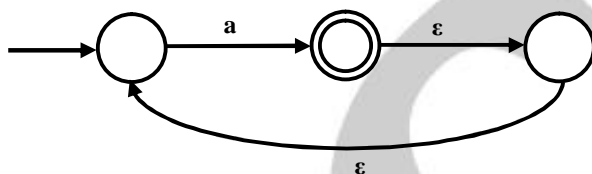# GATE 2012

Computer Science & Information Technology

Set – C

Q. 1 – Q. 25 carry one mark each.

1. What is the complement of the language accepted by the NFA shown below?
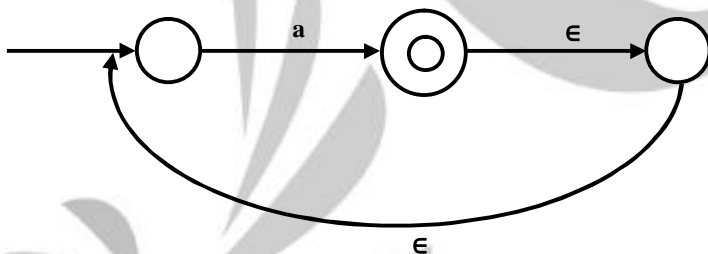   Assume $\Sigma = \{a\}$ and ε is the empty string.

(A) $\emptyset$ (C) a*

(B) $\{\varepsilon\}$ (D) $\{a, \varepsilon\}$

[Ans. B]
NFA accept

$L = a^+$
So complement
$a^* - a^+ \Rightarrow \{\in\}$

2. Let A be the 2×2 matrix with element $a_{11} = a_{12} = a_{21} = +1$ and $a_{22} = -1$. Then the eigen values of the matrix A^{19} are

(A) 1024 and -1024 (C) $4\sqrt{2}$ and $-4\sqrt{2}$

(B) $1024\sqrt{2}$ and $-1024\sqrt{2}$ (D) $512\sqrt{2}$ and $-512\sqrt{2}$

[Ans. D]

From the matrix

$A = \begin{bmatrix} 1 & 1 \\ 1 & -1 \end{bmatrix}$ $A^2 = 2 \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix} = 2I$

Where $I = 2 \times 2$ unit matrix

So $A^{19} = (A^2)^9 . A = (2I)^9 A = 2^9 A$

Now to get Eigen values, we must solve the equation.

$[\lambda I - A^{19}] = 0$

$\begin{vmatrix} \lambda - 2^9 & -2^9 \\ -2^9 & \lambda + 2^9 \end{vmatrix} = 0$

$\Rightarrow \lambda^2 - 2^{18} - 2^{18} = 0$

$\Rightarrow \lambda = \pm 5 \sqrt[12]{2}$

3. The protocol data unit (PDU) for the application layer in the Internet stack is

(A) Segment (C) Message
(B) Datagram (D) Frame

[Ans. C]

Protocol Data Unit (PDU)

Application layer – Message

Transport layer – Segment

Network layer – Datagram

Data Link layer – Frame

Ans = Message

4. Consider the function f(x) = sin (x) in the interval x ∈ [π/4, 7π/4]. The number and location(s) of the local minima of this function are

(A) One, at π/2 (C) Two, at π/2 and 3π/2
(B) One, at 3π/2 (D) Two, at π/4 and 3π/2

[Ans. D]

5. A process executes the code

```
fork( );
fork( );
fork( );
```

The total number of **child** processes created is

(A) 3 (C) 7
(B) 4 (D) 8

[Ans. C]

If fork is called n times, there will be total 2^n running processes including the parent process. So, there will be $2^n - 1$ child processes.

6. The decimal value 0.5 in IEEE single precision floating point representation has
   (A) fraction bits of 000…000 and exponent value of 0
   (B) fraction bits of 000…000 and exponent value of -1
   (C) fraction bits of 100…000 and exponent value of 0
   (D) no exact representation

[Ans. B]

$0.5 \equiv \lfloor 0.1 \rfloor$

⬆ Its equivalent binary value

∵ $0.5 \times 2 = 1.0$

So in binary 0.5 is written as 0.1

Now $0.1 \equiv 0.1 \times 2^0$

$\equiv 1.0 \times 2^{-1}$ [To make the no. normalize. In normalize no. left bit before the dot should be 1]

∴ Exponent value $\equiv (-1)$

Mantissa value $\equiv$ All 0 & the 1 bit before the dot is not written in the format. It is implicit.

7. The truth table

X	Y	f(X, Y)
0	0	0
0	1	0
1	0	1
1	1	1

represents the Boolean function

(A) X

(B) X + Y

(C) X $\oplus$ Y

(D) Y

[Ans. A]

Truth table

X	Y	f(x, y)
0	0	0
0	1	0
1	0	1
1	1	1

x \ y	$\bar{y}$ 0	y 1
$\bar{x}$ 0	0	0
x 1	1	1

$\Rightarrow$ Ans = X

8. The worst case running time to search for an element in a balanced binary search tree with n2^n
   elements is

   (A) $\Theta(n \log n)$ (C) $\Theta(n)$

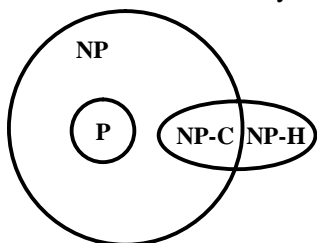   (B) $\Theta(n2^n)$ (D) $\Theta(\log n)$

   [Ans. C]

   The worst case R.T. of search in BST is $\log n$ where n is total number of elements in the tree. The
   total number of elements are $n. 2^n$ thus search R. T. will be $\log(n. 2^n)$.

   $\log n . 2^n = \log n + \log 2^n$

   $= \log n + n \log 2$

   $\Rightarrow \Theta(n)$

9. Assuming P ≠ NP, which of the following is **TRUE**?

   (A) NP-complete = NP   (C) NP-hard = NP

   (B) NP-complete ∩ P = ∅   (D) P = NP-complete

   [Ans. B]

When P ≠ NP, It satisfy this subset diagram:

NP – complete ∩ P = ɸ

∴ Option (B) is correct.

10. What will be the output of the following C program segment?

    char inChar = 'A' ;
    switch (inChar) {
    case 'A' : printf ("Choice A\ n") ;
    case 'B' :
    case 'C' : printf ("Choice B") ;
    case 'D' :
    case 'E' :
    default : printf (" No Choice") ; }

    (A) No Choice
    (B) Choice A
    (C) Choice A
        Choice B No Choice
    (D) Program gives no output as it is erroneous

    [Ans. Marks to All*] (*Ambiguous options)
   **One of the solutions could be as given below:**
    As no break in given in any of case, there fore, all statements will be executed.

11. Which of the following is **TRUE**?

    (A) Every relation in 3NF is also in BCNF
    (B) A relation R is in 3NF if every non-prime attribute of R is fully functionally dependent on every key of R
    (C) Every relation in BCNF is also in 3NF
    (D) No relation can be in both BCNF and 3NF

    [Ans. C]

According to relations between the different normal forms i.e.:
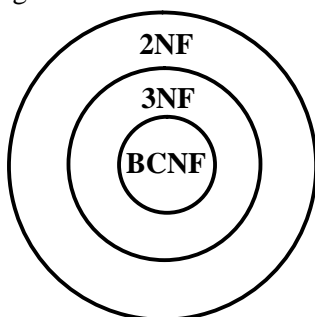
Every relations in BCNF is also in 3NF but reverse is not true.
So option (C) is correct.

12. Consider the following logical inferences.
  l_1: If it rains then the cricket match will not be played.
       The cricket match was played.
       Inference: There was no rain.
  l_2: If it rains then the cricket match will not be played.
       It did not rain.
       Inference: The cricket match was played.
  Which of the following is **TRUE**?
  (A) Both l_1 and l_2 are correct inferences
  (B) l_1 is correct but l_2 is not a correct inference
  (C) l_1 is not correct but l_2 is a correct inference
  (D) Both l_1 and l_2 are not correct inferences

  [Ans. B]
  l_1: If it rains then the cricket match will not be played
       The cricket match was played
       Inference: There was no rain.

    l_1 is correct.
    Proof: Suppose   P: It rains
                                  Q: The cricket match will no be played
    It is Given $P \rightarrow Q$
    We know that $P \rightarrow Q \equiv \sim Q \rightarrow \sim P$
    $\therefore$ ~Q: The cricket match will be played
       ~P: Its not rain
    $\therefore$ If the cricket match was played then there was no rain [$\because P \rightarrow Q \equiv \sim Q \rightarrow \sim P$]

$\therefore I_1$ is correct

I_2: If it rains then the cricket match will not be played.

It did not rain.

Inference: The cricket match was played.

I_2 is not correct.

Proof: According to logic table of $P \rightarrow Q$ i.e.

P	Q	P → Q
F	F	T
F	T	T
T	F	F
T	T	T

i.e. If there was not rain [i.e. P is F in logic table] then match may or may not be played. [In both cases $P \rightarrow Q$ is true]

So the correct Inference is : The cricket match might be played.

13. Given the language L = {ab, aa, baa}, which of the following strings are in L*?

   1) abaabaaabaa

   2) aaaabaaaa

   3) baaaaabaaaab

   4) baaaaabaa

   (A) 1, 2 and 3   (C) 1, 2 and 4

   (B) 2, 3 and 4   (D) 1, 3 and 4

[Ans. C]

   1.   we can make using an catenation on ab, aa, baa, ab, aa

   2.   aa, aa, baa, aa

   3.   <u>baa</u> <u>aa</u> <u>ab</u> <u>aa</u> aab

       we don't have aab in L

   4.   <u>baa</u> <u>aa</u> <u>ab</u> <u>aa</u>

Only (3) option cannot be in L^*.

14. Which of the following problems are decidable?

   1) Does a given program ever produce an output?

   2) If L is a context-free language, then, is $\bar{L}$ also context-free?

   3) If L is a regular language, then, is $\bar{L}$ also regular?

   4) If L is a recursive language, then, as $\bar{L}$ also recursive?

(A) 1, 2, 3, 4   (C) 2, 3, 4
(B) 1, 2   (D) 3, 4

[Ans. D]

15. In the IPv4 addressing format, the number of networks allowed under Class C addresses is
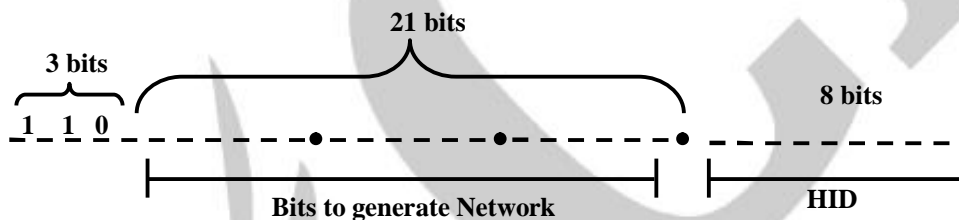
(A) 2^{14} (C) 2^{21}
(B) 2^{7} (D) 2^{24}

[Ans. C]

In class C. in IPv4 addressing format

Network ID   **HID**

In that for class 'C' addressing in 1st Octast

3 bits   **21 bits**   **8 bits**

1 1 0

Bits to generate Network   **HID**

We have 21 bits to generated network.
So total number of network in class 'C'
$= 2^{21}$

16. Which of the following transport layer protocols is used to support electronic mail?

(A) SMTP   (C) TCP
(B) IP   (D) UDP

[Ans. C]

E-mail uses SMTP in application layer to transfer mail. And SMTP uses TCP to transfer data in transport layer.

17. Consider a random variable X that takes values $+1$ and -1 with probability 0.5 each. The values of the cumulative distribution function F(x) at $x = -1$ and $+1$ are

(A) 0 and 0.5   (C) 0.5 and 1
(B) 0 and 1   (D) 0.25 and 0.75

[Ans. C]

X	−1	+1
P(x)	0.5	0.5

The cumulative distribution function

F(x) = P(X ≤ x)

F(−1) = P(X ≤ −1) = P(X = −1) = 0.5

F(+1) = P(X ≤ +1) = P(X = −1) + P(X = +1) = 0.5 + 0.5 = 1

18. Register renaming is done in pipelined processors
    (A) as an alternative to register allocation at compile time
    (B) for efficient access to function parameters and local variables
    (C) to handle certain kinds of hazards
    (D) as part of address translation

    [Ans. C]
    Register renaming is used to avoid done Hazard.

19. The amount of ROM needed to implement a 4 bit multiplier is
    (A) 64 bits　　　　　　　　　　　　(C) 1 Kbits
    (B) 128 bits　　　　　　　　　　　(D) 2 Kbits

    [Ans. D]
    To store multiplier & multiple can we require total possible combination of 2^3 bits for each possible combination we required 2^8 bits to store result. So total memory required is
    $2^3 \times 2^8$ bits = 2 Kbits

20. Let W(n) and A(n) denote respectively, the worst case and average case running time of an algorithm executed on an input of size n. Which of the following is **ALWAYS TRUE**?
    (A) $A(n) = \Omega(W(n))$　　　　　　　(C) $A(n) = O(W(n))$
    (B) $A(n) = \Theta(W(n))$　　　　　　　(D) $A(n) = o(W(n))$

    [Ans. C]
    As given, W(n) will name higher or equal growth ratio as of A(n). Only option 'C' represents that growth rate relation correctly.

21. Let G be a simple undirected planar graph on 10 vertices with 15 edges. If G is a connected graph, then the number of **bounded** faces in any embedding of G on the plane is equal to
    (A) 3　　　　　　　　　　　　　　(C) 5
    (B) 4　　　　　　　　　　　　　　(D) 6

[Ans. D]

r = e – v + 2 for bound + non bound

r = e – v + 2 – 1 for bounded

r = 15 – 10 + 2 – 1

r = 6.

22. The recurrence relation capturing the optimal execution time of the *Towers of Hanoi* problem with n discs is

(A) T(n) = 2T(n – 2) + 2

(C) T(n) = 2T(n/2) + 1

(B) T(n) = 2T(n – 1) + n

(D) T(n) = 2T(n – 1) + 1

[Ans. D]

TOH A to C using B

TOH (A, B, C, n)

TOH (A, C, B, n – 1); (T (n - 1))

A → C   1

TOH (B, C, A, n-1)   T(n-1)

Hence T (n) = T (n – 1) + 1 + T (n – 1)

= 2 T (n – 1) + 1

23. Which of the following statements are **TRUE** about an SQL query?

P: An SQL query can contain a HAVING clause even if it does not have a GROUP BY clause

Q: An SQL query can contain a HAVING clause only if it has a GROUP BY clause

R: All attributes used in the GROUP BY clause must appear in the SELECT clause

S: Not all attributes used in the GROUP BY clause need to appear in the SELECT clause

(A) P and R

(C) Q and R

(B) P and S

(D) Q and S

[Ans. C]

24. Given the basic ER and relational models, which of the following is **INCORRECT**?

(A) An attribute of an entity can have more than one value

(B) An attribute of an entity can be composite

(C) In a row of a relational table, an attribute can have more than one value

(D) In a row of a relational table, an attribute can have exactly one value or a NULL value

[Ans. C]

Row cannot have attribute more than one value.

25. What is the correct translation of the following statement into mathematical logic?
    "Some real numbers are rational"
    (A) ∃x (real(x) ∨ rational(x))   (C) ∃x(real(x) ∧ rational(x))
    (B) ∀x (real(x) → rational(x))   (D) ∃x(rational(x) → real(x))

    [Ans. C]
    Only option 'C' says that some x(∃x) are real and rational.
    B says all x(∀x) which are real are also rational which is not the given statement. Likewise A and
    D does not represent the given statement.

    Q. 26 – Q. 55 carry two marks each.

26. Consider the program given below, in a block-structured pseudo-language with lexical scoping
    and nesting of procedures permitted.
    Program main;
        Var . . .
        Procedure A1;
           Var . . .
           Call A2;
        End A1
        Procedure A2;
           Var . . .
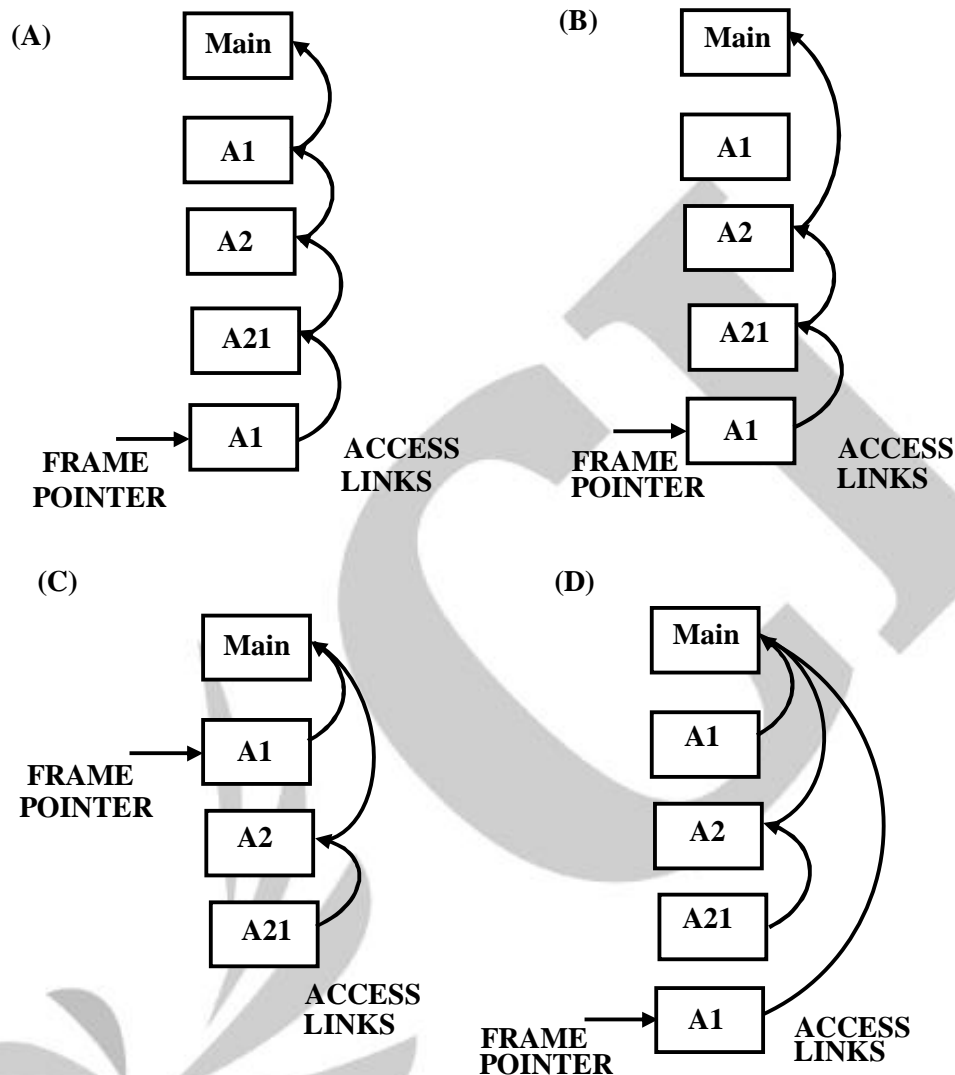   Procedure A21;
              Var . . .
              Call A1;
              End A21;
              Call A21;
           End A2
           Call A1;
        End main.
    Consider the calling chain: Main → A1 → A2 → A21 → A1
    The correct set of activation records along with their access links is given by

(A)

(B)

(C)

(D)

[Ans. D]

Access link is defined as link to activation record of closest lexically enclosing block in program text, so the closest enclosing blocks respectively for A1, A2 and A21 are main, main and A2.

27. Suppose a circular queue of capacity $(n - 1)$ elements is implemented with an array of n elements. Assume that the insertion and deletion operations are carried out using REAR and FRONT as array index variables, respectively. Initially, REAR = FRONT = 0. The conditions to detect *queue full* and *queue empty* are

(A) *full*: (REAR + 1) mod n = = FRONT   (C) *full*: REAR = = FRONT
    empty: REAR == FRONT   *empty*: (REAR + 1) mod n== FRONT

(B) *full*: (REAR + 1) mod n = = FRONT   (D) *full*: (FRONT + 1) mod n = = REAR
    empty: (FRONT + 1) mod n = REAR   *empty*: REAR == FRONT

[Ans. A]

The **counter example** for the condition full: REAR = FRONT is

         Initially when the Queue is empty REAR = FRONT = 0 by which the above full condition is satisfied which is false

The **counter example** for the condition full: (FRONT + 1) mod n = REAR is

         Initially when the Queue is empty REAR = FRONT = 0 and let n = 3, so after inserting one element REAR = 1 and FRONT = 0, at this point the condition full above is satisfied, but still there is place for one more element in Queue, so this condition is also false

The **counter example** for the condition empty: (REAR + 1) mod n = FRONT is

         Initially when the Queue is empty REAR = FRONT = 0 and let n = 2, so after inserting one element REAR = 1 and FRONT = 0, at this point the condition empty above is satisfied, but the queue of capacity n – 1 is full here
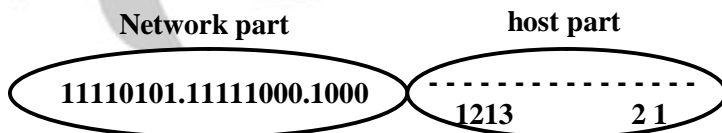
The **counter example** for the condition empty: (FRONT + 1) mod n = REAR is

         Initially when the Queue is empty REAR = FRONT = 0 and let n = 2, so after inserting one element REAR = 1 and FRONT = 0, at this point the condition empty above is satisfied, but the queue of capacity n – 1 is full here

28. An Internet Service Provider (ISP) has the following chunk of CIDR-based IP addresses available with it: 245.248.128.0/20. The ISP wants to give half of this chunk of addresses to Organization. A, and a quarter to Organization B, while retaining the remaining with itself. Which of the following is a valid allocation of addresses to A and B?

    (A) 245.248.136.0/21 and 245.248.128.0/22
    (B) 245.248.128.0/21 and 245.248.128.0/22
    (C) 245.248.132.0/22 and 245.248.132.0/21
    (D) 245.248.136.0/24 and 245.248.132.0/21

[Ans. A]

            Network part   **host part**

       11110101.11111000.1000   - - - - - - - - - - - - - -

                              1213   **2 1**

Since half of 4096 host addresses must be given to organization A, we can set 12th bit to 1 and include that bit into network part of organization A, so the valid allocation of addresses to A is 245.248.136.0/21

Now for organization B, 12th bit is set to '0' but since we need only half of 2048 addresses, 13th bit can be set to '0' and include that bit into network part of organization B so the valid allocation of addresses to B is 245.248.128.0/22

29. Suppose a fair six-sided die is rolled once. If the value on the die is 1, 2 or 3, the die is rolled a second time. What is the probability that the sum total of values that turn up is at least 6?

(A) 10/21   (C) 2/3
(B) 5/12   (D) 1/6

[Ans. B]

Successful event combinations is given below

Event that is succeeded		Probability
Dice is rolled only once if 6 comes	$\longrightarrow$	$\frac{1}{6}$
Dice is rolled twice and if 1, 5 comes	$\longrightarrow$	$\frac{1}{36}$
Dice is rolled twice and if 1, 6 comes	$\longrightarrow$	$\frac{1}{36}$
Dice is rolled twice and if 2, 4 comes	$\longrightarrow$	$\frac{1}{36}$
Dice is rolled twice and if 2, 5 comes	$\longrightarrow$	$\frac{1}{36}$
Dice is rolled twice and if 2, 6 comes	$\longrightarrow$	$\frac{1}{36}$
Dice is rolled twice and if 3, 3 comes	$\longrightarrow$	$\frac{1}{36}$
Dice is rolled twice and if 3, 4 comes	$\longrightarrow$	$\frac{1}{36}$
Dice is rolled twice and if 3, 5 comes	$\longrightarrow$	$\frac{1}{36}$
Dice is rolled twice and if 3, 6 comes	$\longrightarrow$	$\frac{1}{36}$

Probability that event is successful is $P = \frac{9}{36} + \frac{1}{6} = \frac{9+6}{36} = \frac{5}{12}$

30. Fetch_And_Add(X, i) is an atomic Read-Modify-Write instruction that reads the value of memory location X, increments it by the value i, and returns the old value of X. It is used in the pseudocode shown below to implement a busy-wait lock. L is an unsigned integer shared variable initialized to 0. The value of 0 corresponds to lock being available, while any non-zero value corresponds to the lock being not available.

```
AcquireLock (L) {
        while (Fetch_And_Add(L, 1))
                L = 1;
}
ReleaseLock (L) {
        L = 0;
}
```

This implementation

(A) fails as L can overflow

(B) fails as L can take on a non-zero value when the lock is actually available

(C) works correctly but may starve some processes

(D) works correctly without starvation

[Ans. B]

1.   Acquire Lock (L) {
2.   While (Fetch_And_Add(L, 1))
3.   L = 1.
     }
4.   Release Lock (L) {
5.   L = 0;
6.   }

Let P and Q be two concurrent processes in the system currently executing as follows

P executes 1, 2, 3 then Q executes 1 and 2 then P executes 4, 5, 6 then L = 0 now Q executes 3 by which L will be set to 1 and thereafter no process can set L to zero, by which all the processes could starve.

31. Consider the 3 processes, P1, P2 and P3 shown in the table.

Process	Arrival time	Time Units Required
P1	0	5
P2	1	7
P3	3	4

The completion order to the 3 processes under the policies FCFS and RR2 (round robin scheduling with CPU quantum of 2 time units) are

(A) FCFS: P1, P2, P3   RR2: P1, P2, P3   (C) FCFS: P1, P2, P3   RR2: P1, P3, P2

(B) FCFS: P1, P3, P2   RR2: P1, P3, P2   (D) FCFS: P1, P3, P2   RR2: P1, P2, P3

[Ans. C]

FCFS will complete in

P$_1$　　P$_2$　　P$_3$

and RR　　in

　　P$_1$　　P$_3$　　P$_2$

P$_1$	P$_2$	P$_1$	P$_3$	P$_2$	P$_1$	P$_3$	

0　　　2　　　4　　　6　　　8　　　10　　11　　13

32. What is the minimal form of the Karnaugh map shown below? Assume that X denotes a don't care term.

ab cd	00	01	11	10
00	1	X	X	1
01	X			1
11				
10	1			X

(A) $\bar{b}\bar{d}$

(B) $\bar{b}\bar{d} + \bar{b}\bar{c}$

(C) $\bar{b}\bar{d} + a\bar{b}\bar{c}d$

(D) $\bar{b}\bar{d} + \bar{b}\bar{c} + \bar{c}\bar{d}$

[Ans. B]

$b'c' + b'd'$
$= \bar{b}\,\bar{c} + \bar{b}\,\bar{d}$

33. Let G be a weighed graph will edge weights greater than one and G′ be the graph constructed by squaring the weights of edges in G. Let T and T′ be the minimum spanning tress of G and G′ respectively, with total weights t and t′. Which of the following statements is **TRUE**?

(A) T′ = T with total weight t′ = t²   (C) T′ ≠ T but total weight t′ = t²

(B) T′ = T with total weight t′ < t²   (D) None of the above

[Ans. Marks to All*] (*Ambiguous options)

One of the solution could be as given below:

Both T and T¹ will be same MST but assume t has edge with weight a and b so t¹ will have $a^2 + b^2$

So T = T¹ and

$t = a + b$

$t^1 = a^2 + b^2$

$t^1 < t^2$

34. The bisection method is applied to compute a zero of the function $f(x) = x^4 - x^3 - x^2 - 4$ in the interval [1, 9]. The method converges to a solution after _____ iterations.

(A) 1   (C) 5

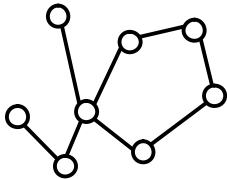(B) 3   (D) 7

[Ans. B]

After first iteration solution lies between, $\left(1, \frac{49}{2}\right) = (1, 5)$

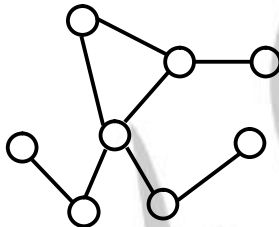After 2nd iteration, solution lies between $\left(1, \frac{1+5}{2}\right) = (1, 3)$

After 3rd iteration solution lies between $\left(1, \frac{1+3}{2}\right) = (1,2)$

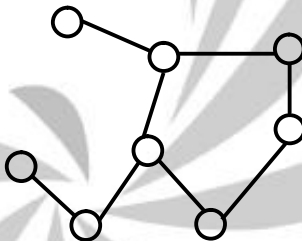Since 2 is itself solution, therefore at 3rd iteration, solution completely converges.

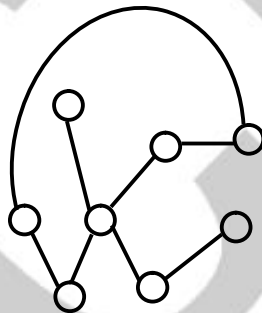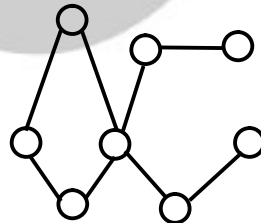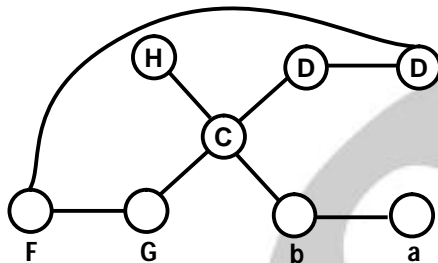35. Which of the following graphs is isomorphic to

(A)

(B)

(C)

(D)

[Ans. B]
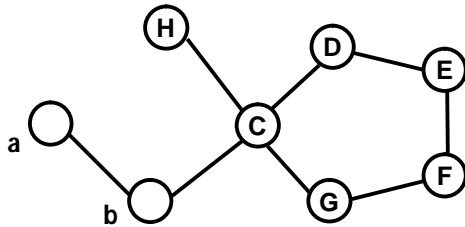
36. Consider the following transactions with data items P and Q initialized to zero:

T_1: read (P);
     read (Q);
     if P = 0 then Q : = Q + 1;
     write (Q)

T_2: read (Q);
     read (P);
     if Q = 0 then P: = P + 1;
     write (P)

Any non-serial interleaving of T_1 and T_2 for concurrent execution leads to

(A) a serializable schedule

(B) a schedule that is not conflict serializable

(C) a conflict serializable schedule

(D) a schedule for which a precedence graph cannot be drawn

[Ans. B]

T1	T2
R(P)	R(Q)
R(Q)	R(P)
W(Q)	W(P)

T1   T2

R(P)

         R(Q)

         R(P)
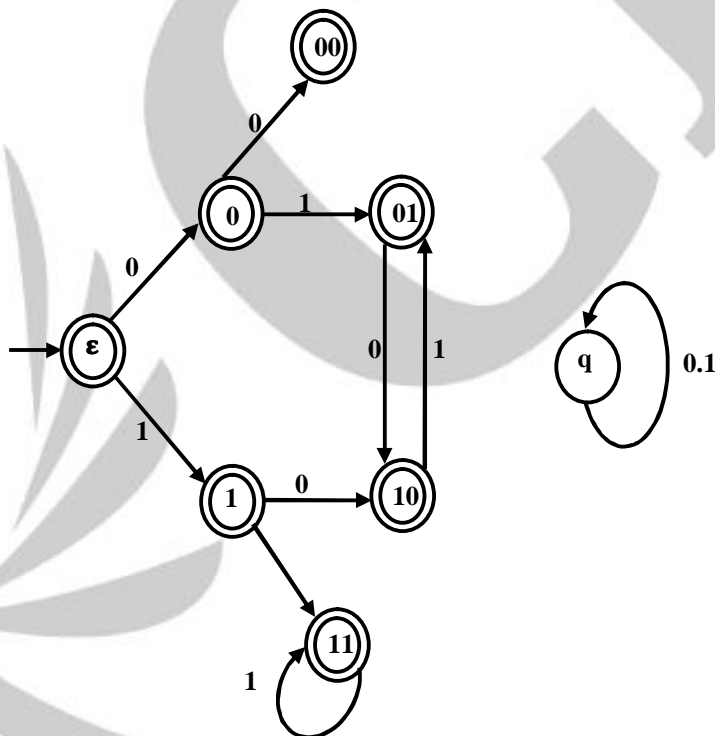
         W(P)

R(Q)

W(Q)

Which is not conflict serializeably.

37. Consider the set of strings on {0, 1} in which, *every substring of 3 symbols* is has at most two zeros. For example, 001110 and 011001 are in the language, but 100010 is not. All strings of length less than 3 are also in the language. A partially completed DFA that accepts this language is shown below.

The missing arcs in the DFA are

(A)

	00	01	10	11	q
00	1	0			
01				1	
10	0				
11			0		

(C)

	00	01	10	11	q
00		1			0
01		1			
10			0		
11		0			

(B)

	00	01	10	11	q
00		0			1
01		1			
10			0		
11		0			

(D)

	00	01	10	11	q
00		1			0
01			1		
10	0				
11		0			

[Ans. D]
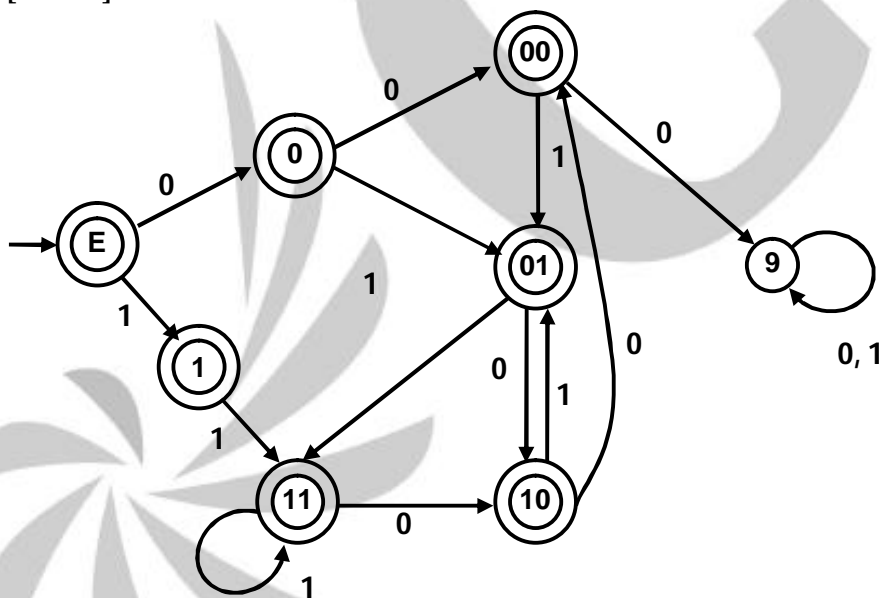
38. The height of a tree is defined as the number of edges on the longest path in the tree. The function shown in the pseudocode below is invoked as height (root) to compute the height of a binary tree rooted at the tree pointer root.
int height (treeptr n)

```
{ if  (n == NULL) return  –1;
    if (n → left == NULL)
        if (n → right == NULL) return 0;
        else return ⎡ B1 ⎤ ;                      // Box 1
    else { h1 = height (n → left);
            if ((n → right == NULL) return (1+h1);
            else {h2 = height (n → right);
                    return ⎡ B2 ⎤ ;               //Box 2
                 }
        }
}
```
The appropriate expressions for the two boxes B1 and B2 are

(A) B1: (1 + height(n → right))   (C) B1: height(n → right)
    B2: (1 + max(h1, h2))   B2: max(h1, h2)

(B) B1: (height(n → right))   (D) B1: (1 + height(n → right))
    B2: (1 + max(h1, h2))   B2: max(h1, h2))

[Ans. A]
If right child is present
B1 = 1 + height (n → right)
Other if both are present
B2 = 1 + max (h_1, h_2)

39. Consider an instance of TCP's Additive Increase Multiplicative Decrease (AIMD) algorithm
    where the window size at the start of the slow start phase is 2 MSS and the threshold at the start
    of the first transmission is 8 MSS. Assume that a timeout occurs during the fifth transmission.
    Find the congestion window size at the end of the tenth transmission.

    (A) 8 MSS   (C) 7 MSS
    (B) 14 MSS   (D) 12 MSS

[Ans. Marks to All*] (*Ambiguous options)
One of the solution could be as given below:
AIMD Algorithm says before threshold increase the window size twice each time. But after
threshold increase it linear every time. Whenever there will be a time out window size will be
initial value.

Transmission	Window size	
5th	2 MSS	(There was a time out)
6th	4 MSS	
7th	8 MSS	(Threshold)
8th	10 MSS	
9th	12 MSS	Linear increment by 2
10th	14 MSS	MSS

Ans = 14 MSS

40. Consider a source computer (S) transmitting a file of size 10^6 bits to a destination computer (D) over a network of two routers (R_1 and R_2) and three links (L_1, L_2 and L_3), L_1 connects S to R_1; L_2 connects R_1 to R_2; and L_3 connects R_2 to D. Let each link be of length 100 km. Assume signals travel over each link at a speed of 10^8 meters per second. Assume that the link bandwidth on each link is 1 Mbps. Let the file be broken down into 1000 packets each of size 1000 bits. Find the total sum of transmission and propagation delays in transmitting the file from S to D?

(A) 1005 ms   (C) 3000 ms

(B) 1010 ms   (D) 3003 ms

[Ans. A]

Source   **Router 2**   **Destination**

Router 1

T_t, Transmission time $= \dfrac{\text{Size of packet}}{\text{Link bandwidth}}$

$= \dfrac{1000 \text{ bits}}{1 \text{ Mbps}}$

$= \dfrac{10^3}{10^6}$ sec = 1 mili sec

T_p, Propagation time $= \dfrac{\text{Distance}}{\text{Speed of signal}} = \dfrac{10^5 \text{m}}{10^8 \text{m/s}}$

$= \dfrac{1}{1000}$ sec = 1 mili sec

Time taken to reach the packet(only one) from source to destination $= 3 \times (1 + 1)\text{ms} = 6$ ms

IInd packet will reach in 7 ms

IIIrd packet will reach in 8 ms

.

.

.

1000th packet will reach in 1005 ms

41. Suppose $R_1(\underline{A}, B)$ amd $R_2(\underline{C}, D)$ are two relation schemas. Let r_1 and r_2 be the corresponding relation instances, B is a foreign key that refers to C in R_2. If data in r_1 and r_2 satisfy referential integrity constraints, which of the following is **ALWAYS TRUE**?

(A) $\Pi_B(r_1) - \Pi_C(r_2) = \emptyset$ (C) $\Pi_B(r_1) = \Pi_C(r_2)$

(B) $\Pi_C(r_2) - \Pi_B(r_1) = \emptyset$ (D) $\Pi_B(r_1) - \Pi_C(r_2) \neq \emptyset$

[Ans. A]

Foreign key should refer to existing keys so:-

$\pi_B(r_1) - \pi_C(r_2) = \phi$

42. Consider the virtual page reference string

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

on a demand paged virtual memory system running on a computer system that has main memory size of 3 page frames which are initially empty. Let LRU, FIFO and OPTIMAL denote the number of page faults under the corresponding page replacement policy. Then

(A) OPTIMAL < LRU < FIFO   (C) OPTIMAL = LRU

(B) OPTIMAL < FIFO < LRU   (D) OPTIMAL = FIFO

[Ans. B]

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

LRV	1	1	1	1	3	2	4	1	3	2
		2	2	3	2	4	1	3	2	4
			3	2	4	1	3	2	4	1
	F	F	F		F	F	F	F	F	F = 9
FIFO	1	1	1	1	2	3	3	4	4	4
		2	2	2	3	4	4	1	1	1
			3	3	4	1	1	2	2	2
	F	F	F		F	F		F	=	6

OPTIMAL

	1	1	1	1	4	4	4	2	2	2
		2	2	2	1	1	1	1	1	1
			3	3	3	3	3	4	4	4
	F	F	F	NF	F			F		= 5

Optimal < FIFO < LRV

5 < 6 < 9

43. A file system with 300 GByte disk uses a file descriptor with 8 direct block addresses, 1 indirect block address and 1 doubly indirect block address. The size of each disk block is 128 bytes and the size of each disk block address is 8 Bytes. The maximum possible file size in this file system is

(A) 3 KBytes

(C) 28 KBytes

(B) 35 KBytes

(D) dependent on the size of the disk

[Ans. B]

0
1
2
3
4
5
6
7
8
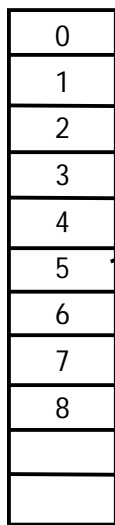
No. of entries in a block

$= \frac{126}{8} = 16$ entries

8 blocks direct

16 entries = 16 block

16 × 16 = 256 double indirect block

Max total no. of blocks = 8 + 16 + 256

= 280 block

Max size $= \frac{280 \times 128}{1024} = 35$ K bytes

44. Consider the directed graph shown in the figure below. There are multiple shortest paths between vertices S and T. Which one will be reported by Dijkstra's shortest path algorithm? Assume that, in any iteration, the shortest path to a vertex v is updated only when a strictly shortest path to v is discovered.
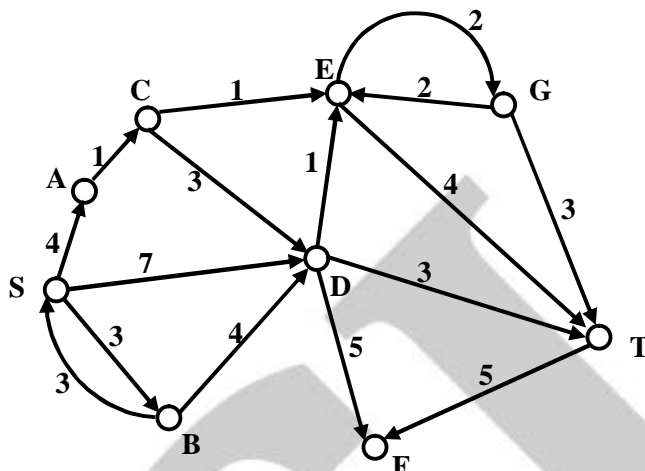
(A) SDT   (C) SACDT
(B) SBDT   (D) SACET

[Ans. D]

Let d[v] represent the shortest path distance computed from 'S'

Initially d[S] = 0, d[A] = ∞, d[B] = ∞, - - - - -, d[T] = ∞

And let P[v] represent the predecessor of v in the shortest path from 'S' to 'v' and let P[v] = −1
denote that currently predecessor of 'v' has not been computed

→ Let Q be the set of vertices for which shortest path distance has not been computed

→ Let W be the set of vertices for which shortest path distance has not been computed

→ So initially, Q = {S, A, B, C, D, E, F, G, T}, W = φ

We will use the following procedure

Repeat until Q is empty

{

1. u = choose a vertex from Q with minimum d[u] value
2. Q = Q – u
3. update all the adjacent vertices of u
4. W = W U{u}

}

d[S] = 0, d[A] = ∞, d[B] = ∞, ... , d[T] = ∞

Iteration 1:

    Step 1: u = S

    Step 2: Q = {A, B, C, D, E, F, G, T}

    Step 3: final values after adjustment

$d[S] = 0, d[A] = 4, d[B] = 3, d[C] = \infty, d[D] = 7, d[E] = \infty$ - - -, $d[T] = \infty$

$P[A] = S, P[B] = S, P[C] = -1, P[D] = S, P[E] = -1$ - - - , $P[T] = -1$

Step 4: W = {S}

Iteration 2:

Step 1: u = S

Step 2: Q = {A, C, D, E, F, G, T}

Step 3: final values after adjustment

$d[S] = 0, d[A] = 4, d[B] = 3, d[C] = \infty, d[D] = 7, d[E] = \infty$ - - -, $d[T] = \infty$

$P[A] = S, P[B] = S, P[C] = -1, P[D] = S, P[E] = -1$ - - - , $P[T] = -1$

Step 4: W = {S, B}

Iteration 3:

Step 1: u = A

Step 2: Q = {C, D, E, F, G, T}

Step 3: final values after adjustment

$d[S] = 0, d[A] = 4, d[B] = 3, d[C] = 5, d[D] = 7, d[E] = \infty$ - - -, $d[T] = \infty$

$P[A] = S, P[B] = S, P[C] = A, P[D] = S, P[E] = -1$ - - - , $P[T] = -1$

Step 4: W = {S, B, A}

Iteration 4:

Step 1: u = C

Step 2: Q = {D, E, F, G, T}

Step 3: final values after adjustment

$d[S] = 0, d[A] = 4, d[B] = 3, d[C] = 5, d[D] = 7, d[E] = 6$, - - -, $d[T] = \infty$

$P[A] = S, P[B] = S, P[C] = A, P[D] = S, P[E] = C$, - - - , $P[T] = -1$

Step 4: W = {S, B, A, C}

Iteration 5:

Step 1: u = E

Step 2: Q = {D, F, G, T}

Step 3: final values after adjustment

$d[S] = 0, d[A] = 4, d[B] = 3, d[C] = 5, d[D] = 7, d[E] = 6, d[F] = \infty, d[G] = 8, d[T] = 10$

$P[A] = S, P[B] = S, P[C] = A, P[D] = S, P[E] = C, P[F] = -1, P[G] = E, P[T] = E$

Step 4: W = {S, B, A, C, E}

After iteration 5, we can observe that P[T] = E, P[E] = C, P[C] = A, P[A] = S, So the shortest path from S to T is SACET

45. A list of n strings, each of length n, is sorted into lexicographic order using the merge-sort algorithm. The worst case running time of this computation is

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

(B) $O(n^2 \log n)$ (D) $O(n^2)$

[Ans. Marks to All*] (*Ambiguous options)

One of the solutions could be as given below:

n string sorting = $n \log_n \times$ each string pair = $n \, \log n \, \times O(n) = O(n^2 \log n)$

46. Let G be a complete undirected graph on 6 vertices. If vertices of G are labeled, then the number of distinct cycles of length 4 in G is equal to

(A) 15   (C) 90

(B) 30   (D) 360

[Ans. Marks to All*] (*Ambiguous options)

One of the solutions could be as given below:

Total no. of 4 length cycles $= {}^6C_4$

Each cycle repeats 4 times (rotating) like 1234, 2341, 3412, 4123

So, unique cycles $= \frac{6C_4}{4} = \frac{C_6 \times C_2}{C_4 \times 4}$

$= \frac{6 \times 5 \times 2}{4} = 15$

47. How many onto (or surjective) functions are there an n-element ($n \geq 2$) set to a 2-element set?

(A) 2^n (C) $2^n - 2$

(B) $2^n - 1$ (D) $2(2^n - 2)$

[Ans. C]

Onto are

Number of function

n — 2

2^n

No. of one element function 2

So Onto

$2^n - 2$

Common Data Questions

Common Data for Questions 48 and 49:

Consider the following relations A, B and C;

A				B				C		
Id	**Name**	**Age**		**Id**	**Name**	**Age**		**Id**	**Phone**	**Area**
12	Arun	60		15	Shreya	24		10	2200	02
15	Shreya	24		25	Hari	40		99	2100	01
99	Rohit	11		98	Rohit	20				
				99	Rohit	11				

48. How many tuples does the result of the following relational algebra expression contain? Assume that the schema of A ∪ B is the same as that of A.

$(A \cup B) \bowtie_{A.Id>40 \vee C.Id<15} C$

(A) 7   (C) 5

(B) 4   (D) 9

[Ans. A]

A ∪ B   C

Id	Name	Age		id	Phone	Area
15	Shreya	24		10	2200	02
25	Hari	40		99	2100	01
98	Rohit	20				
99	Rohit	11				
12	Arun	60				

15 – 10	y	12 – 10	y
15 – 99	N	12 – 99 N	
25 – 10	y		
25 – 99	N		
98 – 10	y		
98 – 99	y		
99 – 10	y		
99 – 99	y		

49. How many tuples does the result of the following SQL query contain?

SELECT A.Id
FROM A
WHERE A.Age > **ALL** (**SELECT** B.Age

FROM B

WHERE B.Name = 'Arun')

(A) 4   (C) 0

(B) 3   (D) 1

[Ans. B]

Select A.id

From A

Where a. age > All (Select B. age from B where B. Name = 'Arun')

Inner query will return no tuple. So all A tuble will be selected.

Common Data for Questions 50 and 51:

Consider the following C code segment:

```
int a, b, c = 0;
void prtFun(void);
main ( )
{    static int a = 1;                /* Line 1 */
     prt Fun( );
     a += 1;
     prtFun( );
     printf("\n %d %d", a, b);
}
void prtFun(void)
{    static int a = 2;                /* Line 2 */
     int b = 1;
     a += ++b;
     printf("\n %d %d", a, b);
}
```

50. What output will be generated by the given code segment?

(A)	3	1	(C)	4	2
	4	1		6	2
	4	2		2	0
(B)	4	2	(D)	3	1
	6	1		5	2
	6	1		5	2

[Ans. C]

Static

mains

    a = 1

    prt function ()

    a = 2

    b = 1

    a = a + ++ b

    a = 2 + 2

    a = 4

    P (4, 2)

    a = a + 1

    a = 1 + 1 = 2

    Part function ()

    a = 4

    b = 1

    a = a + ++b

    a = 4 + 2

    a = 6

    P (6, 2)

    P (2, 0)

51. What output will be generated by the given code segment if:

Line 1 is replaced by **auto int a = 1;**

Line 2 is replace by   **register int a = 2;**

(A) 3   1   (C) 4   2

       4   1   6   2

       4   2   2   0

(B) 4   2   (D) 4   2

       6   1   4   2

       6   1   2   0

[Ans. D]

No static so:-

    a = 1

    Part function ()

    a = 2

    b = 1

    a = a + ++b

    a = 2 + 2 = 4

P (4, 2)

a = a + 1

a = 1 + 1 = 2

Part function ()

a = 2

b = 1

a = a + ++b   2 + 2 = 4

P (4, 2)

P (2, 0)

Linked Answer Questions

Statement for Linked Answer Questions 52 and 53:

For the grammar below, a partial LL(1) parsing table is also presented along with the grammar. Entries that need to filled are indicated as E1, E2 and E3, ε is the empty string, $ indicates end of input, and | separates alternate right hand sides of productions.

S → a A b B | b A a B | ε

A → S

B → S

	a	b	$
S	E1	E2	S → ε
A	A → S	A → S	Error
B	B → S	B → S	E3

52. The FIRST and FOLLOW sets for the non-terminals A and B are

(A) FIRST(A) = {a, b, ε} = FIRST(B)
    FOLLOW(A) = {a, b}
    FOLLOW(B) = {a, b, $}

(B) FIRST(A) = {a, b, $}
    FIRST(B) = {a, b, ε}
    FOLLOW(A) = {a, b}
    FOLLOW(B) = {$}

(C) FIRST(A) = {a, b, ε} = FIRST(B)
    FOLLOW(A) = {a, b}
    FOLLOW(B) = ∅

(D) FIRST(A) = {a, b} = FIRST(B)
    FOLLOW(A) = {a, b}
    FOLLOW(B) = {a, b}

[Ans. A]

	First	Follow	
S	a, b, ∈	a, b	$
A	a, b, ∈	a, b	
C	a, b, ∈	a, b,	$

53. The appropriate entries for E1, E2 and E3 are

(A) E1: S→ aAbB, A → S
    E2: S→ bAaB, B → S
    E3: B → S

(B) E1: S→ aAbB, S → ε
    E2: S→ bAaB, S → ε
    E3: S → ε

(C) E1: S→ aAbB, S → ε
    E2: S→ bAaB, S → ε
    E3: B → S

(D) E1: A→ S, S → ε
    E2: B→ S, S → ε
    E3: B → S

[Ans. C]

S → aAbB

S →∈ because follow (S) contain a.

E^2 b

S   S → bAaB

S → ∈   because follow (s) contain b

E^3 B → S

Because first (S) contain ∈ and follow of B contain $.

Statement for Linked Answer Questions 54 and 55:

A computer has a 256 KByte, 4-way set associative, write back data cache will block size of 32 Bytes. The processor sends 32 bit addresses to the cache controller. Each cache tag directory entry contains, in addition to address tag, 2 valid bits, 1 modified bit and 1 replacement bit.

54. The number of bits in the tag field of an address is

(A) 11   (C) 16
(B) 14   (D) 27

[Ans. C]

No. of Blocks

$$\frac{256 \times 2^{10}}{32}$$

$\Rightarrow 2^{13}$ blocks

No. of sets:-

$= 2^{13}/4 = 2^{11}$ Set

16	11	5
Tag	Set	Block

55. The size of the cache tag directory is
    (A) 160 Kbits
    (B) 136 bits
    (C) 40 Kbits
    (D) 32 bits

    [Ans. A]
    16 bit   address
     2 bit   valid
     1   modified
    _1_ replace
     20
    20 × no. of blocks
    20 × 2^{13} = 160 K bits.

    General Aptitude (GA) Questions

    Q. 56 – Q. 60 carry one mark each.

56. Which one of the following options is the closest in meaning to the word given below?
    Mitigate
    (A) Diminish
    (B) Divulge
    (C) Dedicate
    (D) Denote

    [Ans. A]
    Statement (a) should be "minus the service charge"

57. Choose the grammatically **INCORRECT** sentence:
    (A) They gave us the money back less the service charges of Three Hundred rupees.
    (B) This country's expenditure is not less than that of Bangladesh.
    (C) The committee initially asked for a funding of Fifty Lakh rupees, but later settled for a lesser sum.
    (D) This country's expenditure on educational reforms is very less.

    [Ans. D]

58. Choose the most appropriate alternative from the options given below to complete the following sentence.
    Suresh's dog is the one _____ was hurt in the stampede.
    (A) that   (C) who
    (B) which   (D) whom

    [Ans. Marks to All*] (*Ambiguous options)

59. The cost function for a product in a firm is given by $5q^2$, where q is the amount of production. The firm can sell the product at a market price of Rs 50 per unit. The number of units to be produced by the firm such that the profit is maximized is
    (A) 5   (C) 15
    (B) 10   (D) 25

    [Ans. A]
    'Mitigate' means to make something less harmful, serious, intense etc. Hence correct answer is 'Diminish'.

60. Choose the most appropriate alternative from the options given below to complete the following sentence:
    Despite several _____ the mission succeeded in its attempt to resolve the conflict.
    (A) attempts   (C) meetings
    (B) setbacks   (D) delegations

    [Ans. B]

    Q. 61 – Q. 65 carry two marks each.

61. An automobile plant contracted to buy absorbers from two suppliers X and Y. X supplies 60% and Y supplies 40% of the shock absorbers. All shock absorbers are subjected to a quality test. The ones that pass the quality test are considered reliable. Of X's shock absorbers, 96% are reliable.

The probability that a randomly chosen shock absorber, which is found to be reliable, is made by Y is

(A) 0.288
(C) 0.667
(B) 0.334
(D) 0.720

[Ans. B]

62. Which of the following assertions are **CORRECT**?
    P: Adding 7 to each entry in a list adds 7 to the mean of the list
    Q: Adding 7 to each entry in a list adds 7 to the standard deviation of the list
    R: Doubling each entry in a list doubles the mean of the list
    S: Doubling each entry in a list leaves the standard deviation of the list unchanged

    (A) P, Q
    (C) P, R
    (B) Q, R
    (D) R, S

    [Ans. C]

63. Given the sequence of terms, AD CG FK JP, the next term is
    (A) OV
    (C) PV
    (B) OW
    (D) PW

    [Ans. A]
    The first letter increases by 2, 3 and 4 letters and the second letter increases by 3, 4 and 5 letters. Hence J will increase by 5 letters and P will increase by 6 letters. So the answer will be OV.

64. **Wanted Temporary, Part-time persons for the post of Field Interviewer to conduct personal interviews to collect and collate economic data. Requirements: High School-pass, must be available for Day, Evening and Saturday work. Transportation paid, expenses reimbursed.**
    Which one of the following is the best inference from the above advertisement?
    (A) Gender-discriminatory
    (B) Xenophobic
    (C) Not designed to make the post attractive
    (D) Not gender-discriminatory

    [Ans. D]

65. A political party orders an arch for the entrance to the ground in which the annual convention is being held. The profile of the arch follows the equation $y = 2x - 0.1 x^2$ where y is the height of the arch in meters. The maximum possible height of the arch is

(A) 8 meters   (C) 12 meters

(B) 10 meters   (D) 14 meters

[Ans. B]