(c) 2-1-1 is the general resource allocation which will never cause a deadlock as the process getting 2 resources will release its resources after its task is over.

7 votes

-- Rajarshi Sarkar (29.7k points)

### 16.20.19 Resource Allocation: GATE2009-30 [top](#)

<http://gateoverflow.in/1316>



Selected Answer

At  $t = 3$ , the process P1 has to wait because available R1=1, but P1 needs 2 R1. so P1 is blocked.

similarly, at various times what is happening can be analyzed with table below.

|          |     | R1(3) | R2(2) | R3(3) | R4(2) |
|----------|-----|-------|-------|-------|-------|
|          | t=0 | 3     | 0     | 1     | 1     |
|          | t=1 | 3     | 0     | 0     | 1     |
|          | t=2 | 1     | 0     | 0     | 0     |
| block P1 | t=3 | 1     | 0     | 0     | 0     |
|          | t=4 | 0     | 0     | 0     | 0     |
|          |     |       |       |       |       |
|          |     |       |       |       |       |

|       |      |   |   |   |   |
|-------|------|---|---|---|---|
| UB P1 | t=5  | 1 | 1 | 0 | 0 |
|       |      |   |   |   |   |
|       | t=6  | 1 | 1 | 1 | 0 |
|       |      |   |   |   |   |
|       | t=7  | 1 | 0 | 2 | 0 |
|       |      |   |   |   |   |
| B P1  | t=8  | 2 | 0 | 2 | 1 |
|       |      |   |   |   |   |
| UB P1 | t=9  | 2 | 1 | 3 | 0 |
|       |      |   |   |   |   |
|       | t=10 |   |   |   |   |

there are no process in deadlock, hence **A is right choice :)**

5 votes

-- Sachin Mittal (361 points)

## 16.20.20 Resource Allocation: GATE2010-46 [top](#)

<http://gateoverflow.in/2348>



Selected Answer

From the resource allocation logic, it's clear that even numbered processes are taking even numbered resources and all even numbered processes share no more than 1 resource. Now, if we make sure that all odd numbered processes take odd numbered resources without a cycle, then deadlock cannot occur. The "else" case of the resource allocation logic, is trying to do that. But, if n is odd,  $R_{n-i}$  and  $R_{n-i-2}$  will be even and there is possibility of deadlock, when two processes requests the same  $R_i$  and  $R_j$ . So, only B and D are the possible answers.

Now, in D, we can see that  $P_0$  requests  $R_0$  and  $R_2$ ,  $P_2$  requests  $R_2$  and  $R_4$ , so on until,  $P_{18}$  requests  $R_{18}$  and  $R_{20}$ . At the same time  $P_1$  requests  $R_{40}$  and  $R_{38}$ ,  $P_3$  requests  $R_{38}$  and  $R_{36}$ , so on until,  $P_{17}$  requests  $R_{24}$  and  $R_{22}$ . i.e.; there are no two processes requesting the same two resources and hence there can't be a cycle of dependencies which means, no deadlock is possible.

But for B,  $P_8$  requests  $R_8$  and  $R_{10}$  and  $P_{11}$  also requests  $R_{10}$  and  $R_8$ . Hence, a deadlock is possible. (Suppose  $P_8$  comes first and occupies  $R_8$ . Then  $P_{11}$  comes and occupies  $R_{10}$ . Now, if  $P_8$  requests  $R_{10}$  and  $P_{11}$  requests  $R_8$ , there will be deadlock)

34 votes

-- Arjun Suresh (150k points)

## 16.20.21 Resource Allocation: GATE1994\_28 [top](#)

<http://gateoverflow.in/2524>



Selected Answer

From the RAG we can make the necessary matrices.

Allocation

|    | R1 | R2 | R3 |
|----|----|----|----|
| P0 | 1  | 0  | 1  |

|    |   |   |   |
|----|---|---|---|
| P1 | 1 | 1 | 0 |
| P2 | 0 | 1 | 0 |
| P3 | 0 | 1 | 0 |

Future Need

|    | R1 | R2 | R3 |
|----|----|----|----|
| P0 | 0  | 1  | 1  |
| P1 | 1  | 0  | 0  |
| P2 | 0  | 0  | 1  |
| P3 | 1  | 2  | 0  |

Total=(2 3 2)

Allocated=(2 3 1)

Available=Total -Allocated

=(0 0 1)

P2 s need (0 0 1 ) can be met

And it releases its held resources after running to completion

A=(0 0 1)+(0 1 0)=(0 1 1)

P0 s need (0 1 1 ) can be met

and it releases

A=(0 1 1)+(1 0 1)=(1 1 2)

P1 needs can be met (1 0 0)

A=(1 1 2)+(1 0 0)=(2 1 2)

P3 s need can be met

so the safe sequence would be P2 P0 P1 P3.

6 votes

-- Sourav Roy (2.7k points)

## 16.20.22 Resource Allocation: GATE2007\_57 top

<http://gateoverflow.in/125>



Selected Answer

The answer is C.

Available Resources

| X | Y | Z |
|---|---|---|
| 0 | 1 | 2 |

Now, P1 will execute first, As it meets the needs.

After completion, The available resources are updated.

Updated Available Resources

| X | Y | Z |
|---|---|---|
| 2 | 1 | 3 |

Now P0 will complete the execution, as it meets the needs.

After completion of P0 the table is updated and then P2 completes the execution.

Thus P2 completes the execution in the last.

4 votes

-- Gate Keeda (17.7k points)

**16.20.23 Resource Allocation: GATE1996\_22** [top](#)<http://gateoverflow.in/2774>

Selected Answer

Allocation

|    | R0 | R1 | R2 |
|----|----|----|----|
| P0 | 1  | 0  | 2  |
| P1 | 0  | 3  | 1  |
| P2 | 1  | 0  | 2  |

MAX NEED

|    | R0 | R1 | R2 |
|----|----|----|----|
| P0 | 4  | 1  | 2  |
| P1 | 1  | 5  | 1  |
| P2 | 1  | 2  | 3  |

Future Need

|    | R0 | R1 | R2 |
|----|----|----|----|
| P0 | 3  | 1  | 0  |
| P1 | 1  | 2  | 0  |
| P2 | 0  | 2  | 1  |

$$\text{Available} = (2 \ 2 \ 0)$$

P1(1 2 0) s needs can be met. P1 executes and completes releases its allocated resources.

$$A = (2 \ 2 \ 0) + (0 \ 3 \ 1) = (2 \ 5 \ 1)$$

Further P2 (0 2 1) s needs can be met.

$$A = (2 \ 5 \ 1) + (1 \ 0 \ 2) = (3 \ 5 \ 3)$$

next P0 s needs can be met.

Thus safe sequence exists P1 P2 P0.

Next Request P0(0 1 0)

Allocation

|    | R0 | R1    | R2 |
|----|----|-------|----|
| P0 | 1  | 0+1=1 | 2  |
| P1 | 0  | 3     | 1  |
| P2 | 1  | 0     | 2  |

MAX NEED

|    | R0 | R1 | R2 |
|----|----|----|----|
| P0 | 4  | 1  | 2  |
| P1 | 1  | 5  | 1  |
| P2 | 1  | 2  | 3  |

Future Need

Future Need

|    | R0 | R1 | R2 |
|----|----|----|----|
| P0 | 3  | 0  | 0  |
| P1 | 1  | 2  | 0  |
| P2 | 0  | 2  | 1  |

$$\text{Available} = (2 \ 2 - 1 = 1 \ 0)$$

Here also not a single request need by any process can be made.

a) System is in safe state.

b) Since request of P0 can not be met, system would delay the request and wait till resources are available.

4 votes

-- Sourav Roy (2.7k points)

The system is in safe state and hence allowed by Banker's algorithm. P1 can now finish with the available resource and then P2's request can be satisfied and then P0's.

If P0 request one unit of R1, we cannot give it. That would make only 1 more R1 available and hence P1 cannot finish its execution with the remaining available R1. Also, P2 doesn't have enough R2 left and P0 doesn't have enough R0 left to complete their execution. So, system can go to dead state.

4 votes

-- Arjun Suresh (150k points)

## 16.20.24 Resource Allocation: GATE1993-7.9, UGCNET-Dec2012-III-41 [top](#)



Selected Answer

<http://gateoverflow.in/2297>

13 and 15.

Consider the worst scenario: all processes require one more instance of the resource. So, P1 would have got 2, P2 - 3 and P3 - 5. Now, if one more resource is available at least one of the processes could be finished and all resources allotted to it will be free which will lead to other processes also getting freed. So,  $2 + 3 + 5 = 10$  would be the maximum value of m so that a deadlock can occur.

14 votes

-- Arjun Suresh (150k points)

## 16.21

## Semaphore [top](#)

### 16.21.1 Semaphore: TIFR2012-B-10 [top](#)

<http://gateoverflow.in/25110>

Consider the blocked-set semaphore where the signaling process awakens any one of the suspended process; i.e.,

**Wait (S):** If  $S > 0$  then  $S \leftarrow S - 1$ , else suspend the execution of this process.

**Signal (S):** If there are processes that have been suspended on semaphore  $S$ , then wake any one of them, else  $S \leftarrow S + 1$

Consider the following solution of mutual exclusion problem using blocked-set semaphores.

```
s := 1;
cobegin
P(1) || P(2) || || P(N)
coend
```

Where the task body P(i) is

```
begin
while true do
begin
< non critical section >
Wait (S)
<critical section>
Signal (S)
end
end
```

Here  $N$  is the number of concurrent processors. Which of the following is true?

- The program fails to achieve mutual exclusion of critical regions.
- The program achieves mutual exclusion, but starvation freedom is ensured only for  $N \leq 2$
- The program does not ensure mutual exclusion if  $N \geq 3$
- The program achieves mutual exclusion, but allows starvation for any  $N \geq 2$
- The program achieves mutual exclusion and starvation freedom for any  $N \geq 1$

[tifr2012](#) [operating-system](#) [process-synchronization](#) [semaphore](#)

**Answer****16.21.2 Semaphore: GATE 2016-2-49** [top](#)<http://gateoverflow.in/39576>

Consider a non-negative counting semaphore  $S$ . The operation  $P(S)$  decrements  $S$ , and  $V(S)$  increments  $S$ . During an execution, 20  $P(S)$  operations and 12  $V(S)$  operations are issued in some order. The largest initial value of  $S$  for which at least one  $P(S)$  operation will remain blocked is \_\_\_\_\_

[gate2016-2](#) [operating-system](#) [semaphore](#) [normal](#) [numerical-answers](#)**Answer****16.21.3 Semaphore: GATE1998\_1.31** [top](#)<http://gateoverflow.in/1668>

A counting semaphore was initialized to 10. Then  $6P$  (wait) operations and  $4V$  (signal) operations were completed on this semaphore. The resulting value of the semaphore is

- A. 0
- B. 8
- C. 10
- D. 12

[gate1998](#) [operating-system](#) [process-synchronization](#) [semaphore](#) [easy](#)**Answer****16.21.4 Semaphore: GATE1992-02,x, ISRO2015-35** [top](#)<http://gateoverflow.in/564>

Choose the correct alternatives (more than one may be correct) and write the corresponding letters only:

At a particular time of computation the value of a counting semaphore is 7. Then

20

$P$  operations and

15

$V$  operations were completed on this semaphore. The resulting value of the semaphore is :

- A. 42
- B. 2
- C. 7
- D. 12

[gate1992](#) [operating-system](#) [semaphore](#) [easy](#) [isro2015](#)**Answer****16.21.5 Semaphore: GATE2008-63** [top](#)<http://gateoverflow.in/486>

The P and V operations on counting semaphores, where  $s$  is a counting semaphore, are defined as follows:

$P(s) :$   $s = s - 1;$   
           If  $s < 0$  then wait;

$V(s) :$   $s = s + 1;$   
           If  $s \leq 0$  then wake up process waiting on  $s$ ;

Assume that  $P_b$  and  $V_b$  the wait and signal operations on binary semaphores are provided. Two binary semaphores  $x_b$  and

$y_b$  are used to implement the semaphore operations  $P(s)$  and  $V(s)$  as follows:

$P(s) : P_b(x_b); s = s - 1; \text{ if } (s < 0) \{ V_b(y_b); P_b(y_b); \} \text{ else } V_b(x_b);$

$V(s) : P_b(x_b); s = s + 1; \text{ if } (s <= 0) V_b(y_b); V_b(x_b);$

The initial values of  $x_b$  and  $y_b$  are respectively

- A. 0 and 0
- B. 0 and 1
- C. 1 and 0
- D. 1 and 1

gate2008 operating-system normal semaphore

Answer

## 16.21.6 Semaphore: GATE2006-IT-57 top

<http://gateoverflow.in/3601>

The wait and signal operations of a monitor are implemented using semaphores as follows. In the following,

- $x$  is a condition variable,
- $mutex$  is a semaphore initialized to 1,
- $x\_sem$  is a semaphore initialized to 0,
- $x\_count$  is the number of processes waiting on semaphore  $x\_sem$ , initially 0,
- $next$  is a semaphore initialized to 0,
- $next\_count$  is the number of processes waiting on semaphore  $next$ , initially 0.

The body of each procedure that is visible outside the monitor is replaced with the following:

```
P(mutex);
...
body of procedure
...
if (next_count > 0)
 V(next);
else
 V(mutex);
```

Each occurrence of  $x.wait$  is replaced with the following:

```
x_count = x_count + 1;
if (next_count > 0)
 V(next);
else
 V(mutex);
----- E1;
x_count = x_count - 1;
```

Each occurrence of  $x.signal$  is replaced with the following:

```
if (x_count > 0)
{
 next_count = next_count + 1;
 ----- E2;
 P(next);
 next_count = next_count - 1;
}
```

For correct implementation of the monitor, statements E1 and E2 are, respectively,

- A.  $P(x\_sem), V(next)$
- B.  $V(next), P(x\_sem)$
- C.  $P(next), V(x\_sem)$
- D.  $P(x\_sem), V(x\_sem)$

gate2006-it operating-system process-synchronization semaphore normal

Answer

## Answers: Semaphore

### 16.21.1 Semaphore: TIFR2012-B-10 [top](#)

<http://gateoverflow.in/2510>

I think answer would be option D  
since at one time only one process can enter the critical section.  
If P1 keep on entering the critical section P2 never get the chance to enter the critical section so starvation can occur for any  $n > 2$

1 2 votes

-- Uman Raman (11.3k points)

### 16.21.2 Semaphore: GATE 2016-2-49 [top](#)

<http://gateoverflow.in/3956>



Selected Answer

Ans : (7). Take any sequence of 20P and 12V operations, atleast one process will always remain blocked.

1 9 votes

-- Ashish Deshmukh (1.4k points)

### 16.21.3 Semaphore: GATE1998\_1.31 [top](#)

<http://gateoverflow.in/1668>



Selected Answer

answer is option (b)

Initially semaphore is 10 , then 6 down operations are performed means ( $10-6=4$ ) and 4 up operations means ( $4+4=8$ )  
so , at last option(b) 8 is correct.

1 7 votes

-- Kalpana Bhargav (3k points)

### 16.21.4 Semaphore: GATE1992-02,x, ISRO2015-35 [top](#)

<http://gateoverflow.in/564>



Selected Answer

Ans=option B

currently semaphore is 7 so after 20 P(wait) operation it will come to -12 then for 15 V(signal) operation the value comes to 2.

1 11 votes

-- sanjeev\_zerocode (253 points)

### 16.21.5 Semaphore: GATE2008-63 [top](#)

<http://gateoverflow.in/486>



Selected Answer

Answer is (C) .

Reasoning :-

First let me explain what is counting semaphore & How it works. Counting semaphore gives count, i.e. no of processes that can be in Critical section at same time. Here value of S denotes that count. So suppose S = 3, we need to be able to have 3 processes in Critical section at max. Also when counting semaphore S has negative value we need to have Absolute value of S as no of processes waiting for critical section.

A & B are out of option, because Xb must be 1, otherwise our counting semaphore will get blocked without doing

anything. Now consider options C & D.

Option D :-

$Y_b = 1, X_b = 1$

Assume that initial value of  $S = 2$ . (At max 2 processes must be in Critical Section.)

We have 4 processes,  $P_1, P_2, P_3$  &  $P_4$ .

$P_1$  enters critical section , It calls  $P(s)$  ,  $S = S - 1 = 1$ . As  $S > 1$ , we do not call  $P_b(Y_b)$ .

$P_2$  enters critical section , It calls  $P(s)$  ,  $S = S - 1 = 0$ . As  $S > 0$  we do not call  $P_b(Y_b)$ .

Now  $P_3$  comes, it should be blocked but when it calls  $P(s)$  ,  $S = S - 1 = 0-1 = -1$  As  $S < 0$  ,Now we do call  $P_b(Y_b)$ . Still  $P_3$  enters into critical section & We do not get blocked as  $Y_b$ 's Initial value was 1.

This violates property of counting semaphore.  $S$  is now  $-1$ , & No process is waiting. Also we are allowing 1 more process than what counting semaphore permits.

If  $Y_b$  would have been 0,  $P_3$  would have been blocked here & So Answer is (C).

15 votes

-- Akash (31.7k points)

## 16.21.6 Semaphore: GATE2006-IT-57 [top](#)

<http://gateoverflow.in/3601>

I'm getting option B as the answer. Is it correct..?

@ Ishrat Jahan plz atleast tell which is the correct option.

1 votes

-- GateMaster Prime (1.3k points)

- $x\_count$  is the number of processes waiting on semaphore  $x\_sem$ , initially 0,  
 $x\_count$  is incremented and decremented in  $x.wait$ , which shows that in between them  $wait(x\_sem)$  must happen which is  $P(x\_sem)$ . Correspondingly  $V(x\_sem)$  must happen in  $x.signal$ . So, D choice.

What is a [monitor](#)?

1 votes

-- Arjun Suresh (150k points)

## 16.22

## Threads [top](#)

### 16.22.1 Threads: GATE2014-1\_20 [top](#)

<http://gateoverflow.in/1787>

Which one of the following is **FALSE**?

- (A) User level threads are not scheduled by the kernel.
- (B) When a user level thread is blocked, all other threads of its process are blocked.
- (C) Context switching between user level threads is faster than context switching between kernel level threads.
- (D) Kernel level threads cannot share the code segment.

[gate2014-1](#) [operating-system](#) [threads](#) [normal](#)

Answer

**16.22.2 Threads: GATE2007\_17** [top](#)<http://gateoverflow.in/1215>

Consider the following statements about user level threads and kernel level threads. Which one of the following statements is FALSE?

- A. Context switch time is longer for kernel level threads than for user level threads.
- B. User level threads do not need any hardware support.
- C. Related kernel level threads can be scheduled on different processors in a multi-processor system.
- D. Blocking one kernel level thread blocks all related threads.

[gate2007](#) [operating-system](#) [threads](#) [normal](#)
**Answer****16.22.3 Threads: GATE2011-16, UGCNET-June2013-III-65** [top](#)<http://gateoverflow.in/2118>

A thread is usually defined as a light weight process because an Operating System (OS) maintains smaller data structure for a thread than for a process. In relation to this, which of the following statement is correct?

- A. OS maintains only scheduling and accounting information for each thread
- B. OS maintains only CPU registers for each thread
- C. OS does not maintain a separate stack for each thread
- D. OS does not maintain virtual memory state for each thread

[gate2011](#) [operating-system](#) [threads](#) [normal](#) [ugcnetjune2013iii](#)
**Answer****16.22.4 Threads: GATE2004\_11** [top](#)<http://gateoverflow.in/1008>

Consider the following statements with respect to user-level threads and kernel-supported threads

- I. context switch is faster with kernel-supported threads
- II. for user-level threads, a system call can block the entire process
- III. Kernel supported threads can be scheduled independently
- IV. User level threads are transparent to the kernel

Which of the above statements are true?

- A. (II), (III) and (IV) only
- B. (II) and (III) only
- C. (I) and (III) only
- D. (I) and (II) only

[gate2004](#) [operating-system](#) [threads](#) [normal](#)
**Answer****Answers: Threads****16.22.1 Threads: GATE2014-1\_20** [top](#)<http://gateoverflow.in/1787>

Selected Answer

(D) is the answer. Threads can share the Code segments. They have only separate Registers and stack.

User level threads are scheduled by the thread library and kernel knows nothing about it. So, A is TRUE.

When a user level thread is blocked, all other threads of its process are blocked. So, B is TRUE. (With a multi-threaded kernel, user level threads can make non-blocking system calls without getting blocked. But in this option, it is explicitly said 'a thread is blocked'.)

Context switching between user level threads is faster as they actually have no context-switch- nothing is saved and restored while for kernel level thread, Registers, PC and SP must be saved and restored. So, C also TRUE.

Ref: [http://www.cs.cornell.edu/courses/cs4410/2008fa/homework/hw1\\_soln.pdf](http://www.cs.cornell.edu/courses/cs4410/2008fa/homework/hw1_soln.pdf)

 9 votes

-- Sandeep\_Uniyal (5.5k points)

## 16.22.2 Threads: GATE2007\_17 [top](#)

<http://gateoverflow.in/1215>



Selected Answer

Ans -> D

1. Context switch time is longer for kernel level threads than for user level threads. -> This is True, as Kernel level threads are managed by OS and Kernel maintains lot of data structures. There are many overheads involved in Kernel level thread management, which are not present in User level thread management !
2. User level threads do not need any hardware support.-> This is true, as User level threads are implemented by Libraries programmably, Kernel does not sees them.
3. Related kernel level threads can be scheduled on different processors in a multi-processor system.-> This is true.
4. Blocking one kernel level thread blocks all related threads. -> This is false. If it had been user Level threads this would have been true, (In One to one, or many to one model !) Kernel level threads are independent.
- 5.

 6 votes

-- Akash (31.7k points)

## 16.22.3 Threads: GATE2011-16, UGCNET-June2013-III-65 [top](#)

<http://gateoverflow.in/2118>



Selected Answer

Answer to this question is (C).

Many of you would not agree at first So here I explain it how.

OS , on per thread basis, maintains ONLY TWO things : CPU Register state and Stack space. It does not maintain anything else for individual thread. Code segment and Global variables are shared. Even TLB and Page Tables are also shared since they belong to same process.

- (A) option (A) would have been correct if 'ONLY' word were not there. It NOT only maintains register state BUT stack space also.
- (B) option B is obviously FALSE
- (C) C is TRUE as it says that OS does not maintain VIRTUAL Memory state for individual thread which isTRUE
- (D) This is also FALSE.

 18 votes

-- Sandeep\_Uniyal (5.5k points)

## 16.22.4 Threads: GATE2004\_11 [top](#)

<http://gateoverflow.in/1008>



Selected Answer

Answer A

I) User level thread switching is faster than kernel level switching. SO I is false.

II) & III) is true.

IV) User level threads are transparent to the kernel

This is little confusing .if you search define transparent on google, you get definations like " (of a material or article) allowing light to pass through so that objects behind can be distinctly seen."->"transparent blue water"" , "

easy to perceive or detect."->"the residents will see through any transparent attempt to buy their votes"

This makes it all confusing .Though if go & check more definition

Computing

(of a process or interface) functioning without the user being aware of its presence. So in case of Computing transparent means functioning without being aware. In our case user level threads are functioning without kernel being aware about them. So IV is actually correct. (Even though other definition of transparent disagree to it !)

11 votes

-- Akash (31.7k points)

User level threads can switch almost as fast as a procedure call. Kernel supported threads switch much slower. So, I is false.

II, III and IV are TRUE. So A.

"The kernel knows nothing about user-level threads and manages them as if they were single-threaded processes"

Ref: <http://stackoverflow.com/questions/15983872/difference-between-user-level-and-kernel-supported-threads>

11 votes

-- Arjun Suresh (150k points)

16.23

## User Modes top

### 16.23.1 User Modes: GATE2005-IT-19, UGCNET-June2012-III-57 top

<http://gateoverflow.in/3764>

A user level process in Unix traps the signal sent on a Ctrl-C input, and has a signal handling routine that saves appropriate files before terminating the process. When a Ctrl-C input is given to this process, what is the mode in which the signal handling routine executes?

- A. User mode
- B. Kernel mode
- C. Superuser mode
- D. Privileged mode

[gate2005-it](#) [operating-system](#) [user-modes](#) [normal](#) [ugcnetjune2012iii](#)

Answer

## Answers: User Modes

### 16.23.1 User Modes: GATE2005-IT-19, UGCNET-June2012-III-57 top

<http://gateoverflow.in/3764>

Answer: A

1 votes

-- Rajarshi Sarkar (29.7k points)

<http://computernetsolved.blogspot.in/2015/05/q57paper-3-j-12-user-level-process-in.html>

1 votes

-- resilientknight (1.2k points)

**16.24****Virtual Memory** [top](#)**16.24.1 Virtual Memory: GATE2002\_19** [top](#)<http://gateoverflow.in/872>

A computer uses 32-bit virtual address, and 32-bit physical address. The physical memory is byte addressable, and the page size is 4 kbytes. It is decided to use two level page tables to translate from virtual address to physical address. Equal number of bits should be used for indexing first level and second level page table, and the size of each table entry is 4 bytes.

- Give a diagram showing how a virtual address would be translated to a physical address.
- What is the number of page table entries that can be contained in each page?
- How many bits are available for storing protection and other information in each page table entry?

[gate2002](#) [operating-system](#) [virtual-memory](#) [normal](#)
**Answer****16.24.2 Virtual Memory: GATE1999\_2.11** [top](#)<http://gateoverflow.in/1489>

Which of the following is/are advantage(s) of virtual memory?

- Faster access to memory on an average.
- Processes can be given protected address spaces.
- Linker can assign addresses independent of where the program will be loaded in physical memory.
- Program larger than the physical memory size can be run.

[gate1999](#) [operating-system](#) [virtual-memory](#) [easy](#)
**Answer****16.24.3 Virtual Memory: GATE2014-3\_33** [top](#)<http://gateoverflow.in/2067>

Consider a paging hardware with a TLB. Assume that the entire page table and all the pages are in the physical memory. It takes 10 milliseconds to search the TLB and 80 milliseconds to access the physical memory. If the TLB hit ratio is 0.6, the effective memory access time (in milliseconds) is \_\_\_\_\_.

[gate2014-3](#) [operating-system](#) [virtual-memory](#) [numerical-answers](#) [normal](#)
**Answer****16.24.4 Virtual Memory: GATE 2016-1-47** [top](#)<http://gateoverflow.in/39690>

Consider a computer system with 40-bit virtual addressing and page size of sixteen kilobytes. If the computer system has a one-level page table per process and each page table entry requires 48 bits, then the size of the per-process page table is \_\_\_\_\_ megabytes.

[gate2016-1](#) [operating-system](#) [virtual-memory](#) [easy](#) [numerical-answers](#)
**Answer****16.24.5 Virtual Memory: GATE2015-2\_25** [top](#)<http://gateoverflow.in/8120>

A computer system implements a 40-bit virtual address, page size of 8 kilobytes, and a 128-entry translation look-aside buffer (TLB) organized into 32 sets each having 4 ways. Assume that the TLB tag does not store any process id. The minimum length of the TLB tag in bits is \_\_\_\_\_.

[gate2015-2](#) [operating-system](#) [virtual-memory](#) [easy](#)
**Answer****16.24.6 Virtual Memory: GATE2008-67** [top](#)<http://gateoverflow.in/490>

A processor uses 36 bit physical address and 32 bit virtual addresses, with a page frame size of 4 Kbytes. Each page table entry is of size 4 bytes. A three level page table is used for virtual to physical address translation, where the virtual address is used as follows:

- Bits 30-31 are used to index into the first level page table.
- Bits 21-29 are used to index into the 2nd level page table.
- Bits 12-20 are used to index into the 3rd level page table.
- Bits 0-11 are used as offset within the page.

The number of bits required for addressing the next level page table(or page frame) in the page table entry of the first, second and third level page tables are respectively

- A. 20,20,20
- B. 24,24,24
- C. 24,24,20
- D. 25,25,24

[gate2008](#) [operating-system](#) [virtual-memory](#) [normal](#)

[Answer](#)

### 16.24.7 Virtual Memory: GATE1999\_19 [top](#)

<http://gateoverflow.in/1518>

A certain computer system has the segmented paging architecture for virtual memory. The memory is byte addressable. Both virtual and physical address spaces contain  $2^{16}$  bytes each. The virtual address space is divided into 8 non-overlapping equal size segments. The memory management unit (MMU) has a hardware segment table, each entry of which contains the physical address of the page table for the segment. Page tables are stored in the main memory and consists of 2 byte page table entries.

- a. What is the minimum page size in bytes so that the page table for a segment requires at most one page to store it? Assume that the page size can only be a power of 2.
- b. Now suppose that the pages size is 512 bytes. It is proposed to provide a TLB (Transaction look-aside buffer) for speeding up address translation. The proposed TLB will be capable of storing page table entries for 16 recently referenced virtual pages, in a fast cache that will use the direct mapping scheme. What is the number of tag bits that will need to be associated with each cache entry?
- c. Assume that each page table entry contains (besides other information) 1 valid bit, 3 bits for page protection and 1 dirty bit. How many bits are available in page table entry for storing the aging information for the page? Assume that the page size is 512 bytes.

[gate1999](#) [operating-system](#) [virtual-memory](#) [normal](#)

[Answer](#)

### 16.24.8 Virtual Memory: GATE2013-53 [top](#)

<http://gateoverflow.in/43294>

A computer uses 46-bit virtual address, 32-bit physical address, and a three-level paged page table organization. The page table base register stores the base address of the first-level table (T1), which occupies exactly one page. Each entry of T1 stores the base address of a page of the second-level table (T2). Each entry of T2 stores the base address of a page of the third-level table (T3). Each entry of T3 stores a page table entry (PTE). The PTE is 32 bits in size. The processor used in the computer has a 1 MB 16 way set associative virtually indexed physically tagged cache. The cache block size is 64 bytes.

What is the minimum number of page colours needed to guarantee that no two synonyms map to different sets in the processor cache of this computer?

- A. 2
- B. 4
- C. 8
- D. 16

[gate2013](#) [normal](#) [operating-system](#) [virtual-memory](#)

[Answer](#)

### 16.24.9 Virtual Memory: Gate2006-62, ISRO2016-50 [top](#)

<http://gateoverflow.in/1840>

A CPU generates 32-bit virtual addresses. The page size is 4 KB. The processor has a translation look-aside buffer (TLB) which can hold a total of 128 page table entries and is 4-way set associative. The minimum size of the TLB tag is:

- A. 11 bits
- B. 13 bits
- C. 15 bits
- D. 20 bits

[gate2006](#) [operating-system](#) [virtual-memory](#) [normal](#) [isro2016](#)

[Answer](#)

### 16.24.10 Virtual Memory: GATE2004-IT\_66 [top](#)

<http://gateoverflow.in/3709>

In a virtual memory system, size of virtual address is 32-bit, size of physical address is 30-bit, page size is 4 Kbyte and size of each page table entry is 32-bit. The main memory is byte addressable. Which one of the following is the maximum number of bits that can be used for storing protection and other information in each page table entry?

- |    |    |
|----|----|
| A) | 2  |
| B) | 10 |
| C) | 12 |
| D) | 14 |

[gate2004-it](#) [operating-system](#) [virtual-memory](#) [normal](#)

[Answer](#)

### 16.24.11 Virtual Memory: GATE2003-79 [top](#)

<http://gateoverflow.in/43578>

A processor uses 2-level page tables for virtual to physical address translation. Page tables for both levels are stored in the main memory. Virtual and physical addresses are both 32 bits wide. The memory is byte addressable. For virtual to physical address translation, the 10 most significant bits of the virtual address are used as index into the first level page table while the next 10 bits are used as index into the second level page table. The 12 least significant bits of the virtual address are used as offset within the page. Assume that the page table entries in both levels of page tables are 4 bytes wide. Further, the processor has a translation look-aside buffer (TLB), with a hit rate of 96%. The TLB caches recently used virtual page numbers and the corresponding physical page numbers. The processor also has a physically addressed cache with a hit rate of 90%. Main memory access time is 10 ns, cache access time is 1 ns, and TLB access time is also 1 ns.

Suppose a process has only the following pages in its virtual address space: two contiguous code pages starting at virtual address 0x00000000, two contiguous data pages starting at virtual address 0x00400000, and a stack page starting at virtual address 0xFFFFF000. The amount of memory required for storing the page tables of this process is

- A. 8 KB
- B. 12 KB
- C. 16 KB
- D. 20 KB

[gate2003](#) [operating-system](#) [normal](#) [virtual-memory](#)

[Answer](#)

### 16.24.12 Virtual Memory: GATE2006-63, UGCNET-June2012-III-45 [top](#)

<http://gateoverflow.in/1841>

A computer system supports 32-bit virtual addresses as well as 32-bit physical addresses. Since the virtual address space is of the same size as the physical address space, the operating system designers decide to get rid of the virtual memory entirely. Which one of the following is true?

- A. Efficient implementation of multi-user support is no longer possible
- B. The processor cache organization can be made more efficient now
- C. Hardware support for memory management is no longer needed
- D. CPU scheduling can be made more efficient now

[gate2006](#) [operating-system](#) [virtual-memory](#) [normal](#) [ugcnetjune2012iii](#)

[Answer](#)

### 16.24.13 Virtual Memory: GATE2013-52 [top](#)

<http://gateoverflow.in/379>

A computer uses 46-bit virtual address, 32-bit physical address, and a three-level paged page table organization. The page table base register stores the base address of the first-level table (T1), which occupies exactly one page. Each entry of T1 stores the base address of a page of the second-level table (T2). Each entry of T2 stores the base address of a page of the third-level table (T3). Each entry of T3 stores a page table entry (PTE). The PTE is 32 bits in size. The processor used in the computer has a 1 MB 16 way set associative virtually indexed physically tagged cache. The cache block size is 64 bytes.

What is the size of a page in KB in this computer?

- A. 2
- B. 4
- C. 8
- D. 16

[gate2013](#) [operating-system](#) [virtual-memory](#) [normal](#)

[Answer](#)

### 16.24.14 Virtual Memory: GATE2011-20, UGCNET-June2013-II-48 [top](#)

<http://gateoverflow.in/2122>

Let the page fault service time be 10 milliseconds(ms) in a computer with average memory access time being 20 nanoseconds (ns). If one page fault is generated every  $10^6$  memory accesses, what is the effective access time for memory?

- A. 21 ns
- B. 23 ns
- C. 30 ns
- D. 35 ns

[gate2011](#) [operating-system](#) [virtual-memory](#) [normal](#) [ugcnetjune2013ii](#)

[Answer](#)

### 16.24.15 Virtual Memory: GATE2001-1.21 [top](#)

<http://gateoverflow.in/714>

Consider a virtual memory system with FIFO page replacement policy. For an arbitrary page access pattern, increasing the number of page frames in main memory will

- A. always decrease the number of page faults
- B. always increase the number of page faults
- C. sometimes increase the number of page faults
- D. never affect the number of page faults

[gate2001](#) [operating-system](#) [virtual-memory](#) [normal](#)

[Answer](#)

### 16.24.16 Virtual Memory: GATE2015-1\_12 [top](#)

<http://gateoverflow.in/8186>

Consider a system with byte-addressable memory, 32-bit logical addresses, 4 kilobyte page size and page table entries of 4 bytes each. The size of the page table in the system in megabytes is\_\_\_\_\_.

[gate2015-1](#) [operating-system](#) [virtual-memory](#) [easy](#)

[Answer](#)

### 16.24.17 Virtual Memory: GATE2015-2\_47 [top](#)

<http://gateoverflow.in/8247>

A computer system implements 8 kilobyte pages and a 32-bit physical address space. Each page table entry contains a valid bit, a dirty bit, three permission bits, and the translation. If the maximum size of the page table of a process is 24 megabytes, the length of the virtual address supported by the system is \_\_\_\_\_ bits.

[gate2015-2](#) [operating-system](#) [virtual-memory](#) [normal](#)

[Answer](#)

### 16.24.18 Virtual Memory: GATE2008-IT\_56 [top](#)

<http://gateoverflow.in/3366>

Match the following flag bits used in the context of virtual memory management on the left side with the different purposes on the right side of the table below.

| Name of the bit |           | Purpose |                         |
|-----------------|-----------|---------|-------------------------|
| I.              | Dirty     | a.      | Page initialization     |
| II.             | R/W       | b.      | Write-back policy       |
| III.            | Reference | c.      | Page protection         |
| IV.             | Valid     | d.      | Page replacement policy |

- A) I-d, II-a, III-b, IV-c
- B) I-b, II-c, III-a, IV-d
- C) I-c, II-d, III-a, IV-b
- D) I-b, II-c, III-d, IV-a

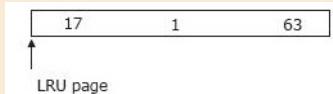
gate2008-it operating-system virtual-memory easy

Answer

### 16.24.19 Virtual Memory: GATE1996\_7 [top](#)

<http://gateoverflow.in/2759>

A demand paged virtual memory system uses 16 bit virtual address, page size of 256 bytes, and has 1 Kbyte of main memory. LRU page replacement is implemented using list, whose current status (page number is decimal) is



For each hexadecimal address in the address sequence given below,

00FF, 010D, 10FF, 11B0

indicate

- i. the new status of the list
- ii. page faults, if any, and
- iii. page replacements, if any.

gate1996 operating-system virtual-memory normal

Answer

### 16.24.20 Virtual Memory: GATE2001-1.8 [top](#)

<http://gateoverflow.in/701>

Which of the following statements is false?

- A. Virtual memory implements the translation of a program's address space into physical memory address space
- B. Virtual memory allows each program to exceed the size of the primary memory
- C. Virtual memory increases the degree of multiprogramming
- D. Virtual memory reduces the context switching overhead

gate2001 operating-system virtual-memory normal

Answer

### 16.24.21 Virtual Memory: GATE1995\_2.16 [top](#)

<http://gateoverflow.in/2628>

In a virtual memory system the address space specified by the address lines of the CUP must be \_\_\_\_\_ than the physical memory size and \_\_\_\_\_ than the secondary storage size.

- A. smaller, smaller

- B. smaller, larger  
 C. larger, smaller  
 D. larger, larger

[gate1995](#) [operating-system](#) [virtual-memory](#) [normal](#)

[Answer](#)

### 16.24.22 Virtual Memory: GATE1995\_1.7 [top](#)

<http://gateoverflow.in/2594>

In a paged segmented scheme of memory management, the segment table itself must have a page table because

- A. The segment table is often too large to fit in one page
- B. Each segment is spread over a number of pages
- C. Segment tables point to page tables and not to the physical locations of the segment
- D. The processor's description base register points to a page table

[gate1995](#) [operating-system](#) [virtual-memory](#) [normal](#)

[Answer](#)

### 16.24.23 Virtual Memory: GATE2001-2.21 [top](#)

<http://gateoverflow.in/739>

Consider a machine with 64 MB physical memory and a 32-bit virtual address space. If the page size is 4KB, what is the approximate size of the page table?

- A. 16 MB
- B. 8 MB
- C. 2 MB
- D. 24 MB

[gate2001](#) [operating-system](#) [virtual-memory](#) [normal](#)

[Answer](#)

### 16.24.24 Virtual Memory: GATE2003-78 [top](#)

<http://gateoverflow.in/788>

A processor uses 2-level page tables for virtual to physical address translation. Page tables for both levels are stored in the main memory. Virtual and physical addresses are both 32 bits wide. The memory is byte addressable. For virtual to physical address translation, the 10 most significant bits of the virtual address are used as index into the first level page table while the next 10 bits are used as index into the second level page table. The 12 least significant bits of the virtual address are used as offset within the page. Assume that the page table entries in both levels of page tables are 4 bytes wide. Further, the processor has a translation look-aside buffer (TLB), with a hit rate of 96%. The TLB caches recently used virtual page numbers and the corresponding physical page numbers. The processor also has a physically addressed cache with a hit rate of 90%. Main memory access time is 10 ns, cache access time is 1 ns, and TLB access time is also 1 ns.

Assuming that no page faults occur, the average time taken to access a virtual address is approximately (to the nearest 0.5 ns)

- A. 1.5 ns
- B. 2 ns
- C. 3 ns
- D. 4 ns

[gate2003](#) [operating-system](#) [normal](#) [virtual-memory](#)

[Answer](#)

### 16.24.25 Virtual Memory: GATE2009-9, ISRO2016-52 [top](#)

<http://gateoverflow.in/1301>

In which one of the following page replacement policies, Belady's anomaly may occur?

- A. FIFO  
 B. Optimal  
 C. LRU  
 D. MRU

[gate2009](#) [operating-system](#) [virtual-memory](#) [normal](#) [isro2016](#)

[Answer](#)

### 16.24.26 Virtual Memory: GATE2009-10 [top](#)

<http://gateoverflow.in/1302>

The essential content(s) in each entry of a page table is / are

- A. Virtual page number  
 B. Page frame number  
 C. Both virtual page number and page frame number  
 D. Access right information

[gate2009](#) [operating-system](#) [virtual-memory](#) [easy](#)

[Answer](#)

### 16.24.27 Virtual Memory: GATE2003\_26 [top](#)

<http://gateoverflow.in/916>

In a system with 32 bit virtual addresses and 1 KB page size, use of one-level page tables for virtual to physical address translation is not practical because of

- A. the large amount of internal fragmentation  
 B. the large amount of external fragmentation  
 C. the large memory overhead in maintaining page tables  
 D. the large computation overhead in the translation process

[gate2003](#) [operating-system](#) [virtual-memory](#) [normal](#)

[Answer](#)

### 16.24.28 Virtual Memory: GATE1991\_03,xi [top](#)

<http://gateoverflow.in/525>

Choose the correct alternatives (more than one can be correct) and write the corresponding letters only:

Indicate all the false statements from the statements given below:

- (a). The amount of virtual memory available is limited by the availability of the secondary memory  
 (b). Any implementation of a critical section requires the use of an indivisible machine- instruction ,such as test-and-set.  
 (c). The use of monitors ensure that no dead-locks will be caused .  
 (d). The LRU page-replacement policy may cause thrashing for some type of programs.  
 (e). The best fit techniques for memory allocation ensures that memory will never be fragmented.

[gate1991](#) [operating-system](#) [virtual-memory](#) [normal](#)

[Answer](#)

### 16.24.29 Virtual Memory: GATE2009-34 [top](#)

<http://gateoverflow.in/1320>

A multilevel page table is preferred in comparison to a single level page table for translating virtual address to physical address because

- A. It reduces the memory access time to read or write a memory location.
- B. It helps to reduce the size of page table needed to implement the virtual address space of a process
- C. It is required by the translation lookaside buffer.
- D. It helps to reduce the number of page faults in page replacement algorithms.

[gate2009](#) [operating-system](#) [virtual-memory](#) [easy](#)

[Answer](#)

### 16.24.30 Virtual Memory: GATE2008-IT\_41 [top](#)

<http://gateoverflow.in/3351>

Assume that a main memory with only 4 pages, each of 16 bytes, is initially empty. The CPU generates the following sequence of virtual addresses and uses the Least Recently Used (LRU) page replacement policy.

0, 4, 8, 20, 24, 36, 44, 12, 68, 72, 80, 84, 28, 32, 88, 92

How many page faults does this sequence cause? What are the page numbers of the pages present in the main memory at the end of the sequence?

- A) 6 and 1, 2, 3, 4
- B) 7 and 1, 2, 4, 5
- C) 8 and 1, 2, 4, 5
- D) 9 and 1, 2, 3, 5

[gate2008-it](#) [operating-system](#) [virtual-memory](#) [normal](#)

[Answer](#)

### 16.24.31 Virtual Memory: GATE2008-IT\_16 [top](#)

<http://gateoverflow.in/3276>

A paging scheme uses a Translation Look-aside Buffer (TLB). A TLB-access takes 10 ns and a main memory access takes 50 ns. What is the effective access time(in ns) if the TLB hit ratio is 90% and there is no page-fault?

- A) 54
- B) 60
- C) 65
- D) 75

[gate2008-it](#) [operating-system](#) [virtual-memory](#) [normal](#)

[Answer](#)

## Answers: Virtual Memory

### 16.24.1 Virtual Memory: GATE2002\_19 [top](#)

<http://gateoverflow.in/872>

B) Since page size is 4KB. And one page entry size is 4B So no of entries in 1 page=1K C) Since each page entry size =4B=32bits And since physical address is of 32bits And frame offset=page offset=12 bits So frame no bits will be=32-12=20 So bits for other purpose=page entry size-frame no bits=32-20=12 bits

5 votes

-- [SONU](#) (1.5k points)

### 16.24.2 Virtual Memory: GATE1999\_2.11 [top](#)

<http://gateoverflow.in/1489>



Selected Answer

Virtual memory provides an interface through which processes access the physical memory. So,

- (a) Is false as direct access can never be slower.
- (b) Is true as without virtual memory it is difficult to give protected address space to processes as they will be accessing physical memory directly. No protection mechanism can be done inside the physical memory as processes are dynamic and number of processes changes from time to time.
- (c) Position independent can be produced even without virtual memory support.
- (d) This is one primary use of virtual memory. Virtual memory allows a process to run using a virtual address space and as and when memory space is required, pages are swapped in/out from the disk if physical memory gets full.

So, answer is b and d.

12 votes

-- Arjun Suresh (150k points)

### 16.24.3 Virtual Memory: GATE2014-3\_33 [top](#)

<http://gateoverflow.in/2067>



Selected Answer

$$\begin{aligned} EMAT &= TLB \text{ hit} * (\text{TLB access time} + \text{memory access time}) + TLB \text{ miss} (\text{TLB access time} + \text{page table access time} + \text{memory access time}) \\ &= 0.6(10+80) + 0.4(10+80+80) \\ &= 54 + 68 \\ &= 122 \text{ msec} \end{aligned}$$

11 votes

-- neha pawar (3.8k points)

### 16.24.4 Virtual Memory: GATE 2016-1-47 [top](#)

<http://gateoverflow.in/39690>



Selected Answer

$$384 \text{ MB } (2^{20} \cdot 2^6 \cdot 6 \text{ bytes})$$

15 votes

-- Bharani Viswas (733 points)

### 16.24.5 Virtual Memory: GATE2015-2\_25 [top](#)

<http://gateoverflow.in/8120>



Selected Answer

$$\text{Ans } 40 - (5+13) = 22 \text{ bits}$$

TLB maps a virtual address to the physical address of the page. (The lower bits of page address - offset bits- are not used in TLB as they are the same for virtual as well as physical addresses). Here, for 8 kB page size we require 13 offset bits.

In TLB we have 32 sets and so virtual address space is divided into 32 using 5 set bits. (Associativity doesn't affect the set bits as they just adds extra slots in each set).

$$\text{So, number of tag bits} = 40 - 5 - 13 = 22$$

12 votes

-- Vikrant Singh (11k points)

### 16.24.6 Virtual Memory: GATE2008-67 [top](#)

<http://gateoverflow.in/490>



Selected Answer

Physical address is 36 bits. So, number of page frame's possible =  $36/12 = 24$  (12 offset bits as given in question). So, the third level page table must have 24 bits for addressing the page frames.

Now we have to find the no. of possible third level page tables and we need to address each of them in second level page table. Similarly we need to find the no. of possible second level page tables and we need to address each of them in first level page table.

$$\text{Number of third level page tables possible} = \frac{\text{Physical memory size}}{\text{Size of a third level page table}} = \frac{2^{36}}{\text{Number of entries in a single third level page table} \times \text{Size of an e}}$$

PS: No. of third level page tables possible means the no. of distinct addresses a page table can have. At any given time, no. of page tables at level  $j$  is equal to the no. of entries in the level  $j - 1$ , but here we are considering the possible page table address.

<http://www.cs.utexas.edu/~lorenzo/corsi/cs372/06F/hw/3sol.html> See Problem 3, second part solution - It clearly says that we should not assume that page tables are page aligned.

So, we need 25 bits in second level page table for addressing the third level page tables.

Now,

$$\text{Number of second level page tables possible} = \frac{\text{Physical memory size}}{\text{Size of a second level page table}} = \frac{2^{36}}{\text{Number of entries in a single second level page table} \times \text{Size o}}$$

So, we need 25 bits for addressing the second level page tables as well.

So, answer is (D).

33 votes

-- Arjun Suresh (150k points)

## 16.24.7 Virtual Memory: GATE1999\_19 [top](#)

<http://gateoverflow.in/1518>



Selected Answer

A)

$$\text{Size of each segment} = \frac{2^{16}}{8} = 2^{13}$$

Let the size of page be  $2^k$  bytes

We need a page table entry for each page. For a segment of size  $2^{13}$ , number of pages required will be

$2^{13-k}$  and so we need  $2^{13-k}$  page table entries. Now, the size of these many entries must be less than or equal to the page size, for the page table of a segment to be requiring at most one page. So,

$$2^{13-k} \times 2 = 2^k \quad (\text{As a page table entry size is 2 bytes})$$

$$k = 7 \text{ bits}$$

$$\text{So, page size} = 2^7 = 128 \text{ bytes}$$

B)

The TLB is placed after the segment table.

$$\text{Each segment will have } \frac{2^{13}}{2^9} = 2^4 \text{ page table entries}$$

So all page table entries of a segment will reside in the cache and segment number will differentiate between page table entry of each segment in the TLB cache.

$$\text{Total segments} = 8$$

Therefore 3 bits of tag is required

C)

$$\text{Number of Pages for a segment} = \frac{2^{16}}{2^9} = 2^7$$

Bits needed for page identification = 7 bits + 1 valid bit + 3 page protection bits + 1 dirty bit = 12 bits needed for a page.

Size of each page table entry = 2 bytes = 16 bits

Number of bits left for aging =  $16 - 12 = 4$  bits

6 votes

-- Danish (2.4k points)

### 16.24.8 Virtual Memory: GATE2013-53 [top](#)

<http://gateoverflow.in/43294>



Selected Answer

Let the page size be  $x$ .

Since virtual address is 46 bits, we have total number of pages =  $\frac{2^{46}}{x}$

We should have an entry for each page in last level page table which here is T3. So,

number of entries in T3 (sum of entries across all possible T3 tables) =  $\frac{2^{46}}{x}$

Each entry takes 32 bits = 4 bytes. So, total size of T3 tables =  $\frac{2^{46}}{x} \times 4 = \frac{2^{48}}{x}$  bytes

Now, no. of T3 tables will be Total size of T3 tables/page table size and for each of these page tables, we must have a T2 entry. Taking T3 size as page size, no. of entries across all T2 tables

$$= \frac{\frac{2^{48}}{x}}{x} = \frac{2^{48}}{x^2}$$

Now, no. of T2 tables (assuming T2 size as pagesize) =  $\frac{2^{48}}{x^2} \times 4$  bytes =  $\frac{\frac{2^{48}}{x^2} \times 4}{x} = \frac{2^{50}}{x^3}$ .

Now, for each of these page table, we must have an entry in T1. So, number of entries in T1

$$= \frac{2^{50}}{x^3}$$

And size of T1 =  $\frac{2^{50}}{x^3} \times 4 = \frac{2^{52}}{x^3}$

Given in question, size of T1 is page size which we took as  $x$ . So,

$$x = \frac{2^{52}}{x^3}$$

$$x^4 = 2^{52}$$

$$x = 2^{13}$$

$$= 8KB$$

Min. no. of page color bits = No. of set index bits + no. of offset bits - no. of page index bits (This ensures no synonym maps to different sets in the cache)

We have 1MB cache and 64B cache block size. So,

number of sets =  $1MB/(64B * \text{Number of blocks in each set}) = 16K/16$  (16 way set associative) =  $1K = 2^{10}$ .

So, we need 10 index bits. Now, each block being 64 ( $2^6$ ) bytes means we need 6 offset bits.

And we already found page size = 8KB =  $2^{13}$ , so 13 bits to index a page

Thus, no. of page color bits =  $10 + 6 - 13 = 3$ .

With 3 page color bits we need to have  $2^3 = 8$  different page colors

**More Explanation:**

A synonym is a physical page having multiple virtual addresses referring to it. So, what we want is no two synonym virtual addresses to map to two different sets, which would mean a physical page could be in two different cache sets. This problem never occurs in a physically indexed cache as indexing happens via physical address bits and so one physical page can never go to two different sets in cache. In virtually indexed cache, we can avoid this problem by ensuring that the bits used for locating a cache block (index+offset) of the virtual and physical addresses are the same.

In our case we have 6 offset bits + 10 bits for indexing. So, we want to make these 16 bits same for both physical and virtual address. One thing is that the page offset bits - 13 bits for 8 KB page, is always the same for physical and virtual addresses as they are never translated. So, we don't need to make these 13 bits same. We have to only make the remaining  $19 + 6 - 13 = 3$  bits same. Page coloring is a way to do this. Here, all the physical pages are colored and a physical page of one color is mapped to a virtual address by OS in such a way that a set in cache always gets pages of the same color. So, in order to make the 3 bits same, we take all combinations of it ( $2^3 = 8$ ) and colors the physical pages with 8 colors and a cache set always gets a page of one color only. (In page coloring, it is the job of OS to ensure that the 3 bits are the same).

<http://ece.umd.edu/courses/enee646.F2007/Cekleov1.pdf>

thumb up 2 votes

-- Arjun Suresh (150k points)

**16.24.9 Virtual Memory: Gate2006-62, ISRO2016-50** [top](#)

<http://gateoverflow.in/1840>



Selected Answer

page size of 4KB.. so offset bits are 12 bits..

so remaining bits of virtual address  $32 - 12 = 20$  bits will be used for indexing...

number of sets =  $128/4 = 32$  (4-way set)  $\Rightarrow 5$  bits..

so tag bits =  $20 - 5 = 15$  bits..

so option (C)

thumb up 13 votes

-- Vicky Bajoria (3.4k points)

**16.24.10 Virtual Memory: GATE2004-IT\_66** [top](#)

<http://gateoverflow.in/3709>



Selected Answer

ans is D

page table entry must contain bits for representing frames and other bits for storing information like dirty bit, reference bit etc

no. of frames (no. of possible pages) = Physical memory size/ Page size =  $2^{30}/2^{12} = 2^{18}$

$18+x=32$  (PT entry size=32 bit)

$x = 14$  bits

thumb up 9 votes

-- neha pawar (3.8k points)

**16.24.11 Virtual Memory: GATE2003-79** [top](#)

<http://gateoverflow.in/4358>



Selected Answer

First level page table is addressed using 10 bits and hence contains  $2^{10}$  entries. Each entry is 4 bytes and hence this table requires 4 KB. Now, the process uses only 3 unique entries from this 1024 possible entries (two code pages starting from 0x00000000 and two data pages starting from 0x00400000 have same first 10 bits). Hence, there are only 3 second level

page tables. Each of these second level page tables are also addressed using 10 bits and hence of size 4 KB. So,

```
total page table size of the process
= 4 KB + 3 * 4 KB
= 16 KB
```

4 votes

-- Arjun Suresh (150k points)

### 16.24.12 Virtual Memory: GATE2006-63, UGCNET-June2012-III-45 [top](#) <http://gateoverflow.in/1841>



Selected Answer

A is the best answer here.

Virtual memory provides

1. increased address space for processes
2. memory protection
3. relocation

So, when we don't need more address space, even if we get rid of virtual memory, we need hardware support for the other two. Without hardware support for memory protection and relocation, we can design a system (by either doing them in software or by partitioning the memory for different users) but those are highly inefficient mechanisms. i.e., there we have to divide the physical memory equally among all users and this limits the memory usage per user and also restricts the maximum number of users.

15 votes

-- Arjun Suresh (150k points)

### 16.24.13 Virtual Memory: GATE2013-52 [top](#) <http://gateoverflow.in/379>



Selected Answer

Let the page size be  $x$ .

Since virtual address is 46 bits, we have total number of pages =  $\frac{2^{46}}{x}$

We should have an entry for each page in last level page table which here is T3. So,

number of entries in T3 (sum of entries across all possible T3 tables) =  $\frac{2^{46}}{x}$

Each entry takes 32 bits = 4 bytes. So, total size of T3 tables =  $\frac{2^{46}}{x} \times 4 = \frac{2^{48}}{x}$  bytes

Now, no. of T3 tables will be Total size of T3 tables/page table size and for each of these page tables, we must have a T2 entry. Taking T3 size as page size, no. of entries across all T2 tables

$$= \frac{\frac{2^{48}}{x}}{x} = \frac{2^{48}}{x^2}$$

Now, no. of T2 tables (assuming T2 size as pagesize) =  $\frac{2^{48}}{x^2} \times 4$  bytes =  $\frac{\frac{2^{48}}{x}}{x} = \frac{2^{50}}{x^3}$ .

Now, for each of these page table, we must have an entry in T1. So, number of entries in T1

$$= \frac{2^{50}}{x^3}$$

And size of T1 =  $\frac{2^{50}}{x^3} \times 4 = \frac{2^{52}}{x^3}$

Given in question, size of T1 is page size which we took as  $x$ . So,

$$x = \frac{2^{52}}{x^3}$$

$$x^4 = 2^{52}$$

$$x = 2^{13}$$

$$= 8KB$$

1 21 votes

-- Arjun Suresh (150k points)

### 16.24.14 Virtual Memory: GATE2011-20, UGCNET-June2013-II-48 [top](#)



Selected Answer

open slide 12-13 to check :

[web.cs.ucla.edu/~ani/classes/cs111.08w/Notes/Lecture%2016.pdf](http://web.cs.ucla.edu/~ani/classes/cs111.08w/Notes/Lecture%2016.pdf)

$$\begin{aligned} \text{EMAT} &= \frac{1}{10^6} \times 10 \text{ ms} + \left(1 - \frac{1}{10^6}\right) \times 20 \text{ ns} \\ &= 29.99998 \text{ ns} \\ &\approx 30 \text{ ns} \end{aligned}$$

answer = **option B**

1 13 votes

-- Amar Vashishth (20.7k points)

### 16.24.15 Virtual Memory: GATE2001-1.21 [top](#)

<http://gateoverflow.in/714>

ans is C.

Belady's anomaly.

1 9 votes

-- jayendra (6.6k points)

### 16.24.16 Virtual Memory: GATE2015-1\_12 [top](#)

<http://gateoverflow.in/8186>



Selected Answer

total no of pages =  $2^{32} / 2^{12} = 2^{20}$

We need a PTE for each page and an entry is 4 bytes. So,  
page table size =  $4 * 2^{20} = 2^{22} = 4\text{MB}$

1 12 votes

-- Anoop Sonkar (4.5k points)

### 16.24.17 Virtual Memory: GATE2015-2\_47 [top](#)

<http://gateoverflow.in/8247>



Selected Answer

8 KB pages means 13 offset bits.

For 32 bit physical address,  $32 - 13 = 19$  page frame bits must be there in each PTE (Page Table Entry).

We also have 1 valid bit, 1 dirty bit and 3 permission bits.

So, total size of a PTE (Page Table Entry) =  $19 + 5 = 24$  bits = 3 bytes.

Given in question, maximum page table size = 24 MB

Page table size = No. of PTEs \* size of an entry

So, no. of PTEs =  $24 \text{ MB} / 3 \text{ B} = 8 \text{ M}$

Virtual address supported = No. of PTEs \* Page size (As we need a PTE for each page and assuming single-level paging)  
 $= 8 \text{ M} * 8 \text{ KB}$   
 $= 64 \text{ GB} = 2^{36} \text{ Bytes}$

So, length of virtual address supported = 36 bits (assuming byte addressing)

21 votes

-- Arjun Suresh (150k points)

### 16.24.18 Virtual Memory: GATE2008-IT\_56 [top](#)

<http://gateoverflow.in/3366>



Selected Answer

Option (D)..

Dirty and R/W is well known..

Reference bit is used in a version of FIFO called second chance (SC) policy, in order to avoid replacement of heavily used page.. It is set to one when a page is used heavily and periodically set to 0.. Since it is used in a version FIFO which is a page replacement policy, this bit is come under category of page replacement..

Valid bit is not used for page replacement.. It is not used in any page replacement policy.. it tells the page in the memory is valid or not.. If it is valid it is directly used and if it is not then a fresh page is loaded.. So basically it is page initialization. because we are not replacing, it is initializing, we not knocking out somebody, we are filling empty space... so initialization.. so option (D)

5 votes

-- Vicky Bajoria (3.4k points)

### 16.24.19 Virtual Memory: GATE1996\_7 [top](#)

<http://gateoverflow.in/2759>



Selected Answer

Given that page size is 256 bytes ( $2^8$ ) and Main memory (MM) is 1KB ( $2^{10}$ ).

So total number of pages that can be accommodated in MM =  $2^{10}/2^8 = 2^2 = 4$

So essentially, there are 4 frames that can be used for paging (or page replacements).

The current sequence of pages in memory shows 3 pages (17, 1, 63). So there is 1 more empty frame left. It also says that the least recently used page is 17.

Now, since page size given is 8 bits wide (256 B), and virtual memory is of 16 bit, we can say that 8 bits are used for offset. The given address sequence is hexadecimal can be divided accordingly:

| Page Number in Hexadecimal | Offset | Page Number in Decimal |
|----------------------------|--------|------------------------|
| 00                         | FF     | 0                      |
| 01                         | 0D     | 1                      |
| 10                         | FF     | 16                     |
| 11                         | B0     | 17                     |

We only need the Page numbers, which can be represented in decimal as: 0, 1, 16, 17.

Now, if we apply LRU algo to the existing frame with these incoming pages, we get the following states:

0 | Miss| 17 1 63 0

1 | Hit| 17 1 63 0

16 | Miss| 16 1 63 0

17 | Miss| 16 1 17 0

i) New status of the list is **16 1 17 0**.

ii) Number of page faults = **3**.

iii) Page replacements are indicated above.

12 votes

-- Ashis Kumar Sahoo (797 points)

**16.24.20 Virtual Memory: GATE2001-1.8** [top](#)<http://gateoverflow.in/701>

Selected Answer

D should be the answer.

A - MMU does this translation but MMU is part of VM (hardware).

B, C - The main advantage of VM is the increased address space for programs, and independence of address space, which allows more degree of multiprogramming as well as option for process security.

D - VM requires switching of page tables (this is done very fast via switching of pointers) for the new process and thus it is theoretically slower than without VM. In anyway VM doesn't directly decrease the context switching overhead.

9 votes

-- Arjun Suresh (150k points)

**16.24.21 Virtual Memory: GATE1995\_2.16** [top](#)<http://gateoverflow.in/2628>

ans is C.

primary memory < virtual memory < secondary memory

we can extend VM upto the size of disk(secondary memory).

3 votes

-- jayendra (6.6k points)

**16.24.22 Virtual Memory: GATE1995\_1.7** [top](#)<http://gateoverflow.in/2594>

ans is A

segment table is too large therefore paged segmented table is used.

9 votes

-- jayendra (6.6k points)

**16.24.23 Virtual Memory: GATE2001-2.21** [top](#)<http://gateoverflow.in/739>

Selected Answer

Number of pages =  $2^{32} / 4KB = 2^{20}$  as we need to map every possible virtual address.

So, we need  $2^{20}$  entries in the page table. Physical memory being 64 MB, a physical address must be 26 bits and a page (of size 4KB) address needs  $26-12 = 14$  address bits. So, each page table entry must be at least 14 bits.

So, total size of page table =  $2^{20} * 14 \text{ bits} \approx 2 \text{ MB}$  (assuming PTE is 2 bytes)

14 votes

-- Arjun Suresh (150k points)

**16.24.24 Virtual Memory: GATE2003-78** [top](#)<http://gateoverflow.in/788>

Selected Answer

78. It's given cache is physically addressed. So, address translation is needed for all memory accesses. (I assume page table lookup happens after TLB is missed, and main memory lookup after cache is missed)

Average access time = Average address translation time + Average memory access time  
= 1ns

```
(TLB is accessed for all accesses)
+ 2*10*0.04
(2 page tables accessed from main memory in case of TLB miss)
+ Average memory access time
= 1.8ns + Cache access time + Average main memory access time
= 1.8ns + 1 * 0.9 (90% cache hit)
+ 0.1 * (10+1) (main memory is accessed for cache misses only)
= 1.8ns + 0.9 + 1.1
= 3.8ns
```

We assumed that page table is in main memory and not cached. This is given in question also, though they do not explicitly say that page tables are not cached. But in practice this is common as given [here](#). So, in such a system,

```
Average address translation time
= 1ns (TLB is accessed for all accesses)
+ 2*0.04 * [0.9 * 1 + 0.1 * 10]
(2 page tables accessed in case of TLB miss and they go through cache)

= 1 ns + 1.9 * .08
= 1.152 ns
```

and average memory access time = 1.152 ns + 2 ns = 3.152 ns

22 votes

-- gatecse (10.7k points)

### 16.24.25 Virtual Memory: GATE2009-9, ISRO2016-52 [top](#)

<http://gateoverflow.in/1301>



Selected Answer

It is A.

[http://en.wikipedia.org/wiki/B%C3%A9zout's\\_anomaly](http://en.wikipedia.org/wiki/B%C3%A9zout's_anomaly)

2 votes

-- Gate Keeda (17.7k points)

### 16.24.26 Virtual Memory: GATE2009-10 [top](#)

<http://gateoverflow.in/1302>



Selected Answer

It is B.

The page table contains the page frame number essentially.

7 votes

-- Gate Keeda (17.7k points)

### 16.24.27 Virtual Memory: GATE2003\_26 [top](#)

<http://gateoverflow.in/916>



Selected Answer

Option A : Internal fragmentation exists only in the last level of paging.

Option B : There is no External fragmentation in the paging.

Option C :  $\frac{2^{32}}{2^{10}} = 2^{22} = 4M$  entries in the page table which is very large. ([Answer](#))

Option D : Not much relevant.

12 votes

-- Abhishek Singh (219 points)

### 16.24.28 Virtual Memory: GATE1991\_03,xi [top](#)

<http://gateoverflow.in/525>



Selected Answer

- A) A is true.
- B) This is false. Example :- Peterson's solution is purely software based solution without use of hardware.  
[https://en.wikipedia.org/wiki/Peterson's\\_algorithm](https://en.wikipedia.org/wiki/Peterson%27s_algorithm)
- C) False. Reference -> [https://en.wikipedia.org/wiki/Monitor\\_\(synchronization\)](https://en.wikipedia.org/wiki/Monitor_(synchronization))
- D) True. This will happen if page getting replaced is immediately referred in next cycle.
- E) False. Memory can get fragmented with First fit.

5 votes

-- Akash (31.7k points)

### 16.24.29 Virtual Memory: GATE2009-34 [top](#)

<http://gateoverflow.in/1320>

Selected Answer

- B.
- Which is a clear reason why we perform paging.

When the page table size increases we perform paging on the page table. Resulting in multi-level page table.

7 votes

-- Gate Keeda (17.7k points)

### 16.24.30 Virtual Memory: GATE2008-IT\_41 [top](#)

<http://gateoverflow.in/3351>

Selected Answer

We have 4 spaces for a page and there will be a replacement only when a 5th distinct page comes. Let's see what happens for the sequence of memory accesses:

(Each page is of 16 bytes, so say for page 0, it contains virtual addresses from 0-15)

- 0: Page fault - 1, Pages in memory - 0
- 4: Page faults - 1, Pages in memory - 0
- 8: Page faults - 1, Pages in memory - 0
- 20: Page faults - 2, Pages in memory - 0, 1
- 24: Page faults - 2, Pages in memory - 0, 1
- 36: Page faults - 3, Pages in memory - 0, 1, 2
- 44: Page faults - 3, Pages in memory - 0, 1, 2
- 12: Page faults - 3, Pages in memory - 1, 2, 0
- 68: Page faults - 4, Pages in memory - 1, 2, 0, 4
- 72: Page faults - 4, Pages in memory - 1, 2, 0, 4
- 80: Page faults - 5, Pages in memory - 2, 0, 4, 5
- 84: Page faults - 5, Pages in memory - 2, 0, 4, 5
- 28: Page faults - 6, Pages in memory - 0, 4, 5, 1
- 32: Page faults - 7, Pages in memory - 4, 5, 1, 2

88: Page faults - 7, Pages in memory - 4, 1, 2, 5

92: Page faults - 7, Pages in memory - 4, 1, 2, 5

So, (B) choice.

10 votes

-- Arjun Suresh (150k points)

### 16.24.31 Virtual Memory: GATE2008-IT\_16 [top](#)



Selected Answer

Effective access time = hit ratio \* time during hit + miss ratio \* time during miss

In both cases TLB is accessed and assuming page table is accessed from memory only when TLB misses.

$$= 0.9 * (10+50) + 0.1 * (10 + 50 + 50)$$

$$= 54 + 11$$

$$= 65$$

9 votes

-- Arjun Suresh (150k points)

## 16.25

### Working Set [top](#)

#### 16.25.1 Working Set: GATE2006-IT\_12 [top](#)

<http://gateoverflow.in/3551>

In the working-set strategy, which of the following is done by the operating system to prevent thrashing?

- I. It initiates another process if there are enough extra frames.
- II. It selects a process to suspend if the sum of the sizes of the working-sets exceeds the total number of available frames.

- |    |                  |
|----|------------------|
| A) | I only           |
| B) | II only          |
| C) | Neither I nor II |
| D) | Both I and II    |

[gate2006-it](#) [operating-system](#) [process-schedule](#) [working-set](#) [normal](#)

Answer

### Answers: Working Set

#### 16.25.1 Working Set: GATE2006-IT\_12 [top](#)

<http://gateoverflow.in/3551>



Selected Answer

Extract from Galvin "If there are enough extra frames, another process can be initiated. If the sum of the working-set sizes increases, exceeding the total number of available frames, the operating system selects a process to suspend. The process's pages are written out (swapped), and its frames are reallocated to other processes. The suspended process can be restarted later."

So Option (D)

7 votes

-- Danish (2.4k points)

# 17 Programming & DS DS (146) [top](#)

## 17.0.1 GATE2013\_44 [top](#)

<http://gateoverflow.in/61>

Consider the following operation along with Enqueue and Dequeue operations on queues, where k is a global parameter.

```
MultiDequeue (Q) {
 m = k
 while (Q is not empty) and (m > 0) {
 Dequeue (Q)
 m = m - 1
 }
}
```

What is the worst case time complexity of a sequence of  $n$  queue operations on an initially empty queue?

- (A)  $\Theta(n)$
- (B)  $\Theta(n + k)$
- (C)  $\Theta(nk)$
- (D)  $\Theta(n^2)$

[gate2013](#) [data-structure](#) [algorithms](#) [normal](#)

[Answer](#)

## 17.0.2 GATE2001-2.16 [top](#)

<http://gateoverflow.in/734>

What is the minimum number of stacks of size n required to implement a queue of size n?

- A. One
- B. Two
- C. Three
- D. Four

[gate2001](#) [data-structure](#) [easy](#)

[Answer](#)

## 17.0.3 GATE2004\_5 [top](#)

<http://gateoverflow.in/1002>

The best data structure to check whether an arithmetic expression has balanced parentheses is a

- A. queue
- B. stack
- C. tree
- D. list

[gate2004](#) [data-structure](#) [easy](#)

[Answer](#)

**17.0.4 GATE2005\_2** [top](#)<http://gateoverflow.in/1344>

An Abstract Data Type (ADT) is:

- A. same as an abstract class
- B. a data type that cannot be instantiated
- C. a data type for which only the operations defined on it can be used, but none else
- D. all of the above

[gate2005](#) [data-structure](#) [normal](#)
**Answer****17.0.5 GATE2015-1\_40** [top](#)<http://gateoverflow.in/8299>

An algorithm performs  $(\log N)^{1/2}$  find operations ,  $N$  insert operations,  $(\log N)^{1/2}$  delete operations, and  $(\log N)^{1/2}$  decrease-key operations on a set of data items with keys drawn from a linearly ordered set . For a delete operation, a pointer is provided to the record that must be deleted . For the decrease-key operation, a pointer is provided to the record that has its key decreased. Which one of the following data structures is the most suited for the algorithm to use, if the goal is to achieve the best total asymptotic complexity considering all the operations?

- A. Unsorted array
- B. Min - heap
- C. Sorted array
- D. Sorted doubly linked list

[gate2015-1](#) [data-structure](#) [normal](#)
**Answer****17.0.6 GATE1996\_1.12** [top](#)<http://gateoverflow.in/2716>

Consider the following statements:

- i. First-in-first out types of computations are efficiently supported by STACKS.
  - ii. Implementing LISTS on linked lists is more efficient than implementing LISTS on an array for almost all the basic LIST operations.
  - iii. Implementing QUEUES on a circular array is more efficient than implementing QUEUES on a linear array with two indices.
  - iv. Last-in-first-out type of computations are efficiently supported by QUEUES.
- 
- A. (ii) and (iii) are true
  - B. (i) and (ii) are true
  - C. (iii) and (iv) are true
  - D. (ii) and (iv) are true

[gate1996](#) [data-structure](#) [easy](#)
**Answer****17.0.7 GATE1992\_09** [top](#)<http://gateoverflow.in/588>

Suggest a data structure for representing a subset  $S$  of integers from 1 to  $n$ . Following operations on the set  $S$  are to be performed in constant time (independent of cardinality of  $S$ ).

- (i). MEMBER ( $X$ ):      Check whether  $X$  is in the set  $S$  or not

- (ii). FIND-ONE( $S$ ): If  $S$  is not empty, return one element of the set  $S$  (any arbitrary element will do)  
 (iii). ADD ( $X$ ): Add integer  $X$  to set  $S$   
 (iv). DELETE ( $X$ ): Delete integer  $X$  from  $S$ .

Give pictorial examples of your data structure. Give routines for these operations in an English like language. You may assume that the data structure has been suitable initialized. Clearly state your assumptions regarding initialization.

gate1992 | programming | normal | descriptive

Answer

### 17.0.8 GATE2003-63, ISRO2009-25 [top](#)

<http://gateoverflow.in/950>

A data structure is required for storing a set of integers such that each of the following operations can be done in  $O(\log n)$  time, where  $n$  is the number of elements in the set.

- I. Deletion of the smallest element
  - II. Insertion of an element if it is not already present in the set
- Which of the following data structures can be used for this purpose?
- A. A heap can be used but not a balanced binary search tree
  - B. A balanced binary search tree can be used but not a heap
  - C. Both balanced binary search tree and heap can be used
  - D. Neither balanced search tree nor heap can be used

gate2003 | data-structure | easy | isro2009

Answer

### Answers:

### 17.0.1 GATE2013\_44 [top](#)

<http://gateoverflow.in/61>



Selected Answer

There are three possible operations on queue- Enqueue, Dequeue and MultiDequeue. MultiDequeue is calling Dequeue multiple times based on a global variable  $k$ . Since, the queue is initially empty, whatever be the order of these operations, there cannot be more no. of Dequeue operations than Enqueue operations. Hence, the total no. of operations will be  $n$  only.

17 votes

-- Arjun Suresh (150k points)

### 17.0.2 GATE2001-2.16 [top](#)

<http://gateoverflow.in/734>

ans b)

7 votes

-- Aditi Dan (5.4k points)

### 17.0.3 GATE2004\_5 [top](#)

<http://gateoverflow.in/1002>



Selected Answer

**STACK** Scan the expression from left to right whenever a left parenthesis is encountered just PUSH it into stack and whenever a right parenthesis is encountered just POP it from stack ..if at the end of expression we are left with an empty stack then it is a correctly parenthesized expression

2 votes

-- Bhagirathi Nayak (11.3k points)

## 17.0.4 GATE2005\_2 top

<http://gateoverflow.in/1344>

Selected Answer

An abstract data type (ADT) supports only the operations which are defined.

Abstract class is one that may not have definitions of all the objects it have. Moreover it can not be instantiated. To instantiate we have to create a subclass then instantiate the class.

Abstract Data Type is like data structure eg. STACK where we have PUSH() POP() operation defined .

Hence they are not the same thing.

<http://www.devx.com/tips/Tip/5681>

8 votes

-- Manali (2.5k points)

## 17.0.5 GATE2015-1\_40 top

<http://gateoverflow.in/8299>

Selected Answer

|                                  | ( $\log N$ ) $^{1/2}$ find | N insert      | ( $\log N$ ) $^{1/2}$ delete | ( $\log N$ ) $^{1/2}$ decrease-key |
|----------------------------------|----------------------------|---------------|------------------------------|------------------------------------|
| <b>Unsorted Array</b>            | $O(N (\log N)^{1/2})$      | $O(N)$        | $O(\log N)^{1/2})$           | $O(\log N)^{1/2})$                 |
| <b>Min-heap</b>                  | $O(N (\log N)^{1/2})$      | $O(N \log N)$ | $O((\log N)^{3/2})$          | $O((\log N)^{3/2})$                |
| <b>Sorted Array</b>              | $O((\log N)^{3/2})$        | $O(N^2)$      | $O(N (\log N)^{1/2})$        | $O(N (\log N)^{1/2})$              |
| <b>Sorted doubly linked-list</b> | $O(N (\log N)^{1/2})$      | $O(N^2)$      | $O((\log N)^{1/2})$          | $O(N (\log N)^{1/2})$              |

So, Unsorted array is the answer.

The operations given can be performed in any order. So, for Min-heap we cannot do the usual BuildHeap method.

Delete in unsorted array is  $O(1)$  as we can just swap the deleted element with the last element in the array and delete the last element.

For sorted-doubly linked-list we cannot do binary search as this would require another array to maintain the pointers to the nodes.

17 votes

-- Arjun Suresh (150k points)

## 17.0.6 GATE1996\_1.12 top

<http://gateoverflow.in/2716>

Selected Answer

A.

i) and iv) are false.

[http://en.wikipedia.org/wiki/List\\_\(abstract\\_data\\_type\)#Operations](http://en.wikipedia.org/wiki/List_(abstract_data_type)#Operations)

8 votes

-- Gate Keeda (17.7k points)

**17.0.7 GATE1992\_09** [top](#)<http://gateoverflow.in/588>

A queue with a hashtable.

Initialize hashtable with 0.

When inserting X into the queue update hashtable[X]=0 to hashtable[X]=1.

(i) If hashtable[X]=1 then return true.

(ii) Return the element at the front or rear of the queue.

(iii) Add the element X to the queue at the rear end and update hashtable[X]=0 to hashtable[X]=1.

(iv) Delete the element X from the front end of the queue and update hashtable[X]=1 to hashtable[X]=0.

2 votes

-- Rajarshi Sarkar (29.7k points)

**17.0.8 GATE2003-63, ISRO2009-25** [top](#)<http://gateoverflow.in/950>

Selected Answer

Balanced search tree have height  $\log n$ Deletion of smallest element will take  $O(\log n)$  timeFinding a element is present/not and doing insertion:  $O(\log n)$ Heap(MIN) is also an almost complete binary tree have height  $\log n$ Deletion of smallest element will take  $O(\log n)$  time (root element removal, replace with last element +balancing)Finding a element is present/not and insertion: Finding only takes  $O(n)$ , insertion then balancing take  $O(\log n)$ . So, total  $O(n) + O(\log n) = O(n)$ .

Ans B

(even if its maxheap our ans does not change only time for deletion of min will increase  $O(n)$ )

11 votes

-- Anurag Semwal (5.5k points)

**17.1****Arrays** [top](#)**17.1.1 Arrays: GATE2015-2\_31** [top](#)<http://gateoverflow.in/8148>

A Young tableau is a 2D array of integers increasing from left to right and from top to bottom. Any unfilled entries are marked with  $\infty$ , and hence there cannot be any entry to the right of, or below a  $\infty$ . The following Young tableau consists of unique entries.

|   |   |   |    |
|---|---|---|----|
| 1 | 2 | 5 | 14 |
| 3 | 4 | 6 | 23 |

|    |          |          |          |
|----|----------|----------|----------|
| 10 | 12       | 18       | 25       |
| 31 | $\infty$ | $\infty$ | $\infty$ |

When an element is removed from a Young tableau, other elements should be moved into its place so that the resulting table is still a Young tableau (unfilled entries may be filled with a  $\infty$ ). The minimum number of entries (other than 1) to be shifted, to remove 1 from the given Young tableau is \_\_\_\_\_.

gate2015-2 databases arrays normal

Answer

### 17.1.2 Arrays: GATE2005\_5 [top](#)

<http://gateoverflow.in/1347>

A program P reads in 500 integers in the range [0, 100] representing the scores of 500 students. It then prints the frequency of each score above 50. What would be the best way for P to store the frequencies?

- A. An array of 50 numbers
- B. An array of 100 numbers
- C. An array of 500 numbers
- D. A dynamically allocated array of 550 numbers

gate2005 data-structure arrays easy

Answer

### 17.1.3 Arrays: GATE2000-1.2 [top](#)

<http://gateoverflow.in/625>

An  $n \times n$  array  $v$  is defined as follows:

$$v[i, j] = i - j \text{ for all } i, j, i \leq n, 1 \leq j \leq n$$

The sum of the elements of the array  $v$  is

- A. 0
- B.  $n - 1$
- C.  $n^2 - 3n + 2$
- D.  $n^2 \frac{(n+1)}{2}$

gate2000 data-structure arrays easy

Answer

### 17.1.4 Arrays: GATE1994\_1.11 [top](#)

<http://gateoverflow.in/2452>

In a compact single dimensional array representation for lower triangular matrices (i.e all the elements above the diagonal are zero) of size  $n \times n$ , non-zero elements, (i.e elements of lower triangle) of each row are stored one after another, starting from the first row, the index of the  $(i, j)^{th}$  element of the lower triangular matrix in this new representation is:

- A.  $i + j$
- B.  $i + j - 1$
- C.  $j + \frac{i(i-1)}{2}$
- D.  $i + \frac{j(j-1)}{2}$

gate1994 data-structure arrays normal

## Answer

**17.1.5 Arrays: GATE2000-15** [top](#)<http://gateoverflow.in/686>

Suppose you are given arrays  $p[1.....N]$  and  $q[1.....N]$  both uninitialized, that is, each location may contain an arbitrary value), and a variable count, initialized to 0. Consider the following procedures set and is\_set:

```
set(i) {
 count = count + 1;
 q[count] = i;
 p[i] = count;
}
is_set(i) {
 if (p[i] ≤ 0 or p[i] > count)
 return false;
 if (q[p[i]] ≠ i)
 return false;
 return true;
}
```

- a. Suppose we make the following sequence of calls:

`set(7); set(3); set(9);`

After these sequence of calls, what is the value of count, and what do  $q[1]$ ,  $q[2]$ ,  $q[3]$ ,  $p[7]$ ,  $p[3]$  and  $p[9]$  contain?

- b. Complete the following statement "The first count elements of \_\_\_\_\_ contain values  $i$  such that `set(____)` has been called".

- c. Show that if `set(i)` has not been called for some  $i$ , then regardless of what  $p[i]$  contains, `is_set(i)` will return false.

[gate2000](#) [data-structure](#) [arrays](#) [easy](#)

## Answer

**17.1.6 Arrays: GATE1998\_2.14** [top](#)<http://gateoverflow.in/1686>

Let A be a two dimensional array declared as follows:

```
A: array [1 10] [1 15] of integer;
```

Assuming that each integer takes one memory location, the array is stored in row-major order and the first element of the array is stored at location 100, what is the address of the element  $A[i][j]$ ?

- A.  $15i + j + 84$
- B.  $15j + i + 84$
- C.  $10i + j + 89$
- D.  $10j + i + 89$

[gate1998](#) [data-structure](#) [arrays](#) [easy](#)

## Answer

**Answers: Arrays****17.1.1 Arrays: GATE2015-2\_31** [top](#)<http://gateoverflow.in/8148>

Selected Answer

The answer should be 5.

1. We first need to shift 2 in place of 1 keeping 5 AND 14 intact as it isn't mentioned in the question that the entire row elements move.

2. 4 is shifted up,next to 2(keeping 12 and infinity intact in column 2).

3. Now in second row 6 is shifted left.

4.18 shifts up to the second row

5. And finally 25 is shifted left to the third column.

So this takes 5 moves and still maintains the tableau property. Also infinity is placed to the right of 25 and below 23(unfilled entries to be filled with  $\infty$ ). The final table would look as follows.

|    |          |          |          |
|----|----------|----------|----------|
| 2  | 4        | 5        | 14       |
| 3  | 6        | 18       | 23       |
| 10 | 12       | 25       | $\infty$ |
| 31 | $\infty$ | $\infty$ | $\infty$ |

10 votes

-- Aman verma (183 points)

### 17.1.2 Arrays: GATE2005\_5 top

<http://gateoverflow.in/1347>



Selected Answer

as we our area of interest is only the 50 numbers so take An array of 50 numbers where A[0] corresponds to 51...A[49] corresponds to 100 then after reading an input just increment the counter in correct position as said above

8 votes

-- Bhagirathi Nayak (11.3k points)

### 17.1.3 Arrays: GATE2000-1.2 top

<http://gateoverflow.in/625>



Selected Answer

The sum of the  $i^{\text{th}}$  row and  $i^{\text{th}}$  column is 0 as shown below. Since, the numbers of rows = no. of columns, the total sum will be 0.

|   |    |    |    |    |
|---|----|----|----|----|
| 0 | -1 | -2 | -3 | -4 |
| 1 | 0  | -1 | -2 | -3 |
| 2 | 1  | 0  | -1 | -2 |
| 3 | 2  | 1  | 0  | -1 |
| 4 | 3  | 2  | 1  | 0  |

6 votes

-- Arjun Suresh (150k points)

Let there are total N rows . You will find  $\sum$  of elements of row  $i$  +  $\sum$  of elements row  $(N-i+1) = 0$ .

So if N is even then

row 1 + row N =0

row 2 + row (N-1) =0

row 3 + row (N-2)=0

similarly row  $(N/2)$  + row  $(N/2+1) = 0$ . (So total sum is 0)

But if N is odd then row  $((N+1)/2)$  will have no corresponding rows BUT the summation of elements of this row is 0 .

So for N = even or Odd , the sum of element is 0 .

1 6 votes

-- Palash Nandi (1.4k points)

#### 17.1.4 Arrays: GATE1994\_1.11 [top](#)

<http://gateoverflow.in/2452>



Selected Answer

$j + (\text{sum of natural number till } i-1)$  because if you form a lower triangular matrix it contains elements in rows 1,2,3,...

So C is the correct answer.

PS: Though not mentioned in question, from options it is clear that array index starts from 1 and not 0.

1 13 votes

-- Bhagirathi Nayak (11.3k points)

#### 17.1.5 Arrays: GATE2000-15 [top](#)

<http://gateoverflow.in/686>



Selected Answer

a)

Initially count= 0;

When we call set(7) - count=1, q[1] =7, p[7]= 1;

when we call set(3) - count=2, q[2]=3, p[3] =2;

when we call set(9) - count=3, q[3]=9, p[9] = 3;

b) Ans- "The first count elements of ( array q ) contain values i such that set ( i ) has been called".

c) If set(i) has not been called for some i, then regardless of what p[i] contains, When we call is\_set(i) then

```
if (q[p[i]] != i)
 return false;
will always execute, because if set(i) is not called then p[i] != count(any) and for then same count q[count] != i. So if statement will be true and \
```

1 0 votes

-- vijaycs (10.7k points)

#### 17.1.6 Arrays: GATE1998\_2.14 [top](#)

<http://gateoverflow.in/1686>



Selected Answer

A [ LB<sub>1</sub>.....UB<sub>1</sub>,LB<sub>2</sub>.....UB<sub>2</sub> ]

BA = Base address.

C = size of each element.

Row major order.

Loc(a[i][j]) = BA + [ (i-LB<sub>1</sub>) (UB<sub>2</sub> - LB<sub>2</sub> + 1) + (j - LB<sub>2</sub>) ] \* C.

Column Major order

Loc(a[i][j]) = BA + [ (j-LB<sub>2</sub>) (UB<sub>1</sub> - LB<sub>1</sub> + 1) + (i - LB<sub>1</sub>) ] \* C.

substituting the values. answer is A.

10 votes

-- Gate Keeda (17.7k points)

## 17.2

Avl Tree top17.2.1 Avl Tree: GATE1998\_21 top<http://gateoverflow.in/1735>

- Derive a recurrence relation for the size of the smallest AVL tree with height  $h$ .
- What is the size of the smallest AVL tree with height 8?

[gate1998](#) [data-structure](#) [trees](#) [avl-tree](#) [descriptive](#) [numerical-answers](#)

Answer

## Answers: Avl Tree

17.2.1 Avl Tree: GATE1998\_21 top<http://gateoverflow.in/1735>

Selected Answer

- a) Consider a function  $N(h)$  which represents the smallest number of nodes  $n$  for an AVL tree with height  $h$  and satisfies  $n = N(h)$ .

For  $h=0$  we have, number of nodes = 1. So  $N(0) = 1$

For  $h = 1$ , we have, number of nodes = 2. We could take 3, but we require the smallest graph (a graph with smallest number of nodes) so we take 2. It means that to create a tree with height 1 we need **at least** 2 nodes.

So  $N(1) = 2$

Now, for  $h = 2$ , we need to create a node with a child subtree of height 1. This may be the right or left subtree. But since this is an AVL tree, to balance a child subtree of height let's say  $H_s$ , we need the other child to have a height of  $H_s-1$ ,  $H_s$  or  $H_s+1$ . But we take  $H_s-1$  for minimal case. In simple words, a node with height 5 must have a child with height 4 ( $H_s$ ) and another child with height 3 ( $H_s-1$ ). So  $N(2)$  can be obtained as:

$N(2) = N(1) + (0) + 1$  (1 is added to count the parent node,  $N(1)$  or  $N(H_s)$  and  $N(0)$  or  $N(H_s-1)$  represent two subtrees.)

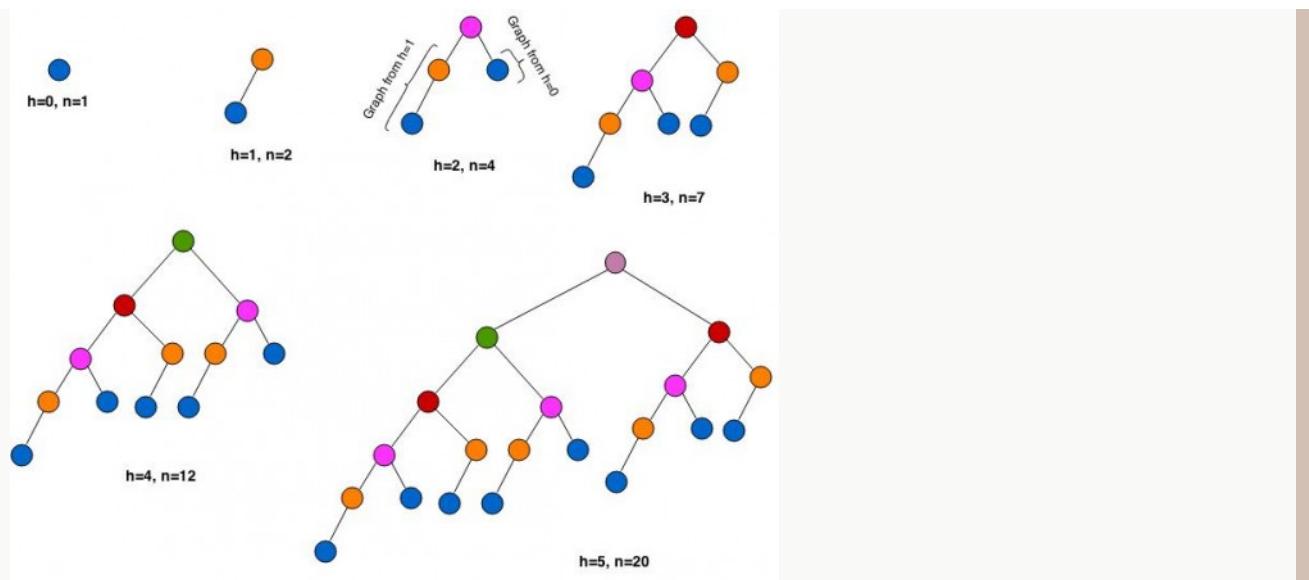
Similarly:

$N(3) = N(2) + N(1) + 1$

and generalizing:

$$N(h) = N(h-1) + N(h-2) + 1$$

This recursion can be graphically seen as below:



b) Using the above recursion, we need to find  $N(8)$

$$N(0) = 1$$

$$N(1) = 2$$

$$N(2) = N(1) + N(0) + 1 = 1 + 2 + 1 = 4$$

$$N(3) = N(2) + N(1) + 1 = 2 + 4 + 1 = 7$$

$$N(4) = N(3) + N(2) + 1 = 4 + 7 + 1 = 12$$

$$N(5) = N(4) + N(3) + 1 = 7 + 12 + 1 = 20$$

$$N(6) = N(5) + N(4) + 1 = 12 + 20 + 1 = 33$$

$$N(7) = N(6) + N(5) + 1 = 20 + 33 + 1 = 54$$

$$N(8) = N(7) + N(6) + 1 = 33 + 54 + 1 = 88$$

So answer for b) is 88.

8 votes

-- Ashis Kumar Sahoo (797 points)

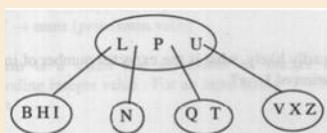
## 17.3

## B Tree

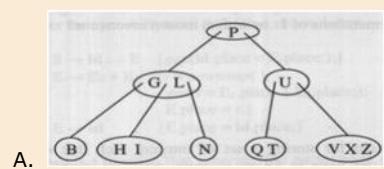
### 17.3.1 B Tree: GATE2003\_65

<http://gateoverflow.in/952>

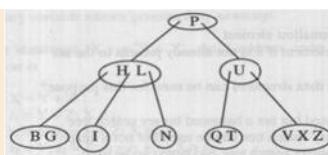
Consider the following 2-3-4 tree (i.e., B-tree with a minimum degree of two) in which each data item is a letter. The usual alphabetical ordering of letters is used in constructing the tree.



What is the result of inserting G in the above tree?



B.



C.

D. None of the above

[gate2003](#) [algorithms](#) [b-tree](#) [normal](#)
[Answer](#)

## Answers: B Tree

### 17.3.1 B Tree: GATE2003\_65 [top](#)

<http://gateoverflow.in/952>


Selected Answer

B is the correct answer.

Once we add G, the leaf node becomes B G H I, since we can have only 3 keys. the node has to split at G or H, and G or H will be added to parent node.

Since P is the parent node in options 1 and 2, its evident the 3rd element i.e. H should be selected for splitting (because after adding any key from the leftmost child node, P becomes the 3rd element in the node)

Now parent node becomes H L P U, select P as for splitting, and you get option B.

Hence **answer is B**

[Upvote](#) 7 votes

-- ryan sequeira (1.6k points)

### 17.4

## Bfs [top](#)

### 17.4.1 Bfs: GATE 2016-2-11 [top](#)

<http://gateoverflow.in/39563>

Breadth First Search (BFS) is started on a binary tree beginning from the root vertex. There is a vertex  $t$  at a distance four from the root. If  $t$  is the  $n - t^{\text{th}}$  vertex in this BFS traversal, then the maximum possible value of  $n$  is \_\_\_\_\_.

[gate2016-2](#) [data-structure](#) [bfs](#) [binary-tree](#) [normal](#) [numerical-answers](#)
[Answer](#)

## Answers: Bfs

### 17.4.1 Bfs: GATE 2016-2-11 [top](#)

<http://gateoverflow.in/39563>


Selected Answer

No of nodes at level 0(root) of tree => 1

No of nodes at level 1 of tree => 2

No of nodes at level 2 of tree =>4  
 No of nodes at level 3 of tree =>8  
 No of nodes at level 4 of tree =>16  
 Last node in level 4th is the node we are looking for =>  $1+2+4+8+16 = > 31$

8 votes

-- Akash (31.7k points)

## 17.5

## Binary Heap top

### 17.5.1 Binary Heap: GATE2015-2\_17 top

<http://gateoverflow.in/8091>

Consider a complete binary tree where the left and right subtrees of the root are max-heaps. The lower bound for the number of operations to convert the tree to a heap is

- A.  $\Omega(\log n)$
- B.  $\Omega(n)$
- C.  $\Omega(n \log n)$
- D.  $\Omega(n^2)$

[gate2015-2](#) [data-structure](#) [binary-tree](#) [heap](#) [binary-heap](#) [normal](#)

Answer

### 17.5.2 Binary Heap: GATE2009-59 top

<http://gateoverflow.in/1341>

Consider a binary max-heap implemented using an array.  
 Which one of the following array represents a binary max-heap?

- A. {25, 12, 16, 13, 10, 8, 14}
- B. {25, 14, 13, 16, 10, 8, 12}
- C. {25, 14, 16, 13, 10, 8, 12}
- D. {25, 14, 12, 13, 10, 8, 16}

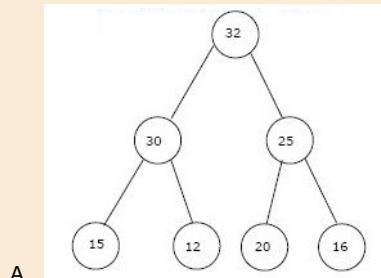
[gate2009](#) [data-structure](#) [heap](#) [binary-heap](#) [normal](#)

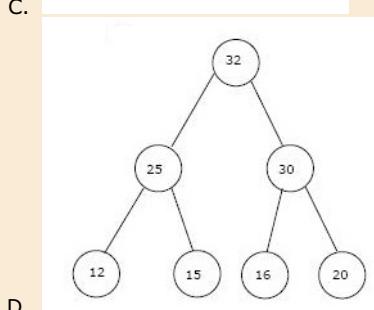
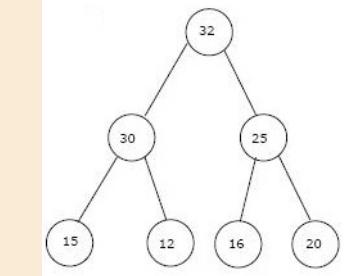
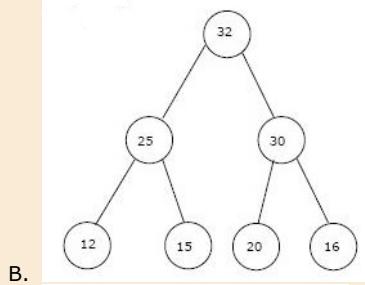
Answer

### 17.5.3 Binary Heap: GATE2004\_37 top

<http://gateoverflow.in/1034>

The elements 32, 15, 20, 30, 12, 25, 16, are inserted one by one in the given order into a maxHeap. The resultant maxHeap is





[gate2004](#) [data-structure](#) [heap](#) [binary-heap](#) [normal](#)

Answer

### 17.5.4 Binary Heap: GATE 2016-1-37 [top](#)

<http://gateoverflow.in/39706>

An operator `delete(i)` for a binary heap data structure is to be designed to delete the item in the  $i$ -th node. Assume that the heap is implemented in an array and  $i$  refers to the  $i$ -th index of the array. If the heap tree has depth  $d$  (number of edges on the path from the root to the farthest leaf), then what is the time complexity to re-fix the heap efficiently after the removal of the element?

- A.  $O(1)$
- B.  $O(d)$  but not  $O(1)$
- C.  $O(2^d)$  but not  $O(d)$
- D.  $O(d \cdot 2^d)$  but not  $O(2^d)$

[gate2016-1](#) [data-structure](#) [binary-heap](#) [normal](#)

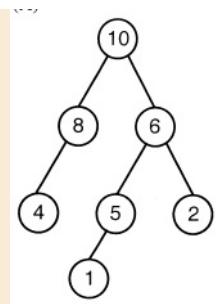
Answer

### 17.5.5 Binary Heap: GATE2011\_23 [top](#)

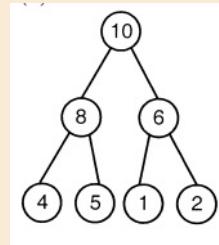
<http://gateoverflow.in/2125>

A max-heap is a heap where the value of each parent is greater than or equal to the value of its children. Which of the following is a max-heap?

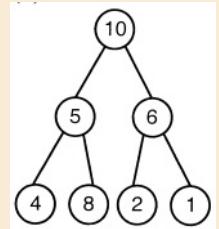
- (A)



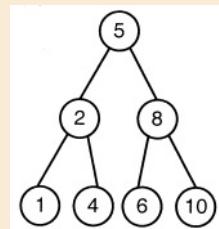
(B)



(C)



(D)


[gate2011](#) [data-structure](#) [heap](#) [binary-heap](#) [easy](#)
**Answer**

### 17.5.6 Binary Heap: GATE2009-60 [top](#)

<http://gateoverflow.in/43466>

Consider a binary max-heap implemented using an array.

What is the content of the array after two delete operations on {25, 14, 16, 13, 10, 8, 12}?

- A. {14, 13, 12, 10, 8}
- B. {14, 12, 13, 8, 10}
- C. {14, 13, 8, 12, 10}
- D. {14, 13, 12, 8, 10}

[gate2009](#) [data-structure](#) [heap](#) [binary-heap](#) [normal](#)
**Answer**

**17.5.7 Binary Heap: GATE2001-1.15** [top](#)<http://gateoverflow.in/708>

Consider any array representation of an  $n$  element binary heap where the elements are stored from index 1 to index  $n$  of the array. For the element stored at index  $i$  of the array ( $i \leq n$ ), the index of the parent is

- A.  $i - 1$
- B.  $\lfloor \frac{i}{2} \rfloor$
- C.  $\lceil \frac{i}{2} \rceil$
- D.  $\frac{(i+1)}{2}$

[gate2001](#) [data-structure](#) [heap](#) [binary-heap](#) [easy](#)

**Answer****Answers: Binary Heap****17.5.1 Binary Heap: GATE2015-2\_17** [top](#)<http://gateoverflow.in/8091>

Selected Answer

Ans A.

Here, lower bound imply best algorithm which works for all cases and hence we should consider worst-case.

Max-Heapify(root)

Upvote 16 votes

-- **Vikrant Singh** (11k points)

**17.5.2 Binary Heap: GATE2009-59** [top](#)<http://gateoverflow.in/1341>

Selected Answer

Taking the given array as level order traversal, we can build binary tree.

- (A) 13 comes as child of 12, which is not allowed in a binary max-heap
- (B) 16 comes as child of 14 violating max-heap property
- (C) is a valid binary max-heap as all children are smaller than their parent
- (D) 16 comes as child of 12, violating max-heap property

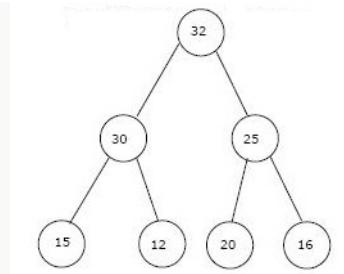
Upvote 7 votes

-- **Arjun Suresh** (150k points)

**17.5.3 Binary Heap: GATE2004\_37** [top](#)<http://gateoverflow.in/1034>

Selected Answer

answer = **option A**



Just keep inserting elements making sure resulting Tree is nearly Complete.(Heap Property) .

While inserting any node, if you find that Value of New Node > Value of it's parent, bubble it up to keep Max heap property

4 votes

-- Akash (31.7k points)

#### 17.5.4 Binary Heap: GATE 2016-1-37 top

<http://gateoverflow.in/39706>



Selected Answer

Answer would be B) O(d) but not O(1).. as we need to apply heapify.. and suppose if we are deleting root, in worst case would take O(d) time..

13 votes

-- Abhilash Panicker (7k points)

#### 17.5.5 Binary Heap: GATE2011\_23 top

<http://gateoverflow.in/2125>



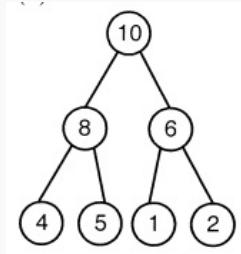
Selected Answer

in option a - it is not a max heap because it is not complete binary tree .

in option c-it is complete binary tree but not follow the max heap property i.e. the values of parent nodes always greater than child nodes

and there node of value 5 is less than one of its children.

in option d- similar to above c option explanation here node of value 2 is less than to the value 4 .



correct option is (B) that is satisfy both properties and all of the max heap .

5 votes

-- ASHU2015 (237 points)

#### 17.5.6 Binary Heap: GATE2009-60 top

<http://gateoverflow.in/43466>



Selected Answer

During delete, the root element is removed, replaced with the last element and heap property is corrected by pushing the root downwards. So, for first delete,

25 14 16 13 10 8 12 -> 12 14 16 13 10 8 -> 16 14 12 13 10 8 (the element not satisfying max-heap property is exchanged with the largest of its children) (heap property satisfied)

Second delete:

16 14 12 13 10 8 -> 8 14 12 13 10 -> 14 8 12 13 10 -> 14 13 12 8 10 (heap property satisfied)

<http://homepages.ius.edu/RWISMAN/C455/html/notes/Chapter6/heapify.htm>

6 votes

-- Arjun Suresh (150k points)

## 17.5.7 Binary Heap: GATE2001-1.15 [top](#)

<http://gateoverflow.in/708>



Selected Answer

for node at index i

left child(L) at 2i

right child(R) at 2i+1

for node at index i

parent will be at floor i/2

7 votes

-- Pooja (25.9k points)

## 17.6

## Binary Search [top](#)

### 17.6.1 Binary Search: GATE2006-IT\_45 [top](#)

<http://gateoverflow.in/3588>

Suppose that we have numbers between 1 and 100 in a binary search tree and want to search for the number 55. Which of the following sequences CANNOT be the sequence of nodes examined?

- A) {10, 75, 64, 43, 60, 57, 55}
- B) {90, 12, 68, 34, 62, 45, 55}
- C) {9, 85, 47, 68, 43, 57, 55}
- D) {79, 14, 72, 56, 16, 53, 55}

[gate2006-it](#) [data-structure](#) [binary-search](#) [normal](#)

Answer

### 17.6.2 Binary Search: GATE2007-IT-29 [top](#)

<http://gateoverflow.in/3462>

When searching for the key value 60 in a binary search tree, nodes containing the key values 10, 20, 40, 50, 70 80, 90 are traversed, not necessarily in the order given. How many different orders are possible in which these key values can occur on the search path from the root to the node containing the value 60?

- A. 35
- B. 64
- C. 128
- D. 5040

[gate2007-it](#) [data-structure](#) [binary-search](#) [normal](#)

Answer

**17.6.3 Binary Search: GATE 2016-2-40** [top](#)<http://gateoverflow.in/39586>

The number of ways in which the numbers 1, 2, 3, 4, 5, 6, 7 can be inserted in an empty binary search tree, such that the resulting tree has height 6, is \_\_\_\_\_.

Note: The height of a tree with a single node is 0.

[gate2016-2](#) [data-structure](#) [binary-tree](#) [binary-search](#) [normal](#) [numerical-answers](#)

[Answer](#)

**Answers: Binary Search****17.6.1 Binary Search: GATE2006-IT\_45** [top](#)<http://gateoverflow.in/3588>

Selected Answer

in option C search sequence progress in ...47,68,43,..

at 47 we see that search key 55 is greater and it will be on right side of 47. so in further comparison a value less than 47 will not come

hence option c is wrong

10 votes

-- Sankaranarayanan P.N (9.8k points)

**17.6.2 Binary Search: GATE2007-IT-29** [top](#)<http://gateoverflow.in/3462>

Selected Answer

10, 20, 40, 50, 70 80, 90

In BST search we if we go from say 10 to 40 while searching for 60, we will never encounter 20. So, 10, 20, 40 and 50 visited, means they are visited in order. Similarly, 90, 80 and 70 are visited in order. So, our required answer will be

No. of possible permutations of 7 numbers

No. of possible permutations of numbers smaller than 60 × No. of possible permutations of numbers larger than 60  
(Since only one permutation is valid for both the smaller set of numbers as well as larger set of numbers)

$$= \frac{7!}{4!3!}$$

$$= 35$$

25 votes

-- Arjun Suresh (150k points)

**17.6.3 Binary Search: GATE 2016-2-40** [top](#)<http://gateoverflow.in/39586>

Selected Answer

We need to fill 7 levels with 7 elements. So, at each level we have exactly 2 possible options like 1 and 7 for root- one corresponding to making it left skewed and other right skewed. And this is the same for all levels up to 6 giving  $2^6 = 64$  possible ways.

28 votes

-- Arjun Suresh (150k points)

**17.7**

**Binary Tree** [top](#)

**17.7.1 Binary Tree: GATE1995\_1.17** [top](#)<http://gateoverflow.in/2604>

A binary tree  $T$  has  $n$  leaf nodes. The number of nodes of degree 2 in  $T$  is

- A.  $\log_2 n$
- B.  $n - 1$
- C.  $n$
- D.  $2^n$

[gate1995](#) [data-structure](#) [binary-tree](#) [normal](#)

[Answer](#)

**17.7.2 Binary Tree: GATE2005-IT\_50** [top](#)<http://gateoverflow.in/3811>

In a binary tree, for every node the difference between the number of nodes in the left and right subtrees is at most 2. If the height of the tree is  $h > 0$ , then the minimum number of nodes in the tree is

- |    |               |
|----|---------------|
| A) | $2^h - 1$     |
| B) | $2^h - 1 + 1$ |
| C) | $2^h - 1$     |
| D) | $2^h$         |

[gate2005-it](#) [data-structure](#) [binary-tree](#) [normal](#)

[Answer](#)

**17.7.3 Binary Tree: GATE2006-IT\_71** [top](#)<http://gateoverflow.in/3615>

An array  $X$  of  $n$  distinct integers is interpreted as a complete binary tree. The index of the first element of the array is 0. The index of the parent of element  $X[i], i \neq 0$ , is?

- A.  $\left\lfloor \frac{i}{2} \right\rfloor$
- B.  $\left\lceil \frac{i-1}{2} \right\rceil$
- C.  $\left\lceil \frac{i}{2} \right\rceil$
- D.  $\left\lceil \frac{i}{2} \right\rceil - 1$

[gate2006-it](#) [data-structure](#) [binary-tree](#) [normal](#)

[Answer](#)

**17.7.4 Binary Tree: GATE2010-10** [top](#)<http://gateoverflow.in/2183>

In a binary tree with  $n$  nodes, every node has an odd number of descendants. Every node is considered to be its own descendant. What is the number of nodes in the tree that have exactly one child?

- A. 0
- B. 1
- C.  $\frac{(n-1)}{2}$
- D.  $n - 1$

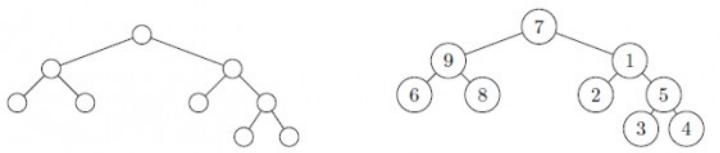
[gate2010](#) [data-structure](#) [binary-tree](#) [normal](#)
**Answer****17.7.5 Binary Tree: GATE2005-IT\_12** [top](#)<http://gateoverflow.in/3757>

The numbers 1, 2, ..., n are inserted in a binary search tree in some order. In the resulting tree, the right subtree of the root contains p nodes. The first number to be inserted in the tree must be

- A. p
- B. p + 1
- C. n - p
- D. n - p + 1

[gate2005-it](#) [data-structure](#) [binary-tree](#) [normal](#)
**Answer****17.7.6 Binary Tree: TIFR2015-B-4** [top](#)<http://gateoverflow.in/29849>

First, consider the tree on the left.



On the right, the nine nodes of the tree have been assigned numbers from the set  $\{1, 2, \dots, 9\}$  so that for every node, the numbers in its left subtree and right subtree lie in disjoint intervals (that is, all numbers in one subtree are less than all numbers in the other subtree). How many such assignments are possible? Hint: Fix a value for the root and ask what values can then appear in its left and right subtrees.

- A.  $2^9 = 512$
- B.  $2^4 \cdot 3^2 \cdot 5 \cdot 9 = 6480$
- C.  $2^3 \cdot 3 \cdot 5 \cdot 9 = 1080$
- D.  $2^4 = 16$
- E.  $2^3 \cdot 3^3 = 216$

[tifr2015](#) [binary-tree](#) [combinatory](#)
**Answer****17.7.7 Binary Tree: GATE1997\_16** [top](#)<http://gateoverflow.in/2276>

A size-balanced binary tree is a binary tree in which for every node the difference between the number of nodes in the left and right subtree is at most 1. The distance of a node from the root is the length of the path from the root to the node. The height of a binary tree is the maximum distance of a leaf node from the root.

- a. Prove, by using induction on h, that a size-balance binary tree of height  $h$  contains at least  $2^h$  nodes.
- b. In a size-balanced binary tree of height  $h \leq 1$ , how many nodes are at distance  $h - 1$  from the root? Write only the answer without any explanations.

[gate1997](#) [data-structure](#) [binary-tree](#) [normal](#)
**Answer****17.7.8 Binary Tree: GATE1993\_16** [top](#)<http://gateoverflow.in/2313>

Prove by the principal of mathematical induction that for any binary tree, in which every non-leaf node has 2-descendants, the number of leaves in the tree is one more than the number of non-leaf nodes.

[gate1993](#) [data-structure](#) [binary-tree](#) [normal](#)

**Answer****17.7.9 Binary Tree: GATE2000-1.14** [top](#)<http://gateoverflow.in/637>

Consider the following nested representation of binary trees: (X Y Z) indicates Y and Z are the left and right subtrees, respectively, of node X. Note that Y and Z may be NULL, or further nested. Which of the following represents a valid binary tree?

- A. (1 2 (4 5 6 7))
- B. (1 (2 3 4) 5 6) 7)
- C. (1 (2 3 4) (5 6 7))
- D. (1 (2 3 NULL) (4 5))

[gate2000](#) [data-structure](#) [binary-tree](#) [easy](#)
**Answer****17.7.10 Binary Tree: GATE2015-3\_25** [top](#)<http://gateoverflow.in/8428>

Consider a binary tree T that has 200 leaf nodes. Then the number of nodes in T that have exactly two children are \_\_\_\_\_.

[gate2015-3](#) [data-structure](#) [binary-tree](#) [normal](#) [numerical-answers](#)
**Answer****17.7.11 Binary Tree: GATE1994\_8** [top](#)<http://gateoverflow.in/2504>

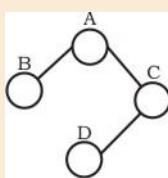
A rooted tree with 12 nodes has its nodes numbered 1 to 12 in pre-order. When the tree is traversed in post-order, the nodes are visited in the order 3, 5, 4, 2, 7, 8, 6, 10, 11, 12, 9, 1.

Reconstruct the original tree from this information, that is, find the parent of each node, and show the tree diagrammatically.

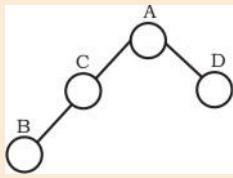
[gate1994](#) [data-structure](#) [binary-tree](#) [normal](#)
**Answer****17.7.12 Binary Tree: GATE2004-IT\_54** [top](#)<http://gateoverflow.in/3697>

Which one of the following binary trees has its inorder and preorder traversals as BCAD and ABCD, respectively?

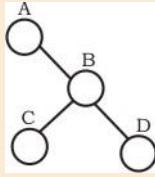
A)

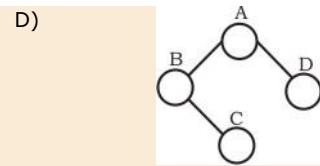


B)



C)





gate2004-it | binary-tree | easy

[Answer](#)

### 17.7.13 Binary Tree: TIFR2014-B-1 [top](#)

<http://gateoverflow.in/27133>

Let  $T$  be a rooted binary tree whose vertices are labelled with symbols  $a, b, c, d, e, f, g, h, i, j, k$ . Suppose the in-order (visit left subtree, visit root, visit right subtree) and post-order (visit left subtree, visit right subtree, visit root) traversals of  $T$  produce the following sequences.

in-order: $a, b, c, d, e, f, g, h, i, j, k$

post-order: $a, c, b, e, f, h, j, k, i, g, d$

How many leaves does the tree have?

- a. THREE.
- b. FOUR.
- c. FIVE.
- d. SIX.
- e. Cannot be determined uniquely from the given information.

tifr2014 | binary-tree

[Answer](#)

### 17.7.14 Binary Tree: GATE2014-1\_12 [top](#)

<http://gateoverflow.in/1776>

Consider a rooted  $n$  node binary tree represented using pointers. The best upper bound on the time required to determine the number of subtrees having exactly 4 nodes is

$O(n^a \log^b n)$ . Then the value of

$a + 10b$  is \_\_\_\_\_.

gate2014-1 | data-structure | binary-tree | numerical-answers | normal

[Answer](#)

### 17.7.15 Binary Tree: GATE1995\_6 [top](#)

<http://gateoverflow.in/2667>

What is the number of binary trees with 3 nodes which when traversed in post-order give the sequence  $A, B, C$ ? Draw all these binary trees.

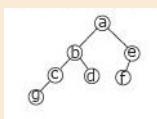
gate1995 | data-structure | binary-tree | normal

[Answer](#)

### 17.7.16 Binary Tree: GATE1996\_1.14 [top](#)

<http://gateoverflow.in/2718>

In the balanced binary tree in the below figure, how many nodes will become unbalanced when a node is inserted as a child of the node "g"?



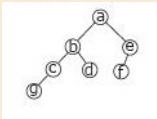
- A. 1
- B. 3
- C. 7
- D. 8

[gate1996](#)
[data-structure](#)
[binary-tree](#)
[normal](#)
**Answer**

### 17.7.17 Binary Tree: GATE1996\_1.15 [top](#)

<http://gateoverflow.in/2719>

Which of the following sequences denotes the post order traversal sequence of the below tree?



- A. f e g c d b a
- B. g c b d a f e
- C. g c d b f e a
- D. f e d g c b a

[gate1996](#)
[data-structure](#)
[binary-tree](#)
[easy](#)
**Answer**

### 17.7.18 Binary Tree: GATE2003-19, ISRO2009-24 [top](#)

<http://gateoverflow.in/909>

Suppose the numbers 7, 5, 1, 8, 3, 6, 0, 9, 4, 2 are inserted in that order into an initially empty binary search tree. The binary search tree uses the usual ordering on natural numbers. What is the in-order traversal sequence of the resultant tree?

- A. 7 5 1 0 3 2 4 6 8 9
- B. 0 2 4 3 1 6 5 9 8 7
- C. 0 1 2 3 4 5 6 7 8 9
- D. 9 8 6 4 2 3 0 1 5 7

[gate2003](#)
[binary-tree](#)
[easy](#)
[isro2009](#)
**Answer**

### 17.7.19 Binary Tree: GATE1996\_2.14 [top](#)

<http://gateoverflow.in/2743>

A binary search tree is generated by inserting in order the following integers:

50, 15, 62, 5, 20, 58, 91, 3, 8, 37, 60, 24

The number of nodes in the left subtree and right subtree of the root respectively is

- A. (4, 7)
- B. (7, 4)
- C. (8, 3)
- D. (3, 8)

[gate1996](#)
[data-structure](#)
[binary-tree](#)
[normal](#)
**Answer**

### 17.7.20 Binary Tree: GATE1996\_4 [top](#)

<http://gateoverflow.in/2756>

A binary search tree is used to locate the number 43. Which of the following probe sequences are possible and which are not? Explain.

- (a) 61 52 14 17 40 43
- (b) 2 3 50 40 60 43
- (c) 10 65 31 48 37 43
- (d) 81 61 52 14 41 43
- (e) 17 77 27 66 18 43

[gate1996](#) [data-structure](#) [binary-tree](#) [normal](#)

[Answer](#)

### 17.7.21 Binary Tree: GATE2008-IT\_71 [top](#)

<http://gateoverflow.in/3385>

A Binary Search Tree (BST) stores values in the range 37 to 573. Consider the following sequence of keys.

- I. 81, 537, 102, 439, 285, 376, 305
- II. 52, 97, 121, 195, 242, 381, 472
- III. 142, 248, 520, 386, 345, 270, 307
- IV. 550, 149, 507, 395, 463, 402, 270

Suppose the BST has been unsuccessfully searched for key 273. Which all of the above sequences list nodes in the order in which we could have encountered them in the search?

- A) II and III only
- B) I and III only
- C) III and IV only
- D) III only

[gate2008-it](#) [data-structure](#) [binary-tree](#) [normal](#)

[Answer](#)

### 17.7.22 Binary Tree: GATE2008-IT\_72 [top](#)

<http://gateoverflow.in/3386>

A Binary Search Tree (BST) stores values in the range 37 to 573. Consider the following sequence of keys.

- I. 81, 537, 102, 439, 285, 376, 305
- II. 52, 97, 121, 195, 242, 381, 472
- III. 142, 248, 520, 386, 345, 270, 307
- IV. 550, 149, 507, 395, 463, 402, 270

Which of the following statements is TRUE?

- A) I, II and IV are inorder sequences of three different BSTs
- B) I is a preorder sequence of some BST with 439 as the root
- C) II is an inorder sequence of some BST where 121 is the root and 52 is a leaf
- D) IV is a postorder sequence of some BST with 149 as the root

[gate2008-it](#) [data-structure](#) [binary-tree](#) [easy](#)

[Answer](#)

### 17.7.23 Binary Tree: GATE2008-IT\_73 [top](#)

<http://gateoverflow.in/3387>

How many distinct BSTs can be constructed with 3 distinct keys?

- |    |   |
|----|---|
| A) | 4 |
| B) | 5 |
| C) | 6 |
| D) | 9 |

[gate2008-it](#)
[data-structure](#)
[binary-tree](#)
[combinatory](#)
[normal](#)
[Answer](#)

### 17.7.24 Binary Tree: GATE2008-IT\_76 [top](#)

<http://gateoverflow.in/3390>

A binary tree with  $n > 1$  nodes has  $n_1$ ,  $n_2$  and  $n_3$  nodes of degree one, two and three respectively. The degree of a node is defined as the number of its neighbours.

$n_3$  can be expressed as

- A)  $n_1 + n_2 - 1$
- B)  $n_1 - 2$
- C)  $\lceil ((n_1 + n_2)/2) \rceil$
- D)  $n_2 - 1$

[gate2008-it](#)
[data-structure](#)
[binary-tree](#)
[normal](#)
[Answer](#)

### 17.7.25 Binary Tree: GATE2008-IT\_77 [top](#)

<http://gateoverflow.in/3391>

A binary tree with  $n > 1$  nodes has  $n_1$ ,  $n_2$  and  $n_3$  nodes of degree one, two and three respectively. The degree of a node is defined as the number of its neighbours.

Starting with the above tree, while there remains a node  $v$  of degree two in the tree, add an edge between the two neighbours of  $v$  and then remove  $v$  from the tree. How many edges will remain at the end of the process?

- A)  $2 * n_1 - 3$
- B)  $n_2 + 2 * n_1 - 2$
- C)  $n_3 - n_2$
- D)  $n_2 + n_1 - 2$

[gate2008-it](#)
[data-structure](#)
[binary-tree](#)
[normal](#)
[Answer](#)

### 17.7.26 Binary Tree: GATE2006-IT\_73 [top](#)

<http://gateoverflow.in/3617>

An array  $X$  of  $n$  distinct integers is interpreted as a complete binary tree. The index of the first element of the array is 0. If the root node is at level 0, the level of element  $X[i]$ ,  $i \neq 0$ , is

- A)  $\lfloor \log_2 i \rfloor$
- B)  $\lceil \log_2 (i + 1) \rceil$
- C)  $\lfloor \log_2 (i + 1) \rfloor$
- D)  $\lceil \log_2 i \rceil$

[gate2006-it](#)
[data-structure](#)
[binary-tree](#)
[normal](#)
[Answer](#)

### 17.7.27 Binary Tree: GATE2006-IT\_9 [top](#)

<http://gateoverflow.in/3548>

In a binary tree, the number of internal nodes of degree 1 is 5, and the number of internal nodes of degree 2 is 10. The number of leaf nodes in the binary tree is

- A)

10

- |    |    |
|----|----|
| B) | 11 |
| C) | 12 |
| D) | 15 |

[gate2006-it](#) [data-structure](#) [binary-tree](#) [normal](#)

[Answer](#)

### 17.7.28 Binary Tree: GATE2005-IT\_55 [top](#)

<http://gateoverflow.in/3816>

A binary search tree contains the numbers 1, 2, 3, 4, 5, 6, 7, 8. When the tree is traversed in pre-order and the values in each node printed out, the sequence of values obtained is 5, 3, 1, 2, 4, 6, 8, 7. If the tree is traversed in post-order, the sequence obtained would be

- |    |                        |
|----|------------------------|
| A) | 8, 7, 6, 5, 4, 3, 2, 1 |
| B) | 1, 2, 3, 4, 8, 7, 6, 5 |
| C) | 2, 1, 4, 3, 6, 7, 8, 5 |
| D) | 2, 1, 4, 3, 7, 8, 6, 5 |

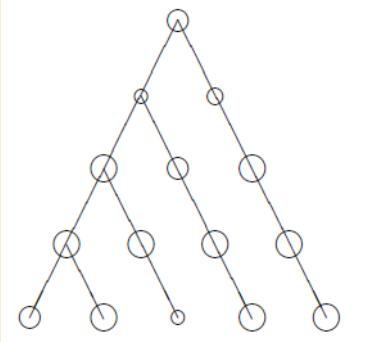
[gate2005-it](#) [data-structure](#) [binary-tree](#) [normal](#)

[Answer](#)

### 17.7.29 Binary Tree: TIFR2013-B-13 [top](#)

<http://gateoverflow.in/25775>

Given a binary tree of the following form and having  $n$  nodes, the height of the tree is



- a.  $\Theta(\log n)$
- b.  $\Theta(n)$
- c.  $\Theta(\sqrt{n})$
- d.  $\Theta(n/\log n)$
- e. None of the above.

[tifr2013](#) [binary-tree](#)

[Answer](#)

### 17.7.30 Binary Tree: GATE2015-2\_10 [top](#)

<http://gateoverflow.in/8059>

A binary tree T has 20 leaves. The number of nodes in T having two children is \_\_\_\_\_.

[gate2015-2](#) [data-structure](#) [binary-tree](#) [normal](#)

[Answer](#)

### 17.7.31 Binary Tree: GATE2001-14 [top](#)

<http://gateoverflow.in/755>

- a. Insert the following keys one by one into a binary search tree in the order specified.  
15, 32, 20, 9, 3, 25, 12, 1  
Show the final binary search tree after the insertions.
- b. Draw the binary search tree after deleting 15 from it.

- c. Complete the statements S1, S2 and S3 in the following function so that the function computes the depth of a binary tree rooted at t.

```
typedef struct tnode{
 int key;
 struct tnode *left, *right;
} *Tree;

int depth (Tree t)
{
 int x, y;
 if (t == NULL) return 0;
 x = depth (t -> left);
 S1: _____;
 S2: if (x > y) return _____;
 S3: else return _____;
}
```

[gate2001](#) [data-structure](#) [binary-tree](#) [normal](#)

[Answer](#)

### 17.7.32 Binary Tree: GATE2006\_13 [top](#)

<http://gateoverflow.in/974>

A scheme for storing binary trees in an array X is as follows. Indexing of X starts at 1 instead of 0. the root is stored at X[1]. For a node stored at X[i], the left child, if any, is stored in X[2i] and the right child, if any, in X[2i+1]. To be able to store any binary tree on n vertices the minimum size of X should be

- (A)  $\log_2 n$
- (B)  $n$
- (C)  $2n + 1$
- (D)  $2^n - 1$

[gate2006](#) [data-structure](#) [binary-tree](#) [normal](#)

[Answer](#)

### 17.7.33 Binary Tree: GATE2004-4, ISRO2009-26 [top](#)

<http://gateoverflow.in/1001>

The following numbers are inserted into an empty binary search tree in the given order: 10, 1, 3, 5, 15, 12, 16. What is the height of the binary search tree (the height is the maximum distance of a leaf node from the root)?

- A. 2
- B. 3
- C. 4
- D. 6

[gate2004](#) [data-structure](#) [binary-tree](#) [easy](#) [isro2009](#)

[Answer](#)

### 17.7.34 Binary Tree: GATE2003\_6 [top](#)

<http://gateoverflow.in/897>

Let  $T(n)$  be the number of different binary search trees on  $n$  distinct elements.

Then  $T(n) = \sum_{k=1}^n T(k-1)T(n-k)$ , where  $x$  is

- A.  $n - k + 1$
- B.  $n - k$
- C.  $n - k - 1$
- D.  $n - k - 2$

[gate2003](#) [binary-tree](#) [normal](#)

**Answer****17.7.35 Binary Tree: GATE2004\_35 [top](#)**<http://gateoverflow.in/1032>

Consider the label sequences obtained by the following pairs of traversals on a labeled binary tree. Which of these pairs identify a tree uniquely?

- I. preorder and postorder
  - II. inorder and postorder
  - III. preorder and inorder
  - IV. level order and postorder
- A. (I) only  
 B. (II), (III)  
 C. (III) only  
 D. (IV) only

[gate2004](#) [data-structure](#) [binary-tree](#) [normal](#)
**Answer****17.7.36 Binary Tree: GATE2015-3\_13 [top](#)**<http://gateoverflow.in/8409>

While inserting the elements 71, 65, 84, 69, 67, 83 in an empty binary search tree (BST) in the sequence shown, the element in the lowest level is

- A. 65  
 B. 67  
 C. 69  
 D. 83

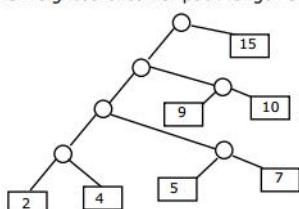
[gate2015-3](#) [data-structure](#) [binary-tree](#) [easy](#)
**Answer****17.7.37 Binary Tree: GATE2002\_6 [top](#)**<http://gateoverflow.in/859>

Draw all binary trees having exactly three nodes labeled A, B and C on which preorder traversal gives the sequence C, B, A.

[gate2002](#) [data-structure](#) [binary-tree](#) [easy](#)
**Answer****17.7.38 Binary Tree: GATE1991\_01,viii [top](#)**<http://gateoverflow.in/506>

The weighted external path length of the binary tree in figure is \_\_\_\_\_

(viii) The weighted external path length of the binary tree in figure is \_\_\_\_\_



[gate1991](#)
[binary-tree](#)
[data-structure](#)
[normal](#)
**Answer**

### 17.7.39 Binary Tree: GATE2004\_43 [top](#)

<http://gateoverflow.in/1040>

Consider the following C program segment

```
struct CellNode{
 struct CellNode *leftChild;
 int element;
 struct CellNode *rightChild;
};

int DoSomething (struct CellNode *ptr)
{
 int value = 0;
 if(ptr != NULL)
 {
 if (ptr -> leftChild != NULL)
 value = 1 + DoSomething (ptr -> leftChild);
 if (ptr -> rightChild != NULL)
 value = max(value, 1 + DoSomething (ptr -> rightChild));
 }
 return (value);
}
```

The value returned by the function DoSomething when a pointer to the root of a non-empty tree is passed as argument is

- A. The number of leaf nodes in the tree
- B. The number of nodes in the tree
- C. The number of internal nodes in the tree
- D. The height of the tree

[gate2004](#)
[data-structure](#)
[binary-tree](#)
[normal](#)
**Answer**

### 17.7.40 Binary Tree: GATE2007\_12 [top](#)

<http://gateoverflow.in/1210>

The height of a binary tree is the maximum number of edges in any root to leaf path. The maximum number of nodes in a binary tree of height  $h$  is:

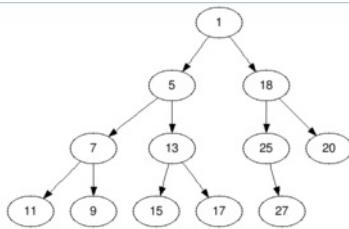
- A.  $2^h - 1$
- B.  $2^{h-1} - 1$
- C.  $2^{h+1} - 1$
- D.  $2^{h+1}$

[gate2007](#)
[data-structure](#)
[binary-tree](#)
[easy](#)
**Answer**

### 17.7.41 Binary Tree: GATE1991\_14,c [top](#)

<http://gateoverflow.in/43027>

Consider the binary tree in the figure below:



Outline a procedure in Pseudo-code to delete an arbitrary node from such a binary tree with  $n$  nodes that preserves the structures. What is the worst-case-time-complexity of your procedure?

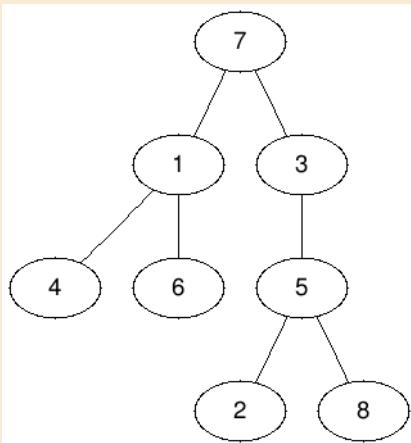
[gate1991](#) [normal](#) [data-structure](#) [binary-tree](#) [time-complexity](#)

[Answer](#)

### 17.7.42 Binary Tree: GATE1991-1,ix [top](#)

<http://gateoverflow.in/502>

If the binary tree in figure is traversed in inorder, then the order in which the nodes will be visited is \_\_\_\_\_



[gate1991](#) [algorithms](#) [binary-tree](#) [easy](#)

[Answer](#)

### 17.7.43 Binary Tree: GATE2002\_2.12 [top](#)

<http://gateoverflow.in/842>

A weight-balanced tree is a binary tree in which for each node, the number of nodes in the left sub tree is at least half and at most twice the number of nodes in the right sub tree. The maximum possible height (number of nodes on the path from the root to the furthest leaf) of such a tree on  $n$  nodes is best described by which of the following?

- A.  $\log_2 n$
- B.  $\log_{\frac{3}{2}} n$
- C.  $\log_3 n$
- D.  $\log_{\frac{3}{2}} n$

[gate2002](#) [data-structure](#) [binary-tree](#) [normal](#)

[Answer](#)

### 17.7.44 Binary Tree: GATE2015-1\_25 [top](#)

<http://gateoverflow.in/8223>

The height of a tree is the length of the longest root-to-leaf path in it. The maximum and minimum number of nodes in a binary tree of height 5 are

- A. 63 and 6, respectively

- B. 64 and 5, respectively  
 C. 32 and 6, respectively  
 D. 31 and 5, respectively

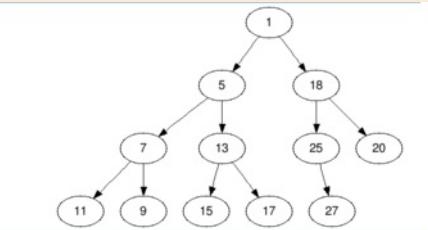
[gate2015-1](#) [data-structure](#) [binary-tree](#) [easy](#)

[Answer](#)

### 17.7.45 Binary Tree: GATE1991\_14,b [top](#)

<http://gateoverflow.in/43026>

Consider the binary tree in the figure below:



Give different steps for deleting the node with key 5 so that the structure is preserved.

[gate1991](#) [data-structure](#) [binary-tree](#) [normal](#)

[Answer](#)

### 17.7.46 Binary Tree: GATE2005\_33 [top](#)

<http://gateoverflow.in/1369>

Postorder traversal of a given binary search tree, T produces the following sequence of keys

10, 9, 23, 22, 27, 25, 15, 50, 95, 60, 40, 29

Which one of the following sequences of keys can be the result of an in-order traversal of the tree T?

- A. 9, 10, 15, 22, 23, 25, 27, 29, 40, 50, 60, 95  
 B. 9, 10, 15, 22, 40, 50, 60, 95, 23, 25, 27, 29  
 C. 29, 15, 9, 10, 25, 22, 23, 27, 40, 60, 50, 95  
 D. 95, 50, 60, 40, 27, 23, 22, 25, 10, 9, 15, 29

[gate2005](#) [data-structure](#) [binary-tree](#) [easy](#)

[Answer](#)

### 17.7.47 Binary Tree: GATE2015-1\_23 [top](#)

<http://gateoverflow.in/8221>

What are the worst-case complexities of insertion and deletion of a key in a binary search tree?

- A.  $\Theta(\log n)$  for both insertion and deletion  
 B.  $\Theta(n)$  for both insertion and deletion  
 C.  $\Theta(n)$  for insertion and  $\Theta(\log n)$  for deletion  
 D.  $\Theta(\log n)$  for insertion and  $\Theta(n)$  for deletion

[gate2015-1](#) [data-structure](#) [binary-tree](#) [easy](#)

[Answer](#)

### 17.7.48 Binary Tree: GATE1998\_20 [top](#)

<http://gateoverflow.in/1734>

Draw the binary tree with node labels a, b, c, d, e, f and g for which the inorder and postorder traversals result in the following sequences:

Inorder: a f b c d g e

Postorder: a f c g e d b

gate1998 | data-structure | binary-tree | descriptive

[Answer](#)

### 17.7.49 Binary Tree: GATE2015-1\_10 [top](#)

<http://gateoverflow.in/8129>

Which of the following is/are correct in order traversal sequence(s) of binary search tree(s)?

- I. 3, 5, 7, 8, 15, 19, 25
- II. 5, 8, 9, 12, 10, 15, 25
- III. 2, 7, 10, 8, 14, 16, 20
- IV. 4, 6, 7, 9, 18, 20, 25

- A. I and IV only
- B. II and III only
- C. II and IV only
- D. II only

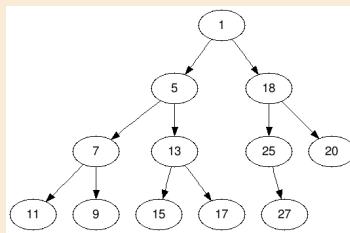
gate2015-1 | data-structure | binary-tree | easy

[Answer](#)

### 17.7.50 Binary Tree: GATE1991\_14,a [top](#)

<http://gateoverflow.in/541>

Consider the binary tree in the figure below:



(a). What structure is represented by the binary tree?

gate1991 | data-structure | binary-tree | time-complexity | normal

[Answer](#)

### 17.7.51 Binary Tree: GATE2013\_7 [top](#)

<http://gateoverflow.in/1416>

Which one of the following is the tightest upper bound that represents the time complexity of inserting an object into a binary search tree of  $n$  nodes?

- (A)  $O(1)$
- (B)  $O(\log n)$
- (C)  $O(n)$
- (D)  $O(n \log n)$

gate2013 | data-structure | binary-tree | time-complexity | easy

[Answer](#)

**17.7.52 Binary Tree: TIFR2012-B-16** [top](#)<http://gateoverflow.in/25214>

Consider a complete binary tree of height  $n$ , where each edge is one Ohm resistor. Suppose all the leaves of the tree are tied together. Approximately how much is the effective resistance from the root to this bunch of leaves for very large  $n$ ?

- a. Exponential in  $n$ .
- b. Cubic in  $n$ .
- c. Linear in  $n$ .
- d. Logarithmic in  $n$ .
- e. Of the order square root of  $n$ .

[tifr2012](#) [binary-tree](#)
**Answer****Answers: Binary Tree****17.7.1 Binary Tree: GATE1995\_1.17** [top](#)<http://gateoverflow.in/2604>

Selected Answer

In Binary Tree a node can have atmost 2 child

Total number of node  $\Rightarrow n = \text{node with 0 child} + \text{node with 1 child} + \text{node with 2 child}$

$$n = n_0 + n_1 + n_2$$

Total number of edges

$$e = n - 1$$

$$\text{and also } e = n_0 * 0 + n_1 * 1 + n_2 * 2$$

Therefore

$$n - 1 = n_0 * 0 + n_1 * 1 + n_2 * 2$$

$$n_0 + n_1 + n_2 - 1 = n_1 * 1 + n_2 * 2$$

$$n_2 = n_0 - 1 \text{ (here leaf node is given } n)$$

therefore

$$n_2 = n - 1$$

**option b**

拇指图标 6 votes

-- Umang Raman (11.3k points)

**17.7.2 Binary Tree: GATE2005-IT\_50** [top](#)<http://gateoverflow.in/3811>

Selected Answer

it should be B)

Since the difference between the nodes in left and right subtree must hold for every node, until the last to last to last level, all levels must be fully filled. So, we get  $2^{h-1} - 1$  nodes (No. of nodes in a complete binary tree of height  $h - 2$ ). Now, our aim is to increase two more levels by adding minimum no. of nodes- just add two in nodes one below other to any of the nodes. So, we get  $2^{h-1} + 1$  nodes - B option.

拇指图标 8 votes

-- Sneha Goel (1k points)

**17.7.3 Binary Tree: GATE2006-IT\_71** [top](#)<http://gateoverflow.in/3615>



Selected Answer

option D

left child of ith element will be at  $2*i+1$  and right child at  $2(i+1)$ 

1 9 votes

-- Sankaranarayanan P.N (9.8k points)

**17.7.4 Binary Tree: GATE2010-10** [top](#)<http://gateoverflow.in/2183>

Selected Answer

0 because every node has an odd number of descendants so least odd number 1 and every node is considered to be its own descendant so all nodes have even number of descendants(0,2,4,6...) so every node has either 0 children or 2 children...

1 5 votes

-- Murali (295 points)

**17.7.5 Binary Tree: GATE2005-IT\_12** [top](#)<http://gateoverflow.in/3757>

Selected Answer

from 1,...n elements p elements are on the right. so root or first inserted will be at n-p

1 9 votes

-- Sankaranarayanan P.N (9.8k points)

**17.7.6 Binary Tree: TIFR2015-B-4** [top](#)<http://gateoverflow.in/29849>

Selected Answer

**Option B****for every node** -all numbers in one subtree are less than all numbers in the other subtree .Firstly **choose** a value for **root**- 9 elements = **9 ways**Now, we hv **8 elements left** - we hv to **choose 3 for left subtree & 5 for right subtree**.**Note:** Here we can either choose 3 nodes from beginning or end out of 8 elements we have ! = **2 ways**Now,we hv 3 elements for left subtree & 5 for right(**Consider subtrees of subtree**).**Left Subtree :**whatever way we place , always one side is smaller than other {6 is smaller than 8 in above example given in question} so, total ways = **3!** {three places put one by one} = **6 ways****Right Subtree :**

Right subtree has two more sub-trees ,so that elements on one side should be smaller than other\*\*

Steps : 1) Select one element for root = **5 ways**2) 4 elements left ,Select one element for left = **2 ways** {Either we can choose from left or right}3) 3 elements left, for right subtree = **3! ways = 6 ways**

Total ways =  $9 \cdot 2 \cdot 3! \cdot 5 \cdot 2 \cdot 3! = 2^4 \cdot 3^2 \cdot 5 \cdot 9 = 6480 = \mathbf{B} (\text{Ans})$

7 votes

-- Himanshu Agarwal (9.8k points)

### 17.7.7 Binary Tree: GATE1997\_16 [top](#)

<http://gateoverflow.in/2276>

B.

1 is Ans if  $h=1$

0 is Ans if  $h=0$

0 votes

-- Rajesh Pradhan (5.4k points)

### 17.7.8 Binary Tree: GATE1993\_16 [top](#)

<http://gateoverflow.in/2313>



Selected Answer

**Base Case :-** When we have just root then, there are no non leaf nodes. So No of leaves = 1, No of non leaf nodes is = 0. Base case holds.

**Induction Hypothesis :-** Assume that now for  $k$  internal nodes we will have  $k+1$  leaves.

**Inducting** on no of leaves, Now we add 2 more leaves to this tree. One of  $k+1$  leaf will become internal node. So now we will have  $k+1$  internal node. No of leafs will be  $K+ 1 - 1(1 \text{ leaf just became internal node}) + 2(\text{New leafs})$ . So we proved that for any binary tree, in which every non-leaf node has 2-descendants, the number of leaves in the tree is one more than the number of non-leaf nodes.

2 votes

-- Akash (31.7k points)

### 17.7.9 Binary Tree: GATE2000-1.14 [top](#)

<http://gateoverflow.in/637>



Selected Answer

(A)  $\rightarrow (4 5 6 7)$  this part of answer is not correct. We have  $(X Y Z)$  not  $(W X Y Z)$ . SO this is wrong

(B)  $\rightarrow$  3 closing parenthesis, 2 opening parenthesis. This is wrong.

(D)  $\rightarrow$  Here in  $(1 (2 3 \text{NULL}) (4 5))$ ,  $(4 5)$  this is not allowed. So this is wrong. (It should be  $(4,5,\text{NULL})$ )

(C) Correct  $\rightarrow$

7 votes

-- Akash (31.7k points)

### 17.7.10 Binary Tree: GATE2015-3\_25 [top](#)

<http://gateoverflow.in/8428>



Selected Answer

Let number of nodes with exactly two children be  $x$ , and with exactly one children be  $y$ .

Total degree =  $200 + 3x + 2y - 1$  (As all nodes with 2 children have degree 3 except the root)

No. of nodes =  $x + y + 200$

No. of edges = Total degree/2 =  $(200 + 3x + 2y - 1)/2$

No. of edges in a tree = No. of nodes - 1

So,  $(200 + 3x + 2y - 1) = 2x + 2y + 400 - 2$

x = 199

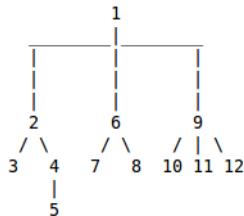
1 21 votes

-- Arjun Suresh (150k points)

**17.7.11 Binary Tree: GATE1994\_8** top<http://gateoverflow.in/2504>

Selected Answer

Answer: The tree is a ternary tree.



1 4 votes

-- Rajarshi Sarkar (29.7k points)

**17.7.12 Binary Tree: GATE2004-IT\_54** top<http://gateoverflow.in/3697>

Selected Answer

inorder traversal is left node right

preorder is node left right

answer: D

1 6 votes

-- Sankaranarayanan P.N (9.8k points)

**17.7.13 Binary Tree: TIFR2014-B-1** top<http://gateoverflow.in/27133>

Selected Answer

We can construct binary tree by postorder and inorder traversal

There we get 5 leaves of the tree are a,c,e,h,j

So answer (C)5

1 4 votes

-- srestha (27.8k points)

**17.7.14 Binary Tree: GATE2014-1\_12** top<http://gateoverflow.in/1776>

Selected Answer

ans: 1..

Explanation:

(1) Come to the 4th level up from the leaf node of the given binary tree, which can be done using tree traversal in  $O(n)$ .

(2) For each node present in the level check whether it's subtree having exactly 4 nodes.. which can be done in constant time for each node, since it's subtree having constant number of nodes..

(3) nodes in the level is less than n.. so its complexity is O(n)

therefore, a = 1 and b = 0

a + 10b = 1... <-Answer

11 votes

-- Vicky Bajoria (3.4k points)

### 17.7.15 Binary Tree: GATE1995\_6 [top](#)



Selected Answer

There are only Five such binary trees.

One with C as root and left child as A and right child B.

Second with C as root, B as left child and A as again left child of B.

Third with C as root, B as left child and A as right child of B.

Fourth with C as root, B as right child and A as right child of B.

Fifth with C as root, B as right child and A as left child of B.

9 votes

-- Gate Keeda (17.7k points)

### 17.7.16 Binary Tree: GATE1996\_1.14 [top](#)



Selected Answer

B.

a,b,c will become unbalanced with Balance factor as +2,+2,+2 respectively. Balance factor should be -1,0,+1.

Balance factor = Height(LST) - Height(RST).

7 votes

-- Gate Keeda (17.7k points)

### 17.7.17 Binary Tree: GATE1996\_1.15 [top](#)



Selected Answer

C.

Left-->Right-->Root.

Ref: [http://gateoverflow.in/2718/gate1996\\_1-14](http://gateoverflow.in/2718/gate1996_1-14)

5 votes

-- Gate Keeda (17.7k points)

### 17.7.18 Binary Tree: GATE2003-19, ISRO2009-24 [top](#)



Selected Answer

In-order traversal returns the elements in sorted order.

Therefore, it's option C

8 votes

-- Gate\_15\_isHere (627 points)

**17.7.19 Binary Tree: GATE1996\_2.14** [top](#)<http://gateoverflow.in/2743>

Selected Answer

B.

Root will be 50. now insert one by one, greater to 50 in the right sub tree, lesser in left sub tree.

Or you can simply count the number looking at the i/p. less than 50 are 7. more than 50 are 4.

5 votes

-- Gate Keeda (17.7k points)

**17.7.20 Binary Tree: GATE1996\_4** [top](#)<http://gateoverflow.in/2756>

Selected Answer

B and E are not possible.

rest all i/p's will have binary trees with only one child. but B and E will have two childs at a point. therefore the probe sequence will not be possible.

For better clarification, make BST's for the given i/p's and probe for 43.

9 votes

-- Gate Keeda (17.7k points)

**17.7.21 Binary Tree: GATE2008-IT\_71** [top](#)<http://gateoverflow.in/3385>

Selected Answer

Answer: D

I. no need to go from 285 to 376 as 273 is less than 285.

II. no need to go from 381 to 472 as 273 is less than 381.

IV. no need to go from 395 to 463 as 273 is less than 395.

8 votes

-- Rajarshi Sarkar (29.7k points)

**17.7.22 Binary Tree: GATE2008-IT\_72** [top](#)<http://gateoverflow.in/3386>

Selected Answer

A) Incorrect because I & IV are not in ascending order.(Inorder sequence of BST is in increasing order)

B)I is a preorder sequence of some BST with 439 as the root . False because if 439 is root, it should be first element in preorder.

D) IV is a postorder sequence of some BST with 149 as the root, False because if 149 is root, it should be last element in postorder

C) This is correct.

6 votes

-- Akash (31.7k points)

**17.7.23 Binary Tree: GATE2008-IT\_73** [top](#)<http://gateoverflow.in/3387>



Selected Answer

for distinct bst we apply this formula

$$C(2n, n) / n+1$$

$$n=3 \text{ here so } C(6, 3)=20$$

$$\text{abd } 20/4=5$$

so ans is 5

9 votes

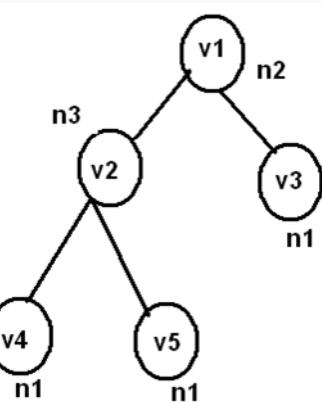
-- Abhimanyu Kumar (189 points)

### 17.7.24 Binary Tree: GATE2008-IT\_76 top

<http://gateoverflow.in/3390>



Selected Answer



assume the above tree so value of n1 is 3 n2 =1 n3 =1 check with options now u vil get option B as correct

14 votes

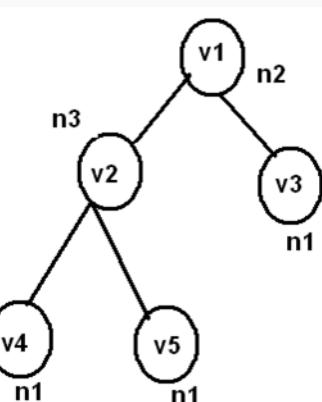
-- Shreyans Dhankhar (2.4k points)

### 17.7.25 Binary Tree: GATE2008-IT\_77 top

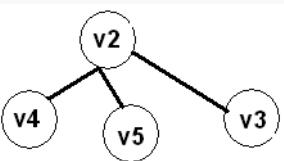
<http://gateoverflow.in/3391>



Selected Answer



from above tree we will get the tree below



now check with the options u vil get a as answer

11 votes

-- Shreyans Dhankhar (2.4k points)

### 17.7.26 Binary Tree: GATE2006-IT\_73 [top](#)

<http://gateoverflow.in/3617>



Selected Answer

Floor( $\log(i+1)$ ) draw the tree and realise that the last element at each level is the best choice to arrive at a conclusion

7 votes

-- Bhagirathi Nayak (11.3k points)

### 17.7.27 Binary Tree: GATE2006-IT\_9 [top](#)

<http://gateoverflow.in/3548>



Selected Answer

In a binary Tree,

no of nodes of degree 2 = no of leaves - 1.

No of nodes of degree 1 do not affect no of leaves !

No of leafs = No of nodes of degree 2 + 1 = 10 + 1 = 11

9 votes

-- Akash (31.7k points)

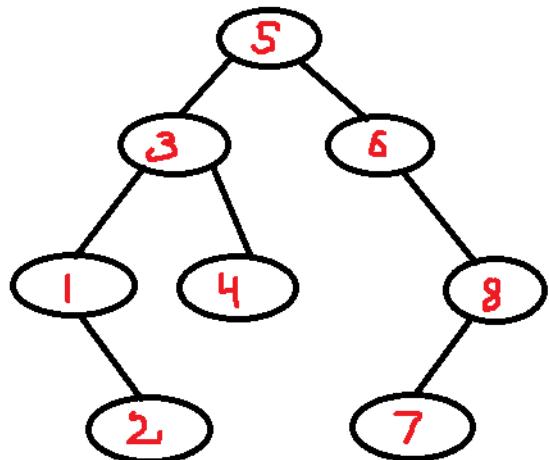
### 17.7.28 Binary Tree: GATE2005-IT\_55 [top](#)

<http://gateoverflow.in/3816>



Selected Answer

Answer is D.



7 votes

-- Gate Keeda (17.7k points)

### 17.7.29 Binary Tree: TIFR2013-B-13 top

<http://gateoverflow.in/25775>



Selected Answer

The correct answer is option c,  $\Theta(\sqrt{n})$ .

$$n = 1 + 2 + 3 + \dots + (h + 1)$$

$$= \frac{(h+1)(h+2)}{2}$$

$$2n = h^2 + 3n + 2$$

$$0 = h^2 + 3n + (2 - 2n)$$

$$\Rightarrow h = \frac{-3 + \sqrt{3^2 - 4 \cdot (2 - 2n)}}{2} \quad \because h \geq 0$$

$$= \frac{-3 + \sqrt{8n + 1}}{2}$$

$$\Rightarrow h = \Theta(\sqrt{n})$$

12 votes

-- Pragy Agarwal (14.4k points)

### 17.7.30 Binary Tree: GATE2015-2\_10 [top](#)

<http://gateoverflow.in/8059>



Selected Answer

19

In Binary tree If there are N leaf nodes then the number of Nodes having two children will be N-1. So in this case answer will be 20-1, means 19.

10 votes

-- Raghuveer Dhakad (969 points)

### 17.7.31 Binary Tree: GATE2001-14 [top](#)

<http://gateoverflow.in/755>

ans for C :

S1:  $y = \text{depth}(t \rightarrow \text{right})$

S2:  $\text{return}(1 + x)$

S3:  $\text{return}(1 + y)$

5 votes

-- jayendra (6.6k points)

### 17.7.32 Binary Tree: GATE2006\_13 [top](#)

<http://gateoverflow.in/974>



Selected Answer

should be D...

Since binary tree can be of any form, the worst case happens for right skewed binary tree. Now, root goes to index 1, its child goes to index 3, its child goes to index 7 and so on the nth vertex goes to  $2^n - 1$  th index of array.

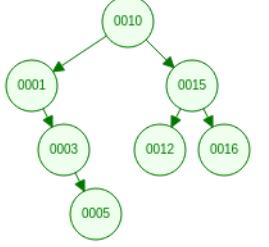
9 votes

-- Shaun Patel (5.8k points)

### 17.7.33 Binary Tree: GATE2004-4, ISRO2009-26 [top](#)

<http://gateoverflow.in/1001>

 Selected Answer



**Height is 3**

5 votes -- Anirudh Pratap Singh (17.7k points)

### 17.7.34 Binary Tree: GATE2003\_6 top

<http://gateoverflow.in/897>

 Selected Answer

The summation is for each node, if that node happens to be the root. When a node is root, it will have  $(k-1)$  nodes on the left sub tree ( $k$  being any number) and correspondingly  $(n-k)$  elements on the right sub tree. So, we can write recurrence  $T(k-1) * T(n-k)$  for the number of distinct binary search trees, as the numbers on left and right sub trees form BSTs independent of each other and only a difference in one of the sub trees produces a difference in the tree. Hence, answer is B.

Knowing the direct formula can also help in getting the answer but is not recommended.

[http://gatecse.in/wiki/Number\\_of\\_Binary\\_trees\\_possible\\_with\\_n\\_nodes](http://gatecse.in/wiki/Number_of_Binary_trees_possible_with_n_nodes)

7 votes -- Arjun Suresh (150k points)

### 17.7.35 Binary Tree: GATE2004\_35 top

<http://gateoverflow.in/1032>

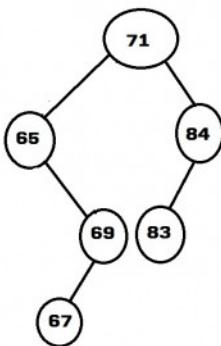
Option b is correct i just draw a tree wrote the preorder,inorder,postorder,level order traversals I find out the options I and IV cant derive a unique tree.

4 votes -- Bhagirathi Nayak (11.3k points)

### 17.7.36 Binary Tree: GATE2015-3\_13 top

<http://gateoverflow.in/8409>

 Selected Answer



on last level 67 , hence option B is True.

9 votes

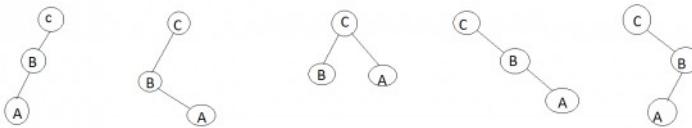
-- Bran Stark (339 points)

### 17.7.37 Binary Tree: GATE2002\_6 top

<http://gateoverflow.in/859>



Selected Answer



5 Binary trees

4 votes

-- Anu (9k points)

### 17.7.38 Binary Tree: GATE1991\_01,viii top

<http://gateoverflow.in/506>



Selected Answer

This is straightforward. The nodes of the given tree are given in square boxes. The weights associated with the nodes are the numbers example 15,9,10 etc.

Weighted path length =  $\sum$ (for(each node in the tree) (path length)\*(weight of the node) ).

So answer (written in **path\_length\*weight** form) =  $4*2 + 4*4 + 4*5 + 4*7 + 3*9 + 3*10 + 1*15 = \underline{\underline{144}}$

14 votes

-- arvchamp (171 points)

### 17.7.39 Binary Tree: GATE2004\_43 top

<http://gateoverflow.in/1040>



Selected Answer

It calculates Height of tree. (D)

Easy way to get this answer .

Draw a tree where all 4 parameters are different.

Get a Tree for which Height, No of Internal Nodes & No of Leafs are different & Trace out this algorithm.

3 votes

-- Akash (31.7k points)

### 17.7.40 Binary Tree: GATE2007\_12 [top](#)

<http://gateoverflow.in/1210>



Selected Answer

$2^{h+1} - 1$  just try this taking a small complete binary

never try to remember these formulae as remembering formulae is an overhead try to take examples in such cases

5 votes

-- Bhagirathi Nayak (11.3k points)

### 17.7.41 Binary Tree: GATE1991\_14,c [top](#)

<http://gateoverflow.in/43027>



Selected Answer

By looking at the values it is clear that It is a **Min-Heap** Data structures. We know that, Heap Data structures are stored in the array.

**==> Delete procedure for Min-Heap Data Structure (If you already know value and position of the node):**

1) Replace that node with the last element of that tree.

2) Apply Heapify property on that node.

For Example, Let If I want to delete 1, then I will replace that with 27. and apply heapify on that node. Or if i want to delete 5 then I will replace that with 17, and apply heapify on that node.

**Time Complexity:** In this case time complexity will not be more than  $O(\log n)$ .

**==> Delete procedure for Min-Heap Data Structure (If you know the value but not position) :**

**1)** Find the position of the number by sequential search. (In worst case it will take  $O(n)$  time).

2) Replace that node with the last element of that tree.

3) Apply heapify property at that node.

Time Complexity: Worst time complexity of this algorithm will be  **$O(n + \log n)$  i.e.  $O(n)$** .

**Note:** This is a standard problem of Minimum element deletion from Min-heap tree. Minimum element always resides at top (Root node). We just replace that value with the last element of the tree and apply heapify at the root node. Time complexity of that algorithm is  **$O(\log n)$** .

Here I have written second method only to show that if we have to delete any of the node, and we just know the value but not the position. Since in question it is mentioned that **Arbitrary node**.

9 votes

-- Rude Maverick (22.6k points)

### 17.7.42 Binary Tree: GATE1991-1,ix [top](#)

<http://gateoverflow.in/502>



Selected Answer

41673258

6 votes

-- Keith Kr (6k points)

**17.7.43 Binary Tree: GATE2002\_2.12** top<http://gateoverflow.in/822>

Selected Answer

Total number of nodes can be described by the recurrence

$$\begin{aligned} T(n) &= T((n-1)/3) + T(2(n-1)/3) + 1 \\ T(1) &= 1 \end{aligned}$$

As this makes maximum nodes go to one subtree and that is what we want to get the maximum height with a given number of nodes.

Now, the height of the tree will be

$$\begin{aligned} H(n) &= H(2/3(n-1)) + 1 \\ H(1) &= 0 \end{aligned}$$

We can draw a recurrence tree and the cost at each level is 1, and the height will be  $\log_{(3/2)}n$ .  
So, D option is the answer.

14 votes

-- Arjun Suresh (150k points)

**17.7.44 Binary Tree: GATE2015-1\_25** top<http://gateoverflow.in/8223>

Selected Answer

option A is correct because height 5 means level 6 so maximum node =  $2^6 - 1 = 63$   
and for minimum, at each level only single node so total 6

18 votes

-- Anoop Sonkar (4.5k points)

**17.7.45 Binary Tree: GATE1991\_14,b** top<http://gateoverflow.in/43026>

Selected Answer

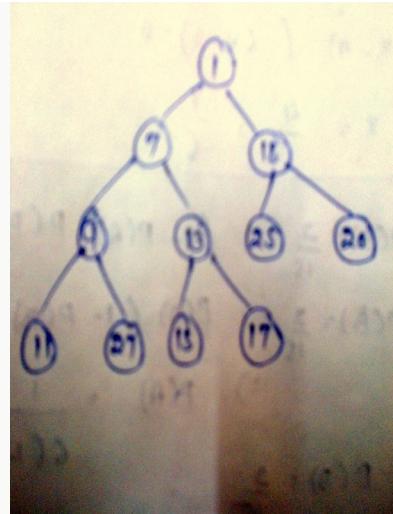
Since given Binary tree is minheap tree.

First swap 27 and 5

Then delete 5

Apply Minheapyfy

And Structure will be



3 votes

-- Manoj Kumar (23.1k points)

### 17.7.46 Binary Tree: GATE2005\_33 [top](#)

<http://gateoverflow.in/1369>



Selected Answer

in order traversal of b binary search tree returns the element in sorted order - ascending (inorder is left parent then right. in a bst left is less than parent and right is greater than parent). In this option 1 is the only sorted list. hence it is the only possibility

7 votes

-- Sankaranarayanan P.N (9.8k points)

### 17.7.47 Binary Tree: GATE2015-1\_23 [top](#)

<http://gateoverflow.in/8221>



Selected Answer

option b, both happens when the BST is skewed.

10 votes

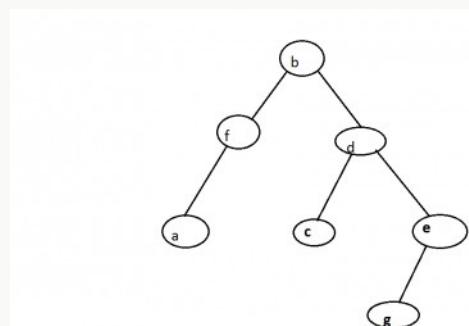
-- GATERush (1.1k points)

### 17.7.48 Binary Tree: GATE1998\_20 [top](#)

<http://gateoverflow.in/1734>



Selected Answer



binary tree

6 votes

-- Anu (9k points)

**17.7.49 Binary Tree: GATE2015-1\_10** [top](#)<http://gateoverflow.in/8129>

option A is right .. chek for left root right rule

6 votes

-- Anoop Sonkar (4.5k points)

**17.7.50 Binary Tree: GATE1991\_14,a** [top](#)<http://gateoverflow.in/511>

Selected Answer

(A) This is min heap. It is obvious looking at tree.

(B) Assuming that we have stored this heap in array structure, Procedure -&gt;

1. Search for element 5 using sequential search in array.

2. Swap it with last element in this case 27.

3. Bubble down it so that min heap property is satisfied.

(C) Deleting element from min heap ,  $O(\log n)$  , but for searching in Heap we need  $O(N)$ So time complexity of sequential search + Delete =  $> O(N) + O(\log N) = O(N)$ .

We can't use binary search as it is heap.

8 votes

-- Akash (31.7k points)

**17.7.51 Binary Tree: GATE2013\_7** [top](#)<http://gateoverflow.in/1416>

Selected Answer

Option (C) is True .

Suppose that we need to insert a node z such that  $k = \text{key}[z]$ . Using binary search we find a nil such that replacing it by z does not break the BST-property**BST-Insert(x, z, k)**

1. : if  $x = \text{nil}$  then return "Error"
2. :  $y \leftarrow x$
3. : while true do {
4. : if  $\text{key}[y] < k$
5. : then  $z \leftarrow \text{left}[y]$
6. : else  $z \leftarrow \text{right}[y]$
7. : if  $z = \text{nil}$  break
8. : }
9. : if  $\text{key}[y] > k$  then  $\text{left}[y] \leftarrow z$
10. : else  $\text{right}[p[y]] \leftarrow z$

**Time Complexity Analysis :**

1. Best Case =  $O(1)$  , When it is smallest/greatest element and BST contains only all greater/smaller element than inserting element respectively.
2. Avg Case =  $O(\log n)$  , When it belongs between some elements .
3. Worst Case =  $O(n)$  , When it is smallest/greatest element and BST contains only all smaller/greater element than inserting element respectively.

9 votes

-- Bhagirathi Nayak (11.3k points)

**17.7.52 Binary Tree: TIFR2012-B-16** [top](#)<http://gateoverflow.in/25214>

sum of resistor when in series =  $r_1 + r_2$

sum of resistor when in parallel

$$\frac{1}{r_{total}} = \frac{1}{r_1} + \frac{1}{r_2}$$

$$r_{total} = \frac{r_1 \cdot r_2}{r_1 + r_2}$$

Every node sibling are in parallel

and sum of each level are in series and all node of last level are tied so all are in series

so total sum of resistor = root + total of level 2 + total of level 3 + .....+ total of level n-1 + total of level n (in series)

| level       | number of node |
|-------------|----------------|
| 1           | 1              |
| $2^0$       |                |
| 2           | 2              |
| $2^1$       |                |
| 3           | 4              |
| $2^2$       |                |
| 4           | 8              |
| $2^3$       |                |
| .           |                |
| $n-1$       | {              |
| $2^{n-2}$ } | {              |
| n           |                |
| $2^{n-1}$ } |                |

so total sum of resistor = root + total of level 2 + total of level 3 + .....+ total of level n-1 + total of level n (series)  
 $= 1 + r/2 + r/4 + r/8 + r/16 + \dots + r/2^{n-2}$

$2^{n-2}$  times) here  $r = 1$

$= 1 + \{1/2 + 1/4 + 1/8 + \dots + 1/2^{n-2}\}$

(decreasing gp) +  $\{(1+1+1+\dots)\}$

$2^{n-1}$  times})\$

$= (2^n)$  approx  
option A

0 votes

-- Umang Raman (11.3k points)

**17.8****Bst** [top](#)**17.8.1 Bst: TIFR2010-B-26** [top](#)<http://gateoverflow.in/18749>

Suppose there is a balanced binary search tree with  $n$  nodes, where at each node, in addition to the key, we store the number of elements in the sub tree rooted at that node.

Now, given two elements  $a$  and  $b$ , such that  $a < b$ , we want to find the number of elements  $x$  in the tree that lie between  $a$  and  $b$ , that is,  $a \leq x \leq b$ . This can be done with (choose the best solution).

- A.  $O(\log n)$  comparisons and  $O(\log n)$  additions.
- B.  $O(\log n)$  comparisons but no further additions.
- C.  $O(\sqrt{n})$  comparisons but  $O(\log n)$  additions.
- D.  $O(\log n)$  comparisons but a constant number of additions.
- E.  $O(n)$  comparisons and  $O(n)$  additions, using depth-first- search.

tifr2010 binary-search-tree bst

Answer

**Answers: Bst****17.8.1 Bst: TIFR2010-B-26** top<http://gateoverflow.in/18749>

Answer should be (D).

We first find  $a$  in the BST in  $O(\log n)$  time. Now there are two possibilities,  $b$  can be in the right subtree of  $a$  or  $b$  can be in the right subtree of any of the parents of  $a$ . For the first case, we simply search for  $b$ , in the right subtree of  $a$  and at each step we add the number of elements in the left subtree +1 (**BST being balanced, this can be retrieved from the depth of the node without any finding method**), if we are moving right and simply 1 if we are moving left. When we find  $b$ , this sum will give us the required number of elements. This requires  $O(\log n)$  additions but we can do smarter by doing

$$N(a) - N(\text{LEFT}(a)) - N(\text{RIGHT}(b))$$

where,  $N(x)$  denote the no. of elements in the subtree rooted at  $x$  and if  $\text{LEFT}(a)$ ,  $\text{RIGHT}(b)$  returning 0 for NULL.

For the second case also we do the same method. But first we find the common ancestor of  $a$  and  $b$  (possible in  $O(\log n)$ - say  $p$  and also count the no. of nodes in the right subtree of each node from  $a$  to  $p$  excluding  $p$ . Now, from  $p$  to  $a$  we proceed the counting as in the earlier case when  $b$  was in the subtree at  $a$ . So, in the worst case we have to do  $O(\log n)$  additions. Here, also we can reduce the no. of additions by doing

$$N(p) - N(\text{LEFT}(a)) - N(\text{RIGHT}(b))$$

where,  $N(x)$  denote the no. of elements in the subtree rooted at  $x$  and if  $\text{LEFT}(a)$ ,  $\text{RIGHT}(b)$  returning 0 for NULL.

6 votes

-- Arjun Suresh (150k points)

**17.9****Counting** top**17.9.1 Counting: GATE2000-5** top<http://gateoverflow.in/676>

A multiset is an unordered collection of elements where elements may repeat any number of times. The size of a multiset is the number of elements in it, counting repetitions.

- a. What is the number of multisets of size 4 that can be constructed from  $n$  distinct elements so that at least one element occurs exactly twice?
- b. How many multisets can be constructed from  $n$  distinct elements?

gate2000 combinatorics counting normal

Answer

**Answers: Counting****17.9.1 Counting: GATE2000-5** top<http://gateoverflow.in/676>

Selected Answer

A) There are four places to be filled in the multiset using the  $n$  distinct elements. Atleast one element has to occur exactly twice. That would leave 2 more places in the multiset. This means, atmost two elements can occur exactly twice. We can thus divide this into 2 mutually exclusive cases as follows:

Exactly one element occurs exactly twice:

Select this element in  $n$  ways.

Fill up the remaining two spots using 2 distinct elements from the remaining  $n-1$  elements in  $(n-1)C_2$  ways .

Exactly two elements that occur twice each: These two will fill up the multiset,

so you only have to select two elements out of  $n$  in  $nC_2$

Since these are mutually exclusive, the total number of ways to form the multiset is:  $nC_2 + n \cdot (n-1)C_2$

B) there are infinite number of sets as  $n$  is unbounded.

ref : <http://cs.stackexchange.com/questions/7578/multisets-of-a-given-set>

5 votes

-- Pranay Datta (6.8k points)

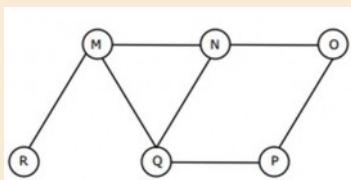
## 17.10

## Graph Algorithms top

### 17.10.1 Graph Algorithms: GATE2008-19 top

<http://gateoverflow.in/417>

The Breadth First Search algorithm has been implemented using the queue data structure. One possible order of visiting the nodes of the following graph is



- A. MNOPQR
- B. NQMPOR
- C. QMNPRO
- D. QMNPOR

[gate2008](#) [normal](#) [data-structure](#) [graph-algorithms](#)

[Answer](#)

## Answers: Graph Algorithms

### 17.10.1 Graph Algorithms: GATE2008-19 top

<http://gateoverflow.in/417>



Selected Answer

- A) MNOPQR -> If you try to run BFS, after M, you must traverse NQR (In some order) Here P is traversed before Q, which is wrong.
- B) NQMPOR -> This is also not BFS. P is traversed before O !
- C) QMNPRO -> Correct
- D) QMNPOR -> Incorrect. Because R need to be traversed before O.(Because M is ahead of N in queue).

Answer :- > C

2 votes

-- Akash (31.7k points)

## 17.11

## Hashing top

**17.11.1 Hashing: GATE2010-52** [top](#)<http://gateoverflow.in/2360>

A hash table of length 10 uses open addressing with hash function  $h(k) = k \bmod 10$ , and linear probing. After inserting 6 values into an empty hash table, the table is shown as below

|   |    |
|---|----|
| 0 |    |
| 1 |    |
| 2 | 42 |
| 3 | 23 |
| 4 | 34 |
| 5 | 52 |
| 6 | 46 |
| 7 | 33 |
| 8 |    |
| 9 |    |

Which one of the following choices gives a possible order in which the key values could have been inserted in the table?

- A. 46, 42, 34, 52, 23, 33
- B. 34, 42, 23, 52, 33, 46
- C. 46, 34, 42, 23, 52, 33
- D. 42, 46, 33, 23, 34, 52

[gate2010](#) [data-structure](#) [hashing](#) [difficult](#)

**Answer**

**17.11.2 Hashing: GATE2004\_7** [top](#)<http://gateoverflow.in/1004>

Given the following input (4322, 1334, 1471, 9679, 1989, 6171, 6173, 4199) and the hash function  $x \bmod 10$ , which of the following statements are true?

- I. 9679, 1989, 4199 hash to the same value
- II. 1471, 6171 hash to the same value
- III. All elements hash to the same value
- IV. Each element hashes to a different value
  
- A. I only
- B. II only
- C. I and II only
- D. III or IV

[gate2004](#) [data-structure](#) [hashing](#) [easy](#)

**Answer**

**17.11.3 Hashing: GATE2007-IT-28** [top](#)<http://gateoverflow.in/3461>

Consider a hash function that distributes keys uniformly. The hash table size is 20. After hashing of how many keys will the probability that any new key hashed collides with an existing one exceed 0.5.

- A. 5

- B. 6  
C. 7  
D. 10

[gate2007-it](#) [data-structure](#) [hashing](#) [probability](#) [normal](#)

[Answer](#)

#### 17.11.4 Hashing: GATE2014-1\_40 [top](#)

<http://gateoverflow.in/1918>

Consider a hash table with 9 slots. The hash function is  $h(k) = k \bmod 9$ . The collisions are resolved by chaining. The following 9 keys are inserted in the order: 5, 28, 19, 15, 20, 33, 12, 17, 10. The maximum, minimum, and average chain lengths in the hash table, respectively, are

- (A) 3, 0, and 1  
(B) 3, 3, and 3  
(C) 4, 0, and 1  
(D) 3, 0, and 2

[gate2014-1](#) [data-structure](#) [hashing](#) [normal](#)

[Answer](#)

#### 17.11.5 Hashing: GATE2010-53 [top](#)

<http://gateoverflow.in/43327>

A hash table of length 10 uses open addressing with hash function  $h(k) = k \bmod 10$ , and linear probing. After inserting 6 values into an empty hash table, the table is shown as below

|   |    |
|---|----|
| 0 |    |
| 1 |    |
| 2 | 42 |
| 3 | 23 |
| 4 | 34 |
| 5 | 52 |
| 6 | 46 |
| 7 | 33 |
| 8 |    |
| 9 |    |

How many different insertion sequences of the key values using the same hash function and linear probing will result in the hash table shown above?

- A. 10  
B. 20  
C. 30  
D. 40

[data-structure](#) [hashing](#) [difficult](#) [gate2010](#)

[Answer](#)

#### 17.11.6 Hashing: GATE2006-IT\_20 [top](#)

<http://gateoverflow.in/3559>

Which of the following statement(s) is TRUE?

- I. A hash function takes a message of arbitrary length and generates a fixed length code.  
II. A hash function takes a message of fixed length and generates a code of variable length.  
III. A hash function may give the same hash value for distinct messages.

- A) I only  
B) II and III only

- C) I and III only  
 D) II only

gate2006-it | data-structure | hashing | normal

[Answer](#)

### 17.11.7 Hashing: GATE2005-IT\_16 [top](#)

<http://gateoverflow.in/3761>

A hash table contains 10 buckets and uses linear probing to resolve collisions. The key values are integers and the hash function used is  $\text{key \% 10}$ . If the values 43, 165, 62, 123, 142 are inserted in the table, in what location would the key value 142 be inserted?

- |    |   |
|----|---|
| A) | 2 |
| B) | 3 |
| C) | 4 |
| D) | 6 |

gate2005-it | data-structure | hashing | easy

[Answer](#)

### 17.11.8 Hashing: GATE2014-3\_40 [top](#)

<http://gateoverflow.in/2074>

Consider a hash table with 100 slots. Collisions are resolved using chaining. Assuming simple uniform hashing, what is the probability that the first 3 slots are unfilled after the first 3 insertions?

- (A)  $(97 \times 97 \times 97)/100^3$
- (B)  $(99 \times 98 \times 97)/100^3$
- (C)  $(97 \times 96 \times 95)/100^3$
- (D)  $(97 \times 96 \times 95)/(3! \times 100^3)$

gate2014-3 | data-structure | hashing | probability | normal

[Answer](#)

### 17.11.9 Hashing: GATE2008-IT\_48 [top](#)

<http://gateoverflow.in/3358>

Consider a hash table of size 11 that uses open addressing with linear probing. Let  $h(k) = k \bmod 11$  be the hash function used. A sequence of records with keys

43 36 92 87 11 4 71 13 14

is inserted into an initially empty hash table, the bins of which are indexed from zero to ten. What is the index of the bin into which the last record is inserted?

- |    |   |
|----|---|
| A) | 3 |
| B) | 4 |
| C) | 6 |
| D) | 7 |

gate2008-it | data-structure | hashing | normal

[Answer](#)

### 17.11.10 Hashing: GATE1996\_15 [top](#)

<http://gateoverflow.in/2767>

Insert the characters of the string K R P C S N Y T J M into a hash table of size 10.

Use the hash function

$$h(x) = (\text{ord}(x) - \text{ord}("a") + 1) \mod 10$$

and linear probing to resolve collisions.

- a. Which insertions cause collisions?
- b. Display the final hash table.

[gate1996](#) [data-structure](#) [hashing](#) [normal](#)

[Answer](#)

### 17.11.11 Hashing: GATE1989, ISRO2015-14 [top](#)

<http://gateoverflow.in/10905>

A hash table with ten buckets with one slot per bucket is shown in the following figure. The symbols S1 to S7 initially entered using a hashing function with linear probing. The maximum number of comparisons needed in searching an item that is not present is

|   |    |
|---|----|
| 0 | S7 |
| 1 | S1 |
| 2 |    |
| 3 | S4 |
| 4 | S2 |
| 5 |    |
| 6 | S5 |
| 7 |    |
| 8 | S6 |
| 9 | S3 |

- A. 4
- B. 5
- C. 6
- D. 3

[hashing](#) [isro2015](#) [gate1989](#)

[Answer](#)

### 17.11.12 Hashing: GATE1996\_1.13 [top](#)

<http://gateoverflow.in/2717>

An advantage of chained hash table (external hashing) over the open addressing scheme is

- A. Worst case complexity of search operations is less
- B. Space used is less
- C. Deletion is easier
- D. None of the above

[gate1996](#) [data-structure](#) [hashing](#) [normal](#)

[Answer](#)

### 17.11.13 Hashing: GATE1997\_12 [top](#)

<http://gateoverflow.in/2272>

Consider a hash table with  $n$  buckets, where external (overflow) chaining is used to resolve collisions. The hash function is such that the probability that a key value is hashed to a particular bucket is  $\frac{1}{n}$ . The hash table is initially empty and  $K$

distinct values are inserted in the table.

- A. What is the probability that bucket number 1 is empty after the  $K^{th}$  insertion?
- B. What is the probability that no collision has occurred in any of the  $K$  insertions?
- C. What is the probability that the first collision occurs at the  $K^{th}$  insertion?

[gate1997](#) | [data-structure](#) | [hashing](#) | [probability](#) | [normal](#)

[Answer](#)

### 17.11.14 Hashing: GATE2009-36 [top](#)

<http://gateoverflow.in/1322>

The keys 12, 18, 13, 2, 3, 23, 5 and 15 are inserted into an initially empty hash table of length 10 using open addressing with hash function  $h(k) = k \bmod 10$  and linear probing. What is the resultant hash table?

**A**

|   |    |
|---|----|
| 0 |    |
| 1 |    |
| 2 | 2  |
| 3 | 23 |
| 4 |    |
| 5 | 15 |
| 6 |    |
| 7 |    |
| 8 | 18 |
| 9 |    |

**B**

|   |    |
|---|----|
| 0 |    |
| 1 |    |
| 2 | 12 |
| 3 | 13 |
| 4 |    |
| 5 | 5  |
| 6 |    |
| 7 |    |
| 8 | 18 |
| 9 |    |

**C**

|   |    |
|---|----|
| 0 |    |
| 1 |    |
| 2 | 12 |
| 3 | 13 |
| 4 | 2  |
| 5 | 3  |
| 6 | 23 |
| 7 | 5  |
| 8 | 18 |
| 9 | 15 |

**D**

|   |           |
|---|-----------|
| 0 |           |
| 1 |           |
| 2 | 2, 12     |
| 3 | 13, 3, 23 |
| 4 |           |
| 5 | 5, 15     |
| 6 |           |
| 7 |           |
| 8 | 18        |
| 9 |           |

[gate2009](#) | [data-structure](#) | [hashing](#) | [normal](#)

[Answer](#)

### Answers: Hashing

### 17.11.1 Hashing: GATE2010-52 [top](#)

<http://gateoverflow.in/2360>



Selected Answer

Option C

46, 34, 42, 23, 52, 33

46 - position 6

34 position 4

42 position 2

23 position 3

52 position 2 - collision next empty is 5

33 position 3- collision next empty is 7

4 votes

-- Sankaranarayanan P.N (9.8k points)

### 17.11.2 Hashing: GATE2004\_7 [top](#)

<http://gateoverflow.in/1004>



Selected Answer

option c is correct because the last digit of every digit given is equal in i and ii

4 votes

-- Bhagirathi Nayak (11.3k points)

### 17.11.3 Hashing: GATE2007-IT-28 top

<http://gateoverflow.in/3461>



Selected Answer

The question is a bit ambiguous.

After hashing of how many keys, will the probability that any new key hashed collides with an existing one exceed 0.5.

Here, 'new key hashed' is the ambiguity. It can mean the probability of a collision in the next 'hash', or the probability of a collision in any of the hashes of the 'new keys'. For the first case answer must be 10 to get probability equal to 0.5, and so 11 must be the answer for probability > 0.5. Thus we can conclude from given choices, it is the second case.

So, we need to find  $n$  such that after  $n$  hashes, probability of collision > 0.5.

Probability that there will be a collision after  $n$  hashes = 1 - Probability that there won't be a collision after  $n$  hashes

$$= 1 - 1 \cdot \frac{19}{20} \cdot \frac{18}{20} \cdots \frac{20-n+1}{20} .$$

So, we need,

$$0.5 < 1 - 1 \cdot \frac{19}{20} \cdot \frac{18}{20} \cdots \frac{20-n+1}{20} .$$

$$\implies \frac{19}{20} \cdot \frac{18}{20} \cdots \frac{20-n+1}{20} < 0.5 .$$

For

$n = 5$ , we get,

0.5814 and for

$n = 6$ , we get

0.43605. So, answer should be

$n = 6$ .

Ref: <http://www.cse.iitd.ernet.in/~bagchi/courses/discrete-book/ch5.pdf>

9 votes

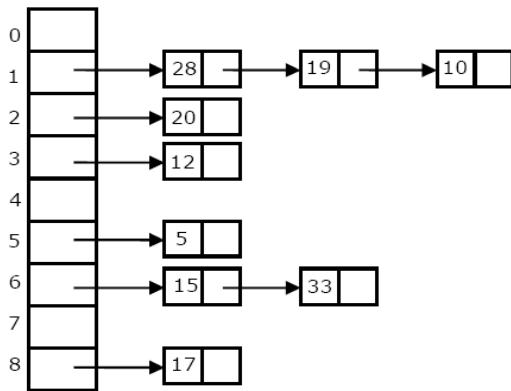
-- Arjun Suresh (150k points)

### 17.11.4 Hashing: GATE2014-1\_40 top

<http://gateoverflow.in/1918>



Selected Answer



**So, Maximum & minimum chain lengths are 3 & 0 respectively.**

**Average chain length =  $(0+3+1+1+0+1+2+0+1)/9 = 1$ .**

**So, Ans is A**

7 votes

-- Jay (1,1k points)

### 17.11.5 Hashing: GATE2010-53 [top](#)

<http://gateoverflow.in/43327>



Selected Answer

53 - option (C).

Slots 3,4,5 and 6 must be filled before 33 comes. Similarly slots 2,3 and 4 must be filled before 52 comes. And 52 must come before 33, as it is not occupying slot 2. So, 33 must be at the end and 52 can come at position 4 or 5.

Let 52 come at position 4. Slots 2, 3 and 4 must be filled before 52 leaving only slot 6 left for the element coming at position 5 which should be 46. So, the first 3 elements can come in any order giving  $3! = 6$  ways.

Let 52 come at position 5. Now, the first four elements can come in any order. So,  $4! = 24$  ways.

So, total number of different insertion sequences possible =  $24 + 6 = 30$

13 votes

-- Arjun Suresh (150k points)

### 17.11.6 Hashing: GATE2006-IT\_20 [top](#)

<http://gateoverflow.in/3559>



Selected Answer

Answer is C)

I) A hash function takes a message of arbitrary length and generates a fixed length code.. This is correct, this is directly from definition of hash function. Ref -> [https://en.wikipedia.org/wiki/Hash\\_function](https://en.wikipedia.org/wiki/Hash_function)

II) As I is correct II is wrong !

III) This is true. example :-> Hash function  $N \% 10$ , this will generate same values for 1 as well as 11 !

(Even in cryptographic hash functions collision happens, just it is not easy to find colluding instances !)

4 votes

-- Akash (31,7k points)

### 17.11.7 Hashing: GATE2005-IT\_16 [top](#)

<http://gateoverflow.in/3761>



Selected Answer

- 43 in loc 3  
 165 in loc 5  
 62 in loc 2  
 123 in loc 4 ( collision and next free space)  
 142 in loc 6 (collision in 2, and 3,4,5 already occupied)  
 hence answer D

7 votes

-- Sankaranarayanan P.N (9.8k points)

### 17.11.8 Hashing: GATE2014-3\_40 top

<http://gateoverflow.in/2074>

Selected Answer

We have 100 slots each of which are picked with equal probability by the hash function (since hashing is uniform). So, to avoid first 3 slots, the hash function has to pick from the remaining 97 slots. And repetition is allowed, since chaining is used- meaning a list of elements are stored in a slot and not a single element.

$$\text{So, required probability} = \frac{97}{100} \times \frac{97}{100} \times \frac{97}{100} \\ = (97 \times 97 \times 97)/100^3$$

12 votes

-- Arjun Suresh (150k points)

### 17.11.9 Hashing: GATE2008-IT\_48 top

<http://gateoverflow.in/3358>

Selected Answer

| Index | Key       |
|-------|-----------|
| 0     | 87        |
| 1     | 11        |
| 2     | 13        |
| 3     | 36        |
| 4     | 92        |
| 5     | 4         |
| 6     | 71        |
| 7     | <b>14</b> |
| 8     |           |
| 9     |           |
| 10    | 43        |

D is answer

1 votes

-- Anirudh Pratap Singh (17.7k points)

### 17.11.10 Hashing: GATE1996\_15 top

<http://gateoverflow.in/2767>



Selected Answer

Here Order(x)-Order ('a') means count difference between that character & a.

Assuming a = 0, b = 1 & so on.

- a) J & M cause collision.
- b) Final Hash Table

| Index | Key |
|-------|-----|
| 0     | T   |
| 1     | K   |
| 2     | J   |
| 3     | C   |
| 4     | N   |
| 5     | Y   |
| 6     | P   |
| 7     | M   |
| 8     | R   |
| 9     | S   |

4 votes

-- Akash (31.7k points)

### 17.11.11 Hashing: GATE1989, ISRO2015-14 top

<http://gateoverflow.in/10905>



Selected Answer

No of comparison in worst case for an element not in hash table is size of largest cluster +1. This is because the probe stops as soon as an empty slot is found (we r using linear probing here).

Size of largest cluster is 4 (s6, s3, s7, s1)

No of comparison is 4 + 1 = 5

14 votes

-- Digvijay (35.8k points)

### 17.11.12 Hashing: GATE1996\_1.13 top

<http://gateoverflow.in/2717>



Selected Answer

C.

[http://en.wikibooks.org/wiki/Data\\_Structures/Hash\\_Tables#Chaining](http://en.wikibooks.org/wiki/Data_Structures/Hash_Tables#Chaining)

9 votes

-- Gate Keeda (17.7k points)

**17.11.13 Hashing: GATE1997\_12** top<http://gateoverflow.in/2272>

Selected Answer

A) probability that other buckets are selected =  $(n-1)/n$

this should happen  $k$  times and each of  $k$  events are independent so  $(n-1)^k/n^k$

B) when  $k=1$  prob of no collision =  $n/n$

for  $k=2$  prob of no collision =  $n/n * (n-1)/n$

for  $k=k$  prob of no collision =  $n/n * (n-1)/n * (n-2)/n \dots * (n-k+1)/n$  for  $k \leq n$

for  $k > n$  prob = 0

C) prob of collision at  $k=1$  =  $(k-1)/n$

prob of collision at  $k=2$  =  $n/n * (k-1)/n$

prob of collision at  $k=3$  =  $n/n * (n-1)/n * (k-1)/n$

prob of collision at  $k=k$  =  $n/n * (n-1)/n * (n-2)/n \dots * 2/n * (k-1)/n$  for  $k \leq n$

for  $k > n$  prob = 1

4 votes

-- Danish (2.4k points)

**17.11.14 Hashing: GATE2009-36** top<http://gateoverflow.in/1322>

Selected Answer

C is the correct option ..directly from the definition of linear probing. In linear probing, when a hashed location is already filled, locations are linearly probed until a free one is found.

<http://courses.cs.washington.edu/courses/cse326/00wi/handouts/lecture16/sld015.htm>

6 votes

-- Bhagirathi Nayak (11.3k points)

**17.12****Heap** top**17.12.1 Heap: GATE2004-IT\_53** top<http://gateoverflow.in/3696>

An array of integers of size  $n$  can be converted into a heap by adjusting the heaps rooted at each internal node of the complete binary tree starting at the node  $\lfloor(n - 1)/2\rfloor$ , and doing this adjustment up to the root node (root node is at index 0) in the order  $\lfloor(n - 1)/2\rfloor, \lfloor(n - 3)/2\rfloor, \dots, 0$ . The time required to construct a heap in this manner is

- A)  $O(\log n)$
- B)  $O(n)$
- C)  $O(n \log \log n)$
- D)  $O(n \log n)$

[gate2004-it](#) [data-structure](#) [heap](#) [normal](#)

Answer

**17.12.2 Heap: GATE2015-3\_17** top<http://gateoverflow.in/8414>

Given that hash table  $T$  with 25 slots that stores 2000 elements, the load factor  $a$  for  $T$  is \_\_\_\_\_.

[gate2015-3](#)
[data-structure](#)
[heap](#)
[normal](#)
**Answer****17.12.3 Heap: GATE2015-1\_32** [top](#)<http://gateoverflow.in/8273>

Consider a max heap, represented by the array: 40, 30, 20, 10, 15, 16, 17, 8, 4.

| Array index | 1  | 2  | 3  | 4  | 5  | 6  | 7  | 8 | 9 |
|-------------|----|----|----|----|----|----|----|---|---|
| Value       | 40 | 30 | 20 | 10 | 15 | 16 | 17 | 8 | 4 |

Now consider that a value 35 is inserted into this heap. After insertion, the new heap is

- A. 40, 30, 20, 10, 15, 16, 17, 8, 4, 35
- B. 40, 35, 20, 10, 30, 16, 17, 8, 4, 15
- C. 40, 30, 20, 10, 35, 16, 17, 8, 4, 15
- D. 40, 35, 20, 10, 15, 16, 17, 8, 4, 30

[gate2015-1](#)
[data-structure](#)
[heap](#)
[easy](#)
**Answer****17.12.4 Heap: GATE2006-IT\_72** [top](#)<http://gateoverflow.in/3616>

An array X of n distinct integers is interpreted as a complete binary tree. The index of the first element of the array is 0. If only the root node does not satisfy the heap property, the algorithm to convert the complete binary tree into a heap has the best asymptotic time complexity of

- A)  $O(n)$
- B)  $O(\log n)$
- C)  $O(n \log n)$
- D)  $O(n \log \log n)$

[gate2006-it](#)
[data-structure](#)
[binary-tree](#)
[heap](#)
[easy](#)
**Answer****17.12.5 Heap: GATE1996\_2.11** [top](#)<http://gateoverflow.in/2740>

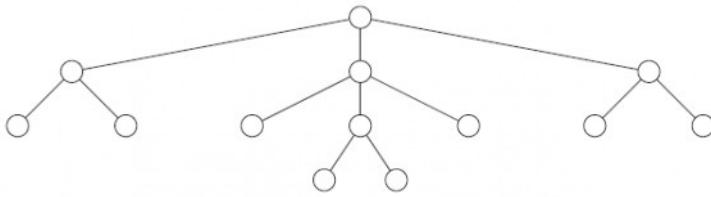
The minimum number of interchanges needed to convert the array into a max-heap is

89, 19, 40, 17, 12, 10, 2, 5, 7, 11, 6, 9, 70

- (a) 0
- (b) 1
- (c) 2
- (d) 3

[gate1996](#)
[data-structure](#)
[heap](#)
[easy](#)
**Answer****17.12.6 Heap: TIFR2014-B-19** [top](#)<http://gateoverflow.in/27352>

Consider the following tree with 13 nodes.



Suppose the nodes of the tree are randomly assigned distinct labels from  $\{1, 2, \dots, 13\}$ , each permutation being equally likely. What is the probability that the labels form a min-heap (i.e., every node receives the minimum label in its subtree)?

- a.  $\left(\frac{1}{6!}\right) \left(\frac{1}{3!}\right)^2$
- b.  $\left(\frac{1}{3!}\right)^2 \left(\frac{1}{2!}\right)^3$
- c.  $\left(\frac{1}{13}\right) \left(\frac{1}{6}\right) \left(\frac{1}{3}\right)^3$
- d.  $\frac{2^2}{13}$
- e.  $\frac{1}{2^{13}}$

[tifr2014](#) [heap](#)

[Answer](#)

### 17.12.7 Heap: GATE2006-IT\_44 [top](#)

<http://gateoverflow.in/3587>

Which of the following sequences of array elements forms a heap?

- A) {23, 17, 14, 6, 13, 10, 1, 12, 7, 5}
- B) {23, 17, 14, 6, 13, 10, 1, 5, 7, 12}
- C) {23, 17, 14, 7, 13, 10, 1, 5, 6, 12}
- D) {23, 17, 14, 7, 13, 10, 1, 12, 5, 7}

[gate2006-it](#) [data-structure](#) [heap](#) [easy](#)

[Answer](#)

### 17.12.8 Heap: GATE2006\_76,77 [top](#)

<http://gateoverflow.in/1852>

Statement for Linked Answer Questions 76 & 77:

A 3-ary max heap is like a binary max heap, but instead of 2 children, nodes have 3 children. A 3-ary heap can be represented by an array as follows: The root is stored in the first location,  $a[0]$ , nodes in the next level, from left to right, is stored from  $a[1]$  to  $a[3]$ . The nodes from the second level of the tree from left to right are stored from  $a[4]$  location onward. An item  $x$  can be inserted into a 3-ary heap containing  $n$  items by placing  $x$  in the location  $a[n]$  and pushing it up the tree to satisfy the heap property.

76. Which one of the following is a valid sequence of elements in an array representing 3-ary max heap?

- (A) 1, 3, 5, 6, 8, 9
- (B) 9, 6, 3, 1, 8, 5
- (C) 9, 3, 6, 8, 5, 1
- (D) 9, 5, 6, 8, 3, 1

77. Suppose the elements 7, 2, 10 and 4 are inserted, in that order, into the valid 3-ary max heap found in the above question, Q.76. Which one of the following is the sequence of items in the array representing the resultant heap?

- (A) 10, 7, 9, 8, 3, 1, 5, 2, 6, 4
- (B) 10, 9, 8, 7, 6, 5, 4, 3, 2, 1
- (C) 10, 9, 4, 5, 7, 6, 8, 2, 1, 3
- (D) 10, 8, 6, 9, 7, 2, 3, 4, 1, 5

[gate2006](#) [data-structure](#) [heap](#) [normal](#)

**Answer****17.12.9 Heap: GATE2005\_34** [top](#)<http://gateoverflow.in/1370>

A priority queue is implemented as a Max-Heap. Initially, it has 5 elements. The level-order traversal of the heap is: 10, 8, 5, 3, 2. Two new elements 1 and 7 are inserted into the heap in that order. The level-order traversal of the heap after the insertion of the elements is:

- (A) 10, 8, 7, 5, 3, 2, 1
- (B) 10, 8, 7, 2, 3, 1, 5
- (C) 10, 8, 7, 1, 2, 3, 5
- (D) 10, 8, 7, 3, 2, 1, 5

[gate2005](#) [data-structure](#) [heap](#) [normal](#)**Answer****17.12.10 Heap: GATE1999\_12** [top](#)<http://gateoverflow.in/1511>

- a. In binary tree, a full node is defined to be a node with 2 children. Use induction on the height of the binary tree to prove that the number of full nodes plus one is equal to the number of leaves.
- b. Draw the min-heap that results from insertion of the following elements in order into an initially empty min-heap: 7, 6, 5, 4, 3, 2, 1. Show the result after the deletion of the root of this heap.

[gate1999](#) [data-structure](#) [binary-tree](#) [heap](#) [normal](#)**Answer****17.12.11 Heap: GATE 2016-2-34** [top](#)<http://gateoverflow.in/39585>

A complete binary min-heap is made by including each integer in  $[1, 1023]$  exactly once. The depth of a node in the heap is the length of the path from the root of the heap to that node. Thus, the root is at depth 0. The maximum depth at which integer 9 can appear is \_\_\_\_\_.

[gate2016-2](#) [data-structure](#) [heap](#) [normal](#) [numerical-answers](#)**Answer****17.12.12 Heap: GATE2015-3\_19** [top](#)<http://gateoverflow.in/8418>

Consider the following array of elements.

$\langle 89, 19, 50, 17, 12, 15, 2, 5, 7, 11, 6, 9, 100 \rangle$

The minimum number of interchanges needed to convert it into a max-heap is

- A. 4
- B. 5
- C. 2
- D. 3

[gate2015-3](#) [data-structure](#) [heap](#) [normal](#)**Answer****17.12.13 Heap: GATE2014-2\_12** [top](#)<http://gateoverflow.in/1967>

A priority queue is implemented as a Max-Heap. Initially, it has 5 elements. The level-order traversal of the heap is: 10, 8, 5, 3, 2. Two new elements 1 and 7 are inserted into the heap in that order. The level-order traversal of the heap after the insertion of the elements is:

- (A) 10, 8, 7, 3, 2, 1, 5  
 (B) 10, 8, 7, 2, 3, 1, 5  
 (C) 10, 8, 7, 1, 2, 3, 5  
 (D) 10, 8, 7, 5, 3, 2, 1

gate2014-2 | data-structure | heap | normal

[Answer](#)

## Answers: Heap

### 17.12.1 Heap: GATE2004-IT\_53 [top](#)

<http://gateoverflow.in/3696>



Selected Answer

By using **Build Heap method** we can create heap from complete binary tree which will take  $O(n)$ .

1 9 votes

-- Sneha Goel (1k points)

### 17.12.2 Heap: GATE2015-3\_17 [top](#)

<http://gateoverflow.in/8414>



Selected Answer

**load factor = total no element / total no of slots**  
 $= > 2000/25 = 80$

1 11 votes

-- Anoop Sonkar (4.5k points)

### 17.12.3 Heap: GATE2015-1\_32 [top](#)

<http://gateoverflow.in/8273>



Selected Answer

Heap is complete binary tree. To insert a new element, we put it at the end of the tree and move up towards root till heap property is satisfied. Here, 35 comes as child of 15, with the path 40-30-15-35. So, we swap 15, 35 and then 30, 35 to get the new path 40-35-30-15. So, new heap will be 40 35 20 10 30 16 17 8 4 15.

1 14 votes

-- Arjun Suresh (150k points)

### 17.12.4 Heap: GATE2006-IT\_72 [top](#)

<http://gateoverflow.in/3616>



Selected Answer

The question is saying best case which will be when only one swap will be required which will be order of 1.  
 As no option matches just call heapify at the root -  $O(\log n)$ .

1 4 votes

-- Ravi Singh (8.2k points)

### 17.12.5 Heap: GATE1996\_2.11 [top](#)

<http://gateoverflow.in/2740>



Selected Answer

"The minimum number of interchanges needed to convert the array 89, 19, 40, 17, 12, 10, 2, 5, 7, 11, 6, 9, 70 into a heap with the maximum element at the root node is:"

This is the correction.

Answer: C.

Only element 70 violates the rule. Hence, it must be shifted to its proper position.

Step1: swap(10, 70)

Step2: swap(40, 70)

Hence, only 2 interchanges are required.

7 votes

-- Gate Keeda (17.7k points)

## 17.12.6 Heap: TIFR2014-B-19 [top](#)

<http://gateoverflow.in/2752>

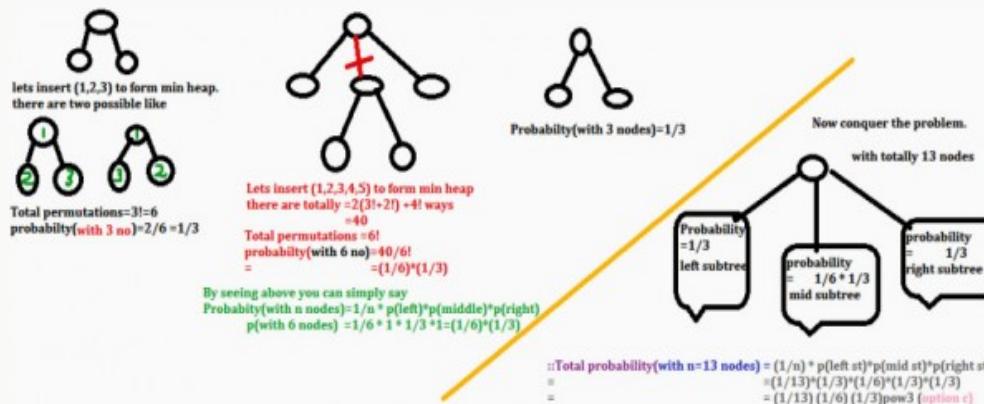


Selected Answer

OPTION C IS CORRECT.

Lets apply ([divide and conquer](#)) to this problem.

First [divide](#) this problem into sub problems. like



Caption

1 votes

-- venky.victory35 (565 points)

## 17.12.7 Heap: GATE2006-IT\_44 [top](#)

<http://gateoverflow.in/3587>



Selected Answer

for a heap(max heap) parent should be greater than or equal to children. in a heap of [1..n] left child of ith node will be at 2\*i th position and right child will be at 2\*i+1 position

so for given options we can verify it

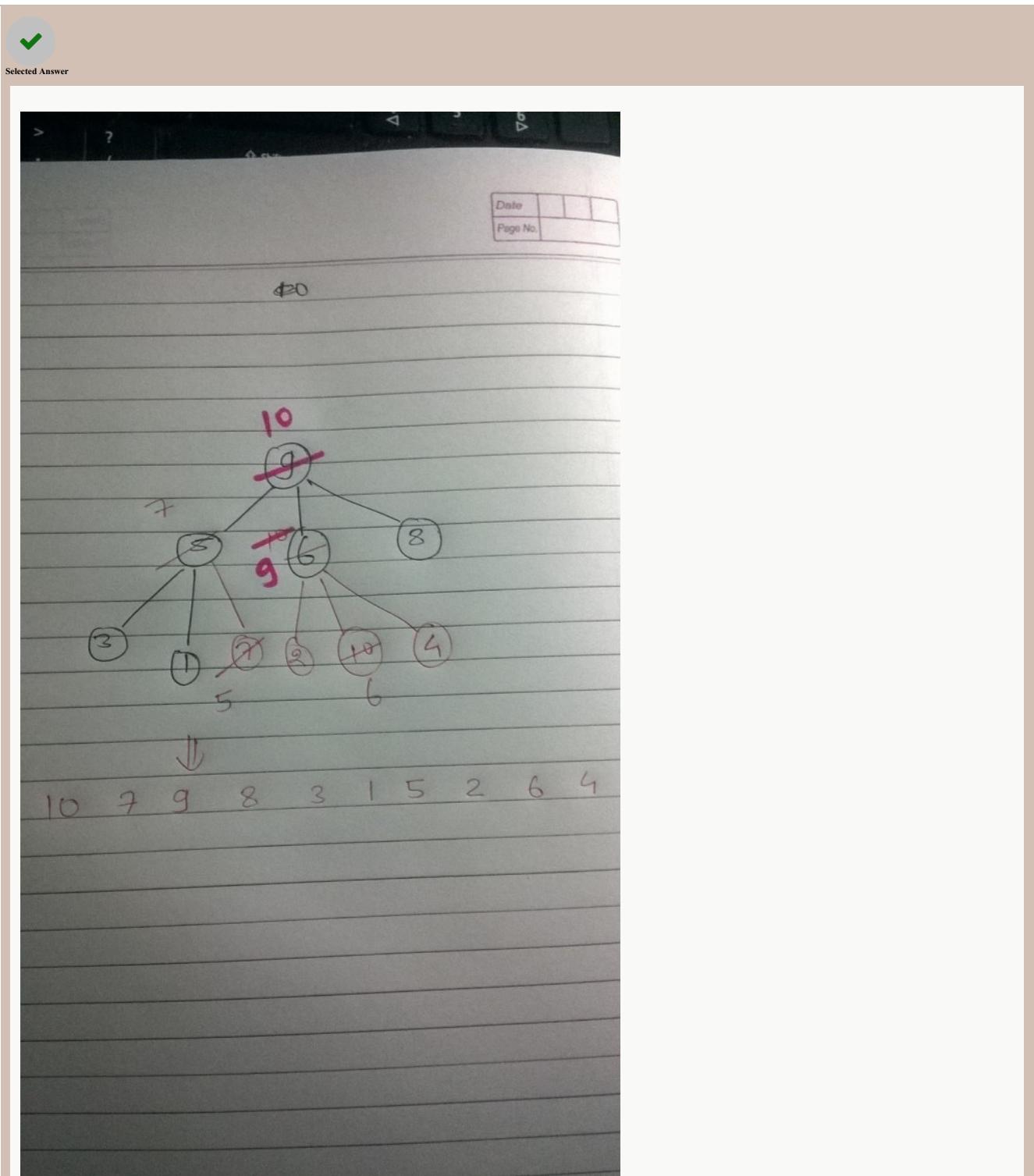
option C seems to be following the property

6 votes

-- Sankaranarayanan P.N (9.8k points)

## 17.12.8 Heap: GATE2006\_76,77 [top](#)

<http://gateoverflow.in/1852>



For 77, heap will be constructed like this, based on the correct answer of 76(which is option D)

6 votes

-- Anurag Pandey (9.7k points)

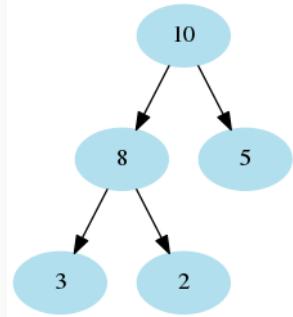
### 17.12.9 Heap: GATE2005\_34 top

<http://gateoverflow.in/1370>

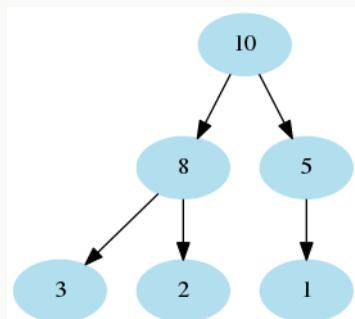


ans is D....whenever we insert an element in heap,it will always inserted in last level from left to right..so here we insert element 1 and 7 as a child of node 5.then we perform heapify algorithm until we get the min/max heap..so here finally in above question we get the heap whose level order traversal is 10,8,7,3,2,1,5

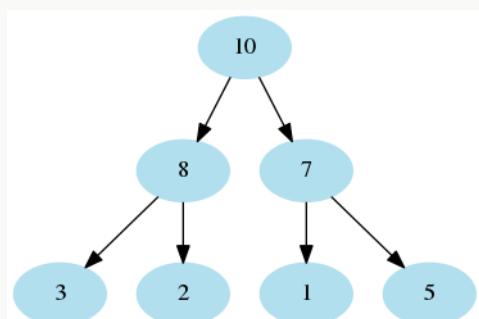
Initial heap:



After insert of 1



After insert of 7



6 votes

-- neha pawar (3.8k points)

## 17.12.10 Heap: GATE1999\_12 top

<http://gateoverflow.in/1511>



Selected Answer

### Part(a)

**Base case:**  $h=1$  There is only one such tree with one leaf node and no full node. Hence the statement holds for base case.

**Inductive step:**  $h=k+1$

**Case 1:** root is not a full node.

we assume it does not have a right child. In this case the number of full nodes and the the number of leaf nodes is equal to the tree which is rooted at at's left child. Since the height of that left subtree is  $k$ , by induction the difference should be 1.

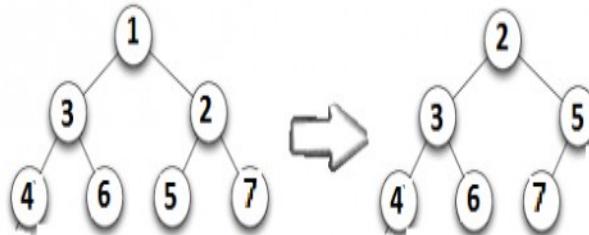
**Case 2:** root is full node.

Total number of leaf nodes = number of leaf nodes in left + number of leaf nodes right subtree.

Total number of full nodes = Root (1) + the number of full nodes to its left and right.

Thus the difference remains 1.

### Part (b)



0 votes

-- Anirudh Pratap Singh (17.7k points)

## (A)

Note My Convention:-

no. Of full node=F

no. Of leaf node=L

-----  
Base Case: H = 0.

A binary tree of height 0 is just a single node with no children, and therefore has 1 leaf.

$$F+1=L$$

$$0+1=1$$

so the base case satisfies the induction hypothesis (see below).

Induction Hypothesis(I.H): Suppose that for some  $k \geq 0$ , all binary trees of height  $\leq k$  have  $(F+1)=L$  leaves .

Induction Step: Let T be a binary tree of height  $k+1$ . Then T's left and right subtrees are each binary trees of height  $\leq k$ , and thus by the I.H. both subtree have  $(F+1)$  leaves. The number of leaves in T is equal to the sum of the number of leaves in T's subtrees,

$$(F+1)_{\text{left sub tree}} + (F+1)_{\text{right sub tree}} = L_{\text{left sub tree}} + L_{\text{right sub tree}}$$

$$2F+2=2L$$

$$2(F+1)=2(L)$$

$$\therefore F+1=L \text{ (proved)}$$

Hence the hypothesis holds for  $k+1$ , and so the theorem is proved.

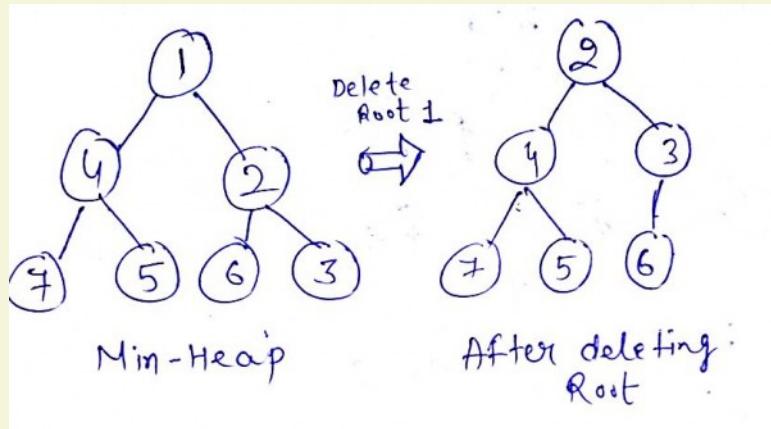
## (B)

Here in question they mentioned to insert element in given order into an empty Heap.

So here we have to use Insertion Method to create the heap instead of using Heapify Method to build the heap.

Plz refer below img the LHS shows the resultant heap after doing insertion of the keys into initial empty heap.

RHS heap is the result of deletion of root.



0 votes

-- Rajesh Pradhan (5.4k points)

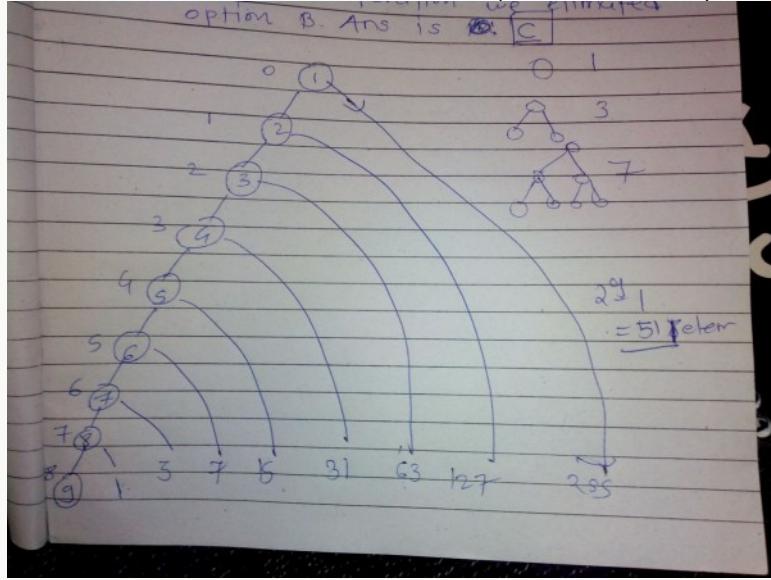
### 17.12.11 Heap: GATE 2016-2-34 top

<http://gateoverflow.in/39585>



Selected Answer

Here answer is 8. With 1024 nodes, we can easily build min heap. Check following diagram



Now once we place 1-9 then remaining elements can be placed easily to fill up heap (While keeping heap property of course) Total elements we need for this heap is 512, we have given 1024 ! So Yes, 8 is answer !

15 votes

-- Akash (31.7k points)

### 17.12.12 Heap: GATE2015-3\_19 top

<http://gateoverflow.in/8418>



Selected Answer

first interchange 15-100  
 2nd 50-100  
 3rd 89-100  
 so total interchange 3 so option D is correct.

12 votes

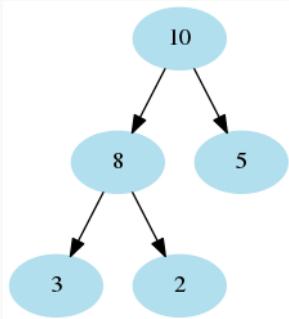
-- Anoop Sonkar (4.5k points)

**17.12.13 Heap: GATE2014-2\_12** [top](#)<http://gateoverflow.in/1967>

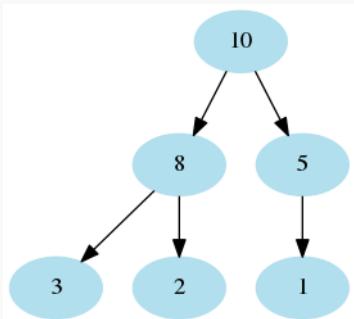
Selected Answer

ans is A....whenever insertion will be done in heap ,it will always inserted in last level from left to right.so we insert 1 and 7as a child of node 5 now we perform heapify algorithm until heap property will satisfied..and then we get the heap whose level order traversal is 10,8,7,3,2,1,5

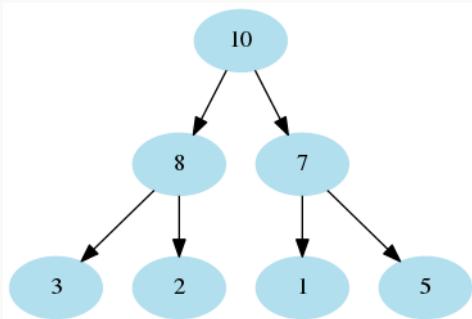
Initial heap



After insert of 1



After insert of 7



6 votes

-- neha pawar (3.8k points)

17.13

**Infix Postfix** top**17.13.1 Infix Postfix: GATE2004-38, ISRO2009-27** top<http://gateoverflow.in/1035>

Assume that the operators  $+, -, \times$  are left associative and  $^$  is right associative. The order of precedence (from highest to lowest) is  $^, \times, +, -$ . The postfix expression corresponding to the infix expression  $a + b \times c - d^e f$  is

- A.  $abc \times +def ^ -$
- B.  $abc \times +de^f ^ -$
- C.  $ab + c \times d - e^f ^$
- D.  $- + a \times bc ^ def$

[gate2004](#) [infix-postfix](#) [isro2009](#)
**Answer****Answers: Infix Postfix****17.13.1 Infix Postfix: GATE2004-38, ISRO2009-27** top<http://gateoverflow.in/1035>

Selected Answer

Ans : A

Here is the procedure first :

Scan Infix Expression from left to right whenever you see operand just print it.

But In case of operator

if(stack is empty) then push it.

if(precedence(tos) &lt; precedence(current operator) ) push it.

else if (precedence(tos) &gt; precedence(current operator) ) pop and print.

else if (precedence(tos) == precedence(current operator) ) then check for associativity.In case Operators are Left to right then pop and print it otherwise push the current operator (Right to Left Associativity)

And once you have scanned infix expression completely. Make sure pop all the element and print it in same order.

Here the infix expression is  $a+b\times c-d^e f$ 

a : print it

+ : push into the Operator Stack

b : print it

\* : its having higher precedence than + then push into Operator Stack

c : print it

'-' : '-' is having less precedence than '\*' so pop from operator stack and print '\*'.after this stack will be having '+' on top.which is having same precedence as '-' but both are left to right associative then just pop + and print it.Now stack is empty. Push '-' to it.

d : print it

'^' : top of the stack is having '-' which has lower precedence than '^' so simply push '^' into stack

e : print it.

'^' : Now top of the stack is '^' and has same precedence so associativity will come to picture. Since '^' is right associative as given in question. So '^' will be pushed.

f : print it.

Now we have scanned entire infix expression.Now pop the stack untill it becomes empty.This way you will get  
 $abc*+def^{^-}$ 

11 votes

-- IgnitorSandeep (455 points)

17.14

**Linked Lists** top**17.14.1 Linked Lists: GATE 2016-2-15** top<http://gateoverflow.in/39557>

$N$  items are stored in a sorted doubly linked list. For a *delete* operation, a pointer is provided to the record to be deleted. For a *decrease-key* operation, a pointer is provided to the record on which the operation is to be performed.

An algorithm performs the following operations on the list in this order:  $\Theta(N)$  *delete*,  $O(\log N)$  *insert*,  $O(\log N)$  *find*, and  $\Theta(N)$  *decrease-key*. What is the time complexity of all these operations put together?

- A.  $O(\log^2 N)$
- B.  $O(N)$
- C.  $O(N^2)$
- D.  $\Theta(N^2 \log N)$

gate2016-2 | data-structure | linked-lists | time-complexity | normal

Answer

### 17.14.2 Linked Lists: GATE2003\_90 [top](#)

<http://gateoverflow.in/973>

Consider the function  $f$  defined below.

```
struct item {
 int data;
 struct item * next;
};

int f(struct item *p) {
 return ((p == NULL) || (p->next == NULL) ||
 ((p->data <= p ->next -> data) &&
 f(p->next)));
}
```

For a given linked list  $p$ , the function  $f$  returns 1 if and only if

- A. the list is empty or has exactly one element
- B. the elements in the list are sorted in non-decreasing order of data value
- C. the elements in the list are sorted in non-increasing order of data value
- D. not all elements in the list have the same data value

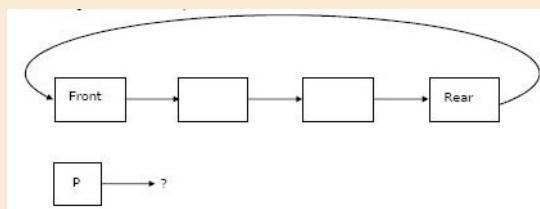
gate2003 | data-structure | linked-lists | normal

Answer

### 17.14.3 Linked Lists: GATE2004\_36 [top](#)

<http://gateoverflow.in/1033>

A circularly linked list is used to represent a Queue. A single variable  $p$  is used to access the Queue. To which node should  $p$  point such that both the operations *enQueue* and *deQueue* can be performed in constant time?



- A. rear node
- B. front node
- C. not possible with a single pointer
- D. node next to front

gate2004 | data-structure | linked-lists | normal

**Answer****17.14.4 Linked Lists: GATE2004\_40** [top](#)<http://gateoverflow.in/1037>

Suppose each set is represented as a linked list with elements in arbitrary order. Which of the operations among union, intersection, membership, cardinality will be the slowest?

- A. union only
- B. intersection, membership
- C. membership, cardinality
- D. union, intersection

[gate2004](#) [data-structure](#) [linked-lists](#) [normal](#)
**Answer****17.14.5 Linked Lists: GATE2008-62** [top](#)<http://gateoverflow.in/485>

The following C function takes a single-linked list of integers as a parameter and rearranges the elements of the list. The function is called with the list containing the integers 1, 2, 3, 4, 5, 6, 7 in the given order. What will be the contents of the list after function completes execution?

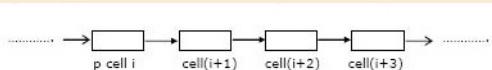
```
struct node {
 int value;
 struct node *next;
};

void rearrange(struct node *list) {
 struct node *p, *q;
 int temp;
 if (!list || !list -> next) return;
 p = list; q = list -> next;
 while(q) {
 temp = p -> value; p->value = q -> value;
 q->value = temp; p = q ->next;
 q = p? p ->next : 0;
 }
}
```

- A. 1, 2, 3, 4, 5, 6, 7
- B. 2, 1, 4, 3, 6, 5, 7
- C. 1, 3, 2, 5, 4, 7, 6
- D. 2, 3, 4, 5, 6, 7, 1

[gate2008](#) [data-structure](#) [linked-lists](#) [normal](#)
**Answer****17.14.6 Linked Lists: GATE1998\_19a** [top](#)<http://gateoverflow.in/1733>

- a. Let p be a pointer as shown in the figure in a single linked list.



What do the following assignment statements achieve?

```
q = p -> next
p -> next := q -> next
q -> next := (q -> next) -> next
(p -> next) -> next := q
```

[gate1998](#) [data-structure](#) [linked-lists](#) [normal](#)
**Answer****17.14.7 Linked Lists: GATE1997\_1.4** [top](#)<http://gateoverflow.in/2220>

The concatenation of two lists is to be performed on  $O(1)$  time. Which of the following implementations of a list should be used?

- A. Singly linked list
- B. Doubly linked list
- C. Circular doubly linked list
- D. Array implementation of list

[gate1997](#) [data-structure](#) [linked-lists](#) [easy](#)
**Answer****17.14.8 Linked Lists: GATE2005-IT\_54** [top](#)<http://gateoverflow.in/3855>

The following C function takes a singly-linked list of integers as a parameter and rearranges the elements of the list. The list is represented as pointer to a structure. The function is called with the list containing the integers 1, 2, 3, 4, 5, 6, 7 in the given order. What will be the contents of the list after the function completes execution?

```
struct node {int value; struct node *next;};
void rearrange (struct node *list) {
 struct node *p, *q;
 int temp;
 if (!list || !list->next) return;
 p = list; q = list->next;
 while (q) {
 temp = p->value;
 p->value = q->value;
 q->value = temp;
 p = q->next;
 q = p ? p->next : 0;
 }
}
```

- A) 1, 2, 3, 4, 5, 6, 7
- B) 2, 1, 4, 3, 6, 5, 7
- C) 1, 3, 2, 5, 4, 7, 6
- D) 2, 3, 4, 5, 6, 7, 1

[gate2005-it](#) [data-structure](#) [linked-lists](#) [identify-function](#) [normal](#)
**Answer****Answers: Linked Lists****17.14.1 Linked Lists: GATE 2016-2-15** [top](#)<http://gateoverflow.in/39557>

Selected Answer

Tip Q means Theata !

Here I believe answer is C

Delete O(1)

Insert O(N)

Find O(N)

Decrease Key => O(N) //Because we need to search position in Linked list. (It is similar to a Delete followed by an Insert)

with the decreased value)

$O(n)$  delete =>  $O(N * 1) = O(N)$

$O(\log N)$  find =>  $O(\log N * N) => O(N \log N)$

$O(\log N)$  insert =>  $O(N \log N)$

$O(N)$  decrease key =>  $O(N^2) => O(N^2)$

Even though it says at start we got  $N$  elements, then we are deleting  $Q(N)$  elements, here  $Q(N)$  can be anything like  $N/2, N/4, N/3$  and list need not be empty, then above explanation holds !

In case it actually deleted all elements at start analysis will be something like below =>

all  $N$  are deleted, Time complexity  $O(1)$  each delete , total delete  $O(N)$

Now  $\log N$  insert, it'll take  $1 + 2 + \log N$  time, then  $(\log N * \log N - 1)/2 => O((\log N)^2)$

Now  $\log N$  finds => it'll take  $\log N$  time per find (because find take  $O(N)$  but here  $N = \log N$ )  
 $=> O((\log N)^2)$

Now  $N$  decrease key, Size of list is  $\log N$ , each decrease key can take  $O(\text{size of list})$

So size of list \* no of decrease key =>  $N * \log N => O(N \log N)$

there is no option like  $O(N \log N)$

so correct answer is  $O(N^2)$

13 votes

-- Akash (31.7k points)

## 17.14.2 Linked Lists: GATE2003\_90 [top](#)

<http://gateoverflow.in/973>



Selected Answer

It returns 1 if and only if the linked list is sorted in non-decreasing order- B option.

It returns 1 if the list is empty or has just 1 element also, but if and only if makes A option false.

9 votes

-- Bhagirathi Nayak (11.3k points)

## 17.14.3 Linked Lists: GATE2004\_36 [top](#)

<http://gateoverflow.in/1033>



Selected Answer

The pointer points to the Rear node.

**EnQueue:** Insert newNode after Rear, and make Rear point to the newly inserted node:

```
//struct node *newNode;
newNode->next = rear->next;
rear->next = newNode;
rear=newNode;
```

**DeQueue:** Delete the Front node, and make the second node the front node.

```
//rear->next points to the front node.
//front->next points to the second node.
struct node* front;
front = rear->next;
rear->next = front->next;
free(front);
```

24 votes

-- Pragy Agarwal (14.4k points)

**17.14.4 Linked Lists: GATE2004\_40** <http://gateoverflow.in/1037>

Selected Answer

answer - D

membership is linear search -  $O(n_1 + n_2)$ cardinality is linear -  $O(n_1 + n_2)$ for union we need to ensure no duplicate elements should be present -  $O(n_1 \times n_2)$  for each element we need to check if that element exists in other setfor intersection also for every element in set1 we need to scan set2 -  $O(n_1 \times n_2)$ 

11 votes

-- ankitrokdeonsns (8.4k points)

**17.14.5 Linked Lists: GATE2008-62** <http://gateoverflow.in/485>

Selected Answer

The loop is interchanging the adjacent elements of the list. But after each interchange, next interchange starts from the unchanged elements only (due to p = q -&gt; next;).

1st iteration 1 2 3 4 5 6 7  
=> 2 1 3 4 5 6 7

2nd iteration 2 1 4 3 5 6 7

3rd iteration 2 1 4 3 6 5 7

p pointing to null q pointing to 7, as p is false hence q=p? p-&gt;next:0; will return q=0 ending the loop

7 votes

-- Manali (2.5k points)

**17.14.6 Linked Lists: GATE1998\_19a** <http://gateoverflow.in/1733>

Selected Answer

Swaps the two nodes next to p in the linked list.

5 votes

-- Arjun Suresh (150k points)

**17.14.7 Linked Lists: GATE1997\_1.4** <http://gateoverflow.in/2220>

Selected Answer

A) & B) Here it is not possible to do it in  $O(1)$ , unless we have pointer to end of one list. As we have not given that pointer, A & B are not option.D) It is not possible to do here in  $O(1)$ , because we will need to allocate memory for bigger array to hold both list & Copy it.C) It is possible in  $O(1)$  as we can break list at any location & connect it anywhere. We don't need to traverse to end of anything here !

9 votes

-- Akash (31.7k points)

**17.14.8 Linked Lists: GATE2005-IT\_54** [top](#)<http://gateoverflow.in/3815>

Selected Answer

i think it's **B**) 2 1 4 3 6 5 7:

as,

p and q are swapping each other.where q is p->next all the time.

8 votes

-- sumit kumar singh dixit (1.8k points)

**17.15****Queues** [top](#)**17.15.1 Queues: GATE1994\_26** [top](#)<http://gateoverflow.in/2522>

A queue  $Q$  containing  $n$  items and an empty stack  $S$  are given. It is required to transfer all the items from the queue to the stack, so that the item at the front of queue is on the TOP of the stack, and the order of all other items are preserved. Show how this can be done in  $O(n)$  time using only a constant amount of additional storage. Note that the only operations which can be performed on the queue and stack are Delete, Insert, Push and Pop. Do not assume any implementation of the queue or stack.

[gate1994](#) [data-structure](#) [queues](#) [stack](#) [normal](#)

Answer

**17.15.2 Queues: GATE 2016-1-41** [top](#)<http://gateoverflow.in/39684>

Let  $Q$  denote a queue containing sixteen numbers and  $S$  be an empty stack.  $\text{Head}(Q)$  returns the element at the head of the queue  $Q$  without removing it from  $Q$ . Similarly  $\text{Top}(S)$  returns the element at the top of  $S$  without removing it from  $S$ . Consider the algorithm given below.

```

while Q is not Empty do
 if S is Empty OR Top(S) <= Head (Q) then
 x:= Dequeue (Q);
 Push (S, x);
 else
 x:= Pop (S);
 Enqueue (Q, x);
 end
end

```

The maximum possible number of iterations of the **while** loop in the algorithm is \_\_\_\_\_.

[gate2016-1](#) [data-structure](#) [queues](#) [difficult](#) [numerical-answers](#)

Answer

**17.15.3 Queues: GATE2007-IT-30** [top](#)<http://gateoverflow.in/3463>

Suppose you are given an implementation of a queue of integers. The operations that can be performed on the queue are:

- i. `isEmpty (Q)` — returns true if the queue is empty, false otherwise.
- ii. `delete (Q)` — deletes the element at the front of the queue and returns its value.
- iii. `insert (Q, i)` — inserts the integer  $i$  at the rear of the queue.

Consider the following function:

```
void f (queue Q) {
 int i ;
 if (!isEmpty(Q)) {
 i = delete(Q);
 f(Q);
 insert(Q, i);
 }
}
```

What operation is performed by the above function f ?

- A. Leaves the queue Q unchanged
- B. Reverses the order of the elements in the queue Q
- C. Deletes the element at the front of the queue Q and inserts it at the rear keeping the other elements in the same order
- D. Empties the queue Q

[gate2007-it](#) [data-structure](#) [queues](#) [normal](#)

**Answer**

#### 17.15.4 Queues: GATE2012\_35 [top](#)

<http://gateoverflow.in/1756>

Suppose a circular queue of capacity  $(n - 1)$  elements is implemented with an array of  $n$  elements. Assume that the insertion and deletion operations are carried out using REAR and FRONT as array index variables, respectively. Initially, REAR = FRONT = 0. The conditions to detect *queue full* and *queue empty* are

(A)

*full:* (REAR+1) mod n == FRONT

*empty:* REAR == FRONT\$

(B)

*full:* (REAR+1) mod n == FRONT

*empty:* (FRONT+1) mod n == REAR

(C)

*full:* REAR == FRONT

*empty:* (REAR+1) mod n == FRONT

(D)

*full:* (FRONT+1) mod n == REAR

*empty:* REAR == FRONT

[gate2012](#) [data-structure](#) [queues](#) [normal](#)

**Answer**

#### 17.15.5 Queues: GATE2006\_49 [top](#)

<http://gateoverflow.in/1826>

An implementation of a queue Q, using two stacks S1 and S2, is given below:

```
void insert (Q, x) {
 push (S1, x);
}
void delete (Q) {
 if (stack-empty(S2)) then
 if (stack-empty(S1)) then {
 print("Q is empty");
 return;
 }
 else while (! (stack-empty(S1))) {
 x=pop(S1);
 push (S2,x);
 }
 x=pop(S2);
}
```

Let  $n$  *insert* and  $m (\leq n)$  *delete* operations be performed in an arbitrary order on an empty queue Q. Let  $x$  and  $y$  be the number of *push* and *pop* operations performed respectively in the process. Which one of the following is true for all  $m$  and  $n$ ?

- (A)  $n + m \leq x < 2n$  and  $2m \leq y \leq n + m$   
 (B)  $n + m \leq x < 2n$  and  $2m \leq y \leq 2n$   
 (C)  $2m \leq x < 2n$  and  $2m \leq y \leq n + m$   
 (D)  $2m \leq x < 2n$  and  $2m \leq y \leq 2n$

gate2006 | data-structure | queues | stack | normal

Answer

### 17.15.6 Queues: GATE 2016-1-10 top

<http://gateoverflow.in/39667>

A queue is implemented using an array such that ENQUEUE and DEQUEUE operations are performed efficiently. Which one of the following statements is **CORRECT** (  
 $n$  refers to the number of items in the queue) ?

- A. Both operations can be performed in  $O(1)$  time.
- B. At most one operation can be performed in  $O(1)$  time but the worst case time for the operation will be  $\Omega(n)$ .
- C. The worst case time complexity for both operations will be  $\Omega(n)$ .
- D. Worst case time complexity for both operations will be  $\Omega(\log n)$

gate2016-1 | data-structure | queues | normal

Answer

## Answers: Queues

### 17.15.1 Queues: GATE1994\_26 top

<http://gateoverflow.in/2522>



Selected Answer

We can do this by first extracting items one by one from Q, and inserting them to S. After all items are done, S will contain the items in reverse order. Now, pop the elements from S and insert to Q. After this operation, items in Q will be in reverse order from the starting. Now, extract items from Q and push on to stack and we are done.

Do

    Delete an item from Q

    Push the item to S

While (! empty Q);

Do

    Pop an item from S

    Insert the item to Q

While (! empty S);

Do

    Delete an item from Q

    Push the item to S

While (! empty Q);

11 votes

-- Arjun Suresh (150k points)

**17.15.2 Queues: GATE 2016-1-41** [top](#)<http://gateoverflow.in/39684>

Selected Answer

256 when 16,15,14,...,1 are present in queue

alternately 15 dequeue & push, 15 pop & enqueue followed by 1 dequeue & push i.e. 31 iterations

brings it to the state 16,15,...,2 in queue and 1 in stack

29 iterations to get to 16,15,...,3 in queue and 2,1 in stack and so on

$31+29+27+\dots+1=16^2=256$

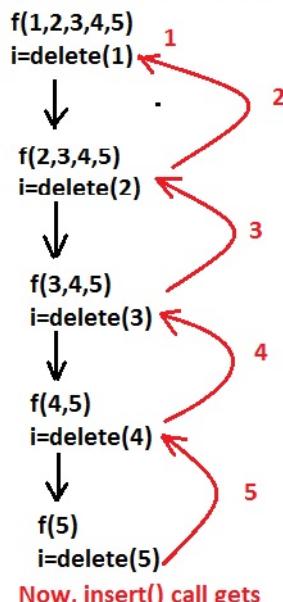
14 votes

-- Krishna murthy (421 points)

**17.15.3 Queues: GATE2007-IT-30** [top](#)<http://gateoverflow.in/3463>

Selected Answer

Suppose Q contains 1,2,3,4,5



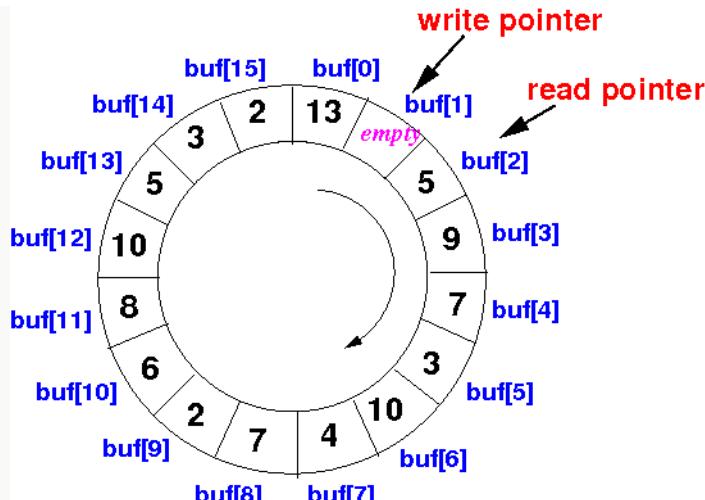
insert() will insert the value in just reverse order.

7 votes

-- srestha (27.8k points)

**17.15.4 Queues: GATE2012\_35** [top](#)<http://gateoverflow.in/1756>

Selected Answer



rear = Write

front = Read

*full:* (REAR+1) mod n == FRONT

*empty:* REAR == FRONT

Only option A matches.

3 votes

-- Anirudh Pratap Singh (17.7k points)

### 17.15.5 Queues: GATE2006\_49 [top](#)

<http://gateoverflow.in/1826>



Selected Answer

Answer is (a)

The order in which insert and delete operations are performed matters here.

**The best case:** Insert and delete operations are performed alternatively. In every delete operation, 2 pop and 1 push operations are performed. So, total  $m + n$  push ( $n$  push for insert() and  $m$  push for delete()) operations and  $2m$  pop operations are performed.

**The worst case:** First  $n$  elements are inserted and then  $m$  elements are deleted. In first delete operation,  $n + 1$  pop operations and  $n$  push operation are performed. Other than first, in all delete operations, 1 pop operation is performed. So, total  $m + n$  pop operations and  $2n$  push operations are performed ( $n$  push for insert() and  $m$  push for delete())

18 votes

-- Kalpana Bhargav (3k points)

### 17.15.6 Queues: GATE 2016-1-10 [top](#)

<http://gateoverflow.in/39667>



Selected Answer

Answer A - Circular Queue Implementation

Reffer : <http://www.mathcs.emory.edu/~cheung/Courses/171/Syllabus/8-List/array-queue2.html>

16 votes

-- Abhilash Panicker (7k points)

17.16

**Spanning Tree** top**17.16.1 Spanning Tree: TIFR2013-B-17** top<http://gateoverflow.in/25860>

In a connected weighted graph with  $n$  vertices, all the edges have distinct positive integer weights. Then, the maximum number of minimum weight spanning trees in the graph is

- a. 1
- b.  $n$
- c. equal to number of edges in the graph.
- d. equal to maximum weight of an edge of the graph.
- e.  $n^{n-2}$

[tifr2013](#) [spanning-tree](#)
**Answer****Answers: Spanning Tree****17.16.1 Spanning Tree: TIFR2013-B-17** top<http://gateoverflow.in/25860>

Selected Answer

There will be unique min weight spanning tree since all weights are distinct.  
option A.

5 votes

-- Urmang Raman (11.3k points)

17.17

**Stack** top**17.17.1 Stack: GATE2003\_64** top<http://gateoverflow.in/951>

Let **S** be a stack of size  $n \geq 1$ . Starting with the empty stack, suppose we push the first  $n$  natural numbers in sequence, and then perform  $n$  pop operations. Assume that Push and Pop operations take  $X$  seconds each, and  $Y$  seconds elapse between the end of one such stack operation and the start of the next operation. For  $m \geq 1$ , define the stack-life of  $m$  as the time elapsed from the end of  $\text{Push}(m)$  to the start of the pop operation that removes  $m$  from **S**. The average stack-life of an element of this stack is

- A.  $n(X+Y)$
- B.  $3Y+2X$
- C.  $n(X+Y)-X$
- D.  $Y+2X$

[gate2003](#) [data-structure](#) [stack](#) [normal](#)
**Answer****17.17.2 Stack: GATE2015-3\_12** top<http://gateoverflow.in/8408>

The result evaluating the postfix expression  $10\ 5\ +\ 60\ 6\ /\ *\ 8\ -$  is

- A. 284
- B. 213

- C. 142  
D. 71

gate2015-3 | data-structure | stack | normal

Answer

### 17.17.3 Stack: GATE2014-2\_41 top

<http://gateoverflow.in/1007>

Suppose a stack implementation supports an instruction REVERSE, which reverses the order of elements on the stack, in addition to the PUSH and POP instructions. Which one of the following statements is TRUE (with respect to this modified stack)?

- (A) A queue cannot be implemented using this stack.
- (B) A queue can be implemented where ENQUEUE takes a single instruction and DEQUEUE takes a sequence of two instructions.
- (C) A queue can be implemented where ENQUEUE takes a sequence of three instructions and DEQUEUE takes a single instruction.
- (D) A queue can be implemented where both ENQUEUE and DEQUEUE take a single instruction each.

gate2014-2 | data-structure | stack | easy

Answer

### 17.17.4 Stack: GATE2004\_3 top

<http://gateoverflow.in/1000>

A single array  $A[1 \dots \text{MAXSIZE}]$  is used to implement two stacks. The two stacks grow from opposite ends of the array. Variables  $\text{top1}$  and  $\text{top2}$  ( $\text{top1} < \text{top2}$ ) point to the location of the topmost element in each of the stacks. If the space is to be used efficiently, the condition for "stack full" is

- A.  $(\text{top1} = \text{MAXSIZE} / 2)$  and  $(\text{top2} = \text{MAXSIZE} / 2 + 1)$
- B.  $\text{top1} + \text{top2} = \text{MAXSIZE}$
- C.  $(\text{top1} = \text{MAXSIZE} / 2)$  or  $(\text{top2} = \text{MAXSIZE})$
- D.  $\text{top1} = \text{top2} - 1$

gate2004 | data-structure | stack | easy

Answer

### 17.17.5 Stack: GATE2007-38, ISRO2016-27 top

<http://gateoverflow.in/1236>

The following postfix expression with single digit operands is evaluated using a stack:

8 2 3 ^ / 2 3 \* + 5 1 \* -

Note that  $^$  is the exponentiation operator. The top two elements of the stack after the first  $*$  is evaluated are

- A. 6, 1
- B. 5, 7
- C. 3, 2
- D. 1, 5

gate2007 | data-structure | stack | normal | isro2016

Answer

### 17.17.6 Stack: GATE2015-2\_38 [top](#)

<http://gateoverflow.in/8164>

Consider the C program below

```
#include <stdio.h>
int *A, stkTop;
int stkFunc (int opcode, int val)
{
 static int size=0, stkTop=0;
 switch (opcode) {
 case -1: size = val; break;
 case 0: if (stkTop < size) A[stkTop++]=val; break;
 default: if (stkTop) return A[--stkTop];
 }
 return -1;
}
int main()
{
 int B[20]; A=B; stkTop = -1;
 stkFunc (-1, 10);
 stkFunc (0, 5);
 stkFunc (0, 10);
 printf ("%d\n", stkFunc(1, 0)+ stkFunc(1, 0));
}
```

The value printed by the above program is \_\_\_\_\_.

[gate2015-2](#) [data-structure](#) [stack](#) [easy](#)

[Answer](#)

### 17.17.7 Stack: GATE2000-13 [top](#)

<http://gateoverflow.in/684>

Suppose a stack implementation supports, in addition to PUSH and POP, an operation REVERSE, which reverses the order of the elements on the stack.

- To implement a queue using the above stack implementation, show how to implement ENQUEUE using a single operation and DEQUEUE using a sequence of 3 operations.
- The following post fix expression, containing single digit operands and arithmetic operators + and \*, is evaluated using a stack.
 

5 2 \* 3 4 + 5 2 \* \* +  
 Show the contents of the stack
 
  - After evaluating 5 2 \* 3 4 +
  - After evaluating 5 2 \* 3 4 + 5 2
  - At the end of evaluation.

[gate2000](#) [data-structure](#) [stack](#) [normal](#)

[Answer](#)

### 17.17.8 Stack: GATE1994\_1.14 [top](#)

<http://gateoverflow.in/2457>

Which of the following permutations can be obtained in the output (in the same order) using a stack assuming that the input is the sequence 1, 2, 3, 4, 5 in that order?

- 3, 4, 5, 1, 2
- 3, 4, 5, 2, 1
- 1, 5, 2, 3, 4
- 5, 4, 3, 1, 2

[gate1994](#) [data-structure](#) [stack](#) [normal](#)

[Answer](#)

### 17.17.9 Stack: GATE1997\_4.7 [top](#)

<http://gateoverflow.in/2248>

A priority queue Q is used to implement a stack that stores characters. PUSH (C) is implemented as INSERT (Q, C, K) where K is an appropriate integer key chosen by the implementation. POP is implemented as DELETEMIN(Q). For a sequence of

operations, the keys chosen are in

- A. non-increasing order
- B. non-decreasing order
- C. strictly increasing order
- D. strictly decreasing order

[gate1997](#) [data-structure](#) [stack](#) [normal](#)

[Answer](#)

### 17.17.10 Stack: GATE1995\_2.21 [top](#)

<http://gateoverflow.in/2633>

The postfix expression for the infix expression  $A + B * (C + D)/F + D * E$  is:

- A.  $AB + CD + *F/D + E*$
- B.  $ABCD + *F/DE * ++$
- C.  $A * B + CD/F * DE ++$
- D.  $A + *BCD/F * DE ++$

[gate1995](#) [data-structure](#) [stack](#) [easy](#)

[Answer](#)

### 17.17.11 Stack: GATE2005-IT\_13 [top](#)

<http://gateoverflow.in/3758>

A function  $f$  defined on stacks of integers satisfies the following properties.  $f(\emptyset) = 0$  and  $f(\text{push}(S, i)) = \max(f(S), 0) + i$  for all stacks  $S$  and integers  $i$ .

If a stack  $S$  contains the integers 2, -3, 2, -1, 2 in order from bottom to top, what is  $f(S)$ ?

- |    |   |
|----|---|
| A) | 6 |
| B) | 4 |
| C) | 3 |
| D) | 2 |

[gate2005-it](#) [data-structure](#) [stack](#) [normal](#)

[Answer](#)

### 17.17.12 Stack: GATE1991\_03,vii [top](#)

<http://gateoverflow.in/522>

Choose the correct alternatives (more than one may be correct) and write the corresponding letters only:

The following sequence of operations is performed on a stack:

PUSH (10), PUSH (20), POP, PUSH (10), PUSH (20), POP, POP, POP, PUSH (20), POP

The sequence of values popped out is

- (a). 20,10,20,10,20
- (b). 20,20,10,10,20
- (c). 10,20,20,10,20
- (d). 20,20,10,20,10

[gate1991](#) [data-structure](#) [stack](#) [easy](#)

**Answer****Answers: Stack****17.17.1 Stack: GATE2003\_64** [top](#)<http://gateoverflow.in/951>

Selected Answer

let us represent stack-life of  $i^{th}$  element as  $S(i)$ . The  $i^{th}$  element will be in stack till  $(n - i)$  elements are pushed and popped. Plus one more  $Y$  for the time interval between the push of  $i^{th}$  element and the  $i + 1^{th}$  element. So,

$$S(i) = Y + 2.(n - i)(Y + X) = Y + 2.(n - i)Z = Y + 2nZ - 2iZ$$

where  $Z = Y + X$

$$\text{average stack-life will, } A = \sum \frac{S(i)}{n}$$

$$nA = nY + 2.n.n.Z - 2.Z.\Sigma i$$

$$nA = nY + 2.n.n.Z - 2.Z \frac{(n(n+1))}{2}$$

$$nA = nY + 2.n.n.Z - Z(n.n) - n.Z$$

$$A = Y + 2.n.Z - (n + 1).Z$$

$$A = Y + (n - 1).Z = Y + (n - 1)(X + Y) = n(X + Y) - X$$

10 votes

-- Vikrant Singh (11k points)

**17.17.2 Stack: GATE2015-3\_12** [top](#)<http://gateoverflow.in/8408>

Selected Answer

we have to keep symbol into stack and when we get two operands followed by operator ..we will apply operator on last two operands

| <u>symbol</u> | <u>stack</u>                                                |
|---------------|-------------------------------------------------------------|
| 10            | 10 (keep in stack)                                          |
| 5             | 10 5 (keep in stack)                                        |
| +             | 10 5 + = 10+5 = 15 ( apply operator on last 2 operands)     |
| 60            | 15 60 (keep in stack)                                       |
| 6             | 15 60 6 (keep in stack)                                     |
| /             | 15 60 6 / = 15 10 ( apply operator on last 2 operands)      |
| *             | 15 10 * = 150 ( apply operator on last 2 operands)          |
| 8             | 150 8 (Keep in stack)                                       |
| -             | 150 8 - = 150 - 8 = 142 (apply operator on last 2 operands) |

So answer is 142

15 votes

-- Praveen Saini (38.4k points)

**17.17.3 Stack: GATE2014-2\_41** [top](#)<http://gateoverflow.in/2007>

Selected Answer

(C) is the answer. While ENQUEUE we REVERSE the stack, PUSH the element and then again REVERSE the stack. For DEQUEUE we simply POP the element.

(Option (B) can be used to get the first element from the stack by doing a POP after REVERSE for DEQUEUE and PUSH for ENQUEUE. But we have to restore the stack using REVERSE (otherwise next POP won't work) which means DEQUEUE actually needs 3 instructions and not 2)

10 votes

-- Arjun Suresh (150k points)

**17.17.4 Stack: GATE2004\_3** [top](#)<http://gateoverflow.in/1000>

Selected Answer

ans d)

Since the stacks are growing from opposite ends, initially top1 = 1 and top2 = MAXSIZE. Now, to make the space usage most efficient we should allow one stack to use the maximum possible space as long as other stack doesn't need it. So, either of the stack can grow as long as there is space on the array and hence the condition must be top1 = top2 - 1;

8 votes

-- Aditi Dan (5.4k points)

**17.17.5 Stack: GATE2007-38, ISRO2016-27** [top](#)<http://gateoverflow.in/1236>

Selected Answer

push 8 so stack is 8

push 2 so stack is 8 2

push 8 2 3

^ pop 3 and 2 perform opn 2^3 and push to stack. stack is 8 8

/ pop 8 and 8 perform 8/8 and push result to stack . stack is 1

push 2 stack is 1 2

push 3 stack is 1 2 3

\* pop 3 and 2 perform by 2\*3 and push . stack is 1 6

hence answer is A

5 votes

-- Sankaranarayanan P.N (9.8k points)

**17.17.6 Stack: GATE2015-2\_38** [top](#)<http://gateoverflow.in/8164>

Selected Answer

Answer: 15

The code is pushing 5 and 10 on stack and then popping the top two elements and printing their sum.

Refer here: <http://ideone.com/kIUdQT>

15 votes

-- Rajarshi Sarkar (29.7k points)

**17.17.7 Stack: GATE2000-13**<http://gateoverflow.in/684>

Selected Answer

a) For enqueue push operation is sufficient

For dequeue operation do the following

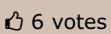
-reverse, pop, reverse

b) Contents of stack from top to bottom:

i) 7 10

ii) 2 5 7 10

iii) 80

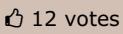


-- Pooja (25.9k points)

**17.17.8 Stack: GATE1994\_1.14**<http://gateoverflow.in/2457>

Selected Answer

push 1 push 2 push 3 pop 3 push 4 pop 4 push 5 pop 5 pop 2 pop 1 then o/p is 3,4,5,2,1 option b



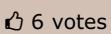
-- Sankaranarayanan P.N (9.8k points)

**17.17.9 Stack: GATE1997\_4.7**<http://gateoverflow.in/2248>

Selected Answer

Implementing stack using priority queue require first element inserted in stack will be deleted at last, and to implement it using deletemin() operation of queue will require first element inserted in queue must have highest priority.

So the keys must be in strictly decreasing order.



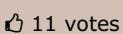
-- Suraj Kaushal (327 points)

**17.17.10 Stack: GATE1995\_2.21**<http://gateoverflow.in/2633>

Selected Answer

$$A + B * (C + D) / F + D * E$$

answer = A B C D + \* F / + D E \* +



-- Amar Vashishth (20.7k points)

**17.17.11 Stack: GATE2005-IT\_13** [top](#)<http://gateoverflow.in/3758>

Selected Answer

i : The element to be pushed

S: Stack

Initially  $f(S)=0$ .

| $f(S)$ | $\max(f(S), 0)$ | i  | Updated $f(S) = \max(f(S), 0) + i$ |
|--------|-----------------|----|------------------------------------|
| 0      | 0               | 2  | 2                                  |
| 2      | 2               | -3 | -1                                 |
| -1     | 0               | 2  | 2                                  |
| 2      | 2               | -1 | 1                                  |
| 1      | 1               | 2  | 3                                  |

Thus, the answer is **Option C.**

I hope this helps!

15 votes

-- Shridhar (393 points)

**17.17.12 Stack: GATE1991\_03,vii** [top](#)<http://gateoverflow.in/522>

Selected Answer

Let's try something different when you read the word pop then delete the last pushed element and print it ..now delete the push word which we have already executed ..now go on from left to right and do the same

6 votes

-- Bhagirathi Nayak (11.3k points)

**17.18****Tree Traversal** [top](#)**17.18.1 Tree Traversal: GATE 2016-2-36** [top](#)<http://gateoverflow.in/39597>

Consider the following New-order strategy for traversing a binary tree:

- Visit the root;
- Visit the right subtree using New-order;
- Visit the left subtree using New-order;

The New-order traversal of the expression tree corresponding to the reverse polish expression

3 4 \* 5 - 2 ^ 6 7 \* 1 + -

is given by:

- A. + - 1 6 7 \* 2 ^ 5 - 3 4 \*
- B. - + 1 \* 6 7 ^ 2 - 5 \* 3 4
- C. - + 1 \* 7 6 ^ 2 - 5 \* 4 3
- D. 1 7 6 \* + 2 5 4 3 \* - ^ -

[gate2016-2](#) [data-structure](#) [tree-traversal](#) [normal](#)
[Answer](#)

## Answers: Tree Traversal

### 17.18.1 Tree Traversal: GATE 2016-2-36 [top](#)

<http://gateoverflow.in/39597>


Selected Answer

Expression given in reverse polish notation (i,e in Post-order)

convert first it into In-order

$$\begin{aligned} & 3 \ 4 \ * \ 5 \ - \ 2 \wedge \ 6 \ 7 \ * \ 1 \ + \ - \\ & (3 * 4) \ 5 \ - \ 2 \wedge \ 6 \ 7 \ * \ 1 \ + \ - \\ & ((3 * 4) - 5) \ 2 \wedge \ 6 \ 7 \ * \ 1 \ + \ - \\ & (((3 * 4) - 5) \wedge 2) \ 6 \ 7 \ * \ 1 \ + \ - \\ & (((3 * 4) - 5) \wedge 2) \ (6 * 7) \ 1 \ + \ - \\ & (((3 * 4) - 5) \wedge 2) \ ((6 * 7) + 1) \ - \\ & (((((3 * 4) - 5) \wedge 2) - ((6 * 7) + 1))) \end{aligned}$$

so Inorder expression is

$$((((3 * 4) - 5) \wedge 2) - ((6 * 7) + 1))$$

New-Order traversal is as by ROOT RIGHT LEFT

$$\begin{aligned} & (((((3 * 4) - 5) \wedge 2) - ((6 * 7) + 1))) \\ & - ((6 * 7) + 1) (((3 * 4) - 5) \wedge 2) \\ & - + 1 (6 * 7) (((3 * 4) - 5) \wedge 2) \\ & - + 1 * 7 6 (((3 * 4) - 5) \wedge 2) \\ & - + 1 * 7 6 \wedge 2 ((3 * 4) - 5) \\ & - + 1 * 7 6 \wedge 2 - 5 (3 * 4) \\ & - + 1 * 7 6 \wedge 2 - 5 * 4 3 \end{aligned}$$

option C is correct

17 votes

-- Praveen Saini (38.4k points)

### 17.19

## Trees [top](#)

### 17.19.1 Trees: GATE1994\_5 [top](#)

<http://gateoverflow.in/2501>

A 3 – ary tree is a tree in which every internal node has exactly three children. Use induction to prove that the number of leaves in a 3 – ary tree with  $n$  internal nodes is  $2(n - 1)$ .

[gate1994](#)
[data-structure](#)
[trees](#)
[proof](#)
**Answer****17.19.2 Trees: GATE1992\_02,vii** [top](#)<http://gateoverflow.in/562>

Choose the correct alternatives (more than one may be correct) and write the corresponding letters only:

A

2 – 3 tree is such that

- a. All internal nodes have either 2 or 3 children
- b. All paths from root to the leaves have the same length.

The number of internal nodes of a 2 – 3 tree having 9 leaves could be

- (a). 4
- (b). 5
- (c). 6
- (d). 7

[gate1992](#)
[trees](#)
[data-structure](#)
[normal](#)
**Answer****17.19.3 Trees: GATE1998\_1.24** [top](#)<http://gateoverflow.in/1661>

Which of the following statements is false?

- (a) A tree with a  $n$  nodes has  $(n-1)$  edges
- (b) A labeled rooted binary tree can be uniquely constructed given its postorder and preorder traversal results.
- (c) A complete binary tree with  $n$  internal nodes has  $(n+1)$  leaves.
- (d) The maximum number of nodes in a binary tree of height  $h$  is  $2^{h+1} - 1$

[gate1998](#)
[data-structure](#)
[trees](#)
[normal](#)
**Answer****17.19.4 Trees: GATE2005\_36** [top](#)<http://gateoverflow.in/1372>

In a complete  $k$ -ary tree, every internal node has exactly  $k$  children. The number of leaves in such a tree with  $n$  internal node is:

- A.  $nk$
- B.  $(n-1)k + 1$
- C.  $n(k-1) + 1$
- D.  $n(k-1)$

[gate2005](#)
[data-structure](#)
[trees](#)
[normal](#)
**Answer****17.19.5 Trees: GATE2002\_2.9** [top](#)<http://gateoverflow.in/839>

The number of leaf nodes in a rooted tree of  $n$  nodes, with each node having 0 or 3 children is:

- A.  $\frac{n}{2}$

- B.  $\frac{(n-1)}{3}$   
 C.  $\frac{(n-1)}{2}$   
 D.  $\frac{(2n+1)}{3}$

gate2002 | data-structure | trees | normal

Answer

### 17.19.6 Trees: GATE2009-37 [top](#)

<http://gateoverflow.in/1323>

What is the maximum height of any AVL-tree with 7 nodes? Assume that the height of a tree with a single node is 0.

- A. 2  
 B. 3  
 C. 4  
 D. 5

gate2009 | data-structure | trees | normal

Answer

### 17.19.7 Trees: GATE2007-43 [top](#)

<http://gateoverflow.in/1241>

A complete  $n$ -ary tree is a tree in which each node has  $n$  children or no children. Let  $I$  be the number of internal nodes and  $L$  be the number of leaves in a complete  $n$ -ary tree. If  $L = 41$  and  $I = 10$ , what is the value of  $n$ ?

- A. 3  
 B. 4  
 C. 5  
 D. 6

gate2007 | data-structure | trees | normal

Answer

### 17.19.8 Trees: GATE1998\_2.11 [top](#)

<http://gateoverflow.in/1683>

A complete  $n$ -ary tree is one in which every node has 0 or  $n$  sons. If  $x$  is the number of internal nodes of a complete  $n$ -ary tree, the number of leaves in it is given by

- A.  $x(n - 1) + 1$   
 B.  $xn - 1$   
 C.  $xn + 1$   
 D.  $x(n + 1)$

gate1998 | data-structure | trees | normal

Answer

## Answers: Trees

### 17.19.1 Trees: GATE1994\_5 [top](#)

<http://gateoverflow.in/2501>

No of nodes at level  $i = 3^i$

Let height of tree be  $h$

So total no of internal nodes =  $3^0 + 3^1 + 3^2 + \dots + 3^{h-1} = \frac{3^h - 1}{2}$

$$2n = 3^h - 1$$

$$\text{No of leaf nodes} = 3^h = 2n + 1 = 2(n - 1) + 3$$

Let us prove by induction

Base case

$n = 1$  (one internal node i.e., root node)

$$\text{No of leaves} = 2(1 - 1) + 3 = 3$$

Let it be true for  $n$  internal nodes

Now we prove for  $m$  nodes where  $m = n + 1$

$$\text{We have } L(m) = 2(n + 1 - 1) + 3$$

$$\text{Also } L(m) = L(n) + 3 - 1 = 2(n - 1) + 3 + 3 - 1 = 2n + 3$$

So if  $L(n)$  is true then  $L(n + 1)$  is also true

Hence proved by induction.

Upvote 3 votes

-- Pooja (25.9k points)

## 17.19.2 Trees: GATE1992\_02,vii [top](#)

<http://gateoverflow.in/562>



Selected Answer

Answer (a)4, (d) 7

4-> When each leaf has 3 childs. So  $9/3 = 3$  Internal nodes, Then one internal node those internal nodes.

7-> When each leaf has 2 childs & one leaf out of 4 get 3 childs. Ex ->  $8/4 = 2$  child per internal node. Then one of that internal node get extra third child. Then 2 internal nodes to connect these 4. Then 1 internal node to connect this 2. So  $4+2+1 = 7$ .

No other way is possible.

Upvote 4 votes

-- Akash (31.7k points)

## 17.19.3 Trees: GATE1998\_1.24 [top](#)

<http://gateoverflow.in/1661>



Selected Answer

A) True

B) From a given inorder and preorder/postorder a binary tree can be constructed. By preorder or post oredr binary tree not possible to construct. Hence False.

C) A complete binary tree of height  $h$  ( say )

$$\text{Total internal nodes } 1+2+4+8+\dots+2^{h-1}=2^h-1=n$$

$$\Rightarrow 2^h=n+1$$

$2^h$  is nothing but total number of leaves in tree hence C is true

D)  $1+2+4+\dots+2^h=2^{h+1}-1$  ( True )

Upvote 4 votes

-- Manali (2.5k points)

## 17.19.4 Trees: GATE2005\_36 [top](#)

<http://gateoverflow.in/1372>



**17.19.7 Trees: GATE2007-43** [top](#)<http://gateoverflow.in/1241>

Selected Answer

If you do little bit experiments on no of leaves, Internal nodes, you will realize that they have equation like following :-

$$\text{No of leaves (L)} = (\text{n}-1) * \text{Internal Nodes (I)} + 1$$

here we need to find n.

Putting values

$$41 = (\text{n}-1) * 10 + 1$$

$$(\text{n}-1) * 10 = 40$$

$$\text{n}-1 = 4$$

$$\text{n} = 5$$

So answer = C

5 votes

-- Akash (31.7k points)

**17.19.8 Trees: GATE1998\_2.11** [top](#)<http://gateoverflow.in/1683>

Selected Answer

Answer :->

A)

$$x(n-1) + 1$$

Originally when we have root , there is only 1 node, which is leaf. (There is no internal node.) **From this base case "+1" part of formula comes.**

When we n children to root, we make root internal. So then Total Leaves = = 1(n-1) + 1 = n.

In complete n ary tree every time you add n children to node, you add n-1 leaves & make that node to which you are inserting children internal.( +n for leaves, -1 for node which you are attaching ). So if you had originally few leaves, you add n-1 "New" leaves to them. This is how  $x(n-1) + 1$  makes sense.

5 votes

-- Akash (31.7k points)

# 18 Programming & DS Programming (90) top

## 18.0.1 GATE2012\_3 top

<http://gateoverflow.in/35>

What will be the output of the following C program segment?

```
char inChar = 'A';
switch (inChar) {
 case 'A' : printf ("Choice A\n");
 case 'B' :
 case 'C' : printf ("Choice B");
 case 'D' :
 case 'E' :
 default : printf ("No Choice");
}
```

- (A) No Choice
- (B) Choice A
- (C) Choice A  
Choice B No Choice
- (D) Program gives no output as it is erroneous

gate2012 | programming | easy

Answer

## 18.0.2 GATE2005\_4 top

<http://gateoverflow.in/1346>

Which one of the following are essential features of an object-oriented programming language?

- I. Abstraction and encapsulation
- II. Strictly-typedness
- III. Type-safe property coupled with sub-type rule
- IV. Polymorphism in the presence of inheritance

- A. (I) and (II) only
- B. (I) and (IV) only
- C. (I), (II) and (IV) only
- D. (I), (III) and (IV) only

gate2005 | programming | normal

Answer

## 18.0.3 GATE2004\_1 top

<http://gateoverflow.in/998>

The goal of structured programming is to

- A. have well indented programs
- B. be able to infer the flow of control from the compiled code
- C. be able to infer the flow of control from the program text
- D. avoid the use of GOTO statements

gate2004 programming easy

Answer

**18.0.4 GATE1997\_1.10** [top](#)<http://gateoverflow.in/2226>

Heap allocation is required for languages.

- A. that support recursion
- B. that support dynamic data structure
- C. that use dynamic scope rules
- D. None of the above

gate1997 programming easy

Answer

**18.0.5 TIFR2010-B-31** [top](#)<http://gateoverflow.in/26484>

Consider the following computation rules. **Parallel-outermost rule:** Replace all the outermost occurrences of F (i.e., all occurrences of F which do not occur as arguments of other F's) simultaneously. **Parallel - innermost rule:** Replace all the innermost occurrences of F (i.e., all occurrences of F with all arguments free of F's) simultaneously. Now consider the evaluations of the recursive program over the integers.

```
F(x, y) ==> if x = 0 then 0 else
 [F(x + 1, F(x, y)) * F(x - 1, F(x, y))]
```

where the multiplication functions \* is extended as follows:

```
0 * w & w * 0 are 0
a * w & w * a are w (for any non-zero integer a)
w * w is w
```

We say that  $F(x, y) = w$  when the evaluation of  $F(x, y)$  does not terminate. Computing  $F(1, 0)$  using the parallel - innermost and parallel - outermost rule yields

- A.  $w$  and  
0 respectively
- B. 0 and  
0 respectively
- C.  $w$  and  
 $w$  respectively
- D.  $w$  and  
1 respectively
- E. none of the above

tifr2010

Answer

**18.0.6 GATE2003\_24** [top](#)<http://gateoverflow.in/914>

Which of the following statements is FALSE?

- A. In statically typed languages, each variable in a program has a fixed type
- B. In un-typed languages, values do not have any types
- C. In dynamically typed languages, variables have no types
- D. In all statically typed languages, each variable in a program is associated with values of only a single type during the execution of the program

[gate2003](#)
[programming](#)
[normal](#)
**Answer****18.0.7 GATE2004\_90** [top](#)<http://gateoverflow.in/1084>

Choose the best matching between the programming styles in Group 1 and their characteristics in Group 2.

| <b>Group 1</b>     | <b>Group 2</b>                                           |
|--------------------|----------------------------------------------------------|
| P. Functional      | 1. Common-based, procedural                              |
| Q. Logic           | 2. Imperative, abstract data types                       |
| R. Object-oriented | 3. Side-effect free, declarative, expression evaluations |
| S. Imperative      | 4. Declarative, clausal representation, theorem proving  |

- A. P-2 Q-3 R-4 S-1
- B. P-4 Q-3 R-2 S-1
- C. P-3 Q-4 R-1 S-2
- D. P-3 Q-4 R-2 S-1

[gate2004](#)
[programming](#)
[normal](#)
**Answer****18.0.8 GATE2002\_2.19** [top](#)<http://gateoverflow.in/849>

To evaluate an expression without any embedded function calls

- A. One stack is enough
- B. Two stacks are needed
- C. As many stacks as the height of the expression tree are needed
- D. A Turing machine is needed in the general case

[gate2002](#)
[programming](#)
[easy](#)
**Answer****18.0.9 GATE2013\_42** [top](#)<http://gateoverflow.in/60>

What is the return value of  $f(p,p)$ , if the value of  $p$  is initialized to 5 before the call? Note that the first parameter is passed by reference, whereas the second parameter is passed by value.

```
int f (int &x, int c) {
 c = c - 1;
 if (c==0) return 1;
 x = x + 1;
 return f(x,c) * x;
}
```

[gate2013](#)
[programming](#)
[normal](#)
[marks-to-all](#)
**Answer****18.0.10 TIFR2011-B-40** [top](#)<http://gateoverflow.in/20937>

Consider the class of object oriented languages. Which of the following is true?

- a. Pascal is an object oriented language.
- b. Object oriented languages require heap management.
- c. Object oriented languages cannot be implemented in language C.
- d. Object oriented languages are more powerful than declarative programming languages.
- e. Parallelism cannot be realized in object oriented languages.

[tifr2011](#) [programming](#)

Answer

### 18.0.11 GATE2005-3, UGCNET-June2012-III-15 [top](#)

<http://gateoverflow.in/1345>

A common property of logic programming languages and functional languages is:

- A. both are procedural languages
- B. both are based on  $\lambda$ -calculus
- C. both are declarative
- D. both use Horn-clauses

[gate2005](#) [programming](#) [normal](#) [ugcnetjune2012ii](#)

Answer

### 18.0.12 GATE2002\_1.16 [top](#)

<http://gateoverflow.in/821>

Sign extension is a step in

- A. floating point multiplication
- B. signed 16 bit integer addition
- C. arithmetic left shift
- D. converting a signed integer from one size to another

[gate2002](#) [digital-logic](#) [easy](#)

Answer

### 18.0.13 GATE1999\_2.5 [top](#)

<http://gateoverflow.in/1483>

Given the programming constructs

- (i) assignment
- (ii) for loops where the loop parameter cannot be changed within the loop
- (iii) if-then-else
- (iv) forward go to
- (v) arbitrary go to
- (vi) non-recursive procedure call
- (vii) recursive procedure/function call
- (viii) repeat loop,

which constructs will you not include in a programming language such that it should be possible to program the terminates (i.e., halting) function in the same programming language

- A. (ii), (iii), (iv)
- B. (v), (vii), (viii)
- C. (vi), (vii), (viii)
- D. (iii), (vii), (viii)

[gate1999](#) [programming](#) [normal](#)

**Answer****18.0.14 GATE2010-14** [top](#)<http://gateoverflow.in/2187>

Which languages necessarily need heap allocation in the runtime environment?

- A. Those that support recursion.\
- B. Those that use dynamic scoping.
- C. Those that allow dynamic data structure.
- D. Those that use global variables.

[gate2010](#) [programming](#) [easy](#)**Answer****18.0.15 GATE2000-2.20** [top](#)<http://gateoverflow.in/667>

The value of j at the end of the execution of the following C program

```
int incr (int i)
{
 static int count = 0;
 count = count + i;
 return (count);
}
main ()
{
 int i, j;
 for (i = 0; i <= 4; i++)
 j = incr (i);
}
```

is

- A. 10
- B. 4
- C. 6
- D. 7

[gate2000](#) [programming](#) [easy](#)**Answer****18.0.16 GATE1994\_1.5** [top](#)<http://gateoverflow.in/2442>

An unrestricted use of the "goto" statement is harmful because

- A. it makes it more difficult to verify programs
- B. it increases the running time of the programs
- C. it increases the memory required for the programs
- D. it results in the compiler generating longer machine code

[gate1994](#) [programming](#) [easy](#)**Answer****18.0.17 GATE2000-1.16** [top](#)<http://gateoverflow.in/639>

Aliasing in the context of programming languages refers to

- A. multiple variables having the same memory location
- B. multiple variables having the same value
- C. multiple variables having the same identifier
- D. multiple uses of the same variable

[gate2000](#) [programming](#) [easy](#)**Answer**

**18.0.18 GATE1995\_3** [top](#)<http://gateoverflow.in/2639>

Consider the following high level programming segment. Give the contents of the memory locations for variables W, X, Y and Z after the execution of the program segment. The values of the variables A and B are 5CH and 92H, respectively. Also indicate error conditions if any.

```
var
 A, B, W, X, Y :unsigned byte;
 Z :unsigned integer, (each integer is represented by two bytes)
begin
 X :=A+B;
 Y :=abs(A-B);
 W :=A-B;
 Z :=A*B
end;
```

[gate1995](#) [programming](#) [normal](#)**Answer****18.0.19 GATE1998\_2.13** [top](#)<http://gateoverflow.in/1685>

What is the result of the following program?

```
program side-effect (input, output);
var x, result: integer;
function f (var x:integer;integer;
begin
 x:=x+1;f:=x;
end
begin
 x:=5;
 result:=f(x)*f(x);
 writeln(result);
end
```

- A. 5
- B. 25
- C. 36
- D. 42

[gate1998](#) [programming](#) [normal](#)**Answer****18.0.20 GATE2004-IT\_15** [top](#)<http://gateoverflow.in/3656>

Let x be an integer which can take a value of 0 or 1. The statement

```
if (x == 0) x = 1;
else x = 0;
```

is equivalent to which one of the following ?

- A)  $x = 1 + x;$
- B)  $x = 1 - x;$
- C)  $x = x - 1;$
- D)  $x = 1 \% x;$

[gate2004-it](#) [programming](#) [easy](#)**Answer****18.0.21 GATE1998\_2.15** [top](#)<http://gateoverflow.in/1687>

Faster access to non-local variables is achieved using an array of pointers to activation records called a

- A. stack
- B. heap
- C. display
- D. activation tree

[gate1998](#) | [programming](#) | [normal](#)

**Answer**

### 18.0.22 GATE2008-61 [top](#)

<http://gateoverflow.in/484>

Choose the correct option to fill ?1 and ?2 so that the program below prints an input string in reverse order. Assume that the input string is terminated by a new line character.

```
void reverse(void) {
 int c;
 if(?1) reverse();
 ?2
}
main() {
 printf("Enter text"); ptintf("\n");
 reverse(); printf("\n");
}
```

- A. ?1 is (getchar() != '\n')  
?2 is getchar(c);
- B. ?1 is ((c = getchar()) != '\n')  
?2 is getchar(c);
- C. ?1 is (c != '\n')  
?2 is putchar(c);
- D. ?1 is ((c = getchar()) != '\n')  
?2 is putchar(c);

[gate2008](#) | [programming](#) | [normal](#)

**Answer**

### 18.0.23 GATE2006-IT\_53 [top](#)

<http://gateoverflow.in/3596>

Match the following concepts and their best possible descriptions.

|      | <b>Concept</b> | <b>Description</b>                                                              |
|------|----------------|---------------------------------------------------------------------------------|
| i.   | overloading    | a. allows to define a class to have properties of another class                 |
| ii.  | friend         | b. defining a set of similar functions                                          |
| iii. | constructor    | c. used in dereferencing                                                        |
| iv.  | protected      | d. used to give a non-member function access to the private parts of an object  |
| v.   | this           | e. a function which is automatically called when an object is created           |
| vi.  | inheritance    | f. allows a derived class to have access to the private parts of the base class |
|      |                | g. a pointer to the object associated with the current function                 |
|      |                | h. used to obtain object                                                        |

|    | Concept                           | Description |
|----|-----------------------------------|-------------|
| A) | i-b, ii-d, iii-e, iv-f, v-g, vi-a |             |
| B) | i-c, ii-a, iii-e, iv-d, v-h, vi-f |             |
| C) | i-c, ii-f, iii-h, iv-a, v-g, vi-d |             |
| D) | i-b, ii-e, iii-c, iv-f, v-g, vi-s |             |

gate2006-it programming easy

**Answer****18.0.24 GATE2008-54** top<http://gateoverflow.in/477>

Which of the following are true?

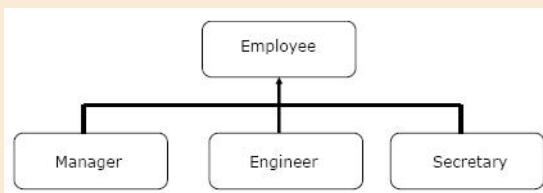
- I. A programming language which does not permit global variables of any kind and has no nesting of procedures/functions, but permits recursion can be implemented with static storage allocation
  - II. Multi-level access link (or display) arrangement is needed to arrange activation records only if the programming language being implemented has nesting of procedures/functions
  - III. Recursion in programming languages cannot be implemented with dynamic storage allocation
  - IV. Nesting procedures/functions and recursion require a dynamic heap allocation scheme and cannot be implemented with a stack-based allocation scheme for activation records
  - V. Programming languages which permit a function to return a function as its result cannot be implemented with a stack-based storage allocation scheme for activation records
- A. II and V only  
 B. I, III and IV only  
 C. I, II and V only  
 D. II, III and V only

gate2008 programming difficult

**Answer****18.0.25 GATE2004\_34** top<http://gateoverflow.in/1031>

It is desired to design an object-oriented employee record system for a company. Each employee has a name, unique id, and salary. Employees belong to different categories and their salary is determined by their category. The functions get name, getId and compute salary are required. Given the class hierarchy below, possible locations for these functions are:

- I. getId is implemented in the superclass
- II. getId is implemented in the subclass
- III. getName is an abstract function in the superclass
- IV. getName is implemented in superclass
- V. getName is implemented in subclass
- VI. getSalary is an abstract function in the superclass
- VII. getSalary is implemented in the superclass
- VIII. getSalary is implemented in the subclass



Choose the best design

- A. (I), (IV), (VI), (VIII)  
 B. (I), (IV), (VII)  
 C. (I), (III), (V), (VI), (VIII)  
 D. (II), (V), (VIII)

gate2004 | programming | normal

[Answer](#)

## Answers:

### 18.0.1 GATE2012\_3 [top](#)

<http://gateoverflow.in/35>



Selected Answer

There is a `space` in between the `/` and `n`. ([see-Q-no.-3](#))

```
case 'A' : printf ("Choice A\ n");
 ^
```

So, [output](#) of the given program is

```
Choice A nChoice BNo Choice
```

Which includes

```
'n'
```

And there is no new line or spaces between outputs. Hence, there is no option matching.

<http://stackoverflow.com/questions/33694700/im-missing-something>

拇指图标 8 votes

-- Arjun Suresh (150k points)

### 18.0.2 GATE2005\_4 [top](#)

<http://gateoverflow.in/1346>

ans b)

拇指图标 1 votes

-- Aditi Dan (5.4k points)

### 18.0.3 GATE2004\_1 [top](#)

<http://gateoverflow.in/998>



Selected Answer

Answer is (c) The goal of structured programming is to able to infer the flow of control from the program text . It means user can execute the code according to his requirement. C and Pascal are good example of structured programming. In structured programming control passes one instruction to another instruction in sequential manner.

Avoiding the use of GOTO statements is not the goal of structured programming, it (avoiding the use of GOTO) is one of the requirements for a program to be structured.

拇指图标 8 votes

-- Kalpana Bhargav (3k points)

### 18.0.4 GATE1997\_1.10 [top](#)

<http://gateoverflow.in/2226>



Selected Answer

memory is taken from heap for dynamic allocation

so option b is correct

4 votes

-- Sankaranarayanan P.N (9.8k points)

### 18.0.5 TIFR2010-B-31 [top](#)

<http://gateoverflow.in/26484>

Answer is A) w and 0

If we solve using parallel innermost rule

$$F(1,0) = F(2,F(1,0)) * F(0,F(1,0))$$

$$= F(2, F(2,F(1,0)) * F(0,F(1,0))) * F(0, F(2,F(1,0)) * F(0,F(1,0)))$$

Since computation of  $F(1,0)$  goes on

we assign  $F(1,0)$  to w

$$\text{So } F(1,0) = w$$

Using parallel outermost rule

$$F(1,0) = F(2,F(1,0)) * F(0,F(1,0))$$

$$= F(2,F(1,0)) * 0$$

$$= 0$$

1 votes

-- zambus (169 points)

### 18.0.6 GATE2003\_24 [top](#)

<http://gateoverflow.in/914>



Selected Answer

Answer is C. In dynamically typed languages variables do have type- just that it is inferred during runtime.

2 votes

-- Arjun Suresh (150k points)

### 18.0.7 GATE2004\_90 [top](#)

<http://gateoverflow.in/1084>



Selected Answer

**D should be the answer.**

4 votes

-- sumit kumar singh dixit (1.8k points)

### 18.0.8 GATE2002\_2.19 [top](#)

<http://gateoverflow.in/849>



Selected Answer

Expression without any calls in it =>  $1+2*3-4$

Expression with embedded calls =>  $1 + \text{fun1}(a,b,c) * \text{fun2}(3.4,58) - \text{fun3}(x,yz);$

First we can convert Infix to Postfix using single stack (Using it as operator stack)

Then we can evaluate that expression using Single stack.

3 votes

-- Akash (31.7k points)

### 18.0.9 GATE2013\_42 [top](#)

<http://gateoverflow.in/60>



Selected Answer

In GATE 2013 marks were given to all as the same code in C/C++ produces undefined behavior. This is because \* is not a sequence point in C/C++. The correct code must replace  
`return f(x,c) * x;`  
with  
`res = f(x,c);  
return res * x;`

In this code, there will be 4 recursive calls with parameters (6,4), (7,3), (8,2) and (9,1). The last call returns 1. But due to pass by reference, x in all the previous functions is now 9. Hence, the value returned by f(p,p) will be  $9 * 9 * 9 * 9 * 1 = 6561$ .

11 votes

-- Arjun Suresh (150k points)

### 18.0.10 TIFR2011-B-40 [top](#)

<http://gateoverflow.in/20937>

ans is B .in programming language like java when object is created it cannot reside on stack so it uses heap.....  
A is wrong because pascal is procedure oriented but object pascal is object oriented.  
C is also wrong coz we can implement some oops concept through c.  
d and e also wrong.....

0 votes

-- khamer (407 points)

### 18.0.11 GATE2005-3, UGCNET-June2012-III-15 [top](#)

<http://gateoverflow.in/1345>



Selected Answer

Answer : both are declarative

Major logic programming language families include Prolog, Answer set programming (ASP) and Datalog. In all of these languages, rules are written in the form of clauses

Prolog is a Declarative Language .

Functional programming is a declarative programming paradigm, which means programming is done with expressions or declarations instead of statements.

Reference : for both that Prolog is a Declarative Language .and comes under [logic programming](#) languages and [Functional programming](#) is a declarative programming paradigm is [Here](#)

2 votes

-- Don't you worry (1.6k points)

### 18.0.12 GATE2002\_1.16 [top](#)

<http://gateoverflow.in/821>



Selected Answer

(d) is the answer. Sign extension (filling the upper bits using the sign bit) is needed while increasing the number of bits for representing a number. For positive numbers, 0 is extended and for negative numbers 1 is extended.

7 votes

-- gatecse (10.7k points)

### 18.0.13 GATE1999\_2.5 [top](#)

<http://gateoverflow.in/1483>

**Ans)B**

Arbitrary goto, recursive call and repeat may enter infinite loop, and hence terminates program may not be able to answer if 'the program does terminate'.

4 votes

-- bahirNaik (2.6k points)

**18.0.14 GATE2010-14** [top](#)

<http://gateoverflow.in/2187>



Selected Answer

Those that allow dynamic data structure.

malloc etc uses memory from heap area

7 votes

-- Sankaranarayanan P.N (9.8k points)

**18.0.15 GATE2000-2.20** [top](#)

<http://gateoverflow.in/667>



Selected Answer

Answer: A

At i=0, j=0  
At i=1, j=1  
At i=2, j=3  
At i=3, j=6  
At i=4, j=10

4 votes

-- Rajarshi Sarkar (29.7k points)

**18.0.16 GATE1994\_1.5** [top](#)

<http://gateoverflow.in/2442>



Selected Answer

Use of goto takes out the structural decomposition of the code and hence it becomes very difficult to verify or debug the code. As far as performance or memory impact is concerned, goto has no effect on them.

7 votes

-- Arjun Suresh (150k points)

**18.0.17 GATE2000-1.16** [top](#)

<http://gateoverflow.in/639>



Selected Answer

A OPTION

5 votes

-- vinay kumar (479 points)

**18.0.18 GATE1995\_3** [top](#)

<http://gateoverflow.in/2639>

Max. value that can be accommodated inside an unsigned byte = 255 and unsigned int = 65535

A and B are given in Hexadecimal.

$$A = 5CH = (92)_{10}$$

$$B = 92H = (146)_{10}$$

$$X = A + B = (238)_{10} = EEH$$

$$Y = \text{abs}(A - B) = (54)_{10} = 36H$$

$$W = A - B = (-54)_{10} = CAH$$

$$Z = A * B = (13432)_{10} = 3478H$$

1 votes

-- Ravi Ranjan (1.2k points)

## 18.0.19 GATE1998\_2.13 top

<http://gateoverflow.in/1685>



Selected Answer

call by value: 36,  
call by reference: undefined behaviour for C/C++ but 42 for languages having \* as a sequence point.

$$f(x) * f(x);$$

If the value of x is being modified inside the function (call by reference) we cannot be sure if this modified value or the old value will be passed as argument for the second call to f(). This is because left and right operand of any arithmetic expression in C/C++ can be evaluated in any order. For languages like Java, strict left-right order is maintained.

2 votes

-- Arjun Suresh (150k points)

## 18.0.20 GATE2004-IT\_15 top

<http://gateoverflow.in/3656>



Selected Answer

Firstly our requirement is for x=1 it makes '0' and for x= 0 it makes '1'

Let's consider options one by one:

A)  $X = 1 + X$

For x = 1, it gives 2 So, False

C)  $X = X - 1$

For x=0 , it gives -1. So, False

D)  $X = 1 \% X$

For x= 0 , it gives 1 % 0 . I think it is undefined.

Even if we consider  $X = X \% 1$

Then for x= 0 ,it gives 0%1 = 0 But we require 1.

B)  $X = 1 - X$

Here B is correct , as

For x= 0, it gives 1.

For x= 1, it gives 0.

So, Option (B) is correct..

5 votes

-- Himanshu Agarwal (9.8k points)

### 18.0.21 GATE1998\_2.15 [top](#)

<http://gateoverflow.in/1687>



Selected Answer

it is C

properties of displays

- 1> Use a pointer array to store the activation records along the static chain.
- 2> Fast access for non-local but may be complicated to maintain.
- 3> Calling a subprogram in the same level – simply replace and restore.
- 4> Calling a subprogram in the higher level – add an entry and may need to save the old pointers.
- 5> Calling a subprogram in the lower level – shrink the pointer and restore it when the subprogram returns.

<http://users.dickinson.edu/~wahlst/356/ch10.pdf>

8 votes

-- sumit kumar singh dixit (1.8k points)

### 18.0.22 GATE2008-61 [top](#)

<http://gateoverflow.in/484>



Selected Answer

Here we are using the '=' operator which has less priority than '!=>' operator. So (c=getchar()) has to be in brackets and after reversing the string we use function putchar(c) for printing the character So option (d) is the right answer

10 votes

-- Kalpana Bhargav (3k points)

### 18.0.23 GATE2006-IT\_53 [top](#)

<http://gateoverflow.in/3596>



Selected Answer

(A) is the answer. All are straight from definitions.

2 votes

-- Arjun Suresh (150k points)

### 18.0.24 GATE2008-54 [top](#)

<http://gateoverflow.in/477>



Selected Answer

Answer is A.

I. Recursion can never be implemented with Static Storage Allocation.

II, Is TRUE.

III. Recursion can be implemented with Dynamic Storage Allocation but not with Static Storage Allocation.

IV. Can be done with Stack based allocation scheme.

V. Is TRUE as with a stack based allocation once a function returns its activation record is no longer valid- so we cannot return a function as a result.

8 votes

-- Gate Keeda (17.7k points)

**18.0.25 GATE2004\_34** [top](#)<http://gateoverflow.in/1031>

Selected Answer

A.

Name and id are a property of every employee and independent of their category. So, these should be implemented in superclass. Every employee has a salary but this is determined by their category. So, getSalary must be a abstract function in superclass and implemented in subclass.

4 votes

-- Arjun Suresh (150k points)

**18.1****Activation Records** [top](#)**18.1.1 Activation Records: GATE2012\_36** [top](#)<http://gateoverflow.in/1758>

Consider the program given below, in a block-structured pseudo-language with lexical scoping and nesting of procedures permitted.

```
Program main;
 Var ...

 Procedure A1;
 Var ...
 Call A2;
 End A1

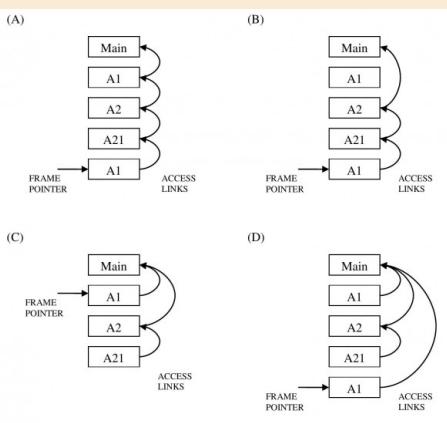
 Procedure A2;
 Var ...
 Procedure A21;
 Var ...
 Call A1;
 End A21

 Call A21;
 End A2

 Call A1;
End main.
```

Consider the calling chain: Main -> A1 -> A2 -> A21 -> A1

The correct set of activation records along with their access links is given by

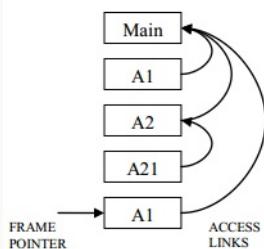

[gate2012](#) [programming](#) [activation-records](#) [normal](#)

Answer

**Answers: Activation Records****18.1.1 Activation Records: GATE2012\_36** [top](#)<http://gateoverflow.in/1758>



Selected Answer



Since, Activation records are created at procedure entry time and destroyed at procedure exit time.

therefore here Calling sequence is given as ,

Main->A1->A2->A3->A1

now A1,A2 are defined under Main...So A1,A2 Access link are pointed to main  
A21 is Defined under A2 hence its Access link will point to A2

15 votes

-- Kalpish Singh (1.7k points)

## 18.2

## Arrays top

### 18.2.1 Arrays: GATE2014-3\_42 top

<http://gateoverflow.in/2076>

Consider the C function given below. Assume that the array

*listA* contains

$n(> 0)$  elements, sorted in ascending order.

```
int ProcessArray(int *listA, int x, int n)
{
 int i, j, k;
 i = 0; j = n-1;
 do {
 k = (i+j)/2;
 if (x <= listA[k]) j = k-1;
 if (listA[k] <= x) i = k+1;
 }
 while (i <= j);
 if (listA[k] == x) return(k);
 else return -1;
}
```

Which one of the following statements about the function  
*ProcessArray* is **CORRECT**?

- A. It will run into an infinite loop when  
 $x$  is not in  
*listA*.
- B. It is an implementation of binary search.
- C. It will always find the maximum element in  
*listA*.
- D. It will return -1 even when  
 $x$  is present in  
*listA*.

[gate2014-3](#) [data-structure](#) [arrays](#) [easy](#)

**Answer**

### 18.2.2 Arrays: GATE 2016-2-37 top

<http://gateoverflow.in/39602>

Consider the following program:

```
int f (int * p, int n)
{
```

```

 if (n <= 1) return 0;
 else return max (f (p+1, n-1), p[0] - p[1]);
}
int main ()
{
 int a[] = {3, 5, 2, 6, 4};
 print f("%d", f(a, 5));
}

```

Note: max ( $x, y$ ) returns the maximum of  $x$  and  $y$ .

The value printed by this program is \_\_\_\_\_.

[gate2016-2](#) [programming-in-c](#) [arrays](#) [normal](#) [numerical-answers](#)

[Answer](#)

## Answers: Arrays

### 18.2.1 Arrays: GATE2014-3\_42 [top](#)

<http://gateoverflow.in/2076>

B)....

8 votes

-- Siddhartha Datta (125 points)

### 18.2.2 Arrays: GATE 2016-2-37 [top](#)

<http://gateoverflow.in/39602>



Selected Answer

$f(a, 5)$

$p,$   
 $n = 5$

|   |   |   |   |   |  |
|---|---|---|---|---|--|
| 3 | 5 | 2 | 6 | 4 |  |
|---|---|---|---|---|--|

$\max(f(p + 1, 5 - 1), \dots)$  or  $\max(f(p + 1, 4), \dots)$

$p,$   
 $n = 4$

|   |   |   |   |  |
|---|---|---|---|--|
| 5 | 2 | 6 | 4 |  |
|---|---|---|---|--|

$\max(\max(f(p + 1, 4 - 1), \dots), \max(f(p + 1, 3), \dots))$

$p,$   
 $n = 3$

|   |   |   |  |
|---|---|---|--|
| 2 | 6 | 4 |  |
|---|---|---|--|

```
max(max(max(f(p
+1,
3-1),
2-6),
3),
-2) or max(max(max(f(p
+1,
2),
-4),
3),
-2)
```

$p,$   
 $n = 2$

|   |   |  |
|---|---|--|
| 6 | 4 |  |
|---|---|--|

```
max(max(max(max(f(p
+1,
1),
2),
-4),
3),
-2)
```

$n = 1$ , return  
0

```
max(max(max(max(
0,
2),
-4),
3),
-2)
```

```
max(max(
2,
-4),
3),
-2)
```

```
max(max(
2,
3),
-2)
```

```
max(
3,
-2)
```

3

Check this code => <http://codepad.org/vVicmkN7>

15 votes

-- Praveen Saini (38.4k points)

## 18.3

## Concurrency

### 18.3.1 Concurrency: TIFR2012-B-9

<http://gateoverflow.in/25109>

Consider the concurrent program

```
x := 1;
cobegin
 x := x + x + 1 || x := x + 2
coend;
```

Reading and writing of a variable is atomic, but evaluation of an expression is not atomic. The set of possible values of variable  $x$  at the end of execution of the program is

- a.  $\{3\}$
- b.  $\{7\}$
- c.  $\{3, 5, 7\}$
- d.  $\{3, 7\}$
- e.  $\{3, 5\}$

[tifr2012](#) | [programming](#) | [concurrency](#)

[Answer](#)

## Answers: Concurrency

### 18.3.1 Concurrency: TIFR2012-B-9 [top](#)

<http://gateoverflow.in/25109>



Selected Answer

1.  $x \times 1$ , Run  $x = x + 2$  then  $x = x + x$  finally  $x$  will be 7.  
 2.  $x = 1$ , run  $x = x + 2$  and  $x = x + x + 1$ , parallelly ..  
 $x = 5, 3$   
 Final answer would be  $\{3, 5, 7\}$

1 votes

-- Digvijay (35.8k points)

## 18.4

### Loop Invariants [top](#)

### 18.4.1 Loop Invariants: GATE2004\_32 [top](#)

<http://gateoverflow.in/1029>

Consider the following program fragment for reversing the digits in a given integer to obtain a new integer.

Let  $n = d_1 d_2 \dots d_m$ .

```
int n, rev;
rev = 0;
while(n > 0) {
 rev = rev * 10 + n%10;
 n = n/10;
}
```

The loop invariant condition at the end of the  $i^{th}$  iteration is:

- A.  $n = d_1 d_2 \dots d_{m-i}$  and  $rev = d_m d_{m-1} \dots d_{m-i+1}$
- B.  $n = d_{m-i+1} \dots d_{m-1} d_m$  or  $rev = d_{m-i} \dots d_2 d_1$
- C.  $n \neq rev$
- D.  $n = d_1 d_2 \dots d_m$  or  $rev = d_m \dots d_2 d_1$

[gate2004](#) | [programming](#) | [loop-invariants](#) | [normal](#)

[Answer](#)

### 18.4.2 Loop Invariants: GATE1991-1,vi [top](#)

<http://gateoverflow.in/504>

Consider the following PASCAL program segment:

```
if i mod 2 = 0 then
 while i >= 0 do
```

```

begin
 i := i div 2;
 if i mod 2 < > 0 then i := i - 1;
 else i := i - 2;
end;

```

An appropriate loop-invariant for the while-loop is \_\_\_\_\_

[gate1991](#) | [programming](#) | [loop-invariants](#) | [normal](#)

[Answer](#)

### 18.4.3 Loop Invariants: TIFR2010-B-37 [top](#)

<http://gateoverflow.in/19251>

Consider the program where  $a, b$  are integers with  $b > 0$ .

```

x:=a; y:=b; z:=0;
while y > 0 do
 if odd (x) then
 z:= z + x;
 y:= y - 1;
 else y:= y % 2;
 x:= 2 * x;
 fi

```

Invariant of the loop is a condition which is true before and after every iteration of the loop. In the above program the loop invariant is given by

$$0 \leq y \text{ and } z + x * y = a * b$$

Which of the following is true of the program?

- a. The program will not terminate for some values of  $a, b$ .
- b. The program will terminate with  $z = 2^b$
- c. The program will terminate with  $z = a * b$ .
- d. The program will not terminate for some values of  $a, b$  but when it does terminate, the condition  $z = a * b$  will hold.
- e. The program will terminate with  $z = a^b$

[tifr2010](#) | [programming](#) | [loop-invariants](#)

[Answer](#)

## Answers: Loop Invariants

### 18.4.1 Loop Invariants: GATE2004\_32 [top](#)

<http://gateoverflow.in/1029>



Selected Answer

A loop invariant is something that holds at the start of a loop, across each iteration (inside an iteration it can change but before the iteration ends original condition must be true) and at the end also. So, we can check for the satisfiability of the condition at the loop header for start of the loop, for each iteration and also at the exit.

Here, in each iteration the right most digit of  $n$ , is moving to the right end of rev. So, answer is A. i.e. the 2 conditions given in A choice are true on entry to loop, after each iteration (not necessarily during an iteration), and at end of loop.

2 votes

-- Arjun Suresh (150k points)

### 18.4.2 Loop Invariants: GATE1991-1,vi [top](#)

<http://gateoverflow.in/504>



Selected Answer

A loop invariant is a condition that is always the same before the loop starts, while in the loop and after the loop ends for each iteration.

Here  $i \bmod 2 = 0$  is the loop invariant.

7 votes

-- Monanshi Jain (6.5k points)

### 18.4.3 Loop Invariants: TIFR2010-B-37 [top](#)

<http://gateoverflow.in/19251>

Typing error in ques: $y=y\%2$

Ans D

```
if x is odd then{
 z = a*b will be o/p
}
if x is even {
 case 1: y is even then x =2*x and z=0 will be o/p
 case 2: y is odd then loop will not terminate .
}
```

2 votes

-- Saurav Shrivastava (719 points)

## 18.5

### Parameter Passing [top](#)

#### 18.5.1 Parameter Passing: GATE2004\_2 [top](#)

<http://gateoverflow.in/999>

Consider the following function

```
void swap(int a, int b) { int temp; temp = a; a = b; b = temp; }
```

In order to exchange the values of two variables x and y.

- A. call swap(x, y)
- B. call swap(&x, &y)
- C. swap (x, y) cannot be used as it does not return any value
- D. swap (x, y) cannot be used as the parameters are passed by value

[gate2004](#) [programming](#) [programming-in-c](#) [parameter-passing](#) [easy](#)

Answer

#### 18.5.2 Parameter Passing: TIFR2011-B-32 [top](#)

<http://gateoverflow.in/20619>

Various parameter passing mechanisms have been used in different programming languages. Which of the following statements is true?

- a. Call by value result is used in language Ada.
- b. Call by value result is the same as call by name.
- c. Call by value is the most robust.
- d. Call by reference is the same as call by name.
- e. Call by name is the most efficient.

[tifr2011](#) [programming](#) [parameter-passing](#)

**Answer****18.5.3 Parameter Passing: GATE1993\_26** [top](#)<http://gateoverflow.in/2322>

A stack is used to pass parameters to procedures in a procedure call.

- a. If a procedure  $P$  has two parameters as described in procedure definition:

```
procedure P (var x :integer; y: integer);
```

and if  $P$  is called by ;  $P(a, b)$

State precisely in a sentence what is pushed on stack for parameters  $a$  and  $b$

- b. In the generated code for the body of procedure  $P$ , how will the addressing of formal parameters  $x$  and  $y$  differ?

[gate1993](#) [programming](#) [parameter-passing](#) [normal](#)
**Answer****Answers: Parameter Passing****18.5.1 Parameter Passing: GATE2004\_2** [top](#)<http://gateoverflow.in/999>

Selected Answer

ans (d).

option a will not swap the values bcoz it is passed by value...

option b will not swap the value

```
void swap(int a, int b) in which arguments will not take
```

option c is false , given reason is wrong

and option d is correct .. we cant use swap(x,y) bcoz it is pass value function call which will not swap the values

Upvote 5 votes

-- sonam vyas (8.1k points)

**18.5.2 Parameter Passing: TIFR2011-B-32** [top](#)<http://gateoverflow.in/20619>

e. Call by name is the most efficient.

<http://stackoverflow.com/questions/838079/what-is-pass-by-name-and-how-does-it-work-exactly>

Upvote 0 votes

-- zambus (169 points)

**18.5.3 Parameter Passing: GATE1993\_26** [top](#)<http://gateoverflow.in/2322>

a is pointer variable so address and b is variable so its value pushed into stack.

Upvote 1 votes

-- Digvijay (35.8k points)

**18.6****Pointers** [top](#)

## 18.6.1 Pointers: GATE2001-2.18 [top](#)

<http://gateoverflow.in/736>

Consider the following three C functions:

[P1]

```
int *g(void)
{
 int x = 10;
 return (&x);
}
```

[P2]

```
int *g(void)
{
 int *px;
 *px = 10;
 return px;
}
```

[P3]

```
int *g(void)
{
 int *px;
 px = (int*) malloc (sizeof(int));
 *px = 10;
 return px;
}
```

Which of the above three functions are likely to cause problems with pointers?

- A. Only P3
- B. Only P1 and P3
- C. Only P1 and P2
- D. P1, P2 and P3

[gate2001](#) [programming-in-c](#) [pointers](#) [programming](#) [normal](#)

[Answer](#)

## Answers: Pointers

### 18.6.1 Pointers: GATE2001-2.18 [top](#)

<http://gateoverflow.in/736>



Selected Answer

[P1] may cause an error because function is returning the address of locally declared variable.

[P2] will cause a problem because px is an int pointer that is not assigned with any address and we are doing dereferencing.

[P3] will work because memory in bytes of size of int will be reserved and its address will be stored in px that can be further use, once function execution completes, this m/m will still exist in Heap until we free() function.

hence answer is C

15 votes

-- Manu Thakur (5.6k points)

## 18.7

## Post Condition [top](#)

### 18.7.1 Post Condition: GATE2015-1\_33 [top](#)

<http://gateoverflow.in/8276>

Consider the following pseudo code, where x and y are positive integers.

```
begin
 q := 0
 r := x
 while r ≥ y do
 begin
 r := r - y
```

```

q := q + 1
end
end

```

The post condition that needs to be satisfied after the program terminates is

- A.  $\{ r = qx + y \wedge r < y \}$
- B.  $\{ x = qy + r \wedge r < y \}$
- C.  $\{ y = qx + r \wedge 0 < r < y \}$
- D.  $\{ q + 1 < r - y \wedge y > 0 \}$

[gate2015-1](#) [programming](#) [post-condition](#) [normal](#)

[Answer](#)

## Answers: Post Condition

### 18.7.1 Post Condition: GATE2015-1\_33 [top](#)

<http://gateoverflow.in/8276>



Selected Answer

The loop terminates when  $r < y$ . So,  $r < y$  is one post condition.

In each iteration  $q$  is incremented by 1 and  $y$  is subtracted from  $r$ . Initial value of  $r$  is  $x$ . So, loop iterates  $x/y$  times and  $q$  will be equal to  $x/y$  and  $r = x \% y \Rightarrow x = qy + r$ ;

So, B choice.

13 votes

-- Arjun Suresh (150k points)

## 18.8

## Programming In C [top](#)

### 18.8.1 Programming In C: GATE2004-IT\_59 [top](#)

<http://gateoverflow.in/3702>

What is the output of the following program?

```

#include<stdio.h>
int funcf (int x);
int funcg (int y);
main ()
{
 int x = 5, y = 10, count;
 for (count = 1; count <= 2; ++count) {
 y += funcf(x) + funcg(x);
 printf ("%d", y);
 }
}
funcf (int x) {
 int y;
 y = funcg(x);
 return (y);
}
funcg (int x) {
 static int y = 10;
 y += 1;
 return (y + x);
}

```

- |    |       |
|----|-------|
| A) | 43 80 |
| B) | 42 74 |
| C) | 33 37 |
| D) | 32 32 |

[gate2004-it](#) [programming](#) [programming-in-c](#) [normal](#)

**Answer****18.8.2 Programming In C: GATE2004-IT\_61** [top](#)<http://gateoverflow.in/3704>

Consider the following C program:

```
#include <stdio.h>
typedef struct {
 char *a;
 char *b;
} t;
void f1 (t s);
void f2 (t *p);
main()
{
 static t s = {"A", "B"};
 printf ("%s %s\n", s.a, s.b);
 f1(s);
 printf ("%s %s\n", s.a, s.b);
 f2(&s);
}
void f1 (t s)
{
 s.a = "U";
 s.b = "V";
 printf ("%s %s\n", s.a, s.b);
 return;
}
void f2(t *p)
{
 p -> a = "V";
 p -> b = "W";
 printf ("%s %s\n", p -> a, p -> b);
 return;
}
```

What is the output generated by the program ?

- A) A B  
U V  
V W  
V W  
A B
- B) U V  
A B  
V W  
A B
- C) U V  
U V  
V W  
A B
- D) U V  
V W  
U V

[gate2004-it](#) [programming](#) [programming-in-c](#) [normal](#)

**Answer****18.8.3 Programming In C: GATE2004-IT\_60** [top](#)<http://gateoverflow.in/3703>

Choose the correct option to fill the ?1 and ?2 so that the program prints an input string in reverse order. Assume that the input string is terminated by a new line character.

```
#include <stdio.h>
void wrt_it (void);
int main (void)
{
 printf("Enter Text");
 printf ("\n");
 wrt_it();
 printf ("\n");
 return 0;
}
void wrt_it (void)
{
 int c;
```

```

if (?1)
 wrt_it();
?2
}

```

- A) ?1 is getchar() != '\n'  
?2 is getchar(c);
- B) ?1 is (c = getchar()) != '\n'  
?2 is getchar(c);
- C) ?1 is c != '\n'  
?2 is putchar(c);
- D) ?1 is (c = getchar()) != '\n'  
?2 is putchar(c);

gate2004-it | programming | programming-in-c | normal

[Answer](#)

#### 18.8.4 Programming In C: GATE2006-IT\_51 [top](#)

<http://gateoverflow.in/3594>

Which one of the choices given below would be printed when the following program is executed?

```

#include <stdio.h>
int a1[] = {6, 7, 8, 18, 34, 67};
int a2[] = {23, 56, 28, 29};
int a3[] = {-12, 27, -31};
int *x[] = {a1, a2, a3};
void print(int *a[])
{
 printf("%d,", a[0][2]);
 printf("%d,", *a[2]);
 printf("%d,", *++a[0]);
 printf("%d,", *(++a)[0]);
 printf("%d\n", a[-1][+1]);
}
main()
{
 print(x);
}

```

- A) 8, -12, 7, 23, 8  
B) 8, 8, 7, 23, 7  
C) -12, -12, 27, -31, 23  
D) -12, -12, 27, -31, 56

gate2006-it | programming | programming-in-c | normal

[Answer](#)

#### 18.8.5 Programming In C: GATE2015-3\_26 [top](#)

<http://gateoverflow.in/8478>

Consider the following C program

```

#include<stdio.h>
int main()
{
 static int a[] = {10, 20, 30, 40, 50};
 static int *p[] = {a, a+3, a+4, a+1, a+2};
 int **ptr = p;
 ptr++;
 printf("%d%d", ptr-p, **ptr);
}

```

The output of the program is \_\_\_\_\_.

gate2015-3 | programming | programming-in-c | normal | numerical-answers

[Answer](#)

#### 18.8.6 Programming In C: GATE2015-2\_15 [top](#)

<http://gateoverflow.in/8086>

Consider the following function written in the C programming language :

```
void foo(char *a)
{
 if (*a && *a != ' ')
 {
 foo(a+1);
 putchar(*a);
 }
}
```

The output of the above function on input "ABCD EFGH" is

- A. ABCD EFGH
- B. ABCD
- C. HGFE DCBA
- D. DCBA

[gate2015-2](#) | [programming](#) | [programming-in-c](#) | [normal](#)

[Answer](#)

### 18.8.7 Programming In C: GATE2015-1\_11 [top](#)

<http://gateoverflow.in/8185>

The output of the following C program is\_\_\_\_\_.

```
void f1 (int a, int b) {
 int c;
 c = a; a = b;
 b = c;
}
void f2 (int * a, int * b) {
 int c;
 c = * a; *a = *b; *b = c;
}
int main () {
 int a = 4, b = 5, c = 6;
 f1 (a, b);
 f2 (&b, &c);
 printf ("%d, c - a - b);
}
```

[gate2015-1](#) | [programming](#) | [programming-in-c](#) | [easy](#)

[Answer](#)

### 18.8.8 Programming In C: GATE2015-1\_35 [top](#)

<http://gateoverflow.in/8283>

What is the output of the following C code? Assume that the address of x is 2000 (in decimal) and an integer requires four bytes of memory.

```
int main () {
 unsigned int x [4] [3] =
 {{1, 2, 3}, {4, 5, 6}, {7, 8, 9}, {10, 11, 12}};
 printf ("%u, %u, %u, x + 3, * (x + 3), * (x + 2) + 3);
}
```

- A. 2036, 2036, 2036
- B. 2012, 4, 2204
- C. 2036, 10, 10
- D. 2012, 4, 6

[gate2015-1](#) | [programming](#) | [programming-in-c](#) | [normal](#)

[Answer](#)

### 18.8.9 Programming In C: GATE2015-3\_7 [top](#)

<http://gateoverflow.in/8401>

Consider the following C program segment.

```
include <stdio.h>
int main()
{
 char s1[7] = "1234", *p;
 p = s1 + 2;
 *p = '0';
 printf("%s", s1);
}
```

What will be printed by the program?

- A. 12
- B. 120400
- C. 1204
- D. 1034

[gate2015-3](#) | [programming](#) | [programming-in-c](#) | [normal](#)

[Answer](#)

### 18.8.10 Programming In C: GATE2006-IT\_49 [top](#)

<http://gateoverflow.in/3592>

Which one of the choices given below would be printed when the following program is executed ?

```
#include <stdio.h>
struct test {
 int i;
 char *c;
}st[] = {5, "become", 4, "better", 6, "jungle", 8, "ancestor", 7, "brother"};
main ()
{
 struct test *p = st;
 p += 1;
 ++p -> c;
 printf("%s,", p++ -> c);
 printf("%c,", *++p -> c);
 printf("%d,", p[0].i);
 printf("%s \n", p -> c);
}
```

- A) jungle, n, 8, nclastor
- B) etter, u, 6, ungle
- C) etter, k, 6, jungle
- D) etter, u, 8, ncestor

[gate2006-it](#) | [programming](#) | [programming-in-c](#) | [normal](#)

[Answer](#)

### 18.8.11 Programming In C: GATE2015-3\_48 [top](#)

<http://gateoverflow.in/8557>

Consider the following C program:

```
#include<stdio.h>
int main()
{
 int i, j, k = 0;
 j=2 * 3 / 4 + 2.0 / 5 + 8 / 5;
 k=--j;
 for (i=0; i<5; i++)
 {
 switch(i+k)
 {
 case 1:
 case 2: printf("\n%d", i+k);
 case 3: printf("\n%d", i+k);
 default: printf("\n%d", i+k);
 }
 }
 return 0;
}
```

The number of times printf statement is \_\_\_\_\_.

[gate2015-3](#) | [programming](#) | [programming-in-c](#) | [normal](#) | [numerical-answers](#)

[Answer](#)

### 18.8.12 Programming In C: GATE2015-3\_54 [top](#)

<http://gateoverflow.in/8563>

Consider the following C program

```
#include<stdio.h>
int f1(void);
int f2(void);
int f3(void);
int x=10;
int main()
{
 int x=1;
 x += f1() + f2() + f3() + f2();
 printf("%d", x);
 return 0;
}
int f1() { int x = 25; x++; return x;}
int f2() { static int x = 50; x++; return x;}
int f3() { x *= 10; return x;}
```

The output of the program is \_\_\_\_\_.

[gate2015-3](#) [programming](#) [programming-in-c](#) [normal](#)

[Answer](#)

### 18.8.13 Programming In C: Gate1989 Programming [top](#)

<http://gateoverflow.in/37264>

In which of the following case(s) is it possible to obtain different results for call-by-reference and call-by-name parameter passing?

- a) Passing an expression as a parameter
- b) Passing an array as a parameter
- c) Passing a pointer as a parameter
- d) Passing an array element as a parameter

[programming-in-c](#) [gate1989](#)

[Answer](#)

### 18.8.14 Programming In C: gate1990 Programming [top](#)

<http://gateoverflow.in/37267>

Match the pairs in the following

List - 1

- A. Pointer data type
- B. Activation method
- C. Repeat until
- D. Coercion

List-2

- P. Type Conversion
- Q. Dynamic Data Structure
- R. Recursion
- S. Nondeterministic loop

[programming-in-c](#) [gate1989](#)

[Answer](#)

### 18.8.15 Programming In C: GATE 2016-2-12 [top](#)

<http://gateoverflow.in/39565>

The value printed by the following program is \_\_\_\_\_.

```
void f (int * p, int m) {
```

```

 m = m + 5;
 *p = *p + m;
 return;
 }
void main () {
 int i=5, j=10;

 f (&i, &j);
 print f ("%d", i+j);
}

```

gate2016-2 | programming-in-c | normal | numerical-answers

**Answer**

### 18.8.16 Programming In C: GATE 2016-1-12 [top](#)

<http://gateoverflow.in/39638>

Consider the following "C" program.

```

void f(int, short);
void main()
{
 int i = 100;
 short s = 12;
 short *p = &s;
 _____; // call to f()
}

```

Which one of the following expressions , when placed in the blank above, will NOT result in a type checking error?

- A. f(s, \*s)
- B. i = f(i,s)
- C. f(i, \*s)
- D. f(i, \*p)

gate2016-1 | programming-in-c | easy

**Answer**

### 18.8.17 Programming In C: GATE 2016-1-15 [top](#)

<http://gateoverflow.in/39642>

Consider the following C program.

```

#include <stdio.h>
void mystery (int *ptr, int *ptrb) {
 int *temp;
 temp = ptrb;
 ptrb = ptr;
 ptr = temp;
}
int main () {
 int a = 2016, b=0, c= 4, d = 42;
 mystery (&a, &b);
 if (a < c)
 mystery (&c, &a);
 mystery (&a, &d);
 print f ("%d\n", a);
}

```

The output of the program is \_\_\_\_\_.

gate2016-1 | programming-in-c | easy | numerical-answers

**Answer**

### 18.8.18 Programming In C: GATE2012-49 [top](#)

<http://gateoverflow.in/43314>

Consider the following C code segment.

```

int a, b, c = 0;
void prtFun(void);
main()
{
 static int a = 1; /* Line 1 */
 prtFun();
 a += 1;
 prtFun();
 printf(" \n %d %d ", a, b);
}

void prtFun(void)
{
 static int a = 2; /* Line 2 */
 int b = 1;
 a += ++b;
 printf(" \n %d %d ", a, b);
}

```

What output will be generated by the given code segment if:

Line 1 is replaced by **auto int a = 1;**

Line 2 is replaced by **register int a = 2;**

(A)

|   |   |
|---|---|
| 3 | 1 |
| 4 | 1 |
| 4 | 2 |

(B)

|   |   |
|---|---|
| 4 | 2 |
| 6 | 1 |
| 6 | 1 |

(C)

|   |   |
|---|---|
| 4 | 2 |
| 6 | 2 |
| 2 | 0 |

(D)

|   |   |
|---|---|
| 4 | 2 |
| 4 | 2 |

|   |   |
|---|---|
| 2 | 0 |
|---|---|

[normal](#) [gate2012](#) [programming-in-c](#) [programming](#)
**Answer**

### 18.8.19 Programming In C: GATE2006-IT\_50 [top](#)

<http://gateoverflow.in/3593>

Which one of the choices given below would be printed when the following program is executed?

```
#include <stdio.h>
void swap (int *x, int *y)
{
 static int *temp;
 temp = x;
 x = y;
 y = temp;
}
void printab ()
{
 static int i, a = -3, b = -6;
 i = 0;
 while (i <= 4)
 {
 if ((i++)%2 == 1) continue;
 a = a + i;
 b = b + i;
 }
 swap (&a, &b);
 printf("a = %d, b = %d\n", a, b);
}
main()
{
 printab();
 printab();
}
```

- A) a = 0, b = 3  
a = 0, b = 3
- B) a = 3, b = 0  
a = 12, b = 9
- C) a = 3, b = 6  
a = 3, b = 6
- D) a = 6, b = 3  
a = 15, b = 12

[gate2006-it](#) [programming](#) [programming-in-c](#) [normal](#)
**Answer**

### 18.8.20 Programming In C: GATE2012-48 [top](#)

<http://gateoverflow.in/2176>

Consider the following C code segment.

```
int a, b, c = 0;
void prtFun(void);
main()
{
 static int a = 1; /* Line 1 */
 prtFun(); /* Line 1 */
 a += 1;
 prtFun(); /* Line 2 */
 printf("\n %d %d ", a, b);
}

void prtFun(void)
{
 static int a = 2; /* Line 2 */
 int b = 1;
 a += ++b;
 printf("\n %d %d ", a, b);
}
```

What output will be generated by the given code segment?

(A)  
3            1  
4            1

4            2

(B)  
4            2  
6            1  
6            1

(C)  
4            2  
6            2  
2            0

(D)  
3            1  
5            2  
5            2

[gate2012](#) [programming](#) [programming-in-c](#) [normal](#)

**Answer**

### 18.8.21 Programming In C: GATE2007-IT\_31 [top](#)

<http://gateoverflow.in/3464>

Consider the C program given below :

```
#include <stdio.h>
int main ()
{
 int sum = 0, maxsum = 0, i, n = 6;
 int a [] = {2, -2, -1, 3, 4, 2};
 for (i = 0; i < n; i++) {
 if (i == 0 || a [i] < 0 || a [i] < a [i - 1]) {
 if (sum > maxsum) maxsum = sum;
 sum = (a [i] > 0) ? a [i] : 0;
 }
 else sum += a [i];
 }
 if (sum > maxsum) maxsum = sum ;
 printf ("%d\n", maxsum);
}
```

What is the value printed out when this program is executed?

- |    |   |
|----|---|
| A) | 9 |
| B) | 8 |
| C) | 7 |
| D) | 6 |

[gate2007-it](#) [programming](#) [programming-in-c](#) [normal](#)

**Answer**

### 18.8.22 Programming In C: GATE2000-1.11 [top](#)

<http://gateoverflow.in/634>

The following C declarations

```
struct node {
 int i;
 float j;
};
struct node *s[10];
```

define s to be

- A. An array, each element of which is a pointer to a structure of type node  
 B. A structure of 2 fields, each field being a pointer to an array of 10 elements  
 C. A structure of 3 fields: an integer, a float, and an array of 10 elements  
 D. An array, each element of which is a structure of type node

gate2000 | programming | programming-in-c | easy

[Answer](#)

### 18.8.23 Programming In C: GATE2000-1.17, ISRO2015-79 [top](#)

<http://gateoverflow.in/640>

Consider the following C declaration

```
struct {
 short x[5];
 union {
 float y;
 long z;
 } u;
} t;
```

Assume that the objects of the type short, float and long occupy 2 bytes, 4 bytes and 8 bytes, respectively. The memory requirement for variable t, ignoring alignment consideration, is

- A. 22 bytes  
 B. 14 bytes  
 C. 18 bytes  
 D. 10 bytes

gate2000 | programming | programming-in-c | easy | isro2015

[Answer](#)

### 18.8.24 Programming In C: GATE2008-60 [top](#)

<http://gateoverflow.in/483>

What is printed by the following C program?

```
int f(int x, int *py, int **ppz)
{
 int y, z;
 **ppz += 1; z = **ppz; // corrected z = *ppz; to z = **ppz;
 *py += 2; y = *py;
 x += 3;
 return x+y+z;
}

void main()
{
 int c, *b, **a;
 c = 4; b = &c; a = &b;
 printf("%d", f(c, b, a));
}
```

- A. 18  
 B. 19  
 C. 21  
 D. 22

gate2008 | programming | programming-in-c | normal

[Answer](#)

### 18.8.25 Programming In C: GATE2002\_1.17 [top](#)

<http://gateoverflow.in/822>

In the C language

- A. At most one activation record exists between the current activation record and the activation record for the main  
 B. The number of activation records between the current activation record and the activation records from the main depends on the actual function calling sequence.  
 C. The visibility of global variables depends on the actual function calling sequence  
 D. Recursion requires the activation record for the recursive function to be saved in a different stack before the recursive

function can be called.

gate2002 | programming | programming-in-c | easy

[Answer](#)

### 18.8.26 Programming In C: GATE2002\_2.8 [top](#)

<http://gateoverflow.in/838>

Consider the following declaration of a two-dimensional array in C:

```
char a[100][100];
```

Assuming that the main memory is byte-addressable and that the array is stored starting from memory address 0, the address of a [40][50] is

- A. 4040
- B. 4050
- C. 5040
- D. 5050

gate2002 | programming-in-c | programming | easy

[Answer](#)

### 18.8.27 Programming In C: GATE2002\_2.18 [top](#)

<http://gateoverflow.in/848>

The C language is:

- A. A context free language
- B. A context sensitive language
- C. A regular language
- D. Parsable fully only by a Turing machine

gate2002 | programming | programming-in-c | normal

[Answer](#)

### 18.8.28 Programming In C: GATE2003\_2 [top](#)

<http://gateoverflow.in/893>

Assume the following C variable declaration

```
int *A[10], B[10][10];
```

Of the following expressions

- I. A[2]
- II. A[2][3]
- III. B[1]
- IV. B[2][3]

which will not give compile-time errors if used as left hand sides of assignment statements in a C program?

- A. I, II, and IV only
- B. II, III, and IV only
- C. II and IV only
- D. IV only

gate2003 | programming | programming-in-c | easy

[Answer](#)

### 18.8.29 Programming In C: GATE2003\_89 [top](#)

<http://gateoverflow.in/972>

Consider the C program shown below:

```
#include<stdio.h>
```

```
#define print(x) printf("%d", x)

int x;
void Q(int z)
{
 z+=x;
 print(z);
}

void P(int *y)
{
 int x = *y + 2;
 Q(x);
 *y = x - 1;
 print(x);
}
main(void) {
 x = 5;
 P(&x);
 print(x);
}
```

The output of this program is

- (A) 12 7 6
- (B) 22 12 11
- (C) 14 6 6
- (D) 7 6 6

[gate2003](#) [programming](#) [programming-in-c](#) [normal](#)

[Answer](#)

### 18.8.30 Programming In C: GATE2008-18 [top](#)

<http://gateoverflow.in/416>

Which combination of the integer variables  $x, y$  and  $z$  makes the variable  $a$  get the value 4 in the following expression?

$$a = (x > y)?((x > z)?x : z) : ((y > z)?y : z)$$

- A.  $x = 3, y = 4, z = 2$
- B.  $x = 6, y = 5, z = 3$
- C.  $x = 6, y = 3, z = 5$
- D.  $x = 5, y = 4, z = 5$

[gate2008](#) [programming](#) [programming-in-c](#) [easy](#)

[Answer](#)

### 18.8.31 Programming In C: GATE2004\_33 [top](#)

<http://gateoverflow.in/1030>

Consider the following C program segment:

```
char p[20];
char* s = "string";
int length = strlen(s);
for(i = 0; i < length; i++)
 p[i] = s[length-i];
printf("%s", p);
```

The output of the program is

- A. gnirts
- B. string
- C. gnirt
- D. no output is printed

[gate2004](#) [programming](#) [programming-in-c](#) [easy](#)

[Answer](#)

### 18.8.32 Programming In C: GATE2005\_1 [top](#)

<http://gateoverflow.in/1343>

What does the following C-statement declare?

```
int (*f) (int *);
```

- A. A function that takes an integer pointer as argument and returns an integer
- B. A function that takes an integer as argument and returns an integer pointer
- C. A pointer to a function that takes an integer pointer as argument and returns an integer
- D. A function that takes an integer pointer as argument and returns a function pointer

[gate2005](#) [programming](#) [programming-in-c](#) [easy](#)

[Answer](#)

### 18.8.33 Programming In C: GATE2005\_32 [top](#)

<http://gateoverflow.in/1368>

Consider the following C program:

```
double foo (double); /* Line 1 */
int main() {
 double da, db;
 //input da
 db = foo(da);
}
double foo (double a) {
 return a;
}
```

The above code compiled without any error or warning. If Line 1 is deleted, the above code will show:

- A. no compile warning or error
- B. some compiler-warnings not leading to unintended results
- C. some compiler-warnings due to type-mismatch eventually leading to unintended results
- D. compiler errors

[gate2005](#) [programming](#) [programming-in-c](#) [compiler-design](#) [easy](#)

[Answer](#)

### 18.8.34 Programming In C: GATE2014-1\_10 [top](#)

<http://gateoverflow.in/1770>

Consider the following program in C language:

```
#include <stdio.h>

main()
{
 int i;
 int*pi = &i;

 scanf("%d",pi);
 printf("%d\n", i+5);
}
```

Which one of the following statements is **TRUE**?

- (A) Compilation fails.
- (B) Execution results in a run-time error.
- (C) On execution, the value printed is 5 more than the address of variable *i*.
- (D) On execution, the value printed is 5 more than the integer value entered.

[gate2014-1](#) [programming](#) [programming-in-c](#) [easy](#)
**Answer**

### 18.8.35 Programming In C: GATE2006\_57 [top](#)

<http://gateoverflow.in/1835>

Consider this C code to swap two integers and these five statements: the code

```
void swap (int *px, int *py)
{
 *px = *px - *py;
 *py = *px + *py;
 *px = *py - *px;
}
```

**S1:** will generate a compilation error

**S2:** may generate a segmentation fault at runtime depending on the arguments passed

**S3:** correctly implements the swap procedure for all input pointers referring to integers stored in memory locations accessible to the process

**S4:** implements the swap procedure correctly for some but not all valid input pointers

**S5:** may add or subtract integers and pointers

- (A) S1
- (B) S2 and S3
- (C) S2 and S4
- (D) S2 and S5

[gate2006](#) [programming](#) [programming-in-c](#) [normal](#)
**Answer**

### 18.8.36 Programming In C: GATE2014-2\_11 [top](#)

<http://gateoverflow.in/1965>

Suppose n and p are unsigned int variables in a C program. We wish to set p to  $\frac{n}{3}$ . If n is large, which one of the following statements is most likely to set p correctly?

- (A)  $p = n * (n-1) * (n-2) / 6;$
- (B)  $p = n * (n-1) / 2 * (n-2) / 3;$
- (C)  $p = n * (n-1) / 3 * (n-2) / 2;$
- (D)  $p = n * (n-1) * (n-2) / 6.0;$

[gate2014-2](#) [programming](#) [programming-in-c](#) [normal](#)
**Answer**

### 18.8.37 Programming In C: GATE2014-2\_42 [top](#)

<http://gateoverflow.in/2008>

Consider the C function given below.

```
int f(int j)
{
 static int i = 50;
 int k;
 if (i == j)
 {
 printf("something");
 k = f(i);
 return 0;
 }
 else return 0;
}
```

Which one of the following is **TRUE**?

- (A) The function returns 0 for all values of  $j$ .
- (B) The function prints the string **something** for all values of  $j$ .
- (C) The function returns 0 when  $j = 50$ .
- (D) The function will exhaust the runtime stack or run into an infinite loop when  $j = 50$ .

gate2014-2 | programming | programming-in-c

[Answer](#)

### 18.8.38 Programming In C: GATE2011\_22 [top](#)

<http://gateoverflow.in/2124>

What does the following fragment of C program print?

```
char c[] = "GATE2011";
char *p = c;
printf("%s", p + p[3] - p[1]);
```

- (A) GATE2011
- (B) E2011
- (C) 2011
- (D) 011

gate2011 | programming | programming-in-c | normal

[Answer](#)

### 18.8.39 Programming In C: GATE2010-11 [top](#)

<http://gateoverflow.in/2184>

What does the following program print?

```
#include<stdio.h>

void f(int *p, int *q) {
 p=q;
 *p=2;
}

int i=0, j=1;

int main() {
 f(&i, &j);
 printf("%d %d\n", i,j);
 return 0;
}
```

- A. 2 2  
 B. 2 1  
 C. 0 1  
 D. 0 2

gate2010 | programming | programming-in-c | easy

[Answer](#)

### 18.8.40 Programming In C: GATE2008-IT\_49 [top](#)

<http://gateoverflow.in/3359>

What is the output printed by the following C code?

```
include <stdio.h>
int main ()
```

```
{
 char a [6] = "world";
 int i, j;
 for (i = 0, j = 5; i < j; a [i++] = a [j--]);
 printf ("%s\n", a);
}
```

- A) dlrow  
 B) Null string  
 C) dlrlid  
 D) worow

gate2008-it | programming | programming-in-c | normal

Answer

### 18.8.41 Programming In C: GATE2008-IT\_50 [top](#)

<http://gateoverflow.in/3360>

Consider the C program below. What does it print?

```
include <stdio.h>
define swap1 (a, b) tmp = a; a = b; b = tmp
void swap2 (int a, int b)
{
 int tmp;
 tmp = a; a = b; b = tmp;
}
void swap3 (int*a, int*b)
{
 int tmp;
 tmp = *a; *a = *b; *b = tmp;
}
int main ()
{
 int num1 = 5, num2 = 4, tmp;
 if (num1 < num2) {swap1 (num1, num2);}
 if (num1 < num2) {swap2 (num1 + 1, num2);}
 if (num1 >= num2) {swap3 (&num1, &num2);}
 printf ("%d, %d", num1, num2);
}
```

- A) 5, 5  
 B) 5, 4  
 C) 4, 5  
 D) 4, 4

gate2008-it | programming | programming-in-c | normal

Answer

### 18.8.42 Programming In C: GATE2008-IT\_51 [top](#)

<http://gateoverflow.in/3361>

Consider the C program given below. What does it print?

```
#include <stdio.h>
int main ()
{
 int i, j;
 int a [8] = {1, 2, 3, 4, 5, 6, 7, 8};
 for(i = 0; i < 3; i++) {
 a[i] = a[i] + 1;
 i++;
 }
 i--;
 for (j = 7; j > 4; j--) {
 int i = j/2;
 a[i] = a[i] - 1;
 }
 printf ("%d, %d", i, a[i]);
}
```

- A) 2, 3  
 B) 2, 4  
 C) 3, 2  
 D) 3, 3

[gate2008-it](#)
[programming](#)
[programming-in-c](#)
[normal](#)
**Answer**

### 18.8.43 Programming In C: GATE2008-IT\_52 [top](#)

<http://gateoverflow.in/3362>

C program is given below:

```
include <stdio.h>
int main ()
{
 int i, j;
 char a [2] [3] = {{'a', 'b', 'c'}, {'d', 'e', 'f'}};
 char b [3] [2];
 char *p = *b;
 for (i = 0; i < 2; i++) {
 for (j = 0; j < 3; j++) {
 *(p + 2*j + i) = a [i] [j];
 }
 }
}
```

What should be the contents of the array b at the end of the program?

- |    |                            |
|----|----------------------------|
| A) | a    b<br>c    d<br>e    f |
| B) | a    d<br>b    e<br>c    f |
| C) | a    c<br>e    b<br>d    f |
| D) | a    e<br>d    c<br>b    f |

[gate2008-it](#)
[programming](#)
[programming-in-c](#)
[normal](#)
**Answer**

### 18.8.44 Programming In C: GATE2000-1.12 [top](#)

<http://gateoverflow.in/635>

The most appropriate matching for the following pairs

|                             |                                 |
|-----------------------------|---------------------------------|
| X: m = malloc(5); m = NULL; | 1: using dangling pointers      |
| Y: free(n); n -> value = 5; | 2: using uninitialized pointers |
| Z: char *p, *p ='a';        | 3: lost memory                  |

is:

- A. X - 1 Y - 3 Z - 2
- B. X - 2 Y - 1 Z - 3
- C. X - 3 Y - 2 Z - 1
- D. X - 3 Y - 1 Z - 2

[gate2000](#)
[programming](#)
[programming-in-c](#)
[normal](#)
**Answer**

## Answers: Programming In C

### 18.8.1 Programming In C: GATE2004-IT\_59 [top](#)

<http://gateoverflow.in/3702>

Selected Answer

```
funcf(x) + funcg(x)
```

funcf or funcg can be executed first. Lets assume funcf is executed first. It calls funcg - so even if the order of call is reversed, result will be same.

In first call of funcg, y becomes 11 and it returns  $5+11 = 16$ .

In second call of funcg, y becomes 12 and it returns  $5+12 = 17$ .

So, in main y is incremented by  $16+17 = 33$  to become  $10+33 = 43$ . (Choice A)

In the second iteration y will be incremented by  $18+19 = 37$  to give  $43+37 = 80$ .

Upvote 8 votes

-- Arjun Suresh (150k points)

## 18.8.2 Programming In C: GATE2004-IT\_61 [top](#)

<http://gateoverflow.in/3704>



Selected Answer

first print A B

f1 is call by value the changes applicable only for local

from f1 U V is printed

back in main A B is printed

then in f2 V W is printed

hence answer is B

Upvote 8 votes

-- Sankaranarayanan P.N (9.8k points)

## 18.8.3 Programming In C: GATE2004-IT\_60 [top](#)

<http://gateoverflow.in/3703>



Selected Answer

it should be option D

?1 is (c = getchar()) != '\n'

?2 is putchar(c);

Upvote 6 votes

-- sumit kumar singh dixit (1.8k points)

## 18.8.4 Programming In C: GATE2006-IT\_51 [top](#)

<http://gateoverflow.in/3594>



Selected Answer

```
a = {a1, a2, a3};
```

```
printf("%d", a[0][2]);
```

a[0] is a1. So, this will print a1[2] = 8;

```
printf("%d", *a[2]);
```

a[2] is a3. So, this will print \*a3 = a3[0] = -12 ([] has greater precedence than \*)

```
printf("%d", *++a[0]);
```

a[0] which is a1 is incremented. a1 is a pointer to int (base address of an integer array) and so increment means adding sizeof(int) and hence a1 now points to the second element in the array. So, \*++a[0] prints second element of a1 which is

7 and now a1 starts from 7.

```
printf ("%d", * (++a) [0]);
```

`++a` will increment `a`, which being an array of pointers (to int) will add `sizeof (pointer)` to `a`. So, `a` now contains {`a2, a3}` and `a[0]` will be `a2` and `*a2` will be the first element in `a2` which is 23

```
printf ("%d\n", a [-1] [+1]);
```

`a[-1]` will subtract a size of pointer from the base address of `a`. Normally this results in invalid memory access, but since we have incremented `a` previously, `a[-1]` is valid and will point to `a1`. So, `a[-1][+1]` will be `a1[1]` which has the value 8. (`a1` was incremented in 3<sup>rd</sup> printf and hence starts from 7 and not 6. +1 is same as 1, just given to create confusion)

16 votes

-- Arjun Suresh (150k points)

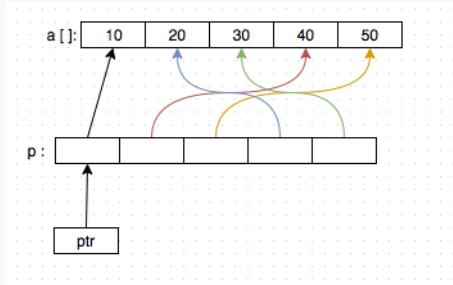
## 18.8.5 Programming In C: GATE2015-3\_26 [top](#)

<http://gateoverflow.in/8478>

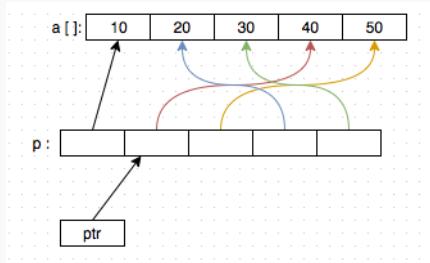


Selected Answer

```
static int a[] = {10, 20, 30, 40, 50};
static int *p[] = {a, a+3, a+4, a+1, a+2};
int **ptr = p;
```



`ptr++;`



$$\text{ptr} - \text{p} = \frac{\text{address of } \text{ptr} - \text{address of } \text{p}}{\text{sizeof}(*\text{ptr})} = 1$$

$$**\text{ptr} = \text{p}[2] = *(\text{a}+3) = 40$$

```
printf ("%d%d", ptr - p, **ptr); // 140
```

9 votes

-- Salman (865 points)

## 18.8.6 Programming In C: GATE2015-2\_15 [top](#)

<http://gateoverflow.in/8086>



## Selected Answer

Ans D as priority of != is greater than that of && in C. The execution happens as

```
if ((*a) && (*a != ' '))
```

So, the if breaks either when \*a = 0 (not '0' but ASCII 0 or null character '\0'), or when \*a = ' '.

So, the recursive call goes like

'A' - 'B' - 'C' - 'D' - ' ' (breaks) and then starts outputting

DCBA

12 votes

-- **Vikrant Singh** (11k points)

## 18.8.7 Programming In C: GATE2015-1\_11 [top](#)

<http://gateoverflow.in/8185>



## Selected Answer

here f1 will not change any values bcz it is call by value but f2 is call by reference and it swaps values of b and c and changes are also reflected in main function...so 5-6-4= -5 hence answer is -5

12 votes

-- **target gate** (245 points)

## 18.8.8 Programming In C: GATE2015-1\_35 [top](#)

<http://gateoverflow.in/8283>



## Selected Answer

Address of x is 2000.

x being a 2 D array,

$x + 3 = x + 3 * \text{sizeof its inner dimension}$

$= 2000 + 3 * 3 * 4$  (as inner dimension is 3 integers of size 4)

$= 2000 + 36 = 2036$ .

$*(x+3)$  returns the value at address 2036. But since x is 2-D array, one \* will just return the 1D array which is the starting address of it, which is 2036 only.

$(x + 2) = 2000 + 2 * 3 * 4 = 2024$

$*(x + 2) + 3 = 2024 + 3 * 4 = 2036$  (The \* changes the data type from 2D to 1D and hence + 3 will add  $3 * 4$  and not  $3 * 3 * 4$ )

So, A.

23 votes

-- **Arjun Suresh** (150k points)

## 18.8.9 Programming In C: GATE2015-3\_7 [top](#)

<http://gateoverflow.in/8401>



## Selected Answer

```
p = s1 + 2;
```

p now points to the third element in s1.

```
*p = '0';
```

The third element in s1 is made 0. So, 1234 becomes 1204. C choice.

20 votes

-- **Arjun Suresh** (150k points)

### 18.8.10 Programming In C: GATE2006-IT\_49 [top](#)

<http://gateoverflow.in/3592>



Selected Answer

Answer is B )

Run The code.

<http://codepad.org/WmSREd4G>

For extra information =>

`++p -> c will become ++(p -> c)`

`p++ -> c will become (p++) -> c`

`*++p -> c will become => *++(p->c)`

Reference-> C Puzzle Book

| OPERATOR                                      | ASSOCIATIVITY |
|-----------------------------------------------|---------------|
| <b>primary:</b> ( ) [ ] -> .                  | left to right |
| <b>unary:</b> ! - + + - - - (type) * & sizeof | right to left |
| <b>multiplicative:</b> * / %                  | left to right |
| <b>additive:</b> + -                          | left to right |
| <b>shift:</b> << >>                           | left to right |
| <b>relational:</b> < <= > >=                  | left to right |
| <b>equality:</b> == !=                        | left to right |
| <b>bitwise:</b> &                             | left to right |
| <b>bitwise:</b> ^                             | left to right |
| <b>bitwise:</b>                               | left to right |
| <b>logical:</b> &&                            | left to right |
| <b>logical:</b>                               | left to right |
| <b>conditional:</b> ?:                        | right to left |
| <b>assignment:</b> = += -= etc.               | right to left |
| <b>comma:</b> ,                               | left to right |

8 votes

-- Akash (31.7k points)

### 18.8.11 Programming In C: GATE2015-3\_48 [top](#)

<http://gateoverflow.in/8557>



Selected Answer

`j=2 * 3 / 4 + 2.0 / 5 + 8 / 5;`

`j = (((2 * 3) / 4) + (2.0 / 5)) + (8/5); //As associativity of +,* and / are from left to right and + has less precedence than * and /.`

`j = ((6/4) + 0.4) + 1; //2.0 is double value and hence 5 is implicitly typecast to double and we get 0.4. But 8 and 5 are integers and hence 8/5 gives 1 and not 1.6`

`j = (1 + 0.4) + 1; // 6/4 also gives 1 as both are integers`

`j = 1.4 + 1; //1 + 0.4 gives 1.4 as 1 will be implicitly typecast to 1.4`

`j = 2.4; // since j is integer when we assign 2.4 to it, it will be implicitly typecast to int.`

`So, j = 2;`

`k -= --j;`

This makes  $j = 1$  and  $k = -1$ .

The variables  $j$  and  $k$  have values 1 and -1 respectively before the for loop. Inside the for loop, the variable  $i$  is initialized to 0 and the loop runs from 0 to 4.

$i = 0, k = -1, i + k = -1$ , default case is executed, printf count = 1

$i = 1, k = -1, i + k = 0$ , default case is executed, printf count = 2

$i = 2, k = -1, i + k = 1$ , case 2, case 3 and default case is executed, printf count = 5

$i = 3, k = -1, i + k = 2$ , case 2, case 3 and default case is executed, printf count = 8

$i = 4, k = -1, i + k = 3$ , case 3 and default case is executed, printf count = 10

$i = 5$ , loop exits and the control returns to main

Answer: 10

Upvote 22 votes

-- Shyam Singh (1.4k points)

### 18.8.12 Programming In C: GATE2015-3\_54 [top](#)

<http://gateoverflow.in/8563>



Selected Answer

The variable  $x$  is initialized to 1. First and only call to  $f1()$  returns 26. First call to  $f2()$  returns 51. First and only call to  $f3()$  returns 100. Second call to  $f2()$  returns 52 (The value of local static variable  $x$  in  $f2()$  retains its previous value 51 and is incremented by 1).

$$x = 1 + 26 + 51 + 100 + 52 = 230$$

Answer: 230

Upvote 20 votes

-- Shyam Singh (1.4k points)

### 18.8.13 Programming In C: Gate1989 Programming [top](#)

<http://gateoverflow.in/37264>

Its A, B. Ignore this question btw. Its conflicting. (Even ACE material gave 2 different answers at diffent positions :p)

Upvote 0 votes

-- Tushar Shinde (1.7k points)

### 18.8.14 Programming In C: gate1990 Programming [top](#)

<http://gateoverflow.in/37267>



Selected Answer

- |                      |                           |
|----------------------|---------------------------|
| A. Pointer data type | Q. Dynamic Data Structure |
| B. Activation method | R. Recursion              |
| C. Repeat until      | S. Nondeterministic loop  |
| D. Coercion          | P. Type Conversion        |

Upvote 5 votes

-- Digvijay (35.8k points)

### 18.8.15 Programming In C: GATE 2016-2-12 [top](#)

<http://gateoverflow.in/39565>



Selected Answer

i is called by reference and j is called by value.

so in function f() only value of i might change,  
Now in function f(\*p,m)  
\*p is pointing to i  
thus \*p is 5.  
m is 10 because of call by value of j.

1.m=10+5 hence m=15  
2.\*p=5 + 15 hence \*p=20, that is, value of variable i is now 20  
3.returns nothing

Now, back to main  
i=20 and j is as it is 10

Hence output of printf will be i+j=20+10 = **30**

Check code in action => <http://codepad.org/mDLsWYp5>

14 votes

-- Shashank Chavan (2.6k points)

### 18.8.16 Programming In C: GATE 2016-1-12 [top](#)

<http://gateoverflow.in/39638>



Selected Answer

Option 1: 1st argument is short and not int, 2nd is type error(since s is a short variable).. so WRONG

Option 2: return type is not void.. so WRONG

Option 3: 1 st argument is int, second is again syntax error.. so WRONG

Option 4: Both the arguments and return type match..p is a pointer to short, so \*p is value of short.. So ANSWER

18 votes

-- Abhilash Panicker (7k points)

### 18.8.17 Programming In C: GATE 2016-1-15 [top](#)

<http://gateoverflow.in/39642>



Selected Answer

The mystery about mystery function is it does not affect values in main. As in C, parameters are passed by value- even if they are pointer. So, here the pointer values are exchanged within the function only. (we can use \* operator to exchange the values at the location of the pointers and this will affect the values in main).

So NO CHANGES in a,b,c,d.  
And ANSWER is 2016

22 votes

-- Abhilash Panicker (7k points)

### 18.8.18 Programming In C: GATE2012-49 [top](#)

<http://gateoverflow.in/43314>



Selected Answer

```
49
main
a=1
prtFun()
a=2
b=1
a= a + ++b = 2+2 = 4
b = 2
printf --> 4 2
back to main
a = a+1 --> 1+1 -->2
prtFun()
a=1 //previous a is lost
```

```
b=1
a= a + ++b = 2+2 = 4
b = 2
printf --> 4 2
back to main
a = 2
b = 0 (initial value of global b. in prtFun local b is only updated)
printf --> 2 0
```

Answer: D

5 votes

-- Sankaranarayanan P.N (9.8k points)

### 18.8.19 Programming In C: GATE2006-IT\_50 [top](#)

<http://gateoverflow.in/3593>



Selected Answer

First of all the swap function just swaps the pointers inside the function and has no effect on the variables being passed.

Inside printab, a and b are added odd integers from 1-5, i.e.,  $1+3+5 = 9$ . So, in first call to printab,  $a = -3 + 9 = 6$  and  $b = -6 + 9 = 3$ .

Static variables have one memory throughout program run (initialized during program start) and they keep their values across function calls. So, during second call to printab,  $a = 6 + 9 = 15$ ,  $b = 3 + 9 = 12$ .

Hence (D) choice.

13 votes

-- Arjun Suresh (150k points)

### 18.8.20 Programming In C: GATE2012-48 [top](#)

<http://gateoverflow.in/2176>



Selected Answer

```
main
a=1
prtFun()
a=2
b=1
a= a + ++b = 2+2 = 4
b = 2
printf --> 4 2
back to main
a = a+1 --> 1+1 -->2 (local static a is taken)
prtFun()
a=4 // previous value in the function is retained bcos of static
b=1
a= a + ++b = 4+2 = 6
b = 2
printf --> 6 2
back to main
a = 2
b = 0 (initial value of global b. in prtFun local b is only updated)
printf --> 2 0
```

Answer: C

11 votes

-- Sankaranarayanan P.N (9.8k points)

### 18.8.21 Programming In C: GATE2007-IT\_31 [top](#)

<http://gateoverflow.in/3464>



Selected Answer

Answer: C

I have tried to explain this question in a better way and the explanation is here...

| i | A[i]      | for-> if ----- satisfied?                               | maxsum | sum |
|---|-----------|---------------------------------------------------------|--------|-----|
| - | -         | -                                                       | 0      | 0   |
| 0 | A[0] = 2  | Yes (i == 0)                                            | 0      | 2   |
| 1 | A[1] = -2 | Yes (a[i] < 0)                                          | 2      | 0   |
| 2 | A[2] = -1 | Yes (a[i] < 0)<br>(for->if->if ----- not satisfied)     | --     | 0   |
| 3 | A[3] = 3  | No (else executed)<br>(for->if->if ----- not satisfied) | --     | 3   |
| 4 | A[4] = 4  | No (else executed)<br>(for->if->if ----- not satisfied) | --     | 7   |
| 5 | A[5] = 2  | Yes (a[i] < a[i - 1])                                   | 7      | 2   |

[End of for loop]

```
If (sum (i.e. 2) > maxsum(i.e. 7)) // No
 maxsum = sum; // Not Executed
printf will output maxsum = 7
```

3 votes

-- MKT (123 points)

## 18.8.22 Programming In C: GATE2000-1.11 [top](#)

<http://gateoverflow.in/644>



Selected Answer

(a) is the answer. [] has greater precedence than \* in C. So, s becomes an array of pointers.

13 votes

-- gatecse (10.7k points)

## 18.8.23 Programming In C: GATE2000-1.17, ISRO2015-79 [top](#)

<http://gateoverflow.in/640>



Selected Answer

answer is (c)

Here structure creates the memory for 'array and union', but union only creates the memory for only 'long z' which is the largest size data type inside it.

hence,

short x [5] = 5\*2 = 10 bytes [ shorts take 2 bytes]  
 long z = 8 bytes  
 so (10+8) = 18 bytes

11 votes

-- Kalpana Bhargav (3k points)

### 18.8.24 Programming In C: GATE2008-60 [top](#)

<http://gateoverflow.in/483>



Selected Answer

Answer is **B.**

**z = \*ppz is a typo and it must be z = \*\*ppz;**

\* \* ppz+ = 1; modifies the value of c to 5. ∴ z=5.  
 \* \*py+ = 2; modifies the value of c to 7. ∴ y=7.  
 But x will be called as x=4, ∴ x=7.  
 Answer: 7+7+5=19.

9 votes

-- Sona Praneeth Akula (3.8k points)

### 18.8.25 Programming In C: GATE2002\_1.17 [top](#)

<http://gateoverflow.in/822>



Selected Answer

(A) Each function call starts a new activation record and since C allows nested function calls more than one activation record can exist between the current activation record and main.

(B) TRUE

(C) Since, C uses static scoping, the actual function calling sequence has no impact on the visibility of global variables. If a variable is not found in the current activation record, it is looked in global address space and this is independent of the calling sequence.

(D) All function calls- whether recursive or not uses the same stack for saving the activation record. There is no need for a different stack as for C compiler a recursive function call and a normal function call make no difference.

14 votes

-- Arjun Suresh (150k points)

### 18.8.26 Programming In C: GATE2002\_2.8 [top](#)

<http://gateoverflow.in/838>



Selected Answer

answer is (b)

Formula to evaluate 2-d array's location is:----

$\text{loc}(a[i][j]) = BA + [(i-lb1)*NC+(j-lb2))*c]$

where BA= Base Address

NC= no. of columns

C= memory size allocated to data type of array

a[lb1.....ub1] [lb2..... ub2]

here BA=0 , NC =100, c=1, a[0.....99][0.....99] so lb1=0 , lb2=0

```
loc(a[40][50])= 0+ [(40-0)*100 + (50-0)]*1
= 0+[4000+50]*1 = 4050
```

10 votes

-- Kalpana Bhargav (3k points)

### 18.8.27 Programming In C: GATE2002\_2.18 [top](#)

<http://gateoverflow.in/848>



Selected Answer

Answer: (B)

Ref: <http://trevorjim.com/c-and-cplusplus-are-not-context-free/>

4 votes

-- Rajarshi Sarkar (29.7k points)

### 18.8.28 Programming In C: GATE2003\_2 [top](#)

<http://gateoverflow.in/893>



Selected Answer

A is an array of pointers to int, and B is a 2-D array.

A[2] =
can take a pointer

A[2][3] =
can take an int

B[1] =
B[1] is the base address of array and it cannot be changed as array in C is a constant pointer.

B[2][3] =
can take an integer

So, A is the answer.

13 votes

-- Arjun Suresh (150k points)

### 18.8.29 Programming In C: GATE2003\_89 [top](#)

<http://gateoverflow.in/972>



Selected Answer

```
main: x = 5; //Global x becomes 5
```

```
P: int x = *y + 2; //local x in P becomes 5+2 = 7
```

```
Q: z+=x; //local z in Q becomes 7 + 5 = 12
```

```
Q: print(z); //prints 12
```

```
P: *y = x - 1; //content of address of local variable y (same as global variable x) becomes 7 - 1 =
```

```
P: print(x); //prints local variable x in P = 7
```

```
main: print(x); //prints the global variable x = 6
```

9 votes

-- Arjun Suresh (150k points)

### 18.8.30 Programming In C: GATE2008-18 [top](#)

<http://gateoverflow.in/416>



Selected Answer

Using option A : x=3, y=4, z=2

a=(3>4)? No

therefore don't evaluate the first part and check second part ((y>z)?y:z)

(4>2)? Yes

a= value of y =4

**Answer is (A) x=3, y=4, z=2**

5 votes

-- Keith Kr (6k points)

### 18.8.31 Programming In C: GATE2004\_33 [top](#)

<http://gateoverflow.in/1030>



Selected Answer

Here,

p[0] = s[length] = '\0'; //compiler puts a '\0' at the end of all string literals

Now, for any string function in C, it checks till the first '\0' to identify the end of string. So, since the first char is '\0', printf "%s", will print empty string. If we use printf("%s", p+1); we will get option (c). For the given code, answer is (D).

6 votes

-- Arjun Suresh (150k points)

### 18.8.32 Programming In C: GATE2005\_1 [top](#)

<http://gateoverflow.in/1343>



Selected Answer

1. A function that takes an integer pointer as argument and returns an integer -> int f (int \*)
2. A function that takes an integer as argument and returns an integer pointer -> int \* f (int )
3. A pointer to a function that takes an integer pointer as argument and returns an integer =>

int (\*f) (int \* );

So Answer is C

7 votes

-- Akash (31.7k points)

### 18.8.33 Programming In C: GATE2005\_32 [top](#)

<http://gateoverflow.in/1368>



Selected Answer

ans is d)

When a function is called without being defined, C compiler assumes it to return "int" but here foo is returning "double" and hence the compiler will throw type mis-match error.

From C99 on ward, implicit declaration of functions is not even allowed.

10 votes

-- Aditi Dan (5.4k points)

### 18.8.34 Programming In C: GATE2014-1\_10 [top](#)

<http://gateoverflow.in/1770>



Selected Answer

```
int i; //i is declared
int*pi = &i; //pi is a pointer variable assigned the address of i
scanf("%d",pi); //i is overwritten with the value we provided because pi is pointing to i earlier
printf("%d\n", i+5) //it will print the value stored in i+5
```

**input=3; output=8**

Option D is answer.

6 votes

-- Bhagirathi Nayak (11.3k points)

### 18.8.35 Programming In C: GATE2006\_57 [top](#)

<http://gateoverflow.in/1835>



Selected Answer

S1 is false.

S2 is true, depending on the argument passed it may generate segmentation fault.

S3 is false because implementation is having some problem. Let x=3 and I want to implement SWAP[x,x]. Now ans would be 0 but that must be x. Problem is because we are not checking whether both pointer are pointing the same address or different so S4 is true.

S5 is obviously false so Option(c) is right

17 votes

-- Kalpana Bhargav (3k points)

### 18.8.36 Programming In C: GATE2014-2\_11 [top](#)

<http://gateoverflow.in/1965>



Selected Answer

B)

In c, \* and / have the same precedence and are left associative.

Evaluation of  $n*(n-1)*(n-2)$  might exceed the unsigned int range.  
So a) and d) are eliminated.

$n*(n-1)$  is always divisible by 2.(Gives an integer value). Where as it is not always divisible by 3.(You dont always get an integer..truncation possible, less accuracy)

c) eliminated.

In option b)

$n*(n-1)/2$  gives an integer value.

This integer value multiplied by  $(n-2)$  again gives an integer value.  
Which when divided by 3 gives an integer value(Sets p correctly).

Reason :  $n*(n-1)*(n-2)$  is the multiplication of 3 consecutive numbers. which is divisible by 2 as well as 3.  
Hence  $( n*(n-1)/2*(n-2) )$  is divisible by 3.

25 votes

-- Srinath Sri (2.9k points)

**18.8.37 Programming In C: GATE2014-2\_42**<http://gateoverflow.in/208>

Selected Answer

There is no updation for i and j in the function. so if we call function with j = 50 the recursive call will be continued infinitely. There is no terminating condition for recursion. hence answer D

5 votes

-- Sankaranarayanan P.N (9.8k points)

**18.8.38 Programming In C: GATE2011\_22**<http://gateoverflow.in/2124>

Selected Answer

2011 is the answer.

In C, there is a rule that whatever character code be used by the compiler, codes of all alphabets and digits must be in order. So, if character code of 'A' is x, then for 'B' it must be x+1.

Now %s means printf takes address and prints all bytes starting from that address as characters till any byte becomes the code for '\0'. Now, the passed value to printf here is p + p[3] - p[1]

p is the starting address of array c. p[3] = 'E' and p[1] = 'A'. So, p[3] - p[1] = 4, and p + 4 will be pointing to the fourth position in the array c. So, printf starts printing from 2 and prints 2011.

(Here "GATE2011" is a string literal and by default a '\0' is added at the end of it by the compiler).

NB: In this question %s is not required.

```
printf(p + p[3] - p[1]);
```

Also gives the same result as first argument to printf is a character pointer and only if we want to pass more arguments we need to use a format string.

10 votes

-- Arjun Suresh (150k points)

**18.8.39 Programming In C: GATE2010-11**<http://gateoverflow.in/2184>

Selected Answer

```
p=q; -- now p and q are pointing to same address i.e. address of j
*p=2; -- value of j will be updated to 2
hence answer is (D) 0 2
```

10 votes

-- Manu Thakur (5.6k points)

**18.8.40 Programming In C: GATE2008-IT\_49**<http://gateoverflow.in/3359>

Selected Answer

```
char a[6] =
```

|   |   |   |  |   |    |
|---|---|---|--|---|----|
| w | o | r |  | d | \0 |
|---|---|---|--|---|----|

|      |   |   |   |   |   |
|------|---|---|---|---|---|
| a[0] | 1 | 2 | 3 | 4 | 5 |
|------|---|---|---|---|---|

After the loop will execute first time,

`a[0] = a[5]`

`a[0] = '\0'`

Next two more iterations of the loop till  $i < j$  condition becomes false are not important for the output as the first position is '\0';

`printf("%s", a)`, the string starting at address `a` prints the string starting with '\0' and it indicates the end of string, so it will print null string.

so option (B)

10 votes

-- Mitali (195 points)

## 18.8.41 Programming In C: GATE2008-IT\_50 [top](#)

<http://gateoverflow.in/3360>



Selected Answer

Answer: C

Only

```
if (num1 >= num2) { swap3 (&num1, &num2); }
```

statement works, which in turn swaps num1 and num2.

8 votes

-- Rajarshi Sarkar (29.7k points)

## 18.8.42 Programming In C: GATE2008-IT\_51 [top](#)

<http://gateoverflow.in/3361>



Selected Answer

Answer is (c) 3,2

First 2 variable integer type declared named i and j

Then **int type array** a[8] declared and initialized.

`a[0] = 1, a[1] = 2, a[2] = 3, a[3] = 4, a[4] = 5, a[5] = 6, a[6] = 7, a[7] = 8`

Then for loop started

`i=0, i<3 (true)`

`a[0]=a[0]+1 = 1+1=2`

`i++(outside for loop), i++(inside for loop);`

`i=2, i<3 (true)`

`a[2]=a[2]+1 = 3+1=4`

`i++, i++(outside for loop),`

`i=4, i<3 (false) //Now come out of loop`

`i-- ; (so i=3)`

Now another for loop started where in loop integer type variable named i declared

**Block Scope:** A Block is a set of statements enclosed within left and right braces ({ and } respectively). Blocks may be nested in C (a block may contain other blocks inside it). A variable declared in a block is accessible in the block and all inner blocks of that block, but not accessible outside the block.

**What if the inner block itself has one variable with the same name?**

If an inner block declares a variable with the same name as the variable declared by the outer block, then the visibility of

the outer block variable ends at the point of declaration by inner block.

So here inner block **int i** has the scope in this block only and outer block int i visibility is not allowed in that block

```
j=7 j>4(true)
int i = 7/2=3
a[3]=a[3]-1=4-1=3

j=6 j>4(true)
int i = 6/2=3
a[3]=a[3]-1=3-1=2

j=5 j>4(true)
int i = 5/2=2
a[2]=a[2]-1=4-1=3

j=4 j>4(false)
```

Now when the for loop ends its variable named **i** scope is also end and the outer block variable now visible. So in printf outer variable **i** is used.

so the output would be: 3,2

18 votes

-- Kalpana Bhargav (3k points)

## 18.8.43 Programming In C: GATE2008-IT\_52 [top](#)

<http://gateoverflow.in/3362>



Selected Answer

The correct answer is option (B)

first integer type two variables declared i and j

then an integer type 2-d array a[2][3] is declared and initialized and 2-d array b[3][2] is created but not initialized. i.e

| <u>address</u> | <u>value</u> | <u>address</u> | <u>value</u>  |
|----------------|--------------|----------------|---------------|
| a[0][0]        | 2000         | a              | garbage value |
| a[0][1]        | 2001         | b              | garbage value |
| a[0][2]        | 2002         | c              | garbage value |
| a[1][0]        | 2003         | d              | garbage value |
| a[1][1]        | 2004         | e              | garbage value |
| a[1][2]        | 2005         | f              | garbage value |

now the char type pointer is declared and the base address of array b is put in it. so p=3000

now the for loop is started where i is initialized to 0 ,so

i=0 : i<2 (true)

```
j=0; j<3 (true)
*(3000+2*0+0) =a [0][0] => *(3000) = a
j++
j=1; j<3 (true)
*(3000+2*1+0) =a [0][1] => *(3002) = b
j++
j=2; j<3 (true)
*(3000+2*2+0) =a [0][2] => *(3004) = c
```

```

 j++
 j=3; j<3 (false)

 i++
 i=1 : i<2 (true)
 j=0; j<3 (true)
 *(3000+2*0+1) =a [1][0] => *(3001) = d
 j++
 j=1; j<3 (true)
 *(3000+2*1+1) =a [1][1] => *(3003) = e
 j++
 j=2; j<3 (true)
 *(3000+2*2+1) =a [1][2] => *(3005) = f
 j++
 j=3; j<3 (false)

 i++

```

now the values in array b is

|         |      |   |
|---------|------|---|
| b[0][0] | 3000 | a |
| b[0][1] | 3001 | d |
| b[1][0] | 3002 | b |
| b[1][1] | 3003 | e |
| b[2][0] | 3004 | c |
| b[2][1] | 3005 | f |

hence the output will be (B) choice.

**Note:**

\* (p + 2\*j + i)

p + sizeofinner dimension \* j + i, hence is same as p[j][i]. Hence with this statement we can identify that the code is transposing the matrix a and storing in b using pointer p.

15 votes

-- Kalpana Bhargav (3k points)

## 18.8.44 Programming In C: GATE2000-1.12 [top](#)

<http://gateoverflow.in/635>



Selected Answer

ans: d)

X: m = NULL; makes the pointer m point to NULL. But the memory created using malloc is still there and but cannot be used as we don't have a link to it. Hence, lost memory

Y: n is freed and so pointer n is now pointing to an invalid memory making it a dangling pointer.

Z: p is not initialized. p = malloc(sizeof(char)); should have been used before assigning 'a' to \*p.

10 votes

-- Aditi Dan (5.4k points)

## 18.9

## Programming Paradigms [top](#)

### 18.9.1 Programming Paradigms: GATE2008-IT\_13 [top](#)

<http://gateoverflow.in/3273>

Match the programming paradigms and languages given in the following table.

|       | Paradigms       |     | Languages             |
|-------|-----------------|-----|-----------------------|
| (I)   | Imperative      | (a) | Prolog                |
| (II)  | Object Oriented | (b) | Lisp                  |
| (III) | Functional      | (c) | C, Fortran 77, Pascal |
| (IV)  | Logic           | (d) | C++, Smalltalk, Java  |

- A. I-c, II-d, III-b, IV-a
- B. I-a, II-d, III-c, IV-b
- C. I-d, II-c, III-b, IV-a
- D. I-c, II-d, III-a, IV-b

[gate2008-it](#) [programming](#) [programming-paradigms](#) [easy](#)

[Answer](#)

### Answers: Programming Paradigms

### 18.9.1 Programming Paradigms: GATE2008-IT\_13 [top](#)

<http://gateoverflow.in/3273>



Selected Answer

A is correct. Lisp is a pure functional language and Prolog is a logic language. Other languages are well known.

7 votes

-- Arjun Suresh (150k points)

## 18.10

### Recursion [top](#)

### 18.10.1 Recursion: GATE 2016-1-35 [top](#)

<http://gateoverflow.in/3970>

What will be the output of the following C program?

```
void count (int n) {
 static int d=1;

 printf ("%d",n);
 printf ("%d",d);
 d++;
 if (n>1) count (n-1);
 printf ("%d",d);

}

void main(){
 count (3);
}
```

- A. 3 1 2 2 1 3 4 4 4
- B. 3 1 2 1 1 1 2 2 2
- C. 3 1 2 2 1 3 4
- D. 3 1 2 1 1 1 2

[gate2016-1](#) [programming-in-c](#) [recursion](#) [normal](#)

[Answer](#)

## 18.10.2 Recursion: GATE2004-31, ISRO2008-40 [top](#)

<http://gateoverflow.in/1028>

Consider the following C function:

```
int f(int n)
{
 static int i = 1;
 if(n >= 5) return n;
 n = n+i;
 i++;
 return f(n);
}
```

The value returned by  $f(1)$  is

- A. 5
- B. 6
- C. 7
- D. 8

[gate2004](#) [programming](#) [programming-in-c](#) [recursion](#) [easy](#) [isro2008](#)

[Answer](#)

## 18.10.3 Recursion: GATE2001-13 [top](#)

<http://gateoverflow.in/754>

Consider the following C program:

```
void abc(char*s)
{
 if(s[0]=='\0')return;
 abc(s+1);
 abc(s+1);
 printf("%c",s[0]);
}

main()
{
 abc("123");
}
```

- a. What will be the output of the program?
- b. If  $abc(s)$  is called with a null-terminated string  $s$  of length  $n$  characters (not counting the null (' $\backslash 0$ ') character), how many characters will be printed by  $abc(s)$ ?

[gate2001](#) [programming](#) [recursion](#) [normal](#)

[Answer](#)

## Answers: Recursion

## 18.10.1 Recursion: GATE 2016-1-35 [top](#)

<http://gateoverflow.in/39730>



Selected Answer

Here  $d$  is static, so the value of  $d$  will persist between the function calls.

1.  $count(3)$  will print the value of  $n$  and  $d$  and increments  $d$  and call  $count(2)$  => prints **3 1**.
2.  $count(2)$  will print the value of  $n$  and  $d$  and increments  $d$  and call  $count(1)$  => prints **2 2**.
3.  $count(1)$  will print the value of  $n$  and  $d$  and increments  $d$  => prints **1 3**.  
now it will return and prints the final incremented value of  $d$  which is **4**, 3 times.

So, option A is correct => 3 1 2 2 1 3 4 4 4

15 votes

-- Monanshi Jain (6.5k points)

### 18.10.2 Recursion: GATE2004-31, ISRO2008-40 [top](#)

<http://gateoverflow.in/1028>



Selected Answer

answer is 7.as,

f(1):n=2,i=2

f(2):n=4,i=3

f(4):n=7,i=4

f(7):print(n)==>>> 7<ans>

9 votes

-- sumit kumar singh dixit (1.8k points)

### 18.10.3 Recursion: GATE2001-13 [top](#)

<http://gateoverflow.in/754>



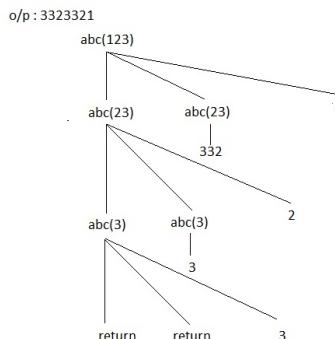
Selected Answer

answer a) 3323321

answer b)  $2^n - 1$

Q. a) O/p :

3 3 2 3 3 2 1



b)

$$T(n) = 2 * T(n-1) + 1 ; n > 0$$

= 0 ; n=0 [Since for length zero string no character will be printed]

After solving it by substitution,

$$\begin{aligned} T(n) &= 2 * T(n-1) + 1 \\ &= 2 * (2 * T(n-2) + 1) + 1 \\ &= 2^2 * T(n-2) + 2 + 1 \\ &= 2^2 * (2 * T(n-3) + 1) + 2 + 1 \\ &= 2^3 * T(n-3) + 2^2 + 2 + 1 \end{aligned}$$

Finally it will expand like

$$\begin{aligned} &= 2^n * T(n-n) + 2^{n-1} + 2^{n-2} + \dots + 2^2 + 2 + 1 \\ &= 2^n * T(0) + 2^{n-1} + 2^{n-2} + \dots + 2^2 + 2 + 1 \\ &= 1 * (2^n - 1) / (2 - 1) \\ &= 2^n - 1 \end{aligned}$$

5 votes

-- jayendra (6.6k points)

## 18.11

Runtime Environments [top](#)18.11.1 Runtime Environments: GATE1991\_09a [top](#)<http://gateoverflow.in/536>

Consider the following pseudo-code (all data items are of type integer):

```
procedure P(a, b, c);
 a := 2;
 c := a + b;
end {P}

begin
 x := 1;
 y := 5;
 z := 100;
 P(x, x*y, z);
 Write ('x = ', x, 'z = ', z);
end
```

Determine its output, if the parameters are passed to the Procedure P by

- i. value
- ii. reference
- iii. name

[gate1991](#) [programming](#) [parameter-passing](#) [runtime-environments](#) [normal](#)

[Answer](#)

18.11.2 Runtime Environments: GATE1991\_09b [top](#)<http://gateoverflow.in/43603>

For the following code, indicate the output if

- a. static scope rules
- b. dynamic scope rules

are used

```
var a,b : integer;

procedure P;
 a := 5;
 b := 10;
end {P};

procedure Q;
 var a, b : integer;
 P;
end {Q};

begin
 a := 1;
 b := 2;
 Q;
 Write ('a = ', a, 'b = ', b);
end
```

[gate1991](#) [runtime-environments](#) [programming](#) [parameter-passing](#) [normal](#)

[Answer](#)

## Answers: Runtime Environments

18.11.1 Runtime Environments: GATE1991\_09a [top](#)<http://gateoverflow.in/536>

Selected Answer

1. Pass by value: Function cannot modify a variable in the calling function. So,

$x = 1, z = 100$

2. Pass by reference: An alias of the variable (a different name but having same memory location) is used to pass the variable to a function. So, whatever change occurs for the variable in the called function is reflected in the calling function.

$x = 2, z = 7 (2 + 5)$

3. Pass by name: The expression used to call a function is copy pasted for each formal parameter. So, the body of P becomes,

```
x := 2;
z := x + x*y;
```

So, printed value will be

$x = 2, z = 12$

Upvote 6 votes

-- Arjun Suresh (150k points)

## 18.11.2 Runtime Environments: GATE1991\_09b [top](#)

<http://gateoverflow.in/43603>



Selected Answer

In static scoping, if a variable is not found (variable definition - memory allocation) in the local scope, it is looked upon in global scope. In dynamic scoping, if a variable is not found in local scope, it is looked upon in the function which called the current executing one.

1.  $a = 5, b = 10$ . main is using global variables. P is also using global variables.

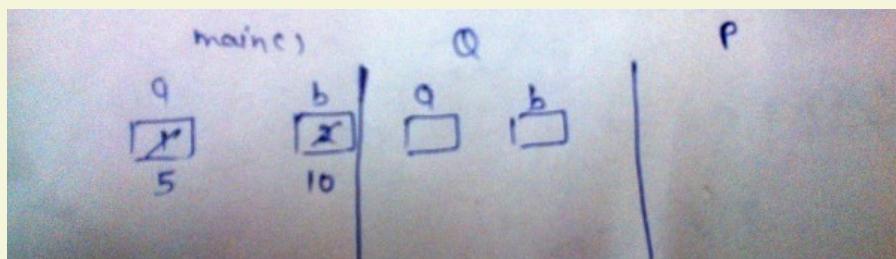
2.  $a = 1, b = 2$ . main is using global variables. P is using the local variables defined in Q.

(The modification in Q, happens to the variables in P but in main we use the global variables)

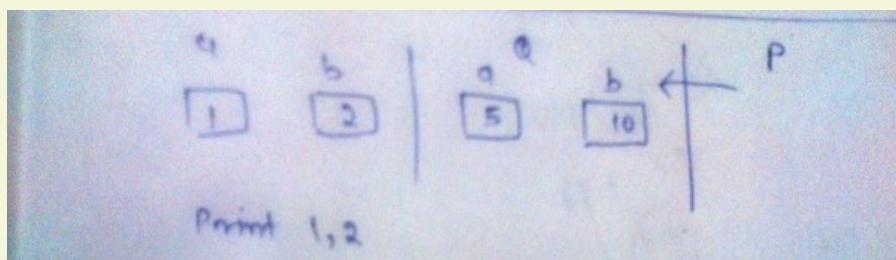
Upvote 3 votes

-- Arjun Suresh (150k points)

Using Static scope rule output: 5,10



Using Dynamic scope rule output :1,2



3 votes

-- Manoj Kumar (23.1k points)

## 18.12

Stack top18.12.1 Stack: GATE2007-IT\_32 top<http://gateoverflow.in/3465>

Consider the following C program:

```
#include <stdio.h>
#define EOF -1
void push (int); /* push the argument on the stack */
int pop (void); /* pop the top of the stack */
void flagError ();
int main ()
{
 int c, m, n, r;
 while ((c = getchar ()) != EOF)
 { if (isdigit (c))
 push (c);
 else if ((c == '+') || (c == '*'))
 {
 m = pop ();
 n = pop ();
 r = (c == '+') ? n + m : n*m;
 push (r);
 }
 else if (c != ' ')
 flagError ();
 }
 printf ("%c", pop ());
}
```

What is the output of the program for the following input ?  
5 2 \* 3 3 2 + \*

- |    |     |
|----|-----|
| A) | 15  |
| B) | 25  |
| C) | 30  |
| D) | 150 |

[gate2007-it](#) [stack](#) [programming-in-c](#) [normal](#)

**Answer**

## Answers: Stack

18.12.1 Stack: GATE2007-IT\_32 top<http://gateoverflow.in/3465>

Selected Answer

B) 25  
let first part  
5 ----push  
2-----push  
push-----5\*2=10. (pops 5 and 2)

push 3  
push 3  
push 2  
push 3+2 = 5 (pops 2 and 3)  
push 5\*3 = 15 (pops (5 and 3))  
push 15 + 10 = 25 (pops (15 and 10))

11 votes

-- Arpit Dhuriya (2.4k points)

## 18.13

Variable Binding top

### 18.13.1 Variable Binding: GATE2003-73 [top](#)

<http://gateoverflow.in/960>

The following program fragment is written in a programming language that allows global variables and does not allow nested declarations of functions.

```
global int i=100, j=5;
void P(x) {
 int i=10;
 print(x+10);
 i=200;
 j=20;
 print (x);
}
main() {P(i+j);}
```

If the programming language uses static scoping and call by need parameter passing mechanism, the values printed by the above program are

- A. 115, 220
- B. 25, 220
- C. 25, 15
- D. 115, 105

[gate2003](#) [programming](#) [variable-binding](#) [parameter-passing](#) [normal](#) [runtime-environments](#)

[Answer](#)

### 18.13.2 Variable Binding: GATE2003-74 [top](#)

<http://gateoverflow.in/43575>

The following program fragment is written in a programming language that allows global variables and does not allow nested declarations of functions.

```
global int i=100, j=5;
void P(x) {
 int i=10;
 print(x+10);
 i=200;
 j=20;
 print (x);
}
main() {P(i+j);}
```

If the programming language uses dynamic scoping and call by name parameter passing mechanism, the values printed by the above program are

- A. 115, 220
- B. 25, 220
- C. 25, 15
- D. 115, 105

[gate2003](#) [programming](#) [variable-binding](#) [parameter-passing](#) [runtime-environments](#) [normal](#)

[Answer](#)

## Answers: Variable Binding

### 18.13.1 Variable Binding: GATE2003-73 [top](#)

<http://gateoverflow.in/960>



Selected Answer

Call-by-name : Is a lazy evaluation (expression passed as an argument evaluated only when used) technique.

Call-by-need: Is a version of call-by-name but when an expression is evaluated during first use, is saved and reused for all later uses.

```
global int i=100, j=5;
//memory created for i and j variable and 100 and 5 stored in them respectively (1)

void P(x) // p(i+j) (3)
 int i=10;
 // new variable created i with value 10 store in it. (4)
```

```

print(x+10);
// print(x+10); = print(i+j +10);= 10 + 5 +10 = 25
// here need of i+j so i+j replaced by 15 everywhere .(5)

i=200;
// local i value changed to 200.

j=20;
//global j value changed to 20 as there is no local j.
//if dynamic scoping used, then the scope of j comes from scope of j in main as
//main called this function. Here, main also uses global j and hence no change.

print (x);
// print (x);= print (i+j); = printf(15) = 15 (7)
// due to call by need. If call by name used answer is 200+20 = 220
}

main() {P(i+j);}
// 1st function call since it is call by name no evaluation done
//here i and j value refer to global values(2)

```

**Ans is C**Refer : <https://www.cs.bgu.ac.il/~comp161/wiki.files/ps9.pdf>

2 votes

-- Anirudh Pratap Singh (17.7k points)

**18.13.2 Variable Binding: GATE2003-74** [top](#)<http://gateoverflow.in/43575>

Selected Answer

```

global int i=100, j=5; // memory created for i and j variable and 100 and 5 store in it respectively (1)
void P(x) { // p(i+j) (3)
 int i=10; // new variable created i with value 10 store in it. (4)
 print(x+10); // print(x+10); = print(i+j +10);= 10 +5 +10 = 25 (5)
 i=200; // global i and j value changed to 200 and 20 respectively (6)
 j=20;
 print (x); // print (x);= print (i +j); = 200 +20 = 220 (7)
}
main() {P(i+j);} // 1st function call since it is call by name dont calculate value just send i+j: here i and j
value reffer to global values(2)

```

**Ans is B**Refer: <http://stackoverflow.com/questions/838079/what-is-pass-by-name-and-how-does-it-work-exactly>

2 votes

-- Anirudh Pratap Singh (17.7k points)

Answer will be B dynamic scope and call by name is used so first print will be evaluated as

print(10+5+10)

and 2nd print will be evaluated as

print(200+20)

2 votes

-- rahulkrr (427 points)

# 19 Theory of Computation (219) top

## 19.0.1 GATE2011\_8 top

<http://gateoverflow.in/2110>

Which of the following pairs have **DIFFERENT** expressive power?

- (A) Deterministic finite automata (DFA) and Non-deterministic finite automata (NFA)
- (B) Deterministic push down automata (DPDA) and Non-deterministic push down automata (NPDA)
- (C) Deterministic single tape Turing machine and Non-deterministic single tape Turing machine
- (D) Single tape Turing machine and multi-tape Turing machine

gate2011 theory-of-computation easy

Answer

## 19.0.2 GATE2001-5 top

<http://gateoverflow.in/746>

Construct DFA's for the following languages:

- $L = \{w \mid w \in \{a, b\}^*, w \text{ has baab as a substring}\}$
- $L = \{w \mid w \in \{a, b\}^*, w \text{ has an odd number of a's and an odd number of b's}\}$

gate2001 theory-of-computation easy

Answer

## 19.0.3 GATE2000-7 top

<http://gateoverflow.in/678>

- Construct as minimal finite state machine that accepts the language, over  $\{0,1\}$ , of all strings that contain neither the sub string 00 nor the sub string 11.
- Consider the grammar

|          |
|----------|
| S → aSAb |
| S → ε    |
| A → bA   |
| A → ε    |

where S, A are non-terminal symbols with S being the start symbol; a, b are terminal symbols and  $\epsilon$  is the empty string. This grammar generates strings of the form  $a^i b^j$  for some  $i, j \geq 0$ , where i and j satisfy some condition. What is the condition on the values of i and j?

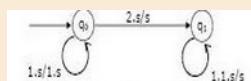
gate2000 theory-of-computation

Answer

## 19.0.4 GATE2000-8 top

<http://gateoverflow.in/679>

A push down automation (pda) is given in the following extended notation of finite state diagram:



The nodes denote the states while the edges denote the moves of the pda. The edge labels are of the form  $d, s/s'$  where d is the input symbol read and s, s' are the stack contents before and after the move. For example the edge labeled 1, s/1.s denotes the move from state  $q_0$  to  $q_0$

in which the input symbol 1 is read and pushed to the stack.

- Introduce two edges with appropriate labels in the above diagram so that the resulting pda accepts the language  $\{x2x^R \mid x \in \{0,1\}^*\}$ ,  $x^R$  denotes reverse of  $x\}$ , by empty stack.
- Describe a non-deterministic pda with three states in the above notation that accept the language  $\{0^n1^m \mid n \leq m \leq 2n\}$  by empty stack

gate2000 theory-of-computation

Answer

### 19.0.5 GATE2007\_30 [top](#)

<http://gateoverflow.in/1228>

The language  $L = \{0^i 2 1^i \mid i \geq 0\}$  over the alphabet  $\{0, 1, 2\}$  is:

- A. not recursive
- B. is recursive and is a deterministic CFL
- C. is a regular language
- D. is not a deterministic CFL but a CFL

gate2007 theory-of-computation normal

Answer

### 19.0.6 GATE2009-16 [top](#)

<http://gateoverflow.in/1308>

Which one of the following is FALSE?

- A. There is a unique minimal DFA for every regular language
- B. Every NFA can be converted to an equivalent PDA.
- C. Complement of every context-free language is recursive.
- D. Every nondeterministic PDA can be converted to an equivalent deterministic PDA.

gate2009 theory-of-computation easy

Answer

### 19.0.7 GATE2013\_17 [top](#)

<http://gateoverflow.in/1439>

Which of the following statements is/are FALSE?

1. For every non-deterministic Turing machine, there exists an equivalent deterministic Turing machine.
2. Turing recognizable languages are closed under union and complementation.
3. Turing decidable languages are closed under intersection and complementation.
4. Turing recognizable languages are closed under union and intersection.

(A) 1 and 4 only (B) 1 and 3 only (C) 2 only (D) 3 only

gate2013 theory-of-computation normal

Answer

### 19.0.8 GATE2013\_8 [top](#)

<http://gateoverflow.in/1417>

Consider the languages  $L_1 = \emptyset$  and  $L_2 = \{a\}$ . Which one of the following represents  $L_1 L_2^* \cup L_1^*$  ?

- (A)  $\{\epsilon\}$
- (B)  $\emptyset$
- (C)  $a^*$
- (D)  $\{\epsilon, a\}$

[gate2013](#) [theory-of-computation](#) [normal](#)

[Answer](#)

### 19.0.9 GATE2008-IT\_33 [top](#)

<http://gateoverflow.in/3343>

Consider the following languages.

- $L_1 = \{a^i b^j c^k \mid i = j, k \geq 1\}$
- $L_2 = \{a^i b^j \mid j = 2i, i \geq 0\}$

Which of the following is true?

- A)  $L_1$  is not a CFL but  $L_2$  is
- B)  $L_1 \cap L_2 = \emptyset$  and  $L_1$  is non-regular
- C)  $L_1 \cup L_2$  is not a CFL but  $L_2$  is
- D) There is a 4-state PDA that accepts  $L_1$ , but there is no DPDA that accepts  $L_2$

[gate2008-it](#) [theory-of-computation](#) [normal](#)

[Answer](#)

### 19.0.10 GATE2004-IT\_9 [top](#)

<http://gateoverflow.in/3650>

Which one of the following statements is FALSE?

- A) There exist context-free languages such that all the context-free grammars generating them are ambiguous
- B) An unambiguous context-free grammar always has a unique parse tree for each string of the language generated by it
- C) Both deterministic and non-deterministic pushdown automata always accept the same set of languages
- D) A finite set of strings from some alphabet is always a regular language

[gate2004-it](#) [theory-of-computation](#) [easy](#)

[Answer](#)

### 19.0.11 GATE2001-6 [top](#)

<http://gateoverflow.in/747>

Give a deterministic PDA for the language  $L = \{a^n cb^{2n} \mid n \geq 1\}$  over the alphabet  $\Sigma = \{a, b, c\}$ . Specify the acceptance state.

[gate2001](#) [theory-of-computation](#) [normal](#)

[Answer](#)

### 19.0.12 GATE1991-17,a [top](#)

<http://gateoverflow.in/26653>

Show that the Turing machines, which have a read only input tape and constant size work tape, recognize precisely the class of regular languages.

[gate1991](#) [theory-of-computation](#) [descriptive](#)

[Answer](#)

**19.0.13 GATE2009-40** [top](#)<http://gateoverflow.in/1326>

Let  $L = L_1 \cap L_2$ , where  $L_1$  and  $L_2$  are languages as defined below:

$$L_1 = \{a^m b^m c a^n b^n \mid m, n \geq 0\}$$

$$L_2 = \{a^i b^j c^k \mid i, j, k \geq 0\}$$

Then L is

- A. Not recursive
- B. Regular
- C. Context free but not regular
- D. Recursively enumerable but not context free.

[gate2009](#) [theory-of-computation](#) [easy](#)

[Answer](#)

**19.0.14 GATE2002\_1.7** [top](#)<http://gateoverflow.in/811>

The language accepted by a Pushdown Automaton in which the stack is limited to 10 items is best described as

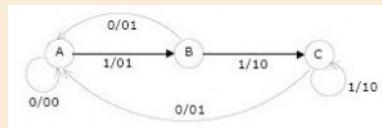
- A. Context free
- B. Regular
- C. Deterministic Context free
- D. Recursive

[gate2002](#) [theory-of-computation](#) [easy](#)

[Answer](#)

**19.0.15 GATE2002\_2.5** [top](#)<http://gateoverflow.in/835>

The finite state machine described by the following state diagram with A as starting state, where an arc label is and x stands for 1-bit input and y stands for 2-bit output



- A. outputs the sum of the present and the previous bits of the input
- B. outputs 01 whenever the input sequence contains 11
- C. outputs 00 whenever the input sequence contains 10
- D. none of the above

[gate2002](#) [theory-of-computation](#) [normal](#)

[Answer](#)

**19.0.16 GATE2005\_54** [top](#)<http://gateoverflow.in/1377>

Let  $N_f$  and  $N_p$  denote the classes of languages accepted by non-deterministic finite automata and non-deterministic push-down automata, respectively. Let  $D_f$  and  $D_p$  denote the classes of languages accepted by deterministic finite automata and deterministic push-down automata respectively. Which one of the following is TRUE?

- A.  $D_f \subset N_f$  and  $D_p \subset N_p$

- B.  $D_f \subset N_f$  and  $D_p = N_p$   
 C.  $D_f = N_f$  and  $D_p = N_p$   
 D.  $D_f = N_f$  and  $D_p \subset N_p$

gate2005 | theory-of-computation | easy

Answer

### 19.0.17 GATE2002\_2.14 top

<http://gateoverflow.in/844>

Which of the following is true?

- A. The complement of a recursive language is recursive  
 B. The complement of a recursively enumerable language is recursively enumerable  
 C. The complement of a recursive language is either recursive or recursively enumerable  
 D. The complement of a context-free language is context-free

gate2002 | theory-of-computation | easy

Answer

### 19.0.18 Gate2011\_24 top

<http://gateoverflow.in/3429>

Let

$P$  be a regular language and

$Q$  be a context-free language such that

$Q \subseteq P$ . (For example, let

$P$  be the language represented by the regular expression

$p^*q^*$  and

$Q$  be

$\{p^nq^n \mid n \in N\}$ ) . Then which of the following is **ALWAYS** regular?

(A)  
 $P \cap Q$

(B)  
 $P - Q$

(C)  
 $\Sigma^* - P$

(D)  
 $\Sigma^* - Q$

gate2011 | theory-of-computation | easy

Answer

### 19.0.19 GATE2005-IT\_6 top

<http://gateoverflow.in/3751>

The language  $\{0^n 1^n 2^n \mid 1 \leq n \leq 10^6\}$  is

- A) regular  
 B) context-free but not regular.  
 C) context-free but its complement is not context-free.  
 D) not context-free.

gate2005-it | theory-of-computation | easy

## Answer

**19.0.20 GATE2003\_13** [top](#)<http://gateoverflow.in/904>

Nobody knows yet if P=NP. Consider the language  $L$  defined as follows.

$$L = \begin{cases} (0+1)^* & \text{if } P = NP \\ \phi & \text{otherwise} \end{cases}$$

Which of the following statements is true?

- (A)  $L$  is recursive
- (B)  $L$  is recursively enumerable but not recursive
- (C)  $L$  is not recursively enumerable
- (D) Whether  $L$  is recursively enumerable or not will be known after we find out if  $P = NP$

[gate2003](#) [theory-of-computation](#) [normal](#)

## Answer

**19.0.21 GATE2006\_30** [top](#)<http://gateoverflow.in/993>

For  $s \in (0+1)^*$  let  $d(s)$  denote the decimal value of  $s$  (e.g.  $d(101) = 5$ ). Let

$$L = \{s \in (0+1)^* \mid d(s) \bmod 5 = 2 \text{ and } d(s) \bmod 7 \neq 4\}$$

Which one of the following statements is true?

- (A)  $L$  is recursively enumerable, but not recursive
- (B)  $L$  is recursive, but not context-free
- (C)  $L$  is context-free, but not regular
- (D)  $L$  is regular

[gate2006](#) [theory-of-computation](#) [normal](#)

## Answer

**19.0.22 GATE2000-1.5** [top](#)<http://gateoverflow.in/628>

Let  $L$  denote the languages generated by the grammar  $S \rightarrow 0S0 \mid 00$ .  
Which of the following is TRUE?

- A.  $L = 0^+$
- B.  $L$  is regular but not  $0^+$
- C.  $L$  is context free but not regular
- D.  $L$  is not context free

[gate2000](#) [theory-of-computation](#) [easy](#)

## Answer

**19.0.23 GATE2007-IT\_46** [top](#)<http://gateoverflow.in/3481>

The two grammars given below generate a language over the alphabet  $\{x, y, z\}$

$$\begin{array}{lll} G1 : & S & \rightarrow x \mid z \mid xS \mid zS \mid yB \\ & B & \rightarrow y \mid z \mid yB \mid zB \\ G2 : & S & \rightarrow y \mid z \mid yS \mid zS \mid xB \\ & B & \rightarrow y \mid yS \end{array}$$

Which one of the following choices describes the properties satisfied by the strings in these languages ?

- A) G1 : No y appears before any x  
 G2 : Every x is followed by at least one y
- B) G1 : No y appears before any x  
 G2 : No x appears before any y
- C) G1 : No y appears after any x  
 G2 : Every x is followed by at least one y
- D) G1 : No y appears after any x  
 G2 : Every y is followed by at least one x

gate2007-it theory-of-computation normal

Answer

### 19.0.24 GATE2008-51 [top](#)

<http://gateoverflow.in/463>

Match the following:

|    |                                                                                                                                    |    |                                                   |
|----|------------------------------------------------------------------------------------------------------------------------------------|----|---------------------------------------------------|
| E. | Checking that identifiers are declared before their use                                                                            | P. | $L = \{a^n b^m c^n d^m \mid n \geq 1, m \geq 1\}$ |
| F. | Number of formal parameters in the declaration of a function agrees with the number of actual parameters in a use of that function | Q. | $X \rightarrow XbX \mid XcX \mid dXf \mid g$      |
| G. | Arithmetic expressions with matched pairs of parentheses                                                                           | R. | $L = \{wcw \mid w \in (a \mid b)^*\}$             |
| H. | Palindromes                                                                                                                        | S. | $X \rightarrow bXb \mid cXc \mid \epsilon$        |

- A. E-P, F-Q, G-R, H-S  
 B. E-R, F-P, G-S, H-Q  
 C. E-R, F-P, G-Q, H-S  
 D. E-P, F-R, G-S, H-Q

gate2008 normal theory-of-computation

Answer

### 19.0.25 GATE2003\_15 [top](#)

<http://gateoverflow.in/120>

If the strings of a language L can be effectively enumerated in lexicographic (i.e., alphabetic) order, which of the following statements is true?

- (A) L is Regular  
 (b) L is context free but not necessarily Regular  
 (c) L is recursive but not necessarily Regular  
 (d) L is recursively enumerable but not necessarily Recursive

theory-of-computation gate2003 normal

Answer

### 19.0.26 GATE2003\_52 [top](#)

<http://gateoverflow.in/356>

Consider two languages  $L_1$  and  $L_2$  each on the alphabet  $\Sigma$ . Let  $f: \Sigma \rightarrow \Sigma$  be a polynomial time computable bijection such that  $(\forall x)[x \in L_1 \text{ iff } f(x) \in L_2]$ . Further, let  $f^{-1}$  be also polynomial time computable.

Which of the following **CANNOT** be true?

- (A)  $L_1 \in P$  and  $L_2$  is finite

- (B)  $L_1 \in NP$  and  $L_2 \in P$   
 (C)  $L_1$  is undecidable and  $L_2$  is decidable  
 (D)  $L_1$  is recursively enumerable and  $L_2$  is recursive

gate2003 theory-of-computation normal

Answer

### 19.0.27 GATE1997\_3.4 [top](#)

<http://gateoverflow.in/2235>

Given  $\Sigma = \{a, b\}$ , which one of the following sets is not countable?

- (a) Set of all strings over  $\Sigma$   
 (b) Set of all languages over  $\Sigma$   
 (c) Set of all regular languages over  $\Sigma$   
 (d) Set of all languages over  $\Sigma$  accepted by Turing machines

gate1997 theory-of-computation normal

Answer

### 19.0.28 GATE2008-9 [top](#)

<http://gateoverflow.in/407>

Which of the following is true for the language

$$\{a^p \mid p \text{ is a prime}\}?$$

- A. It is not accepted by a Turing Machine  
 B. It is regular but not context-free  
 C. It is context-free but not regular  
 D. It is neither regular nor context-free, but accepted by a Turing machine

gate2008 theory-of-computation easy

Answer

### 19.0.29 GATE1994\_1.16 [top](#)

<http://gateoverflow.in/2459>

Which of the following conversions is not possible (algorithmically)?

- A. Regular grammar to context free grammar  
 B. Non-deterministic FSA to deterministic FSA  
 C. Non-deterministic PDA to deterministic PDA  
 D. Non-deterministic Turing machine to deterministic Turing machine

gate1994 theory-of-computation easy

Answer

### 19.0.30 GATE2008-13, ISRO2016-36 [top](#)

<http://gateoverflow.in/411>

If  $L$  and  $\bar{L}$  are recursively enumerable then  $L$  is

- A. regular  
 B. context-free  
 C. context-sensitive  
 D. recursive

gate2008 theory-of-computation easy isro2016

**Answer****19.0.31 GATE2008-48** [top](#)<http://gateoverflow.in/461>

Which of the following statements is false?

- A. Every NFA can be converted to an equivalent DFA
- B. Every non-deterministic Turing machine can be converted to an equivalent deterministic Turing machine
- C. Every regular language is also a context-free language
- D. Every subset of a recursively enumerable set is recursive

[gate2008](#) [theory-of-computation](#) [easy](#)
**Answer****19.0.32 GATE1998\_1.11** [top](#)<http://gateoverflow.in/1648>

Regarding the power of recognition of languages, which of the following statements is false?

- A. The non-deterministic finite-state automata are equivalent to deterministic finite-state automata.
- B. Non-deterministic Push-down automata are equivalent to deterministic Push-down automata.
- C. Non-deterministic Turing machines are equivalent to deterministic Push-down automata.
- D. Non-deterministic Turing machines are equivalent to deterministic Turing machines.
- E. Multi-tape Turing machines are available are equivalent to Single-tape Turing machines.

[gate1998](#) [theory-of-computation](#) [easy](#)
**Answer****19.0.33 GATE1995\_2.20** [top](#)<http://gateoverflow.in/2632>

Which of the following definitions below generate the same language as  $L$ , where  $L = \{x^n y^n \text{ such that } n \geq 1\}$ ?

- I.  $E \rightarrow xEy \mid xy$
  - II.  $xy \mid (x^+ x y y^+)$
  - III.  $x^+ y^+$
- A. I only
  - B. I and II
  - C. II and III
  - D. II only

[gate1995](#) [theory-of-computation](#) [easy](#)
**Answer****19.0.34 TIFR2014-B-14** [top](#)<http://gateoverflow.in/27321>

Which the following is FALSE?

- a. Complement of a recursive language is recursive.
- b. A language recognized by a non-deterministic Turing machine can also be recognized by a deterministic Turing machine.
- c. Complement of a context free language can be recognized by a Turing machine.

- d. If a language and its complement are both recursively enumerable then it is recursive.  
e. Complement of a non-recursive language can never be recognized by any Turing machine.

tifr2014 theory-of-computation

Answer

**19.0.35 GATE2012\_25** top<http://gateoverflow.in/1609>

Given the language  $L = \{ab, aa, baa\}$ , which of the following strings are in  $L^*$ ?

1.  $abaabaaaabaa$
2.  $aaaaabaaaaa$
3.  $baaaaabaaaab$
4.  $baaaaabaa$

- (A) 1, 2 and 3  
(B) 2, 3 and 4  
(C) 1, 2 and 4  
(D) 1, 3 and 4

gate2012 theory-of-computation easy

Answer

**19.0.36 GATE2004\_87** top<http://gateoverflow.in/1081>

The language  $\{a^m b^n c^{m+n} \mid m, n \geq 1\}$  is

- A. regular
- B. context-free but not regular
- C. context-sensitive but not context free
- D. type-0 but not context sensitive

gate2004 theory-of-computation normal

Answer

**19.0.37 GATE1991\_03,xiv** top<http://gateoverflow.in/528>

Choose the correct alternatives (more than one may be correct) and write the corresponding letters only:

Which of the following is the strongest correct statement about a finite language over some finite alphabet  $\Sigma$  ?

- (a). It could be undecidable
- (b). It is Turing-machine recognizable
- (c). It is a context sensitive language.
- (d). It is a regular language.
- (e). None of the above,

gate1991 theory-of-computation easy

Answer

**19.0.38 GATE2006\_33** top<http://gateoverflow.in/996>

Let  $L_1$  be a regular language,  $L_2$  be a deterministic context-free language and  $L_3$  a recursively enumerable, but not recursive, language. Which one of the following statements is false?

- (A)  $L_1 \cap L_2$  is a deterministic CFL
- (B)  $L_3 \cap L_1$  is recursive
- (C)  $L_1 \cup L_2$  is context free
- (D)  $L_1 \cap L_2 \cap L_3$  is recursively enumerable

[gate2006](#) [theory-of-computation](#) [normal](#)

[Answer](#)

### 19.0.39 TIFR2015-B-6 [top](#)

<http://gateoverflow.in/29860>

Let  $B$  consist of all binary strings beginning with a 1 whose value when converted to decimal is divisible by 7.

- A.  $B$  can be recognized by a deterministic finite state automaton.
- B.  $B$  can be recognized by a non-deterministic finite state automaton but not by a deterministic finite state automaton.
- C.  $B$  can be recognized by a deterministic push-down automaton but not by a non-deterministic finite state automaton.
- D.  $B$  can be recognized by a non-deterministic push-down automaton but not by a deterministic push-down automaton.
- E.  $B$  cannot be recognized by any push down automaton, deterministic or non-deterministic.

[tifr2015](#) [theory-of-computation](#)

[Answer](#)

### 19.0.40 GATE1992\_02,xx [top](#)

<http://gateoverflow.in/577>

02. Choose the correct alternatives (more than one may be correct) and write the corresponding letters only:

In which of the cases stated below is the following statement true?

"For every non-deterministic machine  $M_1$  there exists an equivalent deterministic machine  $M_2$  recognizing the same language".

- (a).  $M_1$  is non-deterministic finite automaton.
- (b).  $M_1$  is non-deterministic PDA.
- (c).  $M_1$  is a non-deterministic Turing machine.
- (d). For no machines  $M_1$  and  $M_2$ , the above statement true.

[gate1992](#) [theory-of-computation](#) [easy](#)

[Answer](#)

### 19.0.41 GATE1992\_16 [top](#)

<http://gateoverflow.in/595>

Which of the following three statements are true? Prove your answer.

- (i) The union of two recursive languages is recursive.
- (ii) The language  $\{O^n \mid n \text{ is a prime}\}$  is not regular.
- (iii) Regular languages are closed under infinite union.

[gate1992](#) [theory-of-computation](#) [normal](#)

[Answer](#)

### 19.0.42 GATE2005-IT\_4 [top](#)

<http://gateoverflow.in/3748>

Let  $L$  be a regular language and  $M$  be a context-free language, both over the alphabet  $\Sigma$ . Let  $L^c$  and  $M^c$  denote the complements of  $L$  and  $M$  respectively. Which of the following statements about the language  $L^c \cup M^c$  is TRUE?

- A) It is necessarily regular but not necessarily context-free.

- B) It is necessarily context-free.  
 C) It is necessarily non-regular.  
 D) None of the above

gate2005-it theory-of-computation normal

Answer

## Answers:

### 19.0.1 GATE2011\_8 top

<http://gateoverflow.in/2110>



Selected Answer

(B) Deterministic push down automata (DPDA) and Non-deterministic push down automata (NPDA)

In rest of the options both machine are equivalent in power.

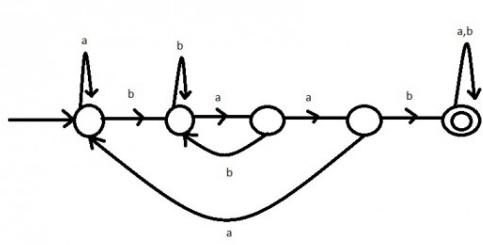
7 votes

-- Omesh Pandita (2.3k points)

### 19.0.2 GATE2001-5 top

<http://gateoverflow.in/746>

DFA for A:



3 votes

-- jayendra (6.6k points)

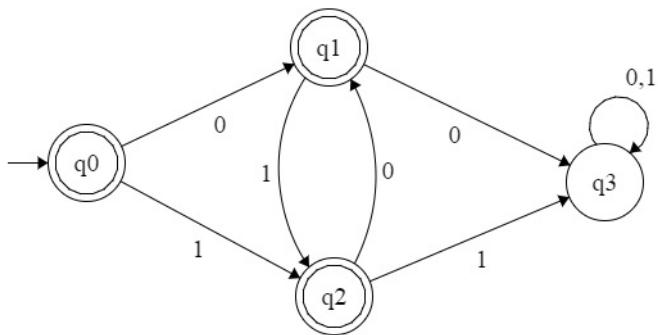
### 19.0.3 GATE2000-7 top

<http://gateoverflow.in/678>



Selected Answer

(a) langauge  $L = (0+1)^* - (0+1)^*(00+11) (0+1)^*$  ..... is it true ?? DFA contains 4 states , 3 are final , 1 is dead state

(b)  $i \leq j$ as  $S \rightarrow aSAb$ 

there will be always for one a in left and minimum one b in right and  $A \rightarrow bA \mid ^*$  can generate any no of b's including null , if A is  $^*$  then  $i=j$  and if A is generate any b then  $j>i$  so condition is  $i \leq j$

8 votes

-- Mithlesh Upadhyay (3.6k points)

#### 19.0.4 GATE2000-8 top

<http://gateoverflow.in/679>in a)  $x2xR$ 

say for some word 0112110 we have to push every thing into the stack till 2 . then we get 1 then 1 will be at top of stack so pop it or if get 0 then 0 will at top of stack so pop it. For any word of language it is applicable. 2 is a mark that tell now we have to pop 0 for 0 and 1 for 1.

so on the edge  $q_0$  to  $q_0$  add  $0,s/0,s$ and on edge  $q_1$  to  $q_1$  add  $0,0,s/s$ 

5 votes

-- Praveen Saini (38.4k points)

#### 19.0.5 GATE2007\_30 top

<http://gateoverflow.in/1228>

$L = \{0^i 2 1^j \mid i \geq 0\}$  is deterministic CFL,

Every DCFL is recursive. As we have membership algorithm for DCFL (Or say CFL in general) , that's why it is recursive. In fact DCFL is subset of Recursive Languages.

SO answer :-

B

6 votes

-- Akash (31.7k points)

#### 19.0.6 GATE2009-16 top

<http://gateoverflow.in/108>

Selected Answer

Option d ndpa is more powerful than dpda so they are not equivalent..actually dpda is a proper subset of ndpa...

C is TRUE as CFL is a proper subset of recursive languages and recursive languages are closed under complement.

9 votes

-- Bhagirathi Nayak (11.3k points)

**19.0.7 GATE2013\_17**<http://gateoverflow.in/1439>

Selected Answer

Recursive enumerable languages are not closed under complement . while recursive languages are.

both Recursive and Recursive enumerable languages are closed under intersection, union, and kleene star.

[http://gatecse.in/wiki/Closure\\_Property\\_of\\_Language\\_Families](http://gatecse.in/wiki/Closure_Property_of_Language_Families)

Non-Deterministic TM is equivalent to DTM

only 2 is false. Option C is correct.

Note: Turing decidable language mean Recursive language and Turing recognizable language mean recursive enumerable language.

9 votes

-- Praveen Saini (38.4k points)

**19.0.8 GATE2013\_8**<http://gateoverflow.in/1417>

Selected Answer

Concatenation of empty language with any language will give the empty language and  $L_1^* = \phi^* = \epsilon$ .

Therefore,

$$\begin{aligned} L_1 L_2^* \cup L_1^* \\ &= \phi \cdot (L_2)^* \cup \phi^* \\ &= \phi \cup \{\epsilon\} (\because \phi \text{ concatenated with anything is } \phi \text{ and } \phi^* = \{\epsilon\}) \\ &= \{\epsilon\}. \end{aligned}$$

Hence option (a) is True.

PS:  $\phi^* = \epsilon$ , where  $\epsilon$  is the regular expression and the language it generates is  $\{\epsilon\}$ .

11 votes

-- Praveen Saini (38.4k points)

**19.0.9 GATE2008-IT\_33**<http://gateoverflow.in/3343>

Selected Answer

Both languages can be accepted by a DPDA :

$L_1$  = start pushing element X into the stack on input 'a' ... start popping X on input 'b' ... move to final state when stack empty and input = 'c'

$L_2$  = start pushing elements XX into the stack on input 'a' ... start popping X on input 'b' ... move to final state when stack empty and input = 'epsilon'

so (A) and (D) are False

$L_1 \cup L_2$  is a CFL ... we can build it by having  $L_1$ ,  $L_2$  and an extra state ... and an 'epsilon' transition to both  $L_1$  and  $L_2$  from that extra state.

so (C) is false

$L_1 \cap L_2 = \Phi$  because we have no string  $a^i b^j$  where  $i=j$  and  $i=2j$  for  $i,j \geq 1$

and clearly  $L_1$  is not a regular language

so (B) is true.

11 votes

-- Danish (2.4k points)

### 19.0.10 GATE2004-IT\_9 [top](#)

<http://gateoverflow.in/3650>



Selected Answer

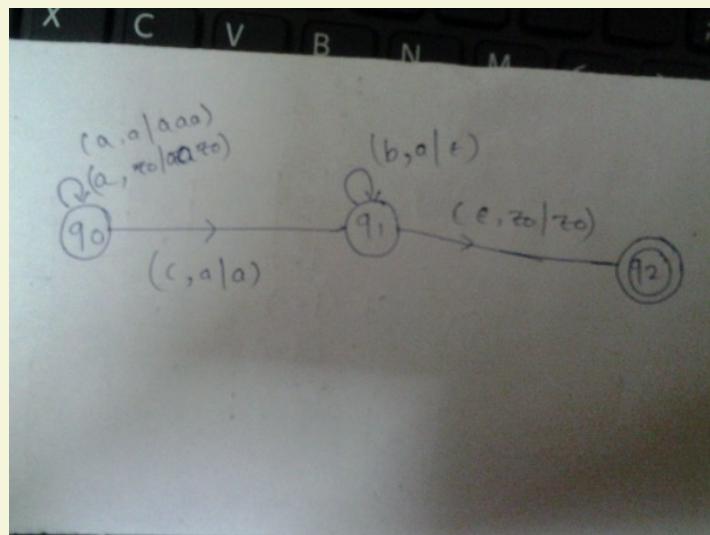
- A) this is true for inherently ambiguous language
- B) always correct, that's why called un ambiguous
- C) NPDA is a superset of DPDA, hence it's FALSE
- D) finite language is always regular

10 votes

-- Manu Thakur (5.6k points)

### 19.0.11 GATE2001-6 [top](#)

<http://gateoverflow.in/747>



$$L = \{a^n c b^{2n}\}$$

$$= \{acbb, aacbffff, aaacbbffff, \dots\}$$

Here 'c' act as center. Push 2 a's for 1 'a' and when you see 'c' pop the b's

2 votes

-- Saraswati Walijkar (223 points)

### 19.0.12 GATE1991-17,a [top](#)

<http://gateoverflow.in/26653>

[https://en.wikipedia.org/wiki/Read-only\\_Turing\\_machine](https://en.wikipedia.org/wiki/Read-only_Turing_machine)

3 votes

-- srestha (27.8k points)

### 19.0.13 GATE2009-40 [top](#)

<http://gateoverflow.in/1326>



Selected Answer

$L_1 \cap L_2 = \{a^m b^m c | m \geq 0\}$ , which is context free but not regular.

Option C.

16 votes

-- Arjun Suresh (150k points)

### 19.0.14 GATE2002\_1.7 top

<http://gateoverflow.in/811>

Selected Answer

B. Regular.

With only finite positions in stack, we can have only finite configurations and these can also be modeled as states in a finite automata.

9 votes

-- Arjun Suresh (150k points)

### 19.0.15 GATE2002\_2.5 top

<http://gateoverflow.in/835>

Selected Answer

answer should be option (A).

option (B) and (C) are clearly wrong . it says input 11 then o/p 01 and i/p 10 then o/p 00 but here at single bit o/p is 2 bit sequence

now for option (a) we can trace out .. suppose string is 0111

at A---0---> A----1---> B--1-->C---1-->C

O/P      00      01      10      10

we can see here at (A,0)---> (A,00) which sum of 0+0=00, (previous i/p bit + present i/p bit)

(A,1)--->(B,01) which is sum of 0+1= 1=01,

(B,1)--->(C,10) which is sum of 1+1= (previous i/p bit + present i/p bit)=10 ,

(C,1)---> (C,10) which is sum of 1+1=10

so answer should be (A).

8 votes

-- sonam vyas (8.1k points)

### 19.0.16 GATE2005\_54 top

<http://gateoverflow.in/1377>

Selected Answer

Option D.

NFA and DFA both have equivalent power.(every nfa can be converted into equivalent dfa) but NPDA can accept more languages than DPDA.

4 votes

-- shreya ghosh (2.9k points)

### 19.0.17 GATE2002\_2.14 top

<http://gateoverflow.in/844>



Selected Answer

Complement of recursive language is always recursive

3 votes

-- Bhagirathi Nayak (11.3k points)

### 19.0.18 Gate2011\_24 top

<http://gateoverflow.in/3429>



Selected Answer

c) complement of regular Language is regular

10 votes

-- VOOTLA SRINIVAS (293 points)

### 19.0.19 GATE2005-IT\_6 top

<http://gateoverflow.in/3751>



Selected Answer

Regular (in fact finite). Since n is finite, we have a finite set of strings satisfying the given conditions. So, we can easily make a finite automata for those strings.

9 votes

-- Arjun Suresh (150k points)

### 19.0.20 GATE2003\_13 top

<http://gateoverflow.in/904>



Selected Answer

(A)  $L$  is recursive. If  $P = NP$ ,  $L$  is  $\Sigma^*$  which is recursive (in fact regular). If not,  $L = \emptyset$  which is again recursive. So, in both cases  $L$  is recursive.

13 votes

-- Arjun Suresh (150k points)

### 19.0.21 GATE2006\_30 top

<http://gateoverflow.in/993>



Selected Answer

Refer this

[http://gateoverflow.in/1695/gate1998\\_4](http://gateoverflow.in/1695/gate1998_4)

$L_1 = \{ s \in (0+1)^* \mid d(s) \bmod 5 = 2 \}$  is regular

having 2 as final state out of {0,1,2,3,4} states

as given in example in posted link [in same DFA , final state will be 2 instead of 0 ]

similarly  $L_2 = \{ s \in (0+1)^* \mid d(s) \bmod 7 \neq 4 \}$  is also regular

having states {0,1,2,3,4,5,6} and all are final state except 4

$L_1 \cap L_2$  is  $L$  (given problem ) is also regular

As regular languages are closed under intersection. D is correct option.

13 votes

-- Praveen Saini (38.4k points)

**19.0.22 GATE2000-1.5** [top](#)<http://gateoverflow.in/628>

Selected Answer

B. is the answer for this question

Language generated by this grammar is  $L = (00)^+ \cup \{0\}^+$  that is regular but not  $0^+$

10 votes

-- Manu Thakur (5.6k points)

**19.0.23 GATE2007-IT\_46** [top](#)<http://gateoverflow.in/3481>

Selected Answer

from Above grammar

Regular expression for G1:  $(x+z)^+ + (x+z)^*y(y+z)^+$

Regular expression for G2 : $(y+z+xy)^+$

Option A is correct

4 votes

-- Praveen Saini (38.4k points)

**19.0.24 GATE2008-51** [top](#)<http://gateoverflow.in/463>

Selected Answer

$H - S$  is true coz strings generated by this grammar satisfies the definition of an even length palindrome string. this rules out B and D options.

$G - Q$  is confirmed as both options A and C has it as true.

$E - R$  is true coz  $R$  is the only grammar that checks: what ( $w$ ) has occurred earlier is present afterwards This equals the definition of  $E$

Hence, **option C** is true.

8 votes

-- Amar Vashishth (20.7k points)

**19.0.25 GATE2003\_15** [top](#)<http://gateoverflow.in/120>

Selected Answer

Answer is (c)- L is recursive but not necessarily Regular or not even context-free.

Since, the strings of L can be enumerated it means L is recursively enumerable. That is we have a TM which accepts all strings in L. Now, to be recursive the TM should reject all strings not in L. Since, the strings of the language can be enumerated in lexicographic order, it's easy to do this. For any word  $w$ , if we see a word in the enumeration which is lexicographically higher than  $w$  but no  $w$ , it means  $w$  is not in the language. This makes L "recursive".

Now, why L need not be context free or regular? Consider

$$L = \{a^n b^n c^n \mid \dots\}$$

The strings of this language can be enumerated in lexicographic order. But we know L is not context free as no PDA can accept L.

22 votes

-- Arjun Suresh (150k points)

**19.0.26 GATE2003\_52** top<http://gateoverflow.in/356>

Selected Answer

Since,  $f$  is a polynomial time computable bijection and  $f^{-1}$  is also polynomial time computable,  $L_1$  and  $L_2$  should have the same complexity (isomorphic). This is because, given a problem for  $L_1$ , we can always do a polynomial time reduction to  $L_2$  and vice versa. Hence, the answer is 'C', as in 'A',  $L_1$  and  $L_2$  can be finite, in 'B',  $L_1$  and  $L_2$  can be in  $P$  and in 'D',  $L_1$  and  $L_2$  can be recursive. Only, in 'C' there is no intersection for  $L_1$  and  $L_2$ , and hence it can't be true.

Alternatively, we can prove 'C' to be false as follows:

Given  $L_2$  is decidable. Now, for a problem in  $L_1$ , we can have a  $TM$ , which takes an input  $x$ , calculates  $f(x)$  in polynomial time, check  $f(x)$  is in  $L_2$  (this is decidable as  $L_2$  is decidable), and if it is, then output yes and otherwise no. Thus  $L_1$  must also be decidable.

6 votes

-- gatecse (10.7k points)

**19.0.27 GATE1997\_3.4** top<http://gateoverflow.in/2235>

Selected Answer

(b) Set of all languages over  $\Sigma$  is uncountable.

Ref: [http://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-045j-automata-computability-and-complexity-spring-2011/lecture-notes/MIT6\\_045JS11\\_lec05.pdf](http://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-045j-automata-computability-and-complexity-spring-2011/lecture-notes/MIT6_045JS11_lec05.pdf)

Power set of an infinite set is uncountable. Set of languages over  $\Sigma$  is the power set of set of strings over  $\Sigma$  which is an infinite set. Hence the set of languages becomes an uncountable set.

6 votes

-- Arjun Suresh (150k points)

**19.0.28 GATE2008-9** top<http://gateoverflow.in/407>

Selected Answer

We have [algorithms to generate prime numbers](#)  $\implies$  we can generate sequence of  $p$  for the given language, hence strings as defined by the language definition.

So by Church Turing Thesis we can say that there exists a Turing Machine which can accept the given language.

answer = **option D**

9 votes

-- Amar Vashishth (20.7k points)

**19.0.29 GATE1994\_1.16** top<http://gateoverflow.in/2459>

Selected Answer

This will be C. Because if that would have been possible then NPDA and DPDA must had same powers, which is not the case. You can take example of NFA and DFA. Both are convertible to each other and hence share the same power.

8 votes

-- Gate Keeda (17.7k points)

**19.0.30 GATE2008-13, ISRO2016-36** [top](#)<http://gateoverflow.in/411>

Selected Answer

(D) recursive

$L$  is recursively enumerable means a  $TM$  accepts all strings in  $L$ .  $\bar{L}$  is recursively enumerable means a  $TM$  accepts all strings in  $\bar{L}$ . So, we can always decide if a string is in  $L$  or not, making  $L$  recursive.

If a language  $L$  and its complement  $\bar{L}$  are both recursively enumerable, then both languages are recursive. If  $L$  is recursive, then  $\bar{L}$  is also recursive, and consequently both are recursively enumerable.

**Proof:** If  $L$  and  $\bar{L}$  are both recursively enumerable, then there exist Turing machines  $M$  and  $\widehat{M}$  that serve as enumeration procedures for  $L$  and  $\bar{L}$ , respectively. The first will produce  $w_1, w_2, \dots$  in  $L$ , the second  $\widehat{w}_1, \widehat{w}_2, \dots$  in  $\bar{L}$ . Suppose now we are given any  $w \in \Sigma^+$ . We first let  $M$  generate  $w_1$  and compare it with  $w$ . If they are not the same, we let  $\widehat{M}$  generate  $\widehat{w}_1$  and compare again. If we need to continue, we next let  $M$  generate  $w_2$ , then  $\widehat{M}$  generate  $\widehat{w}_2$ , and so on. Any  $w \in \Sigma^+$  will be generated by either  $M$  or  $\widehat{M}$ , so eventually we will get a match. If the matching string is produced by  $M$ ,  $w$  belongs to  $L$ , otherwise it is in  $\bar{L}$ . The process is a membership algorithm for both  $L$  and  $\bar{L}$ , so they are both recursive.

For the converse, assume that  $L$  is recursive. Then there exists a membership algorithm for it. But this becomes a membership algorithm for  $\bar{L}$  by simply complementing its conclusion. Therefore,  $\bar{L}$  is recursive. Since any recursive language is recursively enumerable, the proof is completed. ■

<http://goo.gl/RtV8MO>

10 votes

-- Keith Kr (6k points)

**19.0.31 GATE2008-48** [top](#)<http://gateoverflow.in/461>

Selected Answer

there exists a set of languages which is RE but not REC( i.e. Recursively Enumerable but not Recursive), this set is a subset of RE but is Not Recursive

option D tells us that every subset of RE is REC this is false,  
Hence, **option D** is chosen

6 votes

-- Amar Vashishth (20.7k points)

**19.0.32 GATE1998\_1.11** [top](#)<http://gateoverflow.in/1648>

Selected Answer

- A) True. Proof - Subset Construction Procedure
- B) False . No conversion from NPDA To DPDA>
- C) False :- Power(TM) > NPDA > DPDA.
- D) True E) True

Answer :- This question has multiple answers, B and C>

4 votes

-- Akash (31.7k points)

### 19.0.33 GATE1995\_2.20 top

<http://gateoverflow.in/2632>



Selected Answer

A.

In the other two you can have any number of x and y. There is no such restriction over the number of both being equal.

9 votes

-- Gate Keeda (17.7k points)

### 19.0.34 TIFR2014-B-14 top

<http://gateoverflow.in/27321>

A) True. Complement of a recursive language just reverses 'yes' and 'no' condition. So here the new language has a 'yes' and 'no' conditions. So, the new language also recursive

B) True.

C) True. Complement of CFL is recursive. and recursive language is recognized by Turing machine. So, complement of language can be recognized by TM

D) True. If 'yes' and 'no' both cases of a language is recursive enumerable, that means both cases are possible for the language. So, it is recursive

E) False. Non recursive language are recursive enumerable language, and also complement recursive enumerable language is non recursive enumerable. But we know non recursive enumerable language can be recognized by Turing Machine

So answer is (E)

1 votes

-- srestha (27.8k points)

### 19.0.35 GATE2012\_25 top

<http://gateoverflow.in/1609>



Selected Answer

$$L = \{ab, aa, baa\}$$

- |                 |                            |                                                 |
|-----------------|----------------------------|-------------------------------------------------|
| 1. abaabaaaabaa | = ab    aa    baa ab aa    | belong to $L^*$ (combinations of strings in L ) |
| 2. aaaabaaaaa   | = aa    aa    baa aa       | belong to $L^*$                                 |
| 3. baaaaabaaaab | = baa aa ab aa aa <b>b</b> | does not belong to $L^*$                        |
| 4. baaaaabaa    | = baa aa ab aa             | belong to $L^*$                                 |

5 votes

-- Praveen Saini (38.4k points)

### 19.0.36 GATE2004\_87 top

<http://gateoverflow.in/1081>



Selected Answer

Language is not regular bcoz we need to match count of c's is equal to count of b's + count of a's

and that can implement by PDA

$\delta(q_0, a, \epsilon) = (q_0, a)$  [ push a in stack, as per language a comes first]

$\delta(q_0, a, a) = (q_0, aa)$  [push all a's into stack]  
 $\delta(q_0, b, a) = (q_1, ba)$  [push b in stack, state change to q1 that sure b comes after a]  
 $\delta(q_1, b, b) = (q_1, bb)$  [push all b's in stack]  
 $\delta(q_1, c, b) = (q_2, ^)$  [pop one b for one c]  
 $\delta(q_2, c, b) = (q_2, c)$  [pop one b's for each c and continue same]  
 $\delta(q_2, c, a) = (q_3, ^)$  [pop one a for one c, when there is no more b in stack]  
 $\delta(q_3, c, a) = (q_3, ^)$  [pop one a for each c and continue same]  
 $\delta(q_3, ^, ^) = (q_f, ^)$  [if sum of c's is sum of a's and b's then stack will be empty when there is no c in input]

answer = **option B** : language is context-free but not regular.

Note : 1. state changes make sure b's comes after a and c's comes after b's]

6 votes

-- Praveen Saini (38.4k points)

### 19.0.37 GATE1991\_03, xiv [top](#)

<http://gateoverflow.in/528>



Selected Answer

(b), (c) and (d) are true. But the strongest answer would be (d) a regular language. It is trivial to say that a finite set of strings (finite language) can be accepted using a finite set of states. And regular language ⊂ context-free ⊂ context-sensitive ⊂ Turing recognizable, would imply that regular language is the strongest answer.

11 votes

-- gatecse (10.7k points)

### 19.0.38 GATE2006\_33 [top](#)

<http://gateoverflow.in/996>



Selected Answer

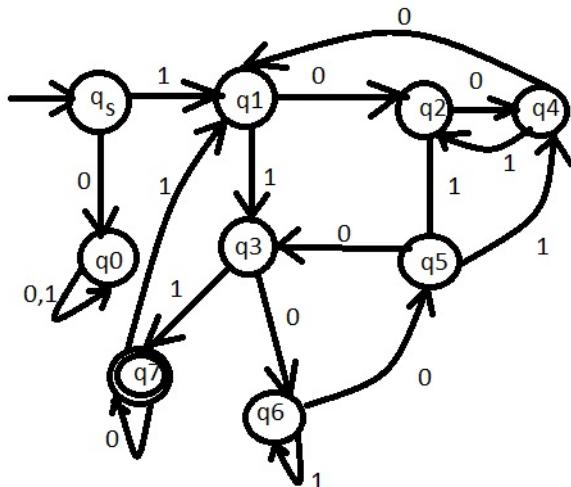
- A) True : DCFL are closed under Intersection with Regular Languages
- C) True : L1 is regular hence also CFL and every DCFL is also CFL and All CFL are closed under Union.
- D) True : L1 is regular hence also RE; L2 is DCFL hence also RE; RE languages are closed under Intersection
- B) False : L1 is recursive hence also decidable, L3 is RE but not Recursive hence it is undecidable. Intersection of Recursive language and Recursive Enumerable language is Recursive Enumerable language.

12 votes

-- Danish (2.4k points)

### 19.0.39 TIFR2015-B-6 [top](#)

<http://gateoverflow.in/29860>



Answer will be (A)

if it starts with 1 it goes to final state

if it starts with 0 it will go to the reject state

5 votes

-- srestha (27.8k points)

### 19.0.40 GATE1992\_02,xx top

<http://gateoverflow.in/577>



Selected Answer

Answer: A and C.

- For every NFA there exists a DFA.
- For every NPDA there does not exist a deterministic PDA.
- Every nondeterministic Turing machine has an equivalent deterministic Turing Machine.

5 votes

-- Rajarshi Sarkar (29.7k points)

### 19.0.41 GATE1992\_16 top

<http://gateoverflow.in/595>



Selected Answer

- True. Recursive languages are closed under union.
- True. The language is Turing Machine acceptable.
- False. Regular languages are closed under finite union.

4 votes

-- Rajarshi Sarkar (29.7k points)

### 19.0.42 GATE2005-IT\_4 top

<http://gateoverflow.in/3748>



Selected Answer

Take  $L = \Sigma^*$  then  $L^c = \emptyset$  and  $M^c \cup \emptyset = M^c$ .

We know that complement of CFL need not be a CFL as CFL is not closed under complement.

So, (A) and (B) are false.

If we take  $L = \emptyset$  then  $L^c = \Sigma^*$  and  $M^c \cup \Sigma^* = \Sigma^*$  which is regular - (C) is also false.

So, answer (D)

14 votes

-- Arjun Suresh (150k points)

## 19.1

### Chomsky Normal Form [top](#)

#### 19.1.1 Chomsky Normal Form: GATE1992\_02,xviii [top](#)

<http://gateoverflow.in/576>

Choose the correct alternatives (more than one may be correct) and write the corresponding letters only:

If  $G$  is a context free grammar and  $w$  is a string of length  $l$  in  $L(G)$ , how long is a derivation of  $w$  in  $G$ , if  $G$  is in Chomsky normal form?

- (a).  $2l$
- (b).  $2l + 1$
- (c).  $2l - 1$
- (d).  $l$

[gate1992](#) [theory-of-computation](#) [context-free](#) [chomsky-normal-form](#) [easy](#)

Answer

### Answers: Chomsky Normal Form

#### 19.1.1 Chomsky Normal Form: GATE1992\_02,xviii [top](#)

<http://gateoverflow.in/576>



Selected Answer

Chomsky Normal Form (If all of its production rules are of the form):

- $A \rightarrow BC$  or
- $A \rightarrow a$  or
- $S \rightarrow \epsilon$

where  $A$ ,  $B$  and  $C$  are nonterminal symbols,  $a$  is a terminal symbol (a symbol that represents a constant value),  $S$  is the start symbol, and  $\epsilon$  is the empty string. Also, neither  $B$  nor  $C$  may be the start symbol, and the third production rule can only appear if  $\epsilon$  is in  $L(G)$ , namely, the language produced by the context-free grammar  $G$ .

Applying productions of the first form will increase the number of nonterminals from  $k$  to  $k + 1$ , since you replace one nonterminal (-1) with two nonterminals (+2) for a net gain of +1 nonterminal. Since you start with one nonterminal, this means you need to do  $I - 1$  productions of the first form. You then need  $I$  more of the second form to convert the nonterminals to terminals, giving a total of  $I + (I - 1) = 2I - 1$  productions.

7 votes

-- Rajarshi Sarkar (29.7k points)

## 19.2

### Closure Property [top](#)

#### 19.2.1 Closure Property: GATE2006-IT\_32 [top](#)

<http://gateoverflow.in/3571>

Let  $L$  be a context-free language and  $M$  a regular language. Then the language  $L \cap M$  is

- A) always regular
- B) never regular

- C) always a deterministic context-free language  
 D) always a context-free language

[gate2006-it](#) [theory-of-computation](#) [closure-property](#) [easy](#)

[Answer](#)

### 19.2.2 Closure Property: TIFR2013-B-11 [top](#)

<http://gateoverflow.in/25772>

Which of the following statements is FALSE?

- a. The intersection of a context free language with a regular language is context free.
- b. The intersection of two regular languages is regular.
- c. The intersection of two context free languages is context free
- d. The intersection of a context free language and the complement of a regular language is context free.
- e. The intersection of a regular language and the complement of a regular language is regular.

[tifr2013](#) [theory-of-computation](#) [closure-property](#)

[Answer](#)

### 19.2.3 Closure Property: GATE 2016-2-18 [top](#)

<http://gateoverflow.in/39574>

Consider the following types of languages:  $L_1$ : Regular,  $L_2$ : Context-free,  $L_3$ : Recursive,  $L_4$ : Recursively enumerable. Which of the following is/are **TRUE** ?

I.  $\bar{L}_3 \cup L_4$  is recursively enumerable.

II.  $\bar{L}_2 \cup L_3$  is recursive.

III.  $L_1^* \cap L_2$  is context-free.

IV.  $L_1 \cup \bar{L}_2$  is context-free.

- A. I only.
- B. I and III only.
- C. I and IV only.
- D. I, II and III only.

[gate2016-2](#) [theory-of-computation](#) [regular-language](#) [context-free](#) [closure-property](#) [normal](#)

[Answer](#)

### 19.2.4 Closure Property: GATE1999\_1.5 [top](#)

<http://gateoverflow.in/1459>

Context-free languages are closed under:

- A. Union, intersection
- B. Union, Kleene closure
- C. Intersection, complement
- D. Complement, Kleene closure

[gate1999](#) [theory-of-computation](#) [context-free](#) [closure-property](#) [easy](#)

[Answer](#)

## Answers: Closure Property

### 19.2.1 Closure Property: GATE2006-IT\_32 [top](#)

<http://gateoverflow.in/3571>



Selected Answer

Let  $\Sigma = \{a, b\}$

Let  $L_1 = \Sigma^*$  be a regular language

Let  $L_2 = \{ww^R \mid w \in (a+b)^*\}$  be a context free language.

$L_1 \cap L_2 = \{ww^R \mid w \in (a+b)^*\}$  which is clearly context free language and not DCFL or Regular  
Hence the answer is option D

5 votes

-- Mari Ganesh Kumar (1.9k points)

### 19.2.2 Closure Property: TIFR2013-B-11 [top](#)

<http://gateoverflow.in/25772>



Selected Answer

Context language are not closed under intersection so option C

4 votes

-- Umang Raman (11.3k points)

### 19.2.3 Closure Property: GATE 2016-2-18 [top](#)

<http://gateoverflow.in/39574>



Selected Answer

I.  
 $\overline{L_3} \cup L_4$

$\overline{L_3}$  is recursive, so

$\overline{L_3}$  is also recursive (closed under complement),

So,

$\overline{L_3}$  is recursive enumerable.

$L_4$  is recursive enumerable,

so,

$\overline{L_3} \cup L_4$  is also recursive enumerable (closed under union).

II.

$\overline{L_2} \cup L_3$

$L_2$  is Context-free, so

$\overline{L_2}$ , may or may not be Context-free (not closed under complement), but definitely

$\overline{L_2}$  is Recursive.

$L_3$  is recursive.

so

$\overline{L_2} \cup L_3$  is also recursive (closed under union).

III.

$L_1^* \cap L_2$

$L_1$  is Regular, so

$L_1^*$  is also regular (closed under kleene star)

$L_2$  is Context-free

so,

$L_1^* \cap L_2$  is also context-free (closed under intersection with regular).

IV.

$L_1 \cup \overline{L_2}$

$L_1$  is regular.

$\overline{L_2}$  is context-free, so

$\overline{L_2}$  may or may not be Context-free (not closed under complement).

so,

$L_1 \cup \overline{L_2}$  may or may not be Context-free.

Here answer is D

20 votes

-- Praveen Saini (38.4k points)

## 19.2.4 Closure Property: GATE1999\_1.5 [top](#)

<http://gateoverflow.in/1459>



Selected Answer

Cfl are not closed under intersection and complement now choose the correct option so b)union and klenne closure

7 votes

-- Bhagirathi Nayak (11.3k points)

## 19.3

## Context Free [top](#)

### 19.3.1 Context Free: GATE2008-IT\_34 [top](#)

<http://gateoverflow.in/3344>

Consider a CFG with the following productions.

$$\begin{aligned} S &\rightarrow AA \mid B \\ A &\rightarrow 0A \mid A0 \mid 1 \\ B &\rightarrow 0B00 \mid 1 \end{aligned}$$

S is the start symbol, A and B are non-terminals and 0 and 1 are the terminals. The language generated by this grammar is

- A)  $\{0^n 1 0^{2n} \mid n \geq 1\}$
- B)  $\{0^i 1 0^j 1 0^k \mid i, j, k \geq 0\} \cup \{0^n 1 0^{2n} \mid n \geq 1\}$
- C)  $\{0^i 1 0^j \mid i, j \geq 0\} \cup \{0^n 1 0^{2n} \mid n \geq 1\}$
- D) The set of all strings over {0, 1} containing at least two 0's

[gate2008-it](#) [theory-of-computation](#) [context-free](#) [normal](#)

Answer

### 19.3.2 Context Free: GATE2005\_57 [top](#)

<http://gateoverflow.in/1380>

Consider the languages:

- $L_1 = \{ww^R \mid w \in \{0,1\}^*\}$
- $L_2 = \{w\#w^R \mid w \in \{0,1\}^*\}$ , where # is a special symbol
- $L_3 = \{ww \mid w \in \{0,1\}^*\}$

Which one of the following is TRUE?

- A.  $L_1$  is a deterministic CFL  
 B.  $L_2$  is a deterministic CFL  
 C.  $L_3$  is a CFL, but not a deterministic CFL  
 D.  $L_3$  is a deterministic CFL

gate2005 theory-of-computation context-free easy

[Answer](#)

### 19.3.3 Context Free: GATE2007-IT\_48 [top](#)

<http://gateoverflow.in/3490>

Consider the grammar given below

$$\begin{array}{l} S \rightarrow xB \mid yA \\ A \rightarrow x \mid xS \mid yAA \\ B \rightarrow y \mid yS \mid yBB \end{array}$$

Consider the following strings.

- (i) xxxyx
- (ii) xxyyxy
- (iii) xyxy
- (iv) yxxxy
- (v) yxx
- (vi) xyx

Which of the above strings are generated by the grammar ?

- A) (i), (ii), and (iii)
- B) (ii), (v), and (vi)
- C) (ii), (iii), and (iv)
- D) (i), (iii), and (iv)

gate2007-it theory-of-computation context-free normal

[Answer](#)

### 19.3.4 Context Free: GATE2009-12, ISRO2016-37 [top](#)

<http://gateoverflow.in/1304>

$$S \rightarrow aSa \mid bSb \mid a \mid b$$

The language generated by the above grammar over the alphabet  $\{a, b\}$  is the set of

- A. all palindromes
- B. all odd length palindromes
- C. strings that begin and end with the same symbol
- D. all even length palindromes

gate2009 theory-of-computation context-free easy isro2016

[Answer](#)

### 19.3.5 Context Free: GATE1996\_2.9 [top](#)

<http://gateoverflow.in/2738>

Define a context free languages  $L \in \{0,1\}^*$ ,  $\text{init}(L) = \{u \mid uv \in L \text{ for some } v \text{ in } \{0,1\}^*\}$  ( in other words,  $\text{init}(L)$  is the set of prefixes of  $L$  )

Let  $L = \{w \mid w \text{ is nonempty and has an equal number of 0's and 1's}\}$

Then  $\text{init}(L)$  is

- A. the set of all binary strings with unequal number of 0's and 1's  
 B. the set of all binary strings including null string  
 C. the set of all binary strings with exactly one more 0 than the number of 1's or one more 1 than the number of 0's  
 D. None of the above

gate1996 theory-of-computation context-free normal

[Answer](#)

### 19.3.6 Context Free: GATE1999\_7 [top](#)

<http://gateoverflow.in/1506>

Show that the language

$$L = \{x c x \mid x \in \{0, 1\}^* \text{ and } c \text{ is a terminal symbol}\}$$

is not context free.  $c$  is not 0 or 1.

gate1999 theory-of-computation context-free normal

[Answer](#)

### 19.3.7 Context Free: GATE1996\_2.8 [top](#)

<http://gateoverflow.in/2737>

If  $L_1$  and  $L_2$  are context free languages and  $R$  a regular set, one of the languages below is not necessarily a context free language. Which one?

- A.  $L_1 \cdot L_2$   
 B.  $L_1 \cap L_2$   
 C.  $L_1 \cap R$   
 D.  $L_1 \cup L_2$

gate1996 theory-of-computation context-free easy

[Answer](#)

### 19.3.8 Context Free: GATE2007-IT\_49 [top](#)

<http://gateoverflow.in/3491>

Consider the following grammars. Names representing terminals have been specified in capital letters.

- G1 :  $\text{stmtnt} \rightarrow \text{WHILE}(\text{expr}) \text{stmtnt}$   
 $\text{stmtnt} \rightarrow \text{OTHER}$   
 $\text{expr} \rightarrow \text{ID}$
- G2 :  $\text{stmtnt} \rightarrow \text{WHILE}(\text{expr}) \text{stmtnt}$   
 $\text{stmtnt} \rightarrow \text{OTHER}$   
 $\text{expr} \rightarrow \text{expr} + \text{expr}$   
 $\text{expr} \rightarrow \text{expr} * \text{expr}$   
 $\text{expr} \rightarrow \text{ID}$

Which one of the following statements is true?

- A)  $G_1$  is context-free but not regular and  $G_2$  is regular  
 B)  $G_2$  is context-free but not regular and  $G_1$  is regular  
 C) Both  $G_1$  and  $G_2$  are regular  
 D) Both  $G_1$  and  $G_2$  are context-free but neither of them is regular

gate2007-it theory-of-computation context-free normal

[Answer](#)

### 19.3.9 Context Free: GATE2006-IT\_34 [top](#)

<http://gateoverflow.in/3573>

In the context-free grammar below, S is the start symbol, a and b are terminals, and  $\epsilon$  denotes the empty string.

$$\begin{aligned}S &\rightarrow aSAb \mid \epsilon \\A &\rightarrow bA \mid \epsilon\end{aligned}$$

The grammar generates the language

- A)  $((a + b)^* b)^*$
- B)  $(a^m b^n \mid m \leq n)$
- C)  $(a^m b^n \mid m = n)$
- D)  $a^* b^*$

[gate2006-it](#) [theory-of-computation](#) [context-free](#) [normal](#)

[Answer](#)

### 19.3.10 Context Free: GATE2001-1.5 [top](#)

<http://gateoverflow.in/698>

Which of the following statements is true?

- A. If a language is context free it can always be accepted by a deterministic push-down automaton
- B. The union of two context free languages is context free
- C. The intersection of two context free languages is a context free
- D. The complement of a context free language is a context free

[gate2001](#) [theory-of-computation](#) [context-free](#) [easy](#)

[Answer](#)

### 19.3.11 Context Free: GATE 2016-1-42 [top](#)

<http://gateoverflow.in/39705>

Consider the following context-free grammars;

$$G_1 : S \rightarrow aS \mid B, B \rightarrow b \mid bB$$

$$G_2 : S \rightarrow aA \mid bB, A \rightarrow aA \mid B \mid \epsilon, B \rightarrow bB \mid \epsilon$$

Which one of the following pairs of languages is generated by  $G_1$  and  $G_2$ , respectively?

- A.  $\{a^m b^n \mid m > 0 \text{ or } n > 0\}$  and  $\{a^m b^n \mid m > 0 \text{ and } n > 0\}$
- B.  $\{a^m b^n \mid m > 0 \text{ and } n > 0\}$  and  $\{a^m b^n \mid m > 0 \text{ or } n \geq 0\}$
- C.  $\{a^m b^n \mid m \geq 0 \text{ or } n > 0\}$  and  $\{a^m b^n \mid m > 0 \text{ and } n > 0\}$
- D.  $\{a^m b^n \mid m \geq 0 \text{ and } n > 0\}$  and  $\{a^m b^n \mid m > 0 \text{ or } n > 0\}$

[gate2016-1](#) [theory-of-computation](#) [context-free](#) [normal](#)

[Answer](#)

### 19.3.12 Context Free: GATE1992\_02,xix [top](#)

<http://gateoverflow.in/572>

02. Choose the correct alternatives (more than one may be correct) and write the corresponding letters only:

(xix) Context-free languages are

- a. closed under union
- b. closed under complementation
- c. closed under intersection
- d. closed under Kleene closure

[gate1992](#) [context-free](#) [theory-of-computation](#) [normal](#)
[Answer](#)

### 19.3.13 Context Free: GATE2006-IT\_4 [top](#)

<http://gateoverflow.in/3543>

In the context-free grammar below,  $S$  is the start symbol,  $a$  and  $b$  are terminals, and  $\epsilon$  denotes the empty string

$$S \rightarrow aSa \mid bSb \mid a \mid b \mid \epsilon$$

Which of the following strings is NOT generated by the grammar?

- |    |           |
|----|-----------|
| A) | aaaa      |
| B) | baba      |
| C) | abba      |
| D) | babaaabab |

[gate2006-it](#) [theory-of-computation](#) [context-free](#) [easy](#)
[Answer](#)

### 19.3.14 Context Free: GATE2006\_19 [top](#)

<http://gateoverflow.in/980>

Let

$$L_1 = \{0^{n+m}1^n0^m \mid n, m \geq 0\},$$

$$L_2 = \{0^{n+m}1^{n+m}0^m \mid n, m \geq 0\} \text{ and}$$

$$L_3 = \{0^{n+m}1^{n+m}0^{n+m} \mid n, m \geq 0\}.$$

Which of these languages are NOT context free?

- (A)  $L_1$  only
- (B)  $L_3$  only
- (C)  $L_1$  and  $L_2$
- (D)  $L_2$  and  $L_3$

[gate2006](#) [theory-of-computation](#) [context-free](#) [normal](#)
[Answer](#)

### 19.3.15 Context Free: GATE 2016-2-43 [top](#)

<http://gateoverflow.in/39605>

Consider the following languages:

$$L_1 = \{a^n b^m c^{n+m} : m, n \geq 1\}$$

$$L_2 = \{a^n b^n c^{2n} : n \geq 1\}$$

Which one of the following is TRUE?

- A. Both  $L_1$  and  $L_2$  are context-free.
- B.  $L_1$  is context-free while  $L_2$  is not context-free.
- C.  $L_2$  is context-free while  $L_1$  is not context-free.
- D. Neither  $L_1$  nor  $L_2$  is context-free.

[gate2016-2](#) [theory-of-computation](#) [context-free](#) [normal](#)
[Answer](#)

**19.3.16 Context Free: GATE 2016-1-16** [top](#)<http://gateoverflow.in/39640>

Which of the following languages is generated by the given grammar?

$$S \rightarrow aS \mid bS \mid \epsilon$$

- A.  $\{a^n b^m \mid n, m \geq 0\}$
- B.  $\{w \in \{a, b\}^* \mid w \text{ has equal number of } a's \text{ and } b's\}$
- C.  $\{a^n \mid n \geq 0\} \cup \{b^n \mid n \geq 0\} \cup \{a^n b^n \mid n \geq 0\}$
- D.  $\{a, b\}^*$

[gate2016-1](#) [theory-of-computation](#) [context-free](#) [normal](#)

[Answer](#)

**19.3.17 Context Free: GATE2003\_51** [top](#)<http://gateoverflow.in/940>

Let  $G = (\{S\}, \{a, b\}, R, S)$  be a context free grammar where the rule set R is  $S \rightarrow aSb \mid SS \mid \epsilon$

Which of the following statements is true?

- A. G is not ambiguous
- B. There exist  $x, y \in L(G)$  such that  $xy \notin L(G)$
- C. There is a deterministic pushdown automaton that accepts  $L(G)$
- D. We can find a deterministic finite state automaton that accepts  $L(G)$

[gate2003](#) [theory-of-computation](#) [context-free](#) [normal](#)

[Answer](#)

**19.3.18 Context Free: GATE2004-IT\_41** [top](#)<http://gateoverflow.in/3684>

Let  $M = (K, \Sigma, \delta, s, F)$  be a finite state automaton, where

$K = \{A, B\}$ ,  $\Sigma = \{a, b\}$ ,  $s = A$ ,  $F = \{B\}$ ,  
 $\delta(A, a) = A$ ,  $\delta(A, b) = B$ ,  $\delta(B, a) = B$  and  $\delta(B, b) = A$

A grammar to generate the language accepted by M can be specified as  $G = (V, \Sigma, R, S)$ , where  $V = K \cup \Sigma$ , and  $S = A$ . Which one of the following set of rules will make  $L(G) = L(M)$ ?

- A)  $\{A \rightarrow aB, A \rightarrow bA, B \rightarrow bA, B \rightarrow aA, B \rightarrow \epsilon\}$
- B)  $\{A \rightarrow aA, A \rightarrow bB, B \rightarrow aB, B \rightarrow bA, B \rightarrow \epsilon\}$
- C)  $\{A \rightarrow bB, A \rightarrow aB, B \rightarrow aA, B \rightarrow bA, B \rightarrow \epsilon\}$
- D)  $\{A \rightarrow aA, A \rightarrow bA, B \rightarrow aB, B \rightarrow bA, A \rightarrow \epsilon\}$

[gate2004-it](#) [theory-of-computation](#) [finite-automata](#) [context-free](#) [normal](#)

[Answer](#)

**19.3.19 Context Free: GATE2015-3\_32** [top](#)<http://gateoverflow.in/8489>

Which of the following languages are context-free?

$$L_1 : \{a^m b^n a^n b^m \mid m, n \geq 1\}$$

$$L_2 : \{a^m b^n a^m b^n \mid m, n \geq 1\}$$

$$L_3 : \{a^m b^n \mid m = 2n + 1\}$$

- A.  $L_1$  and  $L_2$  only
- B.  $L_1$  and  $L_3$  only

- C.  $L_2$  and  $L_3$  only  
D.  $L_3$  only

gate2015-3 | theory-of-computation | context-free | normal

Answer

### Answers: Context Free

#### 19.3.1 Context Free: GATE2008-IT\_34 [top](#)

<http://gateoverflow.in/3344>

$B \rightarrow 0B00 \mid 1$   
generates  $\{0^n10^{2n} \mid n \geq 1\}$

$S \rightarrow AA,$   
 $A \rightarrow 0A \mid A0 \mid 1$

generates  $0A0A \rightarrow 00A0A \rightarrow 00101$ , which is there in only B and D choices. D is not the answer as "00" is not generated by the given grammar. B is also not the answer as it cannot generate "1" which is generated by the given grammar. So, none of the options match.

10 votes

-- Arjun Suresh (150k points)

#### 19.3.2 Context Free: GATE2005\_57 [top](#)

<http://gateoverflow.in/1380>



Selected Answer

B. [http://gatecse.in/wiki/Identify\\_the\\_class\\_of\\_the\\_language](http://gatecse.in/wiki/Identify_the_class_of_the_language)

7 votes

-- Gate Keeda (17.7k points)

#### 19.3.3 Context Free: GATE2007-IT\_48 [top](#)

<http://gateoverflow.in/3490>

ii), iii) and iv)

so option C is correct

Above grammar is for **equal no of x and y**

from Non-terminal S  $\rightarrow xB$

$=>xy$  [as B  $\rightarrow y$  one y for one x]

S  $\rightarrow xB$

$=>xxBB$  [as B  $\rightarrow yBB$  one B result in one y for one x ]

S  $\rightarrow xB$

$=>xyS$  [as B  $\rightarrow yS$  one y for one x and start again]

Note :Same applies for string start with y i.e . S  $\rightarrow yA$

6 votes

-- Praveen Saini (38.4k points)

#### 19.3.4 Context Free: GATE2009-12, ISRO2016-37 [top](#)

<http://gateoverflow.in/1304>



Selected Answer

ans is B..string generated by this language is a,b,aba,bab,aabaa,.....all this strings are odd length palindromes

9 votes

-- neha pawar (3.8k points)

### 19.3.5 Context Free: GATE1996\_2.9 [top](#)

<http://gateoverflow.in/2738>



Selected Answer

(b) is the answer. Because for any binary string of 0's and 1's we can append another string to make it contain equal number of 0's and 1's. i.e., any string over {0,1} is a prefix of a string in L.

Example:

01111 - is prefix of 011110000 which is in L.  
1111- is prefix of 11110000 which is in L.  
01010- is prefix of 010101 which is in L.

4 votes

-- Arjun Suresh (150k points)

### 19.3.6 Context Free: GATE1999\_7 [top](#)

<http://gateoverflow.in/1506>



Selected Answer

language contains strings where sub string on left of c is same as that on right of c

say 01100c01100

sub string on left of c and right of c cannot be matched with one Stack

while that can be done using two stack

if we push all 0's and 1's on left of c in stack 1 , and all 0's and 1' on right of c in stack 2

then **Top of stack** of both stack will have same symbol .. that can be matched

8 votes

-- Praveen Saini (38.4k points)

### 19.3.7 Context Free: GATE1996\_2.8 [top](#)

<http://gateoverflow.in/2737>



Selected Answer

B.

CFL's are not closed under intersection.

5 votes

-- Gate Keeda (17.7k points)

### 19.3.8 Context Free: GATE2007-IT\_49 [top](#)

<http://gateoverflow.in/3491>



Selected Answer

Regular grammar is either right linear or left linear. A left linear grammar is one in which there is at most 1 non-terminal on the right side of any production, and it appears at the left most position. Similarly, in right linear grammar non-terminal appears at the right most position.

Here, we can write a right linear grammar for G1 as

$S \rightarrow w(E$   
 $E \rightarrow id)S$   
 $S \rightarrow o$

(w - WHILE, o - OTHER)

So,  $L(G1)$  is regular.

Now for G2 also we can write a right linear grammar:

$S \rightarrow w(E$   
 $E \rightarrow id)S$   
 $E \rightarrow id+E$   
 $E \rightarrow id^*E$   
 $S \rightarrow o$

making its language regular.

So, both G1 and G2 have an equivalent regular grammar. But as such both these grammars are neither right linear nor left linear and hence not a regular grammar. So, D must be the answer.

<http://www.cs.odu.edu/~toida/nerzic/390teched/regular/grammar/reg-grammar.html>

8 votes

-- Arjun Suresh (150k points)

### 19.3.9 Context Free: GATE2006-IT\_34 [top](#)

<http://gateoverflow.in/3573>



Selected Answer

$$A \rightarrow bA \mid \epsilon$$

$$\therefore A = b^*$$

$$S \rightarrow aSAb \mid \epsilon$$

$$\equiv S \rightarrow aSb^*b \mid \epsilon$$

$$\equiv S \rightarrow aSb^+ \mid \epsilon$$

$$S = a^n(b^+)^n, \quad n \geq 0$$

$$S = a^n b^n b^*, \quad n \geq 0$$

$$S = a^m b^n, \quad m \leq n$$

Hence, option B is correct.

15 votes

-- Pragy Agarwal (14.4k points)

### 19.3.10 Context Free: GATE2001-1.5 [top](#)

<http://gateoverflow.in/698>



Selected Answer

Answer is (B)

(A) is wrong as a language can be context free even if it is being accepted by non deterministic PDA for ex-  $\{WW^r : W \in \Sigma^*(a,b) \text{ and } W^r \text{ is reverse}\}$

(C) and (D) not always true as Context free languages are not closed under Complement and Intersection.

9 votes

-- Prateeksha Keshari (1.7k points)

**19.3.11 Context Free: GATE 2016-1-42** [top](#)<http://gateoverflow.in/39705>

Selected Answer

Ans (D)

G1 results in strings b, ab, bb, aab, abb, bbb, ... i.e  $a^m b^n$ ,  $m \geq 0$  and  $n > 0$  (and because only a's are not possible but only b's are)

G2 result in strings a, b, aa, ab, bb, aaa, aab, abb, bbb ... i.e  $a^m b^n$ ,  $m > 0$  or  $n > 0$  (or because only b's is possible b,bb,bbb, , only a's are possible)

16 votes

-- juxtapose (505 points)

**19.3.12 Context Free: GATE1992\_02,xix** [top](#)<http://gateoverflow.in/572>

Selected Answer

Answer: A, D

Context Free languages are not closed under intersection and complementation.

5 votes

-- Rajarshi Sarkar (29.7k points)

**19.3.13 Context Free: GATE2006-IT\_4** [top](#)<http://gateoverflow.in/3543>

Selected Answer

 $L(G) = \text{PALINDROME}$ 

baba does not belong to palindrome , so B is the answer

7 votes

-- Praveen Saini (38.4k points)

**19.3.14 Context Free: GATE2006\_19** [top](#)<http://gateoverflow.in/980>

Selected Answer

L1 is context-free. We count the number of 0's and check if the remaining number of 1's followed by 0's count to the initial number of 0's.

L2 is not context-free. Here the number of 0's and the following 1's must be same, which can be checked using a PDA. But after that we must also ensure that the following number of 0's must be less than the previous count of 0's and 1's (otherwise  $n < 0$ , which violates the condition for acceptance) and we cannot do these two checks using a single PDA.

L3 is again not context-free as it is nothing but equal number of 0's followed by equal number of 1's followed by equal number of 0's.

9 votes

-- Arjun Suresh (150k points)

**19.3.15 Context Free: GATE 2016-2-43** [top](#)<http://gateoverflow.in/39605>

Selected Answer

$$L_1 = \{a^n b^m c^{n+m} : m, n \geq 1\}$$
 is Context-free language

(push  
 $a's$  into stack, then push  
 $b's$  into stack , read  
 $c's$  and pop  
 $b's$  , when no  
 $b's$  left on stack, keep reading  
 $c's$  and pop  
 $a's$  , when no  $c's$  left in input , and stack is empty, then accepted).

$L_2 = \{a^n b^n c^{2n} : n \geq 1\}$  is Context-sensitive language and not context-free.

(cannot implemented by one stack)

So answer is option B

1 21 votes

-- Praveen Saini (38.4k points)

### 19.3.16 Context Free: GATE 2016-1-16 [top](#)

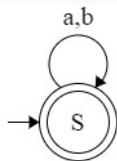
<http://gateoverflow.in/39640>



Selected Answer

$$S \rightarrow aS \mid bS \mid \epsilon$$

is  $(a+b)^*$



1 19 votes

-- Praveen Saini (38.4k points)

### 19.3.17 Context Free: GATE2003\_51 [top](#)

<http://gateoverflow.in/940>



Selected Answer

It will be easy to analyze the problem if we replace terminal a and b by ( and ) respectively.

$$S \rightarrow (S) \mid SS \mid \epsilon$$

$L(G)$  = balanced parentheses [each left parenthesis has a matching right parenthesis and are well nested ]

example () , (()) , ((() , ((())()).

a)  $S \Rightarrow (S) \Rightarrow ()$

$$S \Rightarrow SS \Rightarrow S \Rightarrow (S) \Rightarrow ()$$

$$S \Rightarrow SS \Rightarrow S \Rightarrow (S) \Rightarrow ()$$

String () can be derived by above three way each having different derivation tree.

So G is Ambiguous

b) Concatenation of two balance parenthesis will be balanced also . eq.  $x = (())$   $y = ()$   $xy = ((())()$ .

c) We can design Deterministic PDA for L. put left parenthesis (only) in stack and pop with right parenthesis.

d) We cannot design DFA for L because we need a stack to match left parenthesis with right parenthesis.

only option C is true.

8 votes

-- Praveen Saini (38.4k points)

**19.3.18 Context Free: GATE2004-IT\_41** [top](#)<http://gateoverflow.in/3684>

Selected Answer

$$\delta(A, a) = A, \quad A \rightarrow aA$$

$$\delta(A, b) = B, \quad A \rightarrow bB$$

$$\delta(B, a) = B \quad B \rightarrow aB$$

$$\delta(B, b) = A \quad B \rightarrow bA$$

B is final state so  $B \rightarrow \epsilon$

10 votes

-- Praveen Saini (38.4k points)

**19.3.19 Context Free: GATE2015-3\_32** [top](#)<http://gateoverflow.in/8489>

Selected Answer

first check for L1. now look  $a^m & b^m$  and  $a^n & b^n$  must be comparable using one stack for CFL.

now take a stack push all  $a^m$  in to the stack then push all  $b^n$  in to stack now  $a^n$  is coming so pop  $b^n$  for each  $a^n$  by this  $b^n$  and  $a^n$  will be comparable. now we have left only  $a^m$  in stack and  $b^m$  is coming so pop  $a^m$  for each  $b^m$  by which we can compare  $a^m$  to  $b^m$  ..we conclude that we are comparing this L1 using a single stack so this is CFG.

now for L2. this can not be done in to a single stack because m and n are not comparable we can not find when to push or pop so this is CSL.

now for L3. push all a's in to stack and pop a single a for every 2b and after popping all a's with 2 b's we will get a single b in stack so this comparable hence L3 is CFG.  
so the option is B.. L1 and L3 are CFG

20 votes

-- Anoop Sonkar (4.5k points)

**19.4****Decidability** [top](#)**19.4.1 Decidability: GATE2001-2.7** [top](#)<http://gateoverflow.in/725>

Consider the following problem X.

Given a Turing machine M over the input alphabet  $\Sigma$ , any state q of M and a word  $w \in \Sigma^*$ , does the computation of M on w visit the state q?

Which of the following statements about X is correct?

- A. X is decidable
- B. X is undecidable but partially decidable
- C. X is undecidable and not even partially decidable
- D. X is not a decision problem

[gate2001](#) [theory-of-computation](#) [decidability](#) [normal](#)

**Answer**

## 19.4.2 Decidability: GATE1996\_1.9 [top](#)

<http://gateoverflow.in/2713>

Which of the following statements is false?

- A. The Halting Problem of Turing machines is undecidable
- B. Determining whether a context-free grammar is ambiguous is undecidable
- C. Given two arbitrary context-free grammars  $G_1$  and  $G_2$  it is undecidable whether  $L(G_1) = L(G_2)$
- D. Given two regular grammars  $G_1$  and  $G_2$  it is undecidable whether  $L(G_1) = L(G_2)$

[gate1996](#) [theory-of-computation](#) [decidability](#) [easy](#)

[Answer](#)

## 19.4.3 Decidability: GATE2000-2.9 [top](#)

<http://gateoverflow.in/656>

Consider the following decision problems:

**(P1):** Does a given finite state machine accept a given string?

**(P2):** Does a given context free grammar generate an infinite number of strings?

Which of the following statements is true?

- A. Both (P1) and (P2) are decidable
- B. Neither (P1) nor (P2) is decidable
- C. Only (P1) is decidable
- D. Only (P2) is decidable

[gate2000](#) [theory-of-computation](#) [decidability](#) [normal](#)

[Answer](#)

## 19.4.4 Decidability: TIFR2010-B-25 [top](#)

<http://gateoverflow.in/18745>

Which of the following problems is decidable? (Here, CFG means context free grammar and CFL means context free language.)

- A. Give a CFG  $G$ , find whether  $L(G) = R$ , where  $R$  is regular set.
- B. Given a CFG  $G$ , find whether  $L(G) = \{\}$ .
- C. Find whether the intersection of two CFLs is empty.
- D. Find whether the complement of CFL is a CFL.
- E. Find whether CFG  $G_1$  and CFG  $G_2$  generate the same language, i.e.,  $L(G_1) = L(G_2)$ .

[tifr2010](#) [theory-of-computation](#) [context-free](#) [decidability](#)

[Answer](#)

## 19.4.5 Decidability: GATE2013\_41 [top](#)

<http://gateoverflow.in/1553>

Which of the following is/are undecidable?

1.  $G$  is a CFG. Is  $L(G) = \phi$ ?
2.  $G$  is a CFG. Is  $L(G) = \Sigma^*$ ?
3.  $M$  is a Turing machine. Is  $L(M)$  regular?
4.  $A$  is a DFA and  $N$  is an NFA. Is  $L(A) = L(N)$ ?

- (A) 3 only    (B) 3 and 4 only    (C) 1, 2 and 3 only    (D) 2 and 3 only

[gate2013](#) [theory-of-computation](#) [decidability](#) [normal](#)

**Answer****19.4.6 Decidability: GATE2008-10** [top](#)<http://gateoverflow.in/408>

Which of the following are decidable?

- I. Whether the intersection of two regular languages is infinite
  - II. Whether a given context-free language is regular
  - III. Whether two push-down automata accept the same language
  - IV. Whether a given grammar is context-free
- A. I and II  
B. I and IV  
C. II and III  
D. II and IV

[gate2008](#) [theory-of-computation](#) [decidability](#) [easy](#)
**Answer****19.4.7 Decidability: GATE2012\_24** [top](#)<http://gateoverflow.in/1608>

Which of the following problems are decidable?

1. Does a given program ever produce an output?
2. If  $L$  is a context-free language, then, is  $\bar{L}$  also context-free?
3. If  $L$  is a regular language, then,  $\bar{L}$  is also regular?
4. If  $L$  is a recursive language, then, is  $\bar{L}$  also recursive?

- (A) 1, 2, 3, 4  
(B) 1, 2  
(C) 2, 3, 4  
(D) 3, 4

[gate2012](#) [theory-of-computation](#) [decidability](#) [normal](#)
**Answer****19.4.8 Decidability: GATE2015-2\_21** [top](#)<http://gateoverflow.in/8111>

Consider the following statements.

- I. The complement of every Turing decidable language is Turing decidable
- II. There exists some language which is in NP but is not Turing decidable
- III. If  $L$  is a language in NP,  $L$  is Turing decidable

Which of the above statements is/are true?

- A. Only II  
B. Only III  
C. Only I and II  
D. Only I and III

[gate2015-2](#) [theory-of-computation](#) [decidability](#) [easy](#)
**Answer****19.4.9 Decidability: GATE1997\_6.5** [top](#)<http://gateoverflow.in/2261>

Which one of the following is not decidable?

- A. Given a Turing machine  $M$ , a string  $s$  and an integer  $k$ ,  $M$  accepts  $s$  within  $k$  steps
- B. Equivalence of two given Turing machines
- C. Language accepted by a given finite state machine is not empty
- D. Language generated by a context free grammar is non-empty

gate1997 theory-of-computation decidability easy

Answer

### 19.4.10 Decidability: GATE2014-3-35 [top](#)

<http://gateoverflow.in/2069>

Which one of the following problems is undecidable?

- A. Deciding if a given context-free grammar is ambiguous.
- B. Deciding if a given string is generated by a given context-free grammar.
- C. Deciding if the language generated by a given context-free grammar is empty.
- D. Deciding if the language generated by a given context-free grammar is finite.

gate2014-3 theory-of-computation context-free decidability normal

Answer

### 19.4.11 Decidability: GATE 2016-1-17 [top](#)

<http://gateoverflow.in/39651>

Which of the following decision problems are undecidable?

- I. Given NFAs  $N_1$  and  $N_2$ , is  $L(N_1) \cap L(N_2) = \Phi$
- II. Given a CFG  $G = (N, \Sigma, P, S)$  and a string  $x \in \Sigma^*$ , does  $x \in L(G)$  ?
- III. Given CFGs  $G_1$  and  $G_2$ , is  $L(G_1) = L(G_2)$  ?
- IV. Given a TM  $M$ , is  $L(M) = \Phi$  ?

- A. I and IV only
- B. II and III only
- C. III and IV only
- D. II and IV only

gate2016-1 theory-of-computation decidability easy

Answer

### 19.4.12 Decidability: GATE2007 \_ 6 [top](#)

<http://gateoverflow.in/1204>

Which of the following problems is undecidable?

- A. Membership problem for CFGs
- B. Ambiguity problem for CFGs
- C. Finiteness problem for FSAs
- D. Equivalence problem for FSAs

gate2007 theory-of-computation decidability normal

Answer

## Answers: Decidability

### 19.4.1 Decidability: GATE2001-2.7 [top](#)

<http://gateoverflow.in/725>



Selected Answer

X is undecidable but partially decidable.

We have the TM M. Just make the state q the final state and make all other final states non-final and get a new TM M'.

Give input w to M'. If w would have taken M to state q (yes case of the problem), our new TM M' would accept it. So, the given problem is partially decidable.

If M goes for an infinite loop and never reaches state q (no case for the problem), M' cannot output anything. This problem is the state entry problem, which like word accepting problem and halting problem is undecidable.

18 votes

-- Arjun Suresh (150k points)

### 19.4.2 Decidability: GATE1996\_1.9 [top](#)

<http://gateoverflow.in/2713>



Selected Answer

D..

equivalence of Regular languages is decidable.

1.Membership,

2.Emptiness,

3.Finiteness,

4.Equivalence,

5.Ambiguity,

6.Regularity,

7.Everything,

8.Disjointedness...

All are decidable for Regular languages.

First 3 for CFL.

Only 1<sup>st</sup> for CSL and REC.

None for RE.

7 votes

-- Gate Keeda (17.7k points)

### 19.4.3 Decidability: GATE2000-2.9 [top](#)

<http://gateoverflow.in/656>



Selected Answer

For P1, we just need to give a run on the machine. Finite state machines always halts unlike TM.

For P2, check if the CFG generates any string of length between  $n$  and  $2n - 1$ , where  $n$  is the pumping lemma constant. If so,  $L(\text{CFG})$  is infinite, else finite. But finding the pumping lemma constant is not trivial - but there are other procedures which can do this - <http://cs.stackexchange.com/questions/52507/is-it-decidable-whether-a-given-context-free-grammar-generates-an-infinite-number/52520>

Hence, both P1 and P2 are decidable - (A).

[http://gatecse.in/wiki/Grammar:\\_Decidable\\_and\\_Undecidable\\_Problems](http://gatecse.in/wiki/Grammar:_Decidable_and_Undecidable_Problems)

8 votes

-- Arjun Suresh (150k points)

### 19.4.4 Decidability: TIFR2010-B-25 [top](#)

<http://gateoverflow.in/18745>



Selected Answer

A) we dont have any standard algo to change CFG into CFL.

from a given CFG deciding a language is finite is decidable but regular its undecidable (check out the link provided by Arjun sir in the comment for better clarification.)

B) From a given given CFG we can determine the CFL and CFL emptiness is Decidable.

C) Intersection of two CFL is undecidable coz it is not closed under intersection.

D) CFL is not closed under Complement so its undecidable.

E) CFL is not closed under equivalence so it is undecidable to compare 2 language.

therefore according to me B is decidable and A,C,D and E are undecidable.

4 votes

-- Uman Raman (11.3k points)

#### 19.4.5 Decidability: GATE2013\_41 [top](#)

<http://gateoverflow.in/1553>



Selected Answer

It will be D.

First is Emptiness for CFG.

Second is everything for CFG.

Third is Regularity for REC

Fourth is equivalence for regular.

11 votes

-- Gate Keeda (17.7k points)

#### 19.4.6 Decidability: GATE2008-10 [top](#)

<http://gateoverflow.in/408>



Selected Answer

(1) Intersection of two regular languages is regular. And checking if a regular language is infinite is decidable.

(2) Undecidable

(3) Undecidable

(4) Decidable as we just have to check if the grammar obeys the rules of CFG. (Obviously undecidable had it been language instead of grammar)

Reference: [http://gatcse.in/wiki/Grammar:\\_Decidable\\_and\\_Undecidable\\_Problems](http://gatcse.in/wiki/Grammar:_Decidable_and_Undecidable_Problems)

10 votes

-- gatcse (10.7k points)

#### 19.4.7 Decidability: GATE2012\_24 [top](#)

<http://gateoverflow.in/1608>



Selected Answer

CFL's are not closed under complementation and a program can loop forever. So, it may not produce any output.

Regular and recursive languages are closed under complementation.

Hence, only 3,4 are decidable.

7 votes

-- Bhagirathi Nayak (11.3k points)

**19.4.8 Decidability: GATE2015-2\_21** [top](#)<http://gateoverflow.in/8111>

Selected Answer

1 is true. The solution to a decision problem is either "yes" or "no", and hence if we can decide a problem, we have also decided its complement- just reverse "yes" and "no". (This is applicable for decidability and not for acceptance)

2 is false. Because NP class is defined as the class of languages that can be solved in polynomial time by a non-deterministic Turing machine. So, none of the NP class problems is undecidable.

3 is true for same reason as 2.

So, answer is D.

13 votes

-- Arjun Suresh (150k points)

**19.4.9 Decidability: GATE1997\_6.5** [top](#)<http://gateoverflow.in/2261>

Selected Answer

Equivalence of two TMs is undecidable

8 votes

-- Bhagirathi Nayak (11.3k points)

**19.4.10 Decidability: GATE2014-3-35** [top](#)<http://gateoverflow.in/2069>

Selected Answer

(A) is the answer. Proving (A) is undecidable is not so easy. But we can easily prove the other three options given here are decidable.

[http://gatecse.in/wiki/Grammar:\\_Decidable\\_and\\_Undecidable\\_Problems](http://gatecse.in/wiki/Grammar:_Decidable_and_Undecidable_Problems)

9 votes

-- Arjun Suresh (150k points)

**19.4.11 Decidability: GATE 2016-1-17** [top](#)<http://gateoverflow.in/39651>

Selected Answer

I. is decidable, we may use cross product of NFA (or by converting them into DFA) , if We didn't get final states of both together at any state in it. then  
 $L(N_1) \cap L(N_2) = \phi$  , Disjoint languages.

II. Membership in CFG is decidable (CYK algorithm)

III. Equivalence of Two context free grammars is undecidable.

IV. For TM M ,  
 $L(M) = \phi$  is undecidable.

23 votes

-- Praveen Saini (38.4k points)

**19.4.12 Decidability: GATE2007\_6** [top](#)<http://gateoverflow.in/1204>



Selected Answer

Membership problem is decidable as it can be solved by parsers.

Finiteness problem is decidable for FSAs (also for CFGs), as we just need to check for a loop in the DFA.

Equivalence problem for FSAs is decidable as we can take the complement of one FSA (complement of FSA is another FSA), and do an intersection with the other (FSAs are closed under intersection also), giving a new FSA. If this new FSA accept no string, then the given FSAs are equivalent, else not equivalent.

Only ambiguity problem for CFGs are undecidable.

[http://gatecse.in/wiki/Grammar:\\_Decidable\\_and\\_Undecidable\\_Problems](http://gatecse.in/wiki/Grammar:_Decidable_and_Undecidable_Problems)

9 votes

-- Arjun Suresh (150k points)

19.5

Dfa [top](#)

### 19.5.1 Dfa: GATE 2016-2\_16 [top](#)

<http://gateoverflow.in/39562>

The number of states in the minimum sized DFA that accepts the language defined by the regular expression.

$(0 + 1)^*(0 + 1)(0 + 1)^*$

is \_\_\_\_\_.

[gate2016-2](#) [theory-of-computation](#) [minimal-state-automata](#) [dfa](#) [normal](#) [numerical-answers](#)

Answer

### Answers: Dfa

### 19.5.1 Dfa: GATE 2016-2\_16 [top](#)

<http://gateoverflow.in/39562>

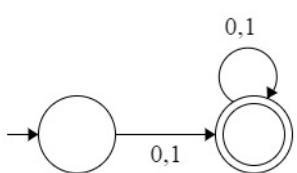


Selected Answer

All strings over  
 $\{0, 1\}$  having length  
 $\geq 1$

$(0 + 1)^*(0 + 1)(0 + 1)^* = (0 + 1)(0 + 1)^* = (0 + 1)^*(0 + 1) = (0 + 1)^+$

having DFA



No of states in minimal DFA  
 $= 2$

20 votes

-- Praveen Saini (38.4k points)

19.6

Finite Automata [top](#)

### 19.6.1 Finite Automata: GATE1994\_3.3 [top](#)

<http://gateoverflow.in/2480>

State True or False with one line explanation

A FSM (Finite State Machine) can be designed to add two integers of any arbitrary length (arbitrary number of digits).

gate1994 theory-of-computation finite-automata normal

Answer

### 19.6.2 Finite Automata: GATE1993\_27 [top](#)

<http://gateoverflow.in/2323>

Draw the state transition of a deterministic finite state automaton which accepts all strings from the alphabet  $\{a, b\}$ , such that no string has 3 consecutive occurrences of the letter b.

gate1993 theory-of-computation finite-automata easy

Answer

### 19.6.3 Finite Automata: GATE1997\_21 [top](#)

<http://gateoverflow.in/2281>

Given that  $L$  is a language accepted by a finite state machine, show that  $L^P$  and  $L^R$  are also accepted by some finite state machines, where

$$L^P = \{s \mid ss' \in L \text{ some string } s'\}$$

$$L^R = \{s \mid s \text{ obtained by reversing some string in } L\}$$

gate1997 theory-of-computation finite-automata proof

Answer

### 19.6.4 Finite Automata: GATE1995\_2.23 [top](#)

<http://gateoverflow.in/2636>

A finite state machine with the following state table has a single input  $x$  and a single output  $z$ .

| present state | next state, $z$ |         |
|---------------|-----------------|---------|
|               | $x = 1$         | $x = 0$ |
| A             | D, 0            | B, 0    |
| B             | B, 1            | C, 1    |
| C             | B, 0            | D, 1    |
| D             | B, 1            | C, 0    |

If the initial state is unknown, then the shortest input sequence to reach the final state C is:

- A. 01
- B. 10
- C. 101
- D. 110

gate1995 theory-of-computation finite-automata normal

Answer

### 19.6.5 Finite Automata: GATE2010-41 [top](#)

<http://gateoverflow.in/2342>

Let  $w$  be any string of length  $n$  in  $\{0, 1\}^*$ . Let  $L$  be the set of all substrings of  $w$ . What is the minimum number of states in non-deterministic finite automaton that accepts  $L$ ?

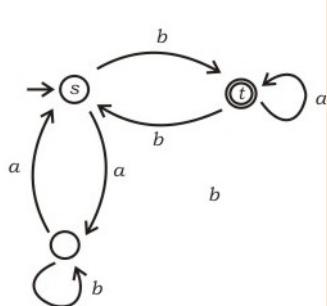
- A.  $n - 1$
- B.  $n$
- C.  $n + 1$
- D.  $2^{n-1}$

gate2010 theory-of-computation finite-automata normal

## Answer

**19.6.6 Finite Automata: GATE2006-IT\_3** [top](#)<http://gateoverflow.in/3542>

In the automaton below, s is the start state and t is the only final state.



Consider the strings  $u = abbaba$ ,  $v = bab$ , and  $w = aabb$ . Which of the following statements is true?

- A) The automaton accepts  $u$  and  $v$  but not  $w$
- B) The automaton accepts each of  $u$ ,  $v$ , and  $w$
- C) The automaton rejects each of  $u$ ,  $v$ , and  $w$
- D) The automaton accepts  $u$  but rejects  $v$  and  $w$

[gate2006-it](#) [theory-of-computation](#) [finite-automata](#) [normal](#)

## Answer

**19.6.7 Finite Automata: GATE 2016-2-42** [top](#)<http://gateoverflow.in/39591>

Consider the following two statements:

- I. If all states of an **NFA** are accepting states then the language accepted by the **NFA** is  $\Sigma^*$ .
- II. There exists a regular language  $A$  such that for all languages  $B$ ,  $A \cap B$  is regular.

Which one of the following is **CORRECT**?

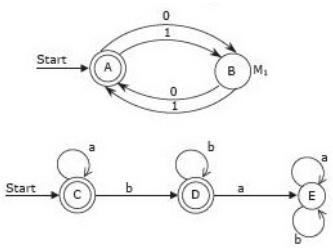
- A. Only I is true
- B. Only II is true
- C. Both I and II are true
- D. Both I and II are false

[gate2016-2](#) [theory-of-computation](#) [finite-automata](#) [normal](#)

## Answer

**19.6.8 Finite Automata: GATE1996\_12** [top](#)<http://gateoverflow.in/2764>

Given below are the transition diagrams for two finite state machines  $M_1$  and  $M_2$  recognizing languages  $L_1$  and  $L_2$  respectively.



- a. Display the transition diagram for a machine that recognizes  $L_1 \cdot L_2$ , obtained from transition diagrams for  $M_1$  and  $M_2$  by adding only  $\epsilon$  transitions and no new states.
- b. Modify the transition diagram obtained in part (a) obtain a transition diagram for a machine that recognizes  $(L_1 \cdot L_2)^*$  by adding only  $\epsilon$  transitions and no new states.
- (Final states are enclosed in double circles).

gate1996 theory-of-computation finite-automata normal

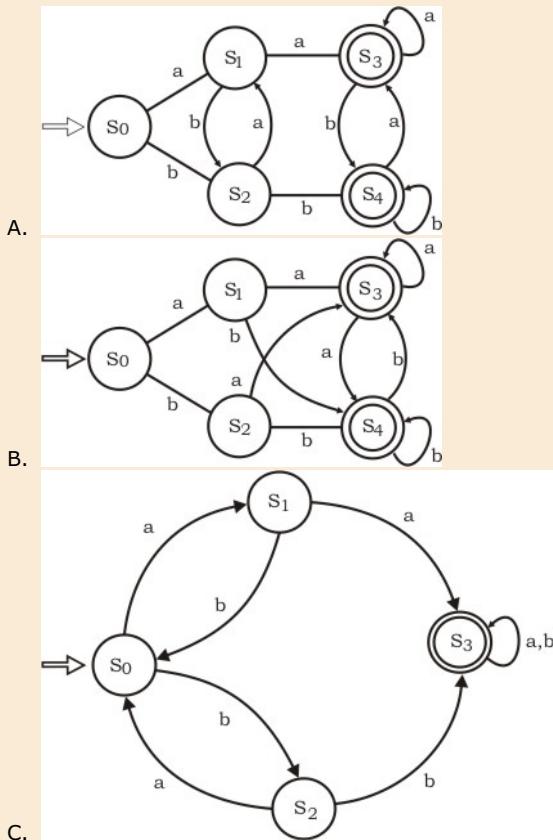
Answer

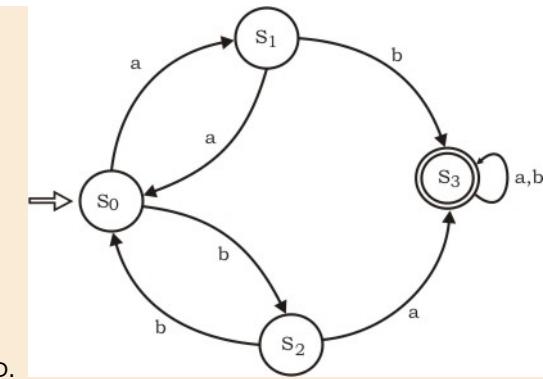
### 19.6.9 Finite Automata: GATE2007-IT-72 [top](#)

<http://gateoverflow.in/3524>

Consider the regular expression  $R = (a + b)^* (aa + bb) (a + b)^*$

Which deterministic finite automaton accepts the language represented by the regular expression R?



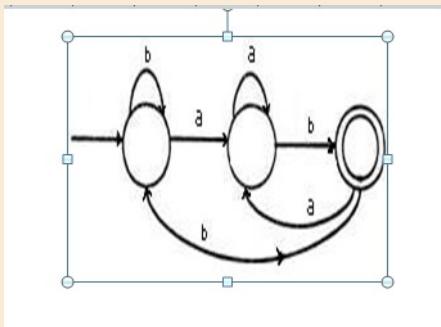

[gate2007-it](#) [theory-of-computation](#) [finite-automata](#) [normal](#)

Answer

### 19.6.10 Finite Automata: GATE2008-IT\_32 [top](#)

<http://gateoverflow.in/3342>

If the final states and non-final states in the DFA below are interchanged, then which of the following languages over the alphabet {a, b} will be accepted by the new DFA?



- A) Set of all strings that do not end with ab
- B) Set of all strings that begin with either an a or a b
- C) Set of all strings that do not contain the substring ab,
- D) The set described by the regular expression  $b^*aa^*(ba)^*b^*$

[gate2008-it](#) [theory-of-computation](#) [finite-automata](#) [normal](#)

Answer

### 19.6.11 Finite Automata: GATE2015-3\_18 [top](#)

<http://gateoverflow.in/8415>

Let L be the language represented by the regular expression  $\Sigma^*0011\Sigma^*$  where  $\Sigma = \{0, 1\}$ . What is the minimum number of states in a DFA that recognizes  $\bar{L}$  (complement of L)?

- A. 4
- B. 5
- C. 6
- D. 8

[gate2015-3](#) [theory-of-computation](#) [finite-automata](#) [normal](#)

Answer

### 19.6.12 Finite Automata: GATE2015-1\_52 [top](#)

<http://gateoverflow.in/8362>



Consider the DFAs M and N given above. The number of states in a minimal DFA that accept the language  $L(M) \cap L(N)$  is \_\_\_\_\_.

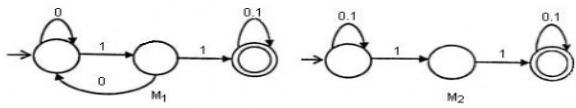
gate2015-1 theory-of-computation finite-automata easy

**Answer**

### 19.6.13 Finite Automata: GATE2008-IT\_36 [top](#)

<http://gateoverflow.in/3346>

Consider the following two finite automata.  $M_1$  accepts  $L_1$  and  $M_2$  accepts  $L_2$ . Which one of the following is TRUE?



(Ctrl) ▾

- A)  $L_1 = L_2$
- B)  $L_1 \subset L_2$
- C)  $L_1 \cap L_2' = \emptyset$
- D)  $L_1 \cup L_2 \neq L_1$

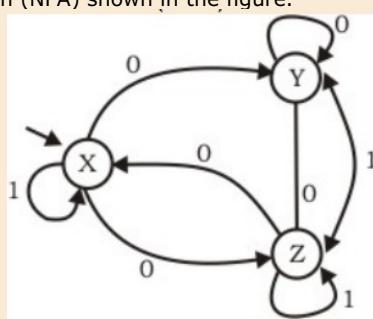
gate2008-it theory-of-computation finite-automata normal

**Answer**

### 19.6.14 Finite Automata: GATE2005-IT\_37 [top](#)

<http://gateoverflow.in/3784>

Consider the non-deterministic finite automaton (NFA) shown in the figure.



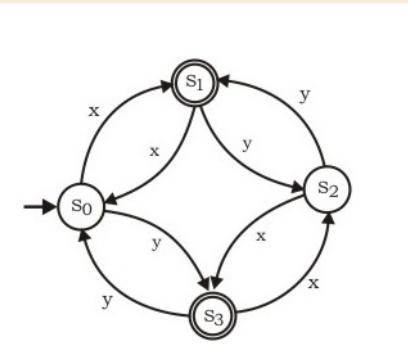
State X is the starting state of the automaton. Let the language accepted by the NFA with Y as the only accepting state be  $L_1$ . Similarly, let the language accepted by the NFA with Z as the only accepting state be  $L_2$ . Which of the following statements about  $L_1$  and  $L_2$  is TRUE?

- A)  $L_1 = L_2$
- B)  $L_1 \subset L_2$
- C)  $L_2 \subset L_1$
- D) None of the above

Answer

**19.6.15 Finite Automata: GATE2007-IT-47** [top](#)<http://gateoverflow.in/3489>

Consider the following DFA in which  $s_0$  is the start state and  $s_1, s_3$  are the final states.



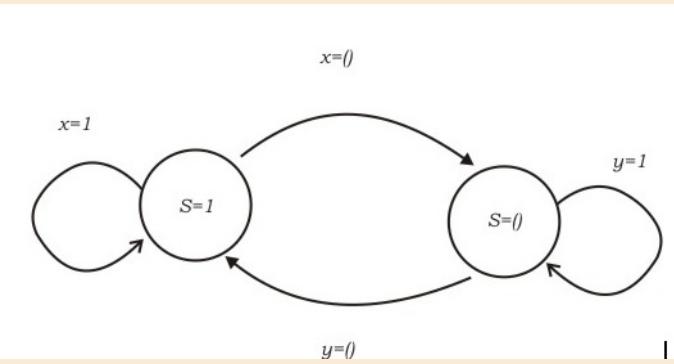
What language does this DFA recognize?

- A. All strings of  $x$  and  $y$
- B. All strings of  $x$  and  $y$  which have either even number of  $x$  and even number of  $y$  or odd number of  $x$  and odd number of  $y$
- C. All strings of  $x$  and  $y$  which have equal number of  $x$  and  $y$
- D. All strings of  $x$  and  $y$  with either even number of  $x$  and odd number of  $y$  or odd number of  $x$  and even number of  $y$

Answer

**19.6.16 Finite Automata: GATE2006-IT\_37** [top](#)<http://gateoverflow.in/3576>

For a state machine with the following state diagram the expression for the next state  $S^+$  in terms of the current state  $S$  and the input variables  $x$  and  $y$  is

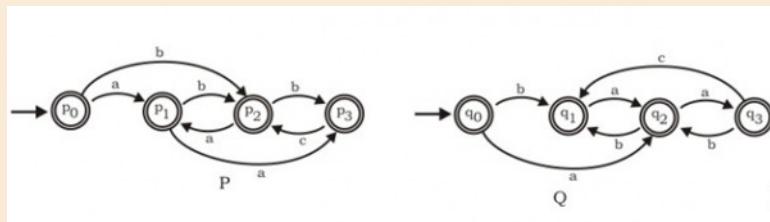


- A)  $S^+ = S' \cdot y' + S \cdot x$
- B)  $S^+ = S \cdot x \cdot y' + S' \cdot y \cdot x'$
- C)  $S^+ = x \cdot y'$
- D)  $S^+ = S' \cdot y + S \cdot x'$

Answer

**19.6.17 Finite Automata: GATE2007-IT\_50** [top](#)<http://gateoverflow.in/3492>

Consider the following finite automata P and Q over the alphabet  $\{a, b, c\}$ . The start states are indicated by a double arrow and final states are indicated by a double circle. Let the languages recognized by them be denoted by  $L(P)$  and  $L(Q)$  respectively.



The automation which recognizes the language  $L(P) \cap L(Q)$  is :

- A)
- B)
- C)
- D)

[gate2007-it](#) [theory-of-computation](#) [finite-automata](#) [normal](#)

Answer

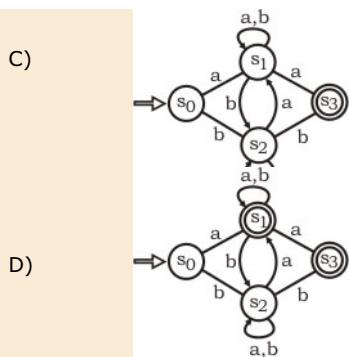
### 19.6.18 Finite Automata: GATE2007-IT\_71 [top](#)

<http://gateoverflow.in/3523>

Consider the regular expression  $R = (a + b)^* (aa + bb) (a + b)^*$

Which of the following non-deterministic finite automata recognizes the language defined by the regular expression R? Edges labeled  $\lambda$  denote transitions on the empty string.

- A)
- B)



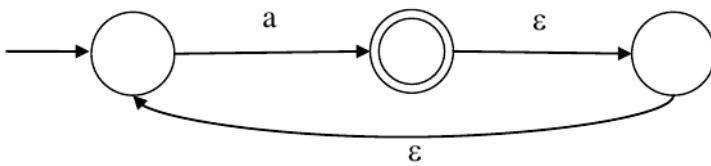
gate2007-it theory-of-computation finite-automata normal

Answer

### 19.6.19 Finite Automata: GATE2012\_12 top

<http://gateoverflow.in/44>

What is the complement of the language accepted by the NFA shown below?  
Assume  $\Sigma = \{a\}$  and  $\epsilon$  is the empty string.



- (A)  $\phi$
- (B)  $\{\epsilon\}$
- (C)  $a^*$
- (D)  $\{a, \epsilon\}$

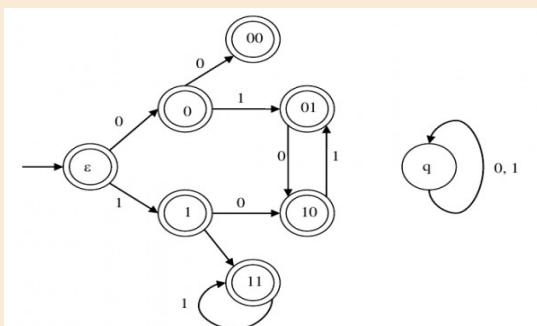
gate2012 finite-automata easy theory-of-computation

Answer

### 19.6.20 Finite Automata: GATE2012\_46 top

<http://gateoverflow.in/2159>

Consider the set of strings on  $\{0, 1\}$  in which, every substring of 3 symbols has at most two zeros. For example, 001110 and 011001 are in the language, but 100010 is not. All strings of length less than 3 are also in the language. A partially completed DFA that accepts this language is shown below.



The missing arcs in the DFA are

(A)

|    | <b>00</b> | <b>01</b> | <b>10</b> | <b>11</b> | <b>q</b> |
|----|-----------|-----------|-----------|-----------|----------|
| 00 | 1         | 0         |           |           |          |
| 01 |           |           |           | 1         |          |
| 10 | 0         |           |           |           |          |
| 11 |           |           | 0         |           |          |

(B)

|    | <b>00</b> | <b>01</b> | <b>10</b> | <b>11</b> | <b>q</b> |
|----|-----------|-----------|-----------|-----------|----------|
| 00 |           | 0         |           |           | 1        |
| 01 |           | 1         |           |           |          |
| 10 |           |           |           | 0         |          |
| 11 |           | 0         |           |           |          |

(C)

|    | <b>00</b> | <b>01</b> | <b>10</b> | <b>11</b> | <b>q</b> |
|----|-----------|-----------|-----------|-----------|----------|
| 00 |           | 1         |           |           | 0        |
| 01 |           | 1         |           |           |          |
| 10 |           |           | 0         |           |          |
| 11 |           | 0         |           |           |          |

(D)

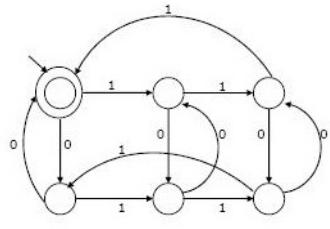
|    | <b>00</b> | <b>01</b> | <b>10</b> | <b>11</b> | <b>q</b> |
|----|-----------|-----------|-----------|-----------|----------|
| 00 |           | 1         |           |           | 0        |
| 01 |           |           |           | 1         |          |
| 10 | 0         |           |           |           |          |
| 11 |           |           | 0         |           |          |

gate2012 theory-of-computation finite-automata normal

Answer

**19.6.21 Finite Automata: GATE2004\_86** top<http://gateoverflow.in/1080>

The following finite state machine accepts all those binary strings in which the number of 1's and 0's are respectively



- A. divisible by 3 and 2
- B. odd and even
- C. even and odd
- D. divisible by 2 and 3

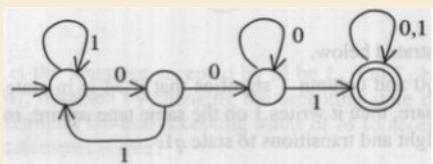
gate2004 theory-of-computation finite-automata easy

[Answer](#)

### 19.6.22 Finite Automata: GATE2003\_50 [top](#)

<http://gateoverflow.in/939>

Consider the following deterministic finite state automaton M.



Let S denote the set of seven bit binary strings in which the first, the fourth, and the last bits are 1. The number of strings in S that are accepted by M is

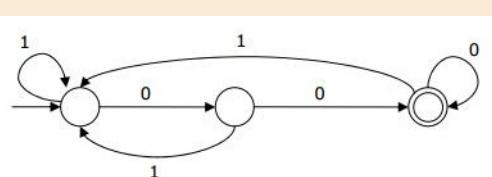
- A. 1
- B. 5
- C. 7
- D. 8

gate2003 theory-of-computation finite-automata normal

[Answer](#)

### 19.6.23 Finite Automata: GATE2009-41 [top](#)

<http://gateoverflow.in/1327>



The above DFA accepts the set of all strings over  $\{0,1\}$  that

- A. begin either with 0 or 1.
- B. end with 0.
- C. end with 00.

- D. contain the substring 00.

gate2009 theory-of-computation finite-automata easy

[Answer](#)

### 19.6.24 Finite Automata: GATE2009-27 [top](#)

<http://gateoverflow.in/1313>

Given the following state table of an FSM with two states A and B, one input and one output.

| PRESENT STATE A | PRESENT STATE B | Input | Next State A | Next State B | Output |
|-----------------|-----------------|-------|--------------|--------------|--------|
| 0               | 0               | 0     | 0            | 0            | 1      |
| 0               | 1               | 0     | 1            | 0            | 0      |
| 1               | 0               | 0     | 0            | 1            | 0      |
| 1               | 1               | 0     | 1            | 0            | 0      |
| 0               | 0               | 1     | 0            | 1            | 0      |
| 0               | 1               | 1     | 0            | 0            | 1      |
| 1               | 0               | 1     | 0            | 1            | 1      |
| 1               | 1               | 1     | 0            | 0            | 1      |

If the initial state is A=0, B=0 what is the minimum length of an input string which will take the machine to the state A=0, B=1 with output=1.

- A. 3
- B. 4
- C. 5
- D. 6

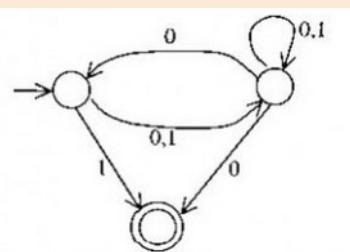
gate2009 theory-of-computation finite-automata normal

[Answer](#)

### 19.6.25 Finite Automata: GATE2003\_55 [top](#)

<http://gateoverflow.in/943>

Consider the NFA M shown below.



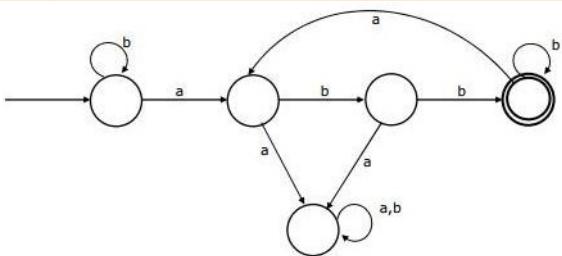
Let the language accepted by M be  $L$ . Let  $L_1$  be the language accepted by the NFA  $M_1$  obtained by changing the accepting state of M to a non-accepting state and by changing the non-accepting states of M to accepting states. Which of the following statements is true?

- A.  $L_1 = \{0,1\}^* - L$
- B.  $L_1 = \{0,1\}^*$
- C.  $L_1 \subseteq L$
- D.  $L_1 = L$

gate2003 theory-of-computation finite-automata normal

**Answer****19.6.26 Finite Automata: GATE2005\_53** [top](#)<http://gateoverflow.in/1376>

Consider the machine M:



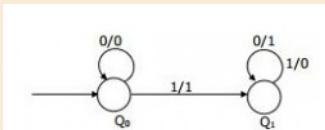
The language recognized by M is:

- A.  $\{w \in \{a,b\}^* \mid \text{every } a \text{ in } w \text{ is followed by exactly two } b's\}$
- B.  $\{w \in \{a,b\}^* \mid \text{every } a \text{ in } w \text{ is followed by at least two } b's\}$
- C.  $\{w \in \{a,b\}^* \mid w \text{ contains the substring 'abb'}\}$
- D.  $\{w \in \{a,b\}^* \mid w \text{ does not contain 'aa' as a substring}\}$

[gate2005](#) [theory-of-computation](#) [finite-automata](#) [normal](#)

**Answer****19.6.27 Finite Automata: GATE2005\_63** [top](#)<http://gateoverflow.in/1386>

The following diagram represents a finite state machine which takes as input a binary number from the least significant bit.



Which of the following is TRUE?

- A. It computes 1's complement of the input number
- B. It computes 2's complement of the input number
- C. It increments the input number
- D. it decrements the input number

[gate2005](#) [theory-of-computation](#) [finite-automata](#) [easy](#)

**Answer****19.6.28 Finite Automata: GATE1998\_1.10** [top](#)<http://gateoverflow.in/1647>

Which of the following set can be recognized by a Deterministic Finite state Automaton?

- A. The numbers  $1, 2, 4, 8, \dots, 2^n, \dots$  written in binary

- B. The numbers  $1, 2, 4, 8, \dots, 2^n, \dots$  written in unary  
 C. The set of binary strings in which the number of zeros is the same as the number of ones.  
 D. The set  $\{1, 101, 11011, 1110111, \dots\}$

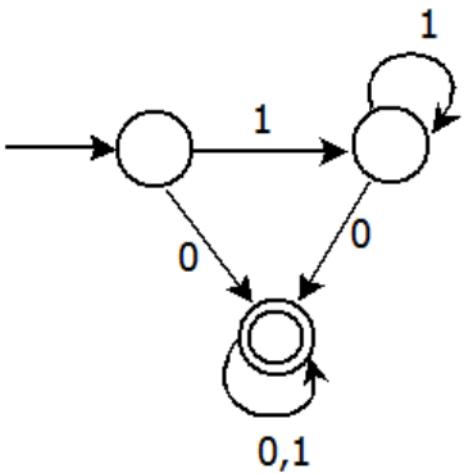
[gate1998](#) [theory-of-computation](#) [finite-automata](#) [normal](#)

Answer

### 19.6.29 Finite Automata: GATE2013\_33 [top](#)

<http://gateoverflow.in/1544>

Consider the DFA A given below.



Which of the following are **FALSE**?

1. Complement of  $L(A)$  is context-free.
  2.  $L(A) = L((11^*0 + 0)(0 + 1)^*0^*1^*)$
  3. For the language accepted by A, A is the minimal DFA.
  4. A accepts all strings over  $\{0, 1\}$  of length at least 2.
- (A) 1 and 3 only  
 (B) 2 and 4 only  
 (C) 2 and 3 only  
 (D) 3 and 4 only

[gate2013](#) [theory-of-computation](#) [finite-automata](#) [normal](#)

Answer

### 19.6.30 Finite Automata: GATE2008-49 [top](#)

<http://gateoverflow.in/462>

Given below are two finite state automata ( → indicates the start state and F indicates a final state)

Y:

|       |   |   |
|-------|---|---|
|       | a | b |
| → 1   | 1 | 2 |
| 2 (F) | 2 | 1 |

Z:

|       |   |   |
|-------|---|---|
|       | a | b |
| → 1   | 2 | 2 |
| 2 (F) | 1 | 1 |

Which of the following represents the product automaton  $Z \times Y$ ?

A.

|                 |   |   |
|-----------------|---|---|
|                 | a | b |
| $\rightarrow P$ | S | R |
| Q               | R | S |
| $R(F)$          | Q | P |
| S               | Q | P |

B.

|                 |   |   |
|-----------------|---|---|
|                 | a | b |
| $\rightarrow P$ | S | Q |
| Q               | R | S |
| $R(F)$          | Q | P |
| S               | P | Q |

C.

|                 |   |   |
|-----------------|---|---|
|                 | a | b |
| $\rightarrow P$ | Q | S |
| Q               | R | S |
| $R(F)$          | Q | P |
| S               | Q | P |

D.

|                 |   |   |
|-----------------|---|---|
|                 | a | b |
| $\rightarrow P$ | S | Q |
| Q               | S | R |
| $R(F)$          | Q | P |
| S               | Q | P |

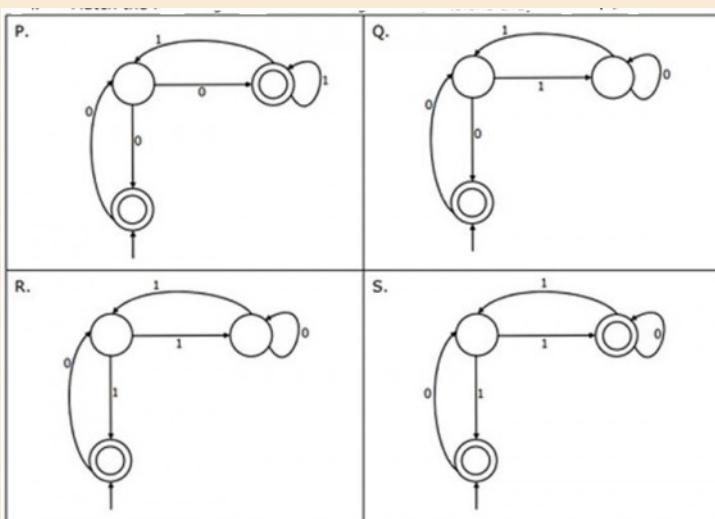
gate2008 normal theory-of-computation finite-automata

Answer

### 19.6.31 Finite Automata: GATE2008-52 [top](#)

<http://gateoverflow.in/464>

Match the following NFAs with the regular expressions they correspond to



1.  $\epsilon + 0(01^*1 + 00)^*01^*$
2.  $\epsilon + 0(10^*1 + 00)^*0$
3.  $\epsilon + 0(10^*1 + 10)^*1$
4.  $\epsilon + 0(10^*1 + 10)^*10^*$

- A. P-2, Q-1, R-3, S-4  
 B. P-1, Q-3, R-2, S-4  
 C. P-1, Q-2, R-3, S-4  
 D. P-3, Q-2, R-1, S-4

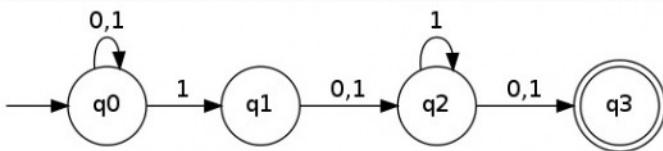
gate2008 | theory-of-computation | finite-automata | normal

**Answer**

### 19.6.32 Finite Automata: GATE2014-1\_16 [top](#)

<http://gateoverflow.in/1782>

Consider the finite automaton in the following figure:



What is the set of reachable states for the input string 0011?

- (A) {  
 $q_0, q_1, q_2$ }  
 (B) {  
 $q_0, q_1$ }  
 (C) {  
 $q_0, q_1, q_2, q_3$ }  
 (D) {  
 $q_3$ }

gate2014-1 | theory-of-computation | finite-automata | easy

**Answer**

## Answers: Finite Automata

### 19.6.1 Finite Automata: GATE1994\_3.3 [top](#)

<http://gateoverflow.in/2480>

No. Perhaps that wont be possible to add any two arbitrary numbers because that will need a memory element which is not there in a FSM.

10 votes

-- Gate Keeda (17.7k points)

### 19.6.2 Finite Automata: GATE1993\_27 [top](#)

<http://gateoverflow.in/2323>

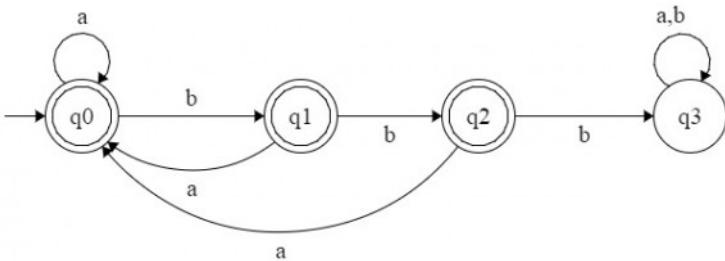


Selected Answer

Design a DFA that accepts all strings contain bbb

regular expression  $(a + b)^*bbb(a + b)^*$

then take complement of DFA such that no string has 3 consecutive occurrences of the letter b.



having regular expression  $(a + ba + bba)^*(\epsilon + b + bb)$

11 votes

-- Praveen Saini (38.4k points)

### 19.6.3 Finite Automata: GATE1997\_21 [top](#)

<http://gateoverflow.in/2281>



Selected Answer

Suppose we have a finite automaton for  $L$ , then we can build a finite automaton for  $L^P$  by marking all the states from which final state is reachable as the final states for new automaton, the reasoning is that suppose we can reach final state  $f$  from some state  $q$ , then that means there exists some string  $s'$  that takes automation from  $q$  to  $f$ , so if there is some string  $s$  that takes automation to state  $q$  from start state this string should belong to the new language  $L^P$ .

Also, we can obtain an automation for  $L^R$  by swapping the start and final states of original automation  $L$  and by reversing all the edges in the DFA.

7 votes

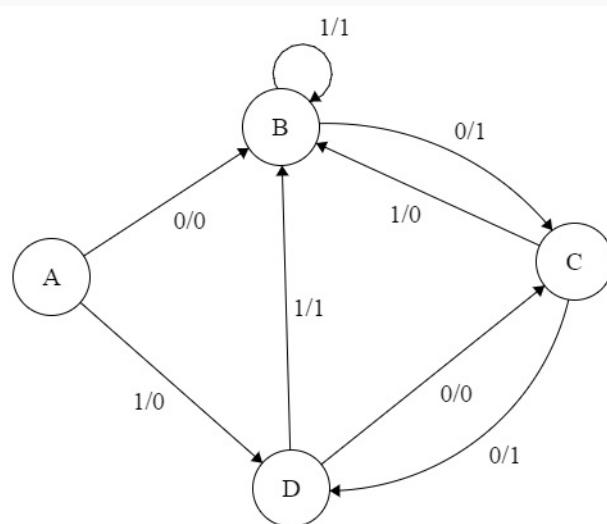
-- Omesh Pandita (2.3k points)

### 19.6.4 Finite Automata: GATE1995\_2.23 [top](#)

<http://gateoverflow.in/2636>



Selected Answer



if A is start state , shortest sequence is 10 or 00 to reach C

if B is start state , shortest sequence is 0 to reach C

if C is start state , shortest sequence is 10 or 00 to reach C

if D is start state , shortest sequence is 0 to reach C

b) is correct.

13 votes

-- Praveen Saini (38.4k points)

### 19.6.5 Finite Automata: GATE2010-41 [top](#)

<http://gateoverflow.in/2342>



Selected Answer

We need a state for counting the length. So, for length n we need n+1 states (one for length zero). We don't need a reject state for larger strings as we have NFA and not DFA. So, totally n+1 states are required. (For DFA it would be n+2).

19 votes

-- Arjun Suresh (150k points)

### 19.6.6 Finite Automata: GATE2006-IT\_3 [top](#)

<http://gateoverflow.in/3542>



Selected Answer

| <b>for u</b>             | <b>for v</b>          | <b>for w</b>           |
|--------------------------|-----------------------|------------------------|
| $\delta(s,abbaba)$       | $\delta(s,bab)$       | $\delta(s,aabb)$       |
| $\vdash \delta(x,bbaba)$ | $\vdash \delta(t,ab)$ | $\vdash \delta(x,abb)$ |
| $\vdash \delta(x,baba)$  | $\vdash \delta(t,b)$  | $\vdash \delta(s,bb)$  |
| $\vdash \delta(x,aba)$   | <b>↓ s - rejected</b> | $\vdash \delta(t,b)$   |
| $\vdash \delta(s,ba)$    |                       | <b>↓ s - rejected</b>  |
| $\vdash \delta(t,a)$     |                       |                        |
| <b>↓ t - accepted</b>    |                       |                        |

10 votes

-- Praveen Saini (38.4k points)

### 19.6.7 Finite Automata: GATE 2016-2-42 [top](#)

<http://gateoverflow.in/39591>



Selected Answer

I , False, as in NFA, it is not necessary that all states have transitions for all symbols.

II True, there exists a regular language  
 $A = \{\}$ , such that for all languages

$B$ ,  
 $A \cap B = \{\}$  is regular

So answer is option B.

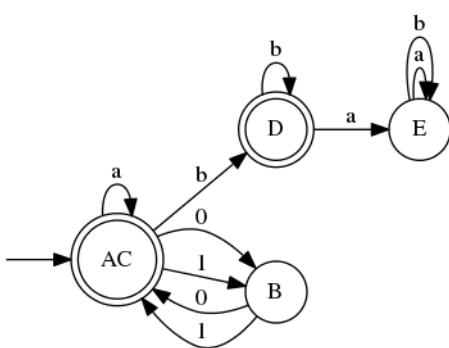
25 votes

-- Praveen Saini (38.4k points)

### 19.6.8 Finite Automata: GATE1996\_12 [top](#)

<http://gateoverflow.in/2764>

We can combine the final state of  $M_1$  with the start state of  $M_2$  as follows recognizing  $L_1L_2$



3 votes

-- Arjun Suresh (150k points)

### 19.6.9 Finite Automata: GATE2007-IT-72 [top](#)

<http://gateoverflow.in/3524>



Selected Answer

DFA given in option A

having S3 and S4 are equivalent states .. that can minimized.

and result in DFA given in

[http://gateoverflow.in/3523/gate2007-it\\_71](http://gateoverflow.in/3523/gate2007-it_71)

9 votes

-- Praveen Saini (38.4k points)

### 19.6.10 Finite Automata: GATE2008-IT\_32 [top](#)

<http://gateoverflow.in/3342>

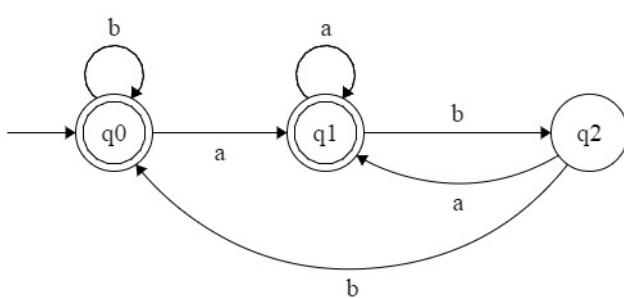


Selected Answer

Above DFA is for regular expression  $(a+b)^*ab$ . All strings end with ab.

Complement of DFA accepts all strings does not end with ab.

DFA( $L'$ ) is



B. String begin with either a or b.

ab (string start with a) doesnt accept in it reach to nonfinal state q2.

bab (string start with b) doesnt accept in it reach to nonfinal state q2.

C. Set of strings that do not contain the substring ab

aba (have substring ab) does accept in it reach to final state q1.

D. The set described by the regular expression  $b^*aa^*(ba)^*b^*$

b is string accepted by DFA( $L'$ ) but above regular expression cannot derive it.

Option A is correct.

DFA ( $L'$ ) accepts all strings that doesn't end with ab.

10 votes

-- Praveen Saini (38.4k points)

### 19.6.11 Finite Automata: GATE2015-3\_18 [top](#)

<http://gateoverflow.in/8415>



Selected Answer

first we can draw dfa for  $L$  which has 5 states after that for  $L$  compliment we will convert all final to non final and all non final to final so total states is 5 .. option B

20 votes

-- Anoop Sonkar (4.5k points)

### 19.6.12 Finite Automata: GATE2015-1\_52 [top](#)

<http://gateoverflow.in/8362>

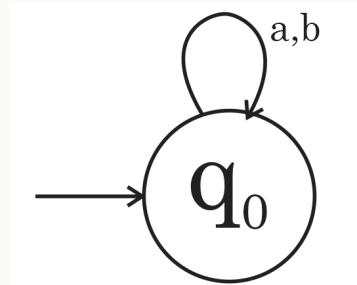


Selected Answer

$$L(M) = (a+b)^* a = \{a, aa, ba, aaa, aba, bba, \dots\}$$

$$L(N) = (a+b)^* b = \{b, ab, bb, aab, abb, bbb, \dots\}$$

So,  $L(M) \cap L(N) = \{\}$ . So, in the minimal DFA, we just have 1 start state with all transitions going to it self and no final state.



29 votes

-- Arjun Suresh (150k points)

### 19.6.13 Finite Automata: GATE2008-IT\_36 [top](#)

<http://gateoverflow.in/3346>



Selected Answer

$$L1: (0 + 10)^* 11(0 + 1)^* L2: (0 + 1)^* 11(0 + 1)^* \text{ it is quite clear that } L1 = L2.. \text{ So, option (A)}$$

13 votes

-- Vicky Bajoria (3.4k points)

### 19.6.14 Finite Automata: GATE2005-IT\_37 [top](#)

<http://gateoverflow.in/3784>



## Selected Answer

In Qs.  $Z \rightarrow Y$  (0 edge)

$L_1$  can have 00 string while  $L_2$  can't.  $L_2$  can have 01 while  $L_1$  can't

So we can conclude neither they are same set not proper subset of each other.

Hence Ans. D.

8 votes

-- shreya ghosh (2.9k points)

### 19.6.15 Finite Automata: GATE2007-IT-47 [top](#)

<http://gateoverflow.in/3489>



## Selected Answer

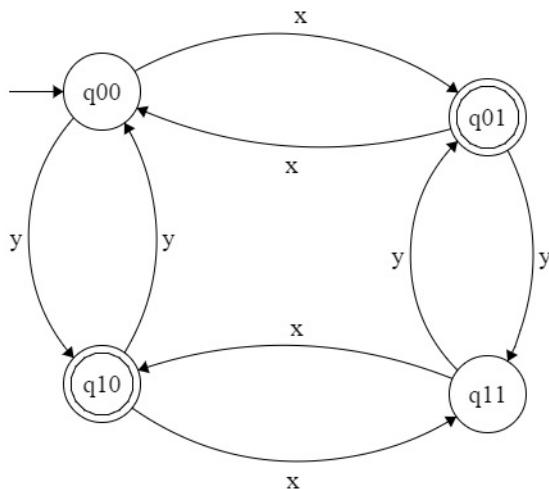
Above DFA can be redesigned as [S0 as q00, S1 as q10 , S2 as q11, S3 as q01 ]

where , each state as  $q_{ab}$  [ $a = n_a \bmod 2$  ,  $b = n_b \bmod 2$ ]

$q00$  as  $n_a \bmod 2 = 0$   $n_b \bmod 2 = 0$  [no of x is even no of y is even ]

and  $\delta(q00, x) \rightarrow q10$  [ $(0+1) \bmod 2 = 1$  as x increase from 0 to 1]  $\delta(q00, y) \rightarrow q01$

and  $\delta(q10, x) \rightarrow q00$  [ $(1+1) \bmod 2 = 0$ ]  $\delta(q00, y) \rightarrow q01$  and soon



$q01$  is final state mean where no of x is even and no of y is odd

$q10$  is final state mean where no of x is odd and no of y is even.

so D is correct answer

9 votes

-- Praveen Saini (38.4k points)

### 19.6.16 Finite Automata: GATE2006-IT\_37 [top](#)

<http://gateoverflow.in/3576>



## Selected Answer

Answer is (A)

For  $S$  is 1 only when: Either ( $s=1$  and  $x=1$ ) OR ( $s=0$  and  $y=0$ )

Therefor  $S(\text{next}) = S'y' + Sx$

6 votes

-- Sandeep\_Uniyal (5.5k points)

### 19.6.17 Finite Automata: GATE2007-IT\_50 [top](#)

<http://gateoverflow.in/3492>



Selected Answer

Design a DFA using P and Q having  $p_0q_0$  as start state

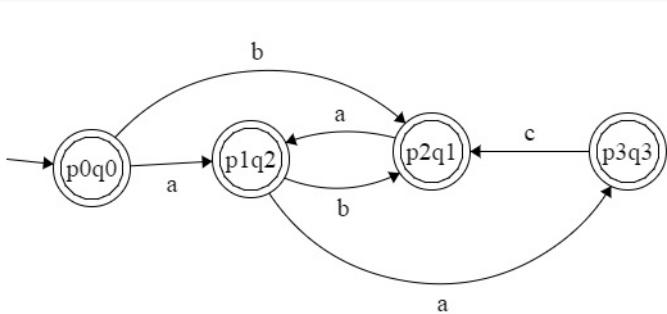
$$\delta(p_0q_0, a) \rightarrow \delta(p_0, a) \cup \delta(q_0, a)$$

| $Q \setminus \Sigma$   | a        | b               | c        |
|------------------------|----------|-----------------|----------|
| $\rightarrow p_0q_0^*$ | $p_1q_2$ | $p_2q_1$        |          |
| $p_1q_2^*$             | $p_3q_3$ | $p_2q_1$        |          |
| $p_2q_1^*$             | $p_1q_2$ | $p_3$ (No Need) |          |
| $p_3q_3^*$             |          | $q_2$ (No Need) | $p_2q_1$ |

**In case of intersection final state are those where final state of P and final state of Q comes together.**

No Need mean when we reach to  $p_3$  (or  $q_2$ ) then we cannot reach to any final state bcoz we cannot have state of P and Q together (intersection) so no need to show it in diagram [may draw a dead state for it if required ]

DFA results in



That is Option A

Note : i) DFA must have transition for each symbol  $Q \times \Sigma \rightarrow Q$

10 votes

-- Praveen Saini (38.4k points)

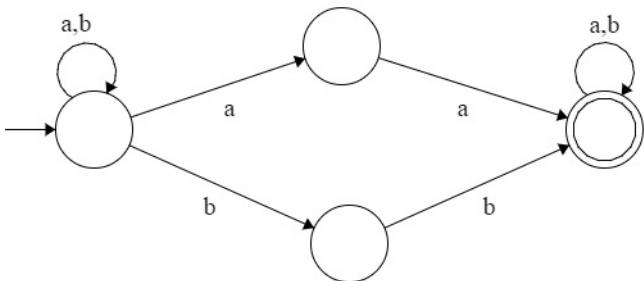
### 19.6.18 Finite Automata: GATE2007-IT\_71 [top](#)

<http://gateoverflow.in/3523>

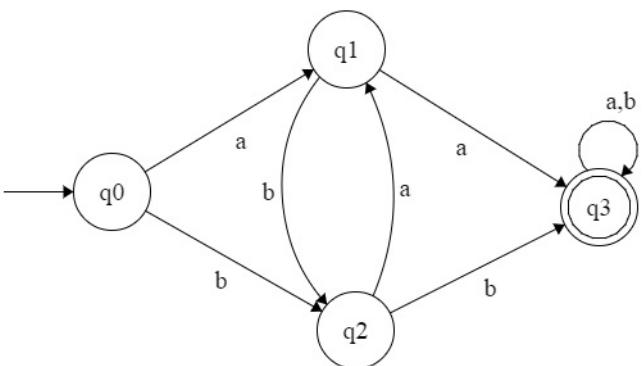


Selected Answer

Design NFA for  $R = (a+b)^*(aa+bb)(a+b)^*$



convert NFA to equivalent DFA



A is correct.

13 votes

-- Praveen Saini (38.4k points)

### 19.6.19 Finite Automata: GATE2012\_12 [top](#)

<http://gateoverflow.in/44>



Selected Answer

The language being accepted is  $a^+$ . So, complement of the language is  $\{\epsilon\}$ .

14 votes

-- Arjun Suresh (150k points)

### 19.6.20 Finite Automata: GATE2012\_46 [top](#)

<http://gateoverflow.in/2159>



Selected Answer

(D) is the answer. From 00 state, a '0' should take the DFA to the dead state-q. From 11, a '0' should go to 00 representing the 00 at the end of string so far. Similarly, from 00 a 1 should go to 01, from 01 a '1' should go to 11 and from 10 a '0' should go to '00'.

6 votes

-- Arjun Suresh (150k points)

**19.6.21 Finite Automata: GATE2004\_86** [top](#)<http://gateoverflow.in/1080>

Selected Answer

Option c and option d are cancelled out clearly because with 3 1s we can reach the final state ...there is a string where we can reach the final state by 6 1's now 6 is not odd but it is divisible by 3 hence option a is correct

6 votes

-- Bhagirathi Nayak (11.3k points)

**19.6.22 Finite Automata: GATE2003\_50** [top](#)<http://gateoverflow.in/939>

Language of above DFA is all strings over {0,1} that contain substring 001.

Regular expression of above DFA is  $(0+1)^*001(0+1)^*$

**1** that is underlined can not be first bit of 7-bit binary no, but can be fourth bit or last bit.

Case 1: if it is 4th bit ,then possible set of strings can be

First 001 two bits Last = **1** 001(00+01+10+11)**1** = 4 strings

Case 2 : if it is last bit, then possible set of strings can be

First two bits fourth 001 = **1**(00+01+10+11) **1** 001 = 4 strings

String common in both cases **1001001**

Total strings = 4 + 4 - 1 = 7 strings

13 votes

-- Praveen Saini (38.4k points)

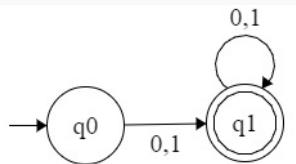
**19.6.23 Finite Automata: GATE2009-41** [top](#)<http://gateoverflow.in/1327>

Selected Answer

A) begin either with 0 or 1

Regular expression  $(0+1)(0+1)^*$

[ begin with 0 or 1 Anything ]



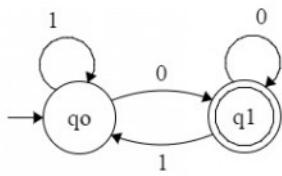
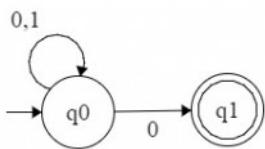
b) end with 0

regular expression =  $(0+1)^*0$

[ Anything end with 0 ]

NFA

Equivalent DFA

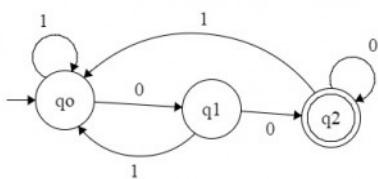
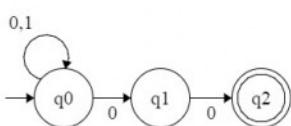


c) end with 00

regular expression  $(0+1)^*00$  [ Anything end with 00 ]

NFA

Equivalent DFA

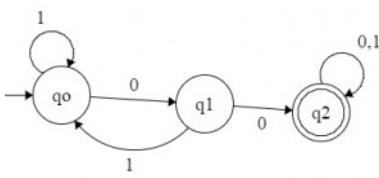
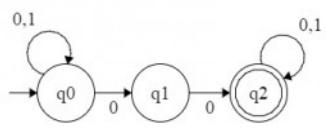


d) containing the substring

regular expression =  $(0+1)^*00(0+1)^*$  [ Anything substring 00 Anything ]

NFA

Equivalent DFA



So C is the correct answer

13 votes

-- Praveen Saini (38.4k points)

## 19.6.24 Finite Automata: GATE2009-27 [top](#)

<http://gateoverflow.in/1313>



Selected Answer

From above table , We look at Next state part

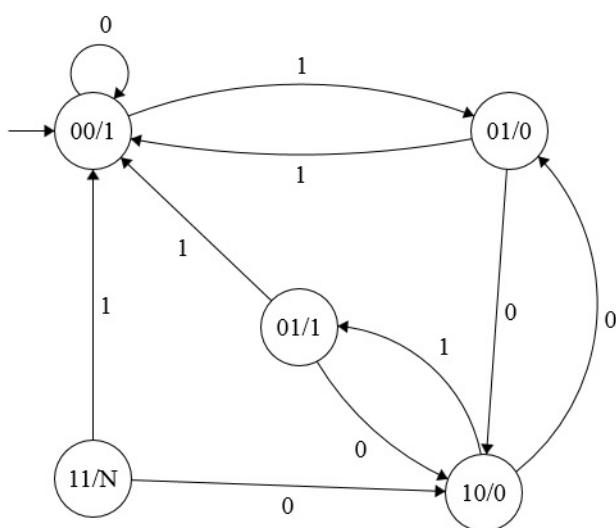
whenever we reach state 00 we get output 1 [at row 1, row 6, row 8], **so we have state 00 with output 1**

when we reach at state 01, we get output 0 [at row 3, row 5] and output 1 [row 7], **so we have two state 01 with output 0, 01 with output 1**

when we reach at state 10, we get output we get output 0 [at row 2, row 4], **so we have state 10 with output 0.**

We dont reach at state 11 [11 is not there in next state part], but **we have state 11 with don't know (N) output.**

if we draw the Moore Machine for above FSM [ from the table: present state x input symbol -> next state ]



It is clear from FSM from state  $00$  to reach state  $01$  with output  $1$  i.e,  $01/1$  with need **minimum length input 101**  
**minimum length of input = length of 101 that is 3**

6 votes

-- Praveen Saini (38.4k points)

### 19.6.25 Finite Automata: GATE2003\_55 [top](#)

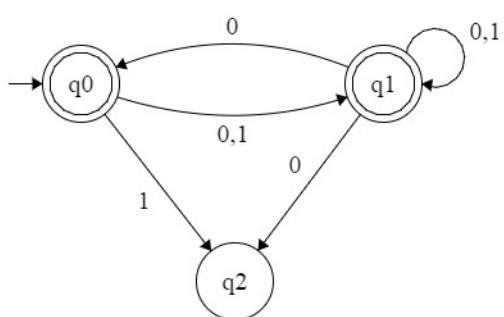
<http://gateoverflow.in/943>



Selected Answer

Answer is B .

As the problem said



as in above NFA language  $L1$  is  $\{0,1\}^*$  . [we don't know  $L$ , we need not to find out]

option A is wrong as  $L$  is accepting 1 and  $L1$  is also accepting 1

option C is wrong as  $L1$  accepting  $^\wedge$ ,null, but  $L$  is not .

Option D is wrong for same reason as option C is wrong.

11 votes

-- Praveen Saini (38.4k points)

### 19.6.26 Finite Automata: GATE2005\_53 [top](#)

<http://gateoverflow.in/1376>

A is Wrong, since abbb is accepted. (1 a is followed by more than 2 bs)

C is Wrong, since abba contains abb as substring, but is still not accepted.

D is Wrong, since ab does not contain aa as substring, but is still not accepted.

Hence correct answer is B.

10 votes

-- saurabhrk (1.3k points)

### 19.6.27 Finite Automata: GATE2005\_63 [top](#)

<http://gateoverflow.in/1386>



Selected Answer

answer = **option B**

for any binary no, FSM read input from LSB and remain unchanged till first 1, and it complement after that

100 -> 100 [1's complement of 100 + 1 = 011 + 1 = 100 = 2's complement of 100]

010 -> 110 [1's complement of 010 + 1 = 101 + 1 = 110 = 2's complement of 010]

1010100 -> 0101100 [ 1's complement of 1010100 + 1 = 0101011 + 1 = 0101100 ]

Note : Underline part is unchanged (till first 1 from lsb) then 0's changed to 1's and 1's changed to 0's

9 votes

-- Praveen Saini (38.4k points)

### 19.6.28 Finite Automata: GATE1998\_1.10 [top](#)

<http://gateoverflow.in/1647>



Selected Answer

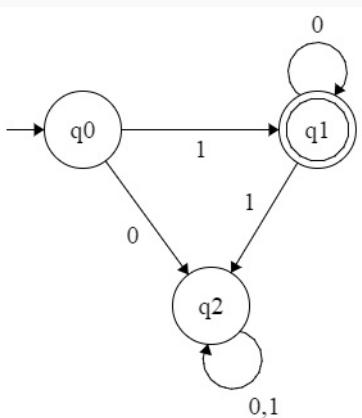
Option A is correct

A. is regular

$L = \{1, 10, 100, 1000, 10000, \dots\}$

regular expression  $10^*$

DFA :



B .  $L = \{1, 11, 1111, 11111111, \dots\} = \{1^i \mid i = 2^n, n \geq 0\}$  is non regular language

C. Equal- Equal, is CFL, and non regular

D,  $L = \{1^i 0 1^i \mid i > 0\} \cup \{1\}$  is also CFL, and non regular

11 votes

-- Praveen Saini (38.4k points)

### 19.6.29 Finite Automata: GATE2013\_33 [top](#)

<http://gateoverflow.in/1544>

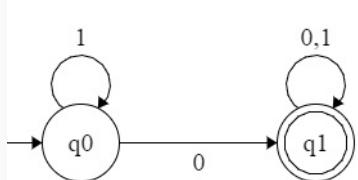


Selected Answer

1. Complement of  $L(A)$  (regular language) is regular , i.e also Context Free . True

2. Regular expression is  $(11*0 + 0)(0+1)^*$  True

3 . Minimized DFA is [both non-final states are equivalents can be minimized]



So 3 is False

4. From 3, shortest length string reached from  $q_0$  to  $q_1$ (final) is 0, so 4 is false

Note : a)  $(0+1)^*0^*1^* = (0+1)^* + \text{something} = (0+1)^*$

b)  $(11^*0+0)(0+1)^* = (11^* + 0)(0+1)^* = 1^*0(0+1)^*$  look at Minimized DFA at 3.

15 votes

-- Praveen Saini (38.4k points)

### 19.6.30 Finite Automata: GATE2008-49 [top](#)

<http://gateoverflow.in/462>



Selected Answer

|            | a  | b  |
|------------|----|----|
| →11 (P)    | 12 | 22 |
| 12 (S)     | 11 | 21 |
| 21 (Q)     | 22 | 12 |
| 22 (F) (R) | 21 | 11 |

So, 11 is P and 22 is R in choice. So, the answer should be (A) but in the row for S, it should be P and Q and not Q and P.

11 votes

-- Arjun Suresh (150k points)

**19.6.31 Finite Automata: GATE2008-52** [top](#)<http://gateoverflow.in/464>

Selected Answer

$S - 4$  is confirmed

$R - 3$  is true coz everything it accepts ends with 1; this is made mandatory only by 3  
this rules out option B and option D

use string 01010 and compare P Vs Q; this makes  $Q - 2$  as confirmed.

hence, **option C** is correct.

4 votes

-- Amar Vashishth (20.7k points)

Correct Ans is (C)

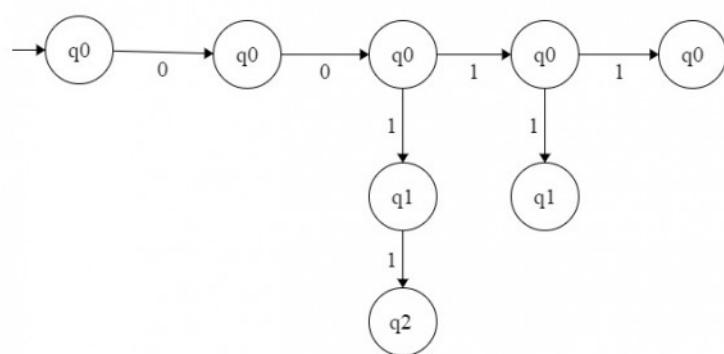
Trace the given regular expressions with the diagrams

4 votes

-- Keith Kr (6k points)

**19.6.32 Finite Automata: GATE2014-1\_16** [top](#)<http://gateoverflow.in/1782>

Selected Answer



$q_0, q_1$  and  $q_2$  are reachable from  $q_0$  on input 0011

9 votes

-- Praveen Saini (38.4k points)

**19.7****Identify Class Language** [top](#)**19.7.1 Identify Class Language: TIFR2012-B-18** [top](#)<http://gateoverflow.in/25216>

Let  $a^i$  denote a sequence  $a.a\dots a$  with  $i$  letters and let  $\mathbb{N}$  be the set of natural numbers  $1, 2, \dots$ . Let  $L_1 = \{a^i b^{2i} \mid i \in \mathbb{N}\}$  and  $L_2 = \{a^i b^{i^2} \mid i \in \mathbb{N}\}$  be two languages. Which of the following is correct?

- Both  $L_1$  and  $L_2$  are context-free languages.
- $L_1$  is context-free and  $L_2$  is recursive but not context-free.
- Both  $L_1$  and  $L_2$  are recursive but not context-free.
- $L_1$  is regular and  $L_2$  is context-free.
- Complement of  $L_2$  is context-free.

[tifr2012](#)
[theory-of-computation](#)
[identify-class-language](#)
**Answer**

### 19.7.2 Identify Class Language: GATE2013\_32 [top](#)

<http://gateoverflow.in/1543>

Consider the following languages.

$$L_1 = \{0^p 1^q 0^r \mid p, q, r \geq 0\}$$

$$L_2 = \{0^p 1^q 0^r \mid p, q, r \geq 0, p \neq r\}$$

Which one of the following statements is **FALSE**?

- (A)  $L_2$  is context-free.
- (B)  $L_1 \cap L_2$  is context-free.
- (C) Complement of  $L_2$  is recursive.
- (D) Complement of  $L_1$  is context-free but not regular.

[gate2013](#)
[theory-of-computation](#)
[identify-class-language](#)
[normal](#)
**Answer**

### 19.7.3 Identify Class Language: GATE1994\_19 [top](#)

<http://gateoverflow.in/2515>

(a) Given a set

$$S = \{x \mid \text{there is an } x\text{-block of 5's in the decimal expansion of } \pi\}$$

(Note:  $x$ -block is a maximal block of  $x$  successive 5's)

Which of the following statements is true with respect to  $S$ ? No reason to be given for the answer.

- i.  $S$  is regular
- ii.  $S$  is recursively enumerable
- iii.  $S$  is not recursively enumerable
- iv.  $S$  is recursive

(b) Given that a language  $L_1$  is regular and that the language  $L_1 \cup L_2$  is regular, is the language  $L_2$  always regular? Prove your answer.

[gate1994](#)
[theory-of-computation](#)
[identify-class-language](#)
[normal](#)
**Answer**

### 19.7.4 Identify Class Language: GATE2010-40 [top](#)

<http://gateoverflow.in/2341>

Consider the languages

$$L_1 = \{0^i 1^j \mid i \neq j\},$$

$$L_2 = \{0^i 1^j \mid i = j\},$$

$$L_3 = \{0^i 1^j \mid i = 2j + 1\},$$

$$L_4 = \{0^i 1^j \mid i \neq 2j\}$$

- A. Only  $L_2$  is context free.
- B. Only  $L_2$  and  $L_3$  are context free.
- C. Only  $L_1$  and  $L_2$  are context free.
- D. All are context free

[gate2010](#)
[theory-of-computation](#)
[context-free](#)
[identify-class-language](#)
[normal](#)
**Answer**

### 19.7.5 Identify Class Language: TIFR2010-B-22 [top](#)

<http://gateoverflow.in/18622>

Let  $L$  consist of all binary strings beginning with a 1 such that its value when converted to decimal is divisible by 5. Which of the following is true?

- a.  $L$  can be recognized by a deterministic finite state automaton.
- b.  $L$  can be recognized by a non-deterministic finite state automaton but not by a deterministic finite state automaton.
- c.  $L$  can be recognized by a deterministic push-down automaton but not by a non-deterministic finite state automaton.
- d.  $L$  can be recognized by a non-deterministic push-down automaton but not by a deterministic push-down automaton.
- e.  $L$  cannot be recognized by any push-down automaton.

[tifr2010](#) [theory-of-computation](#) [identify-class-language](#)

[Answer](#)

### 19.7.6 Identify Class Language: TIFR2010-B-35 [top](#)

<http://gateoverflow.in/19247>

Consider the following languages over the alphabet  $\{0, 1\}$ .

$$L_1 = \{x \cdot x^R \mid x \in \{0, 1\}^*\}$$

$$L_2 = \{x \cdot x \mid x \in \{0, 1\}^*\}$$

Where  $x^R$  is the reverse of string  $x$ ; e.g.  $011^R = 110$ . Which of the following is true?

- a. Both  $L_1$  and  $L_2$  are regular.
- b.  $L_1$  is context-free but not regular whereas  $L_2$  is regular.
- c. Both  $L_1$  and  $L_2$  are context free and neither is regular.
- d.  $L_1$  is context free but  $L_2$  is not context free.
- e. Both  $L_1$  and  $L_2$  are not context free.

[tifr2010](#) [theory-of-computation](#) [identify-class-language](#)

[Answer](#)

### 19.7.7 Identify Class Language: TIFR2014-B-13 [top](#)

<http://gateoverflow.in/2730>

Let  $L$  be a given context-free language over the alphabet  $\{a, b\}$ . Construct  $L_1, L_2$  as follows. Let  $L_1 = L - \{xyx \mid x, y \in \{a, b\}^*\}$ , and  $L_2 = L \cdot L$ . Then,

- a. Both  $L_1$  and  $L_2$  are regular.
- b. Both  $L_1$  and  $L_2$  are context free but not necessarily regular.
- c.  $L_1$  is regular and  $L_2$  is context free.
- d.  $L_1$  and  $L_2$  both may not be context free.
- e.  $L_1$  is regular but  $L_2$  may not be context free.

[tifr2014](#) [theory-of-computation](#) [identify-class-language](#)

[Answer](#)

### 19.7.8 Identify Class Language: GATE2005\_55 [top](#)

<http://gateoverflow.in/1378>

Consider the languages:

$$L_1 = \{a^n b^n c^m \mid n, m > 0\} \text{ and } L_2 = \{a^n b^m c^n \mid n, m > 0\}$$

Which one of the following statements is FALSE?

- A.  $L_1 \cap L_2$  is a context-free language
- B.  $L_1 \cup L_2$  is a context-free language
- C.  $L_1$  and  $L_2$  are context-free languages
- D.  $L_1 \cap L_2$  is a context sensitive language

[gate2005](#) [theory-of-computation](#) [identify-class-language](#) [normal](#)
**Answer**

### 19.7.9 Identify Class Language: TIFR2015-B-8 [top](#)

<http://gateoverflow.in/29865>

Let  $\Sigma_1 = \{a\}$  be a one letter alphabet and  $\Sigma_2 = \{a, b\}$  be a two letter alphabet. A language over an alphabet is a set of finite length words comprising letters of the alphabet. Let  $L_1$  and  $L_2$  be the set of languages over  $\Sigma_1$  and  $\Sigma_2$  respectively. Which of the following is true about  $L_1$  and  $L_2$ :

- a. Both are finite.
- b. Both are countably infinite.
- c.  $L_1$  is countable but  $L_2$  is not.
- d.  $L_2$  is countable but  $L_1$  is not.
- e. Neither of them is countable.

[tifr2015](#) [identify-class-language](#)
**Answer**

### 19.7.10 Identify Class Language: GATE1999\_2.4 [top](#)

<http://gateoverflow.in/1482>

*Multiple choices may be correct:*

If  $L_1$  is context free language and  $L_2$  is a regular language which of the following is/are false?

- A.  $L_1 - L_2$  is not context free
- B.  $L_1 \cap L_2$  is context free
- C.  $\sim L_1$  is context free
- D.  $\sim L_2$  is regular

[gate1999](#) [theory-of-computation](#) [identify-class-language](#) [normal](#)
**Answer**

### 19.7.11 Identify Class Language: GATE2011\_26 [top](#)

<http://gateoverflow.in/2128>

Consider the languages  $L_1$ ,  $L_2$  and  $L_3$  as given below.

$L_1 = \{0^p 1^q \mid p, q \in N\}$ ,  $L_2 = \{0^p 1^q \mid p, q \in N \text{ and } p = q\}$  and  $L_3 = \{0^p 1^q 0^r \mid p, q, r \in N \text{ and } p = q = r\}$ .

Which of the following statements is **NOT TRUE**?

- (A) Push Down Automata (PDA) can be used to recognize  $L_1$  and  $L_2$
- (B)  $L_1$  is a regular language
- (C) All the three languages are context free
- (D) Turing machines can be used to recognize all the languages

[gate2011](#) [theory-of-computation](#) [identify-class-language](#) [normal](#)
**Answer**

### 19.7.12 Identify Class Language: GATE2014-3\_36 [top](#)

<http://gateoverflow.in/2070>

Consider the following languages over the alphabet  $\Sigma = \{0, 1, c\}$

$$L_1 = \{0^n 1^n \mid n \geq 0\}$$

$$L_2 = \{wcw^r \mid w \in \{0,1\}^*\}$$

$$L_3 = \{ww^r \mid w \in \{0,1\}^*\}$$

Here,  $w^r$  is the reverse of the string  $w$ . Which of these languages are deterministic Context-free languages?

(A) None of the languages

(B) Only  
 $L_1$

(C) Only  
 $L_1$  and  
 $L_2$

(D) All the three languages

[gate2014-3](#) [theory-of-computation](#) [identify-class-language](#) [context-free](#) [normal](#)

[Answer](#)

## Answers: Identify Class Language

### 19.7.1 Identify Class Language: TIFR2012-B-18 [top](#)

<http://gateoverflow.in/25216>



Selected Answer

L1 - CFL, S-> aSbb|abb

L2 - Not CFL ,we can't count  $i^2$  using CFL.

- a) False because L2 is not CFL.
- B) True. L2 is recursive
- C) False because L1 is CFL.
- D) False, L1 not regular.

E) False, as complement of L1 is also not context free. It still need to computer  $i^2$  for checking for inequality.

Answer :- B

4 votes

-- Akash (31.7k points)

### 19.7.2 Identify Class Language: GATE2013\_32 [top](#)

<http://gateoverflow.in/1543>



Selected Answer

L1 is regular and hence context-free also. Regular expression for L1 is  $0^*1^*0^*$ . So, (D) is the false choice.

L2 is context-free but not regular. We need a stack to count if the number of 0's before and after the 1 (1 may be absent also) are not same. So,  $L_1 \cap L_2$  is context-free as regular  $\cap$  context-free is context-free.  $\Rightarrow$  (B) is true.

Complement of L2 is recursive as context-free complement is always recursive (actually even context-sensitive).

12 votes

-- Arjun Suresh (150k points)

### 19.7.3 Identify Class Language: GATE1994\_19 [top](#)

<http://gateoverflow.in/2515>

(b) No. need not be. Take  $L_2 = \{a^n b^n \mid n > 0\}$  and  $L_1 = \text{all strings over } \{a, b\}$ . Now,  $L_1 \cup L_2$  is  $L_1$  only and is regular but  $L_2$  is not regular.

4 votes

-- Arjun Suresh (150k points)

#### 19.7.4 Identify Class Language: GATE2010-40 [top](#)

<http://gateoverflow.in/2341>



Selected Answer

All are context free.

$L_1 \rightarrow$  Push 0 on stack and when 1 comes, start popping. If stack becomes empty and 1's are remaining start pushing 1. At end of string accept if stack is non- empty.

$L_2 \rightarrow$  Do the same as for  $L_1$ , but accept if stack is empty at end of string.

$L_3 \rightarrow$  Do, the same as for  $L_2$ , but for each 0, push two 0's on stack and start the stack with a 0.

$L_4 \rightarrow$  Do the same as for  $L_1$ , but for each 0, push two 0's on stack

All are in fact DCFL. Pushing two 0's on stack might sound non-trivial but we can do this by pushing one symbol and going to a new state. Then on this new state on empty symbol, push one more symbol on stack and come back.

13 votes

-- Arjun Suresh (150k points)

#### 19.7.5 Identify Class Language: TIFR2010-B-22 [top](#)

<http://gateoverflow.in/18622>



Selected Answer

I can be recognized by a dfa. we have a dfa to accept all such strings which when interpreted as decimal number are divisible by n. where n can be anything the dfa of such can be made by a trick.

states are equal to possible remainders

|       |       |       |
|-------|-------|-------|
|       | 0     | 1     |
| $q_0$ | $q_0$ | $q_1$ |
| $q_1$ | $q_2$ | $q_3$ |
| $q_2$ | $q_4$ | $q_0$ |
| $q_3$ | $q_1$ | $q_2$ |
| $q_4$ | $q_3$ | $q_4$ |

if u can see the symmetry in it. write states and make fill like  $q_0 q_1 q_2 q_3 \dots$

now it is saying that it has to always start with 1 which the above dfa will not satisfy so make it a nfa by making a transition from  $q_0$  on zero to a new dead state. now you have a nfa reduce it which will result in a deterministic dfa .

so option a

3 votes

-- Ravi Singh (8.2k points)

#### 19.7.6 Identify Class Language: TIFR2010-B-35 [top](#)

<http://gateoverflow.in/19247>



Selected Answer

$L_1 = \{x \cdot x^R \mid x \in \{0,1\}^*\}$  Its a even palindrome so its CFL  
 $L_2 = \{x \cdot x \mid x \in \{0,1\}^*\}$  Its a string matching so its a CSL

Option D)  $L_1$  is context free but  $L_2$  is not context free.

5 votes

-- Umang Raman (11.3k points)

**19.7.7 Identify Class Language: TIFR2014-B-13** [top](#)<http://gateoverflow.in/27320>

Selected Answer

$L$  is a context free language over  $\{a,b\}$   
 $L_1 = L - \{xyx \mid x,y \in \{a,b\}^*\}$

$= L - \{ \text{all strings over } \{a,b\} \}$  [ Note: all strings can be generated from  $y$  by putting  $x = \epsilon$  ]

$= L - (a+b)^* = \{\}$ , empty set. [Note :  $L_1 - L_2 = \{ \text{string in } L_1 \text{ but not in } L_2 \}$  ]

So,  $L_1$  is a Regular Language.

$L$  is a context free language over  $\{a,b\}$

$L_2 = L \cdot L$

Context free languages are closed under Concatenation.

So  $L_2$  is Context Free Language.

Option C is correct.

9 votes

-- Praveen Saini (38.4k points)

**19.7.8 Identify Class Language: GATE2005\_55** [top](#)<http://gateoverflow.in/1378>

Selected Answer

$L_1$  is CFL [ put  $a$ 's in stack , and pop  $a$  with each  $b$ ] ]

$L_2$  is CFL [put  $b$ 's in stack and pop  $b$  with each  $c$  ]

c) is True.

b) is True CFL is closed under Union [  $S \rightarrow S_1 \mid S_2$  where  $S_1$  is grammar for  $L_1$  and  $S_2$  for  $L_2$  ]

CFL is not closed under Intersection, so intersection of two CFLs may or may not be CFL. Lets examine:

$L_1 \cap L_2 = \{ a^i b^j c^j, i > 0 \}$  which is Context sensitive but not context free [can't match  $a$ 's,  $b$ 's and  $c$ 's with one stack]

**So a) is False**

d) is True

8 votes

-- Praveen Saini (38.4k points)

**19.7.9 Identify Class Language: TIFR2015-B-8** [top](#)<http://gateoverflow.in/29865>

Selected Answer

languages over alphabet set are uncountable so ans should be e

2 votes

-- Pooja (25.9k points)

**19.7.10 Identify Class Language: GATE1999\_2.4** [top](#)<http://gateoverflow.in/1482>

Selected Answer

$L_2$  is regular , so complement of  $L_2$ ,  $(\sim L_2)$  , is also regular

Regular languages under complement . So **D is True**

$L_1 \cap L_2$  is context free.

Intersection of Context free language with Regular language is Context free. So **b is True**

$L_1 - L_2 = L_1 \cap (\sim L_2)$  is context free

Intersection of Context free language with Regular language is Context free. So **a is False**

$\sim L_1$  is not context free

Context free languages are not closed under complement. So **c is False (May/not be).**

10 votes

-- Praveen Saini (38.4k points)

### 19.7.11 Identify Class Language: GATE2011\_26 [top](#)

<http://gateoverflow.in/2128>



Selected Answer

Answer is **C.**

$L_1$  is regular.

$L_2$  is context-free.

$L_3$  is not context-free.

8 votes

-- Sona Praneeth Akula (3.8k points)

### 19.7.12 Identify Class Language: GATE2014-3\_36 [top](#)

<http://gateoverflow.in/2070>



Selected Answer

**C.**

$L_3$  is CFL and not DCFL as in no way we can deterministically determine the MIDDLE point of the input string.

8 votes

-- Gate Keeda (17.7k points)

## 19.8

### Minimal State Automata [top](#)

#### 19.8.1 Minimal State Automata: GATE1996\_2.23 [top](#)

<http://gateoverflow.in/2752>

Consider the following state table for a sequential machine. The number of states in the minimized machine will be

|               |   | Input              |      |
|---------------|---|--------------------|------|
|               |   | 0                  | 1    |
| Present State | A | D, 0               | B, 1 |
|               | B | A, 0               | C, 1 |
|               | C | A, 0               | B, 1 |
|               | D | A, 1               | C, 1 |
|               |   | Next state, Output |      |

- A. 4  
B. 3  
C. 2  
D. 1

[gate1996](#) [theory-of-computation](#) [minimal-state-automata](#) [normal](#)

[Answer](#)

### 19.8.2 Minimal State Automata: GATE2001-2.5 [top](#)

<http://gateoverflow.in/723>

Consider a DFA over  $\Sigma = \{a, b\}$  accepting all strings which have number of a's divisible by 6 and number of b's divisible by 8. What is the minimum number of states that the DFA will have?

- A. 8  
B. 14  
C. 15  
D. 48

[gate2001](#) [theory-of-computation](#) [minimal-state-automata](#)

[Answer](#)

### 19.8.3 Minimal State Automata: GATE2006\_34 [top](#)

<http://gateoverflow.in/1291>

Consider the regular language  $L = (111 + 11111)^*$ . The minimum number of states in any DFA accepting this language is:

- (A) 3  
(B) 5  
(C) 8  
(D) 9

[gate2006](#) [theory-of-computation](#) [minimal-state-automata](#) [normal](#)

[Answer](#)

### 19.8.4 Minimal State Automata: GATE2015-2\_53 [top](#)

<http://gateoverflow.in/8256>

The number of states in the minimal deterministic finite automaton corresponding to the regular expression  $(0 + 1)^*(10)$  is \_\_\_\_\_.

[gate2015-2](#) [theory-of-computation](#) [minimal-state-automata](#) [normal](#)

[Answer](#)

### 19.8.5 Minimal State Automata: GATE2002\_2.13 [top](#)

<http://gateoverflow.in/843>

The smallest finite automaton which accepts the language  $\{x \mid \text{length of } x \text{ is divisible by 3}\}$  has

- A. 2 states  
B. 3 states  
C. 4 states  
D. 5 states

[gate2002](#) [theory-of-computation](#) [normal](#) [minimal-state-automata](#)

[Answer](#)

### 19.8.6 Minimal State Automata: GATE1999\_1.4 [top](#)

<http://gateoverflow.in/1458>

Consider the regular expression  $(0+1)(0+1)\dots N$  times. The minimum state finite automaton that recognizes the language represented by this regular expression contains

- A.  $n$  states
- B.  $n+1$  states
- C.  $n+2$  states
- D. None of the above

[gate1999](#) [theory-of-computation](#) [minimal-state-automata](#) [easy](#)

[Answer](#)

### 19.8.7 Minimal State Automata: GATE2005-IT\_39 [top](#)

<http://gateoverflow.in/3786>

Consider the regular grammar:

$$\begin{aligned} S &\rightarrow Xa \mid Ya \\ X &\rightarrow Za \\ Z &\rightarrow Sa \mid \epsilon \\ Y &\rightarrow Wa \\ W &\rightarrow Sa \end{aligned}$$

where  $S$  is the starting symbol, the set of terminals is  $\{a\}$  and the set of non-terminals is  $\{S, W, X, Y, Z\}$ . We wish to construct a deterministic finite automaton (DFA) to recognize the same language. What is the minimum number of states required for the DFA?

- |    |   |
|----|---|
| A) | 2 |
| B) | 3 |
| C) | 4 |
| D) | 5 |

[gate2005-it](#) [theory-of-computation](#) [minimal-state-automata](#) [normal](#)

[Answer](#)

### 19.8.8 Minimal State Automata: GATE2001-1.6 [top](#)

<http://gateoverflow.in/699>

Given an arbitrary non-deterministic finite automaton (NFA) with  $N$  states, the maximum number of states in an equivalent minimized DFA at least

- A.  $N^2$
- B.  $2^N$
- C.  $2N$
- D.  $N!$

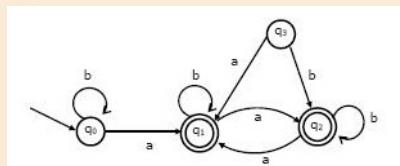
[gate2001](#) [minimal-state-automata](#) [theory-of-computation](#) [easy](#)

[Answer](#)

### 19.8.9 Minimal State Automata: GATE2007-74 [top](#)

<http://gateoverflow.in/1270>

Consider the following Finite State Automaton:



74. The language accepted by this automaton is given by the regular expression

- A.  $b^*ab^*ab^*ab^*$
- B.  $(a+b)^*$
- C.  $b^*a(a+b)^*$
- D.  $b^*ab^*ab^*$

gate2007 theory-of-computation minimal-state-automata finite-automata normal

[Answer](#)

### 19.8.10 Minimal State Automata: GATE1997\_70 [top](#)

<http://gateoverflow.in/19700>

Following is a state table for time finite state machine.

| Present State | Next State Output |           |
|---------------|-------------------|-----------|
|               | Input - 0         | Input - 1 |
| A             | B.1               | H.1       |
| B             | F.1               | D.1       |
| C             | D.0               | E.1       |
| D             | C.0               | F.1       |
| E             | D.1               | C.1       |
| F             | C.1               | C.1       |
| G             | C.1               | D.1       |
| H             | C.0               | A.1       |

- a. Find the equivalence partition on the states of the machine.
- b. Give the state table for the minimal machine. (Use appropriate names for the equivalent states. For example if states X and Y are equivalent then use XY as the name for the equivalent state in the minimal machine).

gate1997 theory-of-computation minimal-state-automata

[Answer](#)

### 19.8.11 Minimal State Automata: GATE1998\_2.5 [top](#)

<http://gateoverflow.in/1677>

Let  $L$  be the set of all binary strings whose last two symbols are the same. The number of states in the minimal state deterministic finite state automaton accepting  $L$  is

- A. 2
- B. 5
- C. 8
- D. 3

gate1998 theory-of-computation minimal-state-automata normal

[Answer](#)

### 19.8.12 Minimal State Automata: GATE1998\_4 [top](#)

<http://gateoverflow.in/1695>

Design a deterministic finite state automaton (using minimum number of states) that recognizes the following language:

$$L = \{w \in \{0,1\}^* \mid w \text{ interpreted as binary number (ignoring the leading zeros) is divisible by five }\}.$$

gate1998 theory-of-computation minimal-state-automata normal

[Answer](#)

### 19.8.13 Minimal State Automata: GATE2007\_29 [top](#)

<http://gateoverflow.in/1227>

A minimum state deterministic finite automaton accepting the language  
 $L = \{w \mid w \in \{0,1\}^*, \text{ number of } 0s \text{ and } 1s \text{ in } w \text{ are divisible by } 3 \text{ and } 5, \text{ respectively}\}$  has

- A. 15 states
- B. 11 states
- C. 10 states
- D. 9 states

[gate2007](#) [theory-of-computation](#) [minimal-state-automata](#) [normal](#)

[Answer](#)

### 19.8.14 Minimal State Automata: GATE1997\_20 [top](#)

<http://gateoverflow.in/2280>

Construct a finite state machine with minimum number of states, accepting all strings over  $(a,b)$  such that the number of  $a$ 's is divisible by two and the number of  $b$ 's is divisible by three.

[gate1997](#) [theory-of-computation](#) [finite-automata](#) [minimal-state-automata](#) [normal](#)

[Answer](#)

### 19.8.15 Minimal State Automata: GATE2002\_21 [top](#)

<http://gateoverflow.in/874>

We require a four state automaton to recognize the regular expression  $(a/b)^*abb$

- a. Give an NFA for this purpose
- b. Give a DFA for this purpose

[gate2002](#) [theory-of-computation](#) [minimal-state-automata](#) [normal](#)

[Answer](#)

### 19.8.16 Minimal State Automata: GATE1991\_17,b [top](#)

<http://gateoverflow.in/544>

Let  $\bar{L}$  be the language of all binary strings in which the third symbol from the right is a 1. Give a non-deterministic finite automaton that recognizes  $\bar{L}$ . How many states does the minimized equivalent deterministic finite automaton have? Justify your answer briefly?

[gate1991](#) [theory-of-computation](#) [minimal-state-automata](#) [normal](#)

[Answer](#)

### 19.8.17 Minimal State Automata: GATE2011\_45 [top](#)

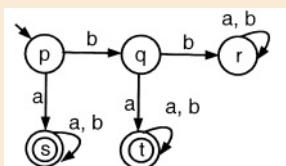
<http://gateoverflow.in/2147>

A deterministic finite automaton (

DFA)

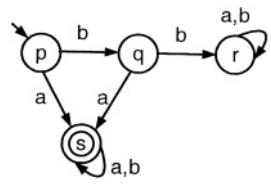
$D$  with alphabet

$\Sigma = \{a, b\}$  is given below.

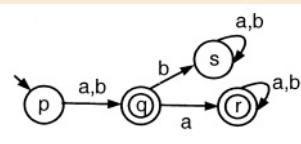


Which of the following finite state machines is a valid minimal DFA which accepts the same languages as  $D$ ?

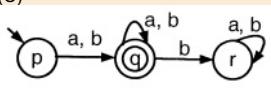
- (A)



(B)



(C)



(D)

[gate2011](#) [theory-of-computation](#) [minimal-state-automata](#) [easy](#)

**Answer**

### 19.8.18 Minimal State Automata: GATE2011\_42 [top](#)

<http://gateoverflow.in/2144>

Definition of a language  $L$  with alphabet  $\{a\}$  is given as following.

$$L = \{a^{nk} \mid k > 0, \text{ and } n \text{ is a positive integer constant}\}$$

What is the minimum number of states needed in a DFA to recognize  $L$ ?

- (A)  $k + 1$
- (B)  $n + 1$
- (C)  $2^{n+1}$
- (D)  $2^{k+1}$

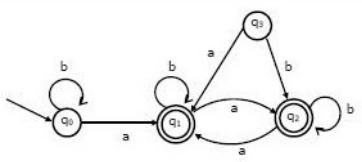
[gate2011](#) [theory-of-computation](#) [minimal-state-automata](#) [normal](#)

**Answer**

### 19.8.19 Minimal State Automata: GATE2007-75 [top](#)

<http://gateoverflow.in/43514>

Consider the following Finite State Automaton



The minimum state automaton equivalent to the above FSA has the following number of states

- A. 1
- B. 2
- C. 3
- D. 4

[normal](#) [gate2007](#) [theory-of-computation](#) [finite-automata](#) [minimal-state-automata](#)

[Answer](#)

### Answers: Minimal State Automata

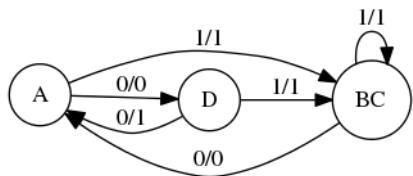
#### 19.8.1 Minimal State Automata: GATE1996\_2.23 [top](#)

<http://gateoverflow.in/2752>



Selected Answer

3 states are required in the minimized machine. States B and C can be combined as follows:



7 votes

-- Arjun Suresh (150k points)

#### 19.8.2 Minimal State Automata: GATE2001-2.5 [top](#)

<http://gateoverflow.in/723>



Selected Answer

Answer is D. It can be proved using Myhill Nerode theorem. We need a separate state for  $\#a \bmod 6 = 0..5$  and  $\#b = 0..7$ . Each combination of them must also be a new state giving  $6*8 = 48$  minimum states required in the DFA.

Reading Myhill-Nerode theorem might be confusing though it is actually very simple.

<http://courses.cs.washington.edu/courses/cse322/05wi/handouts/MyhillNerode.pdf>

9 votes

-- Arjun Suresh (150k points)

#### 19.8.3 Minimal State Automata: GATE2006\_34 [top](#)

<http://gateoverflow.in/1291>

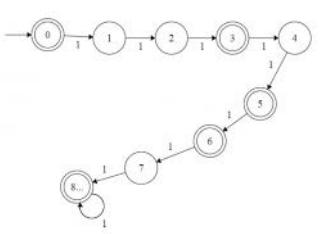


Selected Answer

Given language  $L = (111 + 11111)^*$   
Strings , that belongs in the language

$L = \{\text{null} , 111 , 11111, 111111 , 11111111 , 111111111 , \dots\}$  form string length 8 , (number of 1's) ,

you can generate any length of string from length 3 and 5 (i.e. length 8 ,length 9, length 10 , length 11 ,.....etc})  
 $L = \{\text{null} , 111 , 11111 , 111111 , 11111111 , 11111111*\}$   
 Strings in length , that belongs in the language  
 $L = \{0 , 3, 5, 6, 8, 9, 10, 11, \dots\}$   
 so , required DFA will be ,



So , there are 5 states are final states ,4 states are non-final states ,total number of states are 9 states .  
 hence option D is true.

7 votes

-- Mithlesh Upadhyay (3.6k points)

#### 19.8.4 Minimal State Automata: GATE2015-2\_53 [top](#)

<http://gateoverflow.in/8256>

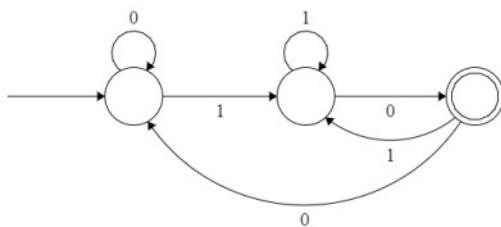


Selected Answer

All strings ending with 10. So, we need 3 states.

From first state on 1, we go to second state.  
 From second state on 0 we go to third state.  
 From third state on 0 we go to first state and on 1 we go to second state.  
 Only third state is final.

$L = (0+1)^*10$   
 following minimal DFA will be



9 votes

-- Arjun Suresh (150k points)

#### 19.8.5 Minimal State Automata: GATE2002\_2.13 [top](#)

<http://gateoverflow.in/843>



Selected Answer

it is 3 states as we need a state each for length mod 3 = 0, 1 and 2.

8 votes

-- priya023 (213 points)

### 19.8.6 Minimal State Automata: GATE1999\_1.4 [top](#)

<http://gateoverflow.in/1458>

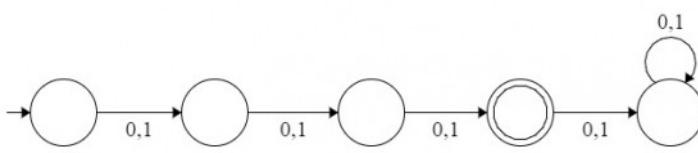


Selected Answer

As far as for above problem say regular expression for  $(0+1)(0+1)\dots 3$  times

$$= (0+1)(0+1)(0+1)$$

Having DFA



so for regular expression  $(0+1)(0+1)\dots N$  times have **N+2** states in DFA

$N+1$  states in NFA (we can remove dead state)

When question is about minimum state finite automata (and nothing is mentioned NFA/DFA) then which ever having minimum no.

$N+1$  states.

12 votes

-- Praveen Saini (38.4k points)

### 19.8.7 Minimal State Automata: GATE2005-IT\_39 [top](#)

<http://gateoverflow.in/3786>



Selected Answer

$$\begin{aligned} S &\rightarrow Xa \mid Ya \\ X &\rightarrow Za \\ Z &\rightarrow Sa \mid \epsilon \\ Y &\rightarrow Wa \\ W &\rightarrow Sa \end{aligned}$$

This is left linear grammar having language  $L$ . Convert it into right linear using following rule :

- The previous slide reversed the language!

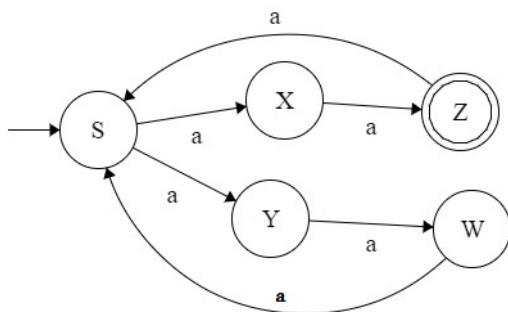
$$\begin{array}{ll} V_i \rightarrow V_j w & \text{Reverses to } V_i \rightarrow w^R V_j \\ V_i \rightarrow w & \text{Reverses to } V_i \rightarrow w^R \end{array}$$

- If the left linear grammar produced language  $L$ , then the resulting right linear grammar produces  $L^R$

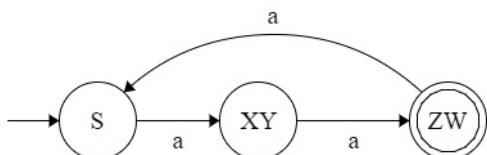
$$\begin{aligned} S &\rightarrow aX \mid aY \\ X &\rightarrow aZ \\ Z &\rightarrow aS \mid \epsilon \\ Y &\rightarrow aW \\ W &\rightarrow aS \end{aligned}$$

is right linear grammar having language  $L^R$ .

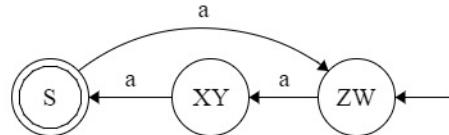
having NFA



Having DFA for language  $L^R$



DFA for language  $L$  (reversal)



$L = \{ w : n_a(w) \bmod 3 = 2, w \text{ belongs to } \{a,b\}^* \}$  same as Omesh Pandita answered

having 3 states

10 votes

-- Praveen Saini (38.4k points)

### 19.8.8 Minimal State Automata: GATE2001-1.6 [top](#)

<http://gateoverflow.in/699>

ans is B.  $2^N$ .

In DFA any subset of the  $N$  states (for  $N$  element set  $2^N$  subsets possible) can become a new state and they can remain even when the DFA is minimized. So, maximum we can get  $2^N$  states for the minimized DFA. (at least in question must be a typo for at most).

7 votes

-- jayendra (6.6k points)

### 19.8.9 Minimal State Automata: GATE2007-74 [top](#)

<http://gateoverflow.in/1270>



Selected Answer

The answer for 74 is C.

You can see that both the states, Q1 and Q2 are final and are accepting  $(a + b)^*$ .

7 votes

-- Gate Keeda (17.7k points)

### 19.8.10 Minimal State Automata: GATE1997\_70 [top](#)

<http://gateoverflow.in/19700>

0 Equivalence = P0 -> [ABEFG] [CDH]

P1 -> [AB] [EG] [F] [CDH]

P2 -> [A] [B] [EG] [F] [C] [D] [H]

P3-> [A] [B] [E] [G] [F] [C] [D] [H]

No Minimization can be possible.

So we having milley machine with same as transition table

0 votes

-- Suhit Kalubarme (97 points)

### 19.8.11 Minimal State Automata: GATE1998\_2.5 [top](#)

<http://gateoverflow.in/1677>

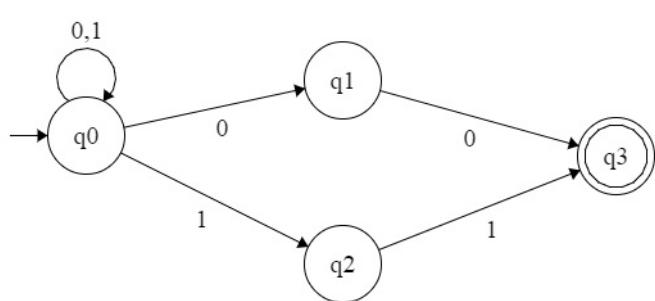


Selected Answer

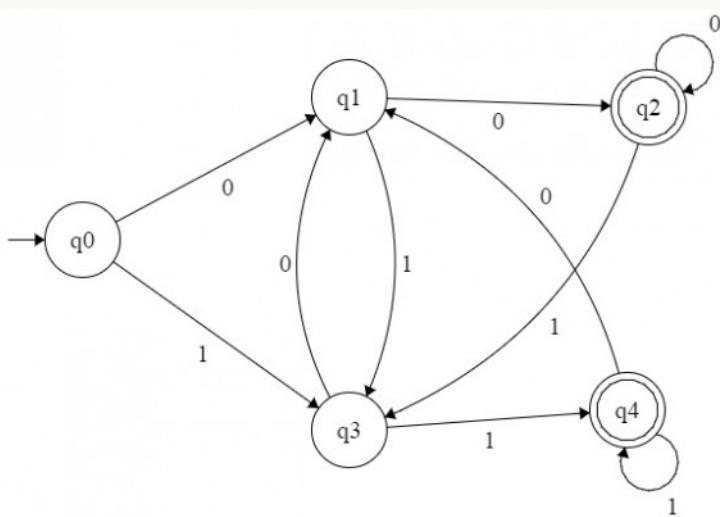
binary strings whose last two symbols are same

regular expression =  $(0+1)^*(00+11)$

Having NFA



Equivalent DFA



Total no of states = 5

10 votes

-- Praveen Saini (38.4k points)

### 19.8.12 Minimal State Automata: GATE1998\_4 [top](#)

<http://gateoverflow.in/1695>



Selected Answer

suppose we have decimal no 3 after that we get a symbol 2 . it becomes 32 as  $3 \times 10 + 2 = 32$

in binary if we have 10 ( i.e 2 in decimal say old no) and after that we get symbol 1 it become 101( i.e 5 in decimal say new no )

$$2 \text{ (old no.)} \times 2 \text{ (base)} + 1 \text{ (input symbol)} = 5 \text{ (new no.)}$$

Now in the given problem , binary no is divisible by 5 , i.e 0,101,1010,1111.....

We need 5 states in DFA , 0,1,2,3 and 4 .Each state represent remainder that comes when we divide no by 5.

input symbol = {0,1}

We get the transition

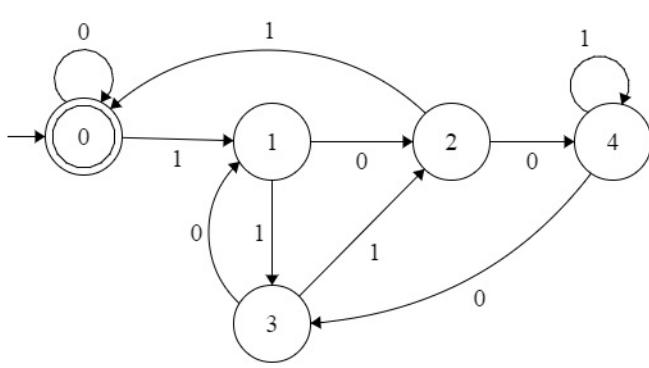
$$[\text{Old state } x \text{ base } + \text{input symbol}] \bmod 5 = \text{New state} \quad , \text{ where base is 2}$$

$$[0 \times 2 + 0] \bmod 5 = 0 \quad [1 \times 2 + 0] \bmod 5 = 2 \quad [2 \times 2 + 0] \bmod 5 = 4$$

$$[0 \times 2 + 1] \bmod 5 = 1 \quad [1 \times 2 + 1] \bmod 5 = 3 \quad [2 \times 2 + 1] \bmod 5 = 0$$

$$[3 \times 2 + 0] \bmod 5 = 1 \quad [4 \times 2 + 0] \bmod 5 = 3$$

$$[3 \times 2 + 1] \bmod 5 = 2 \quad [4 \times 2 + 1] \bmod 5 = 4$$



Upvote 5 votes

-- Praveen Saini (38.4k points)

### 19.8.13 Minimal State Automata: GATE2007\_29 [top](#)

<http://gateoverflow.in/1227>



Selected Answer

Answer will be (A) 15 states.

We need a separate state for #0 = 0, 1, 2 and #1 = 0, 1, 2, 3, 4 giving total minimum number of states =  $3 * 5 = 15$ .

This is a direct consequence of Myhill-Nerode theorem.

<http://courses.cs.washington.edu/courses/cse322/05wi/handouts/MyhillNerode.pdf>

Upvote 3 votes

-- Arjun Suresh (150k points)

### 19.8.14 Minimal State Automata: GATE1997\_20 [top](#)

<http://gateoverflow.in/2280>



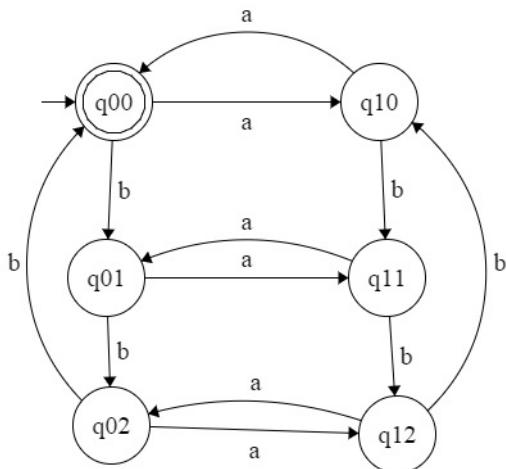
Selected Answer

A state  $q_{xy}$  means  $n_a \bmod 2 = x, n_b \bmod 3 = y$

$q_{00}$  means  $n_a \bmod 2 = 0, n_b \bmod 3 = 0$  [no of a's is divisible of 2 and no of b's are divisible of 3]

$q_{00} \times a \rightarrow q_{10}$

$q_{00} \times b \rightarrow q_{01}$  and so on



7 votes

-- Praveen Saini (38.4k points)

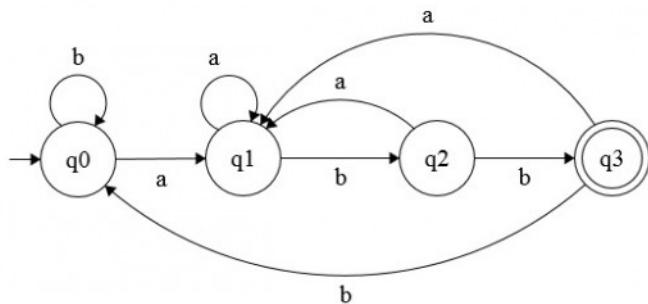
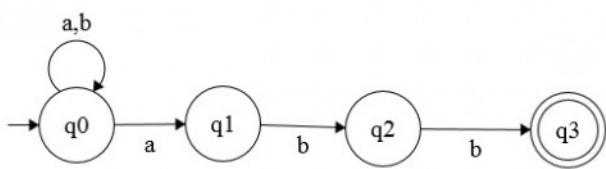
### 19.8.15 Minimal State Automata: GATE2002\_21 [top](#)

<http://gateoverflow.in/874>



Selected Answer

NFA for regular expression  $(a+b)^*abb$  and its equivalent DFA will be as follow:



6 votes

-- Praveen Saini (38.4k points)

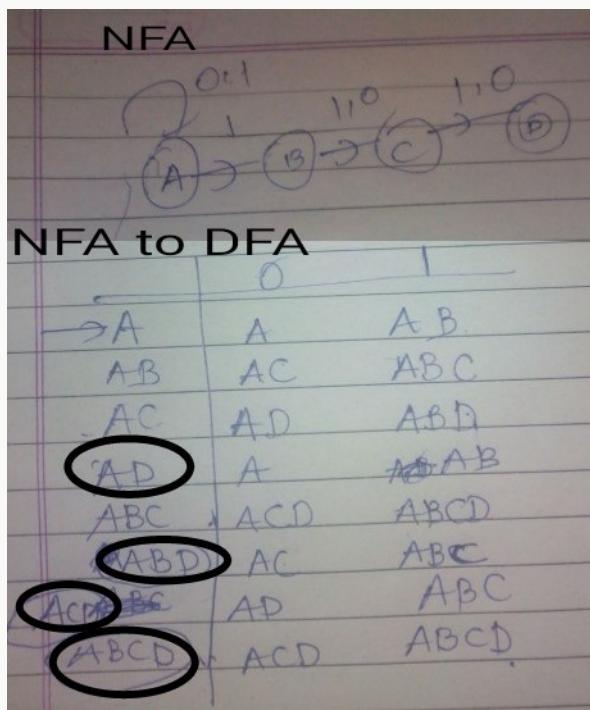
**19.8.16 Minimal State Automata: GATE1991\_17,b**<http://gateoverflow.in/544>

Selected Answer

Answer :-

Check following NFA. I've done subset construction too. 8 States are needed even after minimization..

Every state containing D is final state.



3 votes

-- Akash (31.7k points)

### 19.8.17 Minimal State Automata: GATE2011\_45 [top](#)

<http://gateoverflow.in/2147>



Selected Answer

(A) is the answer.

In (B) and (C) when the first letter of input is 'b' we reach final state, while in the given DFA first letter 'b' is not a final state. So, (B) and (C) are not accepting same language as the given DFA.

In (D) we can reach final state when the last letter is 'a', whatever be the previous transitions. But in the given DFA, when the first 2 letters are 'b' we can never reach the final state. So, (D) is also accepting a different language than the given DFA.

Upvote 8 votes

-- Arjun Suresh (150k points)

### 19.8.18 Minimal State Automata: GATE2011\_42 [top](#)

<http://gateoverflow.in/2144>



Selected Answer

(B)  $n+1$

We need a state for strings of length 0, 1, 2, ...  $n$  (and their respective multiples with  $k$ ). Each of these set of strings form an equivalence class as per Myhill-Nerode theorem and hence needs a separate state in min-DFA.

| Myhill-Nerode Class 1 | Myhill-Nerode Class 2 ...                        | Myhill-Nerode Class n | Myhill-Nerode Class n+1 |
|-----------------------|--------------------------------------------------|-----------------------|-------------------------|
| $\epsilon$            | a, #a = n+1, #a = n-1, #a = 2n+1, #a = 2n-1, ... | #a = n, #a = 3n, ...  | #a = 3n, ...            |

One thing to notice here is  $k > 0$ . Because of this we are not able to combine Class 1 and Class  $n+1$ . Had it been  $k \geq 0$ , we would have had only  $n$  equivalent classes and equivalently  $n$  states in the minimal DFA.

Upvote 6 votes

-- Arjun Suresh (150k points)

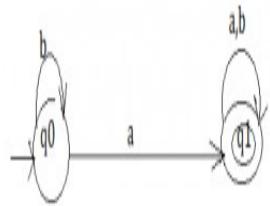
### 19.8.19 Minimal State Automata: GATE2007-75 [top](#)

<http://gateoverflow.in/43514>



Selected Answer

Ans will be 2 state



5 votes

-- Manoj Kumar (23.1k points)

## 19.9

### Myhill Nerode top

#### 19.9.1 Myhill Nerode: GATE2006-IT\_29 top

<http://gateoverflow.in/3568>

Consider the regular grammar below

$$\begin{aligned} S &\rightarrow bS \mid aA \mid \epsilon \\ A &\rightarrow aS \mid bA \end{aligned}$$

The Myhill-Nerode equivalence classes for the language generated by the grammar are

- A)  $\{w \in (a + b)^* \mid \#a(w) \text{ is even}\} \text{ and } \{w \in (a + b)^* \mid \#a(w) \text{ is odd}\}$
- B)  $\{w \in (a + b)^* \mid \#a(w) \text{ is even}\} \text{ and } \{w \in (a + b)^* \mid \#b(w) \text{ is odd}\}$
- C)  $\{w \in (a + b)^* \mid \#a(w) = \#b(w)\} \text{ and } \{w \in (a + b)^* \mid \#a(w) \neq \#b(w)\}$
- D)  $\{\epsilon\}, \{wa \mid w \in (a + b)^*\} \text{ and } \{wb \mid w \in (a + b)^*\}$

[gate2006-it](#) [theory-of-computation](#) [regular-set](#) [myhill-nerode](#) [normal](#)

Answer

### Answers: Myhill Nerode

#### 19.9.1 Myhill Nerode: GATE2006-IT\_29 top

<http://gateoverflow.in/3568>

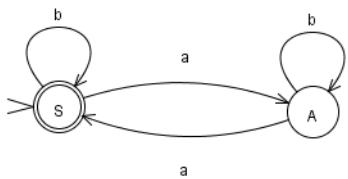


Selected Answer

**Option A is correct.**

The given grammar generates all string over the alphabet  $\{a, b\}$  which have an even number of  $a$ 's.

The given right-linear grammar can be converted to the following DFA.



8 votes

-- Pragy Agarwal (14.4k points)

### 19.10

### Pda

<http://gateoverflow.in/3683>

#### 19.10.1 Pda: GATE2004-IT\_40

Let  $M = (K, \Sigma, \Gamma, \Delta, s, F)$  be a pushdown automaton, where

$K = (s, f)$ ,  $F = \{f\}$ ,  $\Sigma = \{a, b\}$ ,  $\Gamma = \{a\}$  and  
 $\Delta = \{(s, a, \epsilon), (s, a), ((s, b, \epsilon), (s, a)), ((s, a, \epsilon), (f, \epsilon)), ((f, a, a), (f, \epsilon)), ((f, b, a), (f, \epsilon))\}$ .

Which one of the following strings is not a member of  $L(M)$ ?

- |    |       |
|----|-------|
| A) | aaa   |
| B) | aabab |
| C) | baaba |
| D) | bab   |

[gate2004-it](#) [theory-of-computation](#) [pda](#) [normal](#)

[Answer](#)

#### 19.10.2 Pda: GATE2005-IT\_38

<http://gateoverflow.in/3785>

Let  $P$  be a non-deterministic push-down automaton (NPDA) with exactly one state,  $q$ , and exactly one symbol,  $Z$ , in its stack alphabet. State  $q$  is both the starting as well as the accepting state of the PDA. The stack is initialized with one  $Z$  before the start of the operation of the PDA. Let the input alphabet of the PDA be  $\Sigma$ . Let  $L(P)$  be the language accepted by the PDA by reading a string and reaching its accepting state. Let  $N(P)$  be the language accepted by the PDA by reading a string and emptying its stack.

Which of the following statements is TRUE?

- A)  $L(P)$  is necessarily  $\Sigma^*$  but  $N(P)$  is not necessarily  $\Sigma^*$ .
- B)  $N(P)$  is necessarily  $\Sigma^*$  but  $L(P)$  is not necessarily  $\Sigma^*$ .
- C) Both  $L(P)$  and  $N(P)$  are necessarily  $\Sigma^*$ .
- D) Neither  $L(P)$  nor  $N(P)$  are necessarily  $\Sigma^*$

[gate2005-it](#) [theory-of-computation](#) [pda](#) [normal](#)

[Answer](#)

#### 19.10.3 Pda: GATE2006-IT\_31

<http://gateoverflow.in/3570>

Which of the following languages is accepted by a non-deterministic pushdown automaton (PDA) but NOT by a deterministic PDA?

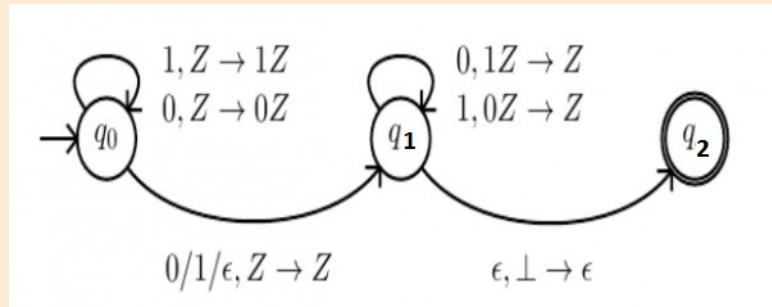
- A)  $\{a^n b^n c^n \mid n \geq 0\}$
- B)  $\{a^l b^m c^n \mid l \neq m \text{ or } m \neq n\}$
- C)  $\{a^n b^n \mid n \geq 0\}$
- D)  $\{a^m b^n \mid m, n \geq 0\}$

[gate2006-it](#) [theory-of-computation](#) [pda](#) [normal](#)
**Answer****19.10.4 Pda: GATE2015-1\_51** [top](#)<http://gateoverflow.in/8357>

Consider the NPDA

$$\langle Q = \{q_0, q_1, q_2\}, \Sigma = \{0, 1\}, \Gamma = \{0, 1, \perp\}, \delta, q_0, \perp, F = \{q_2\} \rangle$$

, where (as per usual convention)  $Q$  is the set of states,  $\Sigma$  is the input alphabet,  $\Gamma$  is the stack alphabet,  $\delta$  is the state transition function  $q_0$  is the initial state,  $\perp$  is the initial stack symbol, and  $F$  is the set of accepting states. The state transition is as follows:



Which one of the following sequences must follow the string 101100 so that the overall string is accepted by the automaton?

- A. 10110
- B. 10010
- C. 01010
- D. 01001

[gate2015-1](#) [theory-of-computation](#) [pda](#) [normal](#)
**Answer****19.10.5 Pda: GATE1996\_13** [top](#)<http://gateoverflow.in/2765>

Let  $Q = (\{q_1, q_2\}, \{a, b\}, \{a, b, \perp\}, \delta, \perp, \phi)$  be a pushdown automaton accepting by empty stack for the language which is the set of all nonempty even palindromes over the set  $\{a, b\}$ . Below is an incomplete specification of the transitions  $\delta$ . Complete the specification. The top of the stack is assumed to be at the right end of the string representing stack contents.

1.  $\delta(q_1, a, \perp) = \{(q_1, \perp a)\}$
2.  $\delta(q_1, b, \perp) = \{(q_1, \perp b)\}$
3.  $\delta(q_1, a, a) = \{(q_1, aa)\}$
4.  $\delta(q_1, b, a) = \{(q_1, ab)\}$
5.  $\delta(q_1, a, b) = \{(q_1, ba)\}$
6.  $\delta(q_1, b, b) = \{(q_1, bb)\}$
7.  $\delta(q_1, a, a) = \{(\dots, \dots)\}$
8.  $\delta(q_1, b, b) = \{(\dots, \dots)\}$
9.  $\delta(q_2, a, a) = \{(q_2, \epsilon)\}$
10.  $\delta(q_2, b, b) = \{(q_2, \epsilon)\}$
11.  $\delta(q_2, \epsilon, \perp) = \{(q_2, \epsilon)\}$

[gate1996](#) [theory-of-computation](#) [pda](#) [normal](#)
**Answer****19.10.6 Pda: GATE1998\_13** [top](#)<http://gateoverflow.in/1727>

Let  $M = (\{q_0, q_1\}, \{0, 1\}, \{z_0, X\}, \delta, q_0, z_0, \phi)$  be a Pushdown automaton where  $\delta$  is given by

$$\delta(q_0, 1, z_0) = \{(q_0, xz_0)\}$$

$$\delta(q_0, \epsilon, z_0) = \{(q_0, \epsilon)\}$$

$$\delta(q_0, 1, X) = \{(q_0, XX)\}$$

$$\delta(q_1, 1, X) = \{(q_1, \epsilon)\}$$

$$\delta(q_0, 0, X) = \{(q_1, X)\}$$

$$\delta(q_0, 0, z_0) = \{(q_0, z_0)\} z$$

- a. What is the language accepted by this PDA by empty stack?
- b. Describe informally the working of the PDA

[gate1998](#) [theory-of-computation](#) [pda](#) [descriptive](#)

[Answer](#)

### 19.10.7 Pda: GATE1997\_6.6 [top](#)

<http://gateoverflow.in/2262>

Which of the following languages over  $\{a, b, c\}$  is accepted by a deterministic pushdown automata?

- (A)  $\{wcw^R \mid w \in \{a, b\}^*\}$
- (B)  $\{ww^R \mid w \in \{a, b, c\}^*\}$
- (C)  $\{a^n b^n c^n \mid n \geq 0\}$
- (D)  $\{w \mid w \text{ is a palindrome over } \{a, b, c\}\}$

Note:  $w^R$  is the string obtained by reversing ' $w$ '.

[gate1997](#) [theory-of-computation](#) [pda](#) [easy](#)

[Answer](#)

### 19.10.8 Pda: GATE1999\_1.6 [top](#)

<http://gateoverflow.in/377>

Let  $L_1$  be the set of all languages accepted by a PDA by final state and  $L_2$  the set of all languages accepted by empty stack. Which of the following is true?

- A)  $L_1 = L_2$
- B)  $L_1 \supset L_2$
- C)  $L_1 \subset L_2$
- D) None

There are two modes of acceptance of DPDA - final state and empty stack. For languages accepted by empty stack there is a prefix property. Explain in simple terms about this property and its importance.

[pda](#) [normal](#) [theory-of-computation](#) [gate1999](#)

[Answer](#)

### 19.10.9 Pda: GATE 2016-1-43 [top](#)

<http://gateoverflow.in/39732>

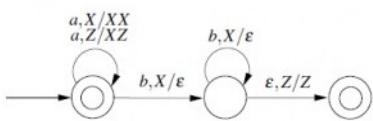
Consider the transition diagram of a PDA given below with input alphabet

$\Sigma = \{a, b\}$  and stack alphabet

$\Gamma = \{X, Z\}$ .

$Z$  is the initial stack symbol. Let

$L$  denote the language accepted by the PDA



Which one of the following is **TRUE**?

- A.  $L = \{a^n b^n \mid n \geq 0\}$  and is not accepted by any finite automata
- B.  $L = \{a^n \mid n \geq 0\} \cup \{a^n b^n \mid n \geq 0\}$  and is not accepted by any deterministic PDA
- C.  $L$  is not accepted by any Turing machine that halts on every input
- D.  $L = \{a^n \mid n \geq 0\} \cup \{a^n b^n \mid n \geq 0\}$  and is deterministic context-free

[gate2016-1](#) [theory-of-computation](#) [pda](#) [normal](#)

**Answer**

### 19.10.10 Pda: GATE2006-IT\_33 [top](#)

<http://gateoverflow.in/3572>

Consider the pushdown automaton (PDA) below which runs over the input alphabet  $(a, b, c)$ . It has the stack alphabet  $\{Z_0, X\}$  where  $Z_0$  is the bottom-of-stack marker. The set of states of the PDA is  $\{s, t, u, f\}$  where  $s$  is the start state and  $f$  is the final state. The PDA accepts by final state. The transitions of the PDA given below are depicted in a standard manner. For example, the transition  $(s, b, X) \rightarrow (t, XZ_0)$  means that if the PDA is in state  $s$  and the symbol on the top of the stack is  $X$ , then it can read  $b$  from the input and move to state  $t$  after popping the top of stack and pushing the symbols  $Z_0$  and  $X$  (in that order) on the stack.

$$\begin{aligned} (s, a, Z_0) &\rightarrow (s, XXZ_0) \\ (s, \epsilon, Z_0) &\rightarrow (f, \epsilon) \\ (s, a, X) &\rightarrow (s, XXX) \\ (s, b, X) &\rightarrow (t, \epsilon) \\ (t, b, X) &\rightarrow (t, \epsilon) \\ (t, c, X) &\rightarrow (u, \epsilon) \\ (u, c, X) &\rightarrow (u, \epsilon) \\ (u, \epsilon, Z_0) &\rightarrow (f, \epsilon) \end{aligned}$$

The language accepted by the PDA is

- A)  $\{a^l b^m c^n \mid l = m = n\}$
- B)  $\{a^l b^m c^n \mid l = m\}$
- C)  $\{a^l b^m c^n \mid 2l = m + n\}$
- D)  $\{a^l b^m c^n \mid m = n\}$

[gate2006-it](#) [theory-of-computation](#) [pda](#) [normal](#)

**Answer**

### Answers: Pda

### 19.10.1 Pda: GATE2004-IT\_40 [top](#)

<http://gateoverflow.in/3683>

ANS : B

The language is like.....

in start state a's or b's come....just push a's on stack...except for the last a...which is used to shift from "start state" to "final state" without consuming any stack symbol....now in "final state" , for equal no's of a's and b's just pop a's from stack.....that the interpretation of transitions given in language.

The transitions given are obviously WRONG .....but what they must have meant is same as i explained.

Based on this.....

- 1) aaa : push a....skip a....pop a ACCEPTED  
 2)aabab: push a....skip a...pop a... REJECTED  
 3)baaba : push a...push a....skip a....pop a....pop a ACCEPTED  
 4)bab : push a....skip a....pop a ACCEPTED

3 votes

-- Rohan Mundhey (1.1k points)

**19.10.2 Pda: GATE2005-IT\_38** [top](#)<http://gateoverflow.in/3785>

Selected Answer

**Answer is (D)**

In NPDA we may have a dead configuration. This mean we may not give any transition to any alphabet from this state.

**we say that a string is accepted if PDA is in final state after reading the final symbol in the string or after it has read '\$' symbol denoting end of the string and it is in final state.**

**Now coming to options:**

**Question never says that we have transitions defined for all the alphabet symbols in the PDA. Although it is ALREADY in the FINAL state we may not have ANY transition for any input symbol. In this case string will be rejected as it will never finish reading the string.**

To sum up: A string is rejected in following two ways:

**1. If no transition is defined for any configuration(this includes the final state as well because to accept the string we need the transition  $(f, \$, \_) \rightarrow (f, \_, \_)$  in final state or accepting state where blank('\_') denotes arbitrary stack symbol that does not matter because we are not accepting by EMPTY stack**

**2. If string enters a configuration for which no transition is defined STRING is rejected.**

**So option (D) is correct. Because the same way it may not empty the stack when it finishes reading the string.**

8 votes

-- Sandeep\_Uniyal (5.5k points)

**19.10.3 Pda: GATE2006-IT\_31** [top](#)<http://gateoverflow.in/3570>

Selected Answer

option B is correct

$$L = \{a^l b^m c^n \mid l \neq m \text{ or } m \neq n\}$$

$(q_0, a, Z_0)$   
 $\rightarrow (q_0, aZ_0)$

$(q_0, a, a)$   
 $\rightarrow (q_0, aa)$

$(q_0, b, a)$   
 $\rightarrow (q_1, \epsilon), (q_2, ba)$

[here it is NPDA where we have to check  $l \neq m$  or  $m \neq n$ ; for  $l \neq m$  we need to pop  $a$  for  $b$ ; for  $m \neq n$  we need to keep  $b$  in stack so that we can pop  $b$  for  $c$  ]

$(q_1, b, a)$   
 $\rightarrow (q_1, \epsilon)$

$(q_1, c, a)$   
 $\rightarrow (q_f, \epsilon)$

(q1,b,Z0)  
 $\rightarrow (qf, \epsilon)$

(q2,b,b)  
 $\rightarrow q2, bb$

(q2,c,b)  
 $\rightarrow (q3, \epsilon)$

(q3,c,b)  
 $\rightarrow (q3, \epsilon)$

(q3,c,a)  
 $\rightarrow (qf, \epsilon)$

(q3, $\epsilon$ ,b)  
 $\rightarrow (qf, \epsilon)$

A is wrong as it is not context free

D  $a^*b^*$  is regular, so must have DFA , and so an equivalent DPDA

C can be accepted using DPDA

7 votes

-- Praveen Saini (38.4k points)

#### 19.10.4 Pda: GATE2015-1\_51 [top](#)

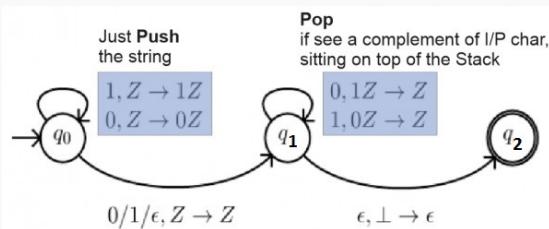
<http://gateoverflow.in/8357>



Selected Answer

Here,  $Z$  is used to represent the entire stack content except the *top*.  $Z$  is the string in Stack read from top to bottom.  $1, Z \rightarrow 1Z$  means, on input symbol 1, the stack content changes from  $Z$  to  $1Z$ .

In  $q_0$  state, for '1', a '1' is pushed and for a '0' a '0' is pushed. In  $q_1$  state, for a '0' a '1' is popped and for a '1' a '0' is popped. So, the given PDA is accepting all strings of the form  $x0x'_r$  or  $x1x'_r$  or  $xx'_r$ , where  $x'_r$  is the reverse of the 1's complement of  $x$ . i.e.:



The given string 101100 has 6 letters and we are given 5 letter strings. So,  $x0$  is done, with  $x = 10110$ . So,  $x'_r = (01001)_r = 10010$ .

answer = **option B**

13 votes

-- Arjun Suresh (150k points)

#### 19.10.5 Pda: GATE1996\_13 [top](#)

<http://gateoverflow.in/2765>



Selected Answer

$\delta(q_1, a, b) = \{(q_2, ba)\}$  means from state  $q_1$  on input  $a$  with stack top being  $b$ , the PDA moves to state  $q_2$  and pushes  $a$  on top of stack.

So, here the missing transitions are at the middle of the input string:

$$\begin{aligned}\delta(q_1, a, a) &= \{(q_2, \epsilon)\} \\ \delta(q_1, b, b) &= \{(q_2, \epsilon)\}\end{aligned}$$

Once middle is reached, now we should start popping. And so, we must go to state  $q_2$  as well as pop the previous character on the stack. (The character before and after the middle must be same as the string is even length palindrome)

(This is a non-deterministic PDA)

7 votes

-- Arjun Suresh (150k points)

### 19.10.6 Pda: GATE1998\_13 [top](#)

<http://gateoverflow.in/1727>



Selected Answer

$q_0$  is start state

$$\delta(q_0, 0, Z_0) = (q_0, Z_0)$$

[ Do Nothing operation, just read any no of 0's but do not keep in stack (any no of 0's bcoz on reading 0's it remains on same state  $q_0$ ) ]

$$\delta(q_0, 1, Z_0) = (q_0, XZ_0) \quad [\text{Read first 1 and keep one } X \text{ in stack}]$$

$$\delta(q_0, 1, X) = (q_0, XX) \quad [\text{Read any no of 1's and keep one } X \text{ for each 1 in stack}]$$

$$\delta(q_0, 0, X) = (q_1, X)$$

[ Read single 0 and do nothing in stack, state changed from  $q_0$  to  $q_1$  ]

$$\delta(q_1, 1, X) = (q_1, \epsilon)$$

[ Pop out one  $X$  from stack on reading each 1 on state  $q_1$  (matching each 1 with the 1 read before single 0) ]

$$\delta(q_0, \epsilon, Z_0) = (q_0, \epsilon)$$

[stack is empty , inputs are accepted here ,that is ,  $\epsilon$  or any of 0's (we read earlier with Do Nothing operation) ]

$$L = \{ 0^m, m \geq 0 \}$$

No input accept after reaching on  $q_1$  because stack will remain with  $Z_0$ , stack initial symbol

Note : if we add one more transition

$$\delta(q_1, \epsilon, Z_0) = (q_1, \epsilon), \text{ then } L \text{ will be } \{ 0^m \bigcup 0^i 1^j 0 1^j, m, i, j \geq 0 \}$$

5 votes

-- Praveen Saini (38.4k points)

### 19.10.7 Pda: GATE1997\_6.6 [top](#)

<http://gateoverflow.in/2262>



Selected Answer

A. rest cannot be accepted by a DPDA.

7 votes

-- Gate Keeda (17.7k points)

### 19.10.8 Pda: GATE1999\_1.6 [top](#)

<http://gateoverflow.in/377>



Selected Answer

Answer to the question is (A)  $L_1 = L_2$ .

Reason is for any PDA which accepts by final state there is an equivalent PDA (equivalent means that accepts the same language) which accepts by empty stack and vice-versa.

Now, this is not the case for DPDA's.

The set of languages accepted by a DPDA by empty stack is a strict subset of the set of languages accepted by a DPDA by final state.

It can also be said that set of languages accepted by a DPDA by empty stack is the set of languages accepted by a DPDA by final state and which has the prefix property.

A language has prefix property means if  $w \in L$ , then no prefix of  $w \in L$ .

From the above definition of prefix property it must be clear why DPDA by empty stack has this property. If any prefix of a word  $w$  ( $w$  in  $L$ ) is in  $L$  means the stack should have been empty even before completely processing  $w$ . But, being a deterministic PDA, once the stack becomes empty, the DPDA accepts and halts. So, in no way can a DPDA accept  $w$  and its prefix.

PS: A DPDA with acceptance by empty stack cannot even accept all regular languages- example  $a^*$ .

Good read: [http://www.cs.ucr.edu/~jiang/cs150/slides4week7\\_PDA+EquivToCFG.pdf](http://www.cs.ucr.edu/~jiang/cs150/slides4week7_PDA+EquivToCFG.pdf)

17 votes

-- gatecse (10.7k points)

### 19.10.9 Pda: GATE 2016-1-43 [top](#)

<http://gateoverflow.in/3972>



Selected Answer

Strings accepted at  
 $I^{st}$  final state are  
 $a^n$ ,  $n \geq 0$  and strings accepted at  
 $II^{nd}$  final state are  
 $a^n b^n$ ,  $n \geq 0$  (actually  
 $n \geq 1$  at this state,  
 $n = 0$  already included at first state).

$$L = \{a^n \mid n \geq 0\} \cup \{a^n b^n \mid n \geq 0\}$$

Language is deterministic context-free accepted by DPDA (dpda is already given) and so by TM too, and not regular (as we need stack to implement it), and so cannot be accepted by FA

26 votes

-- Praveen Saini (38.4k points)

### 19.10.10 Pda: GATE2006-IT\_33 [top](#)

<http://gateoverflow.in/3572>



Selected Answer

for every a we put two X in stack [at state s]

after that for every b we pop out one X [reach to state t (getting b after a)]

after that for every c we pop out one X [reach to state u (getting c after b)]

if all X are popped out then reached to final state f , mean for every b there is a, for every c there is a .

a was followed by b and b was followed by c [ state s to t , t to u , u to f, final]

means sum of no of b's and no of c's = twice of no of a's [ one a for one b , one a for one c ]

i.e.  $\{a^l b^m c^n \mid 2l = m + n\}$

11 votes

-- Praveen Saini (38.4k points)

## 19.11

### Pumping Lemma top

#### 19.11.1 Pumping Lemma: GATE2005-IT\_40 top

<http://gateoverflow.in/3787>

A language L satisfies the Pumping Lemma for regular languages, and also the Pumping Lemma for context-free languages. Which of the following statements about L is TRUE?

- A) L is necessarily a regular language.
- B) L is necessarily a context-free language, but not necessarily a regular language.
- C) L is necessarily a non-regular language.
- D) None of the above

[gate2005-it](#) [theory-of-computation](#) [pumping-lemma](#) [easy](#)

Answer

### Answers: Pumping Lemma

#### 19.11.1 Pumping Lemma: GATE2005-IT\_40 top

<http://gateoverflow.in/3787>



Selected Answer

answer is (D).If a language is regular ,it definitely satisfies pumping lemma.But converse need not be true. If language satisfies pumping lemma then it may or may not be regular.

7 votes

-- Rajat Sharma (373 points)

## 19.12

### Recursive Recursively Enumerable top

#### 19.12.1 Recursive Recursively Enumerable: GATE2015-1\_3 top

<http://gateoverflow.in/8019>

For any two languages  $L_1$  and  $L_2$  such that  $L_1$  is context-free and  $L_2$  is recursively enumerable but not recursive, which of the following is/are necessarily true?

- I.  $\bar{L}_1$  ( Compliment of  $L_1$ ) is recursive
- II.  $\bar{L}_2$  ( Compliment of  $L_2$ ) is recursive
- III.  $\bar{L}_1$  is context-free
- IV.  $\bar{L}_1 \cup L_2$  is recursively enumerable

- A. I only
- B. III only
- C. III and IV only
- D. I and IV only

[gate2015-1](#) [theory-of-computation](#) [recursive-recursively-enumerable](#) [normal](#)
**Answer**

### 19.12.2 Recursive Recursively Enumerable: TIFR2010-B-40 [top](#)

<http://gateoverflow.in/19048>

Which of the following statement is FALSE?

- All recursive sets are recursively enumerable.
- The complement of every recursively enumerable sets is recursively enumerable.
- Every Non-empty recursively enumerable set is the range of some totally recursive function.
- All finite sets are recursive.
- The complement of every recursive set is recursive.

[tifr2010](#) [theory-of-computation](#) [recursive-recursively-enumerable](#)
**Answer**

### 19.12.3 Recursive Recursively Enumerable: TIFR2012-B-19 [top](#)

<http://gateoverflow.in/25218>

Which of the following statements is TRUE?

- Every turning machine recognizable language is recursive.
- The complement of every recursively enumerable language is recursively enumerable.
- The complement of a recursive language is recursively enumerable.
- The complement of a context-free language is context-free.
- The set of turning machines which do not halt on empty input forms a recursively enumerable set.

[tifr2012](#) [theory-of-computation](#) [recursive-recursively-enumerable](#)
**Answer**

### 19.12.4 Recursive Recursively Enumerable: GATE 2016-2-44 [top](#)

<http://gateoverflow.in/39596>

Consider the following languages.

$$\begin{aligned} L_1 &= \{\langle M \rangle \mid M \text{ takes at least 2016 steps on some input}\}, \\ L_2 &= \{\langle M \rangle \mid M \text{ takes at least 2016 steps on all inputs}\} \text{ and} \\ L_3 &= \{\langle M \rangle \mid M \text{ accepts } \epsilon\}, \end{aligned}$$

where for each Turing machine  $M$ ,  $\langle M \rangle$  denotes a specific encoding of  $M$ . Which one of the following is TRUE?

- $L_1$  is recursive and  $L_2, L_3$  are not recursive
- $L_2$  is recursive and  $L_1, L_3$  are not recursive
- $L_1, L_2$  are recursive and  $L_3$  is not recursive
- $L_1, L_2, L_3$  are recursive

[gate2016-2](#) [theory-of-computation](#) [recursive-recursively-enumerable](#) [normal](#)
**Answer**

### 19.12.5 Recursive Recursively Enumerable: GATE 2016-1-44 [top](#)

<http://gateoverflow.in/39721>

Let  $X$  be a recursive language and  $Y$  be a recursively enumerable but not recursive language. Let  $W$  and  $Z$  be two languages such that  $\bar{Y}$  reduces to  $W$ , and  $Z$  reduces to  $\bar{X}$  (reduction means the standard many-one reduction). Which one of the following statements is TRUE?

- $W$  can be recursively enumerable and  $Z$  is recursive.
- $W$  can be recursive and  $Z$  is recursively enumerable.
- $W$  is not recursively enumerable and

- $Z$  is recursive.
- D.  $W$  is not recursively enumerable and  
 $Z$  is not recursive.

gate2016-1 theory-of-computation recursive-recursively-enumerable easy

Answer

### 19.12.6 Recursive Recursively Enumerable: GATE2014-2\_16 [top](#)

<http://gateoverflow.in/1972>

Let  $A \leq_m B$  denotes that language A is mapping reducible (also known as many-to-one reducible) to language B. Which one of the following is FALSE?

- (A) If  $A \leq_m B$  and B is recursive then A is recursive.
- (B) If  $A \leq_m B$  and A is undecidable then B is undecidable.
- (C) If  $A \leq_m B$  and B is recursively enumerable then A is recursively enumerable.
- (D) If  $A \leq_m B$  and B is not recursively enumerable then A is not recursively enumerable.

gate2014-2 theory-of-computation recursive-recursively-enumerable decidability normal

Answer

### 19.12.7 Recursive Recursively Enumerable: GATE2014-2\_35 [top](#)

<http://gateoverflow.in/1994>

Let  $\langle M \rangle$  be the encoding of a Turing machine as a string over  $\Sigma = \{0, 1\}$ . Let

$$L = \{\langle M \rangle \mid M \text{ is a Turing machine that accepts a string of length 2014}\}.$$

Then  $L$  is

- A. decidable and recursively enumerable  
 B. undecidable but recursively enumerable  
 C. undecidable and not recursively enumerable  
 D. decidable but not recursively enumerable

gate2014-2 theory-of-computation recursive-recursively-enumerable decidability normal

Answer

### 19.12.8 Recursive Recursively Enumerable: GATE2005\_56 [top](#)

<http://gateoverflow.in/1379>

Let  $L_1$  be a recursive language, and let  $L_2$  be a recursively enumerable but not a recursive language. Which one of the following is TRUE?

- A.  $L_1'$  is recursive and  $L_2'$  is recursively enumerable  
 B.  $L_1'$  is recursive and  $L_2'$  is not recursively enumerable  
 C.  $L_1'$  and  $L_2'$  are recursively enumerable  
 D.  $L_1'$  is recursively enumerable and  $L_2'$  is recursive

gate2005 theory-of-computation recursive-recursively-enumerable decidability easy

Answer

### 19.12.9 Recursive Recursively Enumerable: GATE2014-1\_35 [top](#)

<http://gateoverflow.in/1810>

Let

$L$  be a language and  $\bar{L}$  be its complement. Which one of the following is **NOT** a viable possibility?

- (A) Neither  $L$  nor  $\bar{L}$  is recursively enumerable (r.e.).
- (B) One of  $L$  and  $\bar{L}$  is r.e. but not recursive; the other is not r.e.
- (C) Both  $L$  and  $\bar{L}$  are r.e. but not recursive.
- (D) Both  $L$  and  $\bar{L}$  are recursive.

gate2014-1 theory-of-computation recursive-recursively-enumerable decidability easy

Answer

### 19.12.10 Recursive Recursively Enumerable: GATE2010-17 [top](#)

<http://gateoverflow.in/2190>

Let  $L_1$  be the recursive language. Let  $L_2$  and  $L_3$  be languages that are recursively enumerable but not recursive. Which of the following statements is not necessarily true?

- A.  $L_2 - L_1$  is recursively enumerable.
- B.  $L_1 - L_3$  is recursively enumerable.
- C.  $L_2 \cap L_3$  is recursively enumerable.
- D.  $L_2 \cup L_3$  is recursively enumerable.

gate2010 theory-of-computation recursive-recursively-enumerable decidability normal

Answer

## Answers: Recursive Recursively Enumerable

### 19.12.1 Recursive Recursively Enumerable: GATE2015-1\_3 [top](#)

<http://gateoverflow.in/8019>



Selected Answer

D.

$L_1$  is context-free and hence recursive also. Recursive set being closed under complement,  $L_1'$  will be recursive.

$L_1'$  being recursive it is also recursively enumerable and Recursively Enumerable set is closed under Union. So,  $L_1' \cup L_2$  is recursively enumerable.

Context free languages are not closed under complement- so III is false

Recursive set is closed under complement. So, if  $L_2'$  is recursive,  $(L_2')' = L_2$  is also recursive which is not the case here. So, II is also false.

15 votes

-- Arjun Suresh (150k points)

### 19.12.2 Recursive Recursively Enumerable: TIFR2010-B-40 [top](#)

<http://gateoverflow.in/19048>



Selected Answer

B) The complement of every recursively enumerable sets is recursively enumerable.  
because RE language are not closed under complement.

6 votes

-- Umang Raman (11.3k points)

**19.12.3 Recursive Recursively Enumerable: TIFR2012-B-19** [top](#)<http://gateoverflow.in/25218>

Selected Answer

- a. False. Turing recognizable languages are recursive enumerable and recursive set is a **proper subset** of it.
- b. False, Complement of r.e. **need not** be r.e.
- c. True. Complement of recursive language is recursive and every recursive language is recursive enumerable.
- d. False. Complement of CFL **need not** be CFL (but is guaranteed to be a CSL).
- e. False. **NOT halt** on empty, yes ans not possible. Only no ans is there. So it will be non r.e. while its complement is r.e. but not recursive.

5 votes

-- srestha (27.8k points)

**19.12.4 Recursive Recursively Enumerable: GATE 2016-2-44** [top](#)<http://gateoverflow.in/39596>

Selected Answer

$L_3$  is not recursive as it asks if  $L(M)$  contains  $\epsilon$  which is a non-trivial property of r.e. languages and hence undecidable as per Rice's theorem.

$L_1$  and  $L_2$  are slightly trickier as these are not describing properties of recursively enumerable languages, but rather of Turing machines. So, we can see if there is some procedure for deciding these.

For  $L_1$  we can give the TM an input of length 2016. Now, it should at least make 2016 steps or reach the halt state before completing the input processing. The second case is possible only if the TM reaches a halt state before reaching the end of string (blank) of input, for all possible inputs of length at least 2016 and can be decided. So, we can be sure that otherwise TM will have at least 2016 steps making  $L_1$  recursive.

$L_2$  is recursive and it is more easier to prove. For the complement of  $L_2$  we need  $M$  to make less than 2016 steps for some input and we can just give it all possible inputs of length less than 2016 and see if it reaches a halt state within 2016 steps. Thus complement of  $L_2$  is recursive  $\implies L_2$  is recursive.

So, answer here is C.

15 votes

-- Arjun Suresh (150k points)

**19.12.5 Recursive Recursively Enumerable: GATE 2016-1-44** [top](#)<http://gateoverflow.in/39721>

Selected Answer

$X$  is recursive language, so  
 $\overline{X}$  is also recursive.

$Y$  is recursively enumerable, but not recursive so  
 $\overline{Y}$  is not recursively enumerable language.

$A \leq B$ , (A is reducible to B), i.e., solving A cannot be "harder" than solving B.

1. if A is reducible to B, and B is decidable, then A is decidable.

i) if A is reducible to B, and B is recursive, then A is recursive.

2. if A is undecidable, and reducible to B, then B is undecidable.

i) if B is recursively enumerable, and A is reducible to B, then A is recursively enumerable.

ii) if A is not recursively enumerable, and reducible to B, then B is not recursively enumerable.

Now Back to question.

$\overline{Y}$  is not recursively enumerable, and reducible to  $\overline{W}$ , then  
 $\overline{W}$  is not recursively enumerable (using 2(ii)).

$Z$  is reducible to

$\overline{X}$  and

$\overline{X}$  is recursive, then

$Z$  is recursive (using 1(i)).

Option C is correct

20 votes

-- Praveen Saini (38.4k points)

### 19.12.6 Recursive Recursively Enumerable: GATE2014-2\_16 [top](#)



Selected Answer

$A \leq_m B$  means A cannot be harder than B. (Since A can be reduced to B, instead of deciding A, we can now decide B)

So, the first 3 options are correct. Option (D) is false, as B is not recursively enumerable doesn't guarantee A is not recursively enumerable.

7 votes

-- Arjun Suresh (150k points)

### 19.12.7 Recursive Recursively Enumerable: GATE2014-2\_35 [top](#)



Selected Answer

There are only a finite number of strings of length 2014. So, we can give all those strings to TM simulating each string for 1 step, then 2 step and so on (dovetailing), and if the TM accepts any of them ("yes" case of TM), we can say "yes". So, L is recursively enumerable.

(If the TM doesn't accept any string of length 2014, it can go to an infinite loop ("no" case of TM), and hence we can't say the method is decidable).

Now, to prove whether the problem is decidable or not we can make use of Rice's theorem. Rice's theorem (I) states that any non-trivial property of L(TM) is undecidable. L(TM) has a string of length 2014 is a non-trivial property as there are TMs whose language contains such a string and there are TMs whose language doesn't have such a string. So, the given problem is undecidable.

[http://gatecse.in/wiki/Rice%27s\\_Theorem\\_with\\_Examples](http://gatecse.in/wiki/Rice%27s_Theorem_with_Examples)

21 votes

-- Arjun Suresh (150k points)

### 19.12.8 Recursive Recursively Enumerable: GATE2005\_56 [top](#)



Selected Answer

$L_1$  being recursive, we have a TM M for  $L_1$  which accepts all words in  $L_1$  and rejects all words in  $L_1'$ . So, this TM also works for  $L_1'$  by changing the accept and reject states. Thus  $L_1'$  is recursive.

$L_2$  being recursively enumerable but not recursive means TM for  $L_2$  can accept all words in  $L_2$  but cannot reject all words not in  $L_2$  => TM for  $L_2'$  cannot exist (as otherwise TM for  $L_2$  could simulate the moves of that TM to reject words in  $L_2'$ )=>  $L_2'$  is not recursively enumerable. So, (B).

9 votes

-- Arjun Suresh (150k points)

**19.12.9 Recursive Recursively Enumerable: GATE2014-1\_35** [top](#)<http://gateoverflow.in/1810>

Selected Answer

(C) is not possible. If  $L$  is re we have a TM that accepts string in  $L$ . If  $L'$  is re, we have a TM that accepts strings in  $L'$ . So, using both these TMs we can make a new TM  $M$  which accepts strings in  $L$  and rejects strings in  $L'$  - that is  $M$  decides  $L$ , making  $L$  recursive.

13 votes

-- Arjun Suresh (150k points)

**19.12.10 Recursive Recursively Enumerable: GATE2010-17** [top](#)<http://gateoverflow.in/2190>

Selected Answer

Recursively enumerable languages are closed under union and intersection. So, lets consider each option

$$(A) L_2 - L_1 = L_2 \cap \overline{L_1}$$

Recursive languages are closed under complement, and so  $\overline{L_1}$  is recursive and hence recursively enumerable also. So,  $L_2 \cap \overline{L_1}$  is recursively enumerable is always TRUE.

$$(B) L_1 - L_3 = L_1 \cap \overline{L_3}$$

Recursively enumerable languages are not closed under complement. So,  $\overline{L_3}$  may or may not be recursively enumerable and hence we can't say anything if  $L_1 \cap \overline{L_3}$  is recursively enumerable or not.

(C) Intersection of two recursively enumerable languages is always recursively enumerable(RE closed under intersection).

(D) Union of two recursively enumerable languages is always recursively enumerable(RE closed under union).

For verifying closure properties:

[http://gatcse.in/wiki/Closure\\_Property\\_of\\_Language\\_Families](http://gatcse.in/wiki/Closure_Property_of_Language_Families)

26 votes

-- Arjun Suresh (150k points)

**19.13****Regular Expressions** [top](#)**19.13.1 Regular Expressions: GATE2000-1.4** [top](#)<http://gateoverflow.in/627>

Let  $S$  and  $T$  be languages over  $\Sigma = \{a, b\}$  represented by the regular expressions  $(a + b^*)^*$  and  $(a + b)^*$ , respectively. Which of the following is true?

- A.  $S \subset T$
- B.  $T \subset S$
- C.  $S = T$
- D.  $S \cap T = \emptyset$

[gate2000](#) [theory-of-computation](#) [regular-expressions](#) [easy](#)

Answer

**19.13.2 Regular Expressions: TIFR2010-B-34** [top](#)<http://gateoverflow.in/19047>

Let  $r, s, t$  be regular expressions. Which of the following identities is correct?

- a.  $(r + s)^* = r^* s^*$

- b.  $r(s+t) = rs + rt$   
 c.  $(r+s)^* = r^* + s^*$   
 d.  $(rs+r)^*r = r(sr+r)^*$   
 e.  $(r^*s)^* = (rs)^*$

tifr2010 theory-of-computation regular-expressions

Answer

### 19.13.3 Regular Expressions: GATE1998\_1.9 [top](#)

<http://gateoverflow.in/1646>

If the regular set  $A$  is represented by  $A = (01+1)^*$  and the regular set  $B$  is represented by  $B = ((01)^*1^*)^*$ , which of the following is true?

- (a)  $A \subset B$   
 (b)  $B \subset A$   
 (c)  $A$  and  $B$  are incomparable  
 (d)  $A = B$

gate1998 theory-of-computation regular-expressions normal

Answer

### 19.13.4 Regular Expressions: GATE1995\_1.9 [top](#)

<http://gateoverflow.in/2596>

In some programming language, an identifier is permitted to be a letter followed by any number of letters or digits. If  $L$  and  $D$  denote the sets of letters and digits respectively, which of the following expressions defines an identifier?

- (a)  $(L \cup D)^+$   
 (b)  $L(L \cup D)^*$   
 (c)  $(LD)^*$   
 (d)  $L(LD)^*$

gate1995 theory-of-computation regular-expressions easy

Answer

### 19.13.5 Regular Expressions: GATE1998\_1.12 [top](#)

<http://gateoverflow.in/1649>

The string 1101 does not belong to the set represented by

- (a)  $110^*(0+1)$   
 (b)  $1(0+1)^*101$   
 (c)  $(10)^*(01)^*(00+11)^*$   
 (d)  $(00+(11)^*0)^*$

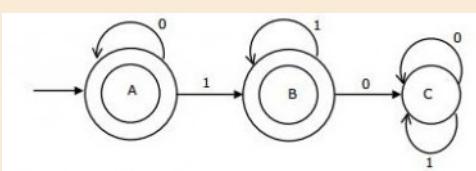
gate1998 theory-of-computation regular-expressions easy

Answer

### 19.13.6 Regular Expressions: GATE1994\_2.10 [top](#)

<http://gateoverflow.in/2477>

The regular expression for the language recognized by the finite state automaton of figure is \_\_\_\_\_



[gate1994](#) [theory-of-computation](#) [finite-automata](#) [regular-expressions](#) [easy](#)
**Answer**

### 19.13.7 Regular Expressions: TIFR2015-B-7 [top](#)

<http://gateoverflow.in/29861>

Let  $a, b, c$  be regular expressions. Which of the following identities is correct?

- a.  $(a + b)^* = a^*b^*$
- b.  $a(b + c) = ab + c$
- c.  $(a + b)^* = a^* + b^*$
- d.  $(ab + a)^*a = a(ba + a)^*$
- e. None of the above.

[tifr2015](#) [theory-of-computation](#) [regular-expressions](#)
**Answer**

### 19.13.8 Regular Expressions: GATE1992\_02,xvii [top](#)

<http://gateoverflow.in/575>

02. Choose the correct alternatives (more than one may be correct) and write the corresponding letters only:

Which of the following regular expression identities is/are TRUE?

- (a)  $r(^*) = r^*$
- (b)  $(r^*s^*) = (r + s)^*$
- (c)  $(r + s)^* = r^* + s^*$
- (d)  $r^*s^* = r^* + s^*$

[gate1992](#) [theory-of-computation](#) [regular-expressions](#) [easy](#)
**Answer**

### 19.13.9 Regular Expressions: GATE1998\_3b [top](#)

<http://gateoverflow.in/2941>

Give a regular expression for the set of binary strings where every 0 is immediately followed by exactly  $k$  1's and preceded by at least  $k$  1's ( $k$  is a fixed integer)

[gate1998](#) [theory-of-computation](#) [regular-expressions](#) [easy](#)
**Answer**

### 19.13.10 Regular Expressions: GATE2010-39 [top](#)

<http://gateoverflow.in/2340>

Let  $L = \{w \in (0 + 1)^* \mid w \text{ has even number of } 1s\}$ . i.e.,  $L$  is the set of all the bit strings with even numbers of 1s. Which one of the regular expressions below represents  $L$ ?

- A.  $(0^*10^*1)^*$
- B.  $0^*(10^*10^*)^*$
- C.  $0^*(10^*1)^*0^*$
- D.  $0^*1(10^*1)^*10^*$

[gate2010](#) [theory-of-computation](#) [regular-expressions](#) [normal](#)
**Answer**

### 19.13.11 Regular Expressions: GATE1991\_03,xiii [top](#)

<http://gateoverflow.in/527>

Choose the correct alternatives (more than one may be correct) and write the corresponding letters only.

Let  $r = 1(1 + 0)^*$ ,  $s = 11^*0$  and  $t = 1^*0$  be three regular expressions. Which one of the following is true?

- A.  $L(s) \subseteq L(r)$  and  $L(s) \subseteq L(t)$

- B.  $L(r) \subseteq L(s)$  and  $L(s) \subseteq L(t)$   
 C.  $L(s) \subseteq L(t)$  and  $L(s) \subseteq L(r)$   
 D.  $L(t) \subseteq L(s)$  and  $L(s) \subseteq L(r)$   
 E. None of the above

gate1991 theory-of-computation regular-expressions normal

Answer

### 19.13.12 Regular Expressions: GATE1997\_6.4 [top](#)

<http://gateoverflow.in/2260>

- Which one of the following regular expressions over  $\{0, 1\}$  denotes the set of all strings not containing 100 as substring?
- (a)  $0^*(1 + 0)^*$   
 (b)  $0^*1010^*$   
 (c)  $0^*1^*01^*$   
 (d)  $0^*(10 + 1)^*$

gate1997 theory-of-computation regular-expressions normal

Answer

### 19.13.13 Regular Expressions: GATE 2016-1-18 [top](#)

<http://gateoverflow.in/39647>

Which one of the following regular expressions represents the language: *the set of all binary strings having two consecutive 0's and two consecutive 1's*?

- A.  $(0 + 1)^*0011(0 + 1)^* + (0 + 1)^*1100(0 + 1)^*$   
 B.  $(0 + 1)^*(00(0 + 1)^*11 + 11(0 + 1)^*00)(0 + 1)^*$   
 C.  $(0 + 1)^*00(0 + 1)^* + (0 + 1)^*11(0 + 1)^*$   
 D.  $00(0 + 1)^*11 + 11(0 + 1)^*00$

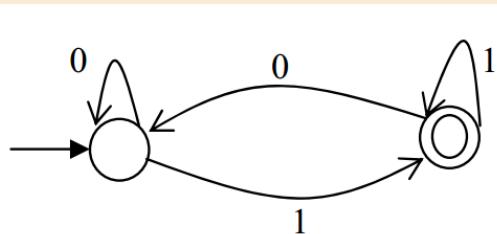
gate2016-1 theory-of-computation regular-expressions normal

Answer

### 19.13.14 Regular Expressions: GATE2014-1\_36 [top](#)

<http://gateoverflow.in/1914>

Which of the regular expressions given below represent the following DFA?



- I.  $0^*1(1 + 00^*1)^*$   
 II.  $0^*1^*1 + 11^*0^*1$   
 III.  $(0 + 1)^*1$

- (A) I and II only  
 (B) I and III only  
 (C) II and III only

(D) I, II and III

gate2014-1 theory-of-computation regular-expressions finite-automata easy

Answer

**19.13.15 Regular Expressions: GATE2014-3\_15** [top](#)<http://gateoverflow.in/2049>The length of the shortest string NOT in the language (over  $\Sigma = \{a, b\}$ ) of the following regular expression is \_\_\_\_\_.

$$a^*b^*(ba)^*a^*$$

gate2014-3 theory-of-computation regular-expressions numerical-answers easy

Answer

**19.13.16 Regular Expressions: GATE1996\_1.8** [top](#)<http://gateoverflow.in/2712>Which two of the following four regular expressions are equivalent? ( $\epsilon$  is the empty string).

- i.  $(00)^*(\epsilon + 0)$
- ii.  $(00)^*$
- iii.  $0^*$
- iv.  $0(00)^*$

- A. (i) and (ii)
- B. (ii) and (iii)
- C. (i) and (iii)
- D. (iii) and (iv)

gate1996 theory-of-computation regular-expressions easy

Answer

**19.13.17 Regular Expressions: Gateforum test series** [top](#)<http://gateoverflow.in/70908>

Identify the regular expression which represents the language containing all strings of a's and b's where each string contains at least two b's

Identify the regular expression which represents the language containing all strings of a's and b's where each string contains at least two b's.

- |                           |                     |
|---------------------------|---------------------|
| (A) $(a+b)^*ba^*b$        | (B) $(a+b)^*ba^*ba$ |
| (C) $(a+b)^*ba^*b(a+b)^*$ | (D) None of these   |

theory-of-computation regular-expressions gateforum-test-series

Answer

**19.13.18 Regular Expressions: GATE2008-IT\_5** [top](#)<http://gateoverflow.in/3265>

Which of the following regular expressions describes the language over {0, 1} consisting of strings that contain exactly two 1's?

- A)  $(0 + 1)^* 11(0 + 1)^*$
- B)  $0^* 110^*$
- C)  $0^* 10^* 10^*$
- D)  $(0 + 1)^* 1(0 + 1)^* 1 (0 + 1)^*$

gate2008-it theory-of-computation regular-expressions easy

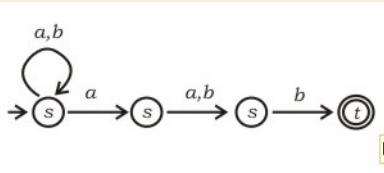
**Answer****19.13.19 Regular Expressions: GATE2009-15** [top](#)<http://gateoverflow.in/1307>

Which one of the following languages over the alphabet  $\{0,1\}$  is described by the regular expression:  $(0+1)^*0(0+1)^*0(0+1)^*$ ?

- A. The set of all strings containing the substring 00
- B. The set of all strings containing at most two 0's
- C. The set of all strings containing at least two 0's
- D. The set of all strings that begin and end with either 0 or 1

[gate2009](#) [theory-of-computation](#) [regular-expressions](#) [easy](#)**Answer****19.13.20 Regular Expressions: GATE2006-IT\_5** [top](#)<http://gateoverflow.in/3544>

Which regular expression best describes the language accepted by the non-deterministic automaton below?



- A)  $(a+b)^* a(a+b)b$
- B)  $(abb)^*$
- C)  $(a+b)^* a(a+b)^* b(a+b)^*$
- D)  $(a+b)^*$

[gate2006-it](#) [theory-of-computation](#) [regular-expressions](#) [normal](#)**Answer****19.13.21 Regular Expressions: GATE2004-IT\_7** [top](#)<http://gateoverflow.in/3648>

Which one of the following regular expressions is NOT equivalent to the regular expression  $(a+b+c)^*$ ?

- A)  $(a^* + b^* + c^*)^*$
- B)  $(a^*b^*c^*)^*$
- C)  $((ab)^* + c^*)^*$
- D)  $(a^*b^* + c^*)^*$

[gate2004-it](#) [theory-of-computation](#) [regular-expressions](#) [normal](#)**Answer****19.13.22 Regular Expressions: GATE2003\_14** [top](#)<http://gateoverflow.in/905>

The regular expression  $0^*(10^*)^*$  denotes the same set as

- (A)  $(1^*0)^*1^*$
- (B)  $0 + (0+10)^*$
- (C)  $(0+1)^*10(0+1)^*$
- (D) None of the above

[gate2003](#) [theory-of-computation](#) [regular-expressions](#) [easy](#)**Answer**

**19.13.23 Regular Expressions: GATE2005-IT\_5** [top](#)<http://gateoverflow.in/3749>

Which of the following statements is TRUE about the regular expression  $01^*0$ ?

- A) It represents a finite set of finite strings.
- B) It represents an infinite set of finite strings.
- C) It represents a finite set of infinite strings.
- D) It represents an infinite set of infinite strings.

[gate2005-it](#) [theory-of-computation](#) [regular-expressions](#) [easy](#)

[Answer](#)

**19.13.24 Regular Expressions: GATE2007-IT\_73** [top](#)<http://gateoverflow.in/3525>

Consider the regular expression  $R = (a + b)^* (aa + bb) (a + b)^*$

Which one of the regular expressions given below defines the same language as defined by the regular expression  $R$ ?

- A)  $(a(ba)^* + b(ab)^*)(a + b)^+$
- B)  $(a(ba)^* + b(ab)^*)^*(a + b)^*$
- C)  $(a(ba)^* (a + bb) + b(ab)^*(b + aa))(a + b)^*$
- D)  $(a(ba)^* (a + bb) + b(ab)^*(b + aa))(a + b)^+$

[gate2007-it](#) [theory-of-computation](#) [regular-expressions](#) [normal](#)

[Answer](#)

**19.13.25 Regular Expressions: GATE2015-2\_35** [top](#)<http://gateoverflow.in/8159>

Consider the alphabet  $\Sigma = \{0, 1\}$ , the null/empty string  $\lambda$  and the set of strings  $X_0, X_1$ , and  $X_2$  generated by the corresponding non-terminals of a regular grammar.  $X_0, X_1$ , and  $X_2$  are related as follows.

$$\begin{aligned}X_0 &= 1X_1 \\X_1 &= 0X_1 + 1X_2 \\X_2 &= 0X_1 + \{\lambda\}\end{aligned}$$

Which one of the following choices precisely represents the strings in  $X_0$ ?

- A.  $10(0^*+(10)^*)1$
- B.  $10(0^*+(10)^*)^*1$
- C.  $1(0+10)^*1$
- D.  $10(0+10)^*1 + 110(0+10)^*1$

[gate2015-2](#) [theory-of-computation](#) [regular-expressions](#) [grammar](#) [normal](#)

[Answer](#)

**Answers: Regular Expressions****19.13.1 Regular Expressions: GATE2000-1.4** [top](#)<http://gateoverflow.in/627>

Selected Answer

(c)  $S = T$ . Both generates all strings over  $\Sigma$ .

10 votes

-- Arjun Suresh (150k points)

**19.13.2 Regular Expressions: TIFR2010-B-34** [top](#)<http://gateoverflow.in/19047>

Selected Answer

- a.  $(r + s)^* = r^*s^*$  LHS can generate 'sr' but RHS not
- b.  $r(s + t) = rs + t$  LHS can generate 'rt' but RHS not
- c.  $(r + s)^* = r^* + s^*$  LHS can generate 'sr' but RHS not
- d.  $(rs + r)^* r = r(sr + r)^*$  They are equivalent
- e.  $(r^*s)^* = (rs)^*$  LHS can generate 'rrrs' but RHS not

So option D is correct answer.

8 votes

-- Umang Raman (11.3k points)

**19.13.3 Regular Expressions: GATE1998\_1.9** [top](#)<http://gateoverflow.in/1646>

Selected Answer

- (d)  $A = B$ . Both generates all strings over  $\{0, 1\}$  where a 0 is immediately followed by a 1.

8 votes

-- Arjun Suresh (150k points)

**19.13.4 Regular Expressions: GATE1995\_1.9** [top](#)<http://gateoverflow.in/2596>

Selected Answer

It is B.

It has to be started by a letter followed by any number of letters and digits.

13 votes

-- Gate Keeda (17.7k points)

**19.13.5 Regular Expressions: GATE1998\_1.12** [top](#)<http://gateoverflow.in/1649>

Selected Answer

Only (a) and (b) can generate 1101.

In (c) after 11, we can not have 01 and so 1101 cannot be generated.

In (d) Every 11 followed by some 0. So it cannot generate 1101 or 11011.

14 votes

-- Arjun Suresh (150k points)

**19.13.6 Regular Expressions: GATE1994\_2.10** [top](#)<http://gateoverflow.in/2477>

Selected Answer

$$L = 0^*1^*$$

$L$  contains all binary strings where a 1 is not followed by a 0.

10 votes

-- Manu Thakur (5.6k points)

**19.13.7 Regular Expressions: TIFR2015-B-7** [top](#)<http://gateoverflow.in/29861>

Selected Answer

a)  
 $(a + b)^* = \{ \text{any strings of over } \{a,b\} \}$

$a^*b^* = \{ \text{any number of } a's \text{ followed by any number of } b's \}$

**False**, as strings, ba , aba, bab, etc are not present in  
 $a^*b^*$

b)  
 $a(b + c) = \{ab, ac\}$

$ab + c = \{ab, c\}$

**False**

c)  
 $(a + b)^* = \{ \text{any strings of over } \{a,b\} \}$   
 $a^* + b^* = \{ \text{any numbers of } a's \text{ or any numbers of } b's \}$

**False** , as strings , ab, ba, aba, bab etc are not present in  
 $a^* + b^*$

d)  
 $(ab + a)^*a = a(ba + a)^* , \text{ True}$   
 $p(qp)^* = p\{\epsilon, qp, qpqp, qpqpqp, \dots\} = \{p, pqp, pqpqp, pqpqpqp, \dots\} = \{\epsilon, pq, pqpq, pqpqpq, \dots\}p = (pq)^*p$   
 $(ab + a)^*a = (a(b + \epsilon))^*a = a((b + \epsilon)a)^* = a(ba + a)^*$

11 votes

-- Praveen Saini (38.4k points)

**19.13.8 Regular Expressions: GATE1992\_02,xvii** [top](#)<http://gateoverflow.in/575>

Selected Answer

(a) is the answer

(b) RHS generates  $\Sigma^*$  while LHS can't generate strings where  $r$  comes after  $s$  like  $sr, srr$  etc. LHS  $\subset$  RHS.

(c) LHS generates  $\Sigma^*$  while RHS can't generate strings where  $r$  comes after an  $s$ . RHS  $\subset$  LHS.

(d) LHS contains all strings where after an  $s$ , no  $r$  comes. RHS contains all strings of either  $r$  or  $s$  but no combination of them. So, RHS  $\subset$  LHS.

12 votes

-- Arjun Suresh (150k points)

**19.13.9 Regular Expressions: GATE1998\_3b** [top](#)<http://gateoverflow.in/2941>

Selected Answer

The expression will be of the form  $1^*1^k(01^k)^*$ .

6 votes

-- neha pawar (3.8k points)

**19.13.10 Regular Expressions: GATE2010-39** [top](#)<http://gateoverflow.in/2340>



Selected Answer

- (A) - If the string contains a 1, it must end in a 1 hence cannot generate all bit strings with even number of 1's (eg, 1010)  
 (B) - is the answer  
 (C) - between the second and third 1's a 0 is not allowed (eg, 011011)  
 (D) - 00 is not allowed, zero is an even number.

20 votes

-- Arjun Suresh (150k points)

### 19.13.11 Regular Expressions: GATE1991\_03,xiii [top](#)

<http://gateoverflow.in/527>

Selected Answer

ans is A and C

to know the ans let us check all the options.

a)  $L(s) \subseteq L(r)$ : strings generated by  $s$  are any numbers of 1's followed by one 0, i.e., 10, 110, 1110, 1110, .... Strings generated by  $r$  are 1 followed by any combination of 0 or 1, i.e., 1, 10, 11, 1110, 101, 110.... This shows that all the strings that can be generated by  $s$ , can also be generated by  $r$  it means  $L(s) \subseteq L(r)$  is true.

$L(s) \subseteq L(t)$ : here strings generated by  $t$  are any numbers of 1 (here  $1^*$  means we have strings as  $\epsilon, 1, 11, 111, \dots$ ) followed by only one 0, i.e., 0, 10, 110, 1110, .... So we can see that all the strings that are present in  $s$  can also be generated by  $t$ , hence  $L(s) \subseteq L(t)$  which shows that option A is true.

b)  $L(r) \subseteq L(s)$  : this is false because string 1 which can be generated by  $r$ , cannot be generated by  $s$ .

c) Same as option A.

d)  $L(t) \subseteq L(s)$  : this is false because string 0 which can be generated by  $t$ , cannot be generated by  $s$ .

11 votes

-- neha pawar (3.8k points)

### 19.13.12 Regular Expressions: GATE1997\_6.4 [top](#)

<http://gateoverflow.in/2260>

Selected Answer

"A regular expression denoting a language (set of strings) means it should generate all string in L and not generate any string not in L"

- (a) - generates 100  
 (b) doesn't generate 0 (start trying strings in lexicographic order- 0, 1, 00, 01, 10,...)  
 (c) doesn't generate 1  
 (d) is the answer

9 votes

-- Arjun Suresh (150k points)

### 19.13.13 Regular Expressions: GATE 2016-1-18 [top](#)

<http://gateoverflow.in/39647>

Selected Answer

Set of all binary strings having two consecutive 0s and two consecutive 1s

*Anything*  
 00 *Anything*  
 11*Anything* + *Anything*  
 11 *Anything*  
 00 *Anything*

$$(0+1)^*00(0+1)^*11(0+1)^* + (0+1)^*11(0+1)^*00(0+1)^*$$

And it is same after taking common.

$$(0+1)^*(00(0+1)^*11 + 11(0+1)^*00)(0+1)^*$$

Neither they said Both are immediate nor they give a predefined order, so it should be as above

1 21 votes

-- Praveen Saini (38.4k points)

### 19.13.14 Regular Expressions: GATE2014-1\_36 [top](#)

<http://gateoverflow.in/1914>



Selected Answer

(B) is the answer. (II) doesn't generate 11011 which is accepted by the given DFA

1 16 votes

-- Arjun Suresh (150k points)

### 19.13.15 Regular Expressions: GATE2014-3\_15 [top](#)

<http://gateoverflow.in/2049>



Selected Answer

$$R = a^*b^*(ba)^*a^*$$

for finding shortest string that is not in language it is better to look strings of length 0, then of length 1 and so on

length0 { } is in L

length1 {a, b} all belong to L

length2 {aa, ab, ba, bb} all belong to L

length 3 {aaa, aab, aba, abb, baa, bab, bba, bbb} **bab does not belong to L**

1 17 votes

-- Praveen Saini (38.4k points)

### 19.13.16 Regular Expressions: GATE1996\_1.8 [top](#)

<http://gateoverflow.in/2712>



Selected Answer

C.

you can have any no. of 0's as well as null.

A is false because you cannot have single 0 in ii). same for option B. In D you are forced to have single 0 in iv) whereas not in iii).

1 11 votes

-- Gate Keeda (17.7k points)

### 19.13.17 Regular Expressions: Gateforum test series [top](#)

<http://gateoverflow.in/70908>



Selected Answer

ans is C

Regular expression which represents the language containing all strings of a's and b's where each string contains at least two b's

is  $(a+b)^* b \ a^* \ b \ (a+b)^*$

option A does not accept bba

option B does not accept bbb

option C accept all

0 votes

-- Shubham Pandey (3.5k points)

Answer is c because it is represent acceptance of atleast 2 b

0 votes

-- sharmishtha paliwal (17 points)

### 19.13.18 Regular Expressions: GATE2008-IT\_5 [top](#)

<http://gateoverflow.in/3265>



Selected Answer

- A) with at least 2 consecutive 1's, any no of 0's and any no of 1's
- B) exactly two consecutive 1's
- C) exactly two 1's but need not be consecutive
- D) any no of 1's and 0's with at least two 1's

Hence C) is the correct option.

10 votes

-- Manu Thakur (5.6k points)

### 19.13.19 Regular Expressions: GATE2009-15 [top](#)

<http://gateoverflow.in/1307>



Selected Answer

(C) is the answer.

Counter example for other choices:

- (A) 1010 is accepted which doesn't contain 00
- (B) 000 is accepted
- (D) 01 is not accepted

10 votes

-- Arjun Suresh (150k points)

### 19.13.20 Regular Expressions: GATE2006-IT\_5 [top](#)

<http://gateoverflow.in/3544>



Selected Answer

Well A is answer

Say s1, s2 , s3 and t are states (in sequence)

s1 is start state

$s_1 = \epsilon + s_1a + s_1b = \epsilon + s_1(a+b) = (a+b)^*$  [using arden's theorem  $R = Q+RP$ , then  $R = QP^*$ ][ $\epsilon$  bcoz of start state]

$s_2 = s_1a = (a+b)^*a$

$s_3 = s_2a + s_2b = s_2(a+b) = (a+b)^*a(a+b)$

$t = s_3b = (a+b)^*a(a+b)b$

$t$  is final state so regular expression is  $(a+b)^*a(a+b)b$

Upvote 9 votes

-- Praveen Saini (38.4k points)

### 19.13.21 Regular Expressions: GATE2004-IT\_7 [top](#)



Selected Answer

- A)  $(a^* + b^* + c^*)^* = (\epsilon + a+aa+..+b+bb+...+c+cc...)^* = (a+b+c+aa+..+bb+..+cc+..)^* = (a+b+c)^*$   
[any combination of rest of aa, bb, cc, etc already come in  $(a+b+c)^*$  ]
- B)  $(a*b*c^*)^* = (a^*+b^*+c^* +a*b^*+b*c^*+a*c^*+..)^* = (a+b+c+....)^* = (a+b+c)^*$
- C)  $((ab)^* + c^*)^* = (ab+c+\epsilon+abab+...)^* = (ab+c)^*$
- D)  $(a*b^* + c^*)^* = (a^*+b^*+c^*+...)^* = (a+b+c+..)^* = (a+b+c)^*$

Upvote 10 votes

-- Praveen Saini (38.4k points)

### 19.13.22 Regular Expressions: GATE2003\_14 [top](#)



Selected Answer

- (A) is the answer. Both (A) and the given expression generates all strings over  $\Sigma$ .  
(B) doesn't generate 11  
(C) doesn't generate 11

Upvote 12 votes

-- Arjun Suresh (150k points)

### 19.13.23 Regular Expressions: GATE2005-IT\_5 [top](#)



Selected Answer

(B). Infinite set (because of \*) of finite strings. A string is defined as a **FINITE sequence** of characters and hence can never be infinite.

Upvote 10 votes

-- Arjun Suresh (150k points)

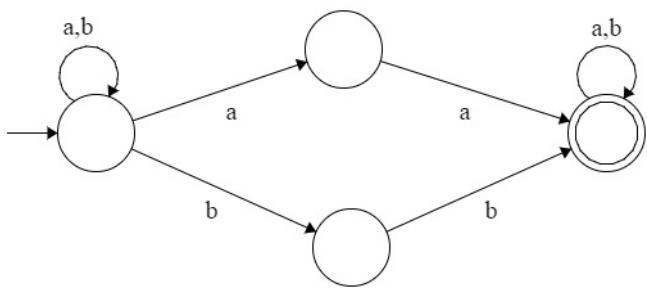
### 19.13.24 Regular Expressions: GATE2007-IT\_73 [top](#)



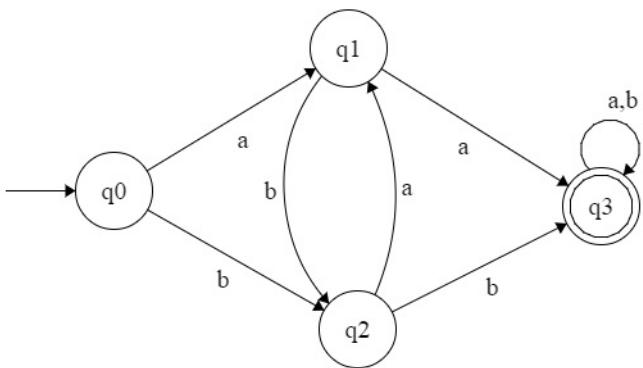
Selected Answer

$R = (a+b)^*(aa+bb)(a+b)^*$

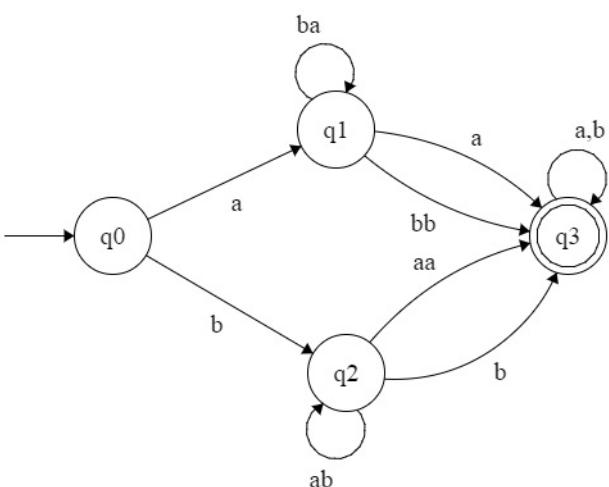
having NFA



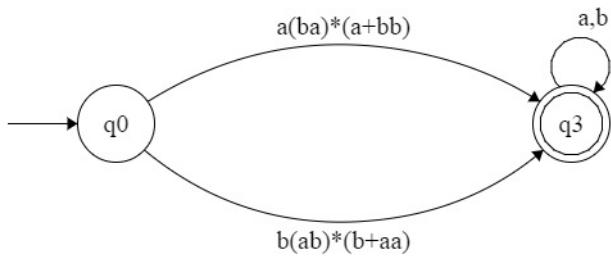
Equivalent DFA :



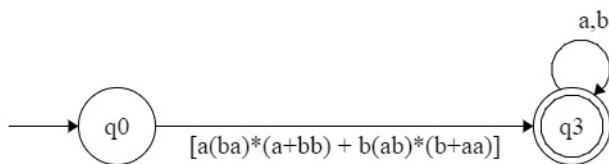
which is equivalent Transition graph [ by removing transition from q1 to q2 and q2 to q1 but does not effect on language ..be careful ]



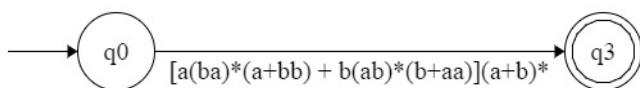
That is equivalent to



which is equivalent to



which is equivalent to



so equivalent regular expression is  $[a(ba)^*(a+bb) + b(ab)^*(b+aa)](a+b)^*$

so option C is answer.

13 votes

-- Praveen Saini (38.4k points)

### 19.13.25 Regular Expressions: GATE2015-2\_35 [top](#)

<http://gateoverflow.in/8159>



Selected Answer

Here we have little different version of Arden's Theorem

if we have  $R = PR + Q$  then it has a solution  $R = P^*Q$

Proof :

$$R = PR + Q$$

$$= P(PR+Q)+Q \quad (\text{by putting } R = PR+Q)$$

$$= PPR+PQ+Q$$

$$= PPP(PR+Q)+PQ+Q \quad (\text{by putting } R = PR+Q)$$

$$= PPPR+PPQ+PQ+Q$$

and so on , we get  $R = \{ \dots \dots \dots + PPPPQ+PPPQ+PPQ+PQ+Q \}$

$$= \{ \dots \dots \dots + PPPP+PPP+PP+P+ \} Q = P^*Q$$

or Another way

$$R = PR + Q$$

$= P(P^*Q) + Q \quad (\text{by putting } R = P^*Q)$

$=(PP^* + \lambda)Q = P^*Q$

So Equation is Proved .

Now for the Above Question

$X_1 = 0X_1 + 1X_2 \quad (\text{Equation 2})$

$= 0X_1 + 1(0X_1 + \lambda) \quad (\text{Put the value of } X_2 \text{ from Equation 3})$

$= 0X_1 + 10X_1 + 1 = (0+10)X_1 + 1$

$X_1 = (0+10)*1 \quad (\text{Apply if } R = PR + Q \text{ then } R = P^*Q)$

$X_0 = 1X_1 \quad (\text{Equation 1})$

$X_0 = 1(0+10)*1 \quad (\text{Put the value of } X_1 \text{ we calculated}).$

So  $1(0+10)*1$  option C is correct.

13 votes

-- Praveen Saini (38.4k points)

## 19.14

## Regular Set top

### 19.14.1 Regular Set: GATE2008-IT\_6 top

<http://gateoverflow.in/3266>

Let N be an NFA with n states and let M be the minimized DFA with m states recognizing the same language. Which of the following is NECESSARILY true?

- A)  $m \leq 2^n$
- B)  $n \leq m$
- C) M has one accept state
- D)  $m = 2^n$

[gate2008-it](#) [theory-of-computation](#) [regular-set](#) [normal](#)

Answer

### 19.14.2 Regular Set: GATE2006-IT\_30 top

<http://gateoverflow.in/3569>

Which of the following statements about regular languages is NOT true ?

- A) Every language has a regular superset
- B) Every language has a regular subset
- C) Every subset of a regular language is regular
- D) Every subset of a finite language is regular

[gate2006-it](#) [theory-of-computation](#) [regular-set](#) [easy](#)

Answer

### 19.14.3 Regular Set: GATE2014-2\_36 top

<http://gateoverflow.in/1995>

$L_1 = \{w \in \{0,1\}^* \mid w \text{ has at least as many occurrences of } (110)'s \text{ as } (011)'s\}$  . Let

$L_2 = \{w \in \{0,1\}^* \mid w \text{ has at least as many occurrences of } (000)'s \text{ as } (111)'s\}$  . Which one of the following is TRUE?

- (A)  $L_1$  is regular but not  $L_2$
- (B)  $L_2$  is regular but not  $L_1$

- (C) Both  $L_1$  and  $L_2$  are regular  
 (D) Neither  $L_1$  nor  $L_2$  are regular

gate2014-2 theory-of-computation regular-set normal

[Answer](#)

#### 19.14.4 Regular Set: GATE2006\_29 [top](#)

<http://gateoverflow.in/992>

If  $s$  is a string over  $(0+1)^*$  then let  $n_0(s)$  denote the number of 0's in  $s$  and  $n_1(s)$  the number of 1's in  $s$ . Which one of the following languages is not regular?

- (A)  $L = \{s \in (0+1)^* \mid n_0(s) \text{ is a 3-digit prime}\}$   
 (B)  $L = \{s \in (0+1)^* \mid \text{for every prefix } s' \text{ of } s, |n_0(s') - n_1(s')| \leq 2\}$   
 (C)  $L = \{s \in (0+1)^* \mid |n_0(s) - n_1(s)| \leq 4\}$   
 (D)  $L = \{s \in (0+1)^* \mid n_0(s) \bmod 7 = n_1(s) \bmod 5 = 0\}$

gate2006 theory-of-computation regular-set normal

[Answer](#)

#### 19.14.5 Regular Set: GATE2014-2\_15 [top](#)

<http://gateoverflow.in/1971>

If  $L_1 = \{a^n \mid n \geq 0\}$  and  $L_2 = \{b^n \mid n \geq 0\}$ , consider

- (I)  $L_1 \cdot L_2$  is a regular language  
 (II)  $L_1 \cdot L_2 = \{a^n b^n \mid n \geq 0\}$

Which one of the following is CORRECT?

- (A) Only (I)  
 (B) Only (II)  
 (C) Both (I) and (II)  
 (D) Neither (I) nor (II)

gate2014-2 theory-of-computation regular-set normal

[Answer](#)

#### 19.14.6 Regular Set: GATE2006-IT\_80 [top](#)

<http://gateoverflow.in/3624>

Let  $L$  be a regular language. Consider the constructions on  $L$  below:

- I. repeat ( $L$ ) =  $\{ww \mid w \in L\}$
- II. prefix ( $L$ ) =  $\{u \mid \exists v : uv \in L\}$
- III. suffix ( $L$ ) =  $\{v \mid \exists u : uv \in L\}$
- IV. half ( $L$ ) =  $\{u \mid \exists v : |v| = |u| \text{ and } uv \in L\}$

Which of the constructions could lead to a non-regular language?

- A) Both I and IV  
 B) Only I  
 C) Only IV  
 D) Both II and III

gate2006-it theory-of-computation regular-set normal

[Answer](#)

### 19.14.7 Regular Set: GATE2006-IT\_81 [top](#)

<http://gateoverflow.in/3637>

Let L be a regular language. Consider the constructions on L below:

- I. repeat (L) = {ww | w ∈ L}
- II. prefix (L) = {u | ∃v : uv ∈ L}
- III. suffix (L) = {v | ∃u uv ∈ L}
- IV. half (L) = {u | ∃v : |v| = |u| and uv ∈ L}

Which of the constructions could lead to a non-regular language?

- A. Both I and IV
- B. Only 1
- C. Only IV
- D. Both II and III

Which choice of L is best suited to support your answer above?

- A) (a + b)\*
- B) {ε, a, ab, bab}
- C) (ab)\*
- D) {a<sup>n</sup>b<sup>n</sup> | n ≥ 0}

[gate2006-it](#) [theory-of-computation](#) [regular-set](#) [normal](#)

[Answer](#)

### 19.14.8 Regular Set: GATE2001-2.6 [top](#)

<http://gateoverflow.in/724>

Consider the following languages:

- L1 = {ww | w ∈ {a, b}\*}
- L2 = {ww<sup>R</sup> | w ∈ {a, b}\*, w<sup>R</sup> is the reverse of w}
- L3 = {0<sup>2i</sup> | i is an integer}
- L4 = {0<sup>i<sup>2</sup></sup> | i is an integer}

Which of the languages are regular?

- A. Only L1 and L2
- B. Only L2, L3 and L4
- C. Only L3 and L4
- D. Only L3

[gate2001](#) [theory-of-computation](#) [regular-set](#) [normal](#)

[Answer](#)

### 19.14.9 Regular Set: GATE2008\_53 [top](#)

<http://gateoverflow.in/476>

Which of the following are regular sets?

- I. {a<sup>n</sup>b<sup>2m</sup> | n ≥ 0, m ≥ 0}
- II. {a<sup>n</sup>b<sup>m</sup> | n = 2m}
- III. {a<sup>n</sup>b<sup>m</sup> | n ≠ m}
- IV. {x<sup>n</sup>y | x, y ∈ {a, b}\*, n ≥ 0}

- A. I and IV only
- B. I and III only
- C. I only
- D. IV only

[gate2008](#) [theory-of-computation](#) [regular-set](#) [normal](#)
[Answer](#)

### 19.14.10 Regular Set: GATE2014-1\_15 [top](#)

<http://gateoverflow.in/1781>

Which one of the following is **TRUE**?

- (A) The language  $L = \{a^n b^n \mid n \geq 0\}$  is regular.
- (B) The language  $L = \{a^n \mid n \text{ is prime}\}$  is regular.
- (C) The language  $L = \{w \mid w \text{ has } 3k+1 \text{ } b's \text{ for some } k \in N \text{ with } \Sigma = \{a, b\}\}$  is regular.
- (D) The language  $L = \{ww \mid w \in \Sigma^* \text{ with } \Sigma = \{0, 1\}\}$  is regular.

[gate2014-1](#) [theory-of-computation](#) [regular-set](#) [normal](#)
[Answer](#)

### 19.14.11 Regular Set: GATE 2016-2-17 [top](#)

<http://gateoverflow.in/39542>

Language  $L_1$  is defined by the grammar:  $S_1 \rightarrow aS_1b \mid \epsilon$

Language  $L_2$  is defined by the grammar:  $S_2 \rightarrow abS_2 \mid \epsilon$

Consider the following statements:

- P:  $L_1$  is regular
- Q:  $L_2$  is regular

Which one of the following is **TRUE**?

- A. Both P and Q are true.
- B. P is true and Q is false.
- C. P is false and Q is true.
- D. Both P and Q are false.

[gate2016-2](#) [theory-of-computation](#) [grammar](#) [regular-set](#) [normal](#)
[Answer](#)

### 19.14.12 Regular Set: TIFR2015-B-10 [top](#)

<http://gateoverflow.in/30039>

Consider the languages

$$L_1 = \{a^m b^n c^p \mid (m = n \vee n = p) \wedge m + n + p \geq 10\}$$

$$L_2 = \{a^m b^n c^p \mid (m = n \vee n = p) \wedge m + n + p \leq 10\}$$

State which of the following is true?

- A.  $L_1$  and  $L_2$  are both regular.
- B. Neither  $L_1$  nor  $L_2$  is regular.
- C.  $L_1$  is regular and  $L_2$  is not regular.
- D.  $L_1$  is not regular and  $L_2$  is regular.
- E. Both  $L_1$  and  $L_2$  are infinite.

[tifr2015](#) [regular-set](#) [identify-class-language](#)

**Answer****19.14.13 Regular Set: GATE2007\_7** [top](#)<http://gateoverflow.in/1205>

Which of the following is TRUE?

- A. Every subset of a regular set is regular
- B. Every finite subset of a non-regular set is regular
- C. The union of two non-regular sets is not regular
- D. Infinite union of finite sets is regular

[gate2007](#) [theory-of-computation](#) [regular-set](#) [easy](#)
**Answer****19.14.14 Regular Set: GATE1999\_6** [top](#)<http://gateoverflow.in/1505>

- a. Given that  $A$  is regular and  $(A \cup B)$  is regular, does it follow that  $B$  is necessarily regular? Justify your answer.
- b. Given two finite automata  $M1, M2$ , outline an algorithm to decide if  $L(M1) \subset L(M2)$ . (note: strict subset)

[gate1999](#) [theory-of-computation](#) [regular-set](#) [normal](#)
**Answer****19.14.15 Regular Set: GATE1996\_1.10** [top](#)<http://gateoverflow.in/2714>

Let  $L \subseteq \Sigma^*$  where  $\Sigma = \{a, b\}$ . Which of the following is true?

- (a)  $L = \{x \mid x \text{ has an equal number of } a\text{'s and } b\text{'s}\}$  is regular
- (b)  $L = \{a^n b^n \mid n \geq 1\}$  is regular
- (c)  $L = \{x \mid x \text{ has more number of } a\text{'s than } b\text{'s}\}$  is regular
- (d)  $L = \{a^m b^n \mid m \geq 1, n \geq 1\}$  is regular

[gate1996](#) [theory-of-computation](#) [regular-set](#) [normal](#)
**Answer****19.14.16 Regular Set: GATE2008-IT\_35** [top](#)<http://gateoverflow.in/3345>

Which of the following languages is (are) non-regular?

- $L_1 = \{0^m 1^n \mid 0 \leq m \leq n \leq 10000\}$
- $L_2 = \{w \mid w \text{ reads the same forward and backward}\}$
- $L_3 = \{w \in \{0, 1\}^* \mid w \text{ contains an even number of } 0\text{'s and an even number of } 1\text{'s}\}$

- |    |                      |
|----|----------------------|
| A) | $L_2$ and $L_3$ only |
| B) | $L_1$ and $L_2$ only |
| C) | $L_3$ only           |
| D) | $L_2$ only           |

[gate2008-it](#) [theory-of-computation](#) [regular-set](#) [normal](#)
**Answer****19.14.17 Regular Set: GATE2007\_31** [top](#)<http://gateoverflow.in/1229>

Which of the following languages is regular?

- A.  $\{ww^R \mid w \in \{0,1\}^+\}$
- B.  $\{ww^Rx \mid x, w \in \{0,1\}^+\}$
- C.  $\{wxw^R \mid x, w \in \{0,1\}^+\}$
- D.  $\{xww^R \mid x, w \in \{0,1\}^+\}$

[gate2007](#) [theory-of-computation](#) [regular-set](#) [normal](#)

[Answer](#)

### 19.14.18 Regular Set: TIFR2013-B-6 [top](#)

<http://gateoverflow.in/25667>

Let  $L$  and  $L'$  be languages over the alphabet  $\Sigma$ . The left quotient of  $L$  by  $L'$  is

$$L/L' \stackrel{\text{def}}{=} \{w \in \Sigma^* : wx \in L \text{ for some } x \in L'\}$$

Which of the following is true?

- a. If  $L/L'$  is regular then  $L'$  is regular.
- b. If  $L$  is regular then  $L/L'$  is regular.
- c. If  $L/L'$  is regular then  $L$  is regular.
- d.  $L/L'$  is a subset of  $L$ .
- e. If  $L/L'$  and  $L'$  are regular, then  $L$  is regular.

[tifr2013](#) [theory-of-computation](#) [regular-set](#)

[Answer](#)

### 19.14.19 Regular Set: TIFR2013-B-8 [top](#)

<http://gateoverflow.in/25670>

Which one of the following languages over the alphabet  $0, 1$  is regular?

- a. The language of balanced parentheses where  $0, 1$  are thought of as  $(, )$  respectively.
- b. The language of palindromes, i.e. bit strings  $x$  that read the same from left to right as well as right to left.
- c.  $L = \{0^{m^2} : 3 \leq m\}$
- d. The Kleene closure  $L^*$ , where  $L$  is the language in (c) above.
- e.  $\{0^m 1^n : 1 \leq m \leq n\}$

[tifr2013](#) [theory-of-computation](#) [regular-set](#)

[Answer](#)

### 19.14.20 Regular Set: GATE2001-1.4 [top](#)

<http://gateoverflow.in/697>

Consider the following two statements:

$S1 : \{0^{2n} \mid n \geq 1\}$  is a regular language

$S2 : \{0^m 1^n 0^{m+n} \mid m \geq 1 \text{ and } n \geq 1\}$  is a regular language

Which of the following statement is correct?

- A. Only S1 is correct

- B. Only S2 is correct  
 C. Both S1 and S2 are correct  
 D. None of S1 and S2 is correct

[gate2001](#) [theory-of-computation](#) [regular-set](#) [easy](#)

[Answer](#)

### 19.14.21 Regular Set: GATE2000-2.8 [top](#)

<http://gateoverflow.in/655>

What can be said about a regular language L over { a } whose minimal finite state automaton has two states?

- A. L must be  $\{a^n \mid n \text{ is odd}\}$   
 B. L must be  $\{a^n \mid n \text{ is even}\}$   
 C. L must be  $\{a^n \mid n \geq 0\}$   
 D. Either L must be  $\{a^n \mid n \text{ is odd}\}$ , or L must be  $\{a^n \mid n \text{ is even}\}$

[gate2000](#) [theory-of-computation](#) [regular-set](#) [easy](#)

[Answer](#)

### 19.14.22 Regular Set: TIFR2014-B-12 [top](#)

<http://gateoverflow.in/27314>

Consider the following three statements:

- (i) Intersection of infinitely many regular languages must be regular.  
 (ii) Every subset of a regular language is regular.  
 (iii) If  $L$  is regular and  $M$  is not regular then  $L \bullet M$  is necessarily not regular.

Which of the following gives the correct true/false evaluation of the above?

- a. true, false, true.  
 b. false, false, true.  
 c. true, false, true.  
 d. false, false, false.  
 e. true, true, true.

[tifr2014](#) [theory-of-computation](#) [regular-set](#)

[Answer](#)

### 19.14.23 Regular Set: GATE1998\_2.6 [top](#)

<http://gateoverflow.in/1678>

Which of the following statements is false?

- (a) Every finite subset of a non-regular set is regular  
 (b) Every subset of a regular set is regular  
 (c) Every finite subset of a regular set is regular  
 (d) The intersection of two regular sets is regular

[gate1998](#) [theory-of-computation](#) [regular-set](#) [easy](#)

[Answer](#)

### 19.14.24 Regular Set: GATE2015-2\_51 [top](#)

<http://gateoverflow.in/8254>

Which of the following is/are regular languages?

$$L_1 : \{wxw^R \mid w, x \in \{a, b\}^* \text{ and } |w|, |x| > 0\}, w^R \text{ is the reverse of string } w$$

$L_2 : \{a^n b^m \mid m \neq n \text{ and } m, n \geq 0\}$

$L_3 : \{a^p b^q c^r \mid p, q, r \geq 0\}$

- A.  $L_1$  and  $L_3$  only
- B.  $L_2$  only
- C.  $L_2$  and  $L_3$  only
- D.  $L_3$  only

gate2015-2 theory-of-computation regular-set normal

Answer

### 19.14.25 Regular Set: GATE1995\_2.24 [top](#)

<http://gateoverflow.in/2637>

Let  $\Sigma = \{0, 1\}$ ,  $L = \Sigma^*$  and  $R = \{0^n 1^n \mid n > 0\}$  then the languages  $L \cup R$  and  $R$  are respectively

- (A) regular, regular
- (B) not regular, regular
- (C) regular, not regular
- (D) not regular, not regular

gate1995 theory-of-computation regular-set easy

Answer

## Answers: Regular Set

### 19.14.1 Regular Set: GATE2008-IT\_6 [top](#)

<http://gateoverflow.in/3266>



Selected Answer

A state in a DFA will be a subset of the set of states of the equivalent NFA. So, the maximum number of states in the equivalent DFA of an NFA, will be  $2^n$ , where  $n$  is the number of states in NFA, as a set with  $n$  items has maximum  $2^n$  subsets.

So, answer here is (A).

9 votes

-- Arjun Suresh (150k points)

### 19.14.2 Regular Set: GATE2006-IT\_30 [top](#)

<http://gateoverflow.in/3569>



Selected Answer

Option C is not True.

- A) Every language has a regular superset:** True.  $\Sigma^*$  is such a superset.
- B) Every language has a regular subset:** True.  $\emptyset$  is such a subset.
- C) Every subset of a regular language is regular:** False.  $a^n b^n \subset \Sigma^*$ , but  $a^n b^n$  is not Regular.
- D) Every subset of a finite language is regular:** True. Every subset of a finite set must be finite by definition. Every finite set is regular. Hence, every subset of a finite language is regular.

13 votes

-- Pragy Agarwal (14.4k points)

### 19.14.3 Regular Set: GATE2014-2\_36 [top](#)

<http://gateoverflow.in/1995>



Selected Answer

(A) is True. Though at first look both L1 and L2 looks non-regular, L1 is in fact regular. The reason is the relation between 110 and 011.

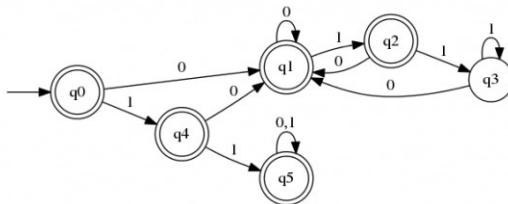
We cannot have two 110's in a string without a 011 or vice versa. And this would mean that we only need a finite number of states to check for acceptance of any word in this language.

That was just an intuitive explanation. Now I say that L contains all binary strings starting with 11. Yes, if a binary string starts with 11, it can never have more no. of 011 than 110.

Lets take an example:

11 011 011 -There are two 011's. But there are also two 110's. Similarly for any binary string starting with 11.

Using this property, DFA for L1 can be constructed as follows:



26 votes

-- gatecse (10.7k points)

### 19.14.4 Regular Set: GATE2006\_29 [top](#)

<http://gateoverflow.in/992>



Selected Answer

A. There are only finite 3 digit primes. And any finite set is regular

B. Here we need just 6 states to recognise L.

1. #0 - #1 = 0
2. #0 - #1 = 1
3. #0 - #1 = 2
4. #0 - #1 = -1
5. #0 - #1 = -2

If the difference goes above 2 or below -2, we go to a dead state. All other states are accepting. This transition to dead state is possible because of the words "for every prefix s' of s" in L and that is what makes this language regular.

C. L is not regular

```
#0 - #1 = 1
#0 - #1 = 2
#0 - #1 = 3
#0 - #1 = 4
#0 - #1 = 5
.....
#0 - #1 = 1000
.....
```

All these form distinct equivalent classes under Myhill-Nerode theorem meaning from the strings in each of these sets, we can append a string which will take the new string to L, while the same string appended to string in any other set won't reach L.

For example, for 000000, we append 11, for 0000000, we append 111 etc. So, in short we need to maintain the count of 1's and 0's and the count here is not finite.

D. This is regular. We need a finite automata with  $5 * 7 = 35$  states for maintaining the counts of 0's mod 7 and 1's mod 5

and there cannot be more than 35 possibilities for this. With each input symbol, the transition must be going to one among these.

6 votes

-- Arjun Suresh (150k points)

### 19.14.5 Regular Set: GATE2014-2\_15 [top](#)

<http://gateoverflow.in/1971>



Selected Answer

#### Option A.

$$L_1 = \{\varepsilon, a, aa, aaa, aaaa, \dots\}$$

$$L_2 = \{\varepsilon, b, bb, bbb, bbbb, \dots\}$$

$$L_1 \cdot L_2 = \left\{ \begin{array}{ll} \varepsilon, & \\ a, & b, \\ aa, & ab, bb \\ aaa, & aab, abb, bbb, \\ aaaa, & aaab, aabb, abbb, bbbb, \dots \end{array} \right\}$$

$$L_1 \cdot L_2 = a^*b^*$$

Thus,  $L_1 \cdot L_2$  is Regular.

(Also, since both  $L_1$  and  $L_2$  are Regular, their concatenation has to be Regular since Regular languages are closed under concatenation)

However,  $L_1 \cdot L_2 \neq a^n b^n$ . This is because in  $a^*b^*$ , the number of  $a$ 's and  $b$ 's can be different whereas in  $a^n b^n$  they have to be the same.

14 votes

-- Viral Kapoor (1.8k points)

### 19.14.6 Regular Set: GATE2006-IT\_80 [top](#)

<http://gateoverflow.in/3624>

correct answer is B. only I .

repeat ( $L$ ) =  $\{ww \mid w \in L\}$  is non regular language

half( $L$ ), suffix( $L$ ), and prefix( $L$ ) are regular languages

refer

[http://gateoverflow.in/3637/gate2006-it\\_81](http://gateoverflow.in/3637/gate2006-it_81)

2 votes

-- Praveen Saini (38.4k points)

### 19.14.7 Regular Set: GATE2006-IT\_81 [top](#)

<http://gateoverflow.in/3637>



Selected Answer

i) repeat( $L$ ) is non regular

<http://www.cs.odu.edu/~toida/nerzic/390teched/regular/reg-lang/non-regularity.html> [example 2]

ii) prefix( $L$ ) is regular

<http://www.public.asu.edu/~ccolbou/src/355hw2sols09.pdf> [2(a)]

iii) suffix( $L$ ) is regular

<http://www.public.asu.edu/~ccolbou/src/355hw2sols09.pdf> [2(b)]

(iv) Half(L) is regular

<https://www.complang.tuwien.ac.at/lkovacs/ATCSHW/hw4-sol.pdf> [4.2(a)]

so in first part of question . option B is correct only i.

[Need someone to explain these language with more clear explanation @Arjun . that can be understandable by an average student]

for second part of question

A is answer.

Explanation is in comment given below by Arjun (for option A,C and D )

note : for option B  $L = \{\epsilon, a, ab, bab\}$ , Repeat( $L$ ) =  $\{\epsilon, aa, abab, babbab\}$  is regular

Upvote 5 votes

-- Praveen Saini (38.4k points)

## 19.14.8 Regular Set: GATE2001-2.6 [top](#)

<http://gateoverflow.in/724>

$L_1 = \{ww \mid w \in \{a,b\}^*\}$  CSL

$L_2 = \{ww^R \mid w \in \{a,b\}^*, w^R \text{ is the reverse of } w\}$  Palindrome so CFL

$L_3 = \{0^{2i} \mid i \text{ is an integer}\}$  Linear Power and regular expression can be stated as  $(00)^*$

$L_4 = \{0^{i^2} \mid i \text{ is an integer}\}$  non linear power So CSL

Therefore answer is option D

Upvote 5 votes

-- Umang Raman (11.3k points)

## 19.14.9 Regular Set: GATE2008\_53 [top](#)

<http://gateoverflow.in/476>



Selected Answer

Answer is A.

Since in option 2 and 3, n is dependent on m, therefore a comparison has to be done to evaluate those and hence are not regular.

I and IV are clearly regular sets.

Upvote 10 votes

-- Gate Keeda (17.7k points)

## 19.14.10 Regular Set: GATE2014-1\_15 [top](#)

<http://gateoverflow.in/1781>



Selected Answer

(A) is CFL and (B) and (D) are CSL. (C) is regular and regular expression for (C) would be

$$a^*b(a^*ba^*ba^*b)^+a^*$$

Upvote 7 votes

-- Arjun Suresh (150k points)

**19.14.11 Regular Set: GATE 2016-2-17** [top](#)<http://gateoverflow.in/39542>

Selected Answer

Answer is C

$$S_1 \rightarrow aS_1b|\epsilon$$

$L_1 = \{a^n b^n \mid n \geq 0\}$  is CFL

$$S_2 \rightarrow abS_2|\epsilon$$

$L_2 = \{(ab)^n \mid n \geq 0\}$  is Regular having regular expression  $(ab)^*$

14 votes

-- Praveen Saini (38.4k points)

**19.14.12 Regular Set: TIFR2015-B-10** [top](#)<http://gateoverflow.in/30039> $L_2$  is finite, so regular. $L_1$  is non-regular.

(It seems CFL to me as I think it can be implemented with the help of PDA, as stack can ensure  $(m = n \vee n = p)$  and we can also ensure  $(m + n + p \geq 10)$  with minimum states changes along with transitions. )

 $L_2$  is actually { $c^p \mid$  $p \leq 10\}$  $\cup \{$  $abc^p \mid$  $p \leq 8\}$  $\cup \{$  $a^2b^2c^p \mid$  $p \leq 6\}$  $\cup \{$  $a^3b^3c^p \mid$  $p \leq 4\}$  $\cup \{$  $a^4b^4c^p \mid$  $p \leq 2\}$  $\cup \{$  $a^5b^5\}$  $\cup \{$  $a^p \mid$  $p \leq 10\}$  $\cup \{$  $a^pbc \mid$  $p \leq 8\}$  $\cup \{$  $a^pb^2c^2 \mid$  $p \leq 6\}$  $\cup \{$  $a^pb^3c^3 \mid$  $p \leq 4\}$

$$\begin{aligned} & \cup \{ \\ & a^p b^4 c^4 \mid \\ & p \leq 2 \} \\ & \cup \{ \\ & b^5 c^5 \mid \\ & p \leq 10 \} \end{aligned}$$

6 votes

-- Praveen Saini (38.4k points)

### 19.14.13 Regular Set: GATE2007\_7 [top](#)

<http://gateoverflow.in/1205>



Selected Answer

(B) Every finite subset of a non-regular set is regular.

Any finite set is always regular.

$\Sigma^*$  being regular any non regular language is a subset of this, and hence (A) is false.

If we take a CFL which is not regular, and takes union with its complement (complement of a CFL which is not regular won't be regular as regular is closed under complement), we get  $\Sigma^*$  which is regular. So, (C) is false.

Regular set is not closed under infinite union. Example:

Let  $L_i = \{0^i 1^i\}, i \in \mathbb{N}$

Now, if we take infinite union over all  $i$ , we get

$L = \{0^i 1^i \mid i \in \mathbb{N}\}$ , which is not regular.

So, D is false.

10 votes

-- Omesh Pandita (2.3k points)

### 19.14.14 Regular Set: GATE1999\_6 [top](#)

<http://gateoverflow.in/1505>



Selected Answer

a) A is regular , A U B is regular , then B is not necessary regular

example :- A = (a+b)\* B = a^n b^n n>=0 A U B is (a+b)\* while B is not regular.

b ) we have two machine M 1 and M 2

draw a DFA using M1 and M2 where start state is, say, p0q0 (where p0 is start state in M1 and q0 is start state in M2)

$\delta(p0q0, 0) = \delta(p0, 0) \cup \delta(q0, 0)$

if  $L(M1) \subseteq L(M2)$

Then final state of M1 will come together with final state of M2, while Final state of M2 can come alone.

i.e All inputs of M1 is also in machine M2 , and there may be different inputs in M2.

11 votes

-- Praveen Saini (38.4k points)

### 19.14.15 Regular Set: GATE1996\_1.10 [top](#)

<http://gateoverflow.in/2714>



Selected Answer

Only D. because n and m are independent and thus no memory element required.

a and b are same and are DCFL's.

c is  $L = \{ a^n b^m \mid n > m \}$ . which is not regular.

Correction:I think c should be that x has more a's than b's.

5 votes

-- Gate Keeda (17.7k points)

### 19.14.16 Regular Set: GATE2008-IT\_35 [top](#)

<http://gateoverflow.in/3345>



Selected Answer

L1 is regular.. since 10000 is finite.. so finite states are required..

L3 is also regular.. we can make DFA for L3.. states will represent mod 2 for 0 and mod 2 for 1, which is finite

L2 is non. regular.. it is CFG  $S \rightarrow aSa \mid \dots \mid zSz \mid \epsilon \mid [a-z]$

so option (d)

11 votes

-- Vicky Bajoria (3.4k points)

### 19.14.17 Regular Set: GATE2007\_31 [top](#)

<http://gateoverflow.in/1229>



Selected Answer

A. CFL

B. CFL

C. Regular, language is string starting and ending with the same symbol and having length at least 3. e.g. 0x0 or 1x1

D. CFL

[http://gatecse.in/wiki/Identify\\_the\\_class\\_of\\_the\\_language](http://gatecse.in/wiki/Identify_the_class_of_the_language)

11 votes

-- Vikrant Singh (11k points)

### 19.14.18 Regular Set: TIFR2013-B-6 [top](#)

<http://gateoverflow.in/25667>

A) False because -  $L = a^*b^*$ ,  $L' = a^nb^n$  Here  $L/L' = a^*$ .  $L/L'$  is regular, but  $L'$  is not.

B) True. If L is regular,  $L/L'$  is prefix of language. Regular languages are closed under Quotient/Prefix. So this is correct.

C) False  $L' = \text{Empty set}$ . Then  $L/L'$  is Empty set whatever L is. Here L can be say  $a^nb^n$ . See definition of  $L/L'$  to see why  $L/L'$  should be empty set.

D) False because  $L/L'$  can accept prefixes of string of Language L, which may or may not be accepted by L itself. So  $L/L'$  is not subset. ( It is not Superset either , because  $L'$  can be empty set )

E) False. Same explanation as C.

Answer :- B.

2 votes

-- Akash (31.7k points)

### 19.14.19 Regular Set: TIFR2013-B-8 [top](#)

<http://gateoverflow.in/25670>



Selected Answer

2

Here , **OPTION D** is **regular**, reason is as follows :

$$L = \{ 0^m : m \geq 3 \}$$

Now, in  $L^*$  if we can **generate 9 continuous powers of zero**, then further every power can be generated by **concatenating 0<sup>9</sup>**.

$$\text{Here , } L = \{0^9, 0^{16}, 0^{25}, \dots\}$$

So, here are **9 continuous powers**:

$$0^{120} : 0^{16} 0^{16} 0^{16} 0^9 0^9 0^9 0^9 0^9 0^9 0^9$$

$$0^{121} : 0^{16} 0^{16} 0^{16} 0^{16} 0^{16} 0^{16} 0^{25}$$

$$0^{122} : 0^{16} 0^{16} 0^9 0^9 0^9 0^9 0^9 0^9 0^9 0^9$$

$$0^{123} : 0^{16} 0^{16} 0^{16} 0^{25} 0^{25} 0^{25}$$

$$0^{124} : 0^{16} 0^{18} 0^{18} 0^{18} 0^{18} 0^{18} 0^{18}$$

$$0^{125} : 0^{25} 0^{25} 0^{25} 0^{25} 0^{25}$$

$$0^{126} : 0^{18} 0^{18} 0^{18} 0^{18} 0^{18} 0^{18} \quad \{0^{18} \text{ can be generated as } 0^9 0^9\}$$

$$0^{127} : 0^{16} 0^{16} 0^{16} 0^{16} 0^9 0^9 0^9 0^9 0^9 0^9$$

$$0^{128} : 0^{16} 0^{16} 0^{16} 0^{16} 0^{16} 0^{16} 0^{16}$$

**Now,  $0^{129}$  can be given as  $0^{120} 0^9$  and so on..**

**Every Further powers can be generated by concatenating  $0^9$ .**

Upvote 4 votes

-- Himanshu Agarwal (9.8k points)

### 19.14.20 Regular Set: GATE2001-1.4 [top](#)

<http://gateoverflow.in/697>



Selected Answer

Only s1 is correct a dfa with 2 states where one of the states is both the initial and final state..

Upvote 8 votes

-- Bhagirathi Nayak (11.3k points)

### 19.14.21 Regular Set: GATE2000-2.8 [top](#)

<http://gateoverflow.in/655>



Selected Answer

Ans 4) Either  $L$  must be  $\{a^n \mid n \text{ is odd}\}$ , or  $L$  must be  $\{a^n \mid n \text{ is even}\}$

Because if we draw the minimal dfa for each of them, we will get two states each.  
Whereas,  $\{a^n \mid n \geq 0\}$  requires only one state.

Upvote 9 votes

-- Keith Kr (6k points)

**19.14.22 Regular Set: TIFR2014-B-12**<http://gateoverflow.in/27314>

Selected Answer

**i) False**

Regular Languages are not closed under Infinite Union and Intersection

$$L_1 \cup L_2 \cup L_3 \cup L_4 \cup \dots$$

For example :

$$ab \cup aabb \cup aaabbb \cup aaaabbbb \cup \dots$$

$$= \{a^n b^n, n \geq 1\}$$

So Infinite Union is not closed

$$L_1 \cap L_2 \cap L_3 \cap L_4 \cap \dots$$

$$= (L_1' \cup L_2' \cup L_3' \cup L_4' \cup \dots)'$$

As Infinite Union is not closed , So Infinite Intersection is also not closed

**ii) False.**

$a^* b^*$  is regular

its subset  $a^n b^n, n \geq 1$  is not regular

$a^*$  is regular

$a^p, p$  is prime, is not regular

**iii) False**

$L = \{\}$  is regular

$M$  be non-regular like  $\{0^n 1^n \mid n > 0\}$  .

$L \cdot M = \{\}$  , is regular

7 votes

-- Praveen Saini (38.4k points)

**19.14.23 Regular Set: GATE1998\_2.6**<http://gateoverflow.in/1678>

Selected Answer

(b) is False. Any language is a subset of  $\Sigma^*$  which is a regular set. So, if we take any non-regular language, it is a subset of a regular language.

(a) and (c) are regular as any finite language is regular.

(d) is regular as regular set is closed under intersection.

8 votes

-- Arjun Suresh (150k points)

**19.14.24 Regular Set: GATE2015-2\_51**<http://gateoverflow.in/8254>

Selected Answer

Ans A.

L1: all strings of length 3 or more with same start and end letter- because everything in middle can be consumed by x as per the definition of L.

L2: We need to compare number of a's and b's and these are not bounded. So, we need at least a DPDA.

L3: Any number of a's followed by any number of b's followed by any number of c's. Hence regular.

15 votes

-- Vikrant Singh (11k points)

### 19.14.25 Regular Set: GATE1995\_2.24 [top](#)



Selected Answer

Answer is (C).  $L \cup R$  is nothing but  $L$  as  $R$  is a subset of  $L$  and hence regular.  $R$  is deterministic context-free but not regular as we require a stack to keep the count of 0's to match that of 1's.

7 votes

-- Arjun Suresh (150k points)

## 19.15

### Turing Machine [top](#)

#### 19.15.1 Turing Machine: GATE2003\_53 [top](#)

<http://gateoverflow.in/941>

A single tape Turing Machine M has two states  $q_0$  and  $q_1$ , of which  $q_0$  is the starting state. The tape alphabet of M is  $\{0, 1, B\}$  and its input alphabet is  $\{0, 1\}$ . The symbol B is the blank symbol used to indicate end of an input string. The transition function of M is described in the following table.

|       | 0           | 1           | B           |
|-------|-------------|-------------|-------------|
| $q_0$ | $q_1, 1, R$ | $q_1, 1, R$ | Halt        |
| $q_1$ | $q_1, 1, R$ | $q_0, 1, L$ | $q_0, B, L$ |

The table is interpreted as illustrated below.

The entry  $(q_1, 1, R)$  in row  $q_0$  and column 1 signifies that if M is in state  $q_0$  and reads 1 on the current page square, then it writes 1 on the same tape square, moves its tape head one position to the right and transitions to state  $q_1$ .

Which of the following statements is true about M?

- A. M does not halt on any string in  $(0 + 1)^+$
- B. M does not halt on any string in  $(00 + 1)^*$
- C. M halts on all strings ending in a 0
- D. M halts on all strings ending in a 1

[gate2003](#) [theory-of-computation](#) [turing-machine](#) [normal](#)

Answer

#### 19.15.2 Turing Machine: GATE2004\_89 [top](#)

<http://gateoverflow.in/1083>

$L_1$  is a recursively enumerable language over  $\Sigma$ . An algorithm A effectively enumerates its words as  $w_1, w_2, w_3, \dots$ . Define another language  $L_2$  over  $\Sigma \cup \{\#\}$  as  $\{w_i \# w_j \mid w_i, w_j \in L_1, i < j\}$ . Here # is new symbol. Consider the following assertions.

- $S_1 : L_1$  is recursive implies  $L_2$  is recursive
- $S_2 : L_2$  is recursive implies  $L_1$  is recursive

Which of the following statements is true?

- A. Both  $S_1$  and  $S_2$  are true
- B.  $S_1$  is true but  $S_2$  is not necessarily true
- C.  $S_2$  is true but  $S_1$  is not necessarily true

- D. Neither is necessarily true

gate2004 theory-of-computation turing-machine difficult

[Answer](#)

### 19.15.3 Turing Machine: GATE2001-7 [top](#)

<http://gateoverflow.in/748>

Let a decision problem  $X$  be defined as follows:

$X$ : Given a Turing machine  $M$  over  $\Sigma$  and any word  $w \in \Sigma$ , does  $M$  loop forever on  $w$ ?

You may assume that the halting problem of Turing machine is undecidable but partially decidable.

- a. Show that  $X$  is undecidable
- b. Show that  $X$  is not even partially decidable

gate2001 theory-of-computation decidability turing-machine easy

[Answer](#)

### 19.15.4 Turing Machine: GATE2003\_54 [top](#)

<http://gateoverflow.in/355>

Define languages  $L_0$  and  $L_1$  as follows :

$$L_0 = \{\langle M, w, 0 \rangle \mid M \text{ halts on } w\}$$

$$L_1 = \{\langle M, w, 1 \rangle \mid M \text{ does not halt on } w\}$$

Here  $\langle M, w, i \rangle$  is a triplet, whose first component  $M$  is an encoding of a Turing Machine, second component  $w$  is a string, and third component  $i$  is a bit.

Let  $L = L_0 \cup L_1$ . Which of the following is true ?

- A.  $L$  is recursively enumerable, but  $L'$  is not
- B.  $L'$  is recursively enumerable, but  $L$  is not
- C. Both  $L$  and  $L'$  are recursive
- D. Neither  $L$  nor  $L'$  is recursively enumerable

theory-of-computation turing-machine gate2003 difficult

[Answer](#)

### 19.15.5 Turing Machine: GATE2002\_14 [top](#)

<http://gateoverflow.in/867>

The aim of the following question is to prove that the language  $\{M \mid M \text{ is the code of the Turing Machine which, irrespective of the input, halts and outputs a 1}\}$ , is undecidable. This is to be done by reducing from the language  $\{M' \mid M' \text{ halts on } x\}$ , which is known to be undecidable. In parts (a) and (b) describe the 2 main steps in the construction of  $M$ . In part (c) describe the key property which relates the behaviour of  $M$  on its input  $w$  to the behaviour of  $M'$  on  $x$ .

- a. On input  $w$ , what is the first step that  $M$  must make?
- b. On input  $w$ , based on the outcome of the first step, what is the second step  $M$  must make?
- c. What key property relates the behaviour of  $M$  on  $w$  to the behaviour of  $M'$  on  $x$ ?

gate2002 theory-of-computation decidability normal turing-machine descriptive difficult

[Answer](#)

## Answers: Turing Machine

**19.15.1 Turing Machine: GATE2003\_53** [top](#)<http://gateoverflow.in/941>

Selected Answer

option A. or epsilon is only accepted i.e tape contain B as the first character

8 votes

-- Supromit Roy (577 points)

**19.15.2 Turing Machine: GATE2004\_89** [top](#)<http://gateoverflow.in/1083>

Selected Answer

$S_1$  is TRUE.

If  $L_1$  is recursive  $L_2$  must also be recursive. Because to check if a word  $w = w_i \# w_j$  belong to  $L_2$ , we can give  $w_i$  and  $w_j$  to the decider for  $L_1$  and if both are accepted then  $w$  belong to  $L_1$  and not otherwise.

$S_2$  is TRUE.

With a decider for  $L_2$  we can make a decider for  $L_1$  as follows. Let  $w_1$  be the first string enumerated by algorithm  $A$  for  $L_1$ . Now, to check if a word  $w$  belongs to  $L_1$ , make a string  $w' = w_1 \# w$  and give it to the decider for  $L_2$  and if accepted, then  $w$  belongs to  $L_1$  and not otherwise.

So, answer must be A.

10 votes

-- Arjun Suresh (150k points)

**19.15.3 Turing Machine: GATE2001-7** [top](#)<http://gateoverflow.in/748>

Selected Answer

The question asks if M loop forever on w. If M loop forever on w, M wouldn't halt on w. And if M doesn't halt on w, M should loop forever. So, this problem is exactly same as asking if "M doesn't halt on w", which is the complement of halting problem and is not even partially decidable. So, X is not even partially decidable.

11 votes

-- Arjun Suresh (150k points)

**19.15.4 Turing Machine: GATE2003\_54** [top](#)<http://gateoverflow.in/355>

Selected Answer

Both  $L$  and  $L'$  are undecidable and not even semi-decidable (not recursively-enumerable). Because halting problem can be solved with both  $L$  and  $L'$ .

Halting problem can be stated as follows: A machine  $M$  and a word  $w$  are given. You have to tell, if  $M$  halts on  $w$ .

So, to solve halting problem  $\langle M, w \rangle$  using  $L$ , just give  $\langle M, w, 0 \rangle$  and  $\langle M, w, 1 \rangle$  to two instances of  $T$  which is the assumed Turing machine for  $L$ . If  $T$  accepts the triplet  $\langle M, w, 0 \rangle$ , it means  $M$  halts on  $w \Rightarrow$  we have solved halting problem. If  $T$  accepts the triplet  $\langle M, w, 1 \rangle$ , it means  $M$  doesn't halt on  $w \Rightarrow$  we have solved halting problem. We know that either  $\langle M, w, 0 \rangle$  or  $\langle M, w, 1 \rangle$  is in  $L$ . So, if  $L$  is recursively enumerable,  $T$  is bound to stop on at least one of these inputs ( $TM$  for a recursively enumerable language stops and accepts, when provided with a word in its language).

Hence, if  $L$  is recursively enumerable we can solve halting problem  $\Rightarrow L$  is not recursively enumerable. Similarly, we can also show that halting problem can be solved with  $L'$ . (shown at end)

Hence, neither  $L$  nor  $L'$  is recursively enumerable.

To solve halting problem  $\langle M, w \rangle$  using  $L'$ , just give  $\langle M, w, 0 \rangle$  and  $\langle M, w, 1 \rangle$  to two instances of  $T'$  which is the assumed Turing machine for  $L'$ . If  $T'$  accepts the triplet  $\langle M, w, 0 \rangle$ , it means  $M$  does not halt on  $w \Rightarrow$  we have solved halting problem. If  $T$  accepts the triplet  $\langle M, w, 1 \rangle$ , it means  $M$  halt on  $w \Rightarrow$  we have solved halting problem. We know that either  $\langle M, w, 0 \rangle$  or  $\langle M, w, 1 \rangle$  is in  $L'$ . So, if  $L'$  is recursively enumerable,  $T'$  is bound to stop on at least one of these inputs ( $TM$  for a recursively enumerable language stops and accepts, when provided with a word in its language).

Hence, if  $L'$  is recursively enumerable we can solve halting problem  $\Rightarrow L'$  is not recursively enumerable.

PS: If the bit part of the triplet is absent then  $L_0$  is halting problem and  $L_1$  is its complement and  $L_0 \cup L_1 = \Sigma^*$ , which is regular. Lets see how it happens.

Let the alphabet set be  $\{0, 1\}$ . Now for any string like 0010101 there are only two options- belong to  $L$  or belong to  $L'$  as this is what complement says. Now, lets take the case for  $L_0$  and a string  $001\dots10 - 01 - 1$ , ("-" shown for notation purpose only) where the first component describes a TM  $M$  followed by input " $w = 01$ " and last bit "1". Now suppose  $M$  halts on "01". Still the given input is not in  $L_0$  as the last bit is "1" and not "0" as required by  $L_0$ . So, this input must be in  $L'_0$ . But since  $M$  halts on  $w$ , this input is not in  $L_1$  either. Similarly, we can get an infinite set of strings which does not belong to both  $L_0$  and  $L_1$  and this makes their union not  $\Sigma^*$  but an irregular (not r.e. as proved earlier) set. If the last bit is removed from the definition of  $L_0$  and  $L_1$ , then any string should be present in either  $L_0$  or  $L_1$  and their union would be  $\Sigma^*$ .

23 votes

-- gatecse (10.7k points)

## 19.15.5 Turing Machine: GATE2002\_14 [top](#)

<http://gateoverflow.in/867>



Selected Answer

(a) M erases its input w and simulate the moves of  $M'$  on x. Thus if  $M'$  halts on x, M accepts any input ( $\Sigma^*$ ) and if  $M'$  doesn't halt on x, M accepts no string ( $\emptyset$ )

(b) Give the description of M -  $\langle M \rangle$  to the TM that decides L. If TM accepts  $\langle M \rangle$ , M halts on all inputs  $\rightarrow M'$  accept x. If TM rejects  $\langle M \rangle$ , M doesn't halt on some input  $\rightarrow M'$  doesn't halt on x, due to our construction of M in 1st step. Thus we decide halting problem

(c) M halting on all inputs w is the key property relating to  $M'$  which is halting on a given input x

1 votes

-- Arjun Suresh (150k points)

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