

OVERALL ANALYSIS

Solution Report

All

Correct Answers

Wrong Answers

Not Attempted Questions

Q.1)

Node A is sending some packets to node B with one-way delay is 50 milliseconds, the bandwidth of the link is 1 Mbps and the size of the packet is 50 bytes. If A is sending 200 packets from A to B, after sending 200 packets node A waits for the ACK then what is the percentage utilization of the link? [ Write the Ceil value of your answer]

Subject: Computer Networks

Max Marks: 1

Correct Answer

Solution: (80)

Explanation:

$$\text{Transmission time}(T_t) = \text{data size} / \text{bandwidth} = 50 \times 8 / 10^6 = 0.4 \text{ ms}$$

$$\text{Propagation time } (T_p) = 50 \text{ ms}$$

$$a = T_p/T_t = 50\text{ms}/0.4 \text{ ms} = 125$$

$$\text{Utilisation of the link} = \text{Window size} / (1 + 2a) = 200/251 = 0.796 = 79.6 \%$$

Q.2)

What will be the output of the C program?

Subject: C Programming

Max Marks: 1

```
#include<stdio.h>
int main()
{
    int a = 5;
    int *p;
    p = &a;
    switch(*p)
    {
        case *p:
            printf("*GATE Applied Course");
            break;
        case a:
            printf("GATE Applied Course");
            break;
        default:
            printf("default Course");
            break;
    }
    return 0;
}
```

A \*GATE Applied Course

B GATE Applied Course

C default Course

D Compilation Error

Correct Option

Solution: (D)

Solution:

Compilation Error: Constant expression required

Q.3)

The total number of minimal POS expressions present for a k-map having total of 8 minterms out of which 5 minterms are covered by essential prime implicants while the remaining minterms are covered by 3 non essential prime implicants are \_\_\_\_\_

Subject: digital logic systems

Max Marks: 1

Note: The minimal expression should be SOP and not POS for the given minterms. Marks are Assigned to All.

Correct Answer

Solution: (27)

Solution: 27

Since the minimal POS expression will consist of essential prime implicants + non essential prime implicants to cover extra minterms.

It is given that extra minterms are  $= 8 - 5 = 3$ , which could be covered by 3 non-essential minterms, therefore, each minterm has 3 choices for their coverage.  
Therefore, minimal POS expression = Essential prime implicants + \_\_\_ + \_\_\_ + \_\_\_  
Each empty space have 3 possibilities, therefore, it will be  $3 * 3 * 3$ .  
Hence, the total number of minimal POS expressions is 27.

Q.4)

Which of the following permutations can not be obtained in the output, using a stack assuming that the input is the sequence 3,4,5,1 and 2 in that order?

A

1,5,2,3,4

Correct Option

Solution: (A)

Solution: 1,5,2,3,4

Considering option 1, 5, 2, 3, 4

Push 3, Push 4, Push 5, Push 1, Pop 1, Pop 5, Push 2, Pop 2, if we Pop now it will be 4 but not 3 hence this option cannot be implemented with the given sequence.

B

3,4,5,2,1

C

5,4,3,2,1

D

None of these

Subject: Data Structures

Max Marks: 1

Q.5)

Given an AVL tree containing N positive integers, print out all the even values contained in the tree in descending order (e.g. 12, 8, 6,

2). What will be the time complexity for an efficient algorithm? Please choose the closest bound function.

A

$O(N^2)$

B

$O(N \log N)$

C

$O(N)$

Correct Option

Solution: (C)

Solution:  $O(N)$

We need to traverse the tree as follows, please note that input to the function Tree() is root node X.

Pseudo code:

```
Tree(node X){  
    Tree(right)  
    if( X → Val % 2 == 0)  
        print(X → Val)  
    Tree(left)  
}
```

Therefore its  $O(N)$ , as we visit each node exactly once.

D

$O(\log N)$

Q.6)

Which of the following is/are True

- I. Every context-free grammar can be converted into an equivalent regular grammar.
- II. Given a context-free grammar generating L, every string in L has a right-most derivation.

A

I and II

B

I only

C

II only

Correct Option

Solution: (C)

Explanation:

- I. False, since there exist context-free languages that are not regular.
- II. True, Given a context-free grammar generating L, every string in L has a right-most derivation.  
Every string in CFG can be either derived by Left most derivation or by the Right most derivation.

D

Neither I nor II

Q.7)

What is the output of the following c program?

Subject: C Programming

Max Marks: 1

```

#include<stdio.h>
#include<string.h>
struct batsman
{
    char name[20];
}p;
char* foo(struct batsman *t)
{
    strcpy(t->name, "rahul");
    return t->name;
}
int main()
{
    strcpy(p.name, "rohit");
    printf("%s %s", p.name, foo(&p));
    return 0;
}

```

A rohit rahul

B rohit rohit

C rahul rahul

Correct Option

**Solution:** (C)

**Solution:**  
In the main function the string "rohit" is copied to the structure member p.name using strcpy function(should have a prototype string.h). A function with structure member as a parameter foo(&p) - call by reference method, will be called inside the printf statement. The function is declared as, structure pointer t as a parameter and char pointer(which returns string) as a return type. Inside that function the string "rahul" is copied to the structure member t->name, here t is the structure(batsman) variable and name is the structure(batsman) member. So the new string is assigned to the structure member. Finally it will prints "rahul rahul".

D None of these

Q.8)

Which of the following kind of web attacks will direct you to the unknown websites, affecting normal advertising?

Subject: Computer Networks

Max Marks: 1

A Phishing

B DDOS

C Malvertising

Correct Option

**Solution:** (C)

**Explanation:**

Malvertising is an attack in which perpetrators inject malicious code into legitimate online advertising networks. The code typically redirects users to malicious websites.

D Man in the middle attack

Q.9)

Which of the following is not a possible intermediate result of merge sort after all lists of size 2 are merged.

Subject: Algorithms

Max Marks: 1

A 10, 23, 45, 98, 5, 32, 40, 41

B 10, 20, 30, 40, 50, 60, 70, 80.

C 7, 30, 34, 40, 8, 20, 19, 53.

Correct Option

**Solution:** (C)

**Solution:**

If the lists of size 2 are merged then we should have sorted sublists of size 4 this is true in the case of options A, B, D, whereas in the case of option C the list 8,20,19,53 is not sorted. Hence is the correct option.

D 75, 100, 230, 500, 10, 22, 34, 50.

Q.10)

Subject: computer organization

Max Marks: 1

Consider the unpipelined processor has a 1ns clock cycle and that it uses 4 cycles for ALU operations and branches, and 5 cycles for memory operations. Assume that the relative frequencies of these operations are 40%, 20%, and 40%, respectively. Suppose that due to clock skew and setup, pipelining the processor adds 0.2 ns of overhead to the clock. Ignoring any latency impact, how much speedup in the instruction execution rate will we gain from a pipeline?

 A

4.4

 B

3.7

Correct Option

**Solution:** (B)**Explanation:**

The average instruction execution time on the non-pipelined processor is

$$\text{Average instruction execution time} = \text{Clock cycle} \times \text{Average CPI} = 1 \text{ ns} \times ((40\% + 20\%) \times 4 + 40\% \times 5) = 1 \text{ ns} \times 4.4 = 4.4 \text{ ns}$$

In the pipeline, the clock must run at the speed of the slowest stage plus overhead, which will be  $1+0.2$  ns.

$$\text{Speedup from pipelining} = \frac{\text{Average instruction time unpipelined}}{\text{Average instruction time pipelined}} = \frac{4.4 \text{ ns}}{1.2 \text{ ns}} = 3.7 \text{ times.}$$

 C

3.5

 D

4.0

Q.11)

Subject: Theory of Computation,Compiler Design

Max Marks: 1

Suppose that L is context free and R is regular. Then which of the following is/are true

- I. Is  $L - R$  necessarily context free
- II. Is  $R - L$  necessarily context free

 A

I only

Correct Option

**Solution:** (A)**Explanation:**

- I.  $L - R$  is context free.  $L - R = L \cap R'$  (the complement of  $R$ ).  $R'$  is regular (since the regular languages are closed under complement) and the intersection of a context-free language and a regular language is context-free, so  $L - R$  is context free.
- II.  $R - L$  need not be context free.  $R - L = R \cap L'$ . But  $L'$  may not be context free, since the context-free languages are not closed under complement. (The deterministic ones are, but  $L$  may not be deterministic.) If we let  $R = \Sigma^*$ , then  $R - L$  is exactly the complement of  $L$ .

 B

II only

 C

I and II only

 D

Neither I nor II

Q.12)

Subject: Discrete Mathematics

Max Marks: 1

Complete bipartite graphs  $K_{m,n}$  have an Euler circuit when :

 A

m is odd and n is even

 B

m is even and n is odd

 C

Both m and n are odd

 D

Both m and n are even

Correct Option

**Solution:** (D)**Explanation:**

We know that a graph has an Euler circuit if and only if all its degrees are even.

Q.13)

A list of customers along with contact information like the name (mandatory), date of birth(mandatory), phone numbers (not mandatory) and address & zip code(not mandatory), is available in the form of a 2-dimensional array in an implementation of a legacy application for which new capability is required to view the customers(along with their contact information) in increasing/decreasing order of their age or ascending/descending order of their name. Which of the following is best suited for this purpose.

Please Note: The combination of name and date of birth of a customer need not be unique.

Subject: Algorithms

Max Marks: 1

 A

Bubble Sort

Correct Option

Solution: (A)

**Solution:**

Here the data on which the sorting is to be performed is customer name and customer date of birth and other contact information is the satellite data, for this type of application we need a stable sorting algorithm out of the above-mentioned options only Bubble sort is stable.

 B

Quick Sort

 C

Heap Sort

 D

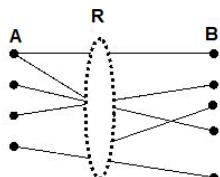
Selection Sort

Q.14)

Which of the following statements is not correct for the below set representation of E-R diagram?

Subject: DBMS

Max Marks: 1



- I. The cardinality of the above relationship R is M:1
- II. Minimum number of relations required for the above instance of E-R diagram is 1.

 A

Only I

Correct Option

Solution: (A)

**Solution:**

- I. In the above E-R diagram we can see that entity A, is participating in more than one relation (many) and entity B is participating in only one relationship. Since, we always write cardinality in reverse format. Therefore, the cardinality of R will be 1:M and not M:1.
- II. Since every instance of both the entities A and B are participating, therefore, there is total participation in between A and B and hence, only 1 relation is required in minimum.

 B

Only II

 C

Both I and II

 D

Neither I nor II

Q.15)

Consider the following relation:

Subject: DBMS

Max Marks: 1



I	J	K	L	M
i1	j1	k1	l1	e1
i2	j2	k2	l2	e2
i1	j1	k1	l1	e1
i2	j2	k3	l3	e4
i3	j3	k4	l4	e5
i2	j2	k5	l3	e6

Which of the following FD's are satisfied for the above relation instance?

- I. I  $\rightarrow$  K
- II. K  $\rightarrow$  I
- III. IJ  $\rightarrow$  K
- IV. J  $\rightarrow$  I
- V. M  $\rightarrow$  IJKL
- VI. L  $\rightarrow$  I

**A** II, III and IV

**B** II, V, IV, and VI

**C** III, IV, V and VI

**D** I and V

**Solution:** (B)  
**Solution:**  
In the given relation, K can uniquely determine I. M can uniquely determine the rest of the attributes. As well as L can uniquely determine I. Therefore only II, V, IV and VI FD's are correct.

Correct Option

Q.16) Subject: Engineering-Mathematics Max Marks: 1

$$\int \frac{\tan^9 x}{\sin x \cos x} dx =$$

**A**  $\frac{1}{10} \tan^9 x + c$

**B**  $\frac{1}{5} \tan^9 x + c$

**C**  $\frac{1}{9} \tan^9 x + c$

Correct Option

**Solution:**

$$= \int \frac{\tan^8 x \sin x}{\sin x * \cos^2 x} dx$$

$$= \int \frac{\tan^8 x \sin x}{\sin x * \cos^2 x} dx$$

$$= \int \tan^8 x \sec^2 x dx$$

$$= \frac{1}{9} \tan^9 x + c$$

D None of the above

Q.17)

For a given set A, the number of elements in the set is \_\_\_\_\_

Subject: Discrete Mathematics

Max Marks: 1

$$A = \{\emptyset, \{\emptyset\}, \{\emptyset, \emptyset\}, \{\emptyset, \emptyset, \emptyset\}, \dots\}$$

Correct Answer

**Solution:** (2)**Answer :** 2**Explanation:**

$$\begin{aligned} A &= \{\emptyset, \{\emptyset\}, \{\emptyset, \emptyset\}, \{\emptyset, \emptyset, \emptyset\}, \dots\} \\ &= \{\emptyset, \{\emptyset\}, \{\emptyset\}, \dots\} \\ &= \{\text{Phi}, \{\text{Phi}\}\} \end{aligned}$$

So, there are two elements in A.

Q.18)

Which of the following is the responsibility of the application layer?

Subject: Computer Networks

Max Marks: 1

Network virtual Terminal

File transfer, access and Management (FTAM)

Mail services

All of the above

Correct Option

**Solution:** (D)**Explanation:**

The Application Layer enables the user, whether human or software, to access the network. It provides user interfaces and support for services such as e-mail, shared database management and other types of distributed information services.

Q.19)

Suppose a program P has the following three threads Thread1, Thread2, and Thread3, and a shared counter, count, as shown below:

Subject: operating systems

Max Marks: 1

```
int count = 10;
Semaphore Lock = 1; // initial value is 1
```

```
Thread1(...)
{
    // do something
    Lock.Wait();
    count++;
    Lock.Signal();
}
```

```
Thread2(...)
{
    // do something
    Lock.Wait();
    count--;
    Lock.Signal();
}
```

```
Thread3(...)
{
    // do something
    Lock.Wait();
    printf("%d", count);
    Lock.Signal();
}
```

Upon the execution of the program P, the number of possible orders of execution of threads where the output will be 10 is \_\_\_\_\_.

Note : The above three threads are non-preemptive threads.



Correct Answer

Solution: (4)

**Explanation :**

Here, depending on the order of execution of threads the distinct outputs possible are 9, 10 and 11.

When  $T_2() \rightarrow T_3() \rightarrow T_1()$  is the execution order then,  
 $T_2()$  decrements count and then  $T_3()$  prints count as 9. And then,  $T_1()$  increments it to 10 again.

When,

$T_3() \rightarrow T_1() \rightarrow T_2()$  or

$T_3() \rightarrow T_2() \rightarrow T_1()$  or

$T_2() \rightarrow T_1() \rightarrow T_3()$  or

$T_1() \rightarrow T_2() \rightarrow T_3()$  are the execution order then,  $T_3()$  prints count as 10.

When  $T_1() \rightarrow T_3() \rightarrow T_2()$  is the execution order then,  
 $T_1()$  increments count to 11 and  $T_3()$  prints count as 11. After that,  $T_2()$  decrements count to 10.

Therefore, four possible ways to get 10 as an output.

Q.20)

Subject: computer organization

Max Marks: 1



Assume an instruction cache miss rate for gcc of 2% and a data cache miss rate of 4%. If a machine has a CPI of 2 without any memory stalls and the miss penalty is 40 cycles for all misses, determine how much faster a machine would run with a perfect cache that never missed. Assume 36% combined frequencies for load and store instructions



Correct Answer

Solution: (1.68)

**Answer:1.68**

**Explanation:**

Assume number of instructions = I

The number of memory miss cycles =  $I \times 2\% \times 40 = 0.8 \times I$

Data miss cycles =  $I \times 36\% \times 4\% \times 40 = 0.56 \times I$

Total number of memory-stall cycles =  $0.8 I + 0.56 I = 1.36 I$

The CPI with memory stalls =  $2 + 1.36 = 3.36$

The performance with the perfect cache is better by  $3.36/2 = 1.68$

Q.21)

Subject: operating systems

Max Marks: 1



Consider the following allocation of a resource. Let the total number of instances of this resource is 10.

Process	Num used	Maximum
P1	1	6
P2	1	5
P3	2	4
P4	4	7

Consider the following statements S1 and S2:

**S1 :** If P4 requests one more instance of the resource then it will lead to a safe state.

**S2:** If P3 requests one more instance of the resource then it will lead to an unsafe state.

Which of the above statements are incorrect?



Only S1

**B**

Only \$2

**C**

Both \$1 and \$2

Correct Option

**Solution:** (C)**Explanation:**

Process	Alloc	Max	Need	Available
P1	1	6	5	2
P2	1	5	4	
P3	2	4	2	
P4	4	7	3	

**S1: is False**

Because, after this allocation, there are not enough free resources to satisfy the maximum number of resources of any processes. Thus this state is *unsafe state*.

**S2 : is False**

Because, this state is a *safe state*. As a possible safe sequence of process execution is :

P3, P4, P1, P2.

**NOTE:**

Please note that MAX resource request per process does not change because of the same process requesting a resource. The value that changes is NO\_OF\_ALLOCATION. The need gets decreased by 1 upon allotment of a resource request. Note that need doesn't mean the requests are already made. The request always should be less than and equal to the need, else it will be an illegal request.

**D**

Neither \$1 nor \$2

Q.22)

The following is the body of an entire procedure that uses six temporaries a, b, c, d, e, f.

```
a = 1
b = a + 2
c = a + 3
d = b + c
e = c + 4
f = d + 5
a = c + e
e = a + f
f = c + e
e = e + f
return e + 9
```

Assume that we must assign one register to each of the six variables.

What is the fewest number of registers that is needed for this program, without spilling

**A**

3

Correct Option

**Solution:** (A)**Explanation:**

```
a = 1 // R1
b = a + 2 // R2
c = a + 3 // R3
d = b + c // R1 = R2+R3
e = c + 4 // R2 = R3+4
f = d + 5 // R1 = R1+5
a = c + e // R2 = R3+R2
e = a + f // R2 = R1+R2
f = c + e // R1 = R3+ R2
e = e + f // R3 = R1+R2
return e + 9 //R3 = R3+9
```

**B**

4

**C**

5

Q.23)

The number of 0's in the binary representation of the following expressions are  
 $(5 \times 4096 + 12 \times 256 + 7 \times 16 + 14)$

Subject: digital logic systems

Max Marks: 1

 A

10

 B

5

Correct Option

**Solution:** (B)

Since, the numbers are getting multiplied by powers of 16, hence, it is nothing but a decimal number i.e.  $(5 \times 4096 + 12 \times 256 + 7 \times 16 + 14) = (5C7E)_{16} = (10110001111110)_2 = 5$  zeros

 C

6

 D

8

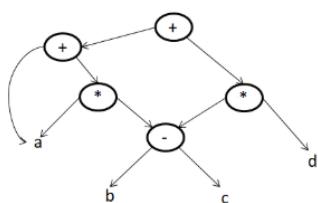
Q.24)

The number of non terminal nodes in Directed Acyclic Graph(DAG)  
of the expression is  
 $a + a * (b - c) + (b - c) * d$

Subject: Theory of Computation,Compiler Design

Max Marks: 1

Correct Answer

**Solution:** (5)**Answer:** 5**Explanation:**

Q.25)

Consider a single-level cache with an access time of 2.5 ns, a line size of 64 bytes, and a hit ratio of H = 0.95. Main memory uses a block transfer capability that has a firstword (4 bytes) access time of 50 ns and an access time of 5 ns for each word thereafter. Suppose that increasing the line size to 128 bytes increases the H to 0.97. The difference between the old and new average memory access time is\_\_\_\_

Subject: computer organization

Max Marks: 1

Correct Answer

**Solution:** (0.1)**Explanation:**

$$T_{old} = (0.95)(2.5) + (0.05)(2.5+125) = 2.375 + 6.375 = 8.75\text{ns}$$

$$T_{new} = (0.97)(2.5) + (0.03)(2.5+205) = 2.425 + 6.225 = 8.65\text{ns}$$

$$\text{Difference} = 8.75 - 8.65 = 0.1$$

Q.26)

Suppose the search field is V = 9 bytes long, the disk block size is B = 512 bytes, a record pointer Pr is 7 bytes, and a block pointer Pb is of 6 bytes. Each B-tree node can have at most p tree pointers, p - 1 data pointers and p - 1 search key field values. These must fit into a single disk block if each B-tree node corresponds to a disk block. What is the average number of block pointers at 2<sup>nd</sup> level of B-tree, given that B-tree is 69% full.

Subject: DBMS

Max Marks: 2

Correct Answer

**Solution:** (4096)**Solution:** 4096

The inequality formed here will be:

$$\begin{aligned} &= 6 * n + (n - 1)(9 + 7) \leq 512 \\ &\approx 6n + 16n - 16 \leq 512 \end{aligned}$$

$$\Leftrightarrow 22n \leq 528$$

$$\Leftrightarrow n = 24$$

Since the B-tree is 69% full, each node on the average will have  $p * 0.69 = 24 * 0.69 = 16.56$  or approximately 16 pointers ( hence, the number of search keys field values will be 15). Since the average pointers are 16, therefore the number of pointer at level 2 could be given as:

Level	Number of nodes	Number of value entries	Number of pointers
Level 0 (Root)	1	15	16
Level 1	16	240	256
Level 2	256	3840	4096
Level 3	4096	61440	

So, the number of pointers at level 2 is 4096

Q.27)

Consider the below schedule along with its timeline:

S:

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
T1	S(A )	R(A )			X(B )	W(B )	C1	U(A )	U(B )					
T2			S(A )	R(A )						X(B )	W(B )	C2	U(A )	U(B )

Which of the operation should be removed/deleted from S in order to make it fall under conservative 2 PL protocol.

A

Deletion of S2(A) and R2(A) at time stamps 3 and 4 respectively

B

Deletion of R1(A) at time stamp 2

C

Both (i) and (ii)

Correct Option

Solution: (C)

Solution:

In the Conservative 2PL protocol, no operation should take place before acquiring all the locks. Therefore, R1(A) at timestamp 2 is an invalid operation due to which S is not allowed under conservative 2 PL and the same for R2(A). Thus, both option (i) and (ii) are correct.

D

Neither (i) nor (ii)

Q.28)

In the framing we are sending the data with the stuffed bits. The bit pattern is used in the starting of the frame and another bit pattern is used in the ending of the frame. The actual data that we are sending is 01101101011010110011. The stuffed data we are sending is 011100110101100101100011001111. What are the bit patterns in starting and end of the frame?

Subject: Computer Networks

Max Marks: 2

A

0111, 1111

B

01110, 01111

Correct Option

Solution: (B)

Explanation:

If we take option b as the example

The flags patterns are 01110, 01111.

To uniquely identify the data we should stuff 0 after two 1's.

The actual data is

01101101011010110011

After stuffing data is 01101011001011001011000110

After attaching the starting and end delimiter pattern

The data would be 011100110101100101100011001111

C 0111001, 01111

D 01110, 1111

Q.29)

What will be the status of the carry, overflow and sign flag bits present in program status word, on adding 113 and -103 represented in 2's complement form?

Subject: digital logic systems

Max Marks: 2

A 1, 0, 0

Correct Option

Solution: (A)

**Solution:**

The 2's complement representation of 113 is: 01110001

The 2's complement representation of -103 is: 10011001

On adding them we will get:

$$\begin{array}{r}
 \text{Carry: } 1 \quad 1 \quad 1 \quad 1 \\
 0 \ 1 \ 1 \ 1 \ 0 \ 0 \ 0 \ 1 \\
 + \quad 1 \ 0 \ 0 \ 1 \ 1 \ 0 \ 0 \ 1 \\
 \hline
 1 \ 0 \ 0 \ 0 \ 0 \ 1 \ 0 \ 1 \ 0
 \end{array}$$

Hence, carry 1 is there, but there is no overflow and the result is also positive. Therefore, only carry flag will be set as 1 while overflow flag and sign flag bit will be set as 0.

B 1, 0, 1

C 0, 1, 0

D 0, 0, 0

Q.30)

What is the output of the following program?

Subject: C Programming

Max Marks: 2

```

#include <stdio.h>
void foo(char **);
int main()
{
    char *a[] = {"rat", "mat", "cat", "bat", "eat", "pot"};
    foo(a);
    return 0;
}
void foo(char **p)
{
    char *p1;
    p1 = (p += sizeof(int))[-2];
    printf("%s", p1);
}
  
```

(Assume sizeof(int) is 4)

A cat

Correct Option

Solution: (A)

**Solution:**

Here foo() gives the address of first value("rat") in an array a. This address is summated by a sizeof(int) which is 4. Now the address in p points the value eat, which is then reduced by 2. Now it points to the value cat which is finally displayed.

B mat

C bat

D eat

Q.31)

Which of the following is/are False

Subject: Theory of Computation, Compiler Design

Max Marks: 2

I.  $[(a \cup b)^* b (a \cup b)^* \cup (a \cup b)^* a (a \cup b)^*] = (a \cup b)^*$

II.  $[(a \cup b)^* b a (a \cup b)^* \cup a^* b^*] = (a \cup b)^*$

III.  $(L_1 - L_2) = (L_2 - L_1)$

A

I,II and III

B

I and III only

Correct Option

Solution: (B)

**Explanation:**

I.  $[(a \cup b)^* b (a \cup b)^* \cup (a \cup b)^* a (a \cup b)^*] = (a \cup b)^*$  False  
 $[(a \cup b)^* b (a \cup b)^* \cup (a \cup b)^* a (a \cup b)^*]$   
 $= \{a, b, aa, bb, ab, ba, \dots\}$  Does not contains Epsilon  
 $\neq (a \cup b)^*$

II.  $[(a \cup b)^* b a (a \cup b)^* \cup a^* b^*] = (a \cup b)^*$  True  
 $\{ba, aba, baa, bab, aaba, \dots\} \cup \{\epsilon, a, b, aa, bb, ab, aab, aabb, abb, \dots\}$   
 $= \{\epsilon, a, b, aa, bb, ab, aab, aabb, abb, ba, bab, bbab, \dots\}$   
 $= (a \cup b)^*$

III.  $(L_1 - L_2) = (L_2 - L_1)$  False

Let  $L_1 = \{aaa, bb, bbb\}$  and  $L_2 = \{ab, ba, aa, bb\}$

Then  $L_1 - L_2 = \{aaa, bbb\}$  and  $L_2 - L_1 = \{ab, ba, aa\}$

C

I and II only

D

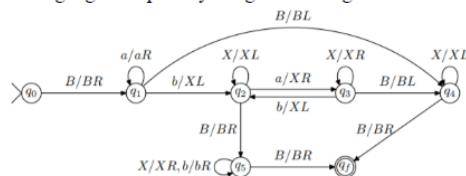
II and III only

Q.32)

The language accepted by the given Turing Machine is

Subject: Theory of Computation, Compiler Design

Max Marks: 2



A

$\{a^i b^j \mid i, j \geq 0\}$

B

$\{a^i b^j \mid i, j \geq 0 \text{ and } i=2j\}$

C

$\{a^i b^j \mid i \geq 0, j \geq i\}$

Correct Option

Solution: (C)

**Explanation:**

Lets consider the string BabbB , where B is the blank symbol

$\delta(q_0, B) = (q_1, B, R)$

$\delta(q_1, a) = (q_1, a, R)$

$\delta(q_1, b) = (q_2, X, L)$

$\delta(q_2, a) = (q_3, X, R)$

$\delta(q_3, X) = (q_3, X, R)$

$\delta(q_3, b) = (q_2, X, L)$

$\delta(q_2, X) = (q_2, X, L)$

$\delta(q_2, B) = (q_5, B, R)$

$\delta(q_5, X) = (q_5, X, R)$

$\delta(q_5, B) = (q_f, B, R)$

The Turing machine will accept all the strings of the form  $a^i b^j$  such that  $i \leq j$ ,  $i, j \geq 0$ .

D

$\{a^i b^j \mid i \geq 0, j \geq i\}$

Q.33)

Let us consider a file system which uses inodes to manage files on disk where each inode consists of a file name of four bytes, user id of two bytes, three timestamps of four bytes each, protection bits of two bytes, a reference count of two bytes, a file type of two bytes, and the file size of four bytes. In addition to that, the inode contains 13 direct indices, 1 index to a single indirect block, 1 index to a double indirect block, and one index to a triple indirect block. Each of these indices is 4 bytes. The file system also stores the first 356 bytes of each file in the inode. A disk sector is assumed to be 512 bytes and that each indirect block fills a single sector. What is the maximum file size for this file system?

A

4 GB

**B** 8 GB

**C** 16 GB

**D** None of the above

**Correct Option**

**Solution:** (D)

**Explanation :**

Given, DBA = 4B

Number of addresses per block =  $512\text{B} / 4\text{B} = 128$  addresses

13 DBA points to 13 Direct Blocks of total size =  $13 * 512\text{B}$

1 Single indirect block pointer points to 1 single indirect block where total size =  $1 * 128 \text{ entries} * 512 \text{ B}$

1 Double indirect block pointer points to 1 double indirect block where total size =  $1 * 128 * 128 \text{ entries} * 512 \text{ B}$

1 Triple indirect block pointer points to 1 triple indirect block where total size =  $1 * 128 * 128 * 128 \text{ entries} * 512 \text{ B}$

It's mentioned that the first 356 B of each file is also stored in the inode. This is to be stored in the primary index table.

And it is mentioned that *an indirect block fills a single sector* and thus can use the entire block size of 512B to store the index entries.

Therefore the maximum file size possible for this system (across all the levels) =  $356 + 13 * 512\text{B} + 1 * 128 \text{ entries} * 512 \text{ B} + 1 * 128 * 128 \text{ entries} * 512 \text{ B} + 1 * 128 * 128 * 128 \text{ entries} * 512 \text{ B} = 1 \text{ GB}$  (approx.)

Q.34)

Subject: operating systems

Max Marks: 2



It is given that on a system, on average, an instruction executes in 1 nano second.

Suppose that it takes 20 micro seconds of processor time for page fault. While, it takes 300 micro seconds of disk time for reading and writing a single page. Suppose that on average 1/3 of the pages that need to be paged out are modified. What is the average number of instructions between page faults that would cause the disk to be busy doing page transfers all the time?

**A**  $3.8 * 10^5$  instructions

**Correct Option**

**Solution:** (A)

**Explanation :**

On an average, time spent on disk is :  $300*2/3 + (300+300)*1/3 = 400$  micro secs.

If 1 page fault occurs every 400ms, it would cause the disk to be busy doing page transfer all the time.

A page fault takes 20 microsecs. So, we have  $(400 - 20)$  microsecs = 380 microsecs to run instructions between page faults.

Average number of instructions between page faults that would cause the disk to be busy doing page transfers all the time =  $(380 \text{ microsecs} / 1\text{ns}) = 3.8 * 10^5$  instructions.

**B**  $2.2 * 10^6$  instructions

**C**  $4.4 * 10^3$  instructions

**D** None of the above

Q.35)

Subject: operating systems

Max Marks: 2



The following table depicts the burst time requirements of five processes (P1, P2, P3, P4 and P5). All these five processes arrive at time 0.

Process ID	CPU requirements (in units of time)
P1	5
P2	4
P3	2
P4	1
P5	8

Now, all these processes are scheduled using first come first served, shortest job first and round robin scheduling (quantum = 2). Then the increasing order (in time units) of the average waiting time of these processes are :

- A RR < SJF < FCFS
- B SJF < RR < FCFS
- C FCFS < SJF < RR
- D None of the above

**Solution:** (D)

**Explanation :**

Scheme	Order	Wait Time					Avg Wait Time
		P1	P2	P3	P4	P5	
FCFS	P1 P2 P3 P4 P5	0	5	9	11	12	7.4
SJF	P4 P3 P2 P1 P5	7	3	1	0	12	4.6
RR	P1 P2 P3 P4 P5 P1 P2 P5 P1 P5 P5	7	9	4	6	12	7.6

Therefore, the increasing order of Avg. Waiting Time is :  $4.6 < 7.4 < 7.6$   
Or, SJF < FCFS < RR

Q.36)

Subject: Computer Networks

Max Marks: 2

In the Go back N protocol we are using the window size of 4, where we are sending a total of 8 frames from the sender to receiver, each frame needs a transmission time of 0.5 milliseconds, round trip time between sender and receiver is 2 milliseconds and the timer timeout time is 3 milliseconds. How much total time it will take in the transmission of 8 frames (time from sending the first frame up to receiving the ACK for the last frame) if the third frame is corrupted? [ Note: Go back N supports individuals as well as cumulative ACK's and timer restarts whenever we are sending the first frame of the new window].



B 12 milliseconds

C 6.5 milliseconds

D 15 milliseconds

Q.37)

A CPU, which addresses the data through its 6 registers in one of 12 different modes, is to be designed to support 10 arithmetic instructions, 15 logic instructions, 24 data-moving instructions, 6 branch instructions and 5 controltype instructions. Of these instructions, respectively 20%, 60%, 50%, 50% and 60% are either single-operand or no-operand instructions, and the rest are of double-operand type. What is the minimum size(Length) of the CPU's instruction word?

Subject: computer organization

Max Marks: 2

Correct Answer

**Solution:** (19)**Explanation:**

Number of registers = 6

Modes = 12

For referring to the 6 six registers we need to assign them codes . Here 3 bits will be enough . As  $2^3=8$

We have 12 modes. So we can easily represent them with four bits . As 16 codes can be accommodated, and we only need 12

Determining Opcode Size

Instruction Type	Number	Single Operand/No Operand	Total Instructions	Double Operand Instruction
Arithmetic	10	20%	2	8
Logic	15	60%	9	6
Data Moving	24	50%	12	12
Branch Instructions	6	50%	3	3
Control Type	5	60%	3	2

Total Double Instructions=31 instructions

Opcode	Mode	Register	Mode	register
5	4	3	4	3

Total Instruction word 19 bits.

Q.38)

Consider the below relation R(X, Y) which contains a tuple (p, q) only if  $p \geq q$ . Here attribute X is primary key and attribute Y is the foreign key referencing X with on delete cascade:

Subject: DBMS

Max Marks: 2

X	Y
12	10
a	b
2	1
c	2
11	8
6	3

Initially tuple (2, 1) is deleted and then in order to preserve referential integrity constraint, tuple (a, b), (c, 2) and (11, 8) are deleted. Which of the following is correct about the variable a, b and c?

A a = 8, b = 2, c = 8

A  $a = 8, b \geq 2, c = 8$

B  $a > 2, b = 2, c = 8$

C None of the above

Correct Option

Solution: (D)

**Solution:**

Here, the rule is to have tuple  $(p, q)$  such that  $q \leq p$  where  $p$  is the primary key. Since  $a$  and  $c$  belongs to attribute  $X$  (primary key), therefore, they could not be the same, thus (i) is wrong.

For 2nd option,  $b$  is given as greater than or equal to 2 while  $a$  is given as 8, since  $b$  should be less than  $a$ , therefore, it is also a wrong option.

For the 3rd option,  $a > 2, b = 2$  and  $c = 8$ , this satisfies all the conditions ( $a > b$  and  $c > 2$ ) and on deleting tuple  $(2, 1)$ , tuple  $(a, 2)$  is deleted,  $(c, 2)$  is deleted and  $(11, 8)$  is deleted due to  $(c, 2)$  as  $(8, 2)$ . But it is given that  $a > 2$ , therefore, it could be equal to  $c$  also and we cannot have same tuples in a single relation. Thus, it is also wrong option.

Thus, the correct option is (iv)

Q.39)

Subject: Algorithms

Max Marks: 2



A recursive algorithm is designed in such a way that it is divided into three subproblems of size in the ratio 2:3:5 and a non-comparison based sorting algorithm is to be used to merge the results obtained by the subproblems(that the results are of a small range  $<<n$ ). Which of the following describes the time complexity of such an algorithm.

A  $O(n^2 \log n)$

B  $O(n \log n)$

Correct Option

Solution: (B)

**Solution:**  
Given that the problem is divided into 3 subproblems in the ratio 2:3:5  
The problem of size  $n$  is divided into subproblems of size  $2n/10, 3n/10, 5n/10$ , also it is given that it makes use of a non-comparison based sorting algorithm also it is given that the numbers are of a small range, therefore, we can take time complexity as  $O(n)$ .  
If we solved by recursion tree method the work done at each level is  $O(n)$  and the tree is of height  $O(\log n)$ , therefore the total time taken is  $O(n \log n)$

C  $O(n^2)$

D None of the above

Q.40)

Subject: Algorithms

Max Marks: 2



Consider the following statements with respect to Dijkstra's Single source shortest path algorithm when applied on a weighted connected graph.

**Statement I:** If there exist multiple shortest paths from the source to a particular vertex then the Dijkstra's algorithm will always return the path with the least number of edges.

**Statement II:** The vertices removed from the priority queue/min-heap are always removed in non-decreasing order of weights.

A Statement I is true only

B Statement II is true only

C Both statements I and II are true

D Neither statement I nor statement II is true

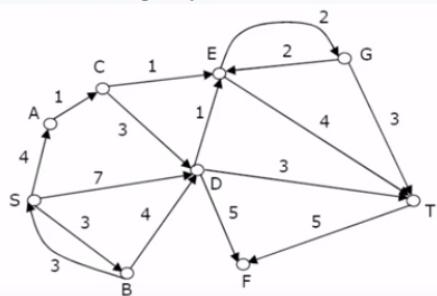
Correct Option

Solution: (D)

**Solution:**

**Statement I:** There is nothing definite about the reported path, it is not always true that always the path with the least number of edges will be reported, if there are multiple paths with the same weight the path which is discovered first is only reported and not updated any further, this path need not be the path with the least number of edges.

Consider the following example



If S is the source and we would like to know the shortest path from S to T. There shortest path cost is 10 and there exist multiple paths SDT, SBDT, SACDT, SACET.

However, if we work out the above example out we will come to know that the path which is reported by Dijkstra's algorithm is SACET.

**Statement II:** It is not necessary that always the min-heap will have elements removed in increasing order of cost, in the case of a graph with a negative weight this is not the case, because of the negative weight edge there is a decrease in the cost of the following vertex.

Q.41)

Subject: Computer Networks

Max Marks: 2

A company has given network id 168.54.0.0/16. A company needs exactly three subnets and the subnets covers all the possible hosts in the network. What would be the subnet addresses of all three subnets?

A 168.54.0.0/18, 168.54.64.0/18 , 168.54.128.0/18

B 168.54.0.0/17, 168.54.128.0/18, 168.54.192.0/18

Correct Option

Solution: (B)

**Explanation:**

We have the net id 168.54.0.0/16

Here initial two octets are the network bits.

For three subnets we require at least two bits:

We want exactly 3 subnets, so the value of the third octet is :

First subnet: 0 0000000 =0 , mask =  $16 + 1 = 17$

Second subnet: 10 0000000 = 128 , mask =  $16+2 = 18$

Third subnet: 11 0000000 = 192 , mask =  $16 + 2 = 18$

C 168.54.64.0/18, 168.54.128.0/18, 168.54.192.0/18

D 68.54.0.0/17, 168.54.128.0/17, 168.54.192.0/17

Q.42)

Subject: Algorithms

Max Marks: 2

Given the following set of tasks and their associated profits and deadlines, what is the most appropriate value of x such that any further incoming tasks can be accommodated to maximize the profit?

Task	Deadline	Profit
1	2	8
2	4	12
3	1	9
4	8	9
5	2	29
6	7	10
7	8	23
8	5	12
9	6	8
10	7	8
11	9	6
12	9	6

Note: Because the question is incomplete x is not defined properly all are allocated marks for it.

A

6

**Solution:** (B)

**Solution:**  
Initially, the tasks are sorted and scheduled as late as possible in a greedy manner upto the task of profit 9.

Time	1	2	3	4	5	6	7	8	9
Profit	9	29		12	12	9	10	23	
Task	3	5		2	5	4	6	7	

Now Task 1,9,10 are of profit 8, Task 1 cannot be scheduled, whereas either task 9 or task 10 can be scheduled in the time slot 3, next we have tasks of profit 6 which as task 11 and 12 each of which has a deadline of 9 only one of them can be scheduled in time slot 9. The total number of optimal schedules is  $2 \times 2 = 4$ .

**C**

8

**D**

12

**Q.43)**

Subject: Engineering-Mathematics

Max Marks: 2

$$\int_0^{2\pi} |cosx - sinx| dx =$$

0

**A** $4\sqrt{2}$ 

Correct Option

**Solution:** (A)**Solution:**A

$$\begin{aligned} & \int_0^{2\pi} |cosx - sinx| dx = \\ &= \int_0^{\pi/4} |cosx - sinx| dx + \int_{\pi/4}^{5\pi/4} |cosx - sinx| dx + \int_{5\pi/4}^{2\pi} |cosx - sinx| dx \\ &= \int_0^{\pi/4} (cosx - sinx) dx + \int_{\pi/4}^{5\pi/4} (sinx - cosx) dx + \int_{5\pi/4}^{2\pi} (cosx - sinx) dx \\ &= [sinx + cosx]_0^{\pi/4} + [-cosx - sinx]_{\pi/4}^{5\pi/4} + [sinx + cosx]_{5\pi/4}^{2\pi} \\ &= 4\sqrt{2} \end{aligned}$$

**B** $2\sqrt{2}$ **C** $4\sqrt{3}$ **D** $3\sqrt{2}$ **Q.44)**

An airport has 15 aircraft and 5 runways the number of ways in which all the aircraft can take off is

Subject: Engineering-Mathematics

Max Marks: 2

**A**

360360

**B**

3003

**C**

3876

**D**

None of the above

Correct Option

**Solution:** (D)

Each aircraft can take off from any of the 5 runways and hence the total number of ways in which the air crafts can take off is  
 $= 5 \times 5 \times 5 \times 5 \dots (15 \text{ times}) = 5^{15}$ .

Q.45)

Subject: Data Structures

Max Marks: 2



A list of records holding 40 bytes per element to be stored, on a system where each pointer requires 4 bytes of storage.

Let N be the number of elements actually stored, where  $N \leq 2020$ .

**We consider two storing techniques:**

1. a doubly-linked list and
2. an array of fixed size which can store 2020 elements.

Considering only total storage cost as important, what is the least possible value of N, if Array has to be a better choice?

 A 2099 B 1010 C 1119 D 1684

Correct Option

Solution: (D)

**Solution: 1684**

For the doubly linked list (DLL), each node will require 8 bytes for pointers and 40 bytes for data, for a total of 48 bytes per node.

Given that the DLL will store N nodes, the total storage cost would be  $48N$ .

(If you want to include the cost of a head pointer, that's OK. It doesn't change the final result significantly.)

For the array of dimension D, each cell will require 40 bytes, so the total storage cost would be  $40D$ .

The array will be the better choice (space-wise) precisely when:  $40D < 48N$ .

We know, D = 2020

$$\Rightarrow 40 * 2020 / 48 < N$$

$$\Rightarrow 1683.33 < N$$

Therefore 1684 is the least value of N if Array has to be a better choice.

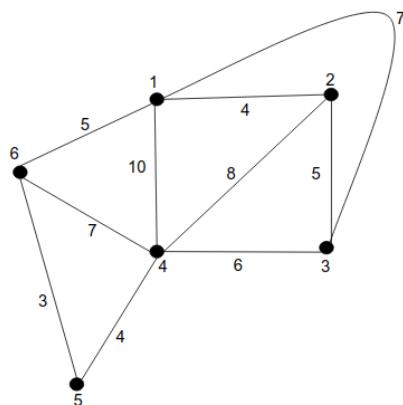
Q.46)

Subject: Algorithms

Max Marks: 2



Which of the following is not the order of removal of vertices from the min-heap/priority queue if the prims algorithm is applied to the following graph.

 A 5-6-4-1-2-3 B 1-2-6-5-4-3 C 2-1-6-5-4-3 D None of the above

Correct Option

Solution: (D)

**Solution:**

- A. If we start Prim's algorithm from vertex 5.
  1. 5 is removed from the Priority Queue.
    - a. 6.key=3
    - b. 4.key=4

2. 6 is removed
    - a. 1.key=5
  3. 4 is removed
    - a. 2.d=8
    - b. 3.d=6
  4. 1 is removed
    - a. 2.d=4
  5. 2 removed
    - a. 3.d=5
  6. 3 is removed
- we end up getting the option 5-6-4-1-2-3

B. If we start Prim's algorithm from vertex 1

1. 1 is removed from the priority queue
  - a. 2.d=4
  - b. 4.d=10
  - c. 6.d=5
  - d. 3.d=7
2. 2 is removed
  - a. 4.d=8
  - b. 3.d=5
3. 6 is removed((6 or 3 could be chosen let's choose 6 as it is in the option)
  - a. 5.d=3
  - b. 4.d=7
4. 5 is removed
  - a. 4.d=4
5. 4 is removed
6. 3 is removed

we end up getting the option 1-2-6-5-4-3

C. If we start Prim's algorithm from vertex 5

1. 2 is removed from the min-heap
  - a. 1.d=4
  - b. 4.d=8
  - c. 3.d=5
2. 1 is removed
  - a. 6.d=5
3. 6 is removed(6 or 3 can be chosen we are choosing 6 because it is present in the option)
  - a. 5.d=3
  - b. 4.d=7
4. 5 is removed
  - a. 4.d=4
5. 4 is removed
6. 3 is removed.

we end up getting the option 2-1-5-6-4-3

None of the above is the most appropriate option.

Q.47)

Minimum number of states in a DFA that accepts the language  
 $L = \{w \mid w \text{ has an even number of } a's \text{ and each } a \text{ is followed by at least one } b\}$

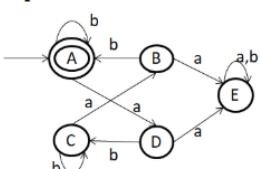
Subject: Theory of Computation,Compiler Design

Max Marks: 2

Correct Answer

**Solution:** (5)

**Explanation:**



Consider an unstructured combinational circuit design, a circuit that divides a 3-bit positive binary number  $x = (x_2 \ x_1 \ x_0)$  by a 2-bit positive binary number  $y = (y_1 \ y_0)$  calculating a 3-bit quotient  $q = (q_2 \ q_1 \ q_0)$  and a 2-bit remainder  $r = (r_1 \ r_0)$  so that

$$x / y = q + (r / y)$$

On taking account on the following table:

$y$	$q_2$	$q_1$	$q_0$	$r_1$	$r_0$
1	$x_2$	$x_1$	$x_0$	0	0
2	0	$x_2$	$x_1$	0	$x_0$
3	-	-	-	-	-

Which of the following options is the correct entry for the blank spaces in the above table?

A

$q_2 = 0$
$q_1 = x_2 x_1 x_0$
$q_0 = x_2' x_1 x_0 + x_2 x_1'$
$r_1 = x_2' x_1 x_0' + x_2 x_1' x_0$
$r_0 = x_2' x_1' x_0 + x_2 x_1' x_0' + x_2 x_1 x_0$

B

$q_2 = 0$
$q_1 = x_2 x_1$
$q_0 = x_2' x_1 x_0 + x_2 x_1$
$r_1 = x_2' x_1 x_0' + x_2 x_1 x_0$
$r_0 = x_2' x_1' x_0 + x_2 x_1' x_0' + x_2 x_1 x_0$

C

$q_2 = 0$
$q_1 = x_2 x_1$
$q_0 = x_2' x_1 x_0 + x_2 x_1'$
$r_1 = x_2' x_1 x_0' + x_2 x_1' x_0$
$r_0 = x_2' x_1' x_0 + x_2 x_1' x_0' + x_2 x_1 x_0$

Correct Option

**Solution:** (c)**Solution:**

The truth table for the  $b = 3$  will be:

$b$	$a$	$q$	$r$	$q_2$	$q_1$	$q_0$	$r_1$	$r_0$
3	0	0	0	0	0	0	0	0
3	1	0	1	0	0	0	0	1
3	2	0	2	0	0	0	1	0
3	3	1	0	0	0	1	0	0
3	4	1	1	0	0	1	0	1
3	5	1	2	0	0	1	1	0
3	6	2	0	0	1	0	0	0
3	7	2	1	0	1	0	0	1

From the K-map for each bit we can draw that:

For  $q_2$ :

$$q_2 = 0$$

For  $q_1$ :

The K-map will be:

$x_2 \setminus x_1 x_0$	00	01	11	10
$\wedge$	$\wedge$	$\wedge$	$\wedge$	$\wedge$

0	0	0	0	0
1	0	0	1	1

The pair formed will result in :  $x_2x_1$

For  $q_0$ :

The K-map will be:

$x_2 \setminus x_1 x_0$	00	01	11	10
0	0	0	1	0
1	1	1	0	0

It will result in one pair and one singleton:  $x_2'x_1x_0 + x_2x_1'$

For  $r_1$ :

The K-map will be:

$x_2 \setminus x_1 x_0$	00	01	11	10
0	0	0	0	1
1	0	1	0	0

It will result in 2 singletons:  $x_2'x_1x_0' + x_2x_1'x_0'$

For  $r_0$ :

The K-map will be:

$x_2 \setminus x_1 x_0$	00	01	11	10
0	0	1	0	0
1	1	0	1	0

It will result in 2 singletons:  $x_2'x_1'x_0 + x_2x_1'x_0' + x_2x_1x_0'$

Thus, the correct option is (iii)

$q_2 = 0$
$q_1 = x_2x_1$
$q_0 = x_2'x_1x_0 + x_2x_1'$
$r_1 = x_2'x_1x_0' + x_2x_1'x_0'$
$r_0 = x_2'x_1'x_0 + x_2x_1'x_0' + x_2x_1x_0'$

Q.49)

Given an N-by-N matrix of integer numbers, find the largest number that appears (at least) once in each row (or report that no such number exists)

Subject: Data Structures

Max Marks: 2

9	6	3	8	5
3	5	1	6	8
0	7	5	3	5
3	5	7	8	6
4	3	5	7	9

What is the order of growth of the best-case running time of this algorithm as a function of N? Please note that  $N^2$  can be read as  $N \cdot N$

A  $N^2$

B  $N \log N^2$

c  $N^2 * (\log N)$

Correct Option

Solution: (c)

**Solution:**  $N^2 * (\log N)$

1. Sort each row using heapsort.
2. For each number in row 0, from largest to smallest, use binary search to check if it appears in the other  $N - 1$  rows.
3. Return the first number that appears in all  $N$  rows.

The order of growth of the running time is  $N^2 \log N$ , with the bottleneck being steps 1 and 2. Correctness follows because the largest common number must appear in row 0. Scanning the numbers in row 0 from largest to smallest ensures that we find the largest common number.

d  $N^3$

Q.50)

For the function  $f : R \times N \rightarrow R \times N$  defined as  $f((x,y)) = (3xy, y)$

Subject: Discrete Mathematics

Max Marks: 2



Which of the following options is correct regarding the above function?

a  $f$  is only injective

b  $f$  is only surjective

c  $f$  is both injective and surjective

Correct Option

Solution: (c)

**Explanation:**

Injective:

Suppose  $f((a,b)) = f((c,d))$

Then,  $(3ab, b) = (3cd, d)$ , which means that  $3ab = 3cd$

And  $b = d$ .

So,  $3ab = 3cd$

or,  $3ad = 3cd$

or,  $a = c$ .

Therefore,

$(a,b) = (c,d)$

Thus,  $f$  is injective

Surjective:

Given  $(a,b)$  belongs to  $R \times N$ , note that  $(a/3b, b)$  belongs to  $R \times N$  and  $f((a/3b), b) = (3(a/3b)b, b) = (a,b)$ .

So,  $f$  is surjective.

d  $f$  is neither injective nor surjective

Q.51)

Given that the rank of an  $n \times n$  square matrix A is strictly less than  $n$  then Which of the following statements are true.

Subject: Engineering-Mathematics

Max Marks: 2



- I. Exactly one of the eigenvalues of A is zero.
- II. The matrix A is not diagonalizable.

a Both statements I and II are true.

b Neither statement I and II are true.

Correct Option

Solution: (b)

**Solution B**

If the rank of the matrix A which is  $n \times n$  is less than  $n$  then  $|A|=0$ , as  $|A|=\text{product of each of the eigenvalues of } A$ , one or more than one of the eigenvalues of A is zero. Statement I is therefore false. Statement II is false because  $|A|=0$  does not mean that the matrix is not diagonalizable. If Algebraic multiplicity  $\neq$  Geometric multiplicity for any of the eigenvalues, then only it is not diagonalizable.

C

Statement I is true only.

D

Statement II is true only.

Q.52)

Subject: Discrete Mathematics

Max Marks: 2



Consider the following sentence:

*Unless I am watching TV, my dog is either eating or sleeping*

Given that,

p : My dog is eating

q : My dog is sleeping

r : I am watching TV

Which of the following option(s) is/are the correct way to represent it in propositional logic?

A

$\neg r \rightarrow (p \text{ XOR } q)$

B

$(p \text{ XOR } q) \vee r$

C

$r \vee \neg(p \leftrightarrow q)$

D

All of the above

Correct Option

Solution: (D)

Explanation:

*Unless I am watching TV, my dog is either eating or sleeping*, is the same as *My dog is either eating or sleeping unless I am watching TV*.

We know, P unless Q  $\Leftrightarrow P \vee Q$

My dog is sleeping or my dog is eating. It cannot eat and sleep at the same time. Therefore, it is the case of exclusive OR.

$(p \text{ AND } \neg q) \vee (\neg p \text{ AND } q) \Leftrightarrow (p \text{ XOR } q)$

Also,

$$\begin{aligned} (p \text{ AND } \neg q) \vee (\neg p \text{ AND } q) &\Leftrightarrow \neg[(\neg p \text{ OR } q) \text{ AND } (p \text{ OR } \neg q)] \\ &\Leftrightarrow \neg[(p \rightarrow q) \text{ AND } (q \rightarrow p)] \Leftrightarrow \neg[p \leftrightarrow q] \end{aligned}$$

Let P = (p XOR q), Q = r

then,

P unless Q

$$\begin{aligned} &\Leftrightarrow (p \text{ XOR } q) \vee r \\ &\Leftrightarrow r \vee (p \text{ XOR } q) \\ &\Leftrightarrow \neg(\neg r) \vee (p \text{ XOR } q) \\ &\Leftrightarrow \neg r \rightarrow (p \text{ XOR } q) \end{aligned}$$

Also,

$$\begin{aligned} r \vee (p \text{ XOR } q) \\ \Leftrightarrow r \vee \neg[p \leftrightarrow q] \end{aligned}$$

Q.53)

Subject: Discrete Mathematics

Max Marks: 2



The order of the element (6,15,4) in  $Z_{30} \times Z_{45} \times Z_{24}$  is \_\_\_\_

A

Correct Answer

Solution: (30)

Answer : 30

Explanation:

In  $Z_{30}$ , order of 6 is  $30/\text{GCD}(6,30) = 30/6 = 5$

In  $Z_{45}$ , order of 15 is  $45/\text{GCD}(15,45) = 45/15 = 3$

In  $Z_{24}$ , order of 4 is  $24/\text{GCD}(4,24) = 24/4 = 6$

The order of the element (6,15,4) in Z30 x Z45 x Z24 = LCM(5, 3, 6) = 30

Q.54)

Subject: Theory of Computation, Compiler Design

Max Marks: 2

Which of the following languages are deterministic context free.

- I.  $\{a^m b^n : m \neq n\}$
- II.  $\{w w^R : w \in \{a, b\}^*\}$
- III.  $\{ca^m b^m : m \geq 0\} \cup \{da^m b^{2m} : m \geq 0\}$
- IV.  $\{a^m c b^m : m \geq 0\} \cup \{a^m d b^{2m} : m \geq 0\}$

A I and II only

B III and IV only

C I, II and III only

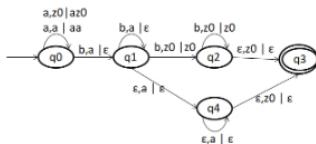
D I, II, III and IV

Correct Option

Solution: (D)

Explanation:

- I.  $\{a^m b^n : m \neq n\}$  DCFL  
 $\{a^m b^n : m \neq n\} \Rightarrow m < n$  or  $m > n$

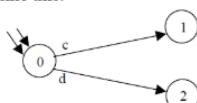


- II.  $\{w w^R : w \in \{a, b\}^*\}$  DCFL  
 III.  $\{ca^m b^m : m \geq 0\} \cup \{da^m b^{2m} : m \geq 0\}$  DCFL

$L = \{ca^m b^m : m \geq 0\} \cup \{da^m b^{2m} : m \geq 0\}$ . Often it's hard to build a deterministic PDA for a language that is

formed by taking the union of two other languages. For example,  $\{a^m b^m : m \geq 0\} \cup \{a^m b^{2m} : m \geq 0\}$  would be hard (in fact it's impossible) because we have no way of knowing, until we run out of b's, whether we're expecting two b's for each a or just one. However,  $\{ca^m b^m : m \geq 0\} \cup \{da^m b^{2m} : m \geq 0\}$  is actually quite easy.

Every string starts with a 'c' or a 'd'. If it's a 'c', then we know to look for one b for each a; if it's a d, then we know to look for two. So the first thing we do is to start our machine like this.



The machine that starts in state 1 is our classic machine for  $a^m b^n$ , except of course that it must have a final transition on \$ to its final state.

We have two choices for the machine that starts in state 2. It can either push one a for every a it sees, and then pop an a for every pair of b's, or it can push two a's for every a it sees, and then pop one a for every b.

- IV.  $\{a^m c b^m : m \geq 0\} \cup \{a^m d b^{2m} : m \geq 0\}$  DCFL

First one that pushes a single a for each a it sees. Then, when we see a c or d, we branch and either pop an a for each b or pop an a for every two b's.

Q.55)

Subject: computer organization

Max Marks: 2

Suppose we have a computer that uses a memory address word size of 8 bits. This computer has a 16-byte cache with 4 bytes per block. The computer accesses a number of memory locations throughout the course of running a program. Suppose this computer uses direct-mapped cache. The format of a memory address as seen by the cache is shown here:

TAG	Block	Offset
4	2	2

The system accesses memory addresses (in hex) in this exact order: 6E, B9, 17, E0, 4E, 4F, 50, 91, A8, A9, AD, 93, and 94. The memory addresses of the first four accesses have been loaded into the cache blocks as shown below

Block 0	Tag Contents (represented by address)	Cache Contents (represented by address)	Block 1	Tag Contents (represented by address)	Cache Contents (represented by address)
	1110	0xE0		0001	0x14

Block 2	1011	0xB8	Block 3	0110	0x6C
		0xB9			0x6D
		0xBA			0x6E
		0xBB			0x6F

The hit ratio for the entire memory reference sequence given above, assuming that we count the first four accesses as misses \_\_\_\_\_ (Consider the answer upto two decimal places).

Correct Answer

**Solution:** (0.23)

Given addresses are 6E, B9,...

Assuming that the first four access are misses

**Binary representation for 6E is**

0110 1101

TAG bits are 0110, index bits are 11, offset is 01

The cache blocks will contain/replaced with 1100, 1101, 1110, 1111  $\Rightarrow$  6C, 6D, 6E, 6F

**Binary representation for B9 is**

1011 1001

TAG bits are 1011, index bits are 10, offset is 01  $\Rightarrow$  Block 2 it is also a Miss

Block is filled with 1000, 1001, 1010, 1011  $\Rightarrow$  B8, B9, BA, BB

Address (Hex)	Address (Binary)	Hit/Miss	Block transferred to Cache	Destination Cache Block
6E	0110 1110	Miss	6C, 6D, 6E, 6F	3
B9	1011 1001	Miss	B8, B9, BA, BB	2
17	0001 0111	Miss	14, 15, 16, 17	1
E0	1110 0000	Miss	E0, E1, E2, E3	0
4E	0100 1110	Miss	4C, 4D, 4E, 4F	3
4F	0100 1111	Hit	--	--
50	0101 0000	Miss	50, 51, 52, 53	0
91	1001 0001	Miss	90, 91, 92, 93	0
A8	1010 1000	Miss	A8, A9, AA, AB	2
A9	1010 1001	Hit	--	--
AD	1010 1101	Miss	AC, AD, AE, AF	3
93	1001 0011	Hit	--	--
94	1001 0100	Miss	94, 95, 96, 97	1

Hence, out of 14 memory accesses, there are 10 misses. The Hit Ratio is calculated as follows:

$$H = \frac{\text{Accesses} - \text{Misses}}{\text{Accesses}}$$

$$H = (13-10)/13 = 3/13 = 0.23$$

**Q.1)**

Find the remainder when  $99^{124}$  is divided by 17

Subject: General Aptitude

Max Marks: 1

**A**

5

**B**

13

**C**

4

Correct Option

**Solution:** (C)

$$\text{Solution: } \frac{99^{124}}{17} \rightarrow \frac{3^{124}}{17}$$

Here 17 is a prime number hence we can use the following property to more simplify the given expression. The property is  $A^{p-1} \equiv 1 \pmod{p}$  where p is a prime number.

simplify the given expression. The property is  $\frac{1}{p} \rightarrow 1$ , here p is a prime number and A is not a multiple of P.

$$\text{So, } \frac{3^{124}}{17} = \frac{3^{16} \cdot 3^{16} \cdot 3^{16} \cdot 3^{16} \cdot 3^{16} \cdot 3^{12}}{17} \rightarrow 1 * 1 * 1 * 1 * 1 * 1 * 1 * \frac{3^{12}}{17}$$

$$\frac{3^{12}}{17} = \frac{3^4 \cdot 3^4 \cdot 3^4}{17} \rightarrow \frac{13 \cdot 13 \cdot 13}{17} = \frac{169}{17} * \frac{13}{17} \rightarrow \frac{169 \cdot 13}{17^2} \rightarrow 4$$

**D** 15

**Q.2)**

Subject: General Aptitude

Max Marks: 1

Three of the mentors started writing notes for the GATE CS Subjects and before they started they had set a target to finish the work on a certain date. But due to some important work these mentors had to take leave, which resulted in the delay of 3 days from the target date to be finished. Mentor A took 2 days more leave than that of Mentor C and Mentor B took 4 days more leave than that of Mentor C. What is the total number of days for which Mentor C was on leave?

**A** 0

**B** 3

**C** 2

**D** 1

Correct Option

**Solution:** (D)

**Solution:** Let us assume that each mentor can write  $\frac{1}{X}$  part of the whole in one day. Let d be the number of days in which the target was set to complete the notes. Let p be the number of leave days for Mentor C.

Hence we can say that,

$$\frac{3d}{X} = 1$$

$$\text{And, } \frac{d+3-(p+2)}{X} + \frac{d+3-(p+4)}{X} + \frac{d+3-p}{X} = 1$$

$$\Rightarrow \frac{3d+9-3p-6}{X} = 1$$

$$\Rightarrow \frac{3d-3p+3}{X} = 1$$

$$\Rightarrow 3d - 3p + 3 = X$$

$$\Rightarrow X - 3p + 3 = X$$

$$\Rightarrow 3p = 3$$

$$\Rightarrow p = 1$$

**Q.3)**

Subject: General Aptitude

Max Marks: 1

A rectangle ABCD is inscribed in a semicircle of centre P and diameter XY. X, D, C, Y are collinear. CY=2 cm and BC=4 cm, then what is the area of the semicircle not overlapped by the rectangle ABCD.

**A**  $(12.5\pi + 12) \text{ cm}^2$

**B**  $(12.5\pi - 12) \text{ cm}^2$

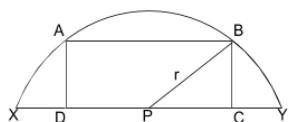
**C**  $(12.5\pi + 24) \text{ cm}^2$

**D**  $(12.5\pi - 24) \text{ cm}^2$

Correct Option

**Solution:** (D)

**Solution:** Let r be the radius of the semicircle.



$$\text{In } \triangle PCB : r^2 = (r - 2)^2 + 4^2$$

$$\Rightarrow r^2 = r^2 + 4 - 4r + 16$$

$$\Rightarrow 4r = 20$$

$$\Rightarrow r = 5 \text{ cm}$$

$$\text{Area of the rectangle } ABCD = 2(r - 2) * 4$$

$$= 2(5 - 2) * 4 = 24 \text{ cm}^2$$

$$\text{Required Area} = \text{Area of the semi-circle} - \text{Area of Rectangle } ABCD$$

$$= \frac{\pi}{2}(5)^2 - 24$$

$$= (12.5\pi - 24) \text{ cm}^2$$

**Q.4)**

Subject: General Aptitude

Max Marks: 1

The sentence has been divided into four parts. Identify the part which is having the error in it.

- (I) If I knew all the facts,
- (II) I would not have stood bail for him
- (III) and defended him to my friends who
- (IV) had warned me to keep away from him

(II) and (IV)

Only (I)

Correct Option

Solution: (B)

Solution: Instead of "If I knew all the facts" it will be "If I had known all the facts". It is a grammatical error.

Only (IV)

(II) and (III)

Q.5)

Select the appropriate synonym of the given word

OMINOUS

Subject: General Aptitude

Max Marks: 1

Threatening

Correct Option

Solution: (A)

Solution: The meaning of the word Ominous is giving the worrying impression that something bad is going to happen which is related to Threatening, so the answer is an option (a).

Powerful

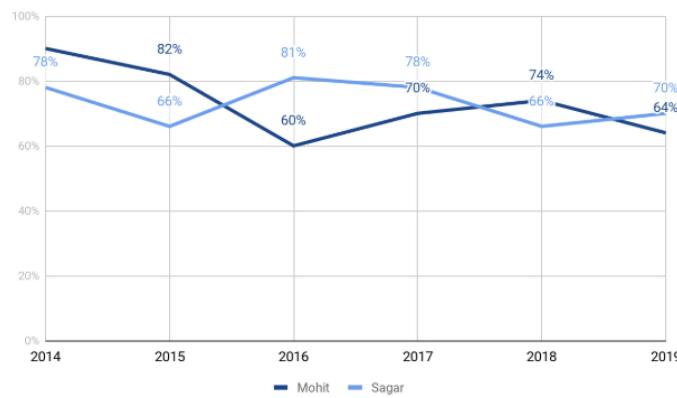
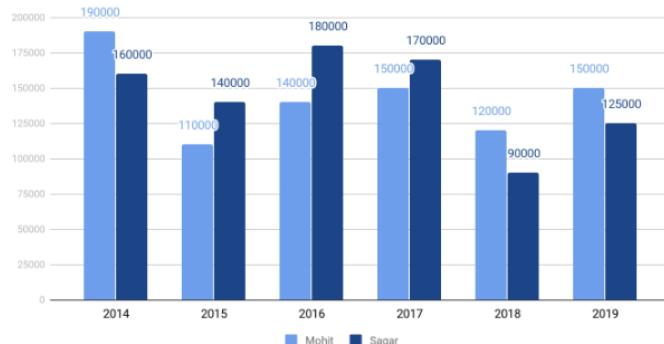
Ubiquitous

Burdensome

Q.6)

Below Column Graph shows the production of goods produced by the company of Mohit and Sagar during the year 2014-2019. The

line graph below shows the percentage of sale of the goods produced by both the companies of Mohit and Sagar. The number of products sold in year 2017 by Mohit's Company is what percentage of the total number of products sold by Sagar's Company in the year 2015?



95.67%

113.63%

Correct Option

Solution: (B)

Solution: Product sold by Mohit's Company in the year

$$2017 = 150000 \times \frac{70}{100} = 105000$$

$$2017 = 140000 * \frac{66}{100} = 92400$$

Product sold by Sagar's Company in the year 2015 =  $140000 * \frac{66}{100} = 92400$

Required Answer =  $\frac{105000}{92400} * 100 = 113.63\%$

C 124.47%

D 105.33%

Q.7)

Find the ratio of the diameter of the circles inscribed in and circumscribing equilateral triangle to its height.

Subject: General Aptitude

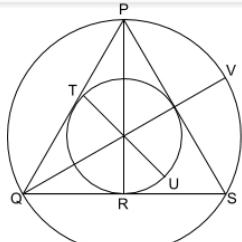
Max Marks: 2

A 1:2:1

B 2:4:3

Correct Option

Solution: (B)



Solution:

Let the length of the sides of the equilateral triangle =  $a$

Then the height of the triangle (PR) =  $\frac{a\sqrt{3}}{2}$

Area of the equilateral triangle (PQS) =  $\frac{\sqrt{3}}{4}a^2$

Semiperimeter (S) of the triangle =  $\frac{a+a+a}{2} = \frac{3a}{2}$

Diameter of the inner circle (TU) =  $\frac{2 * \text{Area}}{S}$

$$= \frac{2 * \sqrt{3} * a^2}{4 * 3 * a} = \frac{a}{\sqrt{3}}$$

Diameter of the outer circle (QV) =  $\frac{a^2}{2 * \text{Area}}$

$$= \frac{a^2 * 4}{2 * \sqrt{3} * a^2} = \frac{2a}{\sqrt{3}}$$

Ratio of TU:QV:PR =  $\frac{a}{\sqrt{3}} : \frac{2a}{\sqrt{3}} : \frac{a\sqrt{3}}{2} = 2 : 4 : 3$

C 1:3:4

D 3:2:1

Q.8)

Their achievement in the field of literature is described as (\_\_\_\_\_), sometimes it is even called (\_\_\_\_\_).

Subject: General Aptitude

Max Marks: 2

A magnificent, irresponsible

B insignificant, influential

C significant, paltry

D unimportant, trivial

Correct Option

Solution: (D)

Solution: The given statement is informing how the achievement of a group of people to literature is described. The second clause refers to something which would be of a higher degree or intensity to what has been mentioned, so for that to be true, both words would be similar, differing only in degree, with the second one being of a higher degree than the other. Only option (d) has such words.

Q.9)

Rahul is a seller of notebooks. He sells notebook at a discount of 5% on the marked price of the notebooks. He also gives one notebook for free on purchase of 11 notebooks. The profit (in %) for Rahul still remains 25%. How much is the marked price more than that of cost price (in %)?

Subject: General Aptitude

Max Marks: 2

A 43%

B 43.47%

Correct Option

**Solution:** (B)

**Solution:** Let the cost price of each notebook be ₹  $x$ .

Then the cost price of 12 notebooks = ₹  $12x$ .

Selling Price of 11 notebooks =  $12 * \frac{125}{100} = ₹ 15$ .

Therefore the selling price of each notebook =  $\frac{15}{11} = ₹ 1.363$ .

When the selling price is ₹ 0.95 (at 5% discount), then Marked Price = ₹  $x$ .

And now the selling price is ₹ 1.363, then the Marked Price

$$= \frac{x}{0.95} * 1.363 = ₹ 1.4347$$

The difference between the Marked Price and Cost Price (in %)

$$= \frac{1-1.4347}{1} * 100 = 43.47\%$$

**c**

45.23%

**d**

30%

**Q.10)**

**Subject: General Aptitude**

**Max Marks: 2**



**A**

Africa is a dangerous place to be in.

**B**

The waterholes are meant specially for the predators.

**C**

Life and death reside simultaneously at the African waterholes.

**Correct Option**

**Solution:** (C)

**Solution:** The passage reveals the fact that in the waterholes of Africa, the prey and the predator meet each other. Here, the prey is in search of cold water and the predator seeks the prey's blood. This creates an atmosphere of death for the herds of herbivorous animals who are thirsty enough to go close to the waterhole. Option (c) is correct as it best suits the theme of the passage. Option (a) is incorrect as one cannot derive that conclusion from the passage. Option (b) is incorrect as the waterholes are meant for the prey and the predator both. Option (d) is incorrect as it is not mentioned anywhere in the passage.

**D**

Herbivores and carnivores are nature's way of maintaining balance.

**close**