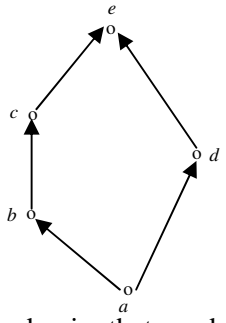
Computer Science and Information Technology

Q. No. 1 – 25 Carry One Mark Each

1. Consider the set $X=\{a,b,c,d,e\}$ under the partial ordering

$R=\{(a,a),(a,b),(a,c),(a,d),(a,e),(b,b),(b,c),(b,e),(c,c),(c,e),(d,d),(d,e),(e,e)\}$.

The Hasse diagram of the partial order (X, R) is shown below.



The minimum number of ordered pairs that need to be added to R to make (X, R) a lattice is _____.

Key: 0

Exp: Given POSET is already a lattice so no need to add any ordered pairs.

2. Which of the following statements about parser is/are CORRECT?

I. Canonical LR is more powerful than SLR.

II. SLR is more powerful than LALR

III. SLR is more powerful than Canonical LR.

(A) I only (B) II only (C) III only (D) II and III only

Key: A

Exp: SLR < LALR < LR(1)

3. Match the following:

P.	static char var;	**i.**	Sequence of memory locations to store addresses
Q.	m= malloc (10); m = NULL;	**ii.**	A variable located in data section of memory
R.	char * ptr [10]	**iii.**	Request to allocate a CPU register to store data
S.	register int var1;	**iv.**	A lost memory which cannot be freed

(A) P-(ii), Q-(iv), R-(i), S-(iii) (B) P-(ii), Q-(i), R-(iv), S-(iii)

(C) P-(ii), Q-(iv), R-(iii), S-(i) (D) P-(iii), Q-(iv), R-(i), S-(ii)

Key: A

Exp: P. static char var:

var is defined as character variable whose associated storage class is static because of this it is given memory from data segment .

Q. $m = \text{malloc}(10);$

$m = \text{NULL};$

10 contiguous bytes of memory is allocated is address of first byte is stored in 'm' and later it is updated with NULL. Now we lost the address of first bytes of that chunk of memory completely. So we can't free that space as we need the address of first byte to free it up

R. char * ptr [10]:

ptr is an array of 10 pointers pointing to character variables.

S. register int varl:

Suggesting the complier to store the var1 "value" in CPU register.

4. Let L_1, L_2 be any two context free languages and R be any regular language. Then which of the following is/are CORRECT ?

I. $L_1 \cup L_2$ is context – free II. $\overline{L_1}$ is context – free

III. $L_1 - R$ is context – free IV. $L_1 \cap L_2$ is context – free

(A) I, II and IV only (B) I and III only

(C) II and IV only (D) I only

Key: B

Exp: CFGs are not closed under intersection and complement.

5. G is undirected graph with n vertices and 25 edges such that each vertex of G has degree at least 3. Then the maximum possible value of n is _____.

Key: 16

Exp: If every vertex has degree at least k then

$$K|V| \le 2(E)$$

$$3|V| \le 2 \times 25$$

$$|V| \le \left\lfloor \frac{50}{3} \right\rfloor$$

$$|V| \le 16$$

6. Let p, q, r denote the statements "It is raining , " It is cold", and " It is pleasant," respectively. Then the statement "It is not raining and it is pleasant, and it is not pleasant only is it is raining and it is cold" is respective by.

(A) $(\neg p \wedge r) \wedge (\neg r \rightarrow (p \wedge q))$ (B) $(\neg p \wedge r) \wedge ((p \wedge q) \rightarrow \neg r)$

(C) $(\neg p \wedge r) \vee ((p \wedge q) \rightarrow \neg r)$ (D) $(\neg p \wedge r) \vee (r \rightarrow (p \wedge q))$

Key: A

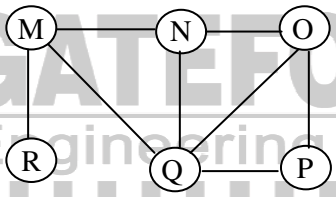
Exp: X only if Y is same as $X \Rightarrow Y$

"it is not raining and it is pleasant" $= \neg p \wedge r$

"it is not pleasant only if it is raining and it is cold" $= \neg r \rightarrow (p \wedge q)$

$\therefore (\neg p \wedge r) \wedge (\neg r \rightarrow (p \wedge q))$

7. The Breadth First Search (BFS) algorithm has been implemented using the queue data structure. Which one of the following is a possible order of visiting the nodes in the graph below?



(A) MNOPQR (B) NQMPOR (C) QMNROP (D) POQNMR

Key: D

Exp: **BFS:** Start at root (some arbitrary node of a graph, sometimes referred to as "search key") and explore the neighbor nodes first, before and moving to the next level neighbors.

8. Let $P = \begin{bmatrix} 1 & 1 & -1 \\ 2 & -3 & 4 \\ 3 & -2 & 3 \end{bmatrix}$ and $Q = \begin{bmatrix} -1 & -2 & -1 \\ 6 & 12 & 6 \\ 5 & 10 & 5 \end{bmatrix}$ be two matrices.

Then the rank of P +Q is _____.

Key: 2

Exp:

$$P+Q=\begin{bmatrix}0 & -1 & 12\\ 8 & 9 & 10\\ 8 & 8 & 8\end{bmatrix}$$

$$R_1 \leftrightarrow R_2 \sim \begin{bmatrix}8 & 9 & 10\\ 0 & -1 & -2\\ 1 & 1 & 1\end{bmatrix}$$

$$\frac{R_3}{8}$$

$$8R_3 - R_1 \sim \begin{bmatrix}8 & 9 & 10\\ 0 & -1 & -2\\ 0 & -1 & -2\end{bmatrix}$$

$$R_3 - R_2 \sim \begin{bmatrix}8 & -9 & 10\\ 0 & -1 & -2\\ 0 & 0 & 0\end{bmatrix}$$

$\therefore$ Rank is 2

9. Consider socket API on a Linux machine the supports connected UDP sockets. A connected UDP socket is a UDP socket on which **connect** function has already been called. Which of the following statements is/are CORRECT ?

I. A connected UDP socket can be used to communicate with multiple peers simultaneously.

II. A process can successfully call **connect** function again for an already connected UDP socket.

(A) I only (B) II only (C) Both I and II (D) Neither I nor II

Key: C

Exp: For a stateless protocol (ie UDP), there is no problem because "connections" don't exist. multiple people can send packets to the same port, and their packets will arrive in whatever sequence. Nobody is ever in the "connected" state.
II) A process with a connected UDP socket can call connect again for that socket for one of two reasons:

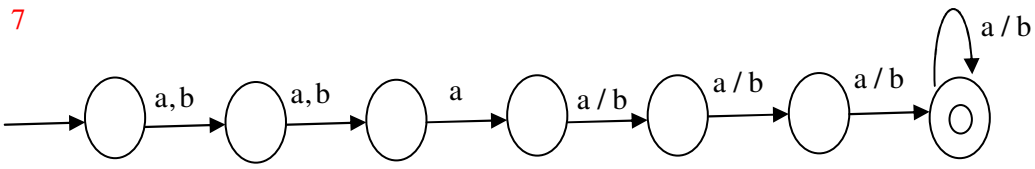
To specify a new IP address and port To unconnect the socket

10. The minimum possible number of states of a deterministic automaton that accepts the regular language

$L = \{w_1 a w_2 \mid w_1, w_2 \in \{a,b\}^* . |w_1| = 2, |w_2| \geq 3\}$ is _____.

Key: 7

Exp:



11. Consider the following tables T1 and T2.

P	Q
2	2
3	8
7	3
5	8
6	9
8	5
9	8

R	S
2	2
8	3
3	2
9	7
5	7
7	2

In table T1, **P** is the primary key and **Q** is the foreign key referencing **R** in table T2 with on-delete cascade and on-update cascade. In table T2, **R** is the primary key and **S** is the foreign key referencing **P** in table T1 on-delete set NULL and on-update cascade. In order to delete record $\langle 3,8 \rangle$ from table T1, the number of additional records that need to be deleted from table T1 is _____.

Key: 0

Exp: Only (8,3) will be deleted from T2.

12. Which of the following is/are shared by all the threads in a process ?

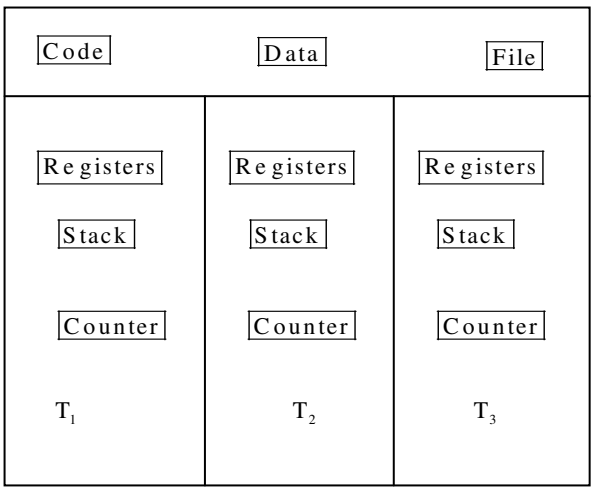
I. Program counter II. Stack

III. Address space IV. Registers

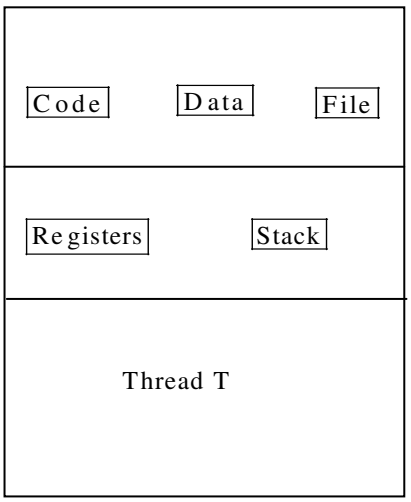
(A) I and II only (B) III only (C) IV only (D) III and IV only

Key: B

Exp:



Single process P with 3 threads Multi threading



Single threaded process

13. A circular queue has been implemented using a single linked list where each node consists of a value and a single pointer pointing to the next node. We maintain exactly two external pointers **FRONT** and **REAR** pointing to the front node and the rear node queue, respectively. Which of the following statements is/are **CORRECT** for such a circular queue, so that insertion and deletion operation can be performed in O (1) time ?

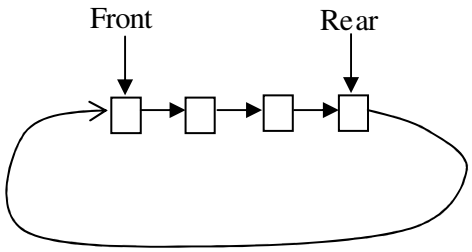
I. Next pointer of front node points to the rear node.

II. Next pointer of rear node points to the front node.

(A) I only (B) II only (C) Both I and II (D) Neither I nor II

Key: B

Exp: Next pointer of the front node would point to the second node, if any.



14. Given the following binary number in 32-bit (single precision) IEEE-754 format:

00111110011011010000000000000000

The decimal value closest to this floating- point number is

(A) 1.45×10^{1} (B) 1.45×10^{-1} (C) 2.27×10^{-1} (D) 2.27×10^{1}

Key: C

Exp: Sign

0 01111100 11011010000000000000000

+1 124

$+1 \quad 2^{-3} \quad \left[2^{-1}+2^{-2}+-----\right] \quad =0.227....$

$[1+]0.8515625$

15. An ER model of a database consist of entity types A and B. These are connected by a relationship R which does not have its own attribute. Under which one of the following conditions, can the relational table for R be merged with that of A?

(A) Relationship R is one-to-many and the participation of A in R is total

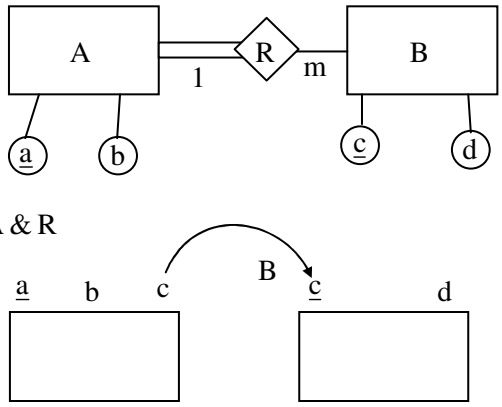
(B) Relationship R is one-to-many and the participation of A in R is partial

(C) Relationship R is many-to one and the participation of A in R is total

(D) Relationship R is many-to one and the participation of A in R is partial

Key: C

Exp:



Note: only M ! N relationship needs exclusive table: If a relationship is 1 ! M or M ! 1 then that relation could be included in the many side table with the help of foreign key concept.

16. Match the algorithms with their time complexities:

	Algorithm		Time complexity
P.	Towers of Hanoi with *n* disks	i.	$\theta(n^2)$
Q.	Binary search given *n* sorted numbers	ii.	$\theta(n\log n)$
R.	Heap sort given n numbers at the worst case	iii.	$\theta(2^n)$
S.	Addition of two $n \times n$ matrices	iv.	$\theta(\log n)$

(A) P-(iii),Q-(iv), R-(i), S-(ii)
(B) P-(iv),Q-(iii), R-(i), S-(ii)
(C) P-(iii),Q-(iv), R-(ii), S-(i)
(D) P-(iv),Q-(iii), R-(ii), S-(i)

Key: C

Exp: P. Towers of Hanoi $\Rightarrow T(n)=2T(n-1)+1\Rightarrow\theta(2^n)$

Q. Binary search $\Rightarrow T(n)=T\left(\frac{n}{2}\right)+C\Rightarrow\theta(\log n)$

R. Heap sort $\Rightarrow\theta(n\log n)$

S. Addition of two $n\times n$ matrices $\Rightarrow\theta(n^r)$

17. Match the following according to input (from the left column) to the complier phase (in the right column) that processes it.

Column-1		Column-2	
P.	Syntax tree	i.	Code generator
Q.	Character stream	ii.	Syntax analyzer
R.	Intermediate representation	iii.	Semantic analyzer
S.	Token stream	iv.	Lexical analyzer

(A) P-(ii),Q-(iii), R-(iv), S-(i)
(B) P-(ii),Q-(i), R-(iii), S-(iv)
(C) P-(iii),Q-(iv), R-(i), S-(ii)
(D) P-(i),Q-(iv), R-(ii), S-(iii)

Key: C

18. Consider the following statements about the routing protocols, Routing information protocol (RIP) and Open Shortest Path (OSPF) in an IPv4 network.

I. RIP uses distance vector routing
II. RIP packets are sent using UDP
III. OSPF packets are sent using TCP
IV. OSPF operation is based on link-state routing

Which of the statements above are CORRECT?

(A) I and IV only
(B) I, II and III only
(C) I, II and IV only
(D) II, III and IV only

Key: C

Exp: **Statement (1):** RIP uses distance vector routing. "CORRECT"

RIP is one of the oldest DVR protocol which employ the hop count as a routing metric.

Statement (2): RIP packets are sent using UDP. "CORRECT"

RIP uses the UDP as its transport protocol, and is assigned the reserved port no 520.

Statement (3): OSPF packets are sent using TCP. "INCORRECT"

OSPF does not use a transport protocol , such as UDP (or) TCP, but encapsulates its data directly in IP packets.

Statement (4): OSPF operation is based on link state routing. "CORRECT"

OSPF is a routing protocol which uses link state routing (LSR) and works within a single autonomous system.

Hence Option "C" is correct.

19. If $f(x)=R\sin\left(\frac{\pi x}{2}\right)+S, f'\left(\frac{1}{2}\right)=\sqrt{2}$ and $\int_0^{-1} f(x)dx=\frac{2R}{\pi}$, then the constant R and S are, respectively

(A) $\frac{2}{\pi}$ and $\frac{16}{\pi}$ (B) $\frac{2}{\pi}$ and 0 (C) $\frac{4}{\pi}$ and 0 (D) $\frac{4}{\pi}$ and $\frac{16}{\pi}$

Key: C

Exp:
$$f^1(x)=\frac{R\pi}{2}\cos\left(\frac{\pi x}{2}\right)$$
$$\Rightarrow f^1(1/2)=\sqrt{2} \text{ gives } \frac{R\pi}{2\sqrt{2}}=\sqrt{2}\Rightarrow R=\frac{4}{\pi}$$
$$\text{Also}\int_0^1 f(x)dx=\frac{2R}{\pi} \text{ gives}\frac{-2R}{\pi}\left(\cos\frac{\pi x}{2}\right)!+S(x)!=2R/\pi$$
$$\Rightarrow S=0$$

20. In a file allocation system, which of the following allocation schemes (s) can be used if no external fragmentation is allowed?

I. Contiguous II. Linked III. Indexed

(A) I and III only (B) II only (C) III only (D) II and III only

Key: D

Exp: Contiguous allocation suffer from external fragmentation. But linked and indexed allocation schemes free from external fragmentation. Hence, option D is correct.

21. Consider a quadratic equation $x^2-13x+36=0$ with coefficients in a base b. The solutions of this equation in the same base b are x = 5 and x = 6. Then b = _____.

Key: 8

Exp: Clearly $13=1\times10+3$ and $36=3\times10+6\Rightarrow$ base $b=10$

The quadratic equation with solutions x = 5 and x = 6 is $x^2-11x+30=0$

According to the given condition, we have b + 3 = 11 and 3b + 6 = 30 $\Rightarrow b=8$

Answer is 8.

Alternate solution:

$x^2-13x+36=0$(given quadratic equation)

In base b, $13=1\times b^1+3\times b^0=b+3$ and

$$36=3\times b^1+6\times b^0=3b+6$$

So the equation becomes $x^2-(b+3)5+(3b+6)=0$

Since x=5 is a solution

$\therefore 5^2-(b+3)5+(3b+6)=0\Rightarrow b=8$

Similarity, by putting x = 6, we get b = 8

22. Identify the language generated by the following grammar, where S is start variable.

$S \rightarrow XY$

$X \rightarrow aX \mid a$

$Y \rightarrow a\,Yb \mid \in$

(A) $\{a^m b^n \mid m \geq n, n > 0\}$ (B) $\{a^m b^n \mid m \geq n, n \geq 0\}$

(C) $\{a^m b^n \mid m > n, n \geq 0\}$ (D) $\{a^m b^n \mid m > n, n > 0\}$

23. The representation of the value of a 16-bit unsigned integer X in hexadecimal number system is BCA9. The representation of the value of X in octal number system is

(A) 571244 (B) 736251 (C) 571247 (D) 136251

Key: D

Exp: $(BCA9)_{16} \rightarrow (136251)_8$

Convert hexadecimal to octal number system.

24. Consider the following function implemented in C:

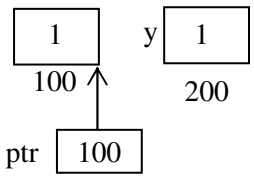
```
void printxy (int x, int y) {
int *ptr ;
x = 0;
ptr = &x;
y = * ptr;
* ptr = l;
print f ("%d, %d," x,y);
}
```

The output of invoking printxy (l, l) is

(A) 0,0 (B) 0,1 (C) 1,0 (D) 1,1

Key: C

Exp:



$\therefore$ 1,0 is printed

25. The maximum number of IPv4 router addresses that can be listed in the record route (RR) option field of an IPv4 header is _____.

Key: 9

Exp: A record route option is used to record the internet routers that handles the datagram. It can list up to nine router addresses. It can be used for debugging and management purpose.

Q. No. 26 – 55 Carry Two Marks Each

26. Consider a binary code that consists of only four valid code words as given below:

00000,01011,10101,11110

Let the minimum Hamming distance of the code be p and the maximum number of erroneous bits that can be corrected by the code be q. then the code be q. Then the values of p and q are

(A) p = 3 and q = 1 (B) p = 3 and q = 2

(C) p = 4 and q = 1 (D) p = 4 and q = 2

Key: A

Exp: Given :

code1 00000

code2 01011

code3 10101

code4 11110

Hamming distance between code 1 and code 2 is 3.

Hamming distance between code 1 and code 3 is 3.

Hamming distance between code 1 and code 4 is 4.

Hamming distance between code 2 and code 3 is 4.

Hamming distance between code 2 and code 4 is 3.

Hamming distance between code 3 and code 4 is 3.

So, as per Hamming code, minimum Hamming distance of all code words is considered as Hamming distance i.e., 3 (p).

Now, the max number of erroneous bits that can be corrected by the Hamming code is 2d + 1. So,

$2d+1=3 \Rightarrow d=1$

So option A is correct.

27. A system shares 9 tape drives. The current allocation and maximum requirement of tape drives for three processes are shown below:

Process	Current Allocation	Maximum Requirement
P1	3	7
P2	1	6
P3	3	5

Which of the following best describes current state of the system ?

(A) Safe, Deadlocked (B) Safe, Not Deadlocked

(C) Not safe, Deadlocked (D) Not safe, Not deadlocked

Key: B

Exp:

PID	Current Allocation	Max need	Available	Need
P_1	3	3	2	4
P_2	1	6	-	5
P_3	3	5	-	2

With the above state of systems, we can get the following 2 safe sequences.

(1) $< P_3, P_2, P_1 >$

(2) $< P_3, P_1, P_2 >$

Hence, system is in safe state, no deadlocked option B is correct.

28. Two transactions T_1 and T_2 are given as

$$T_1 : r_1(X)\, w_1(X)\, r_1(Y)\, w_1(Y)$$

$$T_2 : r_2(Y)\, w_2(Y)\, r_2(Z)\, w_2(Z)$$

where $r_1(V)$ denotes a read operation by transaction T_i on a variable V and $w_\ell(V)$ denotes a write operations by transaction T_i on a variable V. The total number of conflict serializable schedules that can be formed by T_1 and T_2 is _____.

Key: 54

Exp: Conflict conditions RW WR WW

$\therefore$ 5 conflicts

$$T_1 - T_2$$

a b c d

$r_1(X)$ $w_1(X)$ $r_1(Y)$ $w_1(Y)$

$r_2(Y)$ $w_2(Y)$ $r_2(Z)$ $r_2(Z)$

1 2 3 4

Constraints:

$a < b < c < d$

$1 < 2 < 3 < 4$

$d < 1$ (or) $2 < c$

only 1 way

$$\text{Total} = 70 = 70 - (12 + 5)$$

a, b, c, d before 2 a, b, c before 2

Therefore, 53+1=54

29. If w, x, y, z are Boolean variables, then which one of the following is INCORRECT ?

(A) $wx + w(x + y) + x(x + y) = x + wy$

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

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

(D) $(w + y)(wxy + wyz) = wxy + wyz$

Key: C

$\text{LHS}: wx + w(x + y) + x(x + y) = x + wy$

$\text{RHS}:$

$\Rightarrow wx + wx + wy + xx + xy$

Exp: (A) $\Rightarrow wx + wy + x + xy \quad [\because xx = x]$

$\Rightarrow x[1 + y + w] + wy \quad [\because 1 + x = 1]$

$\Rightarrow x + wy$

$\Rightarrow \text{L.H.S} = \text{R.H.S}$

(B) $\text{L.H.S}: \overline{w\bar{x}(y + \bar{z})} + \bar{w}x = \bar{w}\bar{x} + \bar{y}z$

$\text{R.H.S}: \overline{w\bar{x}(y + \bar{z})} + \bar{w}x$

Apply De'Morgan theorem

$\Rightarrow \bar{w}\bar{x} + \overline{(y + \bar{z})} + \bar{w}x \left[\overline{x + y} = \bar{x}.\bar{y}\right]$

$\Rightarrow (\bar{w} + x) + (\bar{y}z) + \bar{w}x$

$\Rightarrow \bar{w} + x + \bar{y}z + \bar{w}x$

$\Rightarrow \bar{w} + x + \bar{y}z = \text{R.H.S}$

$\text{L.H.S} = \text{R.H.S}$

(C)

$\left\{\left[w\bar{x}(y + \bar{z})\right] + \bar{w}\bar{x}\right\} y = x\,\bar{y}$

$\text{L.H.S} \neq \text{R.H.S}$

(D) $\text{L.H.S}: (w + y)(wxy + wyz) = wxy + wyz$

$(w + y)(wxy + wyz)$

$\Rightarrow wxy + wyz + wxy + wyz$

$\Rightarrow wxy + wyz$

$\text{L.H.S} = \text{R.H.S}$

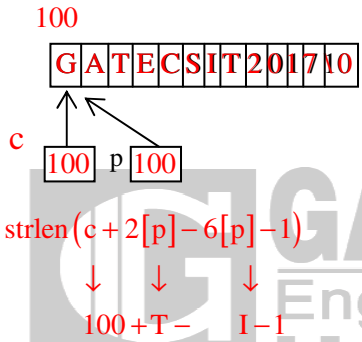
30. Consider the following C program.

```
# include <stdio.h>
#include< string.h>
#int main ( )  {
    char*  c = "GATECSIT2017";
    char*  p = c;
printf("%d", (int) strlen (c+2[p]-6[p]-1));
return 0;
}
```

The output of the program is _____.

Key: 2

Exp:



$\text{strlen}(c+2[p]-6[p]-1)$

$\downarrow \quad \downarrow \quad \downarrow$

$100+T- \quad I-1$

Note: Whenever we have characters in the arithmetic expressions, we can replace those with their ASCII values

$\text{Strlen}(100+x+11-x-1)$ [assume x has the ASCII value of I]

$\Rightarrow \text{Strlen}(110)$

$\therefore 2$ is printed

31. P and Q are considering to apply for a job. The probability that P applies for the job is $\frac{1}{4}$. The probability that P applies for the job given that Q applies for the job is $\frac{1}{2}$, and the probability that Q applies for the job given that P applies for the job $\frac{1}{3}$. Then the probability that P does not apply for the job given that Q does not apply for the job is

(A) $\frac{4}{5}$ (B) $\frac{5}{6}$ (C) $\frac{7}{8}$ (D) $\frac{11}{12}$

Key: A

Exp: Let A,B be the events denote that P, Q respectively applies for a job

$$\Rightarrow P_r(A)=\frac{1}{4}, P_r(A/B)=\frac{1}{2}---(1) \text{ and } P_r(B/A)=\frac{1}{3}--(2)$$

$(2) \text{gives } P_r(A\cap B)=\frac{1}{12}$

$\therefore (1) \text{gives } Pr(B)=\frac{1}{6}$

$$\therefore P_r\left(\frac{\overline{A}}{B}\right)=\frac{P_r(\overline{A}\cap\overline{B})}{P_r(\overline{B})}=\frac{1-P_r(A\cup B)}{1-P_r(B)}=\frac{1-\left(\frac{1}{4}+\frac{1}{6}-\frac{1}{12}\right)}{1-\frac{1}{6}}=\frac{2}{3}\times\frac{6}{5}=\frac{4}{5}$$

32. If the characteristics polynomial of 3×3 matrix M over R (the set of real numbers) is $\lambda^3-4\lambda^2+a\lambda+30, a\in R,$ and one eigen value of M is 2, then the largest among the absolute values of the eigen values of M is _____.

Key: 5

Exp:

$E(X)=5\Rightarrow(X^2)=3, \text{ where } X\sim P(\lambda),\ \lambda=5$

$\therefore E\left[(X+2)^2\right]=E(X^2)+4.E(X)+4=30+20+4=54$

$\left(\because V(X)=E\left(X^2-(E(X))^2\right)\right)$

Since one eigen value of M is 2

$\therefore 2^3-4(2)^2+a(2)+30=0$

$\Rightarrow a=-11$

$\therefore$ Characteristic polynomial is

$\lambda^3-4\lambda^2-11\lambda+30=0$

$(\lambda-2)(\lambda-5)(\lambda+3)=0$

$\therefore\lambda=2,5,-3$

Largest absolute value of $'\lambda'$ is 5

33. Consider the following expression grammar G:

$E\rightarrow E-T\mid T$

$T\rightarrow T+F\mid F$

$F\rightarrow(E)\mid id$

Which of the following grammar is not left recursive, but is equivalent to G?

(A) $E\rightarrow E-T\mid T$
$T\rightarrow T+F\mid F$
$F\rightarrow(E)\mid id$

(B) $E\rightarrow TE'$
$E'\rightarrow -TE'\in$
$T\rightarrow T+F\mid F$
$F\rightarrow(E)\mid id$

(C) $E \to TX$
$X \to -TX \mid \in$
$T \to FY$
$Y \to +FY \mid \in$
$F \to (E) \mid id$

(D) $E \to TX \mid (TX)$
$X \to -TX \mid +TX \mid \in$
$T \to id$

34. In a two-level cache system, the access times of L_1 and L_2 caches are 1 and 8 clock cycles, respectively. The miss penalty from L_2 cache to main memory is 18 clock cycles . The miss rate of L_1 cache is twice that L_2. The average memory access time (AMAT) of this cache system is 2 cycles. This miss rates of L_1 and L_2 respectively are :

(A) 0.111 and 0.056 (B) 0.056 and 0.111

(C) 0.0892 and 0.1784 (D) 0.1784 and 0.0892

Key: A

Exp:

$2 = 1 + 2m \times 8 + m \times 18$

$\therefore m = \frac{1}{34}$

35. Consider two hosts X and Y, connected by a single direct link of rate 10^6 bits/sec . The distance between the two hosts is 10,000km and the propagation speed along the link is 2×10^8 m/sec . Host X sends a file 50,000 bytes as one large message to host Y continuously, Let the transmission and propagation delays be p milliseconds and q milliseconds, respectively . Then the values of p and q are

(A) p = 50 and q = 100 (B) p = 50 and q = 400

(C) p = 100 and q = 50 (D) p = 400 and q = 50

Key: D

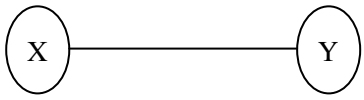
Exp: Given data

$B = 10^6 \text{ bits / sec}$

$d = 10,000\text{km} = 10^4 \times 10^3 \text{ m}$

$V = 2 \times 10^8 \text{ m / s}$

$L = 50,000 \text{ Bytes}$



$\therefore$ Transmission time (p) $= \frac{L}{B} = \frac{50,000 \times 8}{10^6} = 400 \text{ ms}$

$\therefore$ Propagation Time (q) $= \frac{d}{v} = \frac{10^7}{2 \times 10^8} = 50 \text{ ms}$

36. Consider the recurrence function

$$T(n)=\begin{cases}2T\left(\sqrt{n}\right)+1, & n>2\\ 2, & 0<n\le 2\end{cases}$$

Then T(n) in terms of θ notation is

(A) $\theta(\log\log n)$ (B) $\theta(\log n)$ (C) $\theta\left(\sqrt{n}\right)$ (D) $\theta(n)$

Key: B

Exp:

$$T(n)=2T\left(\sqrt{n}\right)+1$$

Put $n=2^K$

$$T\left(2^K\right)=2T\left(2^{K/2}\right)+1$$

Assume $T\left(2^K\right)=\delta(K)$

$$\Rightarrow \delta(K)=2\delta\left(\frac{K}{2}\right)+1$$

By master's theorem

$$\delta(K)=\theta(K)$$

$$T\left(2^K\right)=\theta(K)$$

$$T(n)=\theta(\log n) \quad \because 2^K=n$$

37. If a random variable X has a Poisson distribution with mean 5, then the expectation $E\left[(X+2)^2\right]$ equals _____.

38. Consider the following C function

```
int fun (int n) {
    int i, j;
     for (i = 1; i < = n; i++)    {
              for (j = 1 ; j < n ; j+=i)    {
                        printf (": d , i, j ) ;
                    }
      }
}
```

Time complexity of fun in terms of θ notation is

(A) $\theta\left(n\sqrt{n}\right)$ (B) $\theta\left(n^2\right)$ (C) $\theta(n\log n)$ (D) $\theta\left(n^2\log n\right)$

Key: C

Exp: for i = 1

j will run from 1 to n by incrementing by '1' in each step $\Rightarrow$ 'j 'will run for n times

For i = 2

j will run from 1 ton by incrementing by '2' in each step $\Rightarrow$ j will run for $\frac{n}{2}$ times and so on

$$\text{Time Complexity}(Tc) = n + \frac{n}{2} + \frac{n}{3} + ... + \frac{n}{n}$$

$$= n\left(1 + \frac{1}{2} + \frac{1}{3} + ... + \frac{1}{n}\right) = \theta(n \log n)$$

39. The pre-order transversal of a binary search tree is given by 12, 8, 6, 2, 7, 9, 10, 16, 15, 19, 17, 20. Then the post-order traversal of this tree is:

(A) 2,6,7,8,9,10,12,15,16,17,19,20 (B) 2,7,6,10,9,8,15,17,20,19,16,12

(C) 7,2,6,8,9,10,20,17,19,15,16,12 (D) 7,6,2,10,9,8,15,16,17,20,19,12

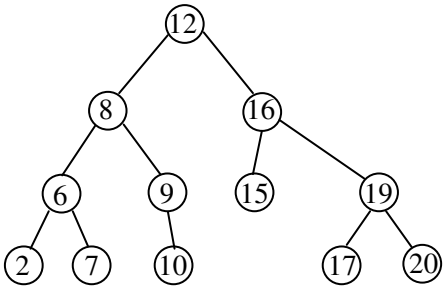
Key: B

Exp: Given: Preorder ! 12, 8, 6, 2, 7, 9, 10, 16, 15, 19, 17, 20

In order! 2, 6, 7, 8, 9, 10, 12, 15, 16, 17, 19, 20

Note: BST In order will give ascending order

Corresponding BST is



$\therefore$ Post order is 2, 7, 6, 10, 9, 8, 15, 17, 20, 19, 16, 12

40. Consider the C program fragment below which is meant to divide x by y using repeated subtractions. The variables x, y, q and r are all unsigned int.

```
while (r >= y)  {
r = r – y;
q = q +1 ;
}
```

Which of the following conditions on the variable x, y, q and r before the execution of the fragment will ensure that the loop terminates in a state satisfying the condition x = = (y*q+r)?

(A) (q = = r) & & (r = =0)

(B) (x > 0) & & (r = =x) & & (y > 0)

(C) (q = = 0) & & (r = = x) & & (y > 0)

(D) (q = = 0) & & (y > 0)

Key: C

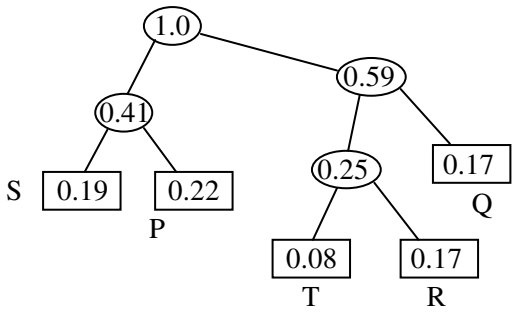
41. A message is made up entirely of characters from the set x= {P,Q,R,S,T}. The table of probabilities for each of the characters is shown below:

Character	Probability
P	0.22
Q	0.34
R	0.17
S	0.19
T	0.08
Total	1.00

If a message of 100 characters over X is encoded using Huffman coding, then the expected length of the encoded message in bits is_____

Key: 225

Exp: Huffman tree is as follows



Average length of the character

$= 2(0.19+0.22)+2(0.34)+3(0.08+0.17)$

$= 2(0.41)+2(0.34)+3(0.25)$

$= 0.82+0.68+0.75$

$= 2.25\,\text{bits}$

$\therefore \text{Message length} = 100\times 2.25\ \text{bits} = 225\ \text{bits}$

42. The next state table of a 2-bit saturating up-counter is given below

Q_1	Q_0	Q_1^+	Q_0^+
0	0	0	1
0	1	1	0
1	0	1	1
1	1	1	1

The counter is built as a synchronous sequential circuit using T flip-flops. The expression for T_1 and T_0 are

(A) $T_1 = Q_1Q_0$, $T_0 = \overline{Q}_1\overline{Q}_0$

(B) $T_1 = \overline{Q}_1Q_0$, $T_0 = \overline{Q}_1 + \overline{Q}_0$

(C) $T_1 = Q_1 + Q_0$, $T_0 = \overline{Q}_1 + \overline{Q}_0$

(D) $T_1 = Q_1Q_0$, $T_0 = \overline{Q}_1 + \overline{Q}_0$

Key: B

Exp:

Q_1	Q_0	Q_1^+	Q_0^+	T_1	T_0
0	0	0	1	0	1
0	1	1	0	1	1
1	0	1	1	0	1
1	1	1	1	0	0

$T_1 = \overline{Q}_1Q_0$

$T_0 = \overline{Q}_1 + \overline{Q}_0$

43. Consider the set of processes with arrival time (in milliseconds). CPU burst time (in milliseconds), and priority (0 is the highest priority) shown below. None of the processes have I/O burst time.

Process	Arrival Time	Burst Time	Priority
P_1	0	11	2
P_2	5	28	0
P_3	12	2	3
P_4	2	10	1
P_5	9	16	4

The average waiting time (in milliseconds) of all the processes using preemptive priority scheduling algorithm is _____

Key: 29

Exp:

PID	AT	BT	Priority	CT	TAT	Waiting Time
P_1	0	11	2	49	49	38
P_2	5	28	0	33	28	0
P_3	12	2	3	51	39	37
P_4	2	10	1	40	38	28
P_5	9	16	4	67	58	42

Gantt Chart:

P_1	P_4	P_2	P_4	P_1	P_3	P_6

0 2 5 33 40 49 51 67

Therefore Average waiting time $= \frac{(38+0+37+28+42)}{5} = \frac{145}{5} = 29$ ms

44. For any discrete random variable X, with probability mass function $P(X=j) = p_j, p_j \geq 0, j \in \{0,.....N\}$ and $\sum_{j=0}^{N} p_j = 1$ define the polynomial function $g_x(z) \sum_{j=0}^{N} p_j z^j$. For a certain discrete random variable Y, there exists a scalar $\beta \in [0,1]$ such that $g_Y(z) = (1-\beta+\beta z)^N$. The expectation of Y is

(A) $N\beta(1-\beta)$

(B) $N\beta$

(C) $N(1-\beta)$

(D) Not expressible in terms of N and β alone

45. The read access times and the hit ratios for different caches in a memory hierarchy are as given below.

Cache	Read access time (in nanoseconds)	Hit ratio
I-cache	2	0.8
D-cache	2	0.9
L2-cache	8	0.9

The read access time of main memory is 90 nanoseconds. Assume that the caches use the referred word-first read policy and the write back policy. Assume that all the caches are direct mapped caches. Assume that the dirty bit is always 0 for all the blocks in the caches. In execution of a program, 60% of memory reads are for instruction fetch and 40% are for memory operand fetch The average read access time in nanoseconds (up to 2 decimal places) is_____.

46. If the ordinary generating function of a sequence $\{a_n\}_{n=0}^{\infty}$ is $\frac{1+z}{(1-z)^3}$ then $a_3 - a_0$ is equal to _____.

Key: 7

Exp:

$$f(z) = \frac{1}{1-z} = 1 + z + z^2 + \ldots . \frac{1+2z-z}{(1-z)^3}$$

$$f'(z) = \frac{-1}{(1-z)^2} = 1 + 2z + 3z^2 + \ldots . = \frac{1}{(1-z)^2} + \frac{2z}{(1-z)^3}$$

$$\frac{1}{(1-z)^2} = -1 - 2z - 3z^2 - 4z^3 \ldots$$

$$f''(z) = \frac{+2}{(1-z)^3} = +2 + 6z + 12z^2 \ldots .$$

$$\frac{1}{(1-z)^2} + \frac{2z}{(1-z)^3}$$

$$= \left(-1 - 2z - 3z^2 - 4z^3 - \ldots\right) + \left(2z + 6z^2 + 12z^3 \ldots .\right)$$

$$= -1 + 0z + 3z^2 + 8z^3 \ldots .$$

$$= a_0 + a_1 z + a_2 z^2 + a_3 z^3 \ldots \ldots z^{-2} = -2z^{-3}$$

$$a_0 = -1$$

$$a_3 = +8$$

$$a_3 - a_0 = 7$$

47. Consider the following snippet of a C program. Assume that swap (& x, &y) exchanges the contents of x and y.

```
int main ( )  {
int array[]={3,5,1,4,6,2};
int done =0 ;
int i ;
```

```
while (done = = 0)  {
    done = 1;
    for (i = 0; i <=4; i ++)  {
    if (array [i] < array [i +1])  {
    swap (& array [i], &array [i+1])
    done = 0 ;
    }
}
for (i = 5 ; i > =1; i --)  {
if (array [i]  < array [ i-1])  {
swap ( & array [i] > array [i-1]);
done = 0;
                    }
    }
}
printf ( " %d " , array [3] );
    }
}
```

The output of the program is _____.

Key: 3

Exp: The final contents of the array is

6	5	4	3	2	1

$\therefore a[3] = 3$ will be printed

48. Consider the following C program.

```
# include <stdio.h>
int main ( )  {
    int m = 10;
    int n, n1;
    n = ++m;
    n1 = m++;
    n--;
    --n1;
    n -=nl;
    printf ("%d", n) ;
    return 0;
}
```

The output of program is _____.

Key: 0

Exp: m= 10

$n = ++m$ will increment m & assign it to $n \Rightarrow n = 11$ & $m = 1$

$n_1 = m++$ will assign m to n_1 and then increment m by 1

$\Rightarrow n_1 = 11, m = 12$

$n--$; decrement n by $1 \Rightarrow n = 10$

$--n_1$; decrement n by $1 \Rightarrow n_1 = 10$

$n -= n_1$; [same as $n = n - n = 10 - 10 = 0$]

$\therefore$ '0' is printed

49. Consider the following database table named *top _scorer.*

top _scorer.

Player	**Country**	**Goals**
Klose	Germany	16
Ronald	Brazil	15
G muller	Germany	14
Fontaine	France	13
Pele	Brazil	12
Klinsmann	Germany	11
Kocsis	Hungary	11
Batistuta	Argentina	10
Cubillas	Peru	10
Lato	Poland	10
Lineker	England	10
T miller	Germany	10
Rahn	Germany	10

Consider the following SQL query :

```
Select ta.player from top _scorer AS ta
WHERE ta.goals > ALL (SELECT tb. goals
                      FROM top _ scorer AS tb
                      WHERE tb.country = 'Spain')
AND ta.goals > ANY ( SELECT tc. goals
                     FROM top_ scorer AS tc
WHERE tc. country = 'Germany')
```

The number of tuples returned by the above SQL query is _____.

Key: 7

Exp: Player

K lose
Ronaldo
G Muller
Fontaine
Pele
Klinsmann
Kocsis

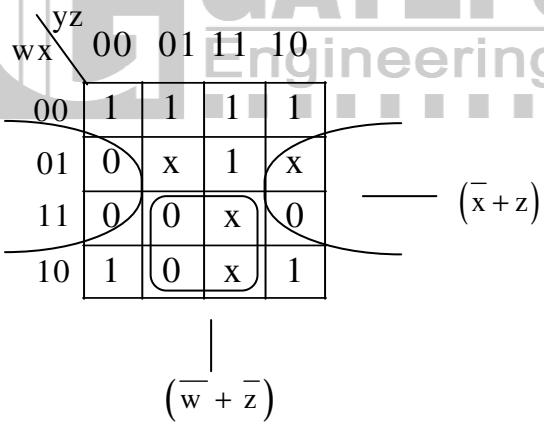
50. Given f (w,x,y,z) $= \sum_m (0,1,2,3,7,8,10) + \sum_d (5,6,11,15)$, where *d* represents the don't care condition in Kamaugh maps, which of the following is a minimum products of sums (POS) form of f(w,x,y,z) ?

(A) $f = (\bar{w} + \bar{z})(\bar{x} + z)$ (B) $f = (\bar{w} + z)(x + z)$

(C) $f = (w + z)(\bar{x} + z)$ (D) $f = (w + \bar{z})(\bar{x} + z)$

Key: A

Exp:



$= (\bar{w} + \bar{z})(\bar{x} + z)$

51. In a B^+ tree, if the search –key value is 8 bytes long, the block size is 512bytes and the block pointer size is 2 bytes, then maximum order of the B^+ tree is _____.

Key: 52

Exp: Let 'K' be the order

$K(2) + (K-1)(8) \le 512$

$\Rightarrow 2K + 8k - 8 \le 512$

$\Rightarrow 10K \le 520 \Rightarrow K \le \frac{520}{10}$

$\therefore K \le 52$

52. Let L(R) be the language represented by regular expression R. Let L(G) be the language generated by a context free grammar G. Let L (M) be the language accepted by a Turning machine M. Which of the following decision problem are undecidable ?

I. Given a regular expression R and a string w, is $w \in L(R)$?

II. Given a context-free grammar G, $L(G)=\varnothing$?

III. Given a context-free grammar G, is $L(G)=\Sigma^*$ forsome alphabet Σ ?

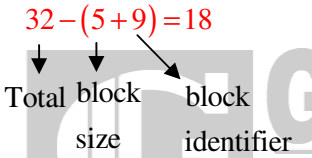
IV. Given a Turning machine M and a string w, is $w \in L(M)$?

(A) I and IV only (B) II and III only (C) II, III and IV only (D) III and IV only

53. Consider a machine with a byte addressable main memory of 2^{32}bytes divided into blocks of size 32 bytes. Assume that a direct mapped cache having 512 cache lines is used with this machine. The size of the tag field bits is _____.

Key: 18

Exp:



54. Let δ denote that transition function and $\hat{\delta}$ denote the extended transition function of the $\in -$ NFA whose transition table is given below:

δ	$\in$	a	b
$\rightarrow q_0$	$\{q_2\}$	$\{q_1\}$	$\{q_0\}$
q_1	$\{q_2\}$	$\{q_2\}$	$\{q_3\}$
q_2	$\{q_0\}$	$\varnothing$	$\varnothing$
q_3	$\varnothing$	$\varnothing$	$\{q_2\}$

Then $\hat{\delta}(q_2, aba)$ is

(A) $\varnothing$ (B) $\{q_0, q_1, q_3\}$ (C) $\{q_0, q_1, q_2\}$ (D) $\{q_0, q_2, q_3\}$

Key: C

Exp:

$\hat{\delta}(q_2, a)=\{q_0\}$

$\hat{\delta}(q_0, b)=\{q_0, q_2\}$

$\hat{\delta}(q_0, a) \cup \hat{\delta}(q_2, a)=\{q_0, q_1, q_2\}$

55. Consider the following languages.

$L_1 = \{a^p \mid p \text{ is a prime number}\}$

$L_2 = \{a^n b^m c^{2m} \mid n \geq 0, m \geq 0\}$

$L_3 = \{a^n b^n c^{2n} \mid n \geq 0\}$

$L_4 = \{a^n b^n \mid n \geq 1\}$

Which of the following are CORRECT ?

I. L_1 is context-free but not regular.

II. L_2 is not context-free.

III. L_3 is not context-free but recursive.

IV. L_4 is deterministic context-free.

(A) I ,II and IV only (B) II and III only (C) I and IV only (D) III and IV only

Key: D

Exp: L_1 is not context free

L_2 is not context free

L_3 is not context free but recursive

L_4 is deterministic context free

General Aptitude

Q. No. 1 - 5 Carry One Mark Each

1. There are 3 red socks, 4 green socks and 3 blue socks, you choose 2 socks. The probability that they are of the same colour is _____.

(A) 1/5 (B) 7/30 (C) 1/4 (D) 4/15

Key: D

Exp: $\frac{{}^3C_2 + {}^4C_2 + {}^3C_2}{{}^{10}C_2} = \frac{12}{45} = \frac{4}{15}$

2. Choose the option with words that are not synonyms.

(A) aversion, dislike (B) luminous, radiant

(C) plunder, loot (D) yielding, resistant

Key: D

3. There are five buildings called V, W, X, Y and Z in a row (not necessarily in that order) V is to the west of W , Z is to the East of X and the West of V, W is to the West of Y, Which of the building in the middle ?

(A) V (B) W (C) X (D) Y

Key: A

Exp: V is to the west of W V W

Z is to the East of X X Z V W

W is to the West of Y X Z V W Y

middle is V

4. A test has twenty questions worth 100 marks in total. There are two types of questions, multiple choice question are worth 3 marks each and essay questions are worth 11 marks each. How many multiple choice questions does the exam have?

(A) 12 (B) 15 (C) 18 (D) 19

Key: B

Exp: $x + y = 20$ $x = MCQ$

$3x + 11y = 100$ $y = essay\ type$

$\Rightarrow x = 15, y = 5$

5. Saturn is ____ to be seen on a clear night with the naked eye.

(A) enough bright (B) bright enough

(C) as enough bright (D) bright as enough

Key: B

Q. No. 6 – 10 Carry Two Marks Each

6. "We lived in a culture that denied any merit to literary works, considering them important only when they were handmaidens to something seemingly more urgent - namely ideology. This was a country where all gestures, even the most private, were interpreted in political terms."

The author's belief that ideology is not as important as literature is revealed by the word:

(A) 'culture' (B) 'seemingly' (C) 'urgent' (D) 'political'

Key: B

7. X is a 30digit number starting with the digit 4 followed by the digit 7, then the number X^3 will have

(A) 90 digits (B) 91 digits (C) 92 digits (D) 93 digits

Key: A

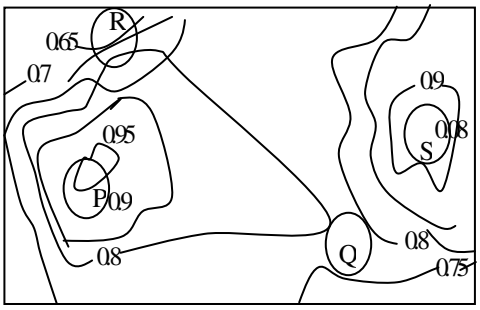
8. There are three boxes, one contains apples, another contains oranges and the last one contains both apples and oranges. All three are known to be incorrectly labelled. If you are permitted to open just one box and then pull out and inspect only one fruit, which box would you open to determine the contents of all three boxes?

(A) The box labelled 'Apples' (B) The box labelled 'Apples and Oranges'

(C) The box labeled 'Oranges' (D) Cannot be determined

Key: B

9. An air pressure contour line joins locations in a region having the same atmospheric pressure . The following is an air contour plot of a geographic region . Contour lines are shown at 0.05 bar intervals in this plot.



If the possibility of a thunderstorm is given by how fast air pressure rises or drops over a region. Which of the following regions is most likely to have a thunder storm?

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

Key: C

Exp: At point R;

The pressure contours are closer. So closer lines represents steep pressure gradient.

10. The number of roots of $e^x + 0.5x^2 - 2 = 0$ in the range [-5,5] is

(A) 0 (B) 1 (C) 2 (D) 3

Key: A

Exp: $f(x) = e^x + 0.5x^2 - 2$

$f(-5) = \quad > 0$

$f(5) = > 0$

By intermediate values process

If $f(a)f(b) > 0;$

Then root does not lie in between a & b. So option (A).