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Section - I (General Aptitude)

Q.1 A test has twenty questions worth 100 marks in total. There are two types of questions. Multiple choice questions 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

Ans. **(b)**

End of Solution

Q.2 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 is the building in the middle?

(a) V (b) W
(c) X (d) Y

Ans. **(a)**

End of Solution

Q.3 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

Ans. **(b)**

End of Solution

Q.4 Choose the option with words that are not synonyms.

(a) aversion, dislike (b) luminous, radiant
(c) plunder, loot (d) yielding, resistant

Ans. **(d)**

End of Solution

Q.5 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

Ans. **(d)**

End of Solution

Q.6 X is a 30 digit number starting with the digit 4 followed by the digit 7. Then the number X^3 will have

(a) 90 digits
(b) 91 digits
(x) 92 digits
(d) 93 digits

Ans. **(a)**

End of Solution

Q.7 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 labelled 'Oranges'
(d) Cannot be determined

Ans. **(b)**

End of Solution

Q.8 "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'

Ans. **(c)**

End of Solution

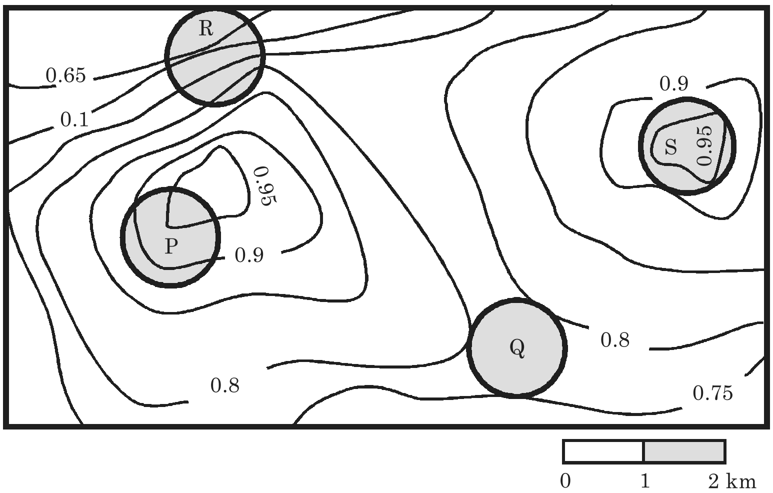
Q.9 The number of roots of $e^x + 0.5x^2 - 2 = 0$ in the range [–5, 5] is

(a) 0
(b) 1
(c) 2
(d) 3

Ans. **(c)**

End of Solution

Q.10 An air pressure contour line joins locations in a region having the same atmospheric pressure. The following is an air pressure contour plot is a geographical 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 thunderstorm?

(a) P
(b) Q
(c) R
(d) S

Ans. **(c)**

End of Solution

Section - II (Computer Science & IT)

Q.1 Identify the language generated by the following grammar, where S is the start variable.

$$S \to XY$$
$$X \to aX|a$$
$$Y \to aYb|\in$$

(a) $\{a^m b^n | m \geq n,\ n > 0\}$
(b) $\{a^m b^n | m \geq n,\ n \geq 0\}$
(c) $\{a^m b^n | m > n,\ n \geq 0\}$
(d) $\{a^m b^n | m > n,\ n > 0\}$

Ans. **(c)**

$$S \to XY$$
$$X \to aX|a \Rightarrow X \to \{a^m | m \geq 1\}$$
$$Y \to aYb|\in \Rightarrow Y \to \{a^n b^n | n \geq 0\}$$
$$S \to XY \Rightarrow S \to \{a^m b^n | m > n,\ n \geq 0\}$$

m > n because at least 1 will be attached on left of $a^n b^n$.

End of Solution

Q.2 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}

Ans. **(c)**

1 bit	8 bit	23 bit
0	01111100	1101101000...
S	BE	M

1. Sign = 0
= +ve

2. AE = BE – Bias

BE =	0 1 1 1 1 1 0 0
Bias =	0 1 1 1 1 1 1 1
AE =	1 1 1 1 1 1 0 1

Here sign of AE is negative so take two complement of AE.

i.e., 00000010
+ 1
00000011

$\Rightarrow -3$

3. Mantissa

$\therefore$ Normal Mantissa = 1.M
= 1.1101101

Data $+1.1101101 \times 2^{-3}$ $\{\pm M \times B^{\pm e}\}$

mantissa align to right upto 3 times

↓

+0.0011101101

↓

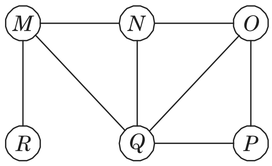
0.228

↓

2.28×10^{-1}

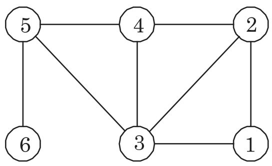
End of Solution

Q.3 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

Ans. **(d)**



Considering each option:

- After vertices 'M' and 'N', vertex 'O' can't be traversed.
- After visiting vertex 'M', vertex 'O' should be traversed.
- After 'N' either of the vertices 'O' or 'P' should be traversed.

End of Solution

Q.4 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

Ans. **(b)**

All the threads share address space but other entities like, stack, PC, resisters are not shared and every thread will have its own.

End of Solution

Q.5 The minimum possible number of states of a deterministic finite automaton that accepts the regular language $L = \{w_1 a w_2 | w_1, w_2 \in \{a, b\}^*, |w_1| = 2, |w_2| \geq 3\}$ is________.

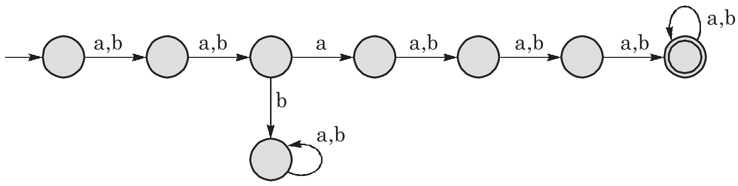
Ans. **(8)**

Min DFA for $L = \{w_1 a w_2 | w_1, w_2 \in \{a, b\}^*, |w_1| = 2, |w_2| \geq 3\}$

The regular expression for L is

(a + b) (a + b)a(a + b)(a + b)(a + b)(a + b)*

The minimal DFA is



End of Solution

Q.6 G is an 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 ______.

Ans. **(16)**

$$n \leq ?$$
$$e = 25$$

Now since each vertex has at least 3 degree

and $2e = \Sigma\text{degree}$

i.e., $2e \geq 3n$

$$n \leq 2e/3$$

$\Rightarrow$ $n \leq \frac{2 \times 25}{3} \leq 16.66$

So n is at most 16.

End of Solution

Q.7 Match the following:

List-I
(P) static char var;
(Q) m = malloc(10); m = NULL;
(R) char *ptr[10];
(S) register int var1;

List-II
(i) Sequence of memory locations to store addresses
(ii) A variable located in data section of memory
(iii) Request to allocate a CPU register to store data
(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)

Ans. **(a)**

- **static char var;** : Initialization of a variable located in data section of memory.
- ***m* = malloc(10); *m* = NULL;** : A lost memory which can't be freed because free (m) is missed in code.
- **char *ptr[10];** : Sequence of memory locations to store addresses.
- **register int var1;** : Request to allocate a CPU register to store data.

End of Solution

Q.8 Consider socket API on a Linux machine that 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

Ans. **(b)**

Bind ( ) function creates local address.
Connect ( ) function is specfying remote address. An unconnected UDP socket is just a Bind ( ) function.
A connected UDP socket is one more step above i.e. connect ( ) function [Just behaves like TCP].

End of Solution

Q.9 Match the algorithms with their time complexities:

List-I (Algorithm)

(P) Towers of Hanoi with n disks
(Q) Binary search given n sorted numbers
(R) Heap sort given n numbers at the worst case
(S) Addition of two $n \times n$ matrices

List-II (Time complexity)

(i) $\Theta(n^2)$
(ii) $\Theta(n \log n)$
(iii) $\Theta(2^n)$
(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)

Ans. **(c)**

- Towers of Hanoi with n disks = $2T(n-1) + 1 = \Theta(2^n)$.
- Binary search given n sorted numbers = $T(n/2) + 1 = \Theta(\log n)$.
- Heap sort given n numbers at the worst case = $2T(n/2) + n = \Theta(n \log n)$.
- Addition of two $n \times n$ matrices = $4T(n/2) + 1 = \Theta(n^2)$.

End of Solution

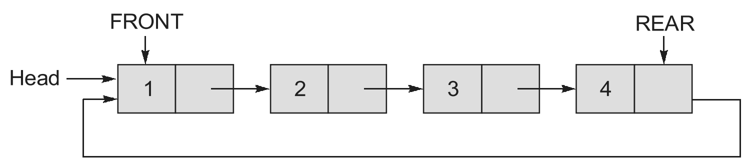
Q.10 A circular queue has been implemented using a singly linked list where each node consists of a value and a single pointer pointing to the next node. We maintain exactly two external pointers **FRONT** and **REAR** pointing to the front node and the rear node of the queue, respectively. Which of the following statements is/are CORRECT for such a circular queue, so that insertion and deletion operations 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

Ans. **(b)**



Since insertion in a queue are always from REAR and deletion is always from FRONT. Hence having the next pointer of REAR node pointing to the FRONT node will lead to both insertion and deletion operations in $O(1)$ time.

End of Solution

Q.11 In a file allocation system, which of the following allocation scheme(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

Ans. **(d)**

Linked and indexed allocations are non contigous so, they will not suffer from external fragmentation.

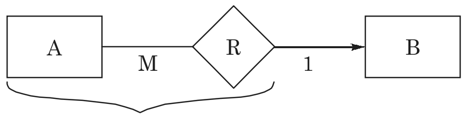
End of Solution

Q.12 An ER model of a database consists 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.

Ans. **(c & d)**

Entity sets A, B
Relationship set R
Relation R merges with that of A.



- Many to one relationship set can merge towards entity set 'A'.
- Partipation towards A side can be total / partial.

End of Solution

Q.13 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

Ans. **(d)**

$$X = (B \quad C \quad A \quad 9)_{16}$$
$$= 1011110010101001$$
$$= (1 \quad 3 \quad 6 \quad 2 \quad 5 \quad 1)_8$$

End of Solution

Q.14 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

Ans. **(b)**

I. $L_1 \cup L_2$ is context-free = CFL ∪ CFL = CFL. So, True

II. $\overline{L_1}$ is context-free = $\overline{CFL} = CSL$ but not CFL. So, false

III. $L_1 - R$ is context-free = CFL ∩ $\overline{\text{Regular}}$ = CFL. So, True

IV. $L_1 \cap L_2$ is context-free = CFL ∩ CFL = CSL. So, False

End of Solution

Q.15 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 $b =$ _______.

Ans. **(8)**

$$x^2 - 13x + 36 = 0$$

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

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

$$= 3b + 6$$

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

Now since it is given that $x = 5$ is a solution, so

$$5^2 - (b + 3)5 + (3b + 6) = 0$$

$\Rightarrow \quad -2b + 16 = 0$

$\Rightarrow \quad b = 8$

Same can be obtained by putting $x = 6$ also.

End of Solution

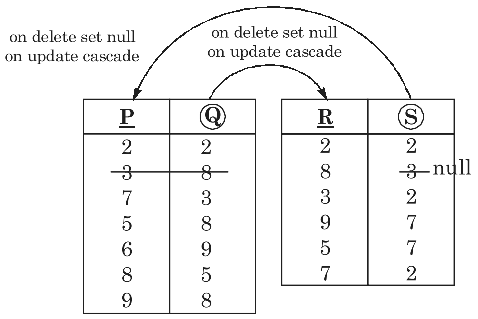
Q.16 Consider the following tables T_1 and T_2.

T_1	
P	**Q**
2	2
3	8
7	3
5	8
6	9
8	5
9	8

T_2	
R	**S**
2	2
8	3
3	2
9	7
5	7
7	2

In table T_1, $\boldsymbol{P}$ is the primary key and Q is the foreign key referencing $\boldsymbol{R}$ in table T_2 with on-delete cascade and on-update cascade. In table T_2, $\boldsymbol{R}$ is the primary key and $\boldsymbol{S}$ is the foreign key referencing $\boldsymbol{P}$ in table T_1 with on-delete set NULL and on-update cascade. In order to delete record (3,8) from table T_1, the number of additional records that need to be deleted from table T_1 is __________.

Ans. **(0)**



No other record need to delete because of deletion of (3, 8) record from T_1.

End of Solution

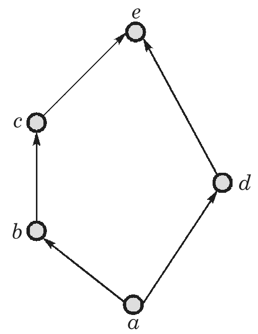
Q.17 The maximum number of IPv4 router addresses that can be listed in the record route (RR) option field of an IPv4 header is _________.

Ans. **(9)**

In IPv4, options and padding 40 bytes are alloted.
Maximum nine routers addresses are allowed.
Each IPv4 address is 32 bits or 4 bytes
So $4 \times 9 = 36$ bytes
Extra byte are used for the option.

End of Solution

Q.18 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 Hase 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 _______.

Ans. **(0)**
Since the given hasse diagram is already a lattice, three is no need to add any ordered pair. So answer is 0.

End of Solution

Q.19 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 _________.

Ans. **(2)**

$$P + Q = \begin{bmatrix} 0 & -1 & -2 \\ 8 & 9 & 10 \\ 8 & 8 & 8 \end{bmatrix}$$

$$|P + Q| = -16 + 16 = 0$$

So, rank ≠ 3

Take the 2 × 2 minor $\begin{bmatrix} 0 & -1 \\ 8 & 9 \end{bmatrix} = 8 \neq 0$

So, rank of P + Q is 2.

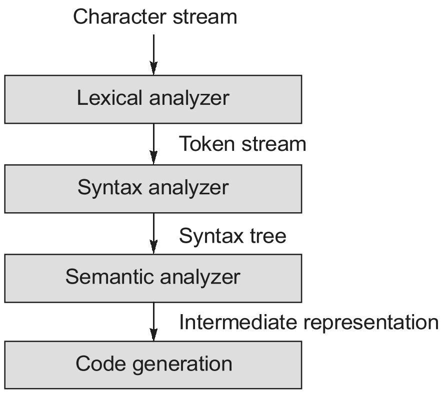
End of Solution

Q.20 Match the following according to input (from the left column) to the compiler phase (in the right column) that processes it:

List-I	List-II
(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)

Ans. **(c)**



End of Solution

Q.21 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 if it is raining and it is cold*" is represented 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) $(\neg p \wedge r) \vee (r \rightarrow (p \wedge q))$

Ans. **(a)**

p : "*It is raining*"
q : "*It is cold*", and
r : "*It is pleasant*",
so the correct representation of ***"It is not raining and it is pleasant, and it is not pleasant only if it is raining and it is cold"*** is

$\neg p \wedge r \wedge \neg r$ only if $p \wedge q \equiv (\neg p \wedge r) \wedge (\neg r \rightarrow (p \wedge q))$

End of Solution

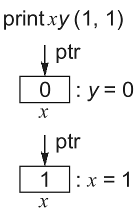
Q.22 Consider tiie following function implemented in C:

```
void printxy (int x, int y)
{
    int *ptr;
    x = 0;
    ptr = &x;
    y = *ptr;
    *ptr = 1;
    printf ("%d, %d", x, y);
}
```

The output of invoking printxy (1, 1) is

(a) 0, 0
(b) 0, 1
(c) 1, 0
(d) 1, 1

Ans. **(c)**



Hence the output will be (1, 0).

End of Solution

Q.23 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 constants 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 $\frac{16}{\pi}$

Ans. **(c)**

Given,

$$f(x) = R\sin\left(\frac{\pi x}{2}\right) + S, \quad ...(1)$$

$$f'\left(\frac{1}{2}\right) = \sqrt{2} \quad ...(2)$$

$$\int_0^1 f(x)dx = \frac{2R}{\pi} \quad ...(3)$$

Now we need to find R and S.

$$f'(x) = R\cos\left(\frac{\pi x}{2}\right)\frac{\pi}{2}$$

$$f'\left(\frac{1}{2}\right) = R\cos\left(\frac{\pi}{4}\right)\times\frac{\pi}{2} = \sqrt{2}$$

$$\Rightarrow \quad \frac{R}{\sqrt{2}}\times\frac{\pi}{2} = \sqrt{2}$$

$$\Rightarrow \quad R = \frac{4}{\pi}$$

Now, $\int f(x)\,dx = \int R\sin\frac{\pi x}{2} + S$

Putting $R = \frac{4}{\pi}$ we get

$$\int f(x)\,dx = \int \frac{4}{\pi}\sin\left(\frac{\pi x}{2}\right)dx + \int S\,dx$$

$$= \frac{4}{\pi}\times - \frac{\cos\left(\frac{\pi x}{2}\right)}{\frac{\pi}{2}} + Sx$$

$$= \frac{-8}{\pi^2}\cos\left(\frac{\pi x}{2}\right) + Sx$$

Putting limit 0 and 1

$$\int_0^1 f(x)\,dx = \frac{-8}{\pi^2}\left(\cos\frac{\pi}{2} - \cos(0)\right) + S(1-0) = \frac{2R}{\pi}$$

$$\Rightarrow \quad \frac{-8}{\pi^2}(0-1) + S = \frac{2R}{\pi}$$

Put $R = \frac{4}{\pi}$ and solve for S

$$\Rightarrow \quad S = 0$$

So, $R = \frac{4}{\pi}$ and $S = 0$ is answer.

End of Solution

Q.24 Consider tlie following statements about the routing protocols, Routing Information Protocol (RIP) and Open Shortest Path First (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

Ans. **(c)**

RIP uses distance vector routing. OSPF uses link-state routing protocols.
RIP uses UDP as transport protocol.
OSPF neither uses TCP nor UDP.
[Link state packet should be given to all routers in subnet so it's not possible with TCP.These link state packets should be reliable at that same time which is not posible with UDP].

End of Solution

Q.25 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

Ans. **(a)**

Cononical LR is the most powerful parsers among all the LR(K) parsers.

End of Solution

Q.26 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 in bits is _______.

Ans. **(18)**

MM size = 2^{32} B, Block size = 32 B
Direct CM
lines = 512

Address format is (32 bit)

Tag	LO	WO
18 bit	$\log_2 512 = 9$ bit	$\log_2 32 = 5$ bit

End of Solution

Q.27 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 is $\frac{1}{3}$. 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) $\frac{11}{12}$

Ans. **(a)**

Given that

$$p(P) = \frac{1}{4} \quad ...(1)$$

$$p(P|Q) = \frac{1}{2} \quad ...(2)$$

$$p(Q|P) = \frac{1}{3} \quad ...(3)$$

$$p(\bar{P} \mid \bar{Q}) = ?$$

First solve for p(Q) and p(P ∩ Q) from equaiton (2) and (3) as follows:

From equation (2)

$$p(P|Q) = \frac{p(P \cap Q)}{p(Q)} = \frac{1}{2} \quad ...(4)$$

From equation (3) $p(Q|P) = \frac{p(P \cap Q)}{p(P)} = \frac{1}{3}$

$$\Rightarrow \quad p(P \cap Q) = \frac{1}{3} \times p(P) = \frac{1}{3} \times \frac{1}{4} = \frac{1}{12}$$

Now substitute in equation (4) and get

$$p(Q) = \frac{p(P \cap Q)}{1/2} = \frac{1/12}{1/2} = \frac{2}{12} = \frac{1}{6}$$

So now we have $p(P) = \frac{1}{4}$

$$p(Q) = \frac{1}{6}$$

and $$p(P \cap Q) = \frac{1}{12}$$

we need to find

$$p(\bar{P} \mid \bar{Q}) = \frac{p(\bar{P} \cap \bar{Q})}{p(\bar{Q})}$$

$$= \frac{1-(P \cup Q)}{1-p(Q)} = 1 - \frac{[p(P)+p(Q)-p(P \cap Q)]}{1-p(Q)}$$

$$= \frac{1-\left[\frac{1}{4}+\frac{1}{6}-\frac{1}{12}\right]}{1-\frac{1}{6}} = \frac{\frac{2}{3}}{\frac{5}{6}} = \frac{4}{5}$$

So, $$p(\bar{P} \mid \bar{Q}) = \frac{4}{5}$$

End of Solution

Q.28 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

Ans. **(d)**

$L_1 = \{a^p \mid p \text{ prime}\}$ is a CSL but not CFL (prime number checking involve divsion)
$L_2 = \{a^n b^m c^{2m} \mid n \geq 0,\ m \geq 0\}$ is CFL (one comparision)
$L_3 = \{a^n b^n c^{2n} \mid n \geq 0\}$ is CSL (two comparision)
$L_4 = \{a^n b^n \mid n \geq 1\}$ is a DCFL

So,

I. L_1 is CFL but not regular is false.
II. L_2 is not CFL is false.
III. L_3 is not CFL but recursive is true since every CSL is recursive.
IV. L_4 is DCFL is true.

So, only III and IV are true and correct.

End of Solution

Q.29 The read access times and the hit ratios for different caches in a memory hierarchy are as given below.

Code	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 (upto 2 decimal places) is _______.

Ans. **(2.74)**

$$\text{Tavg} = H_1T_1 + (1 - H_1)H_2(T_2 + T_1)+(1 - H_1)(1 - H_2)$$
$$H_3(T_3 + T_2 + T_1)+(1-H_1)(1 - H_2)(1 - H_3)H_4$$
$$(T_4 + T_3 + T_2 + T_1)$$

Substitute the given data.

$$\text{Tavg} = (0.8 \times 2)+(1 - 0.8)0.9 \times (2 + 2) + (1 - 0.8)$$
$$(1 - 0.9)0.9 \times (8 + 2 + 2) + (1 - 0.8)(1 - 0.9)$$
$$(1 - 0.9) \times (90 + 8 + 2 + 2)$$
$$= 1.6 + 0.72 + 0.216 + 0.204$$
$$= 2.74 \text{ ns}$$

End of Solution

Q.30 Let δ denote the transition function and $\hat{\delta}$ denote the extended transition function of the ε-NFA whose transition table is given below:

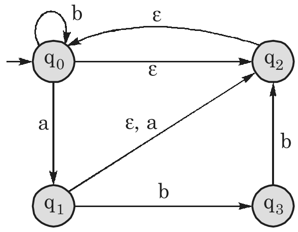
δ	∈	a	b
→ q_0	$\{q_2\}$	$\{q_1\}$	$\{q_0\}$
q_1	$\{q_2\}$	$\{q_2\}$	$\{q_3\}$
q_2	$\{q_0\}$	Φ	Φ
q_3	Φ	Φ	$\{q_2\}$

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

(a) ϕ
(b) (q_0, q_1, q_3)
(c) (q_0, q_1, q_2)
(d) (q_0, q_2, q_3)

Ans. **(c)**

Converting the table to a state diagram, we get,



$$\hat{\delta}(q_2, aba) = \text{All states reachable from } q_2 \text{ by "}aba\text{"}$$

If *aba* is broken as ε.a.ε.ε.b.a. Then from q_2 we can reach q_1 and from there by null transition we can reach state q_2 as well as q_0.

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

End of Solution

Q.31 Given $f(w, x, y, z) = \Sigma_m\{0, 1, 2, 3, 7, 8, 10) + \Sigma_d(5, 6, 11, 15)$, where d represents the *don't-care* condition in Karnaugh maps. Which of the following is a minimum product-of-sums (POS) form of $f(w, x, y, z)$?

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

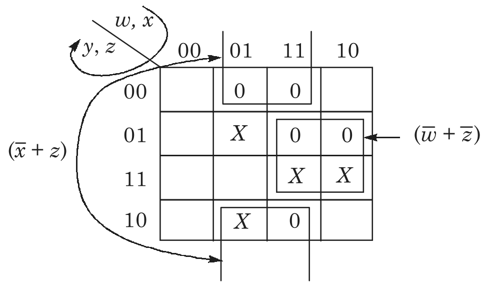
(b) $f = (\bar{w} + z)(x + z)$

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

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

Ans. **(a)**

$$f(w, x, y, z) = \Sigma_m\{0, 1, 2, 3, 7, 8, 10) + d(5, 6, 11, 15)$$
$$= \Pi_M\{4, 9, 12, 13, 14) \,.\, d(5, 6, 11, 15)$$



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

End of Solution

Q.32 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

Ans. **(b)**

Process	Current Allocation	Maximum Requirement	Remaining need	Current avialable
P1	3	7	4	9 – 7 = 2
P2	1	6	5	5
P3	3	5	2	8
				9

Safe sequence $\Rightarrow$ P3 $\rightarrow$ P1 $\rightarrow$ P2
Safe and Not deadlocked

End of Solution

Q.33 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) $\overline{w\overline{x}(y+\overline{z})} + \overline{w}x = \overline{w} + x + \overline{y}z$

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

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

Ans. **(c)**

(a) $wx + w(x + y) + x(x + y) = x + wy$
$wx + wx + wy + x + xy$
$x(w + 1 + y) + wy$
$x + wy = x + wy$ True

(b) $\overline{w\overline{x}(y+\overline{z})} + \overline{w}x = \overline{w} + x + \overline{y}z$
$\overline{w} + \overline{w}x + x + \overline{y}z$
$\overline{w} + x + \overline{y}z = \overline{w} + x + \overline{y}z$ True

(c) $(w\overline{x}(y + x\overline{z}) + \overline{w}\overline{x})y = x\overline{y}$
$(w\overline{x}y + \overline{w}\overline{x})y$
$w\overline{x}y + \overline{w}\overline{x}y$
$\overline{x}y(w + \overline{w})$, since $(w + \overline{w})$ evaluate to 1
$\overline{x}y \neq x\overline{y}$ False

(d) $(w + y)(wxy + wyz) = wxy + wyz$
$wxy + wyz = wxy + wyz$ True

End of Solution

Q.34 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

Ans. **(b)**

$$g_Y(z) = ((1 - \beta) + \beta z)^N$$

If $g_Y(z)$is expanded, we would get a bionomial distribution with $n = N$ and $p = \beta$
So the $E[Y] = np = N\beta$

End of Solution

Q.35 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 expressions for T_1 and T_0 are

(a) $T_1 = Q_1 Q_0$, $T_0 = \bar{Q}_1 \bar{Q}_0$

(b) $T_1 = \bar{Q}_1 Q_0$, $T_0 = \bar{Q}_1 + \bar{Q}_0$

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

(d) $T_1 = \bar{Q}_1 Q_0$, $T_0 = Q_1 + Q_0$

Ans. **(b)**

Q_1	Q_0	Q_1^+	Q_0^+	T_1 (FF inputs)	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

$$T_1(Q_1, Q_0) = \bar{Q}_1 Q_0$$

$$T_2(Q_1, Q_0) = \bar{Q}_1 \bar{Q}_0 + \bar{Q}_1 Q_0 + Q_1 \bar{Q}_0$$

$$= \bar{Q}_1 + \bar{Q}_0$$

End of Solution

Q.36 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 grammars is not left recursive, but is equivalent to G?

(a) $E \rightarrow E - T \mid T$
$T \rightarrow T + F \mid F$
$F \rightarrow (E) \mid \text{id}$

(b) $E \rightarrow TE'$
$E' \rightarrow -TE' \mid \in$
$T \rightarrow T + F \mid F$
$F \rightarrow (E) \mid \text{id}$

(c) $E \rightarrow TX$
$X \rightarrow -TX \mid \in$
$T \rightarrow FY$
$Y \rightarrow +FY \mid \in$
$F \rightarrow (E) \mid \text{id}$

(d) $E \rightarrow TX \mid (TX)$
$X \rightarrow -TX \mid +TX \mid \in$
$T \rightarrow \text{id}$

Ans. **(c)**

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

There are 2 left recurssion and both have to be removed.
The following is the conversion

$$E' \rightarrow -TE' \mid \in$$
$$E \rightarrow TE'$$
$$T' \rightarrow +FT' \mid \in$$
$$Y \rightarrow FT'$$
$$F \rightarrow (E) \mid \text{id}$$

Now by putting E′ as X and T′ as Y we get option (c) which is

$E \rightarrow TX$ $\quad X \rightarrow -TX \mid \in$
$T \rightarrow FY$ $\quad Y \rightarrow +FY \mid \in$
$F \rightarrow (E) \mid \text{id}$

End of Solution

Q.37 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 the L_2 cache to main memory is 18 clock cycles. The miss rate of L_1 cache is twice that of L_2. The average memory access time (AMAT) of this cache system is 2 cycles. The 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

Ans. **(a)**

$$\text{Hit time } L_1 = 1 \text{ cycle}$$
$$\text{Hit time } L_2 = 8 \text{ cycles}$$
$$\text{Miss penality } L_2 = 18 \text{ cycles}$$
$$\text{Tavg} = 2 \text{ ns}$$
$$\text{Miss rate } L_1 = x$$
$$\text{Miss rate } L_1 = 2x$$

Formula:

- Tavg = Hit time L_1 + (Miss rate L_1 × Miss penality L_1)
- Miss penality L_1 = Hit time L_2 + (Miss rate L_2 × Miss penality L_2)
- Substitute the above data and verifying with respect to the given options.
- In this context after substitute the option (A). Data, Tavg becomes 2ns.

End of Solution

Q.38 If the ordinary generating function of a sequence $\{a_n\}_{n=0}^{\infty}$ is $\dfrac{1+z}{(1-z)^3}$, then $a_3 - a_0$ is equal to ________

Ans. **(15)**

Given that generating function $\{a_n\}_{n=0}^{\infty}$ is $\dfrac{1+z}{(1-z)^3}$

$$A(z) = \sum a_r z^r = \frac{1+z}{(1-z)^3}$$

We can replace z by x, also

$$A(x) = \sum a_r x^r = \frac{1+x}{(1-x)^3}$$
$$= \frac{1}{(1-x)^3} + \frac{x}{(1-x)^3}$$
$$= \sum_{r=0}^{\infty} {}^{3-1+r}C_r x^r + x\sum_{r=0}^{\infty} {}^{3-1+r}C_r x^r$$
$$= \sum_{r=0}^{\infty} {}^{r+2}C_2 x^r + \sum_{r=0}^{\infty} {}^{r+2}C_2 x^{r+1}$$

Now we read to find a_0 and a_3 which are nothing but the coefficient of x^0 and x^3 respectively.

a_0 = Coefficient x^0 = ${}^{(0+2)}C_2 = {}^2C_2 = 1$
a_3 = Coefficient x^3 = ${}^{(3+2)}C_2 + {}^{(2+2)}C_2 = {}^5C_2 + {}^4C_2 = 16$
So, $a_3 - a_0 = 16 - 1 = 15$

End of Solution

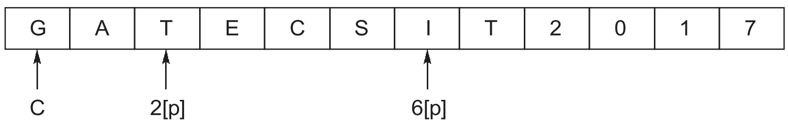
Q.39 Consider the following C program.

```
# 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 __________.

Ans. **(2)**

(C + 2[p] – 6[p] – 1)



$$C + \text{'T'} - \text{'I'} - 1$$
$$= C + 11 - 1$$
$$= C + 10$$

Hence printf will print '2'.

End of Solution

Q.40 Consider the recurrence function

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

Then $T(n)$ in terms of Θ notation is

(a) Θ(log log n)
(b) Θ(log n)
(c) $\Theta(\sqrt{n})$
(d) Θ(n)

Ans. **(b)**

$$T(n) = 2T(\sqrt{n}) + 1 \quad \text{...(1)}$$

$$T(n) = 2T(\sqrt[2]{n}) + 1 \quad \text{...(2)}$$

Substituting (2) in (1)

$$T(n) = 2.2T(\sqrt[2]{n}) + 2$$

$$T(n) = 2^2 T(\sqrt[2]{n}) + 2 \quad \text{...(3)}$$

$$T(\sqrt[2]{n}) = 2T(\sqrt[3]{n}) + 1 \quad \text{...(4)}$$

Substituting (4) in (3)

$$T(n) = 2^3 T(\sqrt[3]{n}) + 3$$

Running the same till K times,

$$T(n) = 2^K T(\sqrt[K]{n}) + K$$

$$\sqrt[K]{n} = 2$$

$$K = \log_2 n$$

Solving this will give $T(n) = \Theta(\log n)$

End of Solution

Q.41 If the characteristic polynomial of a 3 × 3 matrix M over $\mathbb{R}$ (the set of real numbers) is $\lambda^3 - 4\lambda^2 + a\lambda + 30$. $a \in \mathbb{R}$ and one eigenvalue of M is 2. then the largest among the absolute values of the eigenvalues of M is ________.

Ans. **(5)**

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

Now 2 is one of roots of this equation

So, $2^3 - 4 \times 2^2 + a \times 2 + 30 = 0$

$\Rightarrow 8 - 16 + 2a + 30 = 0$

$\Rightarrow a = -11$

So, the equation is $\lambda^3 - 4\lambda^2 - 11\lambda + 30 = 0$

Now, by polynomials division we get

$$\frac{\lambda^3 - 4\lambda^2 - 11\lambda + 30}{\lambda - 2} = \lambda^2 - 2\lambda - 15$$

roots of $\lambda^2 - 2\lambda - 15 = 0$ are

$$\lambda = \frac{2 \pm \sqrt{4+60}}{2} = \frac{2 \pm 8}{2} = 5 \text{ and } -3$$

So the eigen values are 2, 5 and –3, the maximum absolute eigen value is 5.

End of Solution

Q.42 If a random variable X has a Poisson distribution with mean 5, then the expectation $E[(X + 2)^2]$ equals __________.

Ans. **(54)**

Given, Poisson distribution $\lambda = 5$

We know that in Poisson distribution

$$E(X) = V(X) = \lambda$$

so here $E(X) = V(X) = 5$

now, we need $E[(X + 2)^2]$

$$= E(X^2 + 4X + 4) = E(X^2) + 4E(X) + 4$$

To find $E(X^2)$ we write, $V(X) = E(X^2) - (E(X))^2$

$$5 = E(X^2) - 5^2$$

So, $E(X^2) = 5^2 + 5 = 30$

required value = 30 + 4 × 5 + 4 = 54

End of Solution

Q.43 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 variables 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)

Ans. **(c)**

End of Solution

Q.44 In a B^+ tree, if the search-key value is 8 bytes long, the block size is 512 bytes and the block pointer size is 2 bytes, then the maximum order of the B^+ tree is__________.

Ans. **(52)**

B^+ tree
Search key : 8 bytes
Block size : 512 bytes
Block pointer : 2 bytes
Maximum order of B^+ tree node??

$$P \times B_P + (P - 1) \times \text{Key} \leq \text{Block size}$$
$$P \times 2 + (P - 1)8 \leq 512$$
$$10P \leq 520$$
$$P = \left\lfloor \frac{520}{10} \right\rfloor = 52$$

End of Solution

Q.45 Consider the following database table named *top_scorer*.

top_scorer

player	country	gaols
Klose	Germany	16
Ronaldo	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 Muller	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 _______.

Ans. **(7)**

```
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')
```

Number of tuples in result 7.

End of Solution

Q.46 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 10,000 km and the propagation speed along the link is 2×10^8 m/sec. Host X sends a file of 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

Ans. **(d)**

$$\text{Transmission time} = \frac{\text{Data size}}{\text{Bandwidth}}$$

$$= \frac{50000 \times 8 \text{ bits}}{10^6 \text{ bits/sec}}$$

$$= 400 \text{ msec}$$

$$\text{Propagation time} = \frac{\text{Distance}}{\text{Velocity}}$$

$$= \frac{10000 \times 10^3 \text{ m}}{2 \times 10^8 \text{ m/sec}}$$

$$= 50 \times 10^{5-8} \text{ sec}$$

$$= 50 \text{ msec}$$

End of Solution

Q.47 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 _________.

Ans. **(29)**

Process	Arrival Time	Burst Time	Priority	C.T.	T.A.T.	W.T.
P_1	0	11	2	49	49	38
P_2	5	28	0 (high)	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
					Total	145

P_1	P_4	P_2	P_4	P_1	P_3	P_5

0 2 5 33 40 49 51 67

$$\text{Average waiting time} = \frac{145}{5} = 29$$

End of Solution

Q.48 Consider the following C program

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

The output of the program is ________.

Ans. **(0)**

```
1. int m = 10;       // m = 10
2. int n, n1;
3. n = ++m;          // n = 11
4. n1 = m++;         // n1 = 11, m = 12
5. n – –;            // n = 10
6. – – n1;           // n1 = 10
7. n – = n1;         // n = 0
8. printf(“%d”, n);
```

The ouitput will be 0.

End of Solution

Q.49 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 ______.

Ans. **(225)**

End of Solution

Q.50 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 Turing machine M.

Which of the following decision problems are undecidable?

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

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

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

IV. Given a Turing 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

Ans. **(d)**

I. Membership of regular language (Decidable)
II. Emptiness of CFL (Decidable)
III. $L = \Sigma^*$ problem of CFL (Undecidable)
IV. Membership of RE language (Undecidable)
So, only III and IV are undecidable. So, correct answer is (d).

End of Solution

Q.51 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 %d", i, j);
        }
    }
}
```

Time complexity of fun in terms of Θ notation is

(a) $\Theta(n\sqrt{n})$
(b) $\Theta(n^2)$
(c) $\Theta(n\log n)$
(d) $\Theta(n^2\log n)$

Ans. (c)

First loop will execute 'n' times and the inner loop will execute $\Theta(\log n)$ times.

Hence the compelxity will be $\Theta(n\log n)$.

End of Solution

Q.52 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 $r_i(V)$ denotes a read operation by transaction T_i on a variable V and $w_i(V)$ denotes a write operation 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 _______.

Ans. (54)

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

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

(*i*) Number of conflict serializable on $T_1 \to T_2$: 1

$r_1(X)\ w_1(X)\ r_1(Y)\ w_1(Y)\ r_2(Y)\ w_2(Y)\ r_2(Z)\ w_2(Z)$

(*ii*) Number of conflict serializable on $T_2 \to T_1$: 53

S : $r_2(Y)\ w_2(Y)\ r_1(Y)\ w_1(Y)$

$r_1(X)\ w_1(X)$ must be before $r_1(Y)$

So that $(r_2(Y)\ w_2(Y))\ (r_1(X)\ w_1(X))$ can place.

${}^4C_2 = 6$ ways.

1. $r_2(Y)\ w_2(Y)\ r_1(X)\ w_1(X)\ r_1(Y)\ w_1(Y)$

$r_2(Z)\ w_2(Z)$ can place in ${}^6C_2 = 15$ ways.

2. $r_2(Y)\ r_1(X)\ w_1(X)\ w_2(Y)\ r_1(Y)\ w_1(Y)$
   $r_2(Z)\ w_2(Z)$ can place in ${}^4C_2 = 6$ ways.
3. $r_2(Y)\ r_1(X)\ w_2(Y)\ w_1(X)\ r_1(Y)\ w_1(Y)$
   $r_2(Z)\ w_2(Z)$ can place in ${}^5C_2 = 10$ ways.
4. $r_1(X)\ w_1(X)\ r_2(Y)\ w_2(Y)\ r_1(Y)\ w_1(Y)$
   $r_2(Z)\ w_2(Z)$ can place in ${}^4C_2 = 6$ ways.
5. $r_1(X)\ r_2(Y)\ w_2(Y)\ w_1(X)\ r_1(Y)\ w_1(Y)$
   $r_2(Z)\ w_2(Z)$ can place in ${}^5C_2 = 10$ ways.
6. $r_1(X)\ r_2(Y)\ w_1(X)\ w_2(Y)\ r_1(Y)\ w_1(Y)$
   $r_2(Z)\ w_2(Z)$ can place in ${}^4C_2 = 6$ ways.

Total conflict serializable of T_1 and T_2 = 53 + 1 = 54 ways.

End of Solution

Q.53 The pre-order traversal 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:

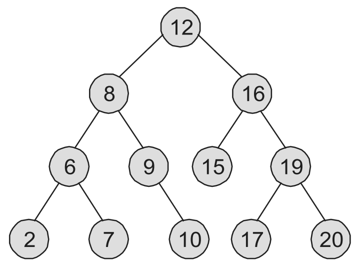
(a) 2, 6, 7, 8, 9, 10, 12, 15, 16, 17, 19, 20
(b) 2, 7, 6, 10, 9, 8, 15, 17, 20, 19, 16, 12
(c) 7, 2, 6, 8, 9, 10, 20, 17, 19, 15, 16, 12
(d) 7, 6, 2, 10, 9, 8, 15, 16, 17, 20, 19, 12

Ans. **(b)**

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

Inorder: 2, 6, 7, 8, 9, 10, 12, 15, 16, 17, 19, 20

Tree will be,



Postorder will be,

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

End of Solution

Q.54 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], Sarray[i + 1]);
            done = 0;
    }
}
for (i = 5; i >= 1; i --)
{
    if (array[i] > array[i – 1])
    {
        swap(&array[i], Sarray[i – 1]);
        done = 0;
    }
}
printf("%d", array[3]);
}
```

The output of the program is ________.

Ans. **(3)**

3	5	1	4	6	2
0	1	2	3	4	5

First for loop:

$(i = 0)$	5	3	1	4	6	2
$(i = 1)$	5	3	1	4	6	2
$(i = 2)$	5	3	4	1	6	2
$(i = 3)$	5	3	4	6	1	2
$(i = 4)$	5	3	4	6	2	1

Second for loop:

$(i = 5)$	5	3	4	6	2	1
$(i = 4)$	5	3	4	6	2	1
$(i = 3)$	5	3	6	4	2	1
$(i = 2)$	5	6	3	4	2	1
$(i = 1)$	6	5	3	4	2	1

Now since done is '0', hence the for loops will execute again.

First for loop:

(i = 0)	6	5	3	4	2	1
(i = 1)	6	5	3	4	2	1
(i = 2)	6	5	4	3	2	1
(i = 3)	6	5	4	3	2	1
(i = 4)	6	5	4	3	2	1

Second for loop:

(i = 5)	6	5	4	3	2	1
(i = 4)	6	5	4	3	2	1
(i = 3)	6	5	4	3	2	1
(i = 2)	6	5	4	3	2	1
(i = 1)	6	5	4	3	2	1

Value of done is still '0', hence the for loop will execute again.

First for loop:

This time there will be no change by the for loop.

The value of done is '1'. Hence the loop terminates as

6	5	4	3	2	1
0	1	2	3	4	5

The output of the program will be '3'.

End of Solution

Q.55 Consider a binary code that consists of only four valid codewords 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 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

Ans. **(a)**

Given codewords

00000
01011
10101
11110

Minimum hamming distance = min(hamming distance between every 2 pair) = 3

To correct errors, the condition is

$$2d + 1 = 3$$

$$\Rightarrow \quad d = 1$$

End of Solution