



**GATE
2025**

Computer Science & IT Shift-1

Memory based
Questions & Solutions

Exam held on
01/02/2025 (Forenoon Session)

SECTION - A

GENERAL APTITUDE

Q.1 A fair dice with six faces labelled as 1, 2, 3, 4, 5, 6 is thrown thrice. What is the probability of getting 6 exactly one time?

(a) $\frac{25}{216}$

(b) $\frac{1}{18}$

(c) $\frac{1}{6}$

(d) $\frac{75}{216}$

Ans. (d)

$$\text{Required probability} = A \times \bar{B} \times \bar{C} + \bar{A} \times \bar{B} \times C + \bar{A} \times B \times \bar{C}$$

$$= \frac{1}{6} \times \frac{5}{6} \times \frac{5}{6} + \frac{5}{6} \times \frac{5}{6} \times \frac{1}{6} + \frac{5}{6} \times \frac{1}{6} \times \frac{5}{6}$$

$$= \frac{75}{216}$$

End of Solution

Q.2 In a class, one student weight 42 is measured as 24 and while correcting it again from 24 to 42, average increases from 30.8 to 31.4, find the total number of student in class is

Ans. (30)

$$[31.4 - 30.8]n = 42 - 24$$

$$0.6n = 18$$

$$n = 30$$

End of Solution

Q.3 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.

Consider the following statements

(i) R has only one son

(ii) P is uncle of S and T

(iii) R is the grandmother of S

(iv) Not Available

Now which of these statements is/are CORRECT?

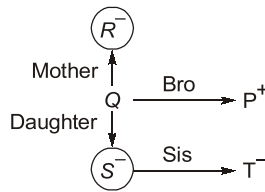
(a) (iii) and (i)

(b) (iii) and (ii)

(c) Only (ii)

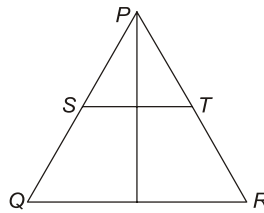
(d) (ii) and (iv)

Ans. (b)



End of Solution

Q.4 Consider the following figure



Distance between ST and QR is half of P to QR, then area of ΔPST /Trapezium STQR is

(a) $\frac{1}{2}$

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

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

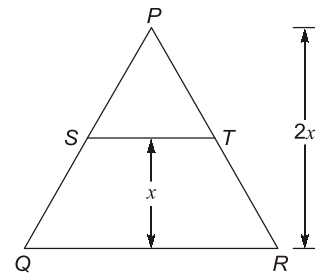
(d) $\frac{1}{3}$

Ans. (d)

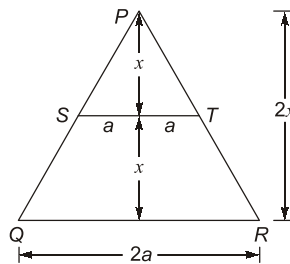
$$\frac{A_1}{A_2} = \left(\frac{a}{b}\right)^2$$

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

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



Alternatively,



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

End of Solution

SECTION - B

TECHNICAL

Q.5 What is the height of max heap with 32 keys the height of tree?

Ans. (5)

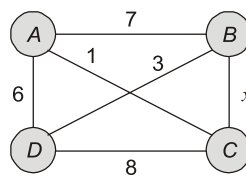
2^h : minimum keys and height h in CBT

2^5 keys

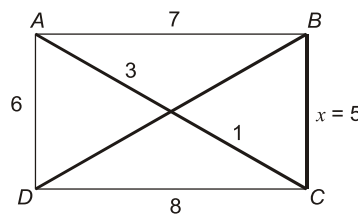
$h = 5$

End of Solution

Q.6 What is the maximum value of x such that an edge with cost x is include in all minimum spanning tree?



Ans. (5)



Maximum value of $x = 5$

End of Solution

Q.7 What is the time complexity?

$$T(n) = \begin{cases} 2T(n-1) + n \cdot 2^n & n > 0 \\ 1 & n = 0 \end{cases}$$

(a) $\theta(2^n \cdot n^2)$

(b) $\theta(2^n \cdot n)$

(c) $\theta(4^n)$

(d) $\theta(2^n \cdot \log n^2)$

Ans. (a)

$$\begin{aligned} T(n) &= 2T(n-1) + n \cdot 2^n \\ &= 2[2T(n-2) + (n-1) \cdot 2^{n-1}] + n \cdot 2^n \\ &= 2^2 T(n-2) + (n-1) \cdot 2^n + n \cdot 2^n \\ &= 2^2 [2T(n-3) + (n-2) \cdot 2^{n-2}] + (n+1) \cdot 2^n + n \cdot 2^n \\ &= 2^3 T(n-3) + 2^n [(n-2) + (n-1) + n] \\ &= \theta(2^n \cdot n^2) \end{aligned}$$

End of Solution



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Q.8 Consider the following code:

```
fun (int a[0 ..... n - 1])
    for (i = 0; i ≤ n - 2; i++)
        for (j = 0; j ≤ n - i - 2; j++)
            if (a[j] > a[j + 1])
                swap (a[j], a[j + 1])
```

If array of size 30 distinct integers in decreasing order. How many number of swap's?

Ans. (435)

```
fun (int a[0 ..... n - 1])
    for (i = 0; i ≤ n - 2; i++) → n - 1 passes
        for (j = 0; j ≤ n - i - 2; j++)
            if (a[j] > a[j + 1])
                swap (a[j], a[j + 1])
```

} Bubble sort algorithm for sort an array in ascending order

Number of swap's = Number of inversion's of array

$$= \frac{n(n-1)}{2} = \frac{30 \times 29}{2} = 435$$

End of Solution

Q.9 Which one of the following techniques used in code optimization in live variable analysis?

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

Ans. (d)

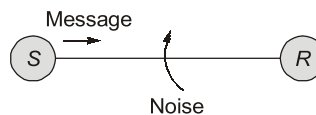
Live variable analysis is used for register allocations.

End of Solution

Q.10 If 5 bits are transmitted and probability of flipping the bit is 0.01 what is the probability that message received is error free.

- (a) $(0.11)^5$
- (b) $(0.99)^5$
- (c) $(0.999)^5$
- (d) $(0.111)^5$

Ans. (b)

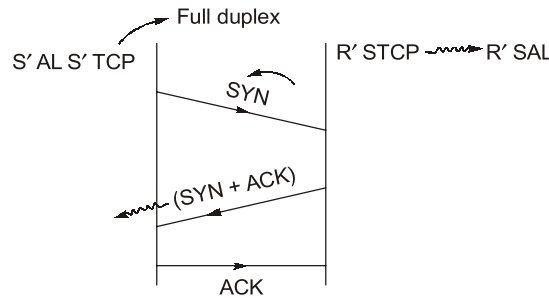


Probability of not getting the bit error
 $= (1 - 0.01) = 0.99$
 Entire message = $(0.99) \times (0.99) \dots \dots 5\text{-bits}$
 $= (0.99)^5$

End of Solution

- Q.11** Three way Handshaking for connection establishment P_1, P_2, P_3 are in order
- (a) $P_2 : \text{SYN} = 1, \text{ACK} = 1$ (b) $P_3 : \text{SYN} = 1, \text{ACK} = 1$
(c) $P_1 : \text{SYN} = 1$ (d) $P_2 : \text{SYN} = 0, \text{ACK} = 1$

Ans. (d)



End of Solution

- Q.12** Match the following layers of the OSI model with their corresponding functions:

List-I (Layer)

- A. Network layer
B. Transport layer
C. Data link layer

List-II (Function)

1. Packet routing
2. Host-host communication
3. Framing and error control

Which of the following is correct?

- (a) A - 1, B - 3, C - 2 (b) A - 1, B - 2, C - 3
(c) A - 3, B - 2, C - 2 (d) A - 2, B - 1, C - 3

Ans. (b)

Network layer \Rightarrow Packet routing
Transport layer \Rightarrow Host-host communication
Data link layer \Rightarrow Framing and error control

End of Solution

- Q.13**

Subnet Id	Mask	Interface
145.36.0.0	/16	Eth ₁
145.36.128.0	/17	Eth ₂
145.36.64.0	/18	Eth ₃
145.36.255.0	/24	Eth ₄

Default

145.36.109.17

Which of the following option is correct?

- (a) Eth₁ (b) Eth₂
(c) Eth₃ (d) Eth₄

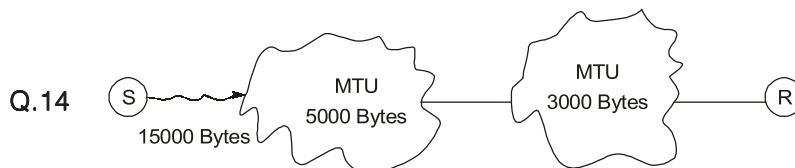
Ans. (c)

$$/ 16 \Rightarrow \frac{145.36.109.17}{255.255.0.0} = 145.36.0.0$$

$$/ 18 \Rightarrow \frac{145.36.109.17}{255.255.192.0} = 145.36.64.0$$

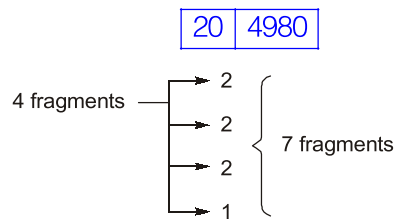
Here taken longest matching.
So correct answer Eth₃

End of Solution



Calculate number of fragments?

Ans. (7)



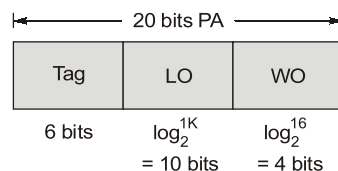
End of Solution

Q.15 Cache size = 16 KB
Main memory = 1 M Byte
Block size = 16 B
Given the directed cache memory
What is the tag memory size in (kilo bits)?

Ans. (6)

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

Address format :

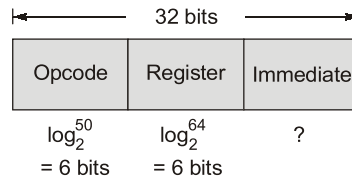


$$\therefore \text{Tag memory size} = N \times \text{tag space in the line} \\ = 1\text{ K} \times 6\text{ bits} = 6\text{ K bits}$$

End of Solution

Q.16 Consider a hypothetical system with a 32-bit instruction that includes an opcode field, register fields, and an immediate field. The opcode field supports 50 instructions, and register file size is 64. What is the size of the immediate field (in bits)?

Ans. (20)



$$\begin{aligned} \text{Immediate field size} &= (32 - 12) \text{ bit} \\ &= 20 \text{ bit} \end{aligned}$$

End of Solution

Q.17 Consider L_1 and L_2 cache memory hit ratio as 95% and 85% respectively. Access time of L_1 cache is 10 ns. Miss penalty of L_1 cache is 20 ns and miss penalty of L_2 cache is 200 ns.

What is the average memory access time in (ns)?

Ans. (11.85)

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

End of Solution

Q.18 When interrupt arrive then. Identify correct sequence.

P_1 : Content of PC load into the stack.

P_2 : Load interrupt service address on the program counter.

P_3 : Complete the current instruction execution.

(a) P_1, P_2, P_3

(b) P_3, P_1, P_2

(c) P_3, P_2, P_1

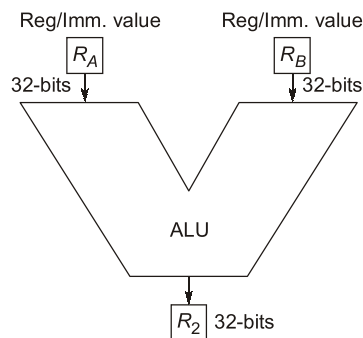
(d) P_2, P_1, P_3

Ans. (b)

First complete the current instruction execution later push the PC value into a stack and load the vector address into a PC to service the interrupt.

End of Solution

Q.19 What R_A and R_B can contain?



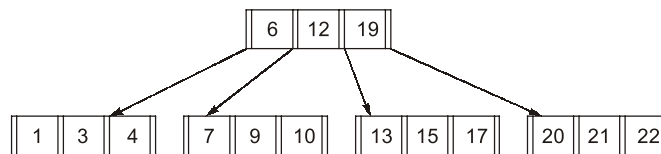
- (a) Register and immediate value (b) Register and register
(c) Immediate and immediate value (d) Only register and immediate

Ans. (a, b, c)

Option (d) is wrong because R_A data may be register data (or) immediate data not only from the registers.

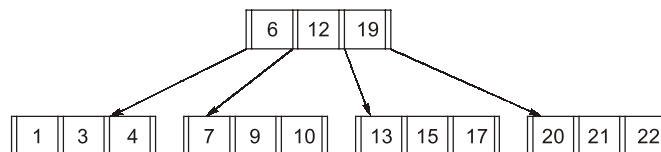
End of Solution

Q.20 Given, B+ tree



If 23 inserted.

Ans. (3, 8)



After 23 inserted \Rightarrow {3 levels, 8 nodes}

End of Solution

Q.21 Given relation $T(A, B, C)$ $\{A \rightarrow B, A \rightarrow C\}$ decomposed into $T_1(AB)$ $T_2(AC)$. Which of the following is correct.

- (a) T_1 is not in BCNF (b) T_2 is not in BCNF
(c) T is in BCNF (d) It is a LLJ

Ans. (c, d)

- The given relations itself in BCNF.
- T_1 and T_2 is in BCNF also BCNF because two attribute always in BCNF.
- Lossless join decomposition become common attribute T_1 and T_2 is \underline{A} which is a key for both relation.

End of Solution



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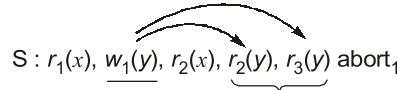
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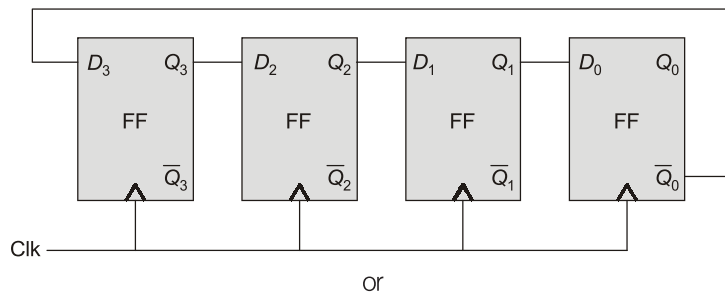
- Q.22** What are transactions aborts because of T_1 aborts?
 $S : r_1(x), w_1(y), r_2(x), r_2(y), r_3(y)$ abort₁
- (a) Only T_2 (b) Only T_3
 (c) Both T_2 and T_3 (d) None of these

Ans. (c)



End of Solution

- Q.23** The mode value of the given sequential circuit is _____.



How many distinct states the above sequential circuit is having before reaching to initial state _____.

Ans. (8)

Number of FF = $n = 4$
 Mod = $2n = 8$

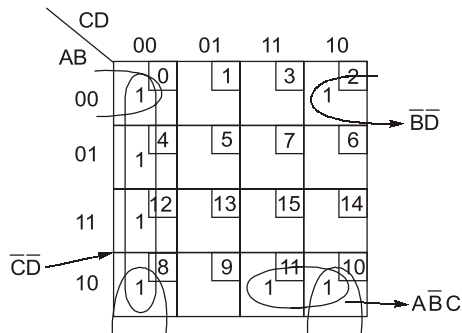
- The mode value of the given sequential circuit is 8.
- 7 Distinct states the above sequential circuit is having before reaching to initial state.

CLK	$D_3 = Q_0$	Q_3	Q_2	Q_1	Q_0
1	1	1	0	0	0
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

End of Solution

- Q.24** The minimal SOP expression of the Boolean function $f(A, B, C, D) = \sum m(0, 2, 4, 8, 10, 11, 12)$ is
- (a) $\bar{A}\bar{B}C + \bar{B}\bar{D} + \bar{C}\bar{D}$ (b) $\bar{B}C + \bar{A}\bar{B}\bar{D} + \bar{C}\bar{D}$
 (c) $\bar{A}\bar{B}\bar{C} + \bar{A}\bar{D} + \bar{C}\bar{D}$ (d) $\bar{A}\bar{B}\bar{C} + \bar{B}\bar{D} + \bar{A}\bar{D}$

Ans. (a)



$$\bar{A}B + \bar{B}D + \bar{C}\bar{D}$$

End of Solution

Q.25 The 2's complements representation of -6 is 1010, it can be expressed as

- (a) 1000 1010 (b) 1111 1010
(c) 0000 1010 (d) 1111 1111 1111 1010

[MSQ]

Ans. (b, d)

$$-6 \rightarrow 1010$$

5 bit

$$11010 \Rightarrow -(00110) \\ (-6)_{10}$$

- (b) 11111010
(d) 111111111111010 are correct.

End of Solution

Q.26 If matrix $A = \begin{bmatrix} 1 & 1 \\ 1 & -1 \end{bmatrix}$ then eigen value of A^{13} is _____.

- (a) $\pm 2\sqrt{2}$ (b) $\pm 64\sqrt{2}$
(c) $\pm \sqrt{2}$ (d)

Ans. (b)

Characteristic equation,

$$\lambda^2 - \text{Trace}(A) + |A| = 0$$

$$\text{Trace} = 0$$

$$|A| = -2$$

$$\lambda^2 - 2 = 0$$

$$\lambda = \pm\sqrt{2}$$

Eigen values of matrix A^{13}

$$= (\pm\sqrt{2})^{13} = \pm 64\sqrt{2}$$

End of Solution

Q.27 If $\begin{bmatrix} k & 1 \\ 1 & k \end{bmatrix} \begin{bmatrix} x \\ y \end{bmatrix} = \begin{bmatrix} 1 \\ -1 \end{bmatrix}$ and k is real, then

- (a) have no solution for exactly one value of k
- (b) have infinite solution for exactly one value of k
- (c) have infinite solution for infinite value of k
- (d)

Ans. (a, b, d)

$$\begin{bmatrix} k & 1 \\ 1 & k \end{bmatrix} \begin{bmatrix} x \\ y \end{bmatrix} = \begin{bmatrix} 1 \\ -1 \end{bmatrix}$$

If $|A| = 0$,

Then there are two possibilities infinite solution or no solution
 $k^2 - 1$

$$k = \pm 1$$

Case-1:

If $k = 1$
 $Ax = B$

$$\begin{bmatrix} 1 & 1 \\ 1 & 1 \end{bmatrix} \begin{bmatrix} x \\ y \end{bmatrix} = \begin{bmatrix} 1 \\ -1 \end{bmatrix}$$

Case-2:

$$\begin{bmatrix} -1 & 1 \\ 1 & -1 \end{bmatrix} \begin{bmatrix} x \\ y \end{bmatrix} = \begin{bmatrix} 1 \\ -1 \end{bmatrix}$$

$$-x + y = 1$$

$$x - y = -1$$

Infinite solution

For unique solution.

$$|A| \neq 0$$

$$k \neq \pm 1$$

System has unique solution for $k \neq \pm 1$

option (d) have unique solution for infinite value of k .

End of Solution

Q.28 $f(x) = \begin{cases} ax + b, & x < 1 \\ x^3 + x^2 + 1, & x \geq 1 \end{cases}$

If f is continuous then value of b is

Ans. (5)

For continuity at $x = 1$

$$\lim_{x \rightarrow 1^-} f(x) = \lim_{x \rightarrow 1^+} f(x)$$

$$\lim_{x \rightarrow 1^-} ax + b = \lim_{x \rightarrow 1^+} (x^3 + x^2 + 1)$$

$$a + b = 3$$

...(i)

For differentiability at $x = 1$

$$\lim_{x \rightarrow 1^-} f'(x) = \lim_{x \rightarrow 1^+} f'(x)$$

$$a = \lim_{x \rightarrow 1^-} 3x^2 + 2x$$

$$a = 3 + 2 = 5$$

$$\therefore a + b = 3$$

$$\therefore 5 + b = 3$$

$$b = -2$$

End of Solution

Q.29 If $f(x) = cx^3, 0 < x < 4,$
 $x=0,$ other wise

then $P(2 < x < 3) = \underline{\hspace{2cm}}$.

Ans. (0.25)

$\therefore f(x)$ is pdf

$$\int_{-\infty}^{\infty} f(x) dx = 1$$

$$\int_0^4 Cx^3 dx = 1$$

$$C \frac{x^4}{4} \Big|_0^4 = 1$$

$$C = \frac{1}{64}$$

$$P(2 < x < 3) = \int_2^3 f(x) dx = \int_2^3 \frac{1}{64} x^3 dx$$

$$= \frac{1}{64} \left(\frac{x^4}{4} \right)$$

$$= \frac{1}{256} [3^4 - 2^4] = \frac{65}{256} = 0.25$$

End of Solution

- Q.30** LA = 32 bits
PA = 20 bits
PS = 2048 bytes
Maximum number of entries in PT = ? (in Mega)
- (a) 3 M (b) 2 M
(c) 1 M (d) 4 M

Ans. (b)

Logical address = 32 bits
Physical address = 20 bits
Page size = 2048 bytes

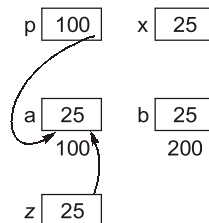
$$\begin{aligned} \text{Number of entries in PT} &= \frac{\text{L.A.S.}}{\text{Page size}} = \frac{2^{32} \text{ B}}{2^{11} \text{ B}} = 2^{21} \\ &= 2^1 \cdot 2^{20} \\ &= 2 \text{ M} \end{aligned}$$

End of Solution

- Q.31** What is the output of following C code?

```
void foo(int &p, int x)
{
    *p = x;
}
int main( )
{
    int *z;
    int a = 20, b = 25;
    z = &a;
    foo(z, b);
    print("%d", a)
    return 0;
}
```

Ans. (25)



O/P = 25

End of Solution



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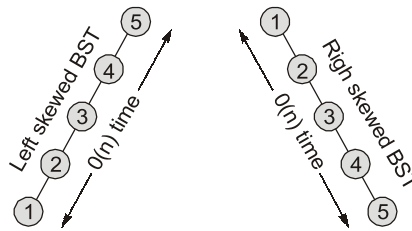
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- Q.32** Which of these are TRUE?
- Finding element takes $O(\log n)$ in worst case.
 - Every BST is also min heap.
 - Insorted traversal of BST is sorted order.
 - The max length of the path from root to any other node is $(n - 1)$.

Ans. (c, d)
B.ST is not balanced tree
B.ST can be skewed BST.



- Every BST is not min heap.
- In order traversal of BST is sorted order.
- Maximum length of path from root to any node is $(n - 1)$.

End of Solution

- Q.33** Consider the following language:
 $L_1 : \{a^m b^m c^{m+n} \mid m, n \geq 1\}$
 $L_2 : \{a^m b^n c^{m+n} \mid m, n \geq 1\}$
 Which of the following is correct?
- Both L_1 and L_2 are CFL
 - L_1 is CFL but L_2 is not CFL
 - L_1 is not CFL but L_2 is CFL
 - Both L_1 and L_2 are not CFL

Ans. (c)

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

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

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

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.34** Consider the following language:
 $L_1 : \{\alpha\beta\alpha \mid \alpha \in \{a, b\}^+ \text{ and } \beta \in \{a, b\}^+\}$
 $L_2 : \{\alpha\beta\alpha \mid \alpha \in \{a\}^+ \text{ and } \beta \in \{a, b\}^+\}$
 Which of the following is correct?
- L_1 is regular and L_2 is not regular
 - L_1 is not regular and L_2 is regular
 - Both L_1 and L_2 are regular
 - Both L_1 and L_2 are not regular

Ans. (b)

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

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.35 Let the number of states in NFA is 'n' then which of the following is false?

- (a) Equivalent DFA will have more than 2^n states.
- (b) Equivalent DFA may have less than n states.
- (c) Equivalent DFA can have maximum 2^n states.
- (d) Equivalent NFA may have less than n states.

Ans. (a)

The maximum number of states of a DFA equivalent to NFA of n states is 2^n .

Hence, option 'a' is false.

End of Solution

Q.36 Let $\Sigma = \{a, b, c\}$ then how many strings of length 5 will be possible having either aa or bb or cc as substring.

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

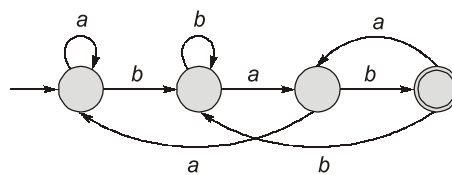
The number of strings in which no two consecutive symbols are same is

$$3 \cdot 2 \cdot 2 \cdot 2 \cdot 2 = 48 \text{ ways}$$

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

End of Solution

Q.37 The following finite automata accepts



- (a) All strings having bab as substring
- (b) All strings ending with bab
- (c) All strings not ending with bab
- (d) All strings starting with bab

Ans. (c)

The given FA accepts all strings ending with bab .

End of Solution



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