GATE

GATE PYQ_2023_CS

CS & IT

Full Syllabus

Q1 We reached the station late, and _____ missed the train.

(A) near (B) nearly

(C) utterly (D) mostly

Q2 Kind : _____ : : Often : Frequently

(By word meaning)

(A) Mean (B) Type

(C) Cruel (D) Kindly

Q3 A series of natural numbers F_1, F_2, F_3, F_4, F_5, F_6, F_7, ... obeys $F_{n+1} = F_n + F_{n-1}$ for all integers $n \geq 2$.

If $F_6 = 37$, and $F_7 = 60$, then what is F_1 ?

(A) 4 (B) 5

(C) 8 (D) 9

Q4 A survey for a certain year found that 90% of pregnant women received medical care at least once before giving birth. Of these women, 60% received medical care from doctors, while 40% received medical care from other healthcare providers. Given this information, which one of the following statements can be inferred with certainty?

(A) More than half of the pregnant women received medical care at least once from a doctor.

(B) Less than half of the pregnant women received medical care at least once from a doctor.

(C) More than half of the pregnant women received medical care at most once from a doctor.

(D) Less than half of the pregnant women received medical care at most once from a doctor.

Q5 Looking at the surface of a smooth 3-dimensional object from the outside, which one of the following options is TRUE?

(A) The surface of the object must be concave everywhere.

(B) The surface of the object must be convex everywhere.

(C) The surface of the object may be concave in some places and convex in other places.

(D) The object can have edges, but no corners.

Q6 The country of Zombieland is in distress since more than 75% of its working population is suffering from serious health issues. Studies conducted by competent health experts concluded that a complete lack of physical exercise among its working population was one of the leading causes of their health issues. As one of the measures to address the problem, the Government of Zombieland has decided to provide monetary incentives to those who ride bicycles to work.

Based only on the information provided above, which one of the following statements can be logically inferred with certainty?

(A) All the working population of Zombieland will henceforth ride bicycles to work.

(B) Riding bicycles will ensure that all of the working population of Zombieland is free of health issues.

(C) The health experts suggested to the Government of Zombieland to declare riding bicycles as mandatory.

(D) The Government of Zombieland believes that riding bicycles is a form of physical exercise.

Q7 Consider two functions of time (t),

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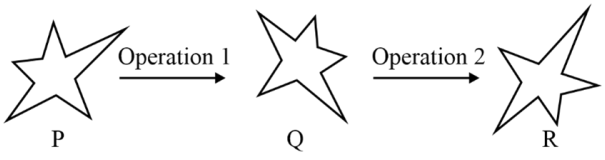
$f(t) = 0.01\ t_2$
$g(t) = 4\ t$
where $0 < t < \infty$.
Now consider the following two statements:
(i) For some $t > 0$, $g(t) > f(t)$.
(ii) There exists a T, such that $f(t) > g(t)$ for all $t > T$.
Which one of the following options is TRUE?
(A) only (i) is correct
(B) only (ii) is correct
(C) both (i) and (ii) are correct
(D) neither (i) nor (ii) is correct

Q8 Which one of the following sentence sequences creates a coherent narrative?
(i) Once on the terrace, on her way to her small room in the corner, she notices the man right away.
(ii) She begins to pant by the time she has climbed all the stairs.
(iii) Mina has bought vegetables and rice at the market, so her bags are heavy.
(iv) He was leaning against the parapet, watching the traffic below
(A) (i), (ii), (iv), (iii)
(B) (ii), (iii), (i), (iv)
(C) (iv), (ii), (i), (iii)
(D) (iii), (ii), (i), (iv)

Q9 f(x) and (y) are functions of x and y, respectively, and f (x) = g (y) for all real values of x and y. Which one of the following options is necessarily TRUE for all x and y?
(A) f (x) = 0 and g (y) = 0
(B) f (x) = g (y) = constant
(C) f (x) ≠ constant and g (y) ≠ constant
(D) f (x) + g (y) = f (x) – g(y)

Q10 Which one of the options best describes the transformation of the 2-dimensional figure P to Q, and then to R, as shown?



(A) Operation 1: A clockwise rotation by 90° about an axis perpendicular to the plane of the figure
Operation 2: A reflection along a horizontal line
(B) Operation 1: A counter clockwise rotation by 90° about an axis perpendicular to the plane of the figure
Operation 2: A reflection along a horizontal line
(C) Operation 1: A clockwise rotation by 90° about an axis perpendicular to the plane of the figure
Operation 2: A reflection along a vertical line
(D) Operation 1: A counter clockwise rotation by 180° about an axis perpendicular to the plane of the figure
Operation 2: A reflection along a vertical line

Q11 Consider the following statements regarding the front-end and back-end of a compiler.
S1: The front-end includes phases that are independent of the target hardware.
S2: The back-end includes phases that are specific to the target hardware.
S3: The back-end includes phases that are specific to the programming language used in the source code.
Identify the CORRECT option.
(A) Only S1 is TRUE.
(B) Only S1 and S2 are TRUE.
(C) S1, S2, and S3 are all TRUE.
(D) Only S1 and S3 are TRUE.

Q12 Which one of the following sequences when stored in an array at locations
A[1], . . . , A[10] forms a max-heap?
(A) 23, 17, 10, 6, 13, 14, 1, 5, 7, 12
(B) 23, 17, 14, 7, 13, 10, 1, 5, 6, 12
(C) 23, 17, 14, 6, 13, 10, 1, 5, 7, 15
(D) 23, 14, 17, 1, 10, 13, 16, 12, 7, 5

Q13 Let SLLdel be a function that deletes a node in a singly-linked list given a pointer to the node and a pointer to the head of the list. Similarly,

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let DLLdel be another function that deletes a node in a doubly-linked list given a pointer to the node and a pointer to the head of the list.

Let n denote the number of nodes in each of the linked lists. Which one of the following choices is TRUE about the worst-case time complexity of SLLdel and DLLdel?

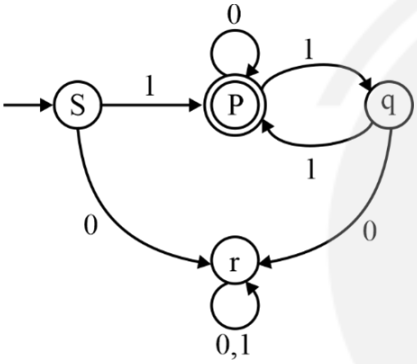
(A) SLLdel is O(1) and DLLdel is O(n)

(B) Both SLLdel and DLLdel are O(log(n))

(C) Both SLLdel and DLLdel are O(1)

(D) SLLdel is O(n) and DLLdel is O(1)

Q14 Consider the Deterministic Finite-state Automaton (DFA) A shown below. The DFA runs on the alphabet {0, 1}, and has the set of states {s, p, q, r}, with s being the start state and p being the only final state.



Which one of the following regular expressions correctly describes the language accepted by A?

(A) $1(0^*11)^*$ (B) $0(0+1)^*$

(C) $1(0+11)^*$ (D) $1(110^*)^*$

Q15 The Lucas sequence L_n is defined by the recurrence relation:

$L_n = L_{n-1} + L_{n-2}$, for $n \geq 3$,

with $L_1 = 1$ and $L_2 = 3$.

Which one of the options given is TRUE?

(A) $L_n = \left(\frac{1+\sqrt{5}}{2}\right)^n + \left(\frac{1-\sqrt{5}}{2}\right)^n$

(B) $L_n = \left(\frac{1+\sqrt{5}}{2}\right)^n - \left(\frac{1-\sqrt{5}}{3}\right)^n$

(C) $L_n = \left(\frac{1+\sqrt{5}}{2}\right)^n + \left(\frac{1-\sqrt{5}}{3}\right)^n$

(D) $L_n = \left(\frac{1+\sqrt{5}}{2}\right)^n - \left(\frac{1-\sqrt{5}}{2}\right)^n$

Q16

Which one of the options given below refers to the degree (or arity) of a relation in relational database systems?

(A) Number of attributes of its relation schema.

(B) Number of tuples stored in the relation.

(C) Number of entries in the relation.

(D) Number of distinct domains of its relation schema.

Q17 Suppose two hosts are connected by a point-to-point link and they are configured to use Stop-and-Wait protocol for reliable data transfer. Identify in which one of the following scenarios, the utilization of the link is the lowest.

(A) Longer link length and lower transmission rate

(B) Longer link length and higher transmission rate

(C) Shorter link length and lower transmission rate

(D) Shorter link length and higher transmission rate

Q18 let $A = \begin{bmatrix} 1 & 2 & 3 & 4 \\ 4 & 1 & 2 & 3 \\ 3 & 4 & 1 & 2 \\ 2 & 3 & 4 & 1 \end{bmatrix}$

and $B = \begin{bmatrix} 3 & 4 & 1 & 2 \\ 4 & 1 & 2 & 3 \\ 1 & 2 & 3 & 4 \\ 2 & 3 & 4 & 1 \end{bmatrix}$

Let det(A) and det(B) denote the determinants of the matrices A and B, respectively.

Which one of the options given below is TRUE?

(A) det(A) = det(B)

(B) det(B) = −det(A)

(C) det(A) = 0

(D) det(AB) = det(A) + det(B)

Q19 Consider the following definition of a lexical token id for an identifier in a programming language, using extended regular expressions:

letter → [A-Za-z]

digit → [0-9]

id → letter (letter | digit)*

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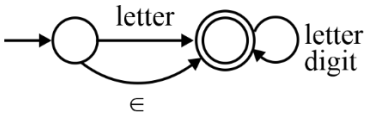
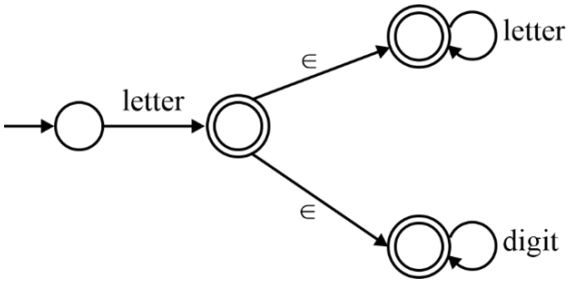
Which one of the following Non-deterministic Finite-state Automata with Î– transitions accepts the set of valid identifiers? (A double-circle denotes a final state)

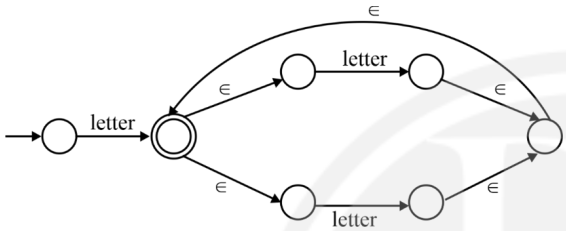
(A)



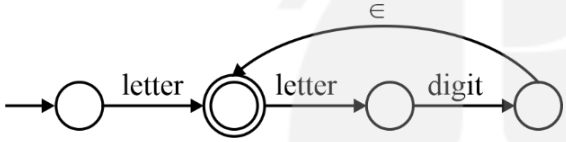
(B)



(C)



(D)



Q20 An algorithm has to store several keys generated by an adversary in a hash table. The adversary is malicious who tries to maximize the number of collisions. Let k be the number of keys, m be the number of slots in the hash table, and k >m.

Which one of the following is the best hashing strategy to counteract the adversary?

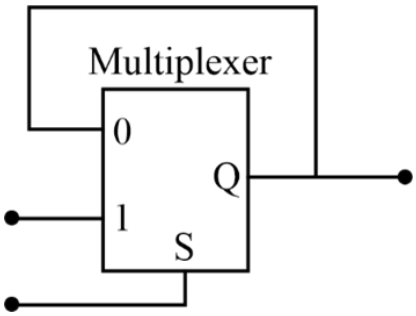
(A) Division method, i.e., use the hash function h(k) = k mod m.

(B) Multiplication method, i.e., use the hash function h(k) $=h(k)=\lfloor m\left(kA-\lfloor kA\rfloor\right)\rfloor$, where A is a carefully chosen constant.

(C) Universal hashing method.

(D) If k is a prime number, use Division method. Otherwise, use Multiplication method.

Q21 The output of a 2-input multiplexer is connected back to one of its inputs as shown in the figure.



Match the functional equivalence of this circuit to one of the following options.

(A) D Flip-flop (B) D Latch

(C) Half-adder (D) Demultiplexer

Q22 Which one or more of the following need to be saved on a context switch from one thread (T1) of a process to another thread (T2) of the same process?

(A) Page table base register

(B) Stack pointer

(C) Program counter

(D) General purpose registers

Q23 Which one or more of the following options guarantee that a computer system will transition from user mode to kernel mode?

(A) Function Call

(B) malloc Call

(C) Page Fault

(D) System Call

Q24 Which of the following statements is/are CORRECT?

(A) The intersection of two regular languages is regular.

(B) The intersection of two context-free languages is context-free.

(C) The intersection of two recursive languages is recursive.

(D) The intersection of two recursively enumerable languages is recursively enumerable.

Q25 Which of the following statements is/are INCORRECT about the OSPF (Open Shortest Path First) routing protocol used in the Internet?

(A)

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OSPF implements Bellman-Ford algorithm to find shortest paths.

(B) OSPF uses Dijkstra's shortest path algorithm to implement least-cost path routing.

(C) OSPF is used as an inter-domain routing protocol.

(D) OSPF implements hierarchical routing.

Q26 Geetha has a conjecture about integers, which is of the form

$\forall x\,(P(x) \Rightarrow \exists y Q(x, y))$,

where P is a statement about integers, and Q is a statement about pairs of integers.

Which of the following (one or more) option(s) would imply Geetha's conjecture?

(A) $\exists x\,(P(x) \wedge \forall y Q(x, y))$

(B) $\forall x \forall y Q(x, y)$

(C) $\exists y \forall x\,(P(x) \Rightarrow Q(x, y))$

(D) $\exists x(\,P(x) \wedge \exists y Q(x, y))$

Q27 Which one or more of the following CPU scheduling algorithms can potentially cause starvation?

(A) First-in First-Out

(B) Round Robin

(C) Priority Scheduling

(D) Shortest Job First

Q28 Let $f(x) = x^3 + 15x^2 - 33x - 36$ be a real-valued function.

(A) f(x) does not have a local maximum.

(B) f(x) has a local maximum.

(C) f(x) does not have a local minimum.

(D) f(x) has a local minimum.

Q29 Let f and g be functions of natural numbers given by $f(n) = n$ and $g(n) = n^2$.

Which of the following statements is/are TRUE?

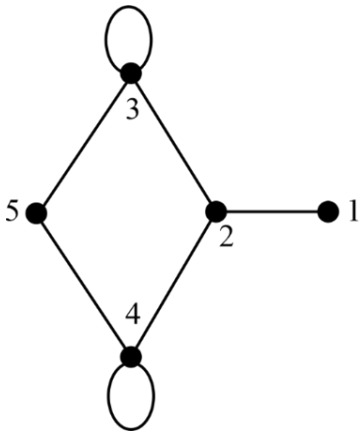
(A) $f \in O(g)$

(B) $f \in \Omega(g)$

(C) $f \in o(g)$

(D) $f \in \Theta(g)$

Q30 Let A be the adjacency matrix of the graph with vertices {1, 2, 3, 4, 5}.



Let λ_1, λ_2, λ_3, λ_4, and λ_5 be the five eigenvalues of A. Note that these eigenvalues need not be distinct.

The value of $\lambda_1 + \lambda_2 + \lambda_3 + \lambda_4 + \lambda_5$ = _____.

Q31 The value of the definite integral

$\int_{-3}^{3}\int_{-2}^{1}\int_{-1}^{1}\left(4x^2y - z^3\right) dz\ dy\ dx$

is _____. (Rounded off to the nearest integer)

Q32 A particular number is written as 132 in radix-4 representation. The same number in radix-5 representation is_____ .

Q33 Consider a 3-stage pipelined processor having a delay of 10 ns (nanoseconds), 20 ns, and 14 ns, for the first, second, and the third stages, respectively. Assume that there is no other delay and the processor does not suffer from any pipeline hazards. Also assume that one instruction is fetched every cycle.

The total execution time for executing 100 instructions on this processor is_____ns.

Q34 A keyboard connected to a computer is used at a rate of 1 keystroke per second. The computer system polls the keyboard every 10 ms (milli seconds) to check for a keystroke and consumes 100 µs (micro seconds) for each poll. If it is determined after polling that a key has been pressed, the system consumes an additional 200 µs to process the keystroke. Let T_1 denote the fraction of a second spent in polling and processing a keystroke. In an alternative implementation, the system uses

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interrupts instead of polling. An interrupt is raised for every keystroke. It takes a total of 1 ms for servicing an interrupt and processing a keystroke. Let T_2 denote the fraction of a second spent in servicing the interrupt and processing a keystroke.

In a alternative implementation, the system uses interrupts instead of polling. An interrupt is raised for every keystroke. It takes a total of 1 ms for servicing an interrupt and processing a keystroke. Let T_2 denote the fraction of a second spent in servicing the interuupt and processing a keystroke.

The ratio $\frac{T_1}{T_2}$ is _____ . (Rounded off to one decimal place)

Q35 The integer value printed by the ANSI-C program given below is .

```
#include<stdio.h>
int funcp(){
    static int x = 1;
    x++;
    return x;
}
int main(){
    int x,y;
    x = funcp();
    y = funcp()+x;
    printf("%d\n", (x+y));
   return 0;
}
```

Q36 Consider the following program:

```
int main()
{
f1();
f2(2);
f3();
return(0);
}
```

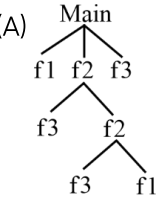
```
int f1()
{
return(1);
}
```

```
int f2(int X)
{
f3();
if (X==1)
return f1();
else
return
(X*f2(X-1));
}
```

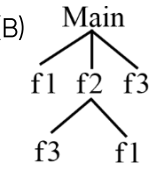
```
int f3()
{
return(5);
}
```

Which one of the following options represents the activation tree corresponding to the main function?

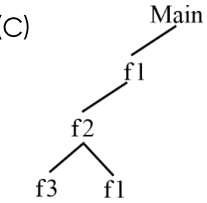
(A)



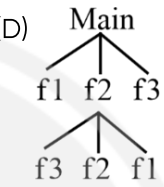
(B)



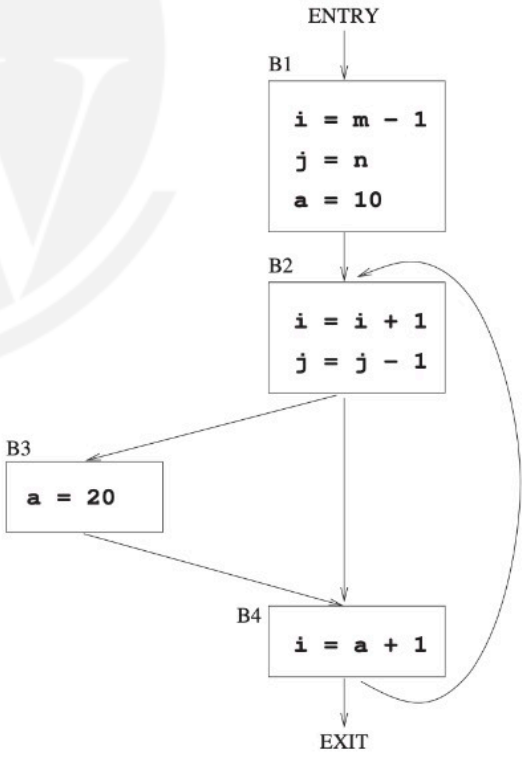
(C)



(D)



Q37 Consider the control flow graph shown.



Which one of the following choices correctly lists the set of live variables at the exit point of each basic block?

(A) B1: {}, B2: {a}, B3: {a}, B4: {a}

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(B) B1: {i, j}, B2: {a}, B3: {a}, B4: {i}
(C) B1: {a, i, j}, B2: {a, i, j}, B3: {a, i}, B4: {a}
(D) B1: {a, i, j}, B2: {a, j}, B3: {a, j}, B4: {a, i, j}

Q38 Consider the two functions incr and decr shown below.

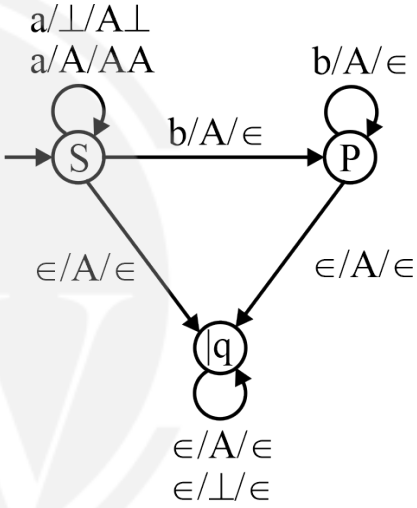
```
incr(){
wait(s);
X = X+1;
signal(s);
}
decr(){
wait(s);
X = X-1;
signal(s);
}
```

There are 5 threads each invoking incr once, and 3 threads each invoking decr once, on the same shared variable X.
The initial value of X is 10. Suppose there are two implementations of the semaphore s, as follows:
I-1: s is a binary semaphore initialized to 1.
I-2: s is a counting semaphore initialized to 2.
Let V1, V2 be the values of X at the end of execution of all the threads with implementations I-1, I-2, respectively.
Which one of the following choices corresponds to the minimum possible values of V1, V2, respectively?

(A) 15, 7 (B) 7, 7
(C) 12, 7 (D) 12, 8

Q39 Consider the context-free grammar G below
S → aSb | X
X → aX | Xb | a | b,
where S and X are non-terminals, and a and b are terminal symbols. The starting non-terminal is S.
Which one of the following statements is CORRECT?
(A) The language generated by G is (a + b)*
(B) The language generated by G is a* (a + b)b*
(C) The language generated by G is a*b*(a + b)
(D) The language generated by G is not a regular language

Q40 Consider the pushdown automaton (PDA) P below, which runs on the input alphabet {a, b}, has stack alphabet {⊥, A}, and has three states {s, p, q}, with s being the start state. A transition from state u to state v, labelled c/X/γ, where c is an input symbol or ∈, X is a stack symbol, and γ is a string of stack symbols, represents the fact that in state u, the PDA can read c from the input, with X on the top of its stack, pop X from the stack, push in the string γ on the stack, and go to state v. In the initial configuration, the stack has only the symbol ⊥ in it. The PDA accepts by empty stack.



Which one of the following options correctly describes the language accepted by P?
(A) $\{a^m b^n \mid 1 \le m \text{ and } n < m\}$
(B) $\{a^m b^n \mid 0 \le n \le m\}$
(C) $\{a^m b^n \mid 0 \le m \text{ and } 0 \le n\}$
(D) $\{a^m \mid 0 \le m\} \cup \{b^n \mid 0 \le n\}$

Q41 Consider the given C-code and its corresponding assembly code, with a few operands U1–U4 being unknown. Some useful information as well as the semantics of each unique assembly instruction is annotated as inline comments in the code. The memory is byte-addressable.

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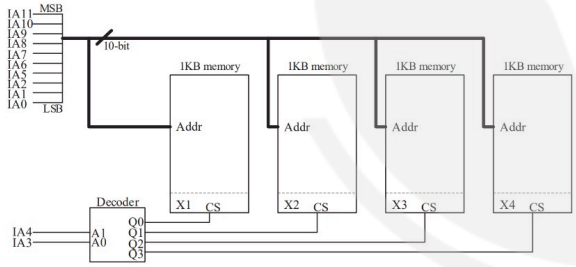
```
//C-code                    ;assembly-code (; indicates comments)
                            ;r1-r5 are 32-bit integer registers
                            ;initialize r1=0, r2=10
                            ;initialize r3, r4 with base address of a, b

int a[10], b[10], i;        L01: jeq r1, r2, end  ;if(r1==r2) goto end
// int is 32-bit            L02: lw  r5, 0(r4)    ;r5 <- Memory[r4+0]
for (i=0; i<10;i++)         L03: shl r5, r5, U1   ;r5 <- r5 << U1
    a[i] = b[i] * 8;        L04: sw  r5, 0(r3)    ;Memory[r3+0] <- r5
                            L05: add r3, r3, U2   ;r3 <- r3+U2
                            L06: add r4, r4, U3
                            L07: add r1, r1, 1
                            L08: jmp U4           ;goto U4
                            L09: end
```

Which one of the following options is a CORRECT replacement for operands in the position (U1, U2, U3, U4) in the above assembly code?

(A) (8, 4, 1, L02) (B) (3, 4, 4, L01)

(C) (8, 1, 1, L02) (D) (3, 1, 1, L01)

Q42 A 4 kilobyte (KB) byte-addressable memory is realized using four 1 KB memory blocks. Two input address lines (IA4 and IA3) are connected to the chip select (CS) port of these memory blocks through a decoder as shown in the figure. The remaining ten input address lines from IA11–IA0 are connected to the address port of these blocks. The chip select (CS) is active high.



The input memory addresses (IA11–IA0), in decimal, for the starting locations (Addr=0) of each block (indicated as X1, X2, X3, X4 in the figure) are among the options given below. Which one of the following options is CORRECT?

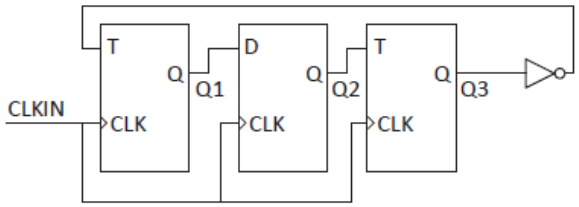
(A) (0, 1, 2, 3)

(B) (0, 1024, 2048, 3072)

(C) (0, 8, 16, 24)

(D) (0, 0, 0, 0)

Q43 Consider a sequential digital circuit consisting of T flip-flops and D flip-flops as shown in the figure. CLKIN is the clock input to the circuit. At the beginning, Q1, Q2 and Q3 have values 0, 1 and 1, respectively.

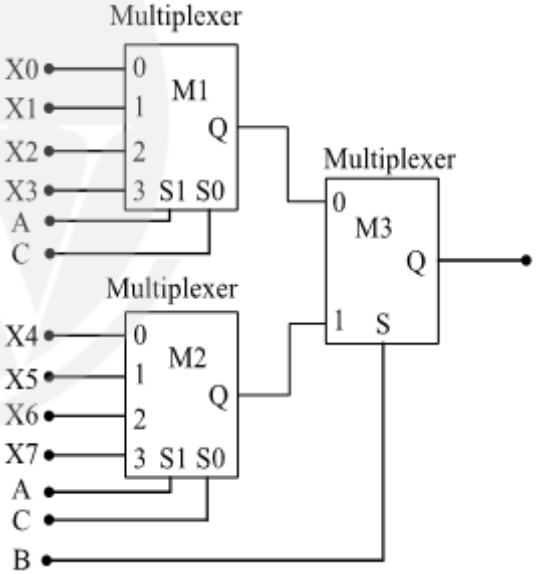


Which one of the given values of (Q1, Q2, Q3) can NEVER be obtained with this digital circuit?

(A) (0, 0, 1) (B) (1, 0, 0)

(C) (1, 0, 1) (D) (1, 1, 1)

Q44 Boolean digital circuit is composed using two 4-input multiplexers (M1 and M2) and one 2-input multiplexer (M3) as shown in the figure. X0–X7 are the inputs of the multiplexers M1 and M2 and could be connected to either 0 or 1. The select lines of the multiplexers are connected to Boolean variables A, B and C as shown.



Which one of the following set of values of (X0, X1, X2, X3, X4, X5, X6, X7) will realise the Boolean function $\overline{A} + \overline{A}.\overline{C} + A.\overline{B}.C$?

(A) (1, 1, 0, 0, 1, 1, 1, 0)

(B) (1, 1, 0, 0, 1, 1, 0, 1)

(C) (1, 1, 0, 1, 1, 1, 0, 0)

(D) (0, 0, 1, 1, 0, 1, 1, 1)

Q45 Consider the IEEE-754 single precision floating point numbers

P = 0xC1800000 and Q = 0x3F5C2EF4.

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Which one of the following corresponds to the product of these numbers (i.e., P × Q), represented in the IEEE-754 single precision format?

(A) 0x404C2EF4 (B) 0x405C2EF4

(C) 0xC15C2EF4 (D) 0xC14C2EF4

Q46 Let A be a priority queue for maintaining a set of elements. Suppose A is implemented using a max-heap data structure. The operation Extract-Max(A) extracts and deletes the maximum element from A. The operation Insert(A, key) inserts a new element key in A. The properties of a max-heap are preserved at the end of each of these operations.

When A contains n elements, which one of the following statements about the worst case running time of these two operations is TRUE?

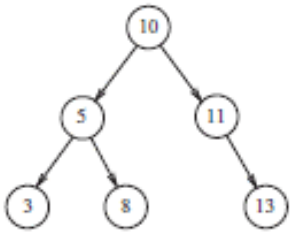
(A) Both Extract-Max(A) and Insert(A,key) run in O(1).

(B) Both Extract-Max(A) and Insert(A,key) run in O(log(n)).

(C) Extract-Max(A) runs in O(1) whereas Insert(A,key) runs in O(n).

(D) Extract-Max(A) runs in O(1) whereas Insert(A,key) runs in O(log(n)).

Q47 Consider the C function foo and the binary tree shown.




```
typedef struct node {
    int val;
    struct node *left, *right;
} node;
int foo(node *p) {
   int retval;
   if (p == NULL)
        return 0;
   else {
      retval = p->val + foo(p->left) + foo(p->right);
      printf("%d ", retval);
      return retval;
      }
}
```

When foo is called with a pointer to the root node of the given binary tree, what will it print?

(A) 3 8 5 13 11 10

(B) 3 5 8 10 11 13

(C) 3 8 16 13 24 50

(D) 3 16 8 50 24 13

Q48 Let U = {1, 2, . . . , n}, where n is a large positive integer greater than 1000. Let k be a positive integer less than n. Let A,B be subsets of U with |A| = |B| = k and A ∩ B = ∅. We say that a permutation of U separates A from B if one of the following is true.

- All members of A appear in the permutation before any of the members of B.
- All members of B appear in the permutation before any of the members of A.

How many permutations of U separate A from B?

(A) n!

(B) $\binom{n}{2k}(n-2k)!$

(C) $\binom{n}{2k}(n-2k)!(k!)^2$

(D) $2\binom{n}{2k}(n-2k)!(k!)^2$

Q49 Let f : A → B be an onto (or surjective) function, where A and B are nonempty sets. Define an equivalence relation ~ on the set A as

$a_1 \sim a_2$ if $f(a_1) = f(a_2)$,

where $a_1, a_2 \in A$. Let E = {[x] : x ∈ A} be the set of all the equivalence classes under ~. Define a new mapping F :E →B as

F([x]) = f(x), for all the equivalence classes [x] in E.

Which of the following statements is/are TRUE?

(A) F is NOT well-defined.

(B) F is an onto (or surjective) function.

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(C) F is a one-to-one (or injective) function.
(D) F is a bijective function.

Q50 Suppose you are asked to design a new reliable byte-stream transport protocol like TCP. This protocol, named myTCP, runs over a 100 Mbps network with Round Trip Time of 150 milliseconds and the maximum segment lifetime of 2 minutes.
Which of the following is/are valid lengths of the Sequence Number field in the myTCP header?
(A) 30 bits (B) 32 bits
(C) 64 bits (D) 36 bits

Q51 Let X be a set and 2^X denote the powerset of X. Define a binary operation Δ on 2^X as follows:
$A\Delta B = (A - B) \cup (B - A)$.
Let H = $(2^X, \Delta)$. Which of the following statements about H is/are correct?
(A) H is a group.
(B) Every element in H has an inverse, but H is NOT a group.
(C) For every $A \in 2^X$, the inverse of A is the complement of A.
(D) For every $A \in 2^X$, the inverse of A is A.

Q52 Suppose in a web browser, you click on the www.gate-2023.in URL. The browser cache is empty. The IP address for this URL is not cached in your local host, so a DNS lookup is triggered (by the local DNS server deployed on your local host) over the 3-tier DNS hierarchy in an iterative mode. No resource records are cached anywhere across all DNS servers.
Let RTT denote the round trip time between your local host and DNS servers in the DNS hierarchy. The round trip time between the local host and the web server hosting www.gate-2023.in is also equal to RTT. The HTML file associated with the URL is small enough to have negligible transmission time and negligible rendering time by your web browser, which references 10 equally small objects on the same web server.
Which of the following statements is/are CORRECT about the minimum elapsed time between clicking on the URL and your browser fully rendering it?
(A) 7 RTTs, in case of non-persistent HTTP with 5 parallel TCP connections.
(B) 5 RTTs, in case of persistent HTTP with pipelining.
(C) 9 RTTs, in case of non-persistent HTTP with 5 parallel TCP connections.
(D) 6 RTTs, in case of persistent HTTP with pipelining.

Q53 Consider a random experiment where two fair coins are tossed. Let A be the event that denotes HEAD on both the throws, B be the event that denotes HEAD on the first throw, and C be the event that denotes HEAD on the second throw.
Which of the following statements is/are TRUE?
(A) A and B are independent.
(B) A and C are independent.
(C) B and C are independent.
(D) Prob(B|C) = Prob(B)

Q54 Consider functions Function 1 and Function 2 expressed in pseudocode as follows:

```
Function 1
while n > 1 do
for i = 1 to n do
x = x + 1;
end for
n = ⌊n/2⌋;
end while
Function 2
for i = 1 to 100 * n do
x = x + 1;
end for
```

Let $f_1(n)$ and $f_2(n)$ denote the number of times the statement "x = x + 1" is executed in Function 1 and Function 2, respectively.
Which of the following statements is/are TRUE?
(A) $f_1(n) \in \Theta(f2(n))$

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(B) $f_1(n) \in o(f2(n))$
(C) $f_1(n) \in \omega(f2(n))$
(D) $f(n) \in O(n)$

Q55 Let G be a simple, finite, undirected graph with vertex set $\{v_1, \ldots, v_n\}$. Let $\Delta(G)$ denote the maximum degree of G and let N = {1, 2, . . .} denote the set of all possible colors. Color the vertices of G using the following greedy strategy: for i = 1, . . . , n
color(v_i) ← min{j ∈ N : no neighbour of v_i is colored j}
Which of the following statements is/are TRUE?
(A) This procedure results in a proper vertex coloring of G.
(B) The number of colors used is at most $\Delta(G)$ + 1.
(C) The number of colors used is at most $\Delta(G)$.
(D) The number of colors used is equal to the chromatic number of G.

Q56 Let U = {1, 2, 3}. Let 2^U denote the powerset of U. Consider an undirected graph G whose vertex set is 2U. For any A,B ∈ 2^U, (A,B) is an edge in G if and only if (i) A ≠ B, and (ii) either A ⊆ B or B ⊆ A. For any vertex A in G, the set of all possible orderings in which the vertices of G can be visited in a Breadth First Search (BFS) starting from A is denoted by B(A).
If ∅ denotes the empty set, then the cardinality of B(∅) is .

Q57 Consider the following two-dimensional array D in the C programming language,
which is stored in row-major order:
int D[128][128];
Demand paging is used for allocating memory and each physical page frame holds 512 elements of the array D. The Least Recently Used (LRU) page-replacement policy is used by the operating system. A total of 30 physical page frames are allocated to a process which executes the following code snippet:

```
for (int i = 0; i < 128; i++)
    for (int j = 0; j < 128; j++)
        D[j][i] *= 10;
```

The number of page faults generated during the execution of this code snippet is _____.

Q58 Consider a computer system with 57-bit virtual addressing using multi-level tree-structured page tables with L levels for virtual to physical address translation. The page size is 4 KB (1 KB = 1024 B) and a page table entry at any of the levels occupies 8 bytes.
The value of L is .

Q59 Consider a sequence a of elements $a_0 = 1$, $a_1 = 5$, $a_2 = 7$, $a_3 = 8$, $a_4 = 9$, and $a_5 = 2$. The following operations are performed on a stack S and a queue Q, both of which are initially empty.
I: push the elements of a from a_0 to a_5 in that order into S.
II: enqueue the elements of a from a_0 to a_5 in that order into Q.
III: pop an element from S.
IV: dequeue an element from Q.
V: pop an element from S.
VI: dequeue an element from Q.
VII: dequeue an element from Q and push the same element into S.
VIII: Repeat operation VII three times.
IX: pop an element from S.
X: pop an element from S.
The top element of S after executing the above operations is ____ .

Q60 Consider the syntax directed translation given by the following grammar and semantic rules. Here N, I, F and B are non-terminals. N is the starting non-terminal, and #, 0 and 1 are lexical tokens corresponding to input letters "#", "0" and "1", respectively. X.val denotes the synthesized attribute (a numeric value) associated with a non-terminal X. I_1 and F_1 denote occurrences of I and F on the right hand side of a production, respectively. For the tokens 0 and 1, 0.val = 0 and 1.val = 1.
N → I #F N.val = I.val + F.val
I → I_1B I.val = (2 I_1.val) + B.val

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I → B I.val = B.val

F → BF_1 F.val = $\frac{1}{2}$ (B.val + F_1.val)

F → B F.val = $\frac{1}{2}$ B.val

B → 0 B.val = 0.val

B → 1 B.val = 1.val

The value computed by the translation scheme for the input string

10#011

is . (Rounded off to three decimal places)

Q61 Consider the following table named Student in a relational database. The primary key of this table is rollNum.

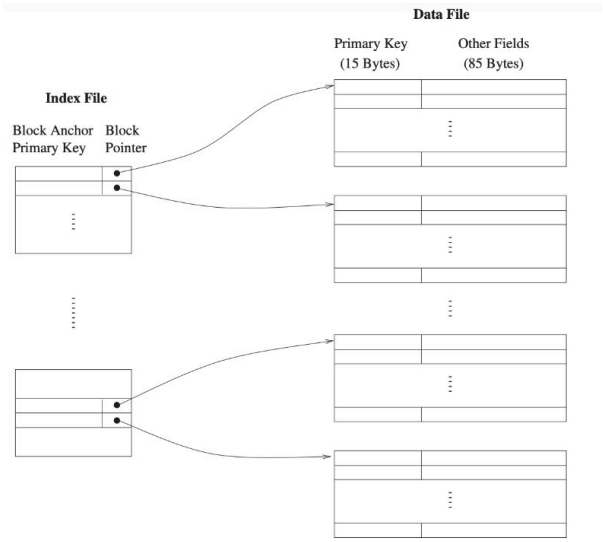
RollNum	name	gender	marks
1	Naman	M	62
2	Aliya	F	70
3	Aliya	F	80
4	James	M	82
5	Swati	F	65

The SQL query below is executed on this database.

```
SELECT *
FROM Student
WHERE gender = 'F' AND
      marks > 65;
```

The number of rows returned by the query is _____ .

Q62 Consider a database of fixed-length records, stored as an ordered file. The database has 25,000 records, with each record being 100 bytes, of which the primary key occupies 15 bytes. The data file is block-aligned in that each data record is fully contained within a block. The database is indexed by a primary index file, which is also stored as a block-aligned ordered file. The figure below depicts this indexing scheme.



Suppose the block size of the file system is 1024 bytes, and a pointer to a block occupies 5 bytes. The system uses binary search on the index file to search for a record with a given key. You may assume that a binary search on an index file of b blocks takes élog2ù b block accesses in the worst case. Given a key, the number of block accesses required to identify the block in the data file that may contain a record with the key, in the worst case, is _____.

Q63 Consider the language L over the alphabet {0, 1}, given below: L = {w ∈ {0, 1}* | w does not contain three or more consecutive 1's}.

The minimum number of states in a Deterministic Finite-State Automaton (DFA) for L is

Q64 An 8-way set associative cache of size 64 KB (1 KB = 1024 bytes) is used in a system with 32-bit address. The address is sub-divided into TAG, INDEX, and BLOCK OFFSET.

The number of bits in the TAG is

Q65 The forwarding table of a router is shown below.

Subnet Number	Subnet Mask	Interface ID
200.150.0.0	255.255.0.0	1
200.150.64.0	255.255.224.0	2
200.150.68.0	255.255.255.0	3
200.150.68.64	255.255.255.224	4

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Default		0

A packet addressed to a destination address 200.150.68.118 arrives at the router.
It will be forwarded to the interface with ID

GATE

Answer Key

Q1	(B)
Q2	(B)
Q3	(A)
Q4	(A)
Q5	(C)
Q6	(D)
Q7	(C)
Q8	(D)
Q9	(B)
Q10	(A)
Q11	(B)
Q12	(B)
Q13	(D)
Q14	(C)
Q15	(A)
Q16	(A)
Q17	(B)
Q18	(B)
Q19	(C)
Q20	(C)
Q21	(B)
Q22	(B, C, D)
Q23	(C, D)
Q24	(A, C, D)
Q25	(A, C)
Q26	(B, C)
Q27	(A, C, D)
Q28	(B, D)
Q29	(A, C)
Q30	2 to 4
Q31	0 to 0
Q32	110 to 110
Q33	2040 to 2040
Q34	(10.2 to 10.2)
Q35	7 to 7
Q36	(A)
Q37	(D)
Q38	(C)
Q39	(B)
Q40	(A)
Q41	(B)
Q42	(C)
Q43	(A)
Q44	(C)
Q45	(C)
Q46	(B)
Q47	(C)
Q48	(D)
Q49	(B, C, D)
Q50	(B, C, D)
Q51	(A, D)
Q52	(C, D)
Q53	(C, D)
Q54	(A, D)
Q55	(A, B)
Q56	5040 to 5040
Q57	4096 to 4096
Q58	5 to 5
Q59	8 to 8
Q60	2.374 to 2.376

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Q61 2 to 2

Q62 6 to 6

Q63 4 to 4

Q64 19 to 19

Q65 3 to 3

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Hints & Solutions

Q1 Text Solution:

We reached the station late, and nearly missed the train.

Utterly → Completely

Mostly → Almost all the time.

Q2 Text Solution:

Frequently is the synonym of often similarly type is the synonym of kind refering to classification.

Q3 Text Solution:

Given $F_{n+1} = F_n + F_{n-1}$

If we put n = 6

$F_7 = F_6 + F_5$

$F_5 = F_7 - F_6 = 60 - 37 = 23$

$F_4 = F_6 - F_5 = 37 - 23 = 14$

$F_3 = F_5 - F_4 = 23 - 14 = 9$

$F_2 = F_4 - F_3 = 14 - 9 = 5$

$F_1 = F_3 - F_2 = 9 - 5 = 4$

Q4 Text Solution:

The percentage of pregnant women received medical care from doctor at least once a year.

$= \left(\frac{60}{100} \times \frac{90}{100}\right) \times 100$

= 54%

So, more than half of the pregnant women received medical care at least once from a doctor.

Q5 Text Solution:

If the object has edges, then it surely shall have corners: option D wrong

Just seeing the surface of SMOOTH 3D object from outside, we cannot say it has concave or convex faces so, options A & B are also wrong and option C is correct.

Q6 Text Solution:

From reading the paragraph we certainly can infer that the government of zombieland believes that riding bicycles is a form of physical exercise.

Q7 Text Solution:

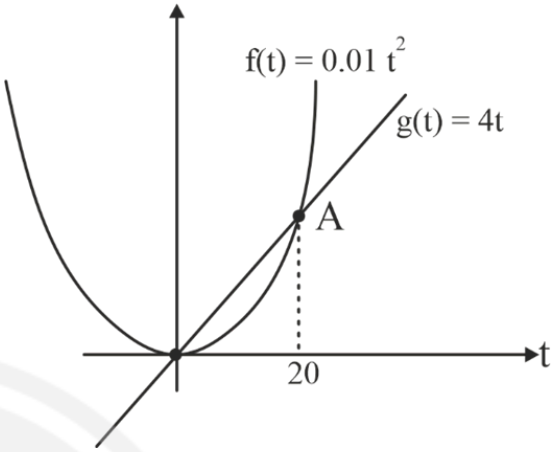
Given $f(t) = 0.01t^2$

$g(t) = 4t$

For point A, $g(t) = f(t)$

$0.01t^2 = 4t$

$t = 20$



(1) Since for some t > 0 (0 < t < 20) g(t) > f(t)

(2) After t = 20 (say T) f(t) > g(t) for all t > T.

Q8 Text Solution:

The correct sequence that creates a coherent narrative is – (iii), (ii), (i), (iv).

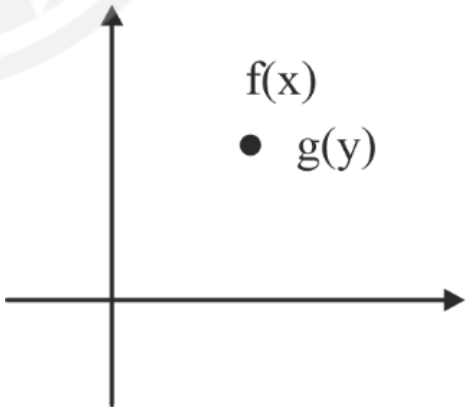
Q9 Text Solution:

Given f(x) = g(y) for all real values of x & y. So,

f (4) = g (5)

or

f (11) = g (6)



This is only possible when

f (4) = f (11) = k (constant)

g (5) = g (6) = k (constant)

Q10 Text Solution:

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Q11 Text Solution:

Phases of compiler:

Machine Indepedent	**Machine Dependent**
1. Lexical Analysis	1. IR Optimization
2. Sentax Analysis	2. Code Generation
3. Semantic Analysis	
4. Intermediate Code Generation	

S1: The front-end includes phases that are independent of the target hardware.True

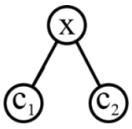
S2: The back-end includes phases that are specific to the target hardware. True

S3: The back-end includes phases that are specific to the programming language used in the source code. False

Therefore, option B is the correct asnwer.

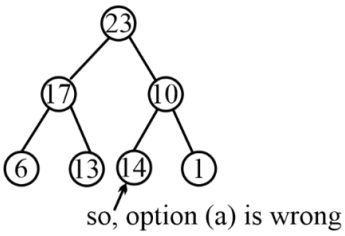
Q12 Text Solution:

Max heap : every node satisfy

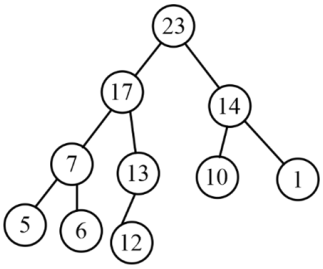


x >(c_1, c_2)

Node value > its child value



14 must be parent.

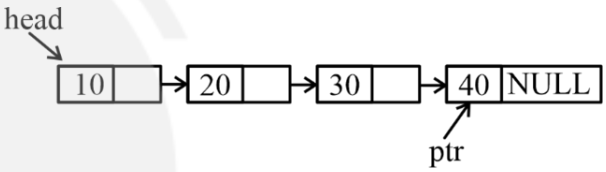


It is satisfying all the property of Max- Heap.

Like that we will check option c and d.

Q13 Text Solution:

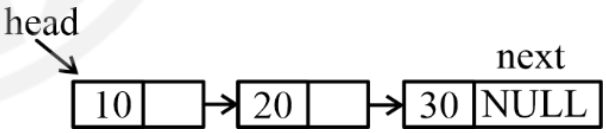
SLLdel:



Assume that we want to delete last node.

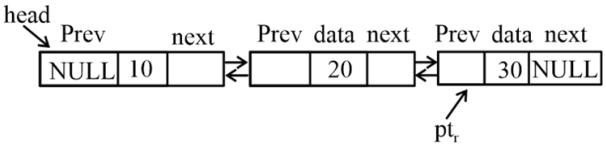
After Deletion we need to NULL in the second last node next field.

After deletion:



One way traversal is possible given ptr and head, how can we reach second last node Þ Traverse from start (head) till second last node Þ Traverse n – 1 nodes.

SLLDel Time complexity = O(n)



DLLdel:

- we can go to previous node as well as next node. No need to traverse from head to node to be deleted.

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- In doubly linked list ptr → prev : Point to second last node

Delete operation:

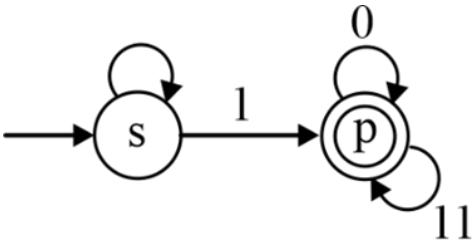
ptr → Prev → next = NULL

free (ptr)

It will take constant time i.e. O(1).

Q14 Text Solution:

In given machine, r is dead state. After deleting state q, the resultant transition graph is:



Above transition graph represents R = 1 (0 + 11) *

Q15 Text Solution:

$L_n = L_{n-1} + L_{n-2}$, for $n \geq 3$

$L_1 = 1$ and $L_2 = 3$

Putting L = 1 and 2 in option one, we get

$L_1 = \left(\frac{1+\sqrt{5}}{2}\right)^1 + \left(\frac{1-\sqrt{5}}{2}\right)^1 = \frac{1}{2} + \frac{1}{2} = 1$

$L_2 = \left(\frac{1+\sqrt{5}}{2}\right)^2 + \left(\frac{1-\sqrt{5}}{2}\right)^2 = (a + b)^2 + (a - b)^2$

$= 2(a^2 + b^2)$

$= 2\left(\frac{1}{4} + \frac{5}{4}\right) = 2 \times \frac{6}{4} = 3$

Therefore option (a) is correct.

Q16 Text Solution:

Arity (Degree): Number of Attributes/fields

Cardinality: Number of Tuples/Records

Q17 Text Solution:

Efficiency (η) = $\frac{1}{1+2(a)}$

$\boxed{a = \frac{T_p}{T_t}}$

Transmission Time (T_t) = $\frac{\text{Frame Size}}{\text{Bandwidth}}$

Propagation time (T_P) = $\frac{\text{Length}}{\text{Velocity}}$

$\eta = \frac{1}{1+2\left(\frac{T_p}{T_t}\right)}$

- T_P increases then overall efficiency will decrease (as denominator bigger than the numerator)
- Also, if bandwidth (Transmission Rate) is higher than T_t value will be small and hence T_p / T_t will be a large value.
- Therefore, to get overall h low, higher link length and higher transmission rate is required.

Q18 Text Solution:

The elements of both the matrix A, B are the same. in matrix B R_1, R_3 are interchanged.

As we know the important property of any determinants: • If two rows (or 2 columns) of a determinant are interchanged the sign of the value of the determinant is changed. Here only one time rows is changed so the determinant should be multiplied by (–1)

det(B) = –det(A)

∴ Option (B) is correct.

Q19 Text Solution:

Option c is the correct option. it will accept all the strings of letters letter (letter+digit)*

Q20 Text Solution:

Division method:-

h(k) = k mod m

m = 2^P

m = 2^4

h(100) = 100 mod2^4 = 100 mod 16 = 4

h (128 + 4)

= h (132) = 132 mod 16 = 4

132 = 1011100

Last 4 bits is deciding the slot.

A is not correct

h(k) = Lm (kA ·kA)

m = 100

A = $\frac{1}{3}$

h(10) = $\lfloor m\,(KA.\lfloor KA \rfloor) \rfloor$

h(11) = 66

h(12) = 99

B is wrong we will get only 3 values of h(k)

Optimal choice of a depends of keys themseleve

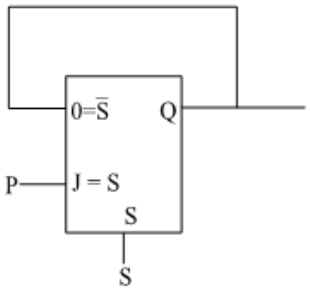
$A = \frac{\sqrt{5}-1}{2}$

Malicious adversary can always choose keys. So, that all the keys are mapped to same slot ⇒ O(n).

GATE

Worst case retrieval time Set of uniform hash function Minimum collision Randomly hash function are picked.

Q21 Text Solution:



$Q_{n+1} = Q\,\bar{S} + DS$

$Q_{n+1} = Q.0+D.1$

$Q_{n+1} = D$

Q_{n+1} is generated after delay

Now in a flip flop we always consider edge but in the circuit, it is level sensitive, therefore the circuit is equivalent to a D-latch.

Q22 Text Solution:

Page table base register is used to access the virtual address space, as all threads share the same address space, so there is no need to save it. Therfore, option A is incorrect.

Every thread has its own stack pointer, program counter, and general purpose registers, so we need to save them. Therefore, Option B, C, and D are correct.

Q23 Text Solution:

A computer system has to make a transition from user mode to kernel mode, whenver a page fault occurs, the page fault handler will run in kernel mode.

System call alaways makes a transition from user to kernel mode.

Therfore, option C and D are correct.

Q24 Text Solution:

(a) The intersection of two redular languages is regular.

Reg ∩ Reg ⇒ Reg **True**

(b) The intersection of two context-free languages is context-free.

CFL ∩ CFL ⇒ CSL **False**

(c) The intersection of two recursive languages is recursive.

Rec ∩ Rec ⇒ Rec **True**

(d) The intersection of two recusively enumerable languages is recursively enumerable.

REL ∩ REL ⇒ REL **True**

Q25 Text Solution:

OSPF uses Dijkstra's algorithm not bellman ford algorithm. OSPF is an intra-domain routing protocol not inter domain. OSPF supports hierarchical network design (implemented using two layers).

Q26 Text Solution:

L : ∀x[P(x) ➔ ∃y Q(x,y)]

"For every x if P(x) is true then there exists some y such that Q(x,y) will be true.

Option :

(i) ∃x P(x) ∧ ∀yQ(x, y)

"For some x. P(x) is true and for all y Q(x.y) is true which is not implies L"

(ii) ∀x∀yQ(x, y)

"For every x and every yQ(x,y) is true which implies L"

(iii) ∃y∀x P(x) =⇒ Q(x, y)

"These exists some y such that for every x if P(x) is true then Q(x,y) is also true which implies L"

(iv) ∃x P(x) ∧∃yQ(x, y)

"There exists some x for which P(x) is true and also for some y Q(x,y) is true which cannot implies L"

Q27 Text Solution:

First-In-First-Out may suffer from starvation in some exceptional case. In FIFO if a process has arrived then it will definitely get CPU once all the processes arrived before that are serviced. But processes may starve when a process has very long burst time and wait in waiitng queue.

Round robin never suffers from starvation because every process gets time to execute on CPU in circular manner.

GATE

Priority Scheduling suffers from starvation as processes with lower priority may starve for processor if higher prioirty process keeps arriving.

Shortest Job First also suffers from starvation as processes with higher burst time may starve for processor when processes with lower burst time keeps on arriving.

Therefore, option C and D are correct

Q28 Text Solution:

The real valued function $f(x) = x_2 + 15x^2 - 33x - 36 = 0$

1. find $f'(x) = 0$

$\Rightarrow 3x^2 + 30x - 33 = 0$

$\Rightarrow x^2 + 10x - 11 = 0$

$\Rightarrow x^2 + 11x - x - 11 = 0$

$\Rightarrow (x + 11)(x - 1) = 0$

$\Rightarrow x = -11, 1$

2. find $f''(x)$ we get: $f''(x) = 6x + 30$
3. $f''(1) = 6 + 30 = 36 > 0$ it is local minima
4. $f''(-11) = -66 + 30 = -36 < 0$ it is local maxima

So given function f(x) will give local maxima at x = −11 and local minima at x = 1

∴ b,d is correct.

Q29 Text Solution:

Given f is 'n' and g is "n^2" we can conclude that f(n) = O(g) that is f(n) can be smaller than or equal to O(g).

Q30 Text Solution:

Firstly convert the given undirected graph into an adjacency matrix, we will get:

$$A = \begin{pmatrix} 0 & 1 & 0 & 0 & 0 \\ 1 & 0 & 1 & 1 & 0 \\ 0 & 1 & 1 & 0 & 1 \\ 0 & 1 & 0 & 1 & 1 \\ 0 & 0 & 1 & 1 & 0 \end{pmatrix}$$

Now we know that the summation of the eigenvalued is equal to the trace of the matrix.

so the trace of matrix is:

$\lambda_1 = 0$

$\lambda_2 = 0$

$\lambda_3 = 1$

$\lambda_4 = 1$

$\lambda_5 = 0$

$\lambda_1 + \lambda_2 + \lambda_3 + \lambda_4 + \lambda_5 = 0 + 0 + 1 + 1\,0 = 2$

Correct answer is 2.

Q31 Text Solution:

Let $I = \int_{-3}^{3}\int_{-2}^{2}\int_{-1}^{1}\left(4x^2y - z^3\right) dzdydx$

$= \int_{-3}^{3}\int_{-2}^{2}\left(4x^2\,yz - \frac{z^4}{4}\Big|_{-1}^{1}\right) dydx$

$= \int_{-3}^{3}\int_{-2}^{2}\left\{\left(4x^2y - \frac{1}{4}\right) - \left(-4x^2y - \frac{1}{4}\right)\right\} dydx$

$= \int_{-3}^{3}\int_{-2}^{2} 8x^2\,ydydx$

$= \int_{-3}^{3} \frac{8x^2y^2}{2}\Big|_{-2}^{2} dx =$ = 0

$\int_{-3}^{3}\left\{\left(16x^2\right) - \left(16x^2\right)\right\} dx$

$\therefore \boxed{\int_{-3}^{3}\int_{-2}^{2}\int_{-1}^{1}\left(4x^2y - z^3\right)dzdydx = 0}$

Q32 Text Solution:

Here we have to solve this as it is in the radix 4 representation.

$(134)_4$

$(1*4^2+3*4^1+4*4^0)_{10}$

$(30)_{10}$

$(25+5+0)_{10}$

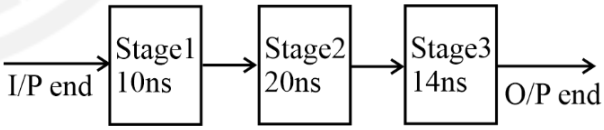
We have represented in the power of 5

$(1*5^2+1*5^1+1*5^0) = 110$

Q33 Text Solution:

Number of stage (k) = 3.

Number of instruction [n] = 100.



T_p = max (stage delay) = max (10, 20, 14)

T_p = 20 nsec

$ET_{pipe} = [k + (n - 1)]\,tp$

$= [3 + (100 - 1)]20 = 102 \times 20$

ET_{pipe} = 2040 nsec

Q34 Text Solution:

1 key stroke per second,

Each polling takes = 100μsec.

After every 10 m sec polling is done.

If key is press then additional = 200 μsec

In every 10×10^{-3} sec → 1 poll.

GATE

In 1 sec → $\frac{1}{10\times10^{-3}}$ ⇒ 10^{+2} = 100 poll in one second.

Each poll takes = 100μsec

Total 100 poll takes = 100 × 100 = 10000μsec = 10 msec.

If key stroke is pressed then addition = 200μsec

Total time for polling and processing pressing key stroke = 10.000 + 200 = 10,200μsec = 10.2msec

T_1 in 1 sec – 10.2 msec.

$$T_1 = \frac{10.2}{1000}$$

T_2 Alternative approach: Interrupt

Total time taken to servicing interrupt = 1msec. and processing key stroke.

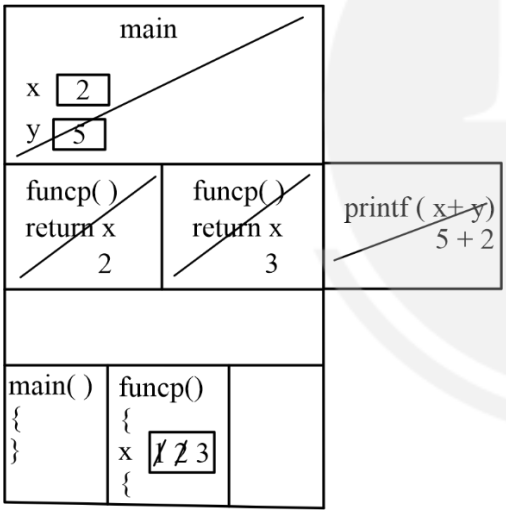
$$T_2 = \frac{1}{1000}$$

(In 1 sec = 1000 msec)

= 1000 × 10^{-3} = 1 sec

$$\frac{T_1}{T_2} = \frac{10.2}{1000} \times \frac{1000}{1} = 10.2$$

Q35 Text Solution:

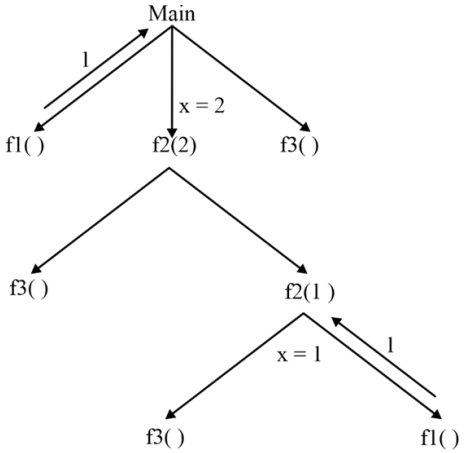


After execution of funcp 2 times, printf function prints the output (7) and gets deleted from activation record.

Similarly, control is returned to the main function, main function also gets deleted from activation record and control is returned to operating system.

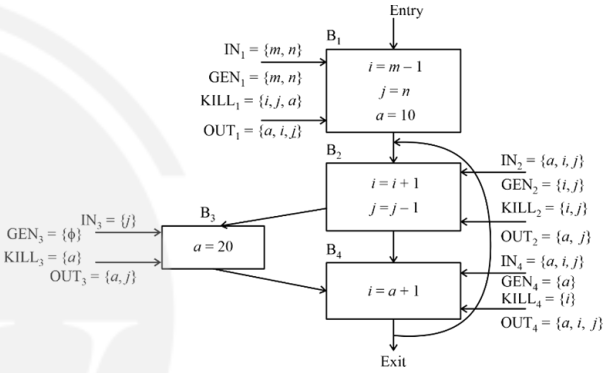
Hence 7 is printed.

Q36 Text Solution:



Comparing the above tree with the given trees in options. Above tree matches with the tree given in option A, hence a is correct answer.

Q37 Text Solution:



Live variables at the end of each basic block are:

B1: { a, i , j }

B2: {a, j}

B3: {a, j}

B4: {a, i, j}

So, option D is the correct answer.

Q38 Text Solution:

Case I: Let's the minimum possible value of x for v1, when semaphore 's' is binary semaphore initialized to 1.

P4 ...P8 ⇒ Incr() Decr () ⇒ P1 , P2, P3

1. Wait (s); Wait(s);
2. x = x +1 x = x –1;
3. signal(s); Signal(s)

Semaphore s = 1 0 1

P_1 = Decr ()

1. wait (s); s = 0
2. **Read x; x = 10**

Now, if you pre-empt P1, before performing decrement operation then other process would not be able to execute on 'x' as semaphore value is s = 0.

x – 1: 10 – 1: 9

x = 9; update x by 9

3. signal(s); s = 1

P_2 Decr()

1, 2, 3: Final value of x = 8

P_3: Decr ()

1, 2,3 : Final value of x = 7

P_4 P_5: Incr()

1,2,3 Increment x 5 times: x ⇒ 12

Hence, minimum possible value is 12 for V_1.

Case II: Let's find the minimum possible value of x for V_2. when semaphore S is counting semaphore

initialized to 2.

P_1: Decr ()

1. wait (s): s ≯ 2 1
2. read (x); x = 10

Preempt Process P_1.

Now. execute Incr()

P_4 ... P_5: Incr()

1, 2, 3: Final x value will be, x = 15

Now. revoke the process P_1 from pre-emption

2. Perform x – 1: 10–1 = 9

Update x: x ≡ 9

P_2 : Decr()

1,2,3 x = 8

P_3 Decr()

1,2,3 x = 7

Hence, find value of V_2 is 7 for counting semaphore

So, option C is the correct answer.

Q39 Text Solution:

X = a*(a + b)b*

S = $a^n b^n$ = a^n a* (a + b) b* b^n = a* (a + b) b*

Q40 Text Solution:

State s can push A for each input a, and whenever b comes as input, it will pop A and then changes to state p. If end of the input happens from state s, then it will change to state q and will pop all A's to make empty stack.

State p can pop A for each input b, and whenever end of input reaches, it will change to state q and pop all A's from stack to make empty stack.

Case1: a* will be accepted if s and q are involved.

Case2: $a^m b^n$ will be accepted (m > n > 0) if s, p, and q are involved.

L = {$a^m b^n$ | m > n ≥ 0} = {$a^m b^n$ | m > n, m ≥ 1}

Therefore, option (a) is correct.

Q41 Text Solution:

U_1 = 3 multiply by 8.

U_2 = 4 32 bit given

U_3 = 4 memory is byte (8bit) Addressable

U_4 = L01

r_1 = 0 r_2 = 10

r_3 ∈[a]

r_4 ∈ [b]

r_5 ← m [b_0 + 0]

U_1 = 3

M [a_0 + 0]

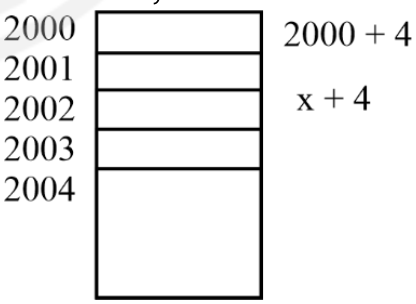
U_2 = 4

U_3 = 4

L03 : Multiple by 8 then left shift by 3 bit

U_3 memory is Byte addressable but size is 32 bit

32 bit ≈ 4 Byte



U_2 = 4

U_3 = 4

L08 Jmp U_4 ⇒ U_4 = L01

Because at L01 condition checking.

Q42 Text Solution:

IA_4 IA_3 Connect to decodes.

IA4 IA3

0 0 : x_1 enabled

GATE

0 1 : x_2 enabled

1 0 : x_3 enabled

1 1 : x_4 enabled

16 8 4 2 1

2^4 2^3 2^2 2^1 2^0

IA_6 IA_5 IA_4 IA_3 IA_2 IA_1 IA_0

0 0 → x_1 enabled (0)

0 1 → x_2 enabled (8)

1 0 → x_3 enabled (16)

1 1 → x_4 enabled (24)

Q43 Text Solution:

The characteristics table of given sequential circuit

Clock				Q_1	Q_2	Q_3
0	-	-	-	0	1	1
1	0	0	1	0	0	0
2	1	0	0	1	0	0
3	1	1	0	0	1	0
4	1	0	1	1	0	1
5	0	1	0	1	1	1
6	0	1	1	1	1	0
7	1	1	1	0	1	1

From above table states involved 011, 000, 100, 010, 101, 111, 110. The only state 001 can never be achieved.

Hence correct answer is option (a).

Q44 Text Solution:

Given function f (ABC) = $\overline{\mathrm{A}} + \overline{\mathrm{A}}\overline{\mathrm{C}} + \mathrm{A}\overline{\mathrm{B}}\,\mathrm{C}$

First, we minimize the given function

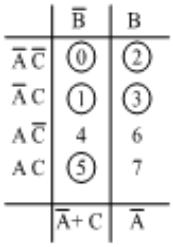
f (ABC) = $\overline{\mathrm{A}}\left(B+\overline{B}\right)\left(C+\overline{C}\right)+\overline{\mathrm{A}}\left(B+\overline{B}\right)\overline{C} + \mathrm{A}\overline{\mathrm{B}}\,\mathrm{C}$

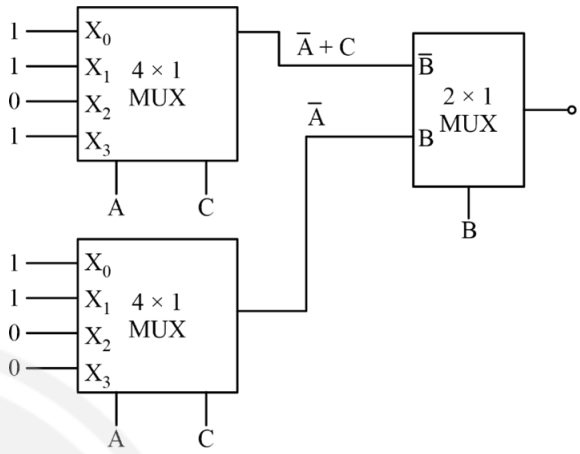
f (ABC) = $\overline{\mathrm{A}}\overline{\mathrm{B}}\overline{C}+\overline{A}\,\overline{\mathrm{B}}\,\mathrm{C}+\overline{A}\,B\overline{C}+\overline{A}\,BC+\overline{\mathrm{A}}\overline{\mathrm{B}}\overline{C} + \overline{A}\,B\overline{C}+A\overline{B}C$

f (ABC) = $\overline{\mathrm{A}}\overline{\mathrm{B}}\overline{C}+\overline{A}\,\overline{\mathrm{B}}\,\mathrm{C}+\overline{A}\,B\overline{C}+\overline{A}\,BC+\overline{A}\,B\overline{C} + A\overline{B}C$

f (ABC) = Sm (0, 1, 2, 3, 5)

Now implementing on 2 × 1 mux.





∴ (X_0 X_1 X_2 X_3 X_4 X_5 X_6 X_7) = (11011100)

Hence correct answer is option (c).

Q45 Text Solution:

P = O_x C1800000 Q = O_x 3F5C2EF4

1bit	8bit	23bit
S	E	M

Bias = bias = 127

P = O_x C1800000

1	100 0001 1	000 0000 0000 0000 0000 0000
Sign 1bit	E(8bit)	Mantissa (23bit)

S = 1(–ve)

E = 10000011 = 131

BE or E = 131

M = 00000000

$(-1)^S$ 1.M × 2^e

$(-1)^1$ 1.00000000 × $2^{131-127}$

P = –(1.00000000) × 2^{+4}

BE = AE + bias

Or

E = e + bias

e = E – bias

GATE

E = 131

Bias = 127

Q = 3F5C2EF4

0	011 1111 0	101 1100 0010 1110 1111 0100
Sign 1bit	E(8bit)	Mantissa (23bit)

Sign = 0 (+ve) E = 126 bias = 127

E = 01111110 ⇒ E = 126 e = E – bias

BE or E = 126 126 – 127

M = 101 1100 0010 1110 1111 0100.

Bias = 127

E = e + bias

e = E – bias

$(-1)^s$ 1.M × 2^e

$(-1)^0$ 1.101 1100 0010 1110 1111 0100 ×$2^{126-127}$

Q = (1.101 1100 0010 1110 1111 0100) × 2^{-1}

Sign = –ve.

P × Q = exponent = (+4) + (–1) = +3.

Mantissa

= (1.0000) *(1.101 1100 0010 1110 1111 0100)

– (1.101 1100 0010 1110 1111 0100) × 2^{+3}

Sign = 1(–ve)

e = +3

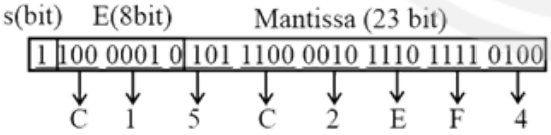
bias = 127

E = e + bias

= 3 + 127

E = 130

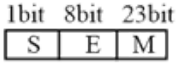
E = 10000010

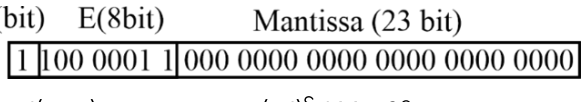


(C15C2EF4 H)

2nd Approach.

Alternate Approach. P = C1800000





S = 1(–ve) $(-1)^S$ 1.M × 2^e

E = 10000011 $(-1)^1$ 1.000000 × 2

BE or E = 131 – 1.000000 × 2^{+4}

M = 00000000 – 10000.00

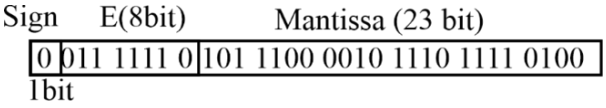
Bias = 2^{8-1}–1 P = – 16

Bias = 127

E = e + bias

e = E – bias

Q = 3F5C2EF4



S = 0 (+ve)

E = 01111100

BE or E = 126

M = 10111000010 ... Q = 1.101 1100 × 2^{-1}

Bias = 129 = 0.1101 1100

E = e + bias Q = 0.8593

e = E – bias

$(-1)^S$ 1.M × 2^e

$(-1)^0$ 1.101 1100 0010 1110 × $2^{126-127}$

P * Q = – 16 × .8593

= – (13.75)

P * Q = – 13.75

– 1101.11

⇒ – 1.10111 × 2^{+3}

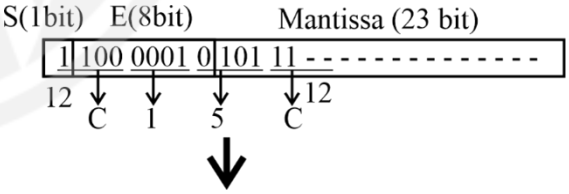
$\boxed{e = +3}$ $\boxed{\text{bias} = 127}$

E or BE = e + bias Þ 3 + 127

= 130

E = 130

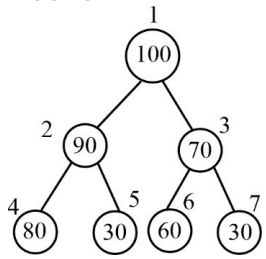
M = 10111 → 10000010



(C15C2EF4)

Q46 Text Solution:

Suppose we have a max heap

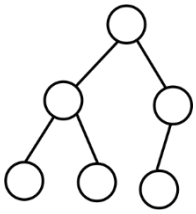


Array Representation:

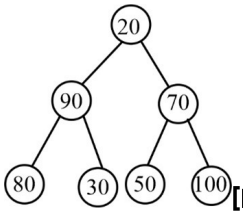
1	2	3	4	5	6	7
100	90	70	80	30	50	20

GATE

Structure after delete an element:



Swap last with first element:



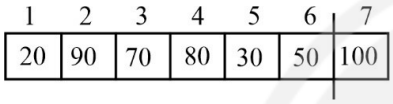
[Now Heapify]

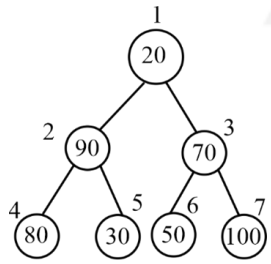
Operations:

A[1]: Max element

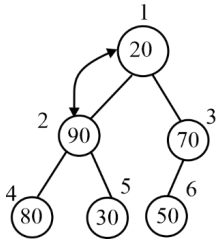
Swap A[1] → A[n]

n = n – 1

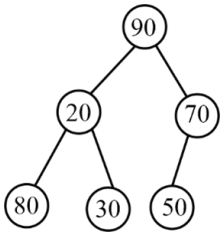




Delete element 100:

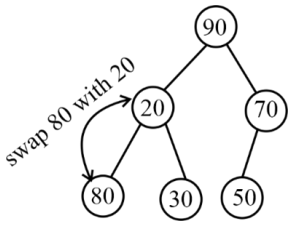


Swap 90 with 20:



Apply heapify method:

Heapify method will take O(n) time.

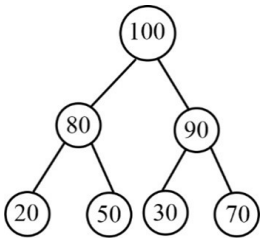


Height of heap = O(logn)

EXTRACT Max = O(logn)time

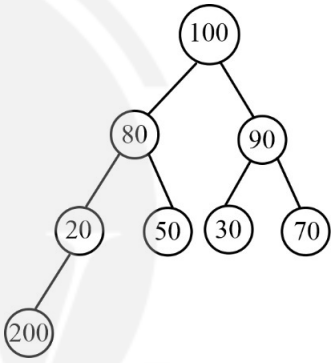
INSERT:

Suppose a max heap

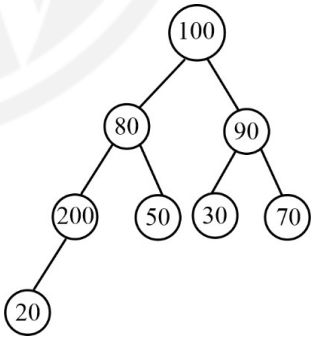


Insert 200 in given heap

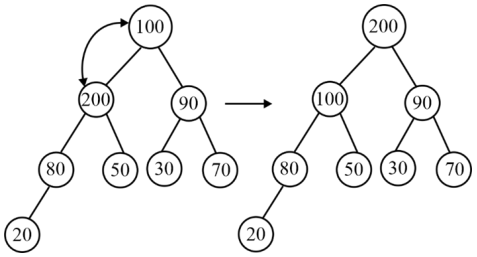
Insert (A,key) ⇒ O(logn)



Parent is smallelr (swap)



200 is greater than 80. So, we need to swap



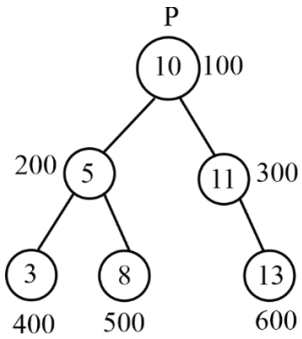
Now, a max-heap

Total inertion time = O(logn)

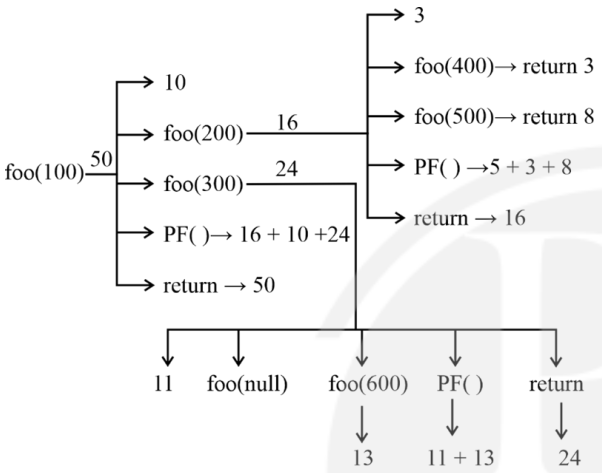
GATE

So, operation will take O(n) time.

Q47 Text Solution:



P is a root node



Output = 3, 8, 16, 13, 24, 50

Output matched with option (c)

Q48 Text Solution:

$u = \{1, 2, 3.....n\} \forall n > 2000$

|A| = |B| = k & A ∩ B = ϕ

|A| = k such that A ⊆ u

|B| = k such that B ⊆ u

K is positive integer less than n.

Number of permutation for every element of A that appear before element of B.

$^{n}C_{2k} * (n-2k)! \times k! \times k!$

Number of permutations for all element of B appear before element of A.

$^{n}C_{2k} * (n-2k)! \times k! \times k!$

Total permutation = $2 \times {}^{n}C_{2k}$ (n – 2k)! × k! × k!.

Therefore option (d) is the right choice.

Q49 Text Solution:

Because each class of x that follows an equivalence relation is uniquely mapped to one element of x in a function, Option A is false.

Every function has a clear definition.

If no two elements of x are mapped to any element of y, the function is said to be one-one. [X], [Y] are distinct equivalence, and as a result, they adhere to the one-to-one property.

A function is onto if it has a relationship between each element of domain E and an element of co-domain B.

F is a bijective function if it is one-one and onto.

Therefore opions (b), (c), and (d) are correct choices.

Q50 Text Solution:

LT = 2 min

LT = 120 sec.

B = 100 × 10^6 Bit/sec.

Byte/sec.

12.5 ×10^6 Byte/sec.

1 sec._____12.5×10^6 Byte

1 sec._____12.5×10^6 Seq. Number

120 sec._____120 × 12.5 ×10^6 Seq. Number

= 1500 ×10^6 Seq. Number

= 15 ×10^8 Seq. Number

Minimum sequence number required in the Life time = 15 ×10^8 Seq. No

= $\lceil 10g_2\ 15 \times 10^8 \rceil$ = $\lceil 30.32 \rceil$ = 31 bits.

So, option (b, c, d) are correct

Q51 Text Solution:

Let x be a set and 2^x is a power set of x

AΔB = (A –B) ∪ (B –A) for A,B ∈ 2^x

H = (2^x, Δ)

Check H for each property.

(i) H satisfies the closure property under Δ

(ii) H satisfies the associative property under a such that Δ

AΔ (BΔC) = (AΔB) ΔC

- H satisfies the identity property such that 'ϕ', is the identity element. AΔe =
- H satisfies inverse property such that inverse of A = A

AΔϕ = ϕ = (A – ϕ) u (ϕ – A)

= A∪ϕ

= A

So, H is group and inverse of A is A.

Q52 Text Solution:

GATE

9 RTTs, in case of non-persistent HTTP with 5 parallel TCP connections.

6 RTTs, in case of persistent HTTP with pipelining.

Q53 Text Solution:

Events are indepedent if

$P(A|B) = P(A)$

$P(A|B) = \frac{P(A \cap B)}{P(B)}$

$P(A \cap B) = P(A).P(B)$

C

$P(B) = \frac{2}{4}$

$P(C) = \frac{2}{4}$

$P(B \cap C) = \frac{1}{4}$

$\frac{1}{4} = \frac{2}{4} \times \frac{2}{4}$

D

$P(B|C) = \frac{P(B \cap C)}{P(C)}$

Q54 Text Solution:

```
Function_1                    | Function_2
  while n > 1 do              |   for i = 1 to 100 * n
    for i = 1 to n do         |   do
      x = x + 1;              |     x = x + 1;
    end for                   |   end for
  end while                   |
```

$f_2(n) = O(n)$

$f_1(n) = n + \frac{n}{2} + \frac{n}{4} + \frac{n}{8} + \ldots \frac{n}{2^k}$

$= n\left[\sum_{i=0}^{k} \frac{1}{2} i\right] = n\left[1 - \frac{1}{2^k}\right]$

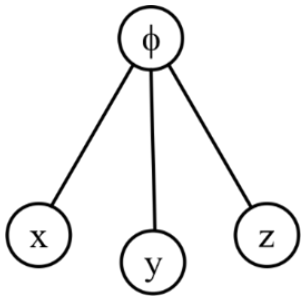
$= n - \frac{n}{2^k} = n - 1 = O(n)$

$\boxed{f_1(n) = O(n); f_2(n) = O(n)}$

Q55 Text Solution:

- This procedure results in a proper vertex coloring of G.
- The number of colors used in at most Δ (G) + 1.

Q56 Text Solution:



$\left.\begin{array}{ll} \phi & (x, y, z) \\ \phi & y, z, x \\ \phi & z, x, y \\ \phi & x, z, y \\ \phi & y, x, z \\ \phi & z, y, x \end{array}\right\} 3!$

U = {1, 2, 3,}; 2^4 = V = {f, {1}, {2}, {1, 2},{1, 3}, {2, 3}, {1, 2, 3}}

B(f) = 71

= 7 * 6 * 5 * 4 * 3 * 2 * 1

= 42 * 20 * 6 = 42 * 120

= $\boxed{5040}$

Q57 Text Solution:

Each value i causes 32 Page Faults

→ matrix is stored in R.M.O

→ matrix size int D[128] [128]

→ Page Size = 512

→ Number of frames = 30

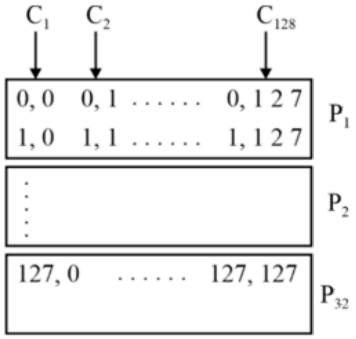
→ Page replacement technique is LRU.

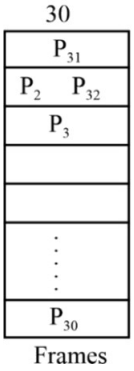
Number of pages needed to store the matrix

$\frac{128 \times 128}{512} = \frac{2^{14}}{2^9} = 2^5$

= 32 pages

GATE





→ each value of 'i' causes 32 Page Faults

→ All value of i(128) causes a total of 128 × 32 = 2^{12} = 4096 Page Faults

Q58 Text Solution:

L : number of paging.

Virtual Address space = 57 bits

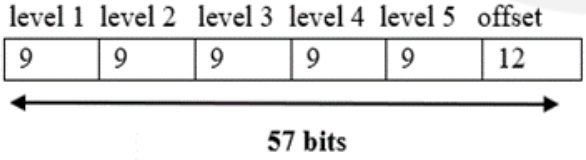
Page Size = 4 KB

Page table entry = 8 B

Page number = (57–12) = 45 bits

Number of entries in P.T = $\frac{4\,KB}{8B} = 512 = 2^9$.

Means, we need 9 bits to index the page table.

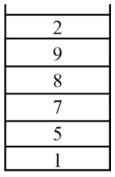


So, number of levels = 9 × L = 45

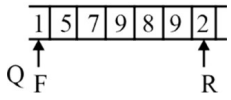
$$\boxed{L = \frac{45}{9} = 5}$$

Q59 Text Solution:

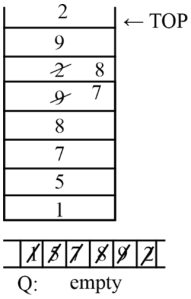
Step 1:



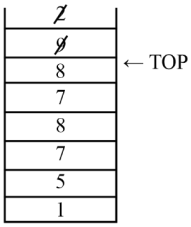
Step 2:



Step 3 to 8:



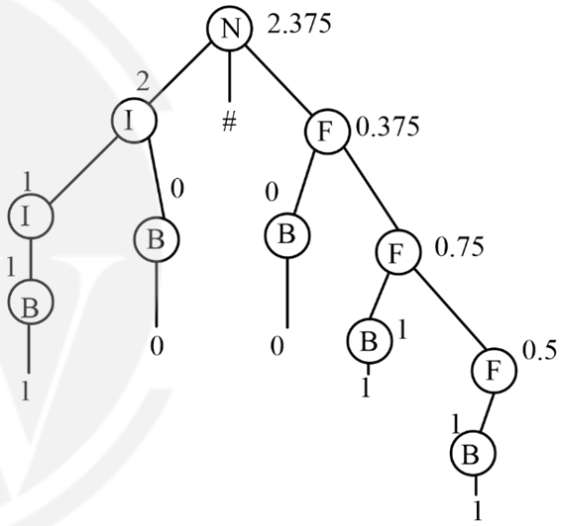
Step 9 & 10:



TOP element = 8

Q60 Text Solution:

The parse tree for the given SDT is



The end of the production is 2.375.

Q61 Text Solution:

Roll Num	Name	Gender	Marks
1	Naman	M	62
2	**Aliya**	**F**	**70**
3	**Aliya**	**F**	**80**
4	James	M	82

GATE

5	Swati	F	65

The given query on above relation will yield two tuples in the output relation

"SELECT *

FROM Student

WHERE gender = 'F' AND marks > 65;"

Number of tuples (Records) = 2

Output

Roll No.	Name	Gender	Marks
2	Aliya	F	70
3	Aliya	F	80

Q62 Text Solution:

Total number of Records = 25,000

Block size = 1024 Byte, Records size = 100 Byte

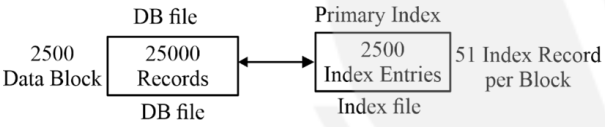
Key = 15 byte, B_P = 5 byte, Fixed length, Unspanned organization, primary index

Block factor of DB file [B_{FDB}] = $\left\lfloor \frac{\text{Block size}}{\text{Record size}} \right\rfloor \Rightarrow \left\lfloor \frac{1024\ \text{B}}{100\ \text{B}} \right\rfloor$ = 10 Records per Block

Total number of Records = 25,000

Total number of DB block = $\left\lceil \frac{25000}{10} \right\rceil$

= 2500 Data Blocks



One Index record size = Size of key + size of block pointer

15 + 5 = 20 Byte

Block factor of Index file = $\left\lfloor \frac{1024\ \text{B}}{20\ \text{B}} \right\rfloor = \lfloor 51.2 \rfloor$ = 51 51 index record per Block (entries).

Primary Index:

SPARSE ⇒ Total number of Index Entries = 2500 (Number of DB Block)

Total number Index entries = 2500

Block factor of Index file = 51 Index entries per Block.

$\lfloor \text{B: Index Block} \rfloor$

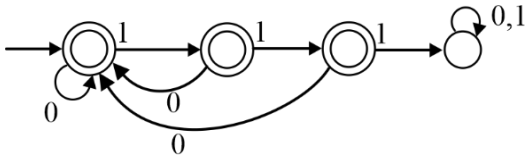
Total number of Index Block [b] = $\left\lceil \frac{2500}{51} \right\rceil = \lceil 49.01 \rceil$ = 50 Index Block

In worst case number of Block Access Required = $\lceil \log_2 \text{b} \rceil \Rightarrow \lceil \log_2 50 \rceil$

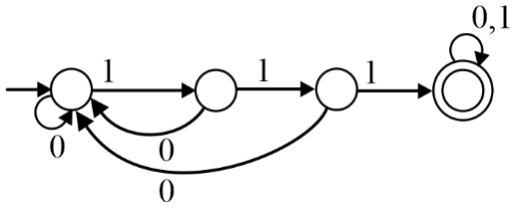
= $\boxed{6\ \text{Block Access}}$

Q63 Text Solution:

DFA for L:



DFA for $\overline{L}$



Number of states will be same in both L and .

Number of states = 4

Q64 Text Solution:

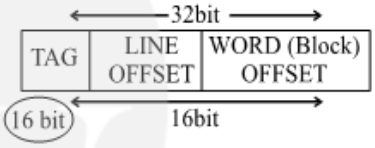
8 way set Associative.

Cache size = 64kB,

Physical address = 32 bit

Cache size = 64 KB = 2^{16} Byte.

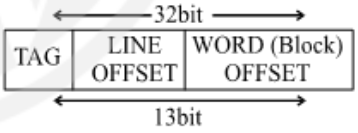
Direct Mapping:



But In Question 8 way set Associative.

$\text{Log}_2(8)$ = 3bit

8 Way set Associative



TAG = 32–13 = 19bit

Alternate approach

8 Way set Associative

Cache size = 64 KB

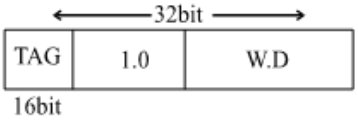
Physical address = 32bit

Assume Block size = 1 Byte

Number of lines = $\frac{\text{CM size}}{\text{Block size}}$

$= \frac{64\ \text{KB}}{1\text{B}} = 64\text{K}\ (2^{16})\ \text{Line}$

Line off set = $\log_2 2^{16}$ = 16 bit

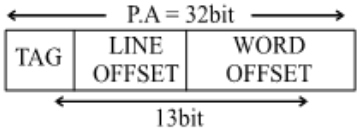


8 Way set associative

GATE

Number of set = $\frac{\#\text{Lines}}{\text{N}-\text{ways}} = \frac{2^{16}}{2^3} = 2^{13}$

Set offset = 13 bit



Tag = 32–13 = 19bit.

Q65 **Text Solution:**

First start with the longest subnet mask

I 200.150.68.01110110

AND

255.255.255.11100000

NID = 200.150.68.96

Not matched with interface (4)

II 200.150.68.118

AND

255.255.255.0

NID = 200.150.68.0

Matched with interface (3)

No need to check further if it matches with more than one interfaces then we choose longest subnet mask.