GATE Computer Science & IT

2017

Time : 3 hrs **MM :** 100

Read the following instructions carefully

1. In this paper, there are 65 questions carrying 100 marks of 3 hrs duration.
2. Questions 1 to 25 carry 1 mark each and questions 26 to 55 carry 2 marks each.
3. Questions 56 to 65 belong to General Aptitude (GA) Type. Questions 56 to 60 carry 1 mark each and questions 61 to 65 carry 2 marks each.
4. Unattempted questions will carry zero marks.
5. For questions 1 to 25 and 56 to 60, 1/3 mark will be deducted for each wrong answer. For questions 26 to 55 and 61 to 65, 2/3 mark will be deducted for each wrong answer.
6. There is no negative marking for numerical answer type questions.
7. No any physical calculator will be allowed. Charts, graph sheets and mathematical tables are not allowed in the examination hall.

(1 *Mark Questions*)

1. When two 8-bit numbers $A_7 \dots A_0$ and $B_7 \dots B_0$ in 2's complement representation (with A_0 and B_0 as the least significant bits) are added using a **ripple-carry adder**, the sum bits obtained are $S_7 \dots S_0$ and the carry bits are $C_7 \dots C_0$. An overflow is said to have occurred if

(a) the carry bit C_7 is 1

(b) all the carry bits $(C_7 \dots C_0)$ are 1

(c) $(A_7 \cdot B_7 \cdot \overline{S}_7 + \overline{A}_7 \cdot \overline{B}_7 \cdot S_7)$ is 1

(d) $(A_0 \cdot B_0 \cdot \overline{S}_0 + \overline{A}_0 \cdot \overline{B}_0 \cdot S_0)$ is 1

Sol. (c) Let first 8 bit number be A and second 8 bit number be B.

Hence, $A \Rightarrow A_7 A_6 \dots A_0$

$B \Rightarrow B_7 B_6 \dots B_0$

$+$

sum $\rightarrow$ $S_7 S_6 \dots S_0$

carry $\rightarrow$ $C_7 C_6 \dots C_0$

For positive number, $\overline{A}_7 \overline{B}_7 S_7$ is 1, whenever there is a overflow.

For negative numbers $A_7 B_7 \overline{S}_7$ is 1, whenever there is a overflow.

Hence, $(A_7 \cdot B_7 \cdot \overline{S}_7 + \overline{A}_7 \cdot \overline{B}_7 \cdot S_7)$ is 1 whenever overflow occurred.

2. Consider a TCP client and a TCP server running on two different machines. After completing data transfer, the TCP client calls **close** to terminate the connection and a FIN segment is sent to the TCP server. Server-side TCP responds by sending an ACK, which is received by the client-side TCP. As per the TCP connection state diagram (RFC 793). In which state does the client-side TCP connection wait for the FIN from the server-side TCP ?

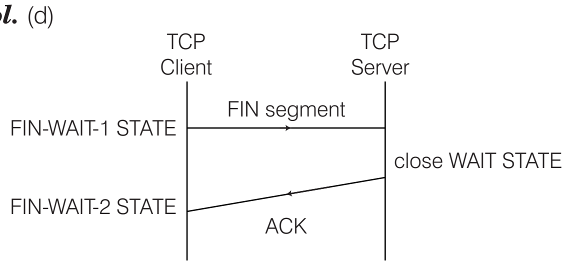
(a) LAST-ACK

(b) TIME-WAIT

(c) FIN-WAIT-1

(d) FIN-WAIT-2

Sol. (d)



3. Consider the following grammar :

$P \to xQRS \qquad Q \to yz \mid z$

$R \to w \mid \in \qquad S \to y$

What is FOLLOW (Q) ?

(a) $\{R\}$ (b) $\{w\}$

(c) $\{w, y\}$ (d) $\{w, \$\}$

Sol. (c) Follow (Q) = First (RS) = First (R) $\cup$ First (S)

$= \{\{w\} - \in\} \cup \{y\}$

$= \{w, y\}$ [$\because$ R can be $\in$]

4. Let X be a Gaussian random variable with mean 0 and variance σ^2. Let Y = max (X, 0) where max (a, b) is the maximum of a and b. The median of Y is……

Sol. (0) We know that Gaussian random variable is same as normal random variable.

So, the distribution of X would be $N(0, \sigma^2)$

For X, Median = Mean = Mode = 0

For Y, Median = max (X, 0)

Now half the data are below 0 and half the data are above 0 for X. If we apply Y = max (X, 0) then, all the negative values will becomes 0 and and all the positive values will remains positive.

So, Median being positional average will not be affected and will remain at 0, since now half will be at 0 and half will be at positive.

So, Median (Y) = 0

5. Consider the first-order logic sentence $F : \forall x\, (\exists y R(x, y))$. Assuming non-empty logical domains, which of the sentences below are implied by F ?

I. $\exists y\, (\exists x R(x, y))$

II. $\exists y\, (\forall x R(x, y))$

III. $\forall y\, (\exists x R(x, y))$

IV. $\neg \exists x\, (\forall y \neg R(x, y))$

(a) IV only (b) Both I and IV

(c) II only (d) Both II and III

Sol. (b) I. $\forall x\, (\exists y\, R(x, y) \to \exists y\, (\exists x\, R(x, y))$ is true, because $\exists y\, (\exists x\, R(x, y)) \equiv \exists x\, (\exists y\, R(x, y))$

II. $\forall x\, (\exists y\, R(x, y)) \to \exists y\, (\forall x\, R(x, y))$ is false,

Because $\exists y$ when it is outside is stronger then when it is inside.

III. $\forall x\, (\exists y\, R(x, y)) \to \forall y \exists x\, R(x, y)$ is false

Because $R(x, y)$ may not be symmetric in x and y.

IV. $\forall x\, (\exists y\, R(x, y)) \to \neg\, (\exists x\, \forall y \neg R(x, y)$ is true

Because $\neg\, (\exists x\, \forall y \neg R(x, y)) \equiv \forall x \exists y\, R(x, y)$

So, IV will reduce to $\forall x \exists y\, R(x, y) \to \forall x \exists y\, R(x, y)$ which is trivially true.

Hence, correct answer is both I and IV which is option (b).

6. Consider the following intermediate program in three address code

$p = a - b$
$q = p * c$
$p = u * v$
$q = p + q$

Which one of the following corresponds to a static single assignment form of the above code ?

(a) $p_1 = a - b$, $q_1 = p_1 * c$, $p_1 = u * v$, $q_1 = p_1 + q_1$

(b) $p_3 = a - b$, $q_4 = p_3 * c$, $p_4 = u * v$, $q_5 = p_4 + q_4$

(c) $p_1 = a - b$, $q_1 = p_2 * c$, $p_3 = u * v$, $q_2 = p_4 + q_3$

(d) $p_1 = a - b$, $q_1 = p * c$, $q_2 = u * v$, $q_2 = p + q$

Sol. (b) In option (a) : p_1, q_1 are used for temporary storage which is not allowed under static single assignment.

In option (c) : in 2nd line it should be $q_1 = p_1 * c$.

In option (d) in 2nd line it should be $q_1 = p_1 * c$.

Hence, the corrected code would be:

$p_3 = a - b$
$q_4 = p_3 * c$
$p_4 = u * v$
$q_5 = p_4 + q_4$

7. The following functional dependencies hold true for the relational schema $R\{V, W, X, Y, Z\}$;

$$V \to W,\; VW \to X,\; Y \to VX,\; Y \to Z$$

Which of the following is irreducible equivalent for this set of functional dependencies ?

(a) $V \to W$, $V \to X$, $Y \to V$, $Y \to Z$

(b) $V \to W$, $W \to X$, $Y \to V$, $Y \to Z$

(c) $V \to W$, $V \to X$, $Y \to V$, $Y \to X$, $Y \to Z$

(d) $V \to W$, $W \to X$, $Y \to V$, $Y \to X$, $Y \to Z$

Sol. (a) Given relational schema $R\,(V, W, X, Y, Z)$:

$\{V \to W, VW \to X, Y \to V, Y \to X, Y \to Z\}$

Now, W extraneous from $VW \to X$

$\{V \to W, V \to X, Y \to V, Y \to X, Y \to Z\}$

Again, $Y \to X$ is redundant FD from above set

$\{V \to W, V \to X, Y \to V, Y \to Z\}$ is minimal cover.

8. Let $c_1 \ldots c_n$ be scalars, not all zero, such that $\sum_{i=1}^{n} c_i a_i = 0$ where, a_i are column vectors in R^n.

Consider the set of linear equations, $Ax = b$

where $A = [a_1 \ldots a_n]$ and $b = \sum_{i=1}^{n} a_i$. The set of equations has

(a) a unique solution at $x = J_n$ where J_n denotes a n-dimensional vector of all 1
(b) no solution
(c) infinitely many solutions
(d) finitely many solutions

Sol. (c) The given equation $Ax = b$ becomes according to question

$$[a_1, a_2, \ldots a_n]\begin{bmatrix} x_1 \\ x_2 \\ \\ x_n \end{bmatrix} = a_1 + a_2 + a_3 + \ldots a_n$$

where, a_i are column vectors in R^n but since we have c_i (not all zero) such that,

$$\Sigma c_j a_j = 0$$

It means that n column vectors are not linearly independent and then rank $(A) < n$

So, we have infinitely many solutions one of which will be J_n, where J_n denotes a n-dim vector of all 1.

9. Let T be a tree with 10 vertices. The sum of the degrees of all the vertices in T is……

Sol. (18) Given T be a tree.

Number of vertices $n = 10$

We know that

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

In a tree, $e = n - 1$

So, Σ degree $= 2\,(n-1) = 2\,(10-1) = 2 \times 9 = 18$

10. Consider a two-level cache hierarchy with L_1 and L_2 caches. An application incurs 1.4 memory accesses per instruction on average. For this application, the miss rate of L_1 cache is 0.1 : the L_2 cache experiences, on average, 7 misses per 1000 instructions. The miss rate of L_2 expressed correct to two decimal places is………

Sol. (0.05) According to question,

1.4 memory accesses —— 1instructions
? # memory accesses —— 1000 instructions

So, number of memory access in 1000 instructions

$$= 1.4 \times 1000 = 1400$$

Number of misses in L_2 cache

$$= \frac{7 \text{ miss}}{1400 \text{ memory access}} = \frac{7}{1400} = 0.005$$

$$\text{Miss rate } L_2 = \frac{\#\text{ misses in } L_2}{\#\text{ misses in } L_1} = \frac{0.005}{0.1} = 0.05$$

Hence, the miss rate of L_2 expressed correct to two decimal places is 0.05.

11. Consider the following functions from positive integers to real numbers:

$$10, \sqrt{n}, n, \log_2 n, \frac{100}{n}$$

The CORRECT arrangement of the above functions in increasing order of asymptotic complexity is

(a) $\log_2 n, \frac{100}{n}, 10, \sqrt{n}, n$
(b) $\frac{100}{n}, 10, \log_2 n, \sqrt{n}, n$
(c) $10, \frac{100}{n}, \sqrt{n}, \log_2 n, n$
(d) $\frac{100}{n}, \log_2 n, 10, \sqrt{n}, n$

Sol. (b) For any value of n, the CORRECT arrangement would be : $\frac{100}{n} < 10 < \log_2 n < \sqrt{n} < n$.

So correct option is (b).

12. Consider the following context-free grammer over the alphabet $\Sigma = \{a, b, c\}$ with S as the start symbol

$$S \to abScT \mid abcT$$
$$T \to bT \mid b$$

Which one of the following represents the language generated by the above grammar ?

(a) $\{(ab)^n (cb)^n \mid n \geq 1\}$
(b) $\{(ab)^n cb^{m_1} cb^{m_2} \ldots cb^{m_n} \mid n, m_1, m_2, \ldots, m_n \geq 1\}$
(c) $\{(ab)^n (cb^m)^n \mid m, n \geq 1\}$
(d) $\{(ab)^n (cb^n)^m \mid m, n \geq 1\}$

Sol. (c) Given, $S \to abScT \mid abcT$

$$T \to bT \mid b$$

Solving $T \to bb^*$

Substitute the value of T in S to get $S \to abScbb^* \mid abcbb^*$

So, solution of S would be $\{(ab)^n (cb^m)^n \mid m, n \geq 1\}$

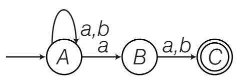
Hence, option (c) is correct.

13. Consider the language L given by the regular expression $(a + b)^* b (a + b)$ over the alphabet $\{a, b\}$. The smallest number of states needed in a deterministic finite-state automaton (DFA) accepting L is………

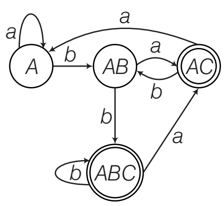
Sol. (4) The given regular expression is $(a + b)^* b (a + b)$.

This is all strings whose second last bit is 'b'.

Minimal NFA is



Converting it into minimal DFA by subset construction algorithm, we get



It is a minimal DFA with 4 states.

14. The n-bit fixed-point representation of an unsigned real number X uses f bits for the fraction part. Let $i = n - f$. The range of decimal values for X in this representation is

(a) 2^{-f} to 2^{i} (b) 2^{-f} to $(2^{i} - 2^{-f})$

(c) 0 to 2^{i} (d) 0 to $(2^{i} - 2^{-f})$

Sol. (d) Let $n = 5$ bit and $f = 2$ bit

$$i = n - f = 5 - 2 = 3 \text{ bit}$$

Hence, Min value : 000.00

$\Rightarrow$ 0

K Max value : 111.11 = 7.75

Now, $[2^{i} - 2^{-f}] = [2^{3} - 2^{-2}] = 8 - 0.25 = 7.75$

15. Threads of a process share

(a) global variables but not heap
(b) heap but not global variables
(c) neither global variables nor heap
(d) both heap and global variables

Sol. (d) Generally, threads are called light weight process. If we divide memory into three sections then it will be: code, data and stack. Every process has its own code, data and stack sections and due to this context switch time is a little high. To reduce context switching time, people come up with concept of thread. Both heap and global variables are shared by every thread of a process.

16. Consider the Karnaugh map given below where X represents "don't care" and blank represents 0.

dc \ ba	00	01	11	10
00		X	X	
01	1			X
11	1			1
10		X	X	

Assume for all inputs (a, b, c, d) the respective complements $(\bar{a}, \bar{b}, \bar{c}, \bar{d})$ are also available. The above logic is implemented using 2-input NOR gates only. The minimum number of gates required is ....

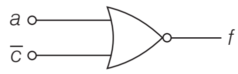
Sol. (1) Given Karnaugh map is :

dc \ ba	00	01	11	10
00		X	X	
01	1			X
11	1			1
10		X	X	

1 quad (0100, 1100, 0110, 1110) = $\bar{a}c$

$\therefore$ $f = \bar{a}c = \overline{a + \bar{c}}$ [using Demorgan's law]

Logic gate :



Hence, number of NOR gates required is 1.

17. Consider the C struct defined below :

```
struct data
{
int marks [100];
char grade;
int cnumber;
};
struct data student;
```

The base address of student is available in register R1. The field student.grade can be accessed efficiently using

(a) Post-increment addressing mode, (R1) +
(b) Pre-decrement addressing mode, – (R1)
(c) Register direct addressing mode, R1
(d) Index addressing mode, X(R1), where X is an offset represented in 2's complement 16-bit representation.

Sol. (d) Because direct access is possible with only index addressing mode in given options. So option (d) is the correct answer.

18. A sender S sends a message m to receiver R, which is digitally signed by S with its private key. In this scenario, one or more of the following security violations can take place.

I. S can launch a birthday attack to replace m with a fraudulent message.
II. A third party attacker can launch a birthday attack to replace m with a fraudulent message.
III. R can launch a birthday attack to replace m with a fraudulent message.

Which of the following are possible security violations ?

(a) I and II only (b) I only

(c) II only (d) II and III only

Sol. (a)

19. The statement $(\neg p) \Rightarrow (\neg q)$ is logically equivalent to which of the statements below ?

I. $p \Rightarrow q$

II. $q \Rightarrow p$

III. $(\neg q) \vee p$

IV. $(\neg p) \vee q$

(a) I only
(b) both I and IV
(c) II only
(d) both II and III

Sol. (d) Statement $\neg p \Rightarrow \neg q \equiv p + \neg q$

I. $p \rightarrow q \equiv \neg p + q$

II. $q \rightarrow p \equiv \neg q + p$

III. $(\neg q \vee p) \equiv \neg q + p$

IV. $(\neg p \vee q) \equiv \neg p + q$

So, clearly from the above statement is same as II and III both.

Hence, option (d) is correct.

20. Consider the following table:

Algorithms		Design Paradigms	
(P)	Kruskal	(i)	Divide and Conquer
(Q)	Quicksort	(ii)	Greedy
(R)	Floyd-Warshall	(iii)	Dynamic Programming

Match the algorithms to the design paradigms they are based on.

(a) (P) ↔ (ii), (Q) ↔ (iii), (R) ↔ (i)
(b) (P) ↔ (iii), (Q) ↔ (i), (R) ↔ (ii)
(c) (P) ↔ (ii), (Q) ↔ (i), (R) ↔ (iii)
(d) (P) ↔ (i), (Q) ↔ (ii), (R) ↔ (iii)

Sol. (c)
- Kruskal's algorithms is a greedy algorithm in a graph theory as it finds a minimum spanning tree for a connected weighted graph adding increasing cost arcs at each step.
- Quicksort uses divide and conquer approach. It picks an element as pivot and partitions the given array around the picked pivot.
- Floyd-Warshall which is used to find the shortest path between every pair of vertices and it follows dynamic programming strategy.

21. Consider a database that has the relation schema EMP (Empld, EmpName, and DeptName).

An instance of the schema EMP and a SQL query on it are given below:

EMP

EmpId	EmpName	DeptName
1	XYA	AA
2	XYB	AA
3	XYC	AA
4	XYD	AA
5	XYE	AB
6	XYF	AB
7	XYG	AB
8	XYH	AC
9	XYI	AC
10	XYJ	AC
11	XYK	AD
12	XYL	AD
13	XYM	AE

SELECT AVG (EC. Num) FROM EC WHERE (DeptName, Num) IN (SELECT DeptName, COUNT (Empld) AS EC (DeptName, Num) FROM EMP GROUP BY DeptName)

The output of executing the SQL query is

Sol. (2.6) Result of inner query:

EC

DeptName	Number
AA	4
AB	3
AC	3
AD	2
AE	1

Result of outer query: = AVG (Num) = $\frac{13}{5} = 2.6$

22. Consider the following C code :

```
#include <stdio.h>
int *assignval (int *x, int val)
{
     *x = val;
     return x;
}
void main ( ) {
     int *x = malloc (size of (int));
     if (NULL = = x return;
     x = assignval (x, 0);
     if(x)
     {
```

```
    x = (int *) malloc (size of (int));
          if(NULL = = x) return;
          x = assignval (x, 10);
}
      printf ("%d"\n", *x);
      free (x);
}
```

The code suffers from which one of the following problems:

(a) compiler error as the return of malloc is not typecast appropriately

(b) compiler error because the comparison should be made as x = = NULL and not as shown

(c) compiles successfully but execution may result in dangling pointer

(d) compiles successfully but execution may result in memory leak

Sol. (a)

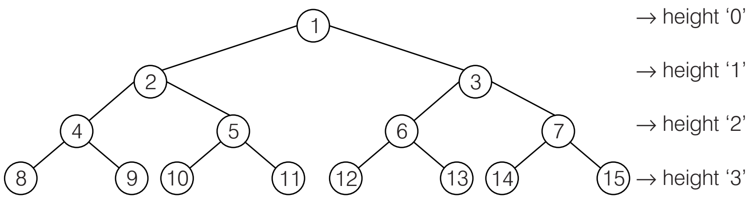
23. Let T be a binary search tree with 15 nodes. The minimum and maximum possible heights of T are

Note : The height of a tree with a single node is 0.

(a) 4 and 15 respectively (b) 3 and 14 respectively

(c) 4 and 14 respectively (d) 3 and 15 respectively

Sol. (b) Because there are 15 nodes (given), hence the minimum height of the tree will be 3 (when tree will be balanced).



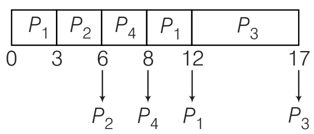
The maximum height will be when the tree is skew tree, which will given rise to height 14.

24. Consider the following CPU processes with arrival times (in milliseconds) and length of CPU bursts (in milliseconds) as given below :

Process	Arrvial time	Burst time
P_1	0	7
P_2	3	3
P_3	5	5
P_4	6	2

If the pre-emptive shortest remaining time first scheduling algorithm is used to schedule the processes, then the average waiting time across all processes is……milliseconds.

Sol. (3.0) Using premptive SRTF (Smallest Remaining Time First) algorithm, Gantt chart will be,



Turnaround time	Waiting time
$P_1 \to 12 - 0 = 12$	$P_1 \to 12 - 7 = 5$
$P_2 \to 6 - 3 = 3$	$P_2 \to 3 - 3 = 0$
$P_3 \to 17 - 5 = 12$	$P_3 \to 12 - 5 = 7$
$P_4 \to 8 - 6 = 2$	$P_4 \to 2 - 2 = 0$

$\therefore$ Average waiting time $= \dfrac{5+0+7+0}{4} = 3.0$

25. Consider the C code fragment given below.

```
typedef struct node
{
     int data;
     node* next;
}    node;
     void join (node* m, node* n)
{
     node* p = n;
     while (p → next ! = NULL)
     {
         p = p → next;
     }
     p → next = m;
}
```

Assuming that m and n point to valid NULL-terminated linked lists, invocation of join will

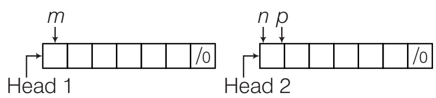
(a) append list m to the end of list n for all inputs.

(b) either cause a null pointer dereference or appened list m to the end of list n.

(c) cause a null pointer dereference for all inputs.

(d) append list n to the end of the list m for all inputs.

Sol. (b) Consider two linked lists as follows :



After the execution of given code, list 'm' will be appended to the end of list 'n'. But in some cases it can cause a null pointer deference also.

(2 *Marks Questions*)

26. Recall that Belady's anomaly is that the page-fault rate may increase as the number of allocated frames increases. Now, consider the following statements:

S1 : *Random page replacement* algorithm (where a page chosen at random is replaced) suffers from Belady's anomaly

S2 : *LRU page replacement* algorithm suffers from Belady's anomaly

Which of the following is CORRECT ?

(a) S1 is true, S2 is true (b) S1 is true, S2 is false

(c) S1 is false, S2 is true (d) S1 is false, S2 is false

Sol. (b) Read to each statement as follows :

- Random page replacement algorithm can behave like any algorithm probably FCFS (First Come First Serve) too, hence it can suffer from Belady's anomaly.
- LRU page replacement algorithm doesn't suffer from Belady's anomaly.

27. Consider the following grammar:

```
stmt → if expr then expr else expr; stmt|0
expr → term relop term|term
term → id|number
id → a | b | c
number → [0-9]
```

where **relop** is a relational operator $(e.g., <, >, \ldots), 0$ refers to the empty statement, and **if, then, else** are terminals. Consider a program *P* following the above grammar containing ten **if** terminals. The number of control flow paths in *P* is………. For example, the program

if e_1 **then** e_2 **else** e_3

has 2 control flow paths, $e_1 \rightarrow e_2$ and $e_1 \rightarrow e_3$.

Sol. (20)

28. Consider a database that has the relation schema CR (StudentName, CourseName). An instance of the schema CR is as given below :

CR

Student Name	Course Name
SA	CA
SA	CB
SA	CC
SB	CB
SB	CC
SC	CA
SC	CB
SC	CC
SD	CA
SD	CB
SD	CC
SD	CD
SE	CD
SE	CA
SE	CB
SF	CA
SF	CB
SF	CC

The following query is made on the database:

$T_1 \leftarrow \pi_{\text{CourseName}}(\sigma_{\text{StudentName} = \text{'SA'}}(\text{CR}))$

$T_2 \leftarrow CR \div T_1$

the number of rows in T_2 is……

Sol. (4) Output of T_1 :

Course Name
CA
CB
CC

Output of T_2 : CR ÷ T_1 ⇒ student name for which every course name of CA, CB, CC is

SA	
SC	4 rows in output
SD	
SF	

29. Consider a database that has the relation schemas EMP (EmpId, EmpName, Depid) and DEPT (DeptName, Deptid).

Note that the Deptid can be permitted to be NULL in the relation EMP.

Consider the following queries on the database expressed in tuple relational calculus.

I. $\{t \mid \exists u \in \text{EMP } (t \text{ [Emp Name]. 4[Emp name]} \wedge \forall v \in \text{DEPT } (t \text{ [DeptId]} \neq v \text{ [DeptId]}))\}$

II. $\{t \mid \exists u \in \text{EMP } (t \text{ [EMP Name]} = u \text{ [Emp Name]} \wedge \exists v \in \text{DEPT } (t \text{ [DeptId]} \neq v \text{ [DeptId]}))\}$

III. $\{t \mid \exists u \in \text{EMP } (t\text{[Emp Name]} = u \text{ [Emp Name]} \wedge \exists v \in \text{DEPT } (t \text{ [DeptId]} = v \text{ [DeptId]}))\}$

Which of the above queries are safe ?

(a) I and II (b) I and III

(c) II and III (d) I, II and III

Sol. (d) Query which generates infinite number of tuples is called unsafe query. In the question, all the given queries generate finite number of tuples.

30. Consider the context-free grammars over the alphabet $\{a, b, c\}$ given below. S and T are non-terminals.

$$G_1 : S \rightarrow aSb \mid T, T \rightarrow cT \mid \in$$

$$G_2 : S \rightarrow bSa \mid T, T \rightarrow cT \mid \in$$

The language $L(G_1) \cap L(G_2)$ is

(a) Finite
(b) Non finite but regular
(c) Context-Free but not regular
(d) Recursive but not context-free

Sol. (b) Given,

$$G_1 : S \rightarrow aSb \mid T, T \rightarrow cT \mid \in$$
$$G_2 : S \rightarrow bSa \mid T, T \rightarrow cT \mid \in$$

Language $L(G_1) = \{a^n c^m b^n \mid m, n \geq 0\}$

$L(G_2) = \{b^n c^m a^n \mid m, n \geq 0\}$

$L(G_1) \cap L(G_2) = \{a^n c^m b^n) \cap (a^n c^m b^n)$

$= \{c^m \mid m \geq 0\} = c^*$

Since, the only common strings will be those strings with only 'c', since in the first language all the other strings start with 'a' and in the second language all the other strings start with 'b'.

Clearly, the intersection is not finite but regular.

31. The number of integers between 1 and 500 (both inclusive) that are divisible by 3 or 5 or 7 is……

Sol. (271) Let A is divisible by 3, B is divisible by 5 and C is divisible by 7.

$\therefore \quad n(A \cup B \cup C) = n(A) + n(B) + n(C)$
$- n(A \cap B) - n(A \cap C) - n(B \cap C) + n(A \cap B \cap C).$

$$= \left[\frac{500}{3}\right] + \left[\frac{500}{5}\right] + \left[\frac{500}{7}\right] - \left[\frac{500}{15}\right] - \left[\frac{500}{21}\right] - \left[\frac{500}{35}\right] + \left[\frac{500}{105}\right]$$

$= 166 + 100 + 71 - 33 - 23 - 14 + 4 = 271$

32. The value of $\lim_{x \to 1} \dfrac{x^7 - 2x^5 + 1}{x^3 - 3x^2 + 2}$

(a) is 0
(b) is -1
(c) is 1
(d) does not exist

Sol. (c) $\lim_{x \to 1} \dfrac{x^7 - 2x^5 + 1}{x^3 - 3x^2 + 2} = \dfrac{(1)^7 - 2(1)^5 + 1}{(1)^3 - 3(1)^2 + 2} = \dfrac{1 - 2 + 1}{1 - 3 + 2}$

$= 0/0$ form

So, use L' Hospital rule

$$= \lim_{x \to 1} \frac{7x^6 - 10x^4}{3x^2 - 6x} = \frac{7(1)^6 - 10(1)^4}{3(1)^2 - 6(1)}$$

$$= \frac{7 - 10}{3 - 6} = \frac{-3}{-3} = 1$$

Hence, option (c) is correct.

33. The output of executing the following C program is……

```
#include <stdio.h>
int total (int v)
{
      static int count = 0;
      while (v)
{
            count + = v&1;
            v >> = 1;
      }
      return count;
}
void main ( )
{
      static int x = 0
      int i = 5;
      for (; i > 0; i − −)
{
            x = x + total (i);
      }
      print f ("%"d\n", x);
}
```

Sol. (23) **Note** x and count are two static variables

$x = x +$ total (i) is executed for each i.

For $i = 5$; $x = 2$ (As it calls total ( ), count incremented twice for $v = 5, 1$. So new count $= 2$)

For $i = 4$; $x = 5$ (Here count increments only once. So new count $= 3$)

For $i = 3$; $x = 10$ (Here count increments two times when $v = 3, 1$. So, new count $= 5$)

For $i = 2$; $x = 16$ (Here count increments only once when $v = 1$. So new count $= 6$)

For $i = 1$; $x = 23$ (Here count increments only once when $v = 1$. So, new count $= 7$)

Final value of x is 23.

34. Let A be $n \times n$ real valued square symmetric matrix of rank 2 with $\sum_{i=1}^{n} \sum_{j=1}^{n} A_{ij}^2 = 50$. Consider the following statements.

I. One eigenvalue must be in $[-5, 5]$
II. The eigenvalue with the largest magnitude must be strictly greater than 5.

Which of the above statements about eigenvalues of A is/are necessarily CORRECT?

(a) Both I and II
(b) I only
(c) II only
(d) Neither I nor II

Sol. (c) Let $||A||_2$ be the frobenius norm

$$= \sqrt{\Sigma\,\Sigma\,A_{ij}^2}$$

and let $\rho(A)$ represent the spectral radius of A *i.e.*, the largest absolute eigen value.

Now, we have a theorem that for any matrix $\rho(A) \le ||A||_2$

But for a symmetric matrix this theorem reduce to $\rho(A) = ||A||_2$

Since in this problem it is given that

$$\Sigma\,\Sigma\,A_{ij}^2 = 50$$

So, $||A||_2 = \sqrt{50} = 7.071$

So, $\rho(A) =$ Largest absolute eigenvalues $= 7.071$

Now consider the 2 statements given :

I. One eigenvalue must be in $[-5, 5]$ is clearly false since $\rho(A) = 7.071$, does not mean that one eigenvalue must been in $[-5, 5]$.

II. Largest eigenvalue in magnitude > 5 is true since $7.071 > 5$ is true.

So only II is true.

35. Let A be an array of 31 numbers consisting of a sequence of 0's followed by a sequence of 1's. The problem is to find the smallest index i such that $A[i]$ is 1 by probing the minimum number of locations in A. The worst case number of probes performed by an optimal algorithm is……

Sol. (8) Assume i be the index of first element and j be the index of last element of an array A. By using modified binary search algorithm *i.e.*,

1. find middle element of array,
2. if it is 1

   if left element is 1 or not

   if it is 1 then apply modified binary search algorithm for i to mid – 1

   else middle element will be our answer.
4. if middle element is 0

   if right element is 1 or not,

   if it is 1 then it will be the answer.

   else we have to apply modified binary search algorithm for mid + 1to j.

   By using above algorithm, we get best case probes 2 and worst case probes 8.

   Hence, the worst case number of probes performed by an optimal algorithm is 8.

36. If G is a grammar with productions

$$S \to SaS \mid aSb \mid bSa \mid SS \mid \in$$

where S is the start variable, then which one of the following strings is not generated by G ?

(a) *abab* (b) *aaab*

(c) *abbaa* (d) *babba*

Sol. (d) 1. $S \to SS \to aSbS \to abS \to abaSb \to abab$

2. $S \to aSb \to aSaSb \to aaaSb \to aaab$

3. $S \to SS \to aSbS \to abS \to abbSa \to abbSaSa \to abbaa$

Given grammar generates all strings where $n(a) \ge n(b)$.

37. In a RSA cryptosystem, a participant A uses two prime numbers $p = 13$ and $q = 17$ to generate her public and private keys. If the public key of A is 35, then the private key of A is……

Sol. (11)

Given Data	As per RSA Algorithm
$p = 13$	**Step 1** : Calculate $n = p \times q = 13 \times 17 = 221$
$q = 17$	**Step 2** : Calculate $\phi(n) = (p-1)(q-1) = (13-1)(17-1)$ $= 12 \times 16 = 192$
$e = 35$	**Step 3** : demod $\phi(n) = 1$ or $de = 1$ mode $\phi(n)$
$d = ?$	$\Rightarrow$ $d \times 35 \bmod 192 = 1$ $\Rightarrow$ $d = 11$

Hence, private key of A is 11.

38. Let $G = (V, E)$ be any connected undirected edge-weighted graph. The weights of the edges in E are positive and distinct. Consider the following statements :

I. Minimum Spanning Tree of G is always unique.

II. Shortest path between any two vertices of G is always unique.

Which of the above statements is/are necessarily true ?

(a) I only

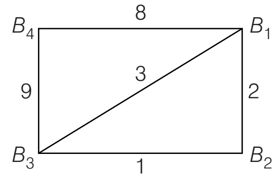
(b) II only

(c) Both I and II

(d) Neither I nor II

Sol. (a)

- All the edge weights are unique, hence the minimum spanning tree of the graph will be unique.
- Shortest path between the two vertices need not to be unique. A counter example for the statement can be,



The path from $B_1 \to B_3$ can be,

I. $B_1 \to B_2 \to B_3 : 2 + 1 = 3$

II. $B_1 \to B_3 : 3$

Hence, the path is not unique.

39. Instruction execution in a processor is divided into 5 stages. Instruction Fetch (IF), Instruction Decode (ID), Operand Fetch (OF), Execute (EX) and Write Back (WB). These stages take 5, 4, 20, 10 and 3 nanoseconds (ns) respectively. A pipelined implementation of the processor requires buffering between each pair of consecutive stages with a delay of 2 ns. Two pipelined implementations of the processor are contemplated :

(i) a native pipeline implementation (NP) with 5 stages and

(ii) an efficient pipleline (EP) where the OF stage is divided into stages OF1 and OF2 with execution times of 12 ns and 8 ns respectively.

The speedup (correct to two decimal places) achieved by EP over NP executing 20 independent instructions with no hazards is ....

Sol. (1.50 – 1.51) NP (Naive Pipeline) $k = 5$

$n = 20$

t_p = Max (Stage delay + Buffer delay) = 22 ns

Execution time $= (k + n - 1) t_p$

$= (5 + 20 - 1) \times 22$ ns = 528 ns

EP (Efficient Pipeline) $k = 6$

$n = 20$

t_p = Max (Stage delay + Buffer delay) = 14 ns

Execution time $= (k + n - 1) t_p$

$= (6 + 20 - 1) \times 14$ ns = 350 ns

$$\text{Speed up (s)} = \frac{ET_{NP}}{ET_{EP}} = \frac{528}{350} = 1.508$$

40. Consider the following language over the alphabet $\Sigma = \{a, b, c\}$.

Let $L_1 = \{a^n b^n c^m \mid m, n \geq 0\}$

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

Which of the following are context-free language ?

I. $L_1 \cup L_2$

II. $L_1 \cap L_2$

(a) I only (b) II only

(c) Both I and II (d) Neither I nor II

Sol. (a) L_1 is a CFL and L_2 is also a CFL.

The union of 2 CFL is always as CFL, but intersection may or may not be.

So, I is clearly true.

Let us intersect and check II

$$\{a^n b^n c^m\} \cap \{a^n b^m c^m\} = \{a^n b^n c^n\}$$

which is clearly not a CFL.

Hence, option (a) is correct.

41. In a database system, unique timestamps are assigned to each transaction using Lamport's logical clock. Let $TS(T_1)$ and $TS(T_2)$ be the timestamps of transactions T_1 and T_2 respectively. Besides, T_1 holds a lock on the resources R and T_1 has requested a conflicting lock on the same resource R. The following algorithm is used to prevent deadlocks in the database system assuming that a killed transaction is restarted with the same timestamp.

if $TS(T_2) < TS(T_1)$ then

T_1 is killed

else T_2 waits

Assume any transaction that is not killed terminates eventually. Which of the following is TRUE about the database system that uses the above algorithm to prevent deadlocks ?

(a) The database system is both deadlock-free and starvation-free.

(b) The database system is deadlock-free, but not starvation-free.

(c) The database system is starvation-free, but not deadlock-free.

(d) The database system is neither deadlock-free nor starvation-free.

Sol. (a) T_1 holds a lock on the resource R.

R_2 requires conflict lock on the same resource R

Wait for graph $T_1 \leftarrow T_2$

if $TS(T_2) < TS(T_1)$

Then T_1 killed [restart with same TS value] else T_2 waits. Avoids both deadlocks is starvation.

42. Let A and B be finite alphabets and let # be a symbol outside both A and B. Let f be a total function from A^* to B^*. We say f is computable if there exists a Turing machine M which given an input x in A^*, always halts with $f(x)$ on its tape. Let L_f denote the language $\{x \# f(x) \mid x \in A^*\}$.

Which of the following statements is true :

(a) f is computable if and only if L_f is recursive.

(b) f is computable if and only if L_f is recursively enumerable.

(c) If f is computable then L_f is recursive, but not conversely.

(d) If f is computable then L_f is recursively enumerable, but not conversely.

Sol. (a) Since the way computable is defined based on halting TM, it means computable is same as Recursive. So, clearly f is computable iff L_f is recursive.

43. Consider a 2-way set associative cache with 256 blocks and uses LRU replacement. Initially the cache is empty. Conflict misses are those misses which occur due to contention of multiple blocks for the same cache set. Compulsory misses occur due to first time access to the block.

The following sequence of accesses to memory blocks (0, 128, 256, 128, 0, 128, 256, 128, 1, 129, 257, 129, 1, 129, 257, 129) is repeated 10 times. The number of conflict misses experienced by the cache is……

Sol. (78) Given, number of lines $= 256$

Number of sets $(S) = \frac{256}{2} = 128$

Cache memory

0	$\cancel{0}\ \cancel{256}\ \cancel{0}$ 256	128
1	$\cancel{1}\ \cancel{257}\ \cancel{1}$ 257	129
2		
127		

$\{K \bmod S = i\}$ LRU

1st time access

0-M (compulsory) : 0 mod 128 = 0

128-M (compulsory) : 128 mod 128 = 0

256-M (compulsory and conflict) : 256 mod 128 = 0

128-H : 128 mod 128 = 0

0-M (conflict) : 0 mod 128 = 0

128-M : 128 mod 128 = 0

256-M (conflict) : 256 mod 128 = 0

128-H : 128 mod 128 = 0

1-M (compulsory) : 1 mod 128 = 1

129-M (compulsory) : 129 mod 128 = 1

257-M (compulsory and conflict) : 257 mod 128 = 1

129-H : 129 mod 128 = 1

1-M (compulsory and conflict): 1 mod 128 = 1

129-H : 129 mod 128 = 1

257-M (compulsory and conflict) : 257 mod 128 = 1

129-H : 129 mod 128 = 1

Number of conflicts miss (C) = 6

2nd time access

Cache memory contains some blocks.

So, 0 becomes conflict miss and 1 becomes conflict miss.

So, two more conflict misses are increases.

$\therefore$ 9 iteration $\Rightarrow 9 \times 8 = 72$

Hence, total conflict misses $= 72 + 6 = 78$.

44. Consider the expression $(a - 1) * (((b + c)/3) + d))$. Let X be the minimum number of registers required by an optimal code generation (without any register spill) algorithm for a load/store architecture, in which (i) only load and store instructions can have memory operands and (ii) arithmetic instructions can have only register or immediate operands. The value of X is ………

Sol. (b) Let T_1 and T_2 be two registers. Then

$$T_1 \leftarrow b$$
$$T_2 \leftarrow c$$
$$T_1 \leftarrow (T_1 + T_2)$$
$$T_1 \leftarrow T_1/3$$
$$T_2 \leftarrow d$$
$$T_1 \leftarrow T_1 + T_2$$
$$T_2 \leftarrow a$$
$$T_2 \leftarrow T_2 - 1$$
$$T_1 \leftarrow T_1 * T_2$$

So, only 2 registers are required. Hence, the value of X is 2.

45. Let p, q and r be propositions and the expression $(p \to q) \to r$ be a contradiction. Then, the expression $(r \to p) \to q$ is

(a) a tautology

(b) a contradiction

(c) always TRUE when p is FALSE

(d) always TRUE when q is TRUE

Sol. (a) $(p \to q) \to r$ is contradiction i.e. always F.

T $\to$ F possible choices.

p	q	r
T	T	F
F	T	F

When q is T statement is T in any case.

When q is F both p, r are F so (F $\to$ F) $\to$ F is T.

$\therefore$ The statement is a tautology.

46. The values of parameters for the Stop-and-Wait ARQ protocol are as given below :

Bit rate of the transmission channel = 1 Mbps.

Propagation delay from sender to receiver = 0.75 ms.

Time to process a frame = 0.25 ms.

Number of bytes in the information frame = 1980.

Number of bytes in the acknowledge frame = 20

Number of overhead bytes in the information frame = 20.

Assume that there are no transmission errors. Then, the transmission efficiency (expressed in percentage) of the Stop-and-Wait ARQ protocol for the above parameters is ……… (correct to 2 decimal places).

Sol. (89.33) Given, processing time of frame = 0.25 msec

We know that, transmission time of data $= \dfrac{\text{Data size}}{\text{Bandwidth}}$

$$= \frac{(1980 + 20)\text{ bytes}}{10^6 \text{bits/sec}}$$

$$= \frac{2000 \times 8 \text{ bits}}{10^6 \text{bits/sec}} = 16 \text{ msec}$$

Propagation time = 0.75 msec

Transmission time of ACK

$$= \frac{20 \times 8 \text{ bits}}{10^6 \text{bits/sec}} = 0.16 \text{ msec}$$

Transmission efficiency of stop and wait ARQ

$$= \frac{16}{0.25 + 16 + 1.5 + 0.16}$$

$$= \frac{16}{17.91} \times 100\% = 89.33\%$$

47. Consider the C functions foo and bar given below :

```
int foo (int val)
{
    int x = 0;
    while (val > 0) {
        x = x + foo (val − −);
    }
    return val;
}
int bar (int val)
{
    int x = 0;
    while (val > 0)
    {
        x = x + bar(val − 1);
    }
    return val;
}
```

Invocations of foo (3) and bar (3) will result in

(a) Return of 6 and 6 respectively.
(b) Infinite loop and abnormal termination respectively.
(c) Abnormal termination and infinite loop respectively.
(d) Both terminating abnormally.

Sol. (c) Both will go in infinite loop.

48. Consider the following C program.

```
#include <stdio.h>
#include <string.h>
void printlength (char *s, char *t)
{
    unsigned int c = 0;
    int len = (strlen(s)−strlen(t))>c)?
    strlen(s):strlen(t);
    printf ("%d\n", len);
}
void main( )
{
    char *x = "abc";
    char *y = "defgh";
    printlength (x, y);
}
```

Recall that strlen is defined in string, *h* as returning a value of type size_*t*, which is an unsigned int. The output of the program is……

Sol. (3) strlen (s) = 3 $[\because s = abc]$

strlen (t) = 5 $[\because t = defgh]$

Value of c is 0

[strlen (s) – strlen (t) > 0] : strlen (s) : strlen (t);

strlen (s) – strlen (t)] = – 2

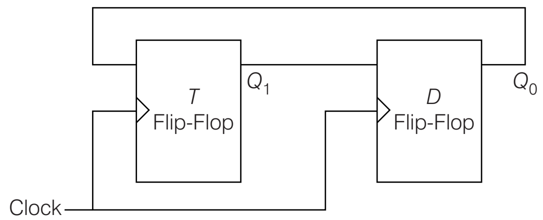
Since it is given in question strlen (s) – strlen (t) will give unsigned value.

So, [strlen (s) – strlen (t)] = [– 2] = 2.

2 > 0 : strlen (s) : strlen (t); since 2 > 0 will evaluate True so it will give output as strlen (s) = 3.

Hence, '3' will be printed.

49. Consider a combination of T and D flip-flops connected as shown below. The output of the D flip-flop is connected to the input of the T flip-flop and the output of the T flip-flop is connected to the input of the D flip-flop.



Initially, both Q_0 and Q_1 are set to 1 (before the 1st clock cycle). The outputs

(a) Q_1Q_0 after the 3rd cycle are 11 and after the 4th cycle are 00 respectively.
(b) Q_1Q_0 after the 3rd cycle are 11 and after the 4th cycle are 01 respectively.
(c) Q_1Q_0 after the 3rd cycle are 00 and after the 4th cycle are 11 respectively.
(d) Q_1Q_0 after the 3rd cycle are 01 and after the 4th cycle are 01 respectively.

Sol. (b)

CLK	$\frac{T-FF}{Q_1}$	$\frac{D-FF}{Q_0}$	$T_1 = Q_0$	$D_0 = Q_1$
	1	1	1	1
1	0	1	1	0
2	1	0	0	1
3	1	1	1	1
4	0	1		

Q_1Q_0 after the 3^{rd} cycle are 11 and after the 4^{th} cycle are 01 respectively.

50. Consider a RISC machine where each instruction is exactly 4 bytes long. Conditional and unconditional branch instructions use PC-relative addressing mode with Offset specified in bytes to the target location of the branch instruction. Further the Offset is always with respect to the address of the next instruction in the program sequence. Consider the following instruction sequence

Instr. No.	Instruction
i	add R2, R3, R4
$i+1$	sub R5, R6, R7
$i+2$	cmp R1, R9, R10
$i+3$	beq R1, Offset

If the target of the branch instruction is i, then the decimal value of the Offset is……

Sol. (–16) Program storage, assume the starting address as 1000

I_1 :	1000	– 1003
I_2 :	1004	– 1007
I_3 :	1008	– 1011
I_4 :	1012	– 1015
	1016	

valid-PC

- I_4 is as branch instruction I_1 as a target location.
- PC-relative addressing mode EA = PC + relative value.

  Relative value = EA – PC = 1000 – 1016 = – 16

51. A multithreaded program P executes with x number of threads and uses y number of locks for ensuring mutual exclusion while operating on shared memory locations. All locks in the program are non-reentrant. *i.e.*, if a thread holds a lock l, then it cannot re-acquire lock l without releasing it. If a thread is unable to acquire a lock, it blocks until the lock becomes available. The minimum value of x and the minimum value of y together for which execution of P can result in a deadlock are

(a) $x = 1, y = 2$ (b) $x = 2, y = 1$
(c) $x = 2, y = 2$ (d) $x = 1, y = 1$

Sol. (c) Give, number of threads is x and number of locks is y.

Now, considering each option,

- If there is 1 thread and two locks then there won't be a situation of deadlock.
- If there is only 1 lock, there will be no deadlock situation.
- But when there are two processes and two threads, deadlock situation can occur because both the process can acquire one lock and may demand another lock which arises deadlock.

52. Let u and v be two vectors in R^2 whose Euclidean norms satisfy $||u|| = 2||v||$. what is the value of α such that $w = u + \alpha v$ bisects the angle between u and v ?

(a) 2 (b) 1/2 (c) 1 (d) $-1/2$

Sol. (a) If the vectors have equal length $|u|| = |v||$, then $u + v$ will bisect the angle between u and v.

Here $||u|| = 2||v||$, so u is twice as long as v.

So, if the vector $2v$ has same length as u and hence $u + 2v$ will bisect angle between u and $2v$. Now, angle between u and v is same as angle between u and $2v$.

Since 2 is the only a scalar. So the required vector is $u + 2v$

So, $w = u + 2v$. So, $\alpha = 2$ is the answer.

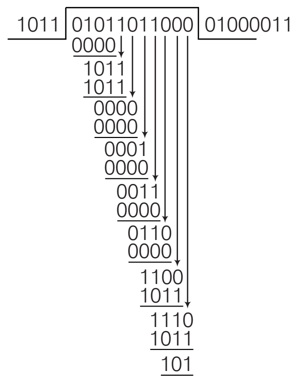
53. A computer network uses polynomials over $GF(2)$ for error checking with 8 bits as information bits and uses $x^3 + x + 1$ as the generator polynomial to generate the check bits. In this network, the message 01011011 is transmitted as

(a) 01011011010 (b) 01011011011
(c) 01011011101 (d) 01011011100

Sol. (c) CRC (Cyclic Redundancy Check) generator = $x^3 + x + 1$

$$= 1\cdot x^3 + 0\cdot x^2 + 1\cdot x^1 + 1\cdot x^0 = 1011$$

Data = 01011011



Hence, the message 01011011 is transmitted as 01011011101.

54. Consider the following two functions :

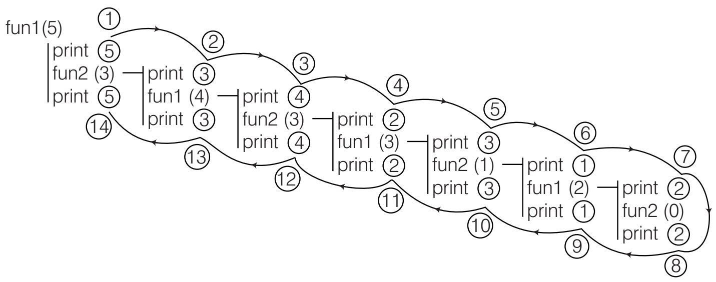
```
void fun1 (int n)
{
     if (n = = 0) return;
     printf ("%d", n);
     fun2 (n − 2);
     printf ("%d", n);
}
void fun2 (int n)
{
     if (n = = 0) return;
     printf ("%d", n);
     fun 1 (+ + n);
     printf ("%d", n);
}
```

The output printed when fun1 (5) is called is

(a) 53423122233445 (b) 53423120112233

(c) 53423122132435 (d) 53423120213243

Sol. (c)



Hence, output is : 53423122132435

55. A cache memory unit with capacity of N words and block size of B words is to be designed. If it is designed as a direct mapped cache, the length of the TAG field is 10 bits.

If the cache unit is now designed as a 16-way set-associative cache, the length of the TAG field is……bits.

Sol. (14) Given, cache memory size = N words

Block size = B words

TAG = 10 bits

Direct cache memory

Address binding

TAG	LO	WO

10 bit

When cache is configured as 16-way set associative, then set offset value decreases.

So TAG size increases.

TAG	SO	WO

14 bit

Hence, the length of the TAG field is 14 bits.

General Aptitude (GA) Questions

(1 *Mark Questions*)

56. The probability that a k-digit number does not contain the digits 0, 5 and 9 is

(a) 0.3^k

(b) 0.6^k

(c) 0.7^k

(d) 0.9^k

Sol. (c) $\underbrace{\text{- - - - - - - - - - - - - - - - - - - -}}_{k\text{-digits}}$

Each digit can be filled in 7 ways as 0, 5 and 9 is not allowed, so each of these places can be filled by 1, 2, 3, 4, 6, 7, 8, so required probability is $\left(\frac{7}{10}\right)^k$ or 0.7^k

$$\frac{fC}{TC} = \frac{7^k}{10^k} = 0.7^k$$

57. Find the smallest number y such that $y \times 162$ is a perfect cube.

(a) 24

(b) 27

(c) 32

(d) 36

Sol. (d) $y \times 162$ = Perfect cube

Option, $y = 24 \Rightarrow 2^3 \times 3 (2 \times 81) \neq$ Not perfect cube

$y = 27 \Rightarrow 3^3 \times (2 \times 3^4) \neq$ Not perfect cube

$y = 32 \Rightarrow 2^5 \times 2 \times 3^4 \neq$ Not perfect cube

$y = 32 \Rightarrow 2^4 \times 2 \times 3^4 \neq$ Not perfect cube

$y = 36 \Rightarrow 2^2 \times 3^2 \times 2 \times 3^4 = 2^3 \times 3^6 = (2 \times 3^2)^3$

is perfect cube

Hence, the answer is, $y = 36$

58. After Rajendra Chola returned from his voyage to Indonesia, he……to visit the temple in Thanjavur.

(a) was wishing

(b) is wishing

(c) wished

(d) had wished

Sol. (c) Correct option is; Wished

After Rajendra Chola **returned** from his voyage to Indonesia, he **wished** to visit the temple in Thanjavur.

Both are events of past. Use of past perfect form is unwarranted as it reflects part of past.

59. Research in the workplace reveal that people work for many reasons……

(a) money beside
(b) beside money
(c) money besides
(d) besides money

Sol. (d) Besides money

Research in the work place reveals the people works for many reasons **besides money.**

Besides conveys the meaning of 'in addition'.

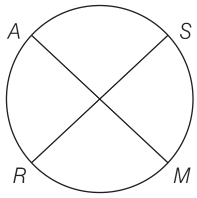
Beside means 'next to'.

60. Rahul, Murali, Srinivas and Arul are seated around a square table. Rahul is sitting to the left of Murali. Srinivas is sitting to the right of Arul.

Which of the following pairs are seated opposite each other ?

(a) Rahul and Murali
(b) Srinivas and Arul
(c) Srinivas and Murali
(d) Srinivas and Rahul

Sol. (d) Following seating arrangement can be drawn.



Therefore, correct option is (d).

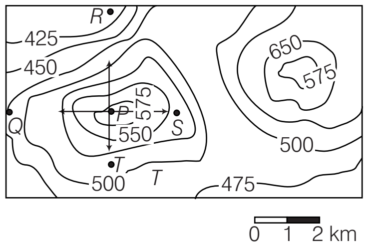
(2 *Marks Questions*)

61. "The hold of the nationalist imagination on our colonial past is such that anything inadequately or improperly nationalist is just not history." Which of the following statements best reflects the author's opinion?

(a) Nationalists are highly imaginative.
(b) History is viewed through the filter of nationalism.
(c) Our colonial past never happened.
(d) Nationalism has to be both adequately and properly imagined.

Sol. (b) History is viewed through the filter of nationalism.

62. A contour line joins locations having the same height above the mean sea level. The following is a contour plot of a geographical region.Contour lines are shown at 25 m intervals in this plot. If a in flood, the water level rises to 525 m, which of the villages P, Q, R, S, T get submerged?



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

Sol. (c) P will not get submerged as it is @ 550. So, P is not present in correct options. Hence, (a) and (b) options are incorrect. Now, compare Q and T. As T is between 500 and 525, T will get submerged. Hence, ans (c) as among option C and D. T is present in only option (c).

63. The expression $\dfrac{(x+y)-|x-y|}{2}$ is equal to

(a) the maximum of x and y
(b) the minimum of x and y
(c) 1
(d) None of the above

Sol. (b) $$\frac{(x+y)-|x-y|}{2} \quad \ldots\text{(i)}$$

If $x > y, |x-y| = x-y$;

If $x < y, |x-y| = y-x$

Now, if $x > y$, above expression (i) becomes

$$\frac{(x+y)-(x-y)}{2} = \frac{2y}{2}$$

$$= y = \text{minimum of } (x, y) \text{ as } x > y$$

Now if $x < y$; $\dfrac{x+y-(y-x)}{2} = \dfrac{2x}{2}$

$$= x = \text{minimum of } (x, y) \text{ as } x < y$$

Therefore, the correct option is (b).

Alternate solution

Use easy values, $x = 1$ and $y = -2$

Now, $\dfrac{(1-2)-|1-(-2)|}{2} = -2$ or $x = 2$ and $y = -1$

$$\frac{(2-1)-|2-(-1)|}{2} = \frac{1-3}{2} = -1$$

which is minimum of (x, y).

Therefore, correct answer should be option (b).

64. Arun, Gulab, Neel and Shweta must choose one shirt, each from a pile of four shirts coloured red, pink, blue and white respectively. Arun dislikes the colour red and Shweta dislikes the colour white. Gulab and Neel like all the colours. In how many different ways can they choose the shirts so that no one has a shirt with a colour he or she dislikes ?

(a) 21 (b) 18 (c) 16 (d) 14

Sol. (d) As there are 4 people A, G, N, S and four colours, so without any restriction total ways have to be $4 \times 4 = 16$.

Now, Arun $\rightarrow$ dislikes Red and Shweta dislikes white, so $16 - 2 = 14$ ways.

Therefore, correct answer should be option (d).

Alternate solution

Only one option is less than 16.

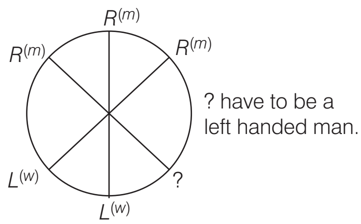
Therefore, correct answer should be option (d).

65. Six people are seated around a circular table. There are atleast two men and two women. There are atleast three right-handed persons. Every woman has a left-handed person to her immediate right. None of the women are right-handed. The number of women at the table is

(a) 2 (b) 3 (c) 4 (d) Cannot be determined

Sol. (a) Out of six people, 3 place definitely occupied by right handed people as atleast 2 women are there, so these two will sit adjacently.

Now, as only one seat is left it will be occupied by a left handed man because on right side of this seat, is sitting a right handed man.



Here, $R^{(m)}$ indicates right handed man and $L^{(w)}$ indicates left handed women. Therefore, answer should be only 2 women.