

**General Aptitude****Q.1 to Q.5 Carry one mark each****Question 1****MCQ (2M)****Question ID : 823251529**

Given below are two statements 1 and 2. and two conclusions I and II.

Statement 1: All bacteria are microorganisms.

Statement 2: All pathogens are microorganisms.

Conclusion I: Some pathogens are bacteria.

Conclusion II: All pathogens are not bacteria.

Based on the above statements and conclusions, which one of the following options is logically CORRECT?

Options

(A) Only conclusion I correct

(B) Only conclusion II is correct

(C) Either conclusion I or II is correct.

(D) Neither conclusion I nor II is correct

**Ans. D****Question 2****MCQ (1M)****Question ID : 823251521**

The Ratio of boys to girls in class 7 to 3, among the options below, An acceptable value for total number of students in class is :

(A) 21

(B) 73

(C) 37

(D) 50

**Ans. D****Sol.** Given :

Ratio of boys to girls = 7 : 3

i.e. boys : Girls = 7 : 3

∴ Total number of strength

$$= 7x + 3x$$

$$= 10x$$

$$= 50$$

**Question 3****MCQ (1M)****Question ID : 823251525**

\_\_\_\_\_ is to surgery as writer is to \_\_\_\_\_

Which maintain similar logic relation.

(A) Doctor, Book

(B) Hospital, Library

(C) Medicine, grammar

(D) Plan, outline

**Ans. A****Sol.** As Doctor performs surgery

Writer writes a Book.

## Question 4

MCQ (2M)

Question ID : 823251527

Item	Cost	Profit	Marked price
P	5400	-	5860
Q	-	25	10000

Detail of prices of two item P and Q are presented in the above table. The ratio of cost of item P to cost of item Q is 3 : 4. Discount is calculated as difference between marked and selling price. The profit percentage is calculated as ratio of difference between selling price and cost, to the cost price.

$$\text{Profit \%} = \frac{\text{Selling Price} - \text{Cost Price}}{\text{Cost Price}} \times 100$$

The discount on Q, as a % marked price is \_\_\_\_\_.

- (A) 25                      (B) 12.5                      (C) 10                      (D) 25

Ans. C

Sol. Given :

Cost price Ratio of P to Q = 3 : 4

$$\therefore 3x = 5400$$

$$\therefore x = 1800 \text{ and } 4x = 7200$$

$$\therefore \text{Profit \% of } Q = 25\%$$

$$\begin{aligned} \therefore \text{Selling price of } Q &= 7200(\text{C.P.}) + 7200 \times 25\%(\text{Profit}) \\ &= 9000 \end{aligned}$$

$$\therefore \text{Discount \%} = \frac{MP - SP}{MP} \times 100\%$$

$$\begin{aligned} \therefore \text{Discount \% for } Q &= \frac{1000}{10000} \times 100\% \\ &= 10\% \end{aligned}$$

## Question 5

MCQ (2M)

Question ID : 823251526

We have 2 rectangular sheets of paper, M and N, of Dimension 6 cm × 1 cm each. Sheet M is rolled to form an open cylinder by bringing short edges of the sheet together. Sheet and N is cut into equal square patches and assembled to form largest possible closed cube. Assuming the ends of the cylinder are closed, ratio of the volume of the cylinder to that of the cube is \_\_\_\_\_.

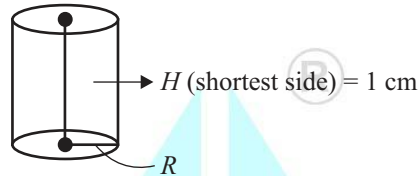
- (A)  $\frac{9}{\pi}$                       (B)  $3\pi$                       (C)  $\frac{\pi}{2}$                       (D)  $\frac{3}{\pi}$

**Ans. A****Sol. Given :**

The dimension of rectangular sheet M and N =  $6 \times 1$  cm

According to the condition :

M is folded along shortest side is form a cylinder i.e.



$$\therefore 2\pi R = 6 \text{ cm}$$

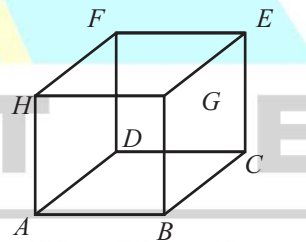
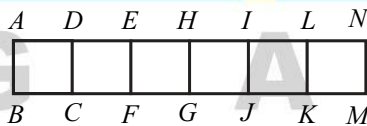
$$\therefore R = \frac{3}{\pi} \text{ cm}$$

$$\therefore \text{Volume. of a right circular cylinder} = \pi R^2 H$$

$$\therefore \text{Volume of folded figure} = \pi \times \frac{3}{\pi} \times \frac{3}{\pi} \times 1$$

$$= \frac{9}{\pi} \text{ cm}^3$$

N is cutted as square to form a cube i.e.

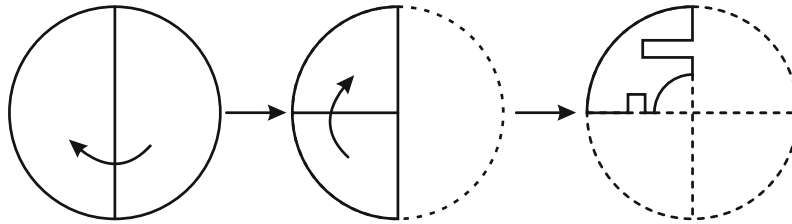


$$\therefore \text{Volume of cube} = (\text{Side})^3$$

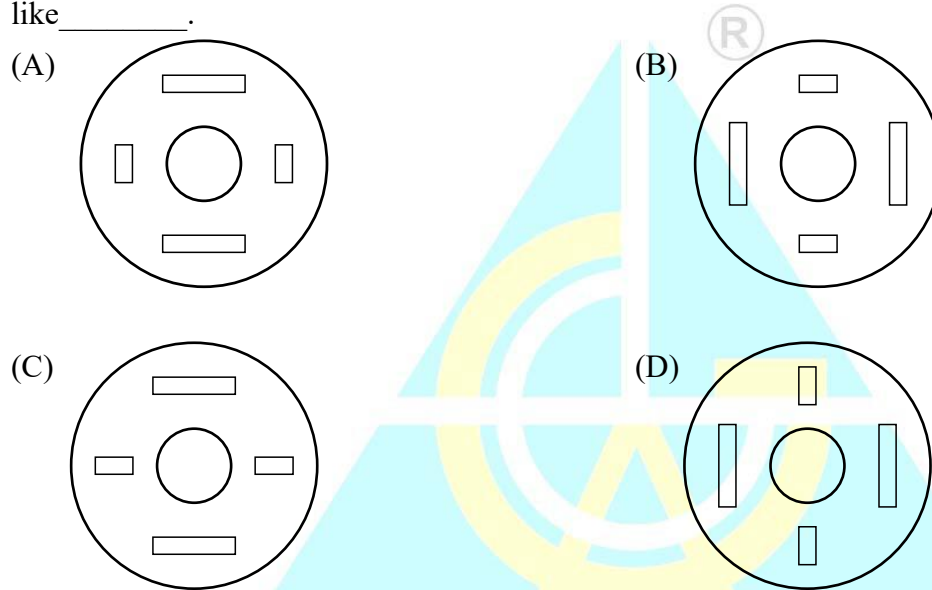
$$\therefore \text{Volume of formed cube from N} = 1 \text{ cm}^3$$

$$\therefore \text{The ratio of vol. of cylinder to cube} = \frac{9/\pi}{1} = 9 : \pi$$

**Question 6****MCQ (1M)****Question ID : 823251524**



A circular sheet of paper is folded along the lines in the directions shown. The paper, after being punched in the final folded state as shown and unfolded in the reverse order of folding, will look like \_\_\_\_\_.



Ans. A

**Question 7**

**MCQ (1M)**

**Question ID : 823251522**

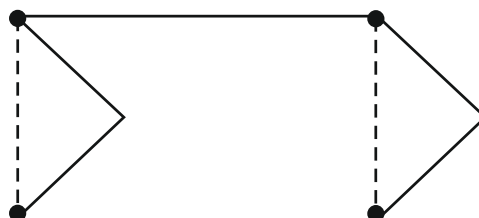
A polygon is convex if, for every pair of points, P and Q belonging to the polygon, the line segment PQ lies completely inside or on the polygon.

Which one of the following is NOT a convex polygon?



Ans. C

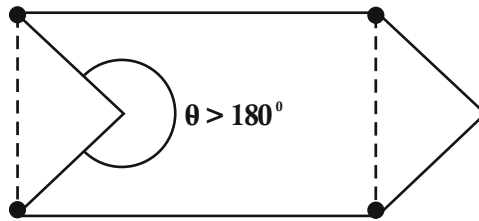
Sol.



Clearly we can see that is some part outside the segment line.

Other point :

Concave polygon one who have one interior angle more than  $180^{\circ}$ .

**Question 8****MCQ (2M)****Question ID : 823251530**

Some people suggest Anti Obesity Measures (AOM) such as displaying calorie information in restaurant menus. Such measures sidestep addressing the core problems that cause obesity, poverty and income inequality

Which of the following statements summarize this page

- (A) AOM addressing the core problem and are likely to succeed
- (B) The Proposed AOM are addressing the core problem that causes obesity.
- (C) AOM addressing the problem superficially
- (D) If Obesity reduces, poverty will naturally reduce, since obesity causes poverty

**Ans. C**

**Sol.** The AOM is not addressing the problem thoroughly or deeply. Only calorie information can side step obesity but not poverty or income inequality.

**Question 9****MCQ (1M)****Question ID : 823251523**

Consider the following sentences:

- (i) Everybody in the class is prepared for the exam.
- (ii) Babu invited Danish to his home because he enjoys playing chess

Which of the following is the CORRECT observation about the above two sentences?

- (A) (i) is grammatically incorrect and (ii) is unambiguous
- (B) (i) is grammatically correct and (ii) is unambiguous
- (C) (i) is grammatically correct and (ii) is ambiguous
- (D) (i) is grammatically incorrect and (ii) is ambiguous

**Ans. C**

**Sol.** Is ambiguous because it is open to more than one interpretation, it is because who enjoys playing chess is not known from the given sentence. It may be Babu or Dinesh.

**Question 10****MCQ (2M)****Question ID : 823251528**

There are five bags each containing identical sets of ten distinct chocolates. One chocolate is picked from each bag. The probability that at least two chocolates are identical is \_\_\_\_\_.

Options :

- (A) 0.8125
- (B) 0.6976
- (C) 0.3024
- (D) 0.4235

**Ans. B**

**Sol.** Numbers of ways to select 2 identical chocolates = total numbers of ways to select 5 chocolates from 5 boxes – number of ways to select 5 chocolates from 5 boxes such that all chocolates are distinct =  $10^5 - 10 \cdot 9 \cdot 8 \cdot 7 \cdot 6 = 69760$

Probability of at least two identical chocolates getting selected = numbers of favorable cases / numbers of all possible cases =  $69760/100000 = 0.6976$

Technical Section

**Question 1****MCQ (2M)****Question ID : 823251564**

Let  $G$  be a group of order 6, and  $H$  be a subgroup of  $G$  such that  $1 < |H| < 6$ . Which one of the following options is correct?

- (A) Both  $G$  and  $H$  may not be cyclic.
- (B) Both  $G$  and  $H$  are always cyclic.
- (C)  $G$  is always cyclic, but  $H$  may not be cyclic.
- (D)  $G$  may not be cyclic, but  $H$  is always cyclic.

**Ans. D****Question 2****NAT (2M)****Question ID : 823251580**

Consider the following c code segments :

 $a = b + c;$  $e = a + 1;$  $d = b + c;$  $f = d + 1;$  $g = e + f;$ 

In a compiler, this code segment is represented internally as a directed acyclic graph (DAG). The number of nodes in the given DAG is \_\_\_\_\_.

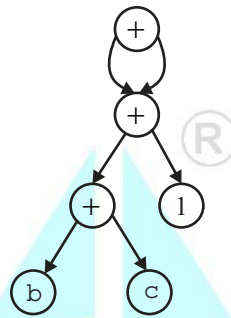
**Ans. 6****Sol.** Given code segment $a = b + c;$  $e = a + 1;$  $d = b + c;$  $f = d + 1;$  $g = e + f;$  $= e + d + 1$

$$= e + b + c + 1$$

$$= a + 1 + b + c + 1$$

$$= (b + c + 1) + (b + c + 1)$$

DAG  $\Rightarrow$



= 6 nodes

**Question 3**

**MCQ (2M)**

**Question ID : 823251562**

Let  $r_i(z)$  and  $w_i(z)$  denote read and write operations respectively on a data item  $Z$  by a transaction  $T_i$ . Consider the following two schedules.

$$S_1 : r_1(x); r_1(y); r_2(x); r_2(y); w_2(y); w_1(x)$$

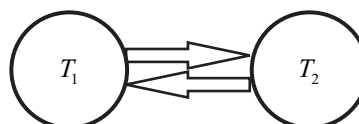
$$S_2 : r_1(x); r_2(x); r_2(y); w_2(y); r_1(y); w_1(x)$$

- (A) Both  $S_1$  and  $S_2$  are conflict serializable.
- (B) Neither  $S_1$  nor  $S_2$  is conflict serializable.
- (C)  $S_1$  is conflict serializable, and  $S_2$  is not conflict serializable.
- (D)  $S_1$  is not conflict serializable and  $S_2$  is conflict serializable.

**Ans. D**

**Sol.** The schedule  $S_2$  is CSS but  $S_1$  is not conflict serializable due to the cycle in the precedence graph.

The precedence graph of  $S_1$  will be :

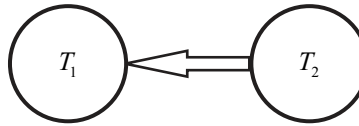


It is not CSS due to the conflict :

$$R_1(Y) - W_2(Y), \text{ and } R_2(X) - W_1(X)$$

The precedence graph of  $S_2$  will be :





$S_2$  is a conflict serializable schedule.

**Question 4****MSQ (1M)****Question ID : 823251544**

Which of the following standard C library functions will always invoke a system call when executed from a single-threaded process in a UNIX/LINUX Operating system ?

- (A) sleep                      (B) strlen                      (C) malloc                      (D) exit

**Ans. A, D****Question 5****MCQ (2M)****Question ID : 823251566**

Let  $G=(V, E)$  be an undirected unweighted connected graph. The diameter of  $G$  is defined as :

$\text{Diam}(G) = \max_{u,v \in G} \{ \text{the length of shortest path between } u \text{ and } v \}$

Let  $M$  be the Adjacency matrix of  $G$ .

Define a graph  $G_2$  on the same set of vertices with adjacency matrix  $N$ , where

$$N_{ij} = \begin{cases} 1 & \text{if } M_{ij} > 0 \text{ or } P_{ij} > 0 \text{ where } P = M^2 \\ 0 & \text{otherwise} \end{cases}$$

Which one of the following statements is true?

- (A)  $\text{diam}(G) < \text{diam}(G_2) \leq 2\text{diam}(G)$                       (B)  $\text{diam}(G_2) = \text{diam}(G)$   
(C)  $\text{diam}(G_2) \leq \lceil \text{diam}(G)/2 \rceil$                       (D)  $\lceil \text{diam}(G_2)/2 \rceil < \text{diam}(G)/2 < \text{diam}(G)$

**Ans. C****Question 6****MSQ (2M)****Question ID : 823251570**

Define  $R_n$  to be the maximum amount earned by cutting a rod of length  $n$  meters into one or more pieces of integer length and selling them. For  $i > 0$ , let  $p[i]$  denote the selling price of a rod whose length is  $i$  meters. Consider the array of prices:

$$p[1] = 1, p[2] = 5, p[3] = 8, p[4] = 9, p[5] = 10, p[6] = 17, p[7] = 13$$

Which of the following statements is/are correct about  $R_7$ ?

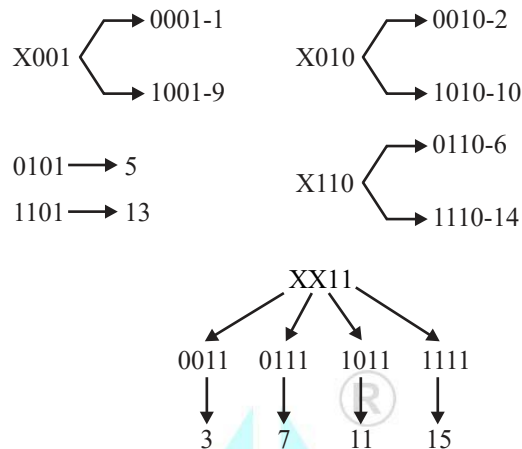
Options :

- (A)  $R_7$  cannot be achieved by a solution consisting of three pieces.  
(B)  $R_7$  is achieved by three different solutions.  
(C)  $R_7 = 19$   
(D)  $R_7 = 18$

**Ans. B, D**







Among above possible values only one in each class should be present.

Only option matches is (B).

**Question 8**

**NAT (1M)**

**Question ID : 823251553**

A relation  $r(A, B)$  in relational database has 1200 tuples. The attribute  $A$  has integer value ranging 6 to 20 and the attribute  $B$  has integer values ranging from 1 to 20. Assume that the attributes  $A$  and  $B$  independently distributed. The estimated number of tuple in the output of  $\sigma_{(A>10) \vee (B=18)}(r)$  is \_\_\_\_\_.

**Ans. 820**

**Question 9**

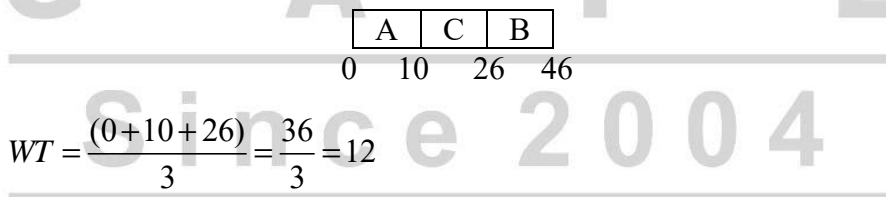
**NAT (1M)**

**Question ID : 823251555**

Three processes arrive at time zero with CPU bursts time of 16, 20 & 10 milliseconds. If the scheduler has prior knowledge about the length of CPU bursts, Minimum achievable average waiting time for this three processes in a non-preemptive scheduler (rounded to nearest integer) is \_\_\_\_\_ milliseconds.

**Ans. 12**

**Sol. Gantt chart :**



**Question 10**

**MCQ (2M)**

**Question ID : 823251567**

Consider the following ANSI C program.

```
#include <stdio.h>
int main()
{
    int i , j, count;
```



```
count=0;
i=0;
for(j=-3;j<=3;j++)
{
    if(j >= 0)&&(i++))
        count=count+j;
}
count=count+i;
printf("%d",count);
return 0;
}
```

Which one of the following options is correct?

- (A) The program will compile successfully and output 8 when executed.
- (B) The program will not compile successfully.
- (C) The program will compile successfully and output 10 when executed.
- (D) The program will compile successfully and output 13 when executed.

**Ans. C**

**Sol.** For  $j = -3$  to  $j = -1$

If  $((j > 0) \&\&(i++))$  will result in false

Hence neither  $i$  nor count null change,  $count = 0, i = 0$

For  $-j = 0$  ( $j \geq 0$ ) result in TRUE hence  $i++$  will execute

$j = 1$  ( $j \geq 0$ ) &&(i++) = TRUE

Hence,  $count = 0 + 1 = 1$  and  $i++$

$j = 2$  ( $j \geq 0$ ) &&(i++) = TRUE

Hence  $count = 1 + 2 = 3$  and  $i++$

$j = 3$  ( $j \geq 0$ ) &&(i++) = TRUE

Hence,  $count = 3 + 3 = 6$  and  $i++$

After exiting loop

```
Count = count+i
       = 6+4=10
```

**Question 11**

**NAT (1M)**

**Question ID : 823251551**

Consider the following sequence of operations on an empty stack.

```
push(54); push(52); pop(); push(55); push(62); s = pop();
```

Consider the following sequence of operations on an empty queue.

```
enqueue(21); enqueue (24); dequeue(); enqueue(28); enqueue(32); q = dequeue();
```

The value of  $s + q$  is \_\_\_\_\_.

**Ans. 86**

**Sol.**  $s = \text{pop}()$  will return top of stack value, i.e.

$$s = 62$$

$q = \text{dequeue}()$  will return head of queue value

$$q = 24$$

$$s + q = 62 + 24 = 86$$

### Question 12

**MSQ (2M)**

**Question ID : 823251573**

A relation  $R$  is said to be circular if  $aRb$  and  $bRc$  together imply  $cRa$ . Which of the following options is/are correct?

- (A) If a relation  $S$  is transitive and circular, then  $S$  is an equivalence relation.
- (B) If a relation  $S$  is reflexive and circular, then  $S$  is an equivalence relation.
- (C) If a relation  $S$  is circular and symmetric, then  $S$  is an equivalence relation.
- (D) If a relation  $S$  is reflexive and symmetric, then  $S$  is an equivalence relation.

**Ans. B**

**Sol.** If  $S$  is reflexive and cyclic then  $S$  will be equivalence relation.

Proof:  $S$  is reflexive there for element  $a, b, c$   $(a, a), (b, b), (c, c)$  belongs to  $S$

If  $(a, b)$  belongs to  $S$  then  $(b, a)$  must belong to  $S$ , as  $(a, b)$  and  $(b, b)$  belongs to  $S$  therefore,  $S$  is symmetric.

If  $(a, b)$  and  $(b, c)$  belongs to  $S$  then because its cyclic  $(c, a)$  must belong to  $S$  and  $S$  is symmetric too, hence  $(a, c)$  also belongs to  $S$  and  $S$  is Equivalence Relation

### Question 13

**MSQ (2M)**

**Question ID : 823251576**

Consider the following pseudocode, where  $S$  is a semaphore initialized to 5 in line#2 and counter is a shared variable initialized to 0 in line#1. Assume that the increment operation in line#7 is not atomic.

1. `int counter = 0;`
2. `Semaphore S = init(5);`
3. `void parop(void)`
4. `{`
5. `wait(S);`
6. `wait(S);`
7. `counter++;`

8. signal(S);  
9. signal(S);  
10. }

If live threads execute the function parop concurrently, which of the following program behavior(s) is/are possible?

- (A) The value of counter is 0 after all the threads successfully complete the execution of parop.  
(B) The value of counter is 1 after all the threads successfully complete the execution of parop.  
(C) There is a deadlock involving all the threads.  
(D) The value of counter is 5 after all the threads successfully complete the execution of parop.

Ans. **B, C, D**

**Question 14****NAT (2M)****Question ID : 823251585**

Consider a computer system consisting of registers R1, R2, R3 and MEMORY[X] denotes the content at the memory location of X. Assume memory is byte addressable

Instruction	Semantics	Instruction size (bytes)
MOV R1 (5000)	$R1 \leftarrow M[5000]$	4
MOV R2 (R3)	$R2 \leftarrow M[R3]$	4
ADD R2,R1	$R2 \leftarrow R1 + R2$	2
MOV(R3)	$M[R3] \leftarrow R2$	4
INC R3	$R3 \leftarrow R3 + 1$	2
DEC R1	$R1 \leftarrow R1 - 1$	2
BNEZ 1004	Branch if non zero to the absolute address	2
HALT	Stop	1

Assume that the content of the memory location 5000 is 10 and the content of the register R3 is 3000. The content of each of the memory locations from 3000 to 3010 is 50. The instruction sequence starts from the memory location 1000. All the numbers are in decimal format. Assume that the memory is byte addressable.

After the execution of the program, the content of memory location 3010 is \_\_\_\_\_.

Ans. **50**

**Question 15****MCQ (1M)****Question ID : 823251536**

Let the representation of a number in base 3 be 210. What is the hexadecimal representation of the number?

- (A) D2                      (B) 528                      (C) 21                      (D) 15

Ans. **D**

**Sol.** Correct the given number representation decimal representation

$$(210)_3 \rightarrow (?)_{10}$$

$$2 \times 3^2 + 1 \times 3^1 + 0 \times 3^0$$

$$18 + 3 = (21)_{10}$$

Now convert decimal representation into hexadecimal representation

$$(21)_{10} \rightarrow (?)_{16}$$

$$16 \overline{) 21} \quad 5$$

$$\underline{16} \phantom{0}$$

$$(15)_{16}$$

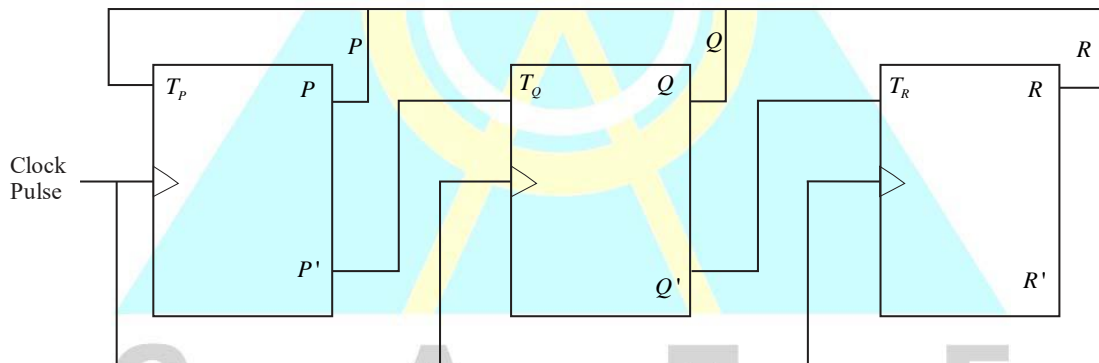
Hence, the correct option is (D)

**Question 16**

**MCQ (2M)**

**Question ID : 823251558**

Consider a 3-bit counter, designed using T flip-flops, as shown below:



Assuming the initial state of the counter given by PQR as 000, what are the next three states?

- (A) 001, 010, 111      (B) 011, 101, 000      (C) 001, 010, 000      (D) 011, 101, 111

**Ans. B**

**Sol.** 1.  $P^+ = T_p \oplus P$

$$= R \oplus P$$

2.  $Q^+ = T_q \oplus Q$

$$= \bar{P} \oplus Q$$

$$\bar{Q} = \overline{P \oplus Q}$$

3.  $R^+ = T_r \oplus R$





$$= \bar{Q} \oplus R$$

$$\bar{R} = \overline{Q \oplus R}$$

$P$	$Q$	$R$	$P^+$	$Q^+$	$R^+$
0	0	0	0	1	1
0	0	1	1	1	0
0	1	0	0	0	0
0	1	1	1	0	1
1	0	0	1	0	1
1	0	1	0	0	0
1	1	0	1	1	0
1	1	1	0	1	1

So, next three step

$$000 \rightarrow 011 \rightarrow 101 \rightarrow 000$$

Hence, the correct option is (B)

**Question 17**

**MSQ (2M)**

**Question ID : 823251572**

Consider the following Boolean expression.

$$F = (X + Y + Z)(\bar{X} + Y)(\bar{Y} + Z)$$

Which of the following Boolean expressions is/are equivalent to  $\bar{F}$  (complement of  $F$ )?

(A)  $X\bar{Y} + Y\bar{Z} + \bar{X}\bar{Y}\bar{Z}$

(B)  $(X + \bar{Z})(\bar{Y} + \bar{Z})$

(C)  $X\bar{Y} + \bar{Z}$

(D)  $(\bar{X} + \bar{Y} + \bar{Z})(X + \bar{Y})(Y + \bar{Z})$

**Ans. A, B, C**

**Sol. Given :**

$$F = (x + y + z)(\bar{x} + y)(\bar{y} + z)$$

$$F = \pi m(0, 2, 4, 5, 6)$$

$$\bar{F} = \pi m(1, 3, 7)$$

$$\bar{F} = \sum m(0, 2, 4, 5, 6)$$

(A)  $x\bar{y} + y\bar{z} + \bar{x}\bar{y}\bar{z}$

$$\sum_m(0, 2, 4, 5, 6)$$

It is correct

(B)  $(x + \bar{z})(\bar{y} + \bar{z})$

$\pi_m(1, 3, 7)$

It is correct

(C)  $x\bar{y} + \bar{z}$

$\sum m(0, 2, 4, 5, 6)$

It is correct

(D)  $(\bar{x} + \bar{y} + \bar{z})(x + \bar{y})(y + \bar{z})$

$\pi_m(1, 3, 2)$

It is incorrect

**Question 18**

**NAT (1M)**

**Question ID : 823251550**

Consider the following expression

$$\lim_{x \rightarrow -3} \frac{\sqrt{2x+22}-4}{x+3}$$

The value of above expression (rounded to 2 decimal places) is \_\_\_\_\_.

**Ans. 0.25**

**Sol. Given :**

$$\begin{aligned} \lim_{x \rightarrow -3} \frac{\sqrt{2x+22}-4}{x+3} &= \frac{\sqrt{-4+22}-4}{-3+3} \\ &= \frac{4-4}{-3+3} \\ &= \frac{0}{0} \end{aligned}$$

Applying "L' Hospital Rule:

$$\lim_{x \rightarrow -3} \frac{1 \times 2}{\sqrt{2x+22}} = \lim_{x \rightarrow -3} \frac{1}{\sqrt{2x+22}}$$

$$\begin{aligned} &= \frac{1}{\sqrt{-6+22}} \\ &= \frac{1}{\sqrt{16}} \\ &= \frac{1}{4} = 0.25 \end{aligned}$$

Hence that correct Ans is 0.25

**Question 19****MCQ (1M)****Question ID : 823251531**

Suppose that  $L_1$  is regular language and  $L_2$  is context free language. Which one of the following language is NOT necessarily contexts free?

- (A)  $L_1 \cup L_2$       (B)  $L_1 - L_2$       (C)  $L_1 \cap L_2$       (D)  $L_1.L_2$

**Ans. B****Question 20****MSQ (2M)****Question ID : 823251575**

Consider two hosts P and Q connected through a router R. The maximum transfer unit (MTU) value of the link between P and R is 1500 bytes, and between R and Q is 820 bytes.

A TCP segment of size 1400 bytes was transferred from P to Q through R, with IP identification value as 0x1234. Assume that the IP header size is 20 bytes. Further, the packet is allowed to be fragmented, i.e., Don't Fragment (DF) flag in the IP header is not set by P.

Which of the following statements is/are correct?

- (A) TCP destination port can be determined by analysing only the second fragment.  
(B) Two fragments are created at R and the IP datagram size carrying the second fragment is 620 bytes.  
(C) If the second fragment is lost, R will resend the fragment with the IP identification value 0x1234.  
(D) If the second fragment is lost, P is required to resend the whole TCP segment.

**Ans. B, D**

**Sol.** The Fragmentation will be taking place at R router only. First Fragment will be of 820 B of which 800B will be the data, total data size was 1400 B, therefore 2<sup>nd</sup> fragment will of size  $1400 - 800 + 20(\text{IP Header}) = 620 \text{ B}$

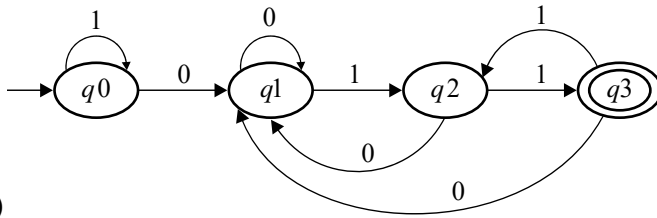
If any fragment get lost, complete data is sent again by the Transport Layer

**Question 21****MCQ (2M)****Question ID : 823251568**

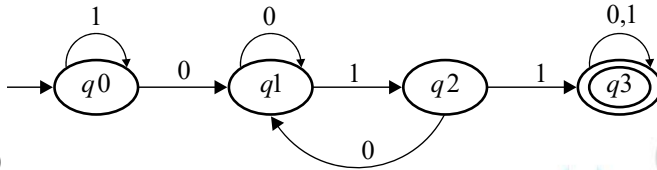
Consider the following language

$$L = \{ w \in \{0,1\}^* \mid w \text{ ends with the substring } 011 \}$$

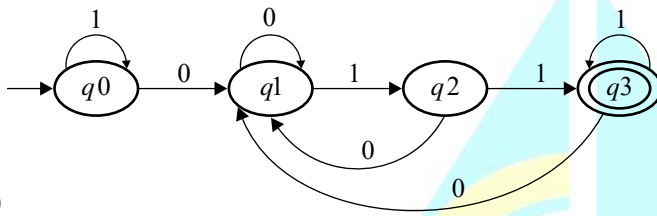
Which of the following deterministic finite automata represents the given language



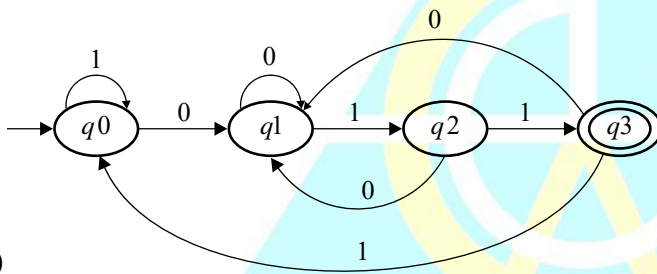
(A)



(B)



(C)



(D)

Ans. D

**Question 22**

**MSQ (2M)**

**Question ID : 823251571**

An articulation point in a connected graph is a vertex such that removing the vertex and its incident edges disconnects the graph into two or more connected components.

Let T be a DFS tree obtained by doing DFS in a connected undirected graph G. Which of the following options in/are correct.

- (A) Root of T can never be an articulation point in G.
- (B) A leaf of T can be an articulation point in G.
- (C) If u is an articulation point in G such that x is an ancestor of u and y is a descendent of v in T then all paths from x to y in G must pass through u
- (D) Root of T is an articulation point in G, if and only if it has 2 or more children.

Ans. D

**Question 23**

**NAT (2M)**

**Question ID : 823251582**

Consider the following matrix.

$$\begin{bmatrix} 0 & 1 & 1 & 1 \\ 1 & 0 & 1 & 1 \\ 1 & 1 & 0 & 1 \\ 1 & 1 & 1 & 0 \end{bmatrix}$$

The largest eigenvalue of the matrix is \_\_\_\_\_.

Ans. 3

Sol. Given :

$$[A] = \begin{bmatrix} 0 & 1 & 1 & 1 \\ 1 & 0 & 1 & 1 \\ 1 & 1 & 0 & 1 \\ 1 & 1 & 1 & 0 \end{bmatrix}$$

$$|A - \lambda I| = 0$$

$$\begin{bmatrix} 0 & 1 & 1 & 1 \\ 1 & 0 & 1 & 1 \\ 1 & 1 & 0 & 1 \\ 1 & 1 & 1 & 0 \end{bmatrix} = 0$$

Applying

$$R_1 \rightarrow R_1 - R_2$$

$$R_2 \rightarrow R_2 - R_3$$

$$R_3 \rightarrow R_3 - R_4$$

$$\begin{bmatrix} -\lambda - 1 & 1 + \lambda & 0 & 0 \\ 0 & -\lambda - 1 & 1 + \lambda & 0 \\ 0 & 0 & -\lambda - 1 & 1 + \lambda \\ 1 & 1 & 1 & -\lambda \end{bmatrix} = 0$$

$$(-\lambda - 1) \begin{bmatrix} -\lambda - 1 & 1 + \lambda & 0 \\ 0 & -\lambda - 1 & 1 + \lambda \\ 1 & 1 & -\lambda \end{bmatrix} - (1 + \lambda) \begin{bmatrix} 0 & 1 + \lambda & 0 \\ 0 & -\lambda - 1 & 1 + \lambda \\ 1 & 1 & -\lambda \end{bmatrix} = 0$$

$$(-\lambda - 1) \begin{bmatrix} (-\lambda - 1) & 2(1 + \lambda) & 0 \\ 0 & 2(-\lambda - 1) & 2(1 + \lambda) \\ 2 & 2 & -2\lambda \end{bmatrix} = 0$$

$$(1 + \lambda) \left[ (-\lambda - 1) \{ 4(\lambda + \lambda^2) - 4(1 + \lambda) \} + 2 \{ 4(1 + \lambda)^2 \} \right] = 0$$

$$(1 + \lambda) \left[ (-\lambda - 1) 4(\lambda^2 - 1) + 8(1 + \lambda)^2 \right] = 0$$

$$(1+\lambda)^3[-4(\lambda-1)+8]=0$$

$$(1+\lambda)^3[12-4\lambda]=0$$

$$\left. \begin{array}{l} 1+\lambda=0 \\ 12-4\lambda=0 \end{array} \right\} \begin{array}{l} \lambda=-1, -1, -1 \\ \lambda=3 \end{array}$$

Hence the maximum, engine value is 3.

**Question 24****MCQ (1M)****Question ID : 823251537**

Let p and q be two propositions. Consider the following two formulae in propositional logic.

$$S_1 : (\neg p \wedge (p \vee q)) \rightarrow q$$

$$S_2 : q \rightarrow (\neg p \wedge (p \vee q))$$

- (A) Both  $S_1$  and  $S_2$  both are tautologies. (B) Neither  $S_1$  nor  $S_2$  is a tautology.  
(C)  $S_1$  is not a tautology but  $S_2$  is a tautology. (D)  $S_1$  is a tautology but  $S_2$  is not a tautology.

**Ans. D**

**Sol.**  $S_1 : (p'(p+q))' + q = (p'p+p'q)' + q = (p'q)' + q = p + q' + q = 1$  ( Tautology )

$$S_2 : q' + (p'(p+q)) = q' + (pp' + p'q) = q' + p'q = (q' + p')(q' + q) = q' + p'$$

**Question 25****MCQ (2M)****Question ID : 823251563**

Consider the relation  $R(P, Q, S, T, X, Y, Z, W)$  with the following functional dependencies.

$$PQ \rightarrow X; P \rightarrow YX; Q \rightarrow Y; Y \rightarrow ZW$$

Consider the decomposition of the relation R into the constituent relations according to the following two decomposition schemes.

$$D_1 : R = [(P, Q, S, T); (P, T, X); (Q, Y); (Y, Z, W)]$$

$$D_2 : R = [(P, Q, S); (T, X); (Q, Y); (Y, Z, W)]$$

Which one of the following options is correct?

- (A)  $D_1$  is a lossless decomposition, but  $D_2$  is a lossy decomposition.  
(B) Both  $D_1$  and  $D_2$  are lossy decompositions.  
(C) Both  $D_1$  and  $D_2$  are lossless decompositions.  
(D)  $D_1$  is a lossy decomposition, but  $D_2$  is a lossless decomposition.

**Ans. A**

**Sol.** For decomposition D1 :





R1(PQST)

R2(PTX)

R3(QY)

R4(YZW)

Since all the relations have a common attribute and either of them have a common attribute as the primary key, therefore, the given relation is lossless.

For decomposition D2 :

R1(PQS)

R2(TX)

R3(QY)

R4(YZW)

Since, neither of them have a common attribute as the primary key, therefore, the given decomposition is not a lossless decomposition.

**Question 26****MCQ (1M)****Question ID : 823251538**

Consider the following two statements.

$S_1$  : Destination MAC address of an AR P reply is a broadcast address.

$S_2$  : Destination MAC address of an AR P request is a broadcast address.

Which one of the following choices is correct?

(A)  $S_1$  is true and  $S_2$  is false.

(B) Both  $S_1$  and  $S_2$  are true.

(C)  $S_1$  is false and  $S_2$  is true.

(D) Both  $S_1$  and  $S_2$  are false.

**Ans. C****Sol.** ARP Request is broadcast and reply is always unicast**Question 27****MCQ (2M)****Question ID : 823251561**

Consider the following context - free grammar where the of terminals is {a,b,c,d,f}

$$S \rightarrow daT \mid Rf$$

$$T \rightarrow aS \mid baT \mid \epsilon$$

$$R \rightarrow caTR \mid \epsilon$$

The following is a partially filled LL(1) parse table \_\_\_\_\_

	a	b	c	d	f	\$
--	---	---	---	---	---	----

S			(1)	$S \rightarrow daT$	(2)	
T	$T \rightarrow aS$	$T \rightarrow baT$	(3)		$T \rightarrow \epsilon$	(4)
R			$R \rightarrow caTR$		$R \rightarrow \epsilon$	

Which one of the following choices represents the correct combination for the numbered cells in the parsing table ("blank" denotes that the corresponding cell is empty)?

- (A) (1)  $S \rightarrow Rf$  (2)  $S \rightarrow Rf$  (3)  $T \rightarrow \epsilon$  (4)  $T \rightarrow \epsilon$   
 (B) (1) blank (2)  $S \rightarrow Rf$  (3) blank (4) blank  
 (C) (1)  $S \rightarrow Rf$  (2) blank (3) blank (4)  $T \rightarrow \epsilon$   
 (D) (1) blank (2)  $S \rightarrow Rf$  (3)  $T \rightarrow \epsilon$  (4)  $T \rightarrow \epsilon$

Ans. A

Question 28

MSQ (1M)

Question ID : 823251541

In the context of operating systems, which of the following statements is/are correct with respect to paging?

- (A) Page size has no impact on internal fragmentation.  
 (B) Paging incurs memory overheads.  
 (C) Multi-level paging is necessary to support pages of different sizes.  
 (D) Paging helps solve the issue of external fragmentation.

Ans. B, D

Sol. Option (A) – Incorrect

Option (B) – Correct, since paging use page table and page table are stored in RAM

Option (C) – Incorrect

Option (D) – Correct because paging is non continuous memory allocation scheme.

Question 29

MCQ (2M)

Question ID : 823251560

Consider the following recurrence relation

$$T(n) = \begin{cases} T(n/2) + T(2n/5) + 7n & \text{if } n > 0 \\ 1 & \text{if } n = 0 \end{cases}$$

Which one of the following options is correct?

- (A)  $T(n) = \theta(n)$  (B)  $T(n) = \theta((\log n)^{5/2})$  (C)  $T(n) = \theta(n \log n)$  (D)  $T(n) = \theta(n^{5/2})$

Ans. A

Question 30

MSQ (1M)

Question ID : 823251543

Suppose a database system crashes again while recovering from a previous crash.

Assume check-pointing is not done by the database either during the transactions or during recovery. Which of the following statements is/are correct?

- (A) The same undo and redo list will be used while recovering again.
- (B) The system cannot recover any further.
- (C) The database will become inconsistent
- (D) All the transactions that are already undone and redone will not be recovered again.

**Ans. A**

**Sol.** We know that in a log file all the operations are idempotent (result will be same on performing same operation multiple times) and are recorded periodically. Therefore, even on multiple crashes the same undo and redo list will be used while recovering the system.

**Question 31**

**MCQ (2M)**

**Question ID : 823251569**

For a Turing machine  $M$ ,  $\langle M \rangle$  denotes encoding of  $M$ , consider

$$L_1 = \{ \langle M \rangle \mid m \text{ takes more than 2021 steps in all input} \}$$

$$L_2 = \{ \langle M \rangle \mid m \text{ takes more than 2021 in some input} \}$$

Which one of the following option is correct?

- (A) Both  $L_1$  and  $L_2$  decidable
- (B)  $L_1$  decidable and  $L_2$  undecidable
- (C)  $L_1$  undecidable and  $L_2$  decidable
- (D) Both  $L_1$  and  $L_2$  undecidable

**Ans. A**

**Question 32**

**MSQ (1M)**

**Question ID : 823251542**

Let,  $\langle M \rangle$  denote an encoding of an automaton  $M$ . Suppose that  $\Sigma = \{0,1\}$ . Which of the following language is/are NOT recursive?

- (A)  $L = \{ \langle M \rangle \mid M \text{ is a DFA such that } L(M) = \emptyset \}$
- (B)  $L = \{ \langle M \rangle \mid M \text{ is a PDA such that } L(M) = \Sigma^* \}$
- (C)  $L = \{ \langle M \rangle \mid M \text{ is a DFA such that } L(M) = \Sigma^* \}$
- (D)  $L = \{ \langle M \rangle \mid M \text{ is a PDA such that } L(M) = \emptyset \}$

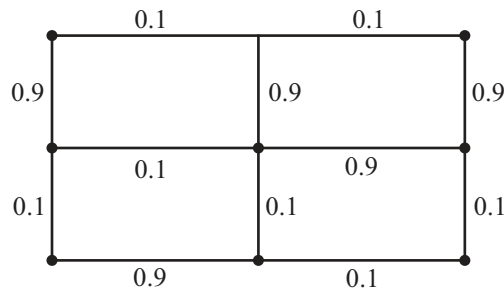
**Ans. B**

**Question 33**

**NAT (1M)**

**Question ID : 823251547**

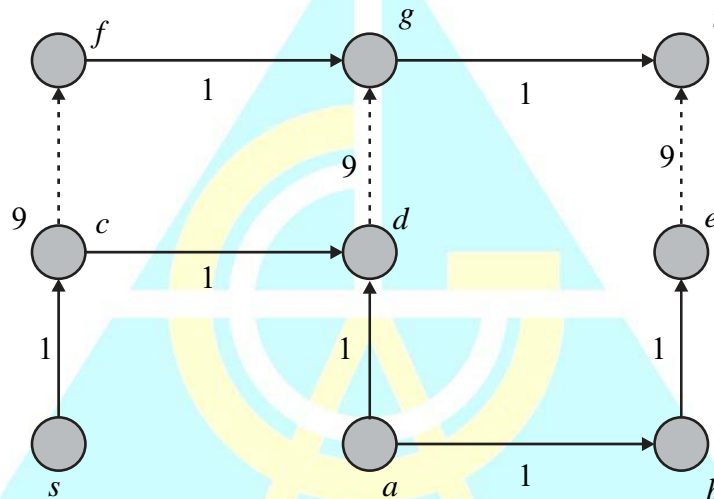
Consider the following undirected graph with edge weights as shown:



The number of minimum-weight spanning trees of the graph is \_\_\_\_\_.

**Ans. 3**

**Sol.** Solid lines represent compulsory edges in MST and dotted lines represent optional edges in MST only one edge out of those 3 edges is possible hence answer is 3.



**Question 34**

**MCQ (1M)**

**Question ID : 823251539**

Consider the following array

23	32	45	69	72	73	89	97
----	----	----	----	----	----	----	----

Which algorithm out of the following option uses the least number of comparisons (among the array elements) to sort the above array in ascending order ?

- (A) Mergesort (B) Quick sort using last element as pivot  
(C) Selection sort (D) Insertion sort

**Ans. D**

**Sol.** Given array is already sorted hence

Insertion sort will use the least number of comparisons.

**Question 35**

**MCQ (2M)**

**Question ID : 823251556**

Consider the following grammar (that admits a series of declaration, followed by expression) and the associated syntax directed translation (SDT) action, given as pseudo-code :



$$S \rightarrow D * E *$$

$$D \rightarrow \text{int ID} \{\text{record that ID.lexeme is of type int}\}$$

$$D \rightarrow \text{bool ID} \{\text{record that ID.lexeme is of type bool}\}$$

$$E \rightarrow E_1 + E_2 \{\text{check if } E_1.\text{type} = E_2.\text{type} = \text{int}; \text{ set } E.\text{type} = \text{int}\}$$

$$E \rightarrow !E_1 \{\text{check that } E_1.\text{type} = \text{bool}; \text{ then set } E.\text{type} = \text{bool}\}$$

$$E \rightarrow \text{ID} \{\text{Set } E.\text{type} = \text{int}\}$$

With respect to the above grammar, which one of the following choices is correct?

- (A) The actions can be used to type-check syntactically correct integer variable declarations and integer expressions.
- (B) The actions will lead to an infinite loop.
- (C) The actions can be used to type-check syntactically correct boolean variable declarations and boolean expressions.
- (D) The actions can be used to correctly type-check any syntactically correct program.

Ans. A

### Question 36

NAT (1M)

Question ID : 823251554

Consider the following representation of a number in IEEE 754 single-precision floating point format with base of 127

S : 1                                      E : 10000001                                      F : 111100000000000000000000

Here S, E and F denote the sign, exponent and fraction components of the floating point representation.

The decimal value corresponding to the above representation (rounded to 2 decimal places) is \_\_\_\_\_.

Ans. -7.75

Sol. Sign bit = 1

$$BE = 10000001$$

$$= 2^7 + 2^0$$

$$= 128 + 1 = 129$$

$$E = BE - 127$$

$$= 129 - 127$$

$$= 2$$

$$\text{Binary No} = -1.1111 \times 2^2$$

$$= (-111.11)_2$$

$$= (-7.75)_{10}$$

**Question 37****MCQ (2M)****Question ID : 823251557**

The following relation records the age of 500 employees of a company, where empNo (indicating the employee number) is the key :

empAge(empNo, cige)

Consider the following relational algebra expression:

$$\Pi_{empNo} (empAge \bowtie_{(age > age1)} \rho_{empNo1, age1} (empAge))$$

What does the above expression generate?

- (A) Employee numbers of only those employees whose age is more than the age of exactly one other employee.
- (B) Employee numbers of only those employees whose age is the maximum.
- (C) Employee numbers of all employees whose age is the minimum.
- (D) Employee numbers of all employees whose age is not the minimum.

**Ans. D**

**Sol.** The given join is the conditional joins the relations if the age is greater than any of the ages mentioned in the database. Therefore, it results employees whose age is not minimum.

**Question 38****MCQ (1M)****Question ID : 823251540**

A Binary search tree T contains n distinct elements. What is time complexity of picking an elements in T that is smaller than the maximum element in T?

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

**Ans. D**

**Sol.** In BST maximal element will be in right most leaf node

If root has right sub tree then root itself is smaller than maximum value

If root does not have right subtree then root is maximum element and left child of root is the required element.

**Question 39****NAT (1M)****Question ID : 823251552**

Consider a computer system with a byte-addressable primary memory of size  $2^{32}$  bytes. Assume the computer system has a direct-mapped cache of size 32 KB (1 KB =  $2^{10}$  bytes), and each cache block is of size 64 bytes. The size of the tag field is \_\_\_\_ bits.

**Ans. 17**

**Sol.** Size of main memory =  $2^{32}$  Bytes

$\therefore$  No. of bits in physical add =  $\log_2(\text{M.M.size})$

$$= \log_2(2^{32})$$



$$= 32 \text{ bits}$$

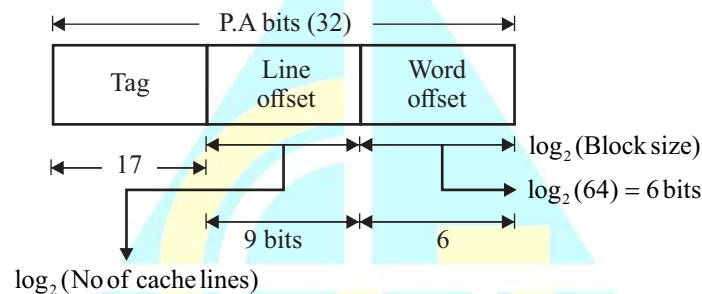
$$\text{Cache memory size} = 32 \text{ kB}$$

$$\text{Cache block size} = 64 \text{ B}$$

$$\therefore \text{No. of cache lines} = \frac{\text{Cache main size}}{\text{Cache block size}}$$

$$= \frac{32 \text{ kB}}{64 \text{ B}} = 512$$

Format of physical add at direct mapped cache is



$$= \log_2(512) = 9 \text{ bits}$$

$$\text{No. of bits in tag} = \text{P.A} - \text{Line offset} - \text{word offse}$$

$$= 32 - 9 - 6$$

$$= 17 \text{ bits}$$

**Question 40**

**MSQ (1M)**

**Question ID : 823251545**

Consider a linear list based directory implementation in a file system. Each directory is a list of nodes, where each node contains the file name along with the file metadata, such as the list of pointers to the data blocks. Consider a given directory foo.

Which of the following operations will necessarily require a full scan of foo for successful completion?

- (A) Deletion of an existing file from foo      (B) Renaming of an existing file in foo  
(C) Creation of a new file in foo      (D) Opening of an existing file in foo

**Ans. B, C**

**Question 41**

**MCQ (1M)**

**Question ID : 823251533**

Consider the following three function :

$$f_1 = 10^n, f_2 = n^{\log n}, f_3 = n^{\sqrt{n}}$$

Which one of the following options arranges the functions in the increasing order of asymptotic growth rate?

- (A)  $f_1 f_2 f_3$                       (B)  $f_2 f_3 f_1$                       (C)  $f_3 f_2 f_1$                       (D)  $f_2 f_1 f_3$

**Ans. B**

**Sol.** Taking log for all the functions

$$\log(f_1) = n \log 10, \log(f_2) = (\log n)^2, \log(f_3) = \sqrt{n} \log n$$

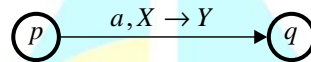
hence  $f_2 < f_3 < f_1$

**Question 42**

**NAT (2M)**

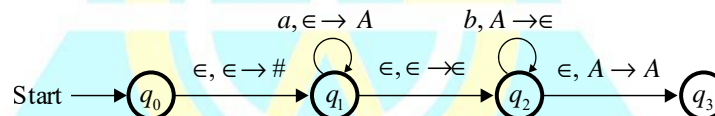
**Question ID : 823251581**

In a pushdown automaton  $P = (Q, \Sigma, \Gamma, q_0, F)$  a transition of the form,



Where,  $p, q \in Q, a \in \Sigma \cup \{\epsilon\}$ , and  $t > n$ , represents  $(q, Y) \in \delta(p, a, X)$

Consider the following pushdown automaton over the input alphabet  $\Sigma = \{a, b\}$  and stack alphabet  $\Gamma = \{\#, A\}$ .



The number of strings of length 100 accepted by the above pushdown automaton is \_\_\_\_\_.

**Ans. 50**

**Question 43**

**NAT (1M)**

**Question ID : 823251546**

In an undirected connected planar graph G, there are eight vertices and five faces. The number of edges in G is \_\_\_\_\_.

**Ans. 11**

**Sol.** Number of Faces/Region(F) = 5

Number of vertices(V) = 8

Number of Edges(E)?

Formula used:  $F = E - N + 2$

$$\rightarrow E = F + N - 2$$

$$= 5 + 8 - 2 = 11$$

**Question 44**

**MCQ (2M)**

**Question ID : 823251559**

Assume that a 12-bit Hamming codeword consisting of 8-bit data and 4 check bits

is  $d_8 d_7 d_6 d_5 c_8 d_4 d_4 d_3 d_2 c_4 d_1 c_2 c_1$ , where the data bits and the check bits are given in the following tables:

Data bits							
d <sub>8</sub>	d <sub>7</sub>	d <sub>6</sub>	d <sub>5</sub>	d <sub>4</sub>	d <sub>3</sub>	d <sub>2</sub>	d <sub>1</sub>
1	1	0	X	0	1	0	1

Check bits			
C <sub>8</sub>	C <sub>4</sub>	C <sub>2</sub>	C <sub>0</sub>
y	0	1	0

Which one of the following choices gives the correct values of x and y?

- (A) x is 1 and y is 0. (B) x is 0 and y is 1. (C) x is 1 and y is 1. (D) x is 0 and y is 0.

Ans. D

#### Question 45

MCQ (1M)

Question ID : 823251532

Let P be an array containing n integers. Let t be the lowest upper bound on the number of comparisons of the array elements, required to find the minimum and maximum values in an arbitrary array of n elements. Which one of the following choices is correct?

- (A)  $t > n$  and  $t \leq 3 \left\lceil \frac{n}{2} \right\rceil$  (B)  $t > 2n - 2$   
 (C)  $t > \lceil \log_2(n) \rceil$  and  $t \leq n$  (D)  $t > 3 \left\lceil \frac{n}{2} \right\rceil$  and  $t \leq 2n - 2$

Ans. A

#### Question 46

MSQ (2M)

Question ID : 823251574

A TCP server application is programmed to listen on port number P on host S. A TCP client is connected to the TCP server over the network.

Consider that while the TCP connection was active, the server machine S crashed and rebooted. Assume that the client does not use the TCP keepalive timer.

Which of the following behaviors is/are possible?

- (A) The TCP server application on S can listen on P after reboot.  
 (B) If the client was waiting to receive a packet, it may wait indefinitely.  
 (C) If the client sends a packet after the server reboot, it will receive a FIN segment.  
 (D) If the client sends a packet after the server reboot, it will receive a RST segment.

Ans. A, B, D

#### Question 47

NAT (2M)

Question ID : 823251578

Consider the following ANSI C function:

```
int SimpleFunction(int Y[], int n, int x)
{
    int total = Y[0], loopIndex;
```

```

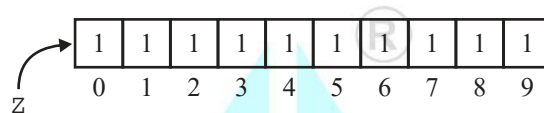
for (loopIndex = 1; loopIndex <= n - 1; loopIndex++)
    total = x * total + Y[loopIndex];
return total;
}

```

Let Z be an array of 10 elements with  $Z[i] = i - 1$ , for all  $i$  such that  $0 < i < 9$ . The value returned by SimpleFunction(Z, 10, 2) is \_\_\_\_\_.

Ans. 1023

Sol.



Total =  $Y[0] = Z[0] = 1$

$n = 10$

$x = 2$

Loop index	Total = $x * \text{total} + Y[\text{loop index}]$
1	$2 * 1 + Y[1] = 2 * 1 + 1 = 3$
2	$2 * 3 + Y[2] = 2 * 3 + 1 = 7$
3	$2 * 7 + Y[3] = 2 * 7 + 1 = 15$
4	$2 * 15 + Y[4] = 2 * 15 + 1 = 31$
5	$2 * 31 + Y[5] = 2 * 31 + 1 = 63$
6	$2 * 63 + Y[6] = 2 * 63 + 1 = 127$
7	$2 * 127 + Y[7] = 2 * 127 + 1 = 255$
8	$2 * 255 + Y[8] = 2 * 255 + 1 = 511$
9	$2 * 511 + Y[9] = 2 * 511 + 1 = 1023$

Question 48

NAT (1M)

Question ID : 823251549

There are 6 jobs with distinct difficulty levels, and 3 computers with distinct processing speeds. Each job is assigned to a computer such that:

- The fastest computer gets the toughest job and the slowest computer gets the easiest job.
- Every computer gets at least one job.

The number of ways in which this can be done is \_\_\_\_\_.

Ans. 65

Sol. As 2 Jobs are already assigned to Fastest and Slowest Computer (Toughest and Easiest job respectively). We are only left with 4 distinct Jobs to be distributed to 3 distinct Computers. Intermediate has not been assigned any, other have got one each, therefore 4 jobs to be distributed such that intermediate must get at least one.

Fastest

Intermediate

Slowest

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

Therefore total cases are  $4C_2 \times 2C_1 \times 3 + 4C_2 \times 2 + 4C_3 \times 4 + 4C_4 = 36 + 12 + 16 + 1 = 65$

**Question 49****NAT (1M)****Question ID : 823251548**

The lifetime of a component of a certain type is a random variable whose probability density function is exponentially distributed with parameter 2. For a randomly picked component of this type, the probability that its lifetime exceeds the expected lifetime (rounded to 2 decimal places) is \_\_\_\_\_.

**Ans. 0.35 to 0.39****Question 50****NAT (2M)****Question ID : 823251583**

A five-stage pipeline has stage delays of 150, 120, 150, 160 and 140 nanoseconds. The registers that are used between the pipeline stages have a delay of 5 nanoseconds each. The total time to execute 100 independent instructions on this pipeline, assuming there are no pipeline stalls, is \_\_\_\_\_ nanoseconds.

**Ans. 17160****Sol.** For pipeline processor

Cycle time  $t_p = \text{Max of stage delay} + \text{Buffer delay}$

$$= \text{Max}(150, 120, 150, 160, 140) + 5 \text{ ns}$$

$$= 160 \text{ ns} + 5 \text{ ns}$$

$$= 165 \text{ ns}$$

For a K stage pipeline processor, execution time for n instruction using cycle turns of  $b_p$  is given by,

$$ET_{pipe} = \text{Execution Time (Pipeline processor)} = (k + n - 1)t_p$$



Given,

$$\text{No. of stages} = 5 = k$$

$$\text{And no. of instructions pipeline} = 100 = n$$

$$\begin{aligned} \therefore ET_{\text{pipe}} &= (5 + 100 - 1) \times 165 \text{ ns} \\ &= 17160 \text{ ns} \end{aligned}$$

**Question 51****MCQ (2M)****Question ID : 823251565**

Consider the two statements.

$S_1$  : There exist random variables X and Y such that

$$(E[X - E(X)](Y - E(Y)))^2 > \text{Var}[X]\text{Var}[Y]$$

$S_2$  : For all random variables X and Y.

$$\text{Cov}[X, Y] = E[|X - E[X]| |Y - E[Y]|]$$

Which one of the following choices is correct?

- (A) Both  $S_1$  and  $S_2$  are true. (B) Both  $S_1$  and  $S_2$  are false.  
(C)  $S_1$  is false, but  $S_2$  is true. (D)  $S_1$  is true, but  $S_2$  is false.

Ans. (B)

**Question 52****MCQ (1M)****Question ID : 823251535**

Consider the following statements

$S_1$  : Every SLR (1) parser parses is unambiguous but there are certain unambiguous grammars that are not SLR (1)

$S_2$  : For any context-free grammar, there is a parser that takes at most  $O(n^3)$  time to parse a string of length n.

Which of the following option is/are correct.

- (A)  $S_1$  is false and  $S_2$  is false (B)  $S_1$  is true and  $S_2$  is false  
(C)  $S_1$  is true and  $S_2$  is true (D)  $S_1$  is false and  $S_2$  is true

Ans. (C)

**Question 53****MCQ (1M)****Question ID : 823251534**

Consider the following statements.

$S_1$  : The sequence of procedure calls corresponds to a preorder traversal of the activation tree.

$S_2$  : The sequence of procedure returns corresponds to a postorder traversal of the activation tree.

Which one of the following options is correct?

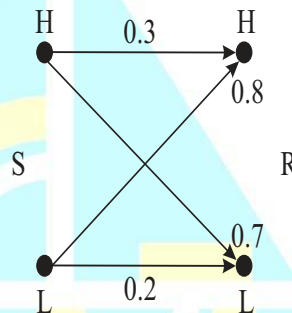


(A)  $S_1$  is true and  $S_0$  is true(B)  $S_1$  is true and is false(C)  $S_1$  is false and is true(D)  $S_1$  is false and  $S_0$  is false

Ans. (A)

**Question 54****NAT (2M)****Question ID : 823251584**

A sender (S) transmits a signal, which can be one of the two kinds: H and L with probabilities 0.1 and 0.9 respectively, to a receiver (R). In the graph below, the weight of edge  $(u, v)$  is the probability of receiving  $v$  when  $u$  is transmitted, where  $u, v \in \{H, L\}$ . For example, the probability that the received signal is L given the transmitted signal was H, is 0.7.



If the received signal is H, the probability that the transmitted signal was H (rounded to 2 decimal places) is \_\_\_\_\_.

Ans. 0.04

**Question 55****NAT (2M)****Question ID : 823251579**

Consider the sliding window flow-control protocol operating between a sender and a receiver over a full-duplex error-free link. Assume the following:

- The time taken for processing the data frame by the receiver is negligible.
- The time taken for processing the acknowledgement frame by the sender is negligible.
- The sender has infinite number of frames available for transmission.
- The size of the data frame is 2,000 bits and the size of the acknowledgement frame is 10 bits.
- The link data rate in each direction is 1 Mbps ( $= 10^6$  bits per second).
- One way propagation delay of the link is 100 milliseconds.

The minimum value of the sender's window size in terms of the number of frames, (rounded to the nearest integer) needed to achieve a link utilization of 50% is \_\_\_\_\_.

Ans. 50 to 52

Sol. Propagation time ( $t_p$ ) = 100 ms

SData = 2000 bits

RData = 10 bits



BW = 1 Mbps

Sender transmission time ( $t_s$ ) =  $2000/1000000 = 2$  ms

Receiver transmission time ( $t_r$ ) =  $10/1000000 = 0.01$  ms

Sender's window size = ? for 50% link utilisation

$$(N \times t_s)/(t_s + t_r + 2t_p) = 0.5$$

$$\Rightarrow N \times 2 / (2 + 0.01 + 2 \times 100) = 0.5$$

$$\Rightarrow N \times 2 / (202.01) = 0.5$$

$$\Rightarrow N = 0.5 \times 202.01 / 2 = 50.5$$

Nearest integer for size of window = 51

