Computer Science Engineering
(Forenoon Session)
Exam Date- 01-02-2025

SECTION - A GENERAL APTITUDE

Q.1 Ravi had _____ younger brother who taught at _____ university. He was widely regarded as _____ honorable man.
Select the option with the correct sequence of articles to fill in the blanks.

(a) a; a; an
(b) the; an; a
(c) a; an; a
(d) an; an; a

Ans. (a)

End of Solution

Q.2 The CEO's decision to downsize the workforce was considered myopic because it sacrificed long-term stability to accommodate short-term gains.
Select the most appropriate option that can replace the word "myopic" without changing the meaning of the sentence.

(a) visionary
(b) shortsighted
(c) progressive
(d) innovative

Ans. (b)

End of Solution

Q.3 The average marks obtained by a class in an examination were calculated as 30.8. However, while checking the marks entered, the teacher found that the marks of one student were entered incorrectly as 24 instead of 42. After correcting the marks, the average becomes 31.4. How many students does the class have?

(a) 25
(b) 28
(c) 30
(d) 32

Ans. (c)

$$[31.4 - 30.8]n = 42 - 24$$
$$0.6n = 18$$
$$n = 30$$

End of Solution

Q.4 Consider the relationships among P, Q, R, S, and T:

- P is the brother of Q.
- S is the daughter of Q.
- T is the sister of S.
- R is the mother of Q.

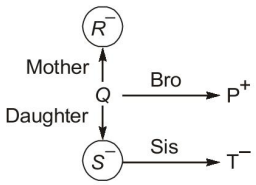
The following statements are made based on the relationships given above.

(1) R is the grandmother of S.
(2) P is the uncle of S and T.
(3) R has only one son.
(4) Q has only one daughter.

Which one of the following options is correct?

(a) Both (1) and (2) are true.
(b) Both (1) and (3) are true.
(c) Only (3) is true.
(d) Only (4) is true.

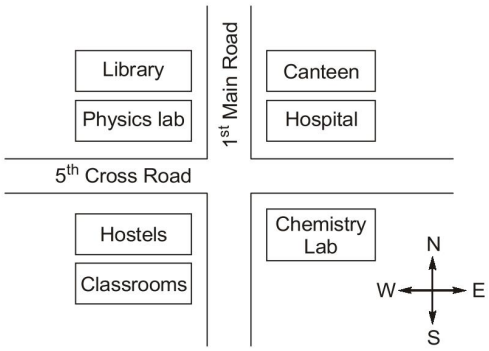
Ans. (a)



End of Solution

Q.5 According to the map shown in the figure, which one of the following statements is correct?

Note: The figure shown is representative.



(a) The library is located to the northwest of the canteen.
(b) The hospital is located to the east of the chemistry lab.
(c) The chemistry lab is to the southeast of physics lab.
(d) The classrooms and canteen are next to each other.

Ans. (c)

End of Solution

Q.6 "I put the brown paper in my pocket along with the chalks, and possibly other things. I suppose every one must have reflected how primeval and how poetical are the things that one carries in one's pocket: the pocket-knife, for instance the type of all human tools, the infant of the sword. Once I planned to write a book of poems entirely about the things in my pocket. But I found it would be too long: and the age of the great epics is past."

(From G.K. Chesterton's "A Piece of Chalk")

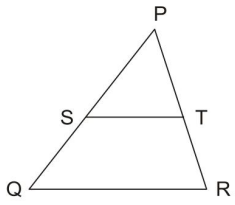
Based only on the information provided in the above passage, which one of the following statements is true?

(a) The author of the passage carries a mirror in his pocket to reflect upon things.
(b) The author of the passage had decided to write a poem on epics.
(c) The pocket-knife is described as the infant of the sword.
(d) Epics are described as too inconvenient to write.

Ans. (c)

End of Solution

Q.7 In the diagram, the lines QR and ST are parallel to each other. The shortest distance between these two lines is half the shortest distance between the point P and line QR. What is the ratio of the area of the triangle PST to the area of the trapezium SQRT?
Note: The figure shown is representative.



(a) $\frac{1}{3}$ (b) $\frac{1}{4}$

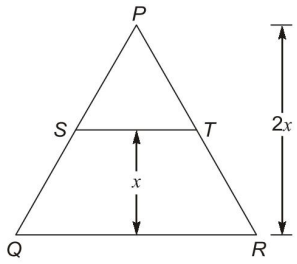
(c) $\frac{2}{5}$ (d) $\frac{1}{2}$

Ans. (a)

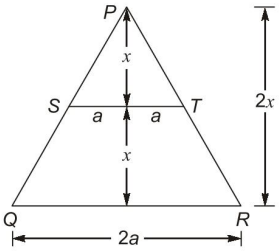
$$\frac{A_1}{A_2} = \left(\frac{a}{b}\right)^2$$

$$\frac{\Delta PST}{\Delta PQR} = \left(\frac{1}{2}\right)^2 = \frac{1}{4}$$

$$\frac{\Delta PST}{T_r QRST} = \frac{1}{4-1} = \frac{1}{3}$$



Alternatively,



$$\frac{\Delta PST}{T_r QRST} = \frac{\frac{1}{2}\times 2a\times x}{\frac{1}{2}\times(4a+2a)} = \frac{2ax}{6ax} = \frac{1}{3}$$

End of Solution

Q.8 A fair six-faced dice, with the faces labelled '1', '2', '3', '4', '5', and '6', is rolled thrice. What is the probability of rolling '6' exactly once?

(a) $\frac{75}{216}$ (b) $\frac{1}{6}$

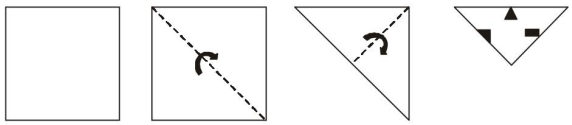
(c) $\frac{1}{18}$ (d) $\frac{25}{216}$

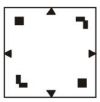
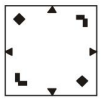
Ans. (a)

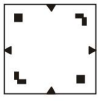
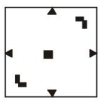
$$\text{Required probability} = A\times\bar{B}\times\bar{C}+\bar{A}\times\bar{B}\times C+\bar{A}\times B\times\bar{C}$$
$$= \frac{1}{6}\times\frac{5}{6}\times\frac{5}{6}+\frac{5}{6}\times\frac{5}{6}\times\frac{1}{6}+\frac{5}{6}\times\frac{1}{6}\times\frac{5}{6}$$
$$= \frac{75}{216}$$

End of Solution

Q.9 A square paper, shown in figure (I), is folded along the dotted lines as shown in the figures (II) and (III). Then a few cuts are made as shown in figure (IV). Which one of the following patterns will be obtained when the paper is unfolded?
Note: The figures shown are representative.



(a)  (b) 

(c)  (d) 

Ans. (a)

End of Solution

Q.10 A shop has 4 distinct flavors of ice-cream. One can purchase any number of scoops of any flavor. **The order in which the scoops are purchased is inconsequential.** If one wants to purchase 3 scoops of ice-cream, in how many ways can one make that purchase?

(a) 4 (b) 20

(c) 24 (d) 48

Ans. (b)

End of Solution

■■■■

SECTION - B TECHNICAL

Q.11 Suppose a program is running on a non-pipelined single processor computer system. The computer is connected to an external device that can interrupt the processor asynchronously. The processor needs to execute the interrupt service routine (ISR) to serve this interrupt. The following steps (not necessarily in order) are taken by the processor when the interrupt arrives:

(i) The processor saves the content of the program counter.
(ii) The program counter is loaded with the start address of the ISR.
(iii) The processor finishes the present instruction.

Which ONE of the following is the CORRECT sequence of steps?

(a) (iii), (i), (ii) (b) (i), (iii), (ii)
(c) (i), (ii), (iii) (d) (iii), (ii), (i)

Ans. **(a)**

Step 1: CPU respond to the interrupt after completion of a current instruction execution.
Step 2: Save the PC value and PSW into a stack.
Step 3: Load the vector Address into a PC.

End of Solution

Q.12 Which ONE of the following statements is **FALSE** regarding the symbol table?

(a) Symbol table is responsible for keeping track of the scope of variables.
(b) Symbol table can be implemented using a binary search tree.
(c) Symbol table is not required after the parsing phase.
(d) Symbol table is created during the lexical analysis phase.

Ans. **(c)**

Symbol table can be accessed by all the phases of a compiler. Symbol table is required after parsing also.

End of Solution

Q.13 Which ONE of the following techniques used in compiler code optimization uses live variable analysis?

(a) Run-time function call management
(b) Register assignment to variables
(c) Strength reduction
(d) Constant folding

Ans. **(b)**

Live variable analysis is used for register assignment to variables.

End of Solution

Q.14 Consider a demand paging memory management system with 32-bit logical address, 20-bit physical address, and page size of 2048 bytes. Assuming that the memory is byte addressable, what is the maximum number of entries in the page table?

(a) 2^{21} (b) 2^{20}

(c) 2^{22} (d) 2^{24}

Ans. **(a)**

L.A. = 32 bits

P.A. = 20 bits

Page size = 2048 byte = 2^{11} B

Number of entries in page table

$$= \frac{\text{L.A.S}}{\text{Page size}} = \frac{2^{32}\text{B}}{2^{11}\text{B}} = 2^{21}$$

End of Solution

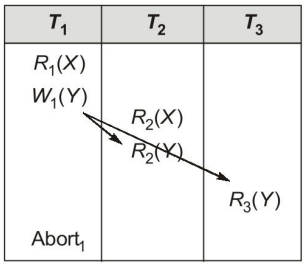
Q.15 A schedule of three database transactions T_1, T_2, and T_3 is shown. $R_i(A)$ and $W_i(A)$ denote read and write of data item A by transaction T_i, i = 1, 2, 3. The transaction T_1 aborts at the end. Which other transaction(s) will be required to be rolled back?

$R_1(X)\ W_1(Y)\ R_2(X)\ R_2(Y)\ R_3(Y)\ ABORT(T_1)$

(a) Only T_2 (b) Only T_3

(c) Both T_2 and T_3 (d) Neither T_2 nor T_3

Ans. **(C)**



T_1 updated data of data item X is reads by T_2 T_3 which are uncommitted reads because of T_1 failure [ABORT] has to rollback T_1 T_2 also. [Cascade Rollbacks]

End of Solution

Q.16 Identify the ONE CORRECT matching between the OSI layers and their corresponding functionalities as shown.

OSI Layers	Functionalities
(a) Network layer	(I) Packet routing
(b) Transport layer	(II) Framing and error handling
(c) Datalink layer	(III) Host to host communication

(a) (a)-(I), (b)-(II), (c)-(III) (b) (a)-(I), (b)-(III), (c)-(II)

(c) (a)-(II), (b)-(I), (c)-(III) (d) (a)-(III), (b)-(II), (c)-(I)

Ans. **(b)**

Packet Routing is the responsibility of network layer (a) (I).

Framing and error (bit level) handling is the responsibility of Data Link Layer.

Hence, (c) (II).

Host to Host communication (end to end Communication) is the responsibility of Transport Layer (Practically). Hence, (b) (III).

Hence, option (b) is correct.

End of Solution

Q.17 $g(.)$ is a function from A to B, $f(.)$ is a function from B to C, and their composition defined as $f(g(.))$ is a mapping from A to C.

If $f(.)$ and $f(g(.))$ are onto (surjective) functions, which ONE of the following is TRUE about the function $g(.)$?

(a) $g(.)$ must be an onto (surjective) function.

(b) $g(.)$ must be a one-to-one (injective) function.

(c) $g(.)$ must be a bijective function, that is, both one-to-one and onto.

(d) $g(.)$ is not required to be a one-to-one or onto function.

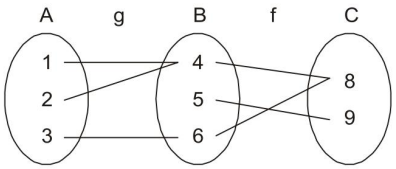
Ans. **(d)**

Given, $g : A \to B$, $f : B \to C$

So, that $f \circ g : A \to C$

We know that, if f_1 g are onto f^n then $f \circ g$ is also onto f^n but converse is need not be true.

For example: Let f is onto, $f \circ g$ is onto.



$f \circ g$: {(1, 8) (2, 8) (3, 9)} is an onto f^n

$\because$ Codomain = Range

and f = {(4, 8) (5, 9) (6, 8)}

$\because$ COD = Range

$\therefore$ f is also onto f^n

But, g = {(1, 4) (2, 4) (3, 5)} is not an onto f^n and also not an one-one f^n

$\because$ Codomain $\neq$ Range

Hence $g(x)$ is need not to be. One-one (or) onto for the given condition.

End of Solution

Q.18 Let G be any undirected graph with positive edge weights, and T be a minimum spanning tree of G. For any two vertices, u and v, let $d_1(u, v)$ and $d_2(u, v)$ be the shortest distances between u and v in G and T, respectively. Which ONE of the options is CORRECT for all possible G, T, u and v?

(a) $d_1(u, v) = d_2(u, v)$ (b) $d_1(u, v) \leq d_2(u, v)$

(c) $d_1(u, v) \geq d_2(u, v)$ (d) $d_1(u, v) \neq d_2(u, v)$

Ans. **(b)**

MST distance from u to v may not be the shortest path distance from u to v.

Shortest path distance from u to v $d_1(u, v) \leq$ MST path distance from u to v $d_2(u, v)$

End of Solution

Q.19 Consider the following context-free grammar G, where S, A, and B are the variables (non-terminals), a and b are the terminal symbols, S is the start variable, and the rules of G are described as:

$S \rightarrow aaB \mid Abb$

$A \rightarrow a \mid aA$

$B \rightarrow b \mid bB$

Which ONE of the languages $L(G)$ is accepted by G?

(a) $L(G) = \{a^2\ b^n \mid n \geq 1\} \cup \{a^n\ b^2 \mid n \geq 1\}$

(b) $L(G) = \{a^n\ b^{2n} \mid n \geq 1\} \cup \{a^{2n}\ b^n \mid n \geq 1\}$

(c) $L(G) = \{a^n\ b^n \mid n \geq 1\}$

(d) $L(G) = \{a^{2n}\ b^{2n} \mid n \geq 1\}$

Ans. **(a)**

$S \rightarrow aa\underline{B} \rightarrow aab$

$S \rightarrow aa\underline{B} \rightarrow aabB \overset{*}{\Rightarrow} a^2b^n \mid n \geq 1$

$S \rightarrow \underline{A}bb \rightarrow abb$

$S \rightarrow \underline{A}bb \rightarrow aAbb \overset{*}{\Rightarrow} a^nb^2 \mid n \geq 1$

$\therefore$ $L(G) = \{a^2\ b^n \mid n \geq 1\} \cup \{a^n\ b^2 \mid n \geq 1\}$

End of Solution

Q.20 Consider the following recurrence relation:

$$T(n) = 2T(n - 1) + n2^n \text{ for } n > 0,\ T(0) = 1$$

Which ONE of the following options is CORRECT?

(a) $T(n) = \Theta(n^2\ 2^n)$ (b) $T(n) = \Theta(n2^n)$

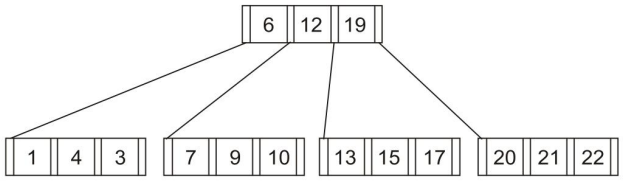
(c) $T(n) = \Theta((\log n)^2\ 2^n)$ (d) $T(n) = \Theta(4^n)$

Ans. **(a)**

$$T(n) = 2T(n-1) + n \cdot 2^n$$
$$= 2[2T(n-2) + (n-1) \cdot 2^{n-1}] + n \cdot 2^n$$
$$= 2^2 T(n-2) + 2^n[(n-1)]$$
$$= 2^3 T(n-3) + 2^n[(n-2) + (n-1) + n]$$
$$= 2^k T[(\underbrace{(n-k)}_{0})] + 2^n[(n-(k-1)) + (n-(k-2)) + \ldots + n]$$
$$n - k = 0 \Rightarrow n = k$$
$$= 2^n \cdot 1 + 2^n[1 + 2 + \ldots + n]$$
$$= 2^n + 2^n\left(\frac{n(n+1)}{2}\right) = \Theta(n^2 \cdot 2^n)$$

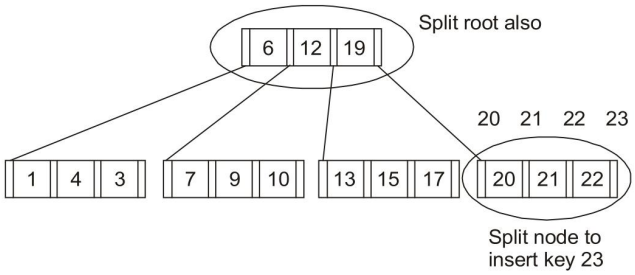
End of Solution

Q.21 Consider the following B^+ tree with 5 nodes, in which a node can store at most 3 key values. The value 23 is now inserted in the B^+ tree. Which of the following options(s) is/are CORRECT?



(a) None of the nodes will split.
(b) At least one node will split and redistribute.
(c) The total number of nodes will remain same.
(d) The height of the tree will increase.

Ans. **(b, d)**



- Leaf node and root node split required.
- Results increases tree height from 1 to 2.

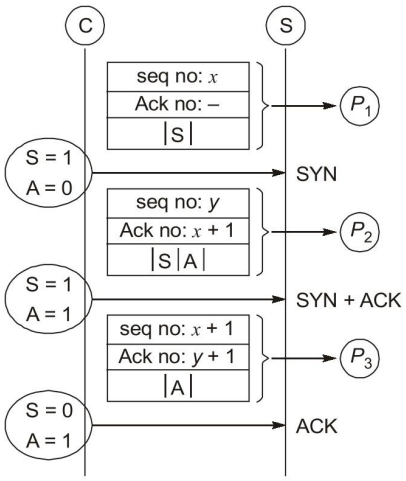
End of Solution

Q.22 Consider the 3-way handshaking protocol for TCP connection establishment. Let the three packets exchanged during the connection establishment be denoted as P1, P2, and P3, in order. Which of the following option(s) is/are TRUE with respect to TCP header flags that are set in the packets?

(a) P3: SYN = 1, ACK = 1
(b) P2: SYN = 1, ACK = 1
(c) P2: SYN = 0, ACK = 1
(d) P1: SYN = 1

Ans. **(b, d)**

Connection establishment phase of TCP



End of Solution

Q.23 Consider the given system of linear equations for variables x and y, where k is a real-valued constant. Which of the following option(s) is/are CORRECT?

$x + ky = 1$

$kx + y = -1$

(a) There is exactly one value of k for which the above system of equations has no solution.
(b) There exist an infinite number of values of k for which the system of equations has no solution.
(c) There exists exactly one value of k for which the system of equations has exactly one solution.
(d) There exists exactly one value of k for which the system of equations has an infinite number of solutions.

Ans. **(a, d)**

Given equations are $x + ky = 1$

$$kx + y = -1$$

1. No solution:

Condition: $\frac{a_1}{a_2} = \frac{b_1}{b_2} \neq \frac{c_1}{c_2}$

$\Rightarrow \quad \frac{1}{k} = \frac{k}{1} \neq \frac{1}{-1}$

$\Rightarrow \quad k^2 - 1 = 0 \quad \text{and} \quad k \neq -1$

$\Rightarrow \quad k = 1$

$\therefore$ System has no solution for only $k = 1$

$\therefore$ (a) is true and (b) is false

2. ∞-many solution:

Condition: $\frac{a_1}{a_2} = \frac{b_1}{b_2} = \frac{c_1}{c_2}$

$\Rightarrow \quad \frac{1}{k} = \frac{k}{1} = \frac{1}{-1}$

$\Rightarrow \quad \frac{1}{k} = -1, \; k = -1, \; k^2 - 1 = 0$

$\Rightarrow \quad k = -1 \quad \text{and} \quad k \neq 1$

$\therefore$ System has ∞ solutions only for $k = -1$

$\therefore$ (d) is true

3. Unique solution:

Condition: $\frac{a_1}{a_2} \neq \frac{b_1}{b_2}$

$\Rightarrow \quad \frac{1}{k} \neq \frac{k}{1} \quad \Rightarrow \quad k^2 \neq 1$

$\Rightarrow \quad k \neq 1, \; k \neq -1$

$\Rightarrow$ k can take ∞ no. of values

$\therefore$ System has unique solution for infinite values of k.

$\therefore$ c is false

End of Solution

Q.24 Let X be a 3-variable Boolean function that produces output as '1' when at least two of the input variables are '1'. Which of the following statement(s) is/are CORRECT, where a, b, c, d, e are Boolean variables?

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

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

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

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

Ans. **(b, d)**

X is a majority function

$$X(P, Q, R) = PQ + QR + PR$$

(a) LHS $= X(a, b, X(c, d, e))$; where $R = cd + de + ce$

$= ab + bR + aR$

$= ab + b(cd + de + ce) + a(cd + de + ce)$

$= ab + bcd + bde + bce + acd + ade + ace$

RHS $= X(X(a, b, c), d, e)$; where $P = ab + bc + ac$

$= Pd + de + Pe$

$= (ab + bc + ac)d + de + (ab + bc + ac)e$

$= abd + bcd + acd + de + abe + bce + ace$

LHS $\neq$ RHS

(b) LHS $= X(a, b, X(a, b, c))$; where $R = ab + bc + ac$

$= ab + bR + aR$

$= ab + b(ab + bc + ac) + a(ab + bc + ac)$

$= ab + ab + bc + abc + ab + abc + ac$

$= ab + bc + ac$

RHS $= X(a, b, c)$

$= ab + bc + ac$

LHS = RHS

(c) LHS $= X(a, b, X(a, c, d))$; where $R = ac + cd + ad$

$= ab + bR + aR$

$= ab + b(ac + cd + ad) + a(ac + cd + ad)$

$= ab + abc + bcd + abd + ac + acd + ad$

$= ab(1 + c + d) + ac(1 + d) + bcd + ad$

$= ab + ac + bcd + ad$

RHS $= X(a, b, a)$ AND $X(c, d, c)$

where $X(a, b, a) = ab + ba + a = a$

and $X(c, d, c) = cd + dc + cc = c$

RHS $= a$ AND c

$= ac$

LHS $\neq$ RHS

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

$= ab + bc + ac$

RHS $= X(a, X(a, b, c), X(a, c, c))$

where, $X(a, b, c) = ab + bc + ac = Q$

and $X(a, c, c) = ac + cc + ac = C$

RHS $= X(a, Q, c)$

$= aQ + Qc + ac$

$$= a(ab + bc + ac) + (ab + bc + ac)c + ac$$
$$= ab + abc + ac + abc + bc + ac + ac$$
$$= ab + bc + ac$$
$$\text{LHS} = \text{RHS}$$

End of Solution

Q.25 The number -6 can be represented as 1010 in 4-bit 2's complement representation. Which of the following is/are CORRECT 2's complement representation(s) of –6?

(a) 1000 1010 in 8-bits
(b) 1111 1010 in 8-bits
(c) 1000 0000 0000 1010 in 16-bits
(d) 1111 1111 1111 1010 in 16-bits

Ans. **(b, d)**

–6 representation in 2's complement form 1010 in 4 bits.
(b) In 8 bit form 1111 1010. It is sign bit extension.
(d) In 16 bit from 1111 1111 1111 1010. It is sign bit extension.

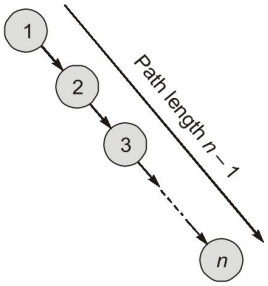
End of Solution

Q.26 Which of the following statement(s) is/are TRUE for any binary search tree (BST) having n distinct integers?

(a) The maximum length of a path from the root node to any other node is $(n - 1)$.
(b) An inorder traversal will always produce a sorted sequence of elements.
(c) Finding an element takes $O(\log_2 n)$ time in the worst case.
(d) Every BST is also a Min-Heap.

Ans. **(a, b)**

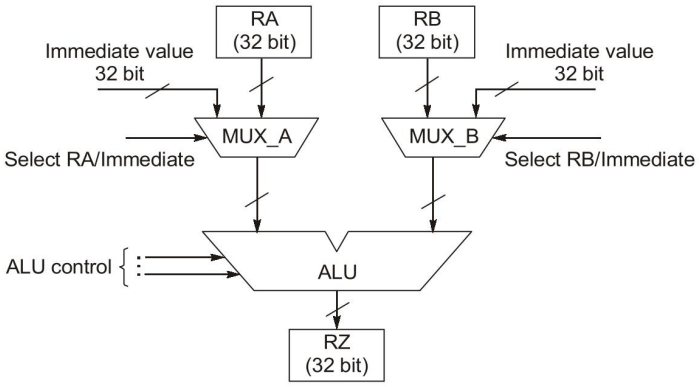
BST can be skewed tree also



Inorder traversal of BST is sorted sequence. Worst case search cost of BST is $\theta(n)$. Not every BST is min-heap.

End of Solution

Q.27 A partial data path of a processor is given in the figure, where RA, RB, and RZ are 32-bit registers. Which option(s) is/are CORRECT related to arithmetic operations using the data path as shown?



(a) The data path can implement arithmetic operations involving two registers.
(b) The data path can implement arithmetic operations involving one register and one immediate value.
(c) The data path can implement arithmetic operations involving two immediate values.
(d) The data path can only implement arithmetic operations involving one register and one immediate value.

Ans. **(a, b, c)**

ALU operation R_A, R_B
ALU operation Immediate, R_B
ALU operation R_A, Immediate
ALU operation Immediate, Immediate

End of Solution

Q.28 A regular language L is accepted by a non-deterministic finite automaton (NFA) with n states. Which of the following statement(s) is/are FALSE?

(a) L may have an accepting NFA with $< n$ states.
(b) L may have an accepting DFA with $< n$ states.
(c) There exists a DFA with $\leq 2^n$ states that accepts L.
(d) Every DFA that accepts L has $> 2^n$ states.

Ans. **(d)**

The number of states in NFA in n states
$\Rightarrow$ There may exists a NFA and DFA with states less than n and a DFA equivalent to the NFA with n states will have maximum 2^n states.

End of Solution

Q.29 Suppose in a multiprogramming environment, the following C program segment is executed. A process goes into I/O queue whenever an I/O related operation is performed. Assume that there will always be a context switch whenever a process requests for an I/O, and also whenever the process returns from an I/O. The number of times the process will enter the ready queue during its lifetime (not counting the time the process enters the ready queue when it is run initially) is _____. (Answer in integer)

```
int main( )
{
    int x = 0, i = 0;
    scanf("%d", &x);
    for(i = 0; i < 20; i++)
    {
        x = x + 20;
        printf("%d\n", x);
    }
    return 0;
}
```

Ans. (21)

Understanding the Process Execution:

1. The program starts execution and enters the ready queue (this is not counted).
2. The first I/O operation occurs at scanf("%d",&x);, which takes input from the user.
   - The process moves to the I/O queue and gets context switched out.
   - Once the I/O is completed, the process returns to the ready queue.
3. The for loop runs 20 times, and in each iteration:
   - The statement printf("%d\n",x); performs I/O operation.
   - Each printf() results in an I/O request, causing the process to move to the I/O queue.
   - After completing each I/O operation, the process returns to the ready queue.

Counting the Number of Times the Process Enters the Ready Queue:

1. 1^{st} time: After scanf() completes $\rightarrow$ 1 time
2. Each printf() (20 times) does I/O:
   - Each causes 1 exit to I/O queue and 1 re-entry to the ready queue.
   - Total for printf() statements: 20 times

Total Entries to Ready Queue (excluding the first time it starts running):

$$1 + 20 = 21$$

End of Solution

Q.30 Let S be the set of all ternary strings defined over the alphabet $\{a, b, c\}$. Consider all strings in S that contain at least one occurrence of two consecutive symbols, that is, "aa", "bb" or "cc". The number of such strings of length 5 that are possible is _____. (Answer in integer)

Ans. **(195)**

The total number of strings of length 5 with $\Sigma = \{a, b, c\}$ is $3 \cdot 3 \cdot 3 \cdot 3 \cdot 3 = 3^5$ ways

$= 243$

The number of strings in which no two consecutive symbols are same is

$3 \cdot 2 \cdot 2 \cdot 2 \cdot 2 = 48$ ways

$\therefore$ The number of strings having either aa or bb or cc or substring is $243 - 48 = 195$

End of Solution

Q.31 Consider the given function $f(x)$.

$$f(x) = \begin{cases} ax + b & \text{for } x < 1 \\ x^3 + x^2 + 1 & \text{for } x \geq 1 \end{cases}$$

If the function is differentiable everywhere, the value of b must be _____. (Rounded off to one decimal place)

Ans. **(–2)**

Let $f(x)$ is differentiable at $x = 1$

Then $f'(1^-) = f'(1^+)$

$a = (3x^2 + 2x)_{x=1}$

$a = 5$

$\because$ Every differential is continuous

$f(x)$ is continuous at $K = 1$

$\Rightarrow$ $f(1^-) = f(1^+) = f(1)$

$a(1) + b = 1^3 + 1 + 1$

$b = 3 - 5$

$b = -2$

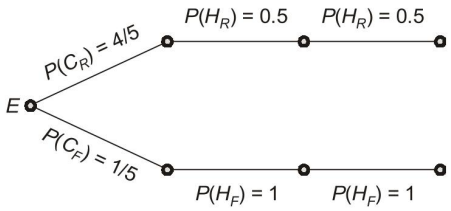
End of Solution

Q.32 A box contains 5 coins: 4 regular coins and 1 fake coin. When a regular coin is tossed, the probability $P(\text{head}) = 0.5$ and for a fake coin, $P(\text{head}) = 1$. You pick a coin at random and toss it twice, and get two heads. The probability that the coin you have chosen is the fake coin is _____. (Rounded off to two decimal places)

Ans. **(0.5)**

$$P(H_R) = 0.5$$
$$P(H_F) = 1$$

Let, E = getting 2 heads when a coin is chosen



By Baye's

$$P\left[\frac{C_F}{E}\right] = \frac{P(C_F \cap E)}{P(E)}$$

$$= \frac{\frac{1}{5}\times 1\times 1}{\frac{1}{5}\times 1\times 1+\frac{4}{5}\times\frac{1}{2}\times\frac{1}{2}} = \frac{1}{2} = 0.5$$

End of Solution

Q.33 The pseudocode of a function fun( ) is given below:

```
fun(int A[0, ..., n – 1]) {
    for i = 0 to n – 2
        for j = 0 to n – i – 2
            if (A[j] > A[j + 1])
                then swap A[j] and A[j + 1]
}
```

Let $A[0, ..., 29]$ be an array storing 30 distinct integers in descending order. The number of swap operations that will be performed, if the function fun( ) is called with $A[0, ..., 29]$ as argument, is _____. (Answer in integer)

Ans. **(435)**

Given algo is bubble sort algo.

Number of swap's are number of inverses of an array.

Number of inverses for the array of 30 elements in decreasing order are $\frac{30\times 29}{2} = 435$.

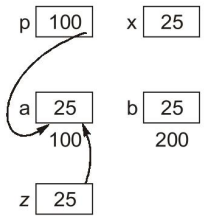
End of Solution

Q.34

```
#include <stdio.h>
void foo(int *p, int x) {
    *p = x;
}
int main( ) {
    int *z;
    int a = 20, b = 25;
    z = &a;
    foo(z, b);
    printf("%d", a);
    return 0;
}
```

The output of the given C program is _____. (Answer in integer)

Ans. (25)



O/P = 25

End of Solution

Q.35 The height of any rooted tree is defined as the maximum number of edges in the path from the root node to any leaf node.
Suppose a Min-Heap T stores 32 keys. The height of T is _____. (Answer in integer)

Ans. (5)

- Number of nodes in min heap with height h are 2^h to $2^{h+1} - 1$.
- 32 keys are minimum nodes in min heap of height 5.

End of Solution

Q.36 Consider a memory system with 1 M bytes of main memory and 16 K bytes of cache memory. Assume that the processor generates 20-bit memory address, and the cache block size is 16 bytes. If the cache uses direct mapping, how many bits will be required to store all the tag values?
[Assume memory is byte addressable, 1 K = 2^{10}, 1 M = 2^{20}]

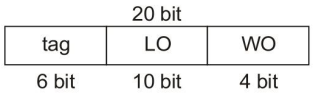
(a) 6×2^{10}
(b) 8×2^{10}
(c) 2^{12}
(d) 214

Ans. **(a)**

MM size = 1 MB
Physical Address = 20 bit
CM size = 16 kB
Block size = 16 B

Direct mapping

$$\text{Number of lines } (N) = \frac{16\,K}{16} = 1K$$



Tag memory size = $N \times$ tag space in the line
$= 2^{10} \times 6$

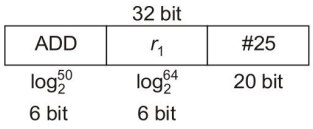
End of Solution

Q.37 A processor has 64 general-purpose registers and 50 distinct instruction types. An instruction is encoded in 32-bits. What is the maximum number of bits that can be used to store the immediate operand for the given instruction?

```
ADD R1, #25     // R1 = R1 + 25
```

(a) 16 (b) 20
(c) 22 (d) 24

Ans. **(b)**



20 bit space is required to represent the immediate value.

End of Solution

Q.38 A computer has two processors, M_1 and M_2. Four processes P_1, P_2, P_3, P_4 with CPU bursts of 20, 16, 25, and 10 milliseconds, respectively, arrive at the same time and these are the only processes in the system. The scheduler uses non-preemptive priority scheduling, with priorities decided as follows:

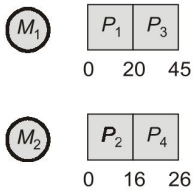
- M_1 uses priority of execution for the processes as, $P_1 > P_3 > P_2 > P_4$, i.e., P_1 and P_4 have highest and lowest priorities, respectively.
- M_2 uses priority of execution for the processes as, $P_2 > P_3 > P_4 > P_1$, i.e., P_2 and P_1 have highest and lowest priorities, respectively.

A process P_i is scheduled to a processor M_k, if the processor is free and no other process P_j is waiting with higher priority. At any given point of time, a process can be allocated to any one of the free processors without violating the execution priority rules. Ignore the context switch time. What will be the average waiting time of the processes in milliseconds?

(a) 9.00 (b) 8.75
(c) 6.50 (d) 7.50

Ans. **(9)**

P.No.	A.T.	B.T.	C.T.	T.A.T.	W.T.
P_1	0	20	20	20	0
P_2	0	16	16	16	0
P_3	0	25	45	45	20
P_4	0	10	26	26	16



$$\text{Average waiting time} = \frac{0+0+20+16}{4} = \frac{36}{4} = 9$$

End of Solution

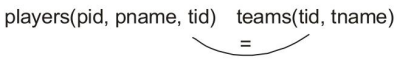
Q.39 Consider two relations describing *teams* and *players* in a sports league:

- teams(tid, tname): tid, tname are team-id and team-name, respectively.
- players(pid, pname, tid): pid, pname, and tid denote player-id, player-name and the team-id of the player, respectively.

Which ONE of the following tuple relational calculus queries returns the name of the players who play for the team having *tname* as '*MI*'?

(a) $\{p.pname \mid p \in players \wedge \exists t\ (t \in teams \wedge p.tid = t.tid \wedge t.name = \text{'MI'})\}$
(b) $\{p.pname \mid p \in teams \wedge \exists t\ (t \in players \wedge p.tid = t.tid \wedge t.name = \text{'MI'})\}$
(c) $\{p.pname \mid p \in players \wedge \exists t\ (t \in teams \wedge t.name = \text{'MI'})\}$
(d) $\{p.pname \mid p \in teams \wedge \exists t\ (t \in players \wedge t.name = \text{'MI'})\}$

Ans. **(a)**



Option (a) correct for given specification.

End of Solution

Q.40 A packet with the destination IP address 145.36.109.70 arrives at a router whose routing table is shown. Which interface will the packet be forwarded to?

Subnet Address	Subnnet Mask (in CIDR notation)	Interface
145.36.0.0	/16	E1
145.36.128.0	/17	E2
145.36.64.0	/18	E3
145.36.255.0	/24	E4
Default	–	E5

(a) E3 (b) E1
(c) E2 (d) E5

Ans. **(a)**

$n_1 = 16$

$\Rightarrow$ 145.36.109.70/16

FA $\Rightarrow$ 145.36.01101101.01000110/16

$\Rightarrow$ 145.36.00000000.00000000/16

$\Rightarrow$ 145.36.0.0/16 $\Rightarrow$ matched with 1st entry of SNA column of RT.

$n_2 = 17$

$\Rightarrow$ 145.36.109.70/17

FA $\Rightarrow$ 145.00100100.01101101.01000110/17

$\Rightarrow$ 145.00100100.00000000.00000000/17

$\Rightarrow$ 145.36.0.0/17 $\Rightarrow$ not matched with 2nd entry of SNA column of RT.

$n_3 = 18$

$\Rightarrow$ 145.36.109.70/18

FA $\Rightarrow$ 145.36.01101101.01000110/18

$\Rightarrow$ 145.36.01000000.00000000/18

$\Rightarrow$ 145.36.64.0/18 $\Rightarrow$ matched with 3rd entry of SNA column of RT.

$n_4 = 24$

$\Rightarrow$ 145.36.109.70/24

$\Rightarrow$ 145.36.109.01000110/24

$\Rightarrow$ 145.36.109.00000000/24

$\Rightarrow$ 145.36.109.0/24 $\Rightarrow$ not matched with 4th entry of SNA column of RT.

$\therefore$ The packet with DA : 145.36.109.70 can be forwarded E3 interface [As per the longest mask rule]

End of Solution

Q.41 Let A be a 2×2 matrix as given.

$$A = \begin{bmatrix} 1 & 1 \\ 1 & -1 \end{bmatrix}$$

What are the eigenvalues of the matrix A^{13}?

(a) 1, – 1 (b) $2\sqrt{2}, -2\sqrt{2}$

(c) $4\sqrt{2}, -4\sqrt{2}$ (d) $64\sqrt{2}, -64\sqrt{2}$

Ans. **(d)**

$$A = \begin{bmatrix} 1 & 1 \\ 1 & -1 \end{bmatrix}, \quad \lambda \text{ of } A^{13} = ?$$

$$\lambda_1 + \lambda_2 = 0, \quad \lambda_1\lambda_2 = -2$$

$$\Rightarrow \quad \lambda_A = -\sqrt{2}, \sqrt{2}$$

$$\therefore \quad \lambda_{A^{13}} = (-\sqrt{2})^{13}, (\sqrt{2})^{13}$$

$$= 64\sqrt{2}, -64\sqrt{2}$$

End of Solution

Q.42 Consider the following four variable Boolean function in sum-of-product form

$$F(b_3, b_2, b_1, b_0) = \Sigma(0, 2, 4, 8, 10, 11, 12)$$

where the value of the function is computed by considering $b_3b_2b_1b_0$ as a 4-bit binary number, where b_3 denotes the most significant bit and b_0 denotes the least significant bit. Note that there are no don't care terms. Which ONE of the following options is the CORRECT minimized Boolean expression for F?

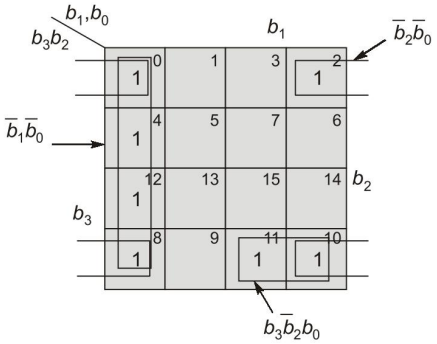
(a) $\bar{b}_1\bar{b}_0 + \bar{b}_2\bar{b}_0 + b_1\bar{b}_2b_3$ (b) $\bar{b}_1\bar{b}_0 + \bar{b}_2\bar{b}_0$

(c) $\bar{b}_2\bar{b}_0 + b_1b_2b_3$ (d) $\bar{b}_0\bar{b}_2 + \bar{b}_3$

Ans. **(a)**

The given Boolean function

$$F(b_3, b_2, b_1, b_0) = \Sigma m(0, 2, 4, 8, 10, 11, 12)$$



$$F = \bar{b}_1\bar{b}_0 + \bar{b}_2\bar{b}_0 + b_1\bar{b}_2b_3$$

End of Solution

Q.43 Let $G(V, E)$ be an undirected and unweighted graph with 100 vertices. Let $d(u, v)$ denote the number of edges in a shortest path between vertices u and v in V. Let the maximum value of $d(u, v)$, $u, v \in V$ such that $u \neq v$, be 30. Let T be any breadth-first-search tree of G. Which ONE of the given options is CORRECT for every such graph G?

(a) The height of T is exactly 15.
(b) The height of T is exactly 30.
(c) The height of T is at least 15.
(d) The height of T is at least 30.

Ans. **(c)**

BFS traversal spanning tree is the shortest path spanning of undirected unweighted graph.

End of Solution

Q.44 Consider the following two languages over the alphabet $\{a, b\}$:

$L_1 = \{\alpha\beta\alpha \mid \alpha \in \{a, b\}^+ \text{ AND } \beta \in \{a, b\}^+\}$

$L_2 = \{\alpha\beta\alpha \mid \alpha \in \{a\}^+ \text{ AND } \beta \in \{a, b\}^+\}$

Which ONE of the following statements is CORRECT?

(a) Both L_1 and L_2 are regular languages.
(b) L_1 is a regular language but L_2 is not a regular language.
(c) L_1 is not a regular language but L_2 is a regular language.
(d) Neither L_1 nor L_2 is a regular language.

Ans. **(c)**

$$L_1 = \{\alpha\beta\alpha \mid \alpha \in \{a, b\}^+ \text{ and } \beta \in \{a, b\}^+\}$$

Here comparison is required.

So, not regular.

$$L_2 = \{\alpha\beta\alpha \mid \alpha \in \{a\}^+ \text{ and } \beta \in \{a, b\}^+\}$$

Starting and ending with a; in between everything comes under β.

Hence it is regular.

End of Solution

Q.45 Consider the following two languages over the alphabet $\{a, b, c\}$, where m and n are natural numbers.

$L_1 = \{a^m b^m c^{m+n} \mid m, n \geq 1\}$

$L_2 = \{a^m b^n c^{m+n} \mid m, n \geq 1\}$

Which ONE of the following statements is CORRECT?

(a) Both L_1 and L_2 are context-free languages.
(b) L_1 is a context-free language but L_2 is not a context-free language.
(c) L_1 is not a context-free language but L_2 is a context-free language.
(d) Neither L_1 nor L_2 are context-free languages.

Ans. **(c)**

$$L_1 = \{a^m\ b^m\ c^{m+n} / \ m,\ n \geq 1\}$$

Here number of a's and b's must be equal and number of c's must be more or equal to number of a's. So, 2 comparisons at a time.

$\therefore$ Not CFL

$$L_2 = \{a^m\ b^n\ c^{m+n} / \ m,\ n \geq 1\}$$

Push a's and push b's when *c* comes delete a's and b's for every a. So it is possible to construct a PDA. Hence L_2 in CFL.

End of Solution

Q.46 Which of the following statement(s) is/are TRUE while computing First and Follow during top down parsing by a compiler?

(a) For a production $A \rightarrow \varepsilon$, ε will be added to First(A).

(b) If there is any input right end marker, it will be added to First(S), where S is the start symbol.

(c) For a production $A \rightarrow \varepsilon$, ε will be added to Follow(A).

(d) If there is any input right end marker, it will be added to Follow(S), where *S* is the start symbol.

Ans. **(a, d)**

(a) True

(b) False; end marker can't be added to the First(A).

(c) False; Follow set never contains 'ε'.

(d) True; end marker will be added to the Follow(S).

End of Solution

Q.47 Consider a relational schema team(name, city, owner), with functional dependencies {name $\rightarrow$ city, name $\rightarrow$ owner}.
The relation *team* is decomposed into two relations, *t*1(name, city) and *t*2(name, owner).
Which of the following statement(s) is/are TRUE?

(a) The relation team is NOT in BCNF.

(b) The relations *t*1 and *t*2 are in BCNF.

(c) The decomposition constitutes a lossless join.

(d) The relation team is NOT in 3NF.

Ans. **(b, c)**

team(name, city, owner)

{name $\rightarrow$ city, name $\rightarrow$ owner}.

Candidate key name. [Relation in BCNF]

Decomposed into

T_1(name city) T_1(name owner)

name $\rightarrow$ city name $\rightarrow$ owner

T_1 T_2 decomposition is lossless join, dependency preserving and BCNF.

End of Solution

Q.48 Which of the following predicate logic formulae/formula is/are CORRECT representation(s) of the statement: "*Everyone has exactly one mother*"?

The meanings of the predicates used are:

- mother(y, x): y is the mother of x
- noteq(x, y): x and y are not equal

(a) $\forall x \exists y \exists z(\text{mother}(y, x) \wedge \neg\text{mother}(z, x))$

(b) $\forall x \exists y[\text{mother}(y, x) \wedge \forall z(\text{noteq}(z, y) \rightarrow \neg\text{mother}(z, x))]$

(c) $\forall x \forall y[\text{mother}(y, x) \rightarrow \exists z(\text{mother}(z, x) \wedge \neg\text{noteq}(z, y))]$

(d) $\forall x \exists y[\text{mother}(y, x) \wedge \neg\exists z(\text{noteq}(z, y) \wedge \text{mother}(z, x))]$

Ans. **(b, d)**

Given, mother(y, x): y is the mother of x

noteq(x, y): x and y are not equal

Given statement: "*Everyone has exactly one mother*"

Can be written as for every x, there is a y such that y is mother of x and for every z, if $y \neq z$ then z is not a mother of x.

Symbolic form:

$$\forall x \exists y,\ [\text{mother}(y, x) \wedge \forall z,\ (y \neq z) \rightarrow \neg\text{mother}(z, x)]$$

$$\forall x \exists y[\text{mother}(y, x) \wedge \forall z,\ [\text{noteq}(z, y) \rightarrow \neg\text{mother}(z, x)]]$$

Same as (b).

Can also written as

$\forall x \exists y[\text{mother}(y, x) \wedge \forall z,\ [\neg\text{noteq}(y, z) \vee \neg\text{mother}(z, x)]]$

$\forall x \exists y[\text{mother}(y, x) \wedge \neg\exists z(\text{noteq}(y, z) \wedge \text{mother}(z, x))]$

Same as (d).

End of Solution

Q.49 $A = \{0, 1, 2, 3, \ldots\}$ is the set of non-negative integers. Let F be the set of functions from A to itself. For any two functions, $f_1, f_2 \in F$ we define

$$(f_1 \odot f_2)(n) = f_1(n) + f_2(n)$$

for every number n in A. Which of the following is/are CORRECT about the mathematical structure (F, $\odot$)?

(a) (F, $\odot$) is an Abelian group.

(b) (F, $\odot$) is an Abelian monoid.

(c) (F, $\odot$) is a non-Abelian group.

(d) (F, $\odot$) is a non-Abelian monoid.

Ans. **(b)**

Given F be the set of all possible functions from A to A.

$$F = \{f_1, f_2, f_3, f_4 .....\}$$

Algebraic structure is defined as

$$(f_1 \odot f_2)(n) = f_1(n) + f_2(n)$$

Associative:

$$\begin{aligned}(f_1 \odot f_2) \odot f_3(n) &= (f_1 \odot f_2)(n) + f_3(n) \\ &= f_1(n) + f_2(n) + f_3(n) \\ &= f_1(n) + (f_2 \odot f_3)(n) \\ &= f_1 \odot (f_2 \odot f_3)\end{aligned}$$

$\therefore$ '$\odot$' is associative.

Identify:

$$f_1 \odot f_e = f_1 = f_e \odot f_1$$

Consider $$\begin{aligned}(f_1 \odot f_e)(n) &= f_1(n) + f_e(n) \\ &= f_1(n) + 0 = f_1(n)\end{aligned}$$

Similarly, $$\begin{aligned}(f_e \odot f_1)(n) &= f_e(n) + f_1(n) \\ &= 0 + f_1(n) = f_1(n)\end{aligned}$$

$\therefore$ $\exists$ an identity w.r.t. $\odot$

$\therefore$ It is monoid.

Inverse:

By definition

$$f_1 \odot f_2(n) = f_e(n) = (f_2 \odot f_1)(n)$$

$$f_1(n) + f_2(n) = 0 = f_2(n_1) + f_1(n)$$

$\Rightarrow$ $f_2(n) = -f_1(n)$ which is –ve integer

$\therefore$ Inverse does not exists.

Commutative:

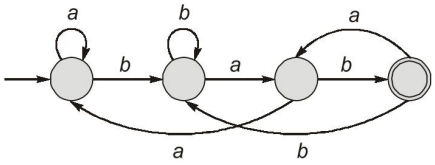
$$\begin{aligned}f_1 \odot f_2(n) &= f_1(n) + f_2(n) \\ &= f_2(n_1) + f_1(n) \\ &= f_2 \odot f_1(n)\end{aligned}$$

$\therefore$ It is abelian.

Hence (F, $\odot$) is an abelian monoid.

End of Solution

Q.50 Consider the following deterministic finite automaton (DFA) defined over the alphabet, $\Sigma = \{a, b\}$. Identify which of the following language(s) is/are accepted by the given DFA.



(a) The set of all strings containing an even number of *b*'s.
(b) The set of all strings containing the pattern *bab*.
(c) The set of all strings ending with the pattern *bab*.
(d) The set of all strings not containing the pattern *aba*.

Ans. **(c)**

The given DFA accepts all the strings ending with *bab*.

End of Solution

Q.51 A disk of size 512 M bytes is divided into blocks of 64 K bytes. A file is stored in the disk using linked allocation. In linked allocation, each data block reserves 4 bytes to store the pointer to the next data block. The link part of the last data block contains a NULL pointer (also of 4 bytes). Suppose a file of 1 M bytes needs to be stored in the disk. Assume, 1 K = 2^{10} and 1 M = 2^{20}. The amount of space in bytes that will be wasted due to internal fragmentation is _____. (Answer in integer)

Ans. **(65468)**

Disc size = 512 MB
Block size = 64 K = 2^{16} = 65536
Pointer size/block = 4 B
File size = 1 MB
Actual space = 65536 – 4 = 65532

$$\text{Number of blocks} = \frac{\text{Total file size}}{\text{Usable data per block}} = \frac{1\text{MB}}{65532} = 16.007$$

So, data stored in the firm 16 block
$16 \times 655532 = 1048512$ B
Remaining data still need to store
1048756 – 1048512 = 64 B
Last block contain 64 bytes of the actual data
In last block used data = 64 + 4 = 68 bytes
Waste space in the last block
= 65536 – 18 = 65468 bytes

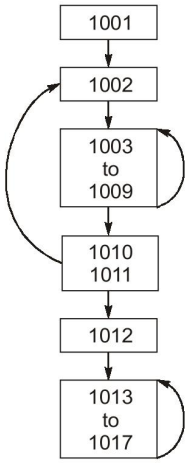
End of Solution

Q.52 Refer to the given 3-address code sequence. This code sequence is split into basic blocks. The number of basic blocks is _____. (Answer in integer)

```
1001: i = 1
1002: j = 1
1003: t1 = 10 * i
1004: t2 = t1 + j
1005: t3 = 8 * t2
1006: t4 = t3 – 88
1007: a[t4] = 0.0
1008: j = j + 1
1009: if j <= 10 goto 1003
1010: i = i + 1
1011: if i <= 10 goto 1002
1012: i = 1
1013: t5 = i – 1
1014: t6 = 88 * t5
1015: a[t6] = 1.0
1016: i = i + 1
1017: if i <= 10 goto 1013
```

Ans. (6)

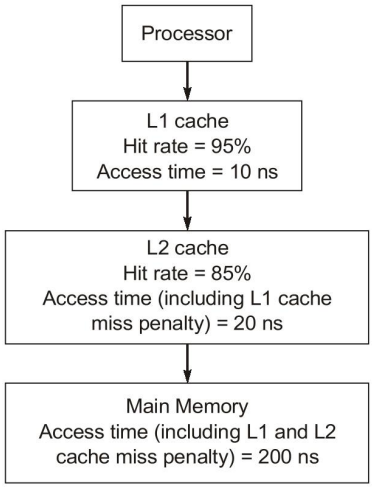
✓ 1001: i = 1
✓ 1002: j = 1
✓ 1003: t1 = 10 * i
1004: t2 = t1 + j
1005: t3 = 8 * t2
1006: t4 = t3 – 88
1007: a[t4] = 0.0
1008: j = j + 1
1009: if j <= 10 goto 1003
✓ 1010: i = i + 1
1011: if i <= 10 goto 1002
✓ 1012: i = 1
✓ 1013: t5 = i – 1
1014: t6 = 88 * t5
1015: a[t6] = 1.0
1016: i = i + 1
1017: if i <= 10 goto 1013



The leader statements are 1001, 1002, 103, 1010, 1012, 1013.
The number of basic blocks is 6.

End of Solution

Q.53 A computer has a memory hierarchy consisting of two-level cache (L1 and L2) and a main memory. If the processor needs to access data from memory, it first looks into L1 cache. If the data is not found in L1 cache, it goes to L2 cache. If it fails to get the data from L2 cache, it goes to main memory, where the data is definitely available. *Hit rates* and *access times* of various memory units are shown in the figure. The *average memory access time* in nanoseconds (ns) is _____. (Rounded off to two decimal places)



Ans. (11.85)

$$\begin{aligned} T_{avg} &= H_1T_1 + (1 - H_1)H_2(T_2 + T_1) + (1 - H_1)(1 - H_2)H_3(T_3 + T_2 + T_1) \\ &= (0.95 \times 10) + (1 - 0.95)0.85 \times 20 + (1 - 0.95)(1 - 0.85)200 \\ &= 9.5 + 0.85 + 1.5 = 11.85 \end{aligned}$$

End of Solution

Q.54 In optimal page replacement algorithm, information about all future page references is available to the operating system (OS). A modification of the optimal page replacement algorithm is as follows:

The OS correctly predicts only up to next 4 page references (including the current page) at the time of allocating a frame to a page.

A process accesses the pages in the following order of page numbers:

1, 3, 2, 4, 2, 3, 1, 2, 4, 3, 1, 4

If the system has three memory frames that are initially empty, the number of page faults that will occur during execution of the process is _____ . (Answer in integer)

Ans. (6)

Optimal page replacement algorithm

Page numbers = 1, 3, 2, 4, 2, 3, 1, 2, 4, 3, 1, 4

1	3	2	4	2	3	1	2	4	3	1	4
		2	2	2	2	2	2	2	3	3	3
	3	3	3	3	3	1	1	1	1	1	1
1	1	1	4	4	4	4	4	4	4	4	4
H	H	H	H			H			H		

Page fault = 6

End of Solution

Q.55 Consider the following database tables of a sports league.

player(pid, pname, age) team(tid, tname, city, cid)

coach(cid, cname) members(pid, tid)

An instance of the table and an SQL query are given.

player

pid	pname	age
1	Jasprit	31
2	Atharva	24
3	Ishan	26
4	Axar	30

coach

cid	cname
101	Ricky
102	Mark
104	Teevor

team

tid	tname	city	cid
10	MI	Mumbai	102
20	DC	Delhi	101
30	PK	Mohali	103

members

pid	tid
1	10
2	30
3	10
4	20

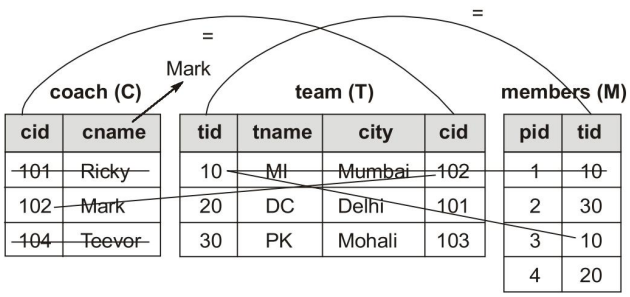
```
SELECT MIN(P.age)
FROM player P
WHERE P.pid IN (
    SELECT M.pid
    FROM team T, coach C, members M
    WHERE C.cname = 'Mark'
        AND T.cid = C.cid
        AND M.tid = T.tid
)
```

The value returned by the given SQL query is _____. (Answer in integer)

Ans. (26)

```
SELECT M.pid
FROM team T, coach C, members M
WHERE C.cname = 'Mark'
      AND T.cid = C.cid
      AND M.cid = T.tid
```

pid
1
3



Minimum age of pid's 1, 3 is 26.

End of Solution

Q.56 Suppose a 5-bit message is transmitted from a source to a destination through a noisy channel. The probability that a bit of the message gets flipped during transmission is 0.01. Flipping of each bit is independent of one another. The probability that the message is delivered error-free to the destination is _____ . (Rounded off to three decimal places)

Ans. (0.951)

Given data,

Number of bits to be transmitted in a msg = 5

$$P_{error} = 0.01$$

$$\Rightarrow \quad P_{correct} = 1 - P_{error} = 1 - 0.01 = 0.99$$

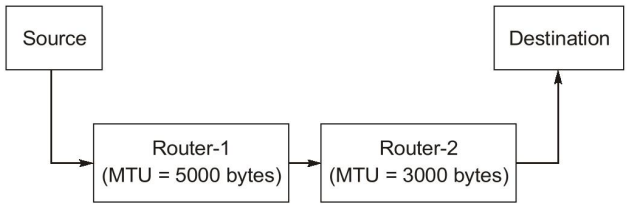
As all 5 bits are independent, Probability that all 5-bits are correctly received.

$$P_{correct} \text{ (for all 5 bits)} = (0.99)^5$$

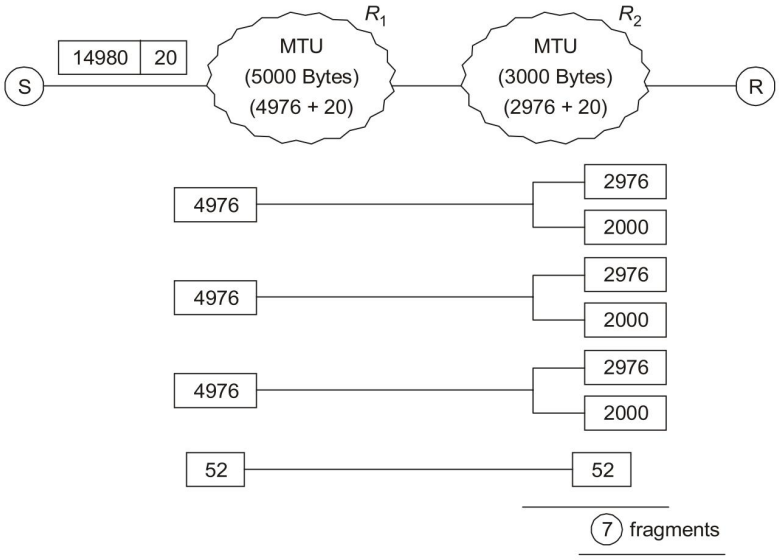
$$= 0.95099 = 0.951$$

End of Solution

Q.57 Suppose a message of size 15000 bytes is transmitted from a source to a destination using IPv4 protocol via two routers as shown in the figure. Each router has a defined maximum transmission unit (MTU) as shown in the figure, including IP header. The number of fragments that will be delivered to the destination is _____ . (Answer in integer)



Ans. **(7)**



End of Solution

Q.58 Consider a probability distribution given by the density function $P(x)$.

$$P(x) = \begin{cases} Cx^2, & \text{for } 1 \le x \le 4 \\ 0, & \text{for } x < 1 \text{ or } x > 4 \end{cases}$$

The probability that x lies between 2 and 3, i.e., $P(2 \le x \le 3)$ is _____. (Rounded off to three decimal places)

Ans. **(0.301)**

$$P(2 \le X \le 3) = ?$$

Find 'c':

Total probability = 1

$$\int_1^4 Cx^2 dx = 1$$

$$C\left(\frac{x^3}{3}\right)_1^4 = 1 \Rightarrow C = \frac{1}{21}$$

$$\therefore \quad P(2 < X \le 3) = \int_2^3 f(x)dx = \frac{1}{21}\int_2^3 x^2 dx$$

$$= \frac{1}{21}\left(\frac{x^3}{3}\right)_2^3 = \frac{1}{21}\left[9 - \frac{8}{3}\right] = \frac{19}{63} = 0.301$$

End of Solution

Q.59 Consider a finite state machine (FSM) with one input X and one output f, represented by the given state transition table. The minimum number of states required to realize this FSM is _____. (Answer in integer)

Present state	Next state		Output f	
	$X = 0$	$X = 1$	$X = 0$	$X = 1$
A	F	B	0	0
B	D	C	0	0
C	F	E	0	0
D	G	A	1	0
E	D	C	0	0
F	F	B	1	1
G	G	H	0	1
H	G	A	1	0

Ans. (5)

By checking the given transition table, we can merge the B and E, D and H. Then the result FSM will be as follows:

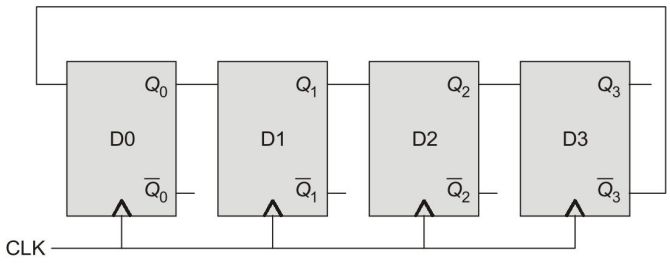
Present state	Next state		Output	
	0	1	0	1
A	F	BE	0	0
BE	DH	C	0	0
C	F	BE	0	0
DH	G	A	1	0
F	F	BE	1	1
G	G	DH	0	1

Now again in the above FSM we can merge the states A and C then the final FSM will be with 5 states as follows:

Present state	Next state		Output	
	0	1	0	1
AC	F	BE	0	0
BE	DH	AC	0	0
DH	G	AC	1	0
F	F	BE	1	1
G	G	DH	0	1

End of Solution

Q.60 Consider the given sequential circuit designed using D-Flip-flops. The circuit is initialized with some value (initial state). The number of distinct states the circuit will go through before returning back to the initial state is _____. (Answer in integer)



Ans. (7)

The given sequential circuit is similar to Johnson counter. (Not exactly Johnson counter. In Johnson counter LSB flip flop complementary output is MSB flip-flop impact).

The number of distinct states the circuit will go through before returning back to the initial state is 7.

CLK	$D_0 = Q_3$	Q_0	Q_1	Q_2	Q_3	
		0	0	0	0	← Consider it is the initial state
1	1	1	0	0	0	before returning back to the initial state the number of states are 7
2	1	1	1	0	0	
3	1	1	1	1	0	
4	1	1	1	1	1	
5	0	0	1	1	1	
6	0	0	0	1	1	
7	0	0	0	0	1	
8	0	0	0	0	0	

Correct answer is 7.

Answer 8 is wrong as per the question description.

End of Solution

Q.61
```
#include <stdio.h>
int foo(int S[ ], int size) {
    if(size == 0) return 0;
    if(size == 1) return 1;
    if(S[0] != S[1]) return 1 + foo(S + 1, size – 1);
    return foo(S + 1, size – 1);
}
int main( ) {
    int A[ ] = {0, 1, 2, 2, 2, 0, 0, 1, 1};
    printf("%d", foo(A, 9));
    return 0;
}
```
The value printed by the given C program is _____. (Answer in integer)

Ans. **(5)**

The function foo(s, size) counts distinct consecutive elements in the array by checking if $s[0] \neq s[1]$. If true, it increments the count and moves to the next element otherwise, it skips duplicates.

Given array:

$A = \{0, 1, 2, 2, 2, 0, 0, 1, 1\}$

Index	s[1]	s[1 + 1]	s[1] ≠ s[1 + 1] ?	Count increment
0	0	1	Yes	+1
1	1	2	Yes	+1
2	2	2	No	0
3	2	2	No	0
4	2	0	Yes	+1
5	0	0	No	0
6	0	1	Yes	+1
7	1	1	No	0
8	1	–	(End)	+1 (Base case)

Total unique transitions = 5

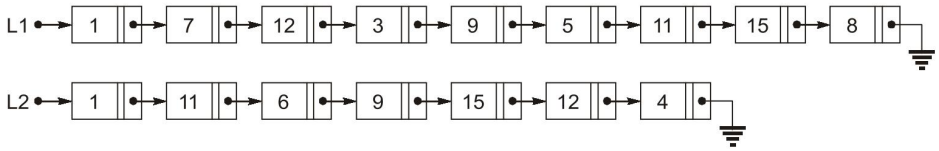
End of Solution

Q.62 Let **LIST** be a datatype for an implementation of linked list defined as follows:

```
typedef struct list {
    int data;
    struct list *next;
}  LIST;
```

Suppose a program has created two linked lists, L1 and L2, whose contents are given in the figure below (code for creating L1 and L2 is not provided here). L1 contains 9 nodes, and L2 contains 7 nodes.

Consider the following C program segment that modifies the list L1. The number of nodes that will be there in L1 after the execution of the code segment is _____ . (Answer in integer)




```
int find (int query, LIST *list) {
     while (list != NULL) {
     if(list -> data == query) return 1;
     list = list -> next;
     }
          return 0;
}
int main( ) {
… … …
ptr1=L1; ptr2=L2;
while (ptr1 -> next != NULL) {
     query = ptr1 -> next -> data;
     if (find (query, L2))
          ptr1 -> next = ptr1 -> next -> next;
     else ptr1 = ptr1 - >next;
}
     … … …
     return 0;
}
```

Ans. (5)

End of Solution

Q.63 Consider the following C program:

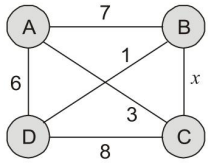
```
#include <stdio.h>
int gate (int n) {
    int d, t, newnum, turn;
    newnum = turn = 0; t = 1;
    while (n >= t) t *= 10;
    t /=10;
    while (t > 0) {
        d = n/t;
        n = n%t;
        t /= 10;
        if (turn) newnum = 10*newnum + d;
        turn = (turn + 1) % 2;
    }
    return newnum;
}
int main( ) {
    printf ("%d", gate(14362));
    return 0;
}
```

The value printed by the given C program is _____ . (Answer in integer)

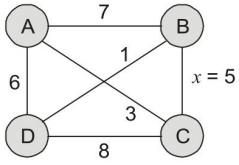
Ans. (46)

End of Solution

Q.64 The maximum value of x such that the edge between the nodes B and C is included in every minimum spanning tree of the given graph is _____ . (Answer in integer)



Ans. (5)



(B, D), (A, C) must be in MST because of 1st min and 2nd min cost edges.
Maximum value of (B, C) edges $x = 5$ so that (B, C) must be in every MST.

End of Solution

Q.65 In a double hashing scheme, $h_1(k) = k \bmod 11$ and $h_2(k) = 1 + (k \bmod 7)$ are the auxiliary hash functions. The size m of the hash table is 11. The hash function for the i^{th} probe in the open address table is $[h_1(k) + i\ h_2(k)] \bmod m$. The following keys are inserted in the given order: 63, 50, 25, 79, 67, 24.
The slot at which key 24 gets stored is _____. (Answer in integer)

Ans. (10)

End of Solution

■■■■