GATE- CS

(Computer & Science)

Previous Year: Fully Solved Papers (2011-14)

(Total- 6 Tests)

GATE- CS 2014

Paper-01

Q. No. 1 – 5 Carry One Mark Each

1. Which of the following options is the closest in meaning to the phrase underlined in the sentence below?
It is fascinating to see life forms cope with varied environmental conditions.
(A) Adopt to (B) Adapt to (C) Adept in (D) Accept with

Answer: (B)

2. Choose the most appropriate word from the options given below to complete the following sentence.
He could not understand the judges awarding her the first prize, because he thought that her performance was quite _____.
(A) Superb (B) Medium (C) Mediocre (D) Exhilarating

Answer: (C)

3. In a press meet on the recent scam, the minister said, "The buck stops here". What did the minister convey by the statement?
(A) He wants all the money (B) He will return the money
(C) He will assume final responsibility (D) He will resist all enquiries

Answer: (C)

4. If $(z+1/z)^2 = 98$, compute (z^2+1/z^2)

Answer: (96)

Exp: Expanding

$$z^2+\frac{1}{z^2}+2.z.\frac{1}{z}=98 \Rightarrow z^2+\frac{1}{z^2}=96$$

5. The roots of $ax^2+bx+c=0$ are real and positive a, b and c are real. Then $ax^2+b|x|+c=0$ has
(A) No roots (B) 2 real roots (C) 3 real roots (D) 4 real roots

Answer: (D)

Exp: $ax^2+bx+c=0$

for roots to be real & +ve

$b^2-4ac>0$

This will have 2 real positive roots.

$ax^2+b|x|+c=0$

This can be written as;

ax^2+bx+c

$\text{Discriminant} = b^2-4ac>0$

ax^2-bx+c

$(-b)^2-4ac$

$\Rightarrow b^2-4ac$

Is also >0. This will have real roots

$\Rightarrow$ This will have 4 real roots.

Q.No. 6 – 10 Carry One Mark Each

6. The Palghat Gap (or Palakkad Gap), a region about 30 km wide in the southern part of the Western Ghats in India, is lower than the hilly terrain to its north and south. The exact reasons for the formation of this gap are not clear. It results in the neighbouring regions of Tamil Nadu getting more rainfall from the South West monsoon and the neighbouring regions of Kerala having higher summer temperatures.

What can be inferred from this passage?

(A) The Palghat gap is caused by high rainfall and high temperatures in southern Tamil Nadu and Kerala

(B) The regions in Tamil Nadu and Kerala that are near the Palghat Gap are low–lying

(C) The low terrain of the Palghat Gap has a significant impact on weather patterns in neighbouring parts of Tamil Nadu and Kerala

(D) Higher summer temperatures result in higher rainfall near the Palghat Gap area

Answer: (C)

7. Geneticists say that they are very close to confirming the genetic roots of psychiatric illnesses such as depression and schizophrenia, and consequently, that doctors will be able to eradicate these diseases through early identification and gene therapy.

On which of the following assumptions does the statement above rely?

(A) Strategies are now available for eliminating psychiatric illnesses

(B) Certain psychiatric illnesses have a genetic basis

(C) All human diseases can be traced back to genes and how they are expressed

(D) In the future, genetics will become the only relevant field for identifying psychiatric illnesses

Answer: (B)

8. Round–trip tickets to a tourist destination are eligible for a discount of 10% on the total fare. In addition, groups of 4 or more get a discount of 5% on the total fare. If the one way single person fare is Rs 100, a group of 5 tourists purchasing round–trip tickets will be charged Rs _____

Answer: (850)

Exp: One way force =100

Two way fare per person=200

5 persons=1000/-

Total discount applicable=10+5=15%

$$\text{Discount amount} = \frac{15}{100} \times 1000 = 150$$

Amount to be paid=1000-150=850

9. In a survey, 300 respondents were asked whether they own a vehicle or not. If yes, they were further asked to mention whether they own a car or scooter or both. Their responses are tabulated below. What percent of respondents do not own a scooter?

		Men	Women
Own vehicle	Car	40	34
	Scooter	30	20
	Both	60	46
Do not own vehicle		20	50

Answer: (48)

Exp: Total respondents=300

Those who don't have scooter

$\Rightarrow$ Men= 40+20=60

$$\text{Women} = 34 + 50 = \frac{84}{144}$$

$$\% = \frac{144}{300} \times 100 = 48\%$$

10. When a point inside of a tetrahedron (a solid with four triangular surfaces) is connected by straight lines to its corners, how many (new) internal planes are created with these lines?

Answer: (6)

Q. No. 1 – 25 Carry One Mark Each

1. Consider the statement:

"Not all that glitters is gold"

Predicate glitters (x) is true if x glitters and predicate gold (x) is true if x is gold. Which one of the following logical formulae represents the above statement?

(A) $\forall x;\ \text{glitters}(x) \Rightarrow \neg\,\text{gold}(x)$ (B) $\forall x;\ \text{gold}(x) \Rightarrow \text{glitters}(x)$

(C) $\exists x;\ \text{gold}(x) \wedge \neg\,\text{glitters}(x)$ (D) $\exists x;\ \text{glitters}(x) \wedge \neg\,\text{gold}(x)$

Answer: (D)

Exp: It means "It is false that every glitter is gold" or "some glitters are not gold".
Then we can say "atleast one glitter object is not gold".

2. Suppose you break a stick of unit length at a point chosen uniformly at random. Then the expected length of the shorter stick is _____ .

Answer: (0.25)

Exp: The smaller sticks, therefore, will range in length from almost 0 meters up to a maximum of 0.5 meters, with each length equally possible.
Thus, the average length will be about 0.25 meters, or about a quarter of the stick.

3. Let G=(V,E) be a directed graph where *V* is the set of vertices and *E* the set of edges. Then which one of the following graphs has the same strongly connected components as *G?*

(A) $G_1 = (V, E_1)$ where $E_1 = \{(u,v) \mid (u,v) \notin E\}$

(B) $G_2 = (V, E_2)$ where $E_2 = \{(u,v) \mid (v,u) \notin E\}$

(C) $G_3 = (V, E_3)$ where $E_3 = \{(u,v) \mid \text{there is a path of length} \le 2 \text{ from u to v in E}\}$

(D) $G_4 = (V_4, E)$ where V_4 is the set of vertices in G which are not isolated

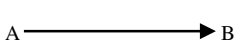
Answer: (B)

Exp: Take an example for Graph G

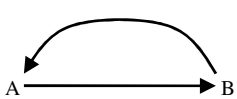
. .
A B

Then option A and D will be eliminated.

Let G is below graph



Then G_3 is a graph with below structure



In G the numbers of strongly connected components are 2 where as in G_3 it is only one.

4 Consider the following system of equations:

$3x + 2y = 1$

$4x + 7z = 1$

$x + y + z = 3$

$x - 2y + 7z = 0$

The number of solutions for this system is _____

Answer: (1)

Exp: $3x+2y=1$

$4x+7z=1$

$x+y+z=3$

$x-2y+7z=0$

Augmented matrix is $\begin{bmatrix} 3 & 2 & 0 & 1 \\ 4 & 0 & 7 & 1 \\ 1 & 1 & 1 & 3 \\ 1 & -2 & 7 & 0 \end{bmatrix}$

$R_1 \leftrightarrow R_3 \begin{bmatrix} 1 & 1 & 1 & 3 \\ 4 & 0 & 7 & 1 \\ 3 & 2 & 0 & 1 \\ 1 & -2 & 7 & 0 \end{bmatrix}$

$R_2 \to R_2 - 4R_1 \; R_3 \to R_3 - 3R_1, \; R_4 \to R_4 - R_1$

$\begin{bmatrix} 1 & 1 & 1 & 3 \\ 0 & -4 & 3 & -11 \\ 0 & -1 & -3 & -8 \\ 0 & -3 & 6 & -3 \end{bmatrix}$

$R_3 \to 4R_3 - R_2 \; R_4 \to 4R_4 - 3R_2 \begin{bmatrix} 1 & 1 & 1 & 3 \\ 0 & -4 & 3 & -11 \\ 0 & 0 & -15 & -21 \\ 0 & 0 & 15 & 21 \end{bmatrix}$

$R_4 \to R_4 + R_3 \begin{bmatrix} 1 & 1 & 1 & 3 \\ 0 & -4 & 3 & -11 \\ 0 & 0 & -15 & -21 \\ 0 & 0 & 0 & 0 \end{bmatrix}$

$\rho(A:B) = \rho(A) = 3 = \text{no. of variables}$

$\therefore$ Unique solution exists

5. The value of the dot product of the eigenvectors corresponding to any pair of different eigen values of a 4-by-4 symmetric positive definite matrix is _____.

Answer: (0)

Exp: (The eigen vectors corresponding to distinct eigen values of real symmetric matrix are orthogonal)

6. Let the function

$$f(\theta)=\begin{vmatrix} \sin\theta & \cos\theta & \tan\theta \\ \sin\left(\pi/6\right) & \cos\left(\pi/6\right) & \tan\left(\pi/6\right) \\ \sin\left(\pi/3\right) & \cos\left(\pi/3\right) & \tan\left(\pi/3\right) \end{vmatrix}$$

Where $\theta=\in\left[\frac{\pi}{6},\frac{\pi}{2}\right]$ and $f'(\theta)$ denote the derivative of f with respect to θ. Which of the following statement is / are TRUE?

(I) There exists $\theta\in\left(\frac{\pi}{6},\frac{\pi}{3}\right)$ such that $f'(\theta)=0$.

(II) There exists $\theta\in\left(\frac{\pi}{6},\frac{\pi}{3}\right)$ such that $f'(\theta)\neq 0$.

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

Answer: (C)

Exp: (By Mean value theorem)

7. Consider the following Boolean expression for *F*:

$$F(P,Q,R,S)=PQ+\overline{P}QR+\overline{P}Q\overline{R}S$$

The minimal sum-of products form of F is

(A) $PQ+QR+QS$ (B) $P+Q+R+S$

(C) $\overline{P}+\overline{Q}+\overline{R}+\overline{S}$ (D) $\overline{P}R+\overline{P}\overline{R}S+P$

Answer: (A)

Exp: $PQ+\overline{P}QR+\overline{P}Q\overline{R}S$

$=PQ+\overline{P}Q\left(R+\overline{R}S\right)$

$=PQ+\overline{P}Q\left(\left(R+\overline{R}\right)(R+S)\right)\left[\because A+BC=(A+B)(A+C)\right]$

$=PQ+\overline{P}Q(R+S)\left[\because R+\overline{R}=1\right]$

$=Q\left(P+\overline{P}(R+S)\right)$

$=Q\left(\left(P+\overline{P}\right)(P+R+S)\right)\left[\because A+BC=(A+B)(A+C)\right]$

$=Q(P+R+S)\qquad\because\left[P+\overline{P}=1\right]$

$=PQ+QR+QS$

8. The base (or radix) of the number system such that the following equation holds is_____.

$$\frac{312}{20} = 13.1$$

Answer: (5)

Exp: Let 'x' be the base or radix of the number system

$$\frac{2\times x^{o} + 1\times x + 3\times x^{2}}{0\times x^{o} + 2\times x} = 3\times x^{o} + 1\times x + 1\times x^{-1}$$

$$\Rightarrow \frac{2 + x + 3x^{2}}{2x} = 3 + x + \frac{1}{x}$$

$$\Rightarrow \frac{3x^{2} + x + 2}{2x} = \frac{3x + x^{2} + 1}{x}$$

$$\Rightarrow 3x^{2} + x + 2 = 6x + 2x^{2} + 2$$

$$\Rightarrow x^{2} - 5x = 0$$

$$\Rightarrow x(x - 5) = 0$$

$$\Rightarrow x = 0 \text{ or } x = 5$$

As base or radix of a number system cannot be zero, here $x = 5$

9. A machine has a 32-bit architecture, with 1-word long instructions. It has 64 registers, each of which is 32 bits long. It needs to support 45 instructions, which have an immediate operand in addition to two register operands. Assuming that the immediate operand is an unsigned integer, the maximum value of the immediate operand is _____.

Answer: (16383)

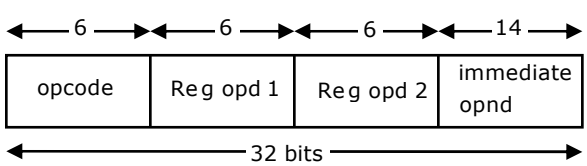
Exp: 1 Word = 32 bits

Each instruction has 32 bits

To support 45 instructions, opcode must contain 6-bits

Register operand1 requires 6 bits, since the total registers are 64.

Register operand 2 also requires 6 bits



14-bits are left over for immediate Operand Using 14-bits, we can give maximum 16383, Since $2^{14} = 16384$ (from 0 to 16383)

10. Consider the following program in C language:

```
# include < stdio.h >
main( )
{
int  i;
int * pi = &i;
scanf ("%d", pi);
printf ("%d \n", i + 5);
}
```

Which one of the following statements is **TRUE**?

(A) Compilation fails.

(B) Execution results in a run-time error.

(C) On execution, the value printed is **5** more than the address of variable **i**.

(D) On execution, the value printed is **5** more than the integer value entered.

Answer: (D)

Exp: pi contains the address of i. So scanf("%d",pi) places the value entered in console into variable i.e So printf("%d\n",i+5),prints 5 more than the value entered in console.

11. Let G be a graph with n vertices and m edges. What is the tightest upper bound on the running time of Depth First Search on G, when G is represented as an adjacency matrix?

(A) $\theta(n)$ (B) $\theta(n+m)$ (C) $\theta(n^2)$ (D) $\theta(m^2)$

Answer: (C)

Exp: DFS visits each vertex once and as it visits each vertex, we need to find all of its neighbours to figure out where to search next. Finding all its neighbours in an adjacency matrix requires O(V) time, so overall the running time will be $O(V^2)$.

12. Consider rooted n node binary tree represented using pointers. The best upper bound on the time required to determine the number of sub trees having exactly 4 nodes is $0(n^a \log^b n)$. Then the value of a + 10b is_____

Answer: 1

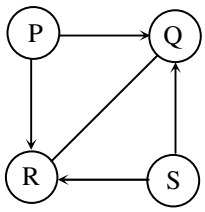
Exp:

```
int print_subtrees_size_4(node  *n)
{
int size=0;
if(node==null)
return 0;
size=print_subtrees_size_4(node->left)+print_subtrees_size_4(node->right)+1;
 if(size==4)
printf("this is a subtree of size 4");
return size;
}
```

The above function on taking input the root of a binary tree prints all the subtrees of size 4 in O(n) time

so a=1 , b=0 and then a+10b=1

13. Consider the directed graph given below.



Which one of the following is **TRUE?**

(A) The graph does not have any topological ordering

(B) Both PQRS and SRQP are topological orderings

(C) Both PSRQ and SPRQ are topological orderings.

(D) PSRQ is the only topological ordering.

Answer: (C)

Exp: Topological ordering of a directed graph is a linear ordering of its vertices such that for every directed edge uv from vertex u to vertex v, u comes before v in the ordering. Topological ordering is possible iff graph has no directed cycles.

(A) As the given graph doesn't contain any directed cycles, it has at least one topological ordering. So option (A) is false

(B) PQRS cannot be topological ordering because S should come before R in the ordering as there is a directed edge from S to R.

SRQP cannot be topological ordering, because P should come before Q in the ordering as there is a directed edge from P to Q

(C) PSRQ and SPRQ are topological orderings as both of then satisfy the above mentioned topological ordering conditions.

(D) PSRQ is not the only one topological ordering as SPRQ is other possibility

14. Let P be a quick sort program to sort numbers in ascending order using the first element as the pivot. Let t_1 and t_2 and t_2 be the number of comparisons made by P for the inputs [1 2 3 4 5] and [4 1 5 3 2] respectively. Which one of the following holds?

(A) $t_1 = 5$ (B) $t_1 < t_2$ (C) $t_1 > t_2$ (D) $t_1 = t_2$

Answer: (C)

Exp: Partition algorithm for quick sort

$\text{Partition}(A, P, q) // A[P, ...q]$

$x \leftarrow A[P] // \text{pivot} = A[P]$

$i \leftarrow P$

for $j = P + 1$ to q

do if $A[j] \le x$

then $i \leftarrow i + 1$

exchange $A[i] \leftrightarrow A[j]$

$\text{exchange} A[P] \leftrightarrow A[i]$

return i [returning where pivot element is there after partitioning]

Recursively call the above algorithm for the two sub arrays [elements before and after pivot element] to complete the sorting.

x = pivot

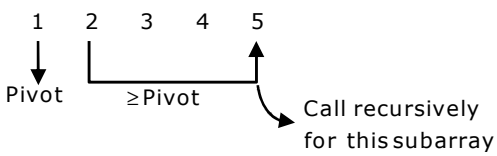
1 2 3 4 5
i j — $2 \le 1$? NO

1 2 3 4 5
i j — $3 \le 1$? NO

1 2 3 4 5
i j — $4 \le 1$? NO

1 2 3 4 5
i j — $5 \le 1$? NO

exchange A[P] & A[i]



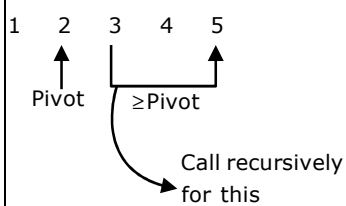
↗ Pivot = x = A[B]

1 2 3 4 5
i j — $3 \le 2$? NO

1 2 3 4 5
i j — $4 \le 2$? NO

1 2 3 4 5
i j — $5 \le 2$? NO

exchange A[P] & A[J]

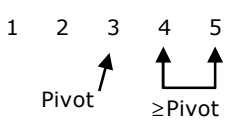


↗ x = Pivot = A[P]

1 2 3 4 5
i j — $4 \le 3$? NO

1 2 3 4 5
i j — $5 \le 3$? NO

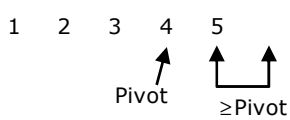
exchange A[P] & A[i]



↗ x = Pivot

1 2 3 4 5
i j — $5 \le 4$? NO

exchange A[P] & A[i]



∴ Total 10 conparisons

↗ $x = pivot = A[P]$

4 1 5 3 2

i j $1 \le 4$? Yes

$i \leftarrow i+1$ exchange $A[i]$ & $A[j]$ & increment j

4 1 5 3 2

i j $5 \le 4$? NO

4 1 5 3 2

i j $3 \le 4$? Yes

$i \leftarrow i+1$ exchange $A[i]$ & $A[j]$ & increment j

4 1 3 5 2

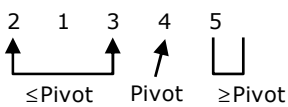
i J $2 \le 4$? Yes

$i \leftarrow i+1$

4 1 3 2 5

i j

exchange $A[P]$ & $A[i]$



$x = pivot = A(P)$

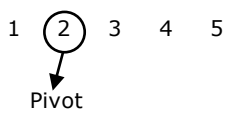
2 1 3 |4| 5

i j $1 \le 2$? yes

2 1 3 |4| 5

i j $3 \le 2$? NO

exchange $A[P]$ & $A[i]$



$\therefore$ 6 conparisons

15. Which one of the following is **TRUE**?

(A) The language $L = \{a^n b^n \mid n \ge 0\}$ is regular.

(B) The language $L = \{a^n \mid n \text{ is prime}\}$ is regular.

(C) The language $L = \{ w \mid w \text{ has } 3k+1 \text{ b's for some } k \in N \text{ with } \Sigma = \{a,b\} \}$ is regular.

(D) The language $L = \{ww \mid w \in \Sigma^* \text{ with } \Sigma = \{0,1\}\}$ is regular.

Answer: (C)

Exp: (A) $L = \{a^n b^n \mid n \ge 0\}$ is a CFL but not regular, it requires memory for the representation

(B) $L = \{a^n \mid n \text{ is prime}\}$ is neither regular nor CFL

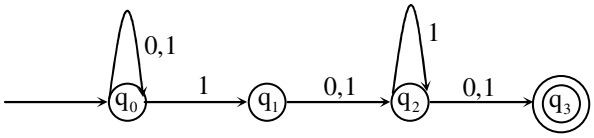
(C) $L = \{w \mid w \text{ has } 3K+1 \text{ b's for some } k \in N \text{ with}\}$

$\Sigma = \{a,b\}$

is a regular language, since the total count of b's are multiple of 3 plus one. The regular expression is $a*ba*(a*ba*ba*ba*)*+(a*ba*ba*ba*)*a*ba*$

(D) $L = \{ww \mid w \in \Sigma* \text{ with } \Sigma = \{0,1\}\}$ is neither regular nor CFL

16. Consider the finite automaton in the following figure.



What is the set of reachable states for the input string 0011?

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

Answer: (A)

Exp: $\delta(q_0, 0011) = \delta(q_0, 011)$

$= \delta(q_0, 11)$

$= \delta(\{q_0, q_1\}, 1)$

$= \delta(q_0, 1) \cup \delta(q_1, 1)$

$= \{q_0, q_1\} \cup \{q_2\}$

$= \{q_0, q_1, q_2\}$

17. Which one of the following is **FALSE**?

(A) A basic block is a sequence of instructions where control enters the sequence at the beginning and exits at the end.

(B) Available expression analysis can be used for common subexpression elimination.

(C) Live variable analysis can be used for dead code elimination

(D) $x = 4 * 5 \Rightarrow x = 20$ is an example of common subexpression elimination

Answer: (D)

Exp: $x = 4 \times 5 \Rightarrow x = 20$ is not an example of common sub-expression but it is constant folding. In constant folding expression consisting of constants will be replaced by their final value at compile time, rather than doing the calculation in run-time.

18. Match the following

(1) Waterfall model	(a) Specifications can be developed
(2) Evolutionary model	(b) Requirements compromises are inevitable
(3) Component based software	(c) Explicit recognition of risk
(4) Spiral development	(d) Inflexible partitioning of the project into stages

(A) 1-a, 2-b, 3-c, 4-d (B) 1-d, 2-a, 3-b, 4-c

(C) 1-d, 2-b, 3-a, 4-c (D) 1-c, 2-a, 3-b, 4-d

Answer: (B)

Exp: The main drawback of the waterfall model is the difficulty of accommodating change after the process is underway. One phase has to be complete before moving onto the next phase. Inflexible partitioning of the project into distinct stages in waterfall model makes it difficult to respond to changing customer requirements.

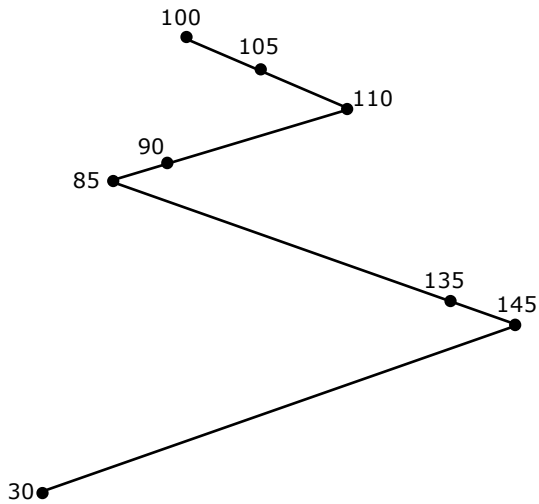
Evolutionary software models are iterative. They are characterized in manner that enables the software engineers to develop increasingly more complete version of software.

In Spiral model, Development can be divided in to smaller parts and more risky parts can be developed earlier which helps better risk management.

19. Suppose a disk has 201 cylinders, numbered from 0 to 200. At some time the disk arm is at cylinder 100, and there is a queue of disk access requests for cylinders 30, 85, 90, 100, 105, 110, 135 and 145. If Shortest-Seek Time First (SSTF) is being used for scheduling the disk access, the request for cylinder 90 is serviced after servicing _____ number of requests.

Answer: (3)

Exp:



Request for cylinder is served after serving 3 requests (100,105 and 110)

20. Which one of the following is **FALSE**?

(A) User level threads are not scheduled by the kernel.

(B) When a user level thread is blocked, all other threads of its process are blocked.

(C) Context switching between user level threads is faster than context switching between kernel level threads.

(D) Kernel level threads cannot share the code segment.

Answer: (D)

Exp: User threads are supported above the kernel and a managed without kernel support. The thread function library to implement user level threads usually runs on top of the system in user mode. Thus these threads with in a process are invisible to the operating system. Since the kernel is unaware of the existence of such threads; when one user level thread is blocked in the kernel all other threads of its process are blocked. So options (A) and (B) are true

(C) The OS is aware of kernel level threads. Kernel threads are scheduled by the OS's scheduling algorithms and require a "lightweight" context switch to switch between (that is, registers, PC and SP must be changed, but the memory context remains the same among kernel threads in the (same process). User level threads are much faster to switch between as there is not context switch

(D) False

Kernel level threads within the same process share code section, data section and other operating system resources such as open files and signals.

21. Consider the relation scheme R = (E, F, G, H, I, J, K, L, M, N) and the set of functional dependencies $\{\{E,F\} \rightarrow \{G\}, \{F\} \rightarrow \{I,J\}, \{E,H\} \rightarrow \{K,L\} \rightarrow (M), \quad \{K\} \rightarrow \{M\}, \}$ $\{L\} \rightarrow \{N\}$ on R. What is the key for R?

(A) {E, F} (B) {E, F, H} (C) {E, F, H, K, L} (D) {E}

Answer: (B)

Exp: $R(EFGHI, JKLMN)$

$F = \{$

$EF \rightarrow G$

$F \rightarrow IJ$

$EH \rightarrow KL$

$K \rightarrow M$

$L \rightarrow N$

$\}$

$(EF)^+ = EFGIJ$, E & F Together functionally derive GIJ and if we observe given FDs, H can't be determined by any other attributes. So H must be part of all the (candidate) keys. H along with E determines K and L, K & L functionally determine M and N respectively.

$\therefore (EFH)^+ = EFGIJHKLMN$

$\therefore$ EFH is the only candidate for key.

22. Given the following statements:

S1: A foreign key declaration can always be replaced by an equivalent check assertion in SQL

S2: Given the table R(a,b,c) where a and b together form the primary key, the following is a valid table definition.

CREATE TABLE S (

a INTEGER,

d INTEGER,

e INTEGER,

PRIMARY KEY (d),

FOREIGN KEY (a) references R)

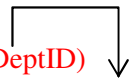
Which one of the following statements is **CORRECT**?

(A) S1 is TRUE and S2 is a FALSE (B) Both S1 and S2 are TRUE

(C) S1 is FALSE and S2 is a TRUE (D) Both S1 and S2 are FALSE

Answer: (D)

Exp: S_1: Manager (Name, DeptID)



Department (DeptName, Deptid)

In given relation Manager DeptID is a foreign key referencing Deptid (P.K) of relation Department.

Let's declare the foreign key by an equivalent check assertion as follows:-

```
CREATE TABLE Manager (
    Name  Varchar (10)
    DeptID  INT (6)  check (DeptID IN (  select Deptid  from Department)),
    PRIMARY KEY (Name)
    );
```

The above use of check assertion is good to declare the foreign key as far as insertion is considered for relation manager (will not insert any tuple in Manager containing such DeptID value which is not present in any tuple of Department).

But the above declaration will fail to implement changes done in Department relation in terms of deletion & updation. For an instance if a deptid present in Department gets deleted, then respective reference in Manager should also be deleted.

$\therefore S_1$ is false.

S_2: The given table definition is not valid due to invalid foreign key declaration. Attribute a is declared as foreign key which is a single valued attribute and it is referencing the primary key (ab) of relation R (a, b, c), which is a composite key.

A single value attribute cannot refer a composite key.

4 S_2 is false.

23. Consider the following three statements about link state and distance vector routing protocols, for a large network with 500 network nodes and 4000 links

[S1] The computational overhead in link state protocols is higher than in distance vector protocols.

[S2] A distance vector protocol (with split horizon) avoids persistent routing loops, but not a link state protocol.

[S3] After a topology change, a link state protocol will converge faster than a distance vector protocol.

Which one of the following is correct about S1, S2, and S3?

(A) S1, S2, and S3 are all true
(B) S1, S2, and S3 are all false.
(C) S1 and S2 are true, but S3 is false
(D) S1 and S3 are true, but S2 is false.

Answer: (D)

Exp: Statement S1

The Distance Vector routing protocols rely on the information from their directly connected neighbours in order to calculate and accumulate route information. Distance Vector routing protocols require very little overhead as compared to Link State routing protocols as measured by memory and processor power while the Link State routing protocols do not rely solely on the information from the neighbours or adjacent router in order to calculate route information. Instead, Link State routing protocols have a system of databases that they use in order to calculate the best route to destinations in the network. This is TRUE

Statement S3

Distance Vector exchanges the routing updates periodically whether the topology is change or not, this will maximize the convergence time which increases the chance of routing loops while the Link State routing protocols send triggered change based updates when there is a topology change. After initial flood, pass small event based triggered link state updates to all other routers. This will minimize the convergence time that's why there is no chance of routing loops. This is TRUE**.**

24. Which one of the following are used to generate a message digest by the network security protocols?

(P) RSA (Q) SHA-1 (R) DES (S) MD5

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

Answer: (C)

Exp: RSA and DES are for Encryption where MD5 and SHA – 1 are used to generate Message Digest.

25. Identify the correct order in which the following actions take place in an interaction between a web browser and a web server.

1. The web browser requests a webpage using HTTP.
2. The web browser establishes a TCP connection with the web server.
3. The web server sends the requested webpage using HTTP.
4. The web browser resolves the domain name using DNS.

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

Answer: (A)

Exp: First of all the browser must now know what IP to connect to. For this purpose browser takes help of Domain name system (DNS) servers which are used for resolving hostnames to IP addresses. As browser is an HTTP client and as HTTP is based on the TCP/IP protocols, first it establishes a TCP connection with the web server and requests a webpage using HTTP, and then the web server sends the requested webpage using HTTP. Hence the order is 4,2,1,3

Q.No. 26 – 55 Carry Two Marks

26. Consider a token ring network with a length of 2km having 10 stations including a monitoring station. The propagation speed of the signal is 2 x 10^8 m/s and the token transmission time is ignored. If each station is allowed to hold the token for 2 µsec, the minimum time for which the monitoring station should wait (**in µsec**) before assuming that the token is lost is _____.

Answer: (28µs to 30µs)

Exp: Given Length (d) = 2 Km

No. of Stations (m) = 10

Propagation Speed (v) = 2×10^8 m/s

THT = 2µs

So, Max. TRT = T_P in the Ring + No. of Active Stations * THT

$= 10 \times 10^{-6} + 10 \times 2 \times 10^{-6}$

$= 30\ \mu s$

27. Let the size of congestion window of a TCP connection be 32 KB when a timeout occurs. The round trip time of the connection is 100 msec and the maximum segment size used is 2kB. The time taken (in msec) by the TCP connection to get back to 32KB congestion window is _____

Answer: (1100 to 1300)

Exp: Given that at the time of Time Out, Congestion Window Size is 32KB and RTT = 100ms

When Time Out occurs, for the next round of Slow Start, Threshold = (size of Cwnd) / 2

It means Threshold = 16KB

Slow Start

2KB

1RTT

4KB

2RTT

8KB

3RTT

16KB ---------- Threshold reaches. So Additive Increase Starts

4RTT

18KB

5RTT

20KB

6RTT

22KB

7RTT

24KB

8RTT

26KB

9RTT

28KB

10RTT

30KB

11RTT

32KB

So, Total no. of RTTs = 11 → 11 * 100 = 1100

28. Consider a selective repeat sliding window protocol that uses a frame size of 1 KB to send data on a 1.5 Mbps link with a one-way latency of 50 msec. To achieve a link utilization of 60%, the minimum number of bits required to represent the sequence number field is _____.

Answer: (5)

Exp: Given $L = 1KB$

$B = 1.5Mbps$

$T_p = 50ms$

$\eta = 60\%$

Efficiency formula for SR protocol is

$$\eta = \frac{W}{1+2a} \Rightarrow \frac{60}{100} = \frac{W}{1+2a} \left(\because a = \frac{T_p}{T_x} \right)$$

$$T_x = \frac{L}{B} = \frac{8 \times 10^3}{1.5 \times 10^6} = 5.3ms$$

$$a = \frac{T_p}{T_x} = \frac{50}{5.3} = \frac{500}{53} = 9.43$$

$$\Rightarrow \frac{60}{100} = \frac{W}{19.86} \Rightarrow W = 11.9 \approx 12$$

$$\Rightarrow W = 2^{n-1} = 12 \Rightarrow 2^n = 24 \Rightarrow 2^n = 24 \approx 2^5 \Rightarrow \boxed{n = 5}$$

29. Consider the following four schedules due to three transactions (indicted by the subscript) using read and write on a data item x, denoted r (x) and w (x) respectively. Which one of them is conflict serializable?

(A) $r_1(x)$; $r_2(x)$; $w_1(x)$; $r_3(x)$; $w_2(x)$

(B) $r_2(x)$; $r_1(x)$; $w_2(x)$; $r_3(x)$; $w_1(x)$

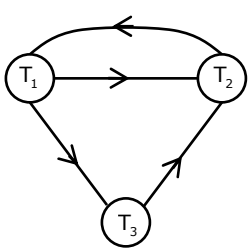
(C) $r_3(x)$; $r_2(x)$; $r_1(x)$; $w_2(x)$; $w_1(x)$

(D) $r_2(x)$; $w_2(x)$; $r_3(x)$; $r_1(x)$; $w_1(x)$

Answer: (D)

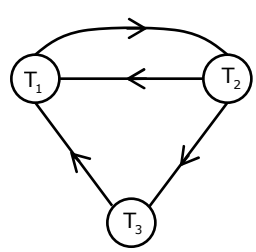
Exp: If there is a cycle in precedence graph, then the schedule is not conflict serializable.

(A)



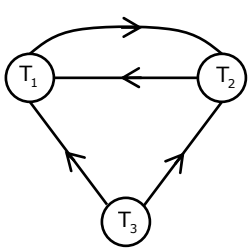
Not conflict serializable

(B)



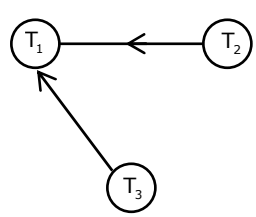
not conflict serializable

(C)



Not conflict serializable

(D)



it is conflict equivalent to

$T_2 \rightarrow T_3 \rightarrow T_1$ &

$T_3 \rightarrow T_2 \rightarrow T_1$

30. Given the following two statements:

S1: Every table with two single-valued attributes is in 1NF, 2NF, 3NF and BCNF

S2 : $AB \rightarrow C, D \rightarrow E, E \rightarrow C$ is a minimal cover for the set of functional dependencies $AB \rightarrow C, D \rightarrow E, AB \rightarrow E, E \rightarrow C$

Which one of the following is **CORRECT?**

(A) S1 is TRUE and S2 is FALSE.
(B) Both S1 and S2 are TRUE.
(C) S1 is FALSE and S2 is TRUE.
(D) Both S1 and S2 are FALSE.

Answer: (A)

Exp: S_1 : True

Consider any table R with two attributes $R(A.B)$

The possible FD sets are

$F_1 = \{$
$A \rightarrow B$
$\}$

Key : A and is in BCNF

$F_2 = \{$
$B \rightarrow A$
$\}$

Key : B and is in BCNF

$F_3 = \{$
$A \rightarrow B$
$B \rightarrow A$
$\}$

Key : A & B It is in BCNF

$F_4 = \{$
$\}$

Key : AB and is in BCNF

If a table is in BCNF it is also in 1NF, 2NF and 3NF also

S_2 : False

First FD set cannot cover second FD set because in second FD set AB can functionally derive E but that is not happing in first FD set.

31. An operating system uses the *Banker's algorithm* for deadlock avoidance when managing the allocation of three resource types X, Y, and Z to three processes P0, P1, and P2. The table given below presents the current system state. Here, the *Allocation* matrix shows the current number of resources of each type allocated to each process and the *Max* matrix shows the maximum number of resources of each type required by each process during its execution.

	Allocation			Max		
	X	Y	Z	X	Y	Z
P0	0	0	1	8	4	3
P1	3	2	0	6	2	0
P2	2	1	1	3	3	3

There are 3 units of type X, 2 units of type Y and 2 units of type Z still available. The system is currently in a **safe** state. Consider the following independent requests for additional resources in the current state:

REQ1: P0 requests 0 units of X, 0 units of Y and 2 units of Z

REQ2: P1 requests 2 units of X, 0 units of Y and 0 units of Z

Which one of the following is **TRUE**?

(A) Only REQ1 can be permitted.

(B) Only REQ2 can be permitted.

(C) Both REQ1 and REQ2 can be permitted.

(D) Neither REQ1 nor REQ2 can be permitted.

Answer: (B)

Exp: REQ1

Once P_0 is allocated with $(0,0,2)$, the status of the system will be as follows

Allocation	Max	Need	Available
X Y Z	X Y Z	X Y Z	X Y Z
0 0 3	8 4 3	8 4 0	3 2 0
3 2 0	6 2 0	3 0 0	
2 1 1	3 3 3	1 2 2	

With available $(3,2,0)$ only P_1 can be served. Once P_1 is executed, available will be $(6,4,0)$, with $(6,4,0)$ we can't serve either P_0 or P_2. Hence there is no safe sequence. Hence REQ1 can't be permitted.

REQ2

Once P_1 is allocated with $(2,0,0)$, the status of the system will be as follows

	Allocated	Max	Need	Available
	X Y Z	X Y Z	X Y Z	X Y Z
P_0	0 0 1	8 4 3	8 4 2	1 2 2
P_1	5 2 0	6 2 0	1 0 0	
P_2	2 1 1	3 3 3	1 2 2	

With available $(1,2,2)$, we can serve either P_1 or P_2.

If we serve P_1 then the safe sequence is $\langle P_1, P_2, P_0 \rangle$. If we serve P_2 then the safe sequence is $\langle P_2, P_1, P_0 \rangle$. As true is at least one safe sequence we can permit REQ2.

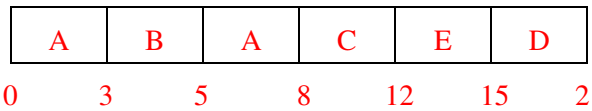
32. Consider the following set of processes that need to be scheduled on a single CPU. All the times are given in milliseconds

Process Name	Arrival Time	Execution Time
A	0	6
B	3	2
C	5	4
D	7	6
E	10	3

Using the *shortest remaining time first* scheduling algorithm, the average process turnaround time (in msec) is _____.

Answer: (7.2)

Exp:



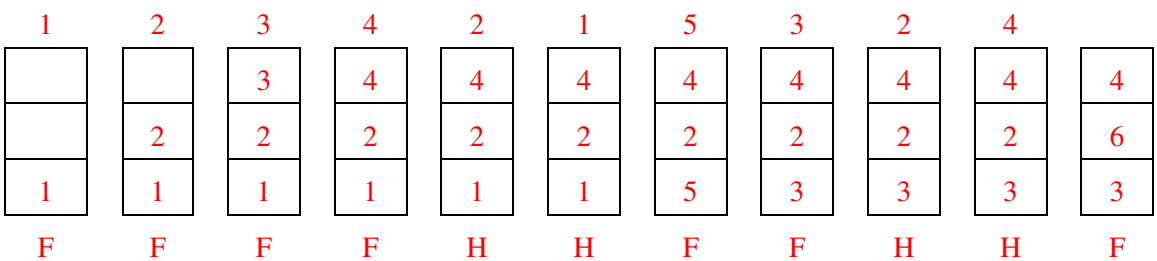
$$\text{Average turn around time} = \frac{(8-0)+(5-3)+(12-5)+(21-7)+(15-10)}{5}$$

$$= \frac{36}{5} \Rightarrow 7.2\,\text{ms}$$

33. Assume that there are 3 page frames which are initially empty. If the page reference string 1, 2, 3, 4, 2, 1, 5, 3, 2, 4, 6, the number of page faults using the optimal replacement policy is _____

Answer: (7)

Exp:



7 page faults

34. A canonical set of items is given below

$$s \rightarrow L. > R$$

$$Q \rightarrow R.$$

On input symbol $<$ the set has

(A) a shift-reduce conflict and a reduce-reduce conflict.

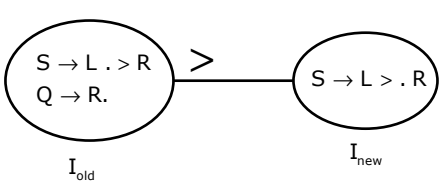
(B) a shift-reduce conflict but not a reduce-reduce conflict.

(C) a reduce-reduce conflict but not a shift-reduce conflict.

(D) neither a shift-reduce nor a reduce-reduce conflict.

Answer: (D)

Exp:



From above diagram, we can see that there is no shift- reduce or reduce-reduce conflict.

35. Let L be a language and $\overline{L}$ be its complement. Which of the following is NOT a viable possibility?

(A) Neither L nor $\overline{L}$ is recursively enumerable (r.e.).

(B) One of L and $\overline{L}$ is r.e. but not recursive; the other is not r.e.

(C) Both L and $\overline{L}$ are r.e. but not recursive.

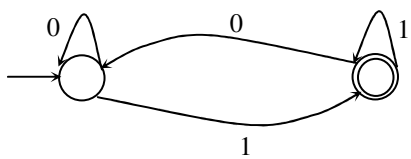
(D) Both L and $\overline{L}$ are recursive.

Answer: (C)

Exp: Recursive languages are closed under complement.

If a language L is recursive enumerable but not recursive then its complement is not a recursive enumerable, so both L and $\overline{L}$ are recursive enumerable but not recursive is not a viable possibility.

36. Which of the regular expressions given below represent the following DFA?



I) 0*1(1+00*1)*

II) 0*1*1+11*0*1

III) (0+1)*1

(A) I and II only

(B) I and III only

(C) II and III only

(D) I, II, and III

Answer: (B)

Exp: Given DFA will accept all the strings over $\varepsilon = \{0,1\}$ which are ending with 1.

$0*1(1+00*1)*$ and $(0+1)*1$, are the regular expressions for ending with 1.

37. There are 5 bags labelled 1 to 5. All the coins in a given bag have the same weight. Some bags have coins of weight 10 gm, others have coins of weight 11 gm. I pick 1, 2, 4, 8, 16 coins respectively from bags 1 to 5. Their total weight comes out to 323 gm. Then the product of the labels of the bags having 11 gm coins is ___.

Answer: 12

Exp: Let the weight of coins in the respective bags (1 through 5) be a,b,c,d and e-each of which can take one of two values namely 10 or 11 (gm).

Now, the given information on total weight can be expressed as the following equation:

1.a+2.b+4.c+8.d+16.e = 323

$\Rightarrow$ a must be odd $\Rightarrow$ a = 11

The equation then becomes:

11+2.b+4.c+8.d+16.e = 323

$\Rightarrow$ 2.b+4.c+8.d+16.e = 312

$\Rightarrow$ b+2.c+4.d+8.e = 156

$\Rightarrow$ b must be even $\Rightarrow$ b = 10

The equation then becomes:

10+2.c+4.d+8.e = 156

$\Rightarrow$ 2.c+4.d+8.e = 146

$\Rightarrow$ c+2.d+4.e = 73

$\Rightarrow$ c must be odd $\Rightarrow$ c = 11

The equation now becomes:

11+2.d+4.e = 73

$\Rightarrow$ 2.d+4.e = 62

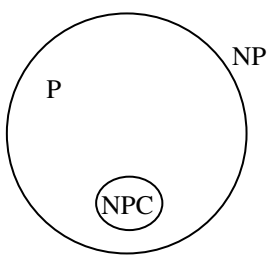
$\Rightarrow$ d+2.e = 31

$\Rightarrow$ e = 11 and e = 10

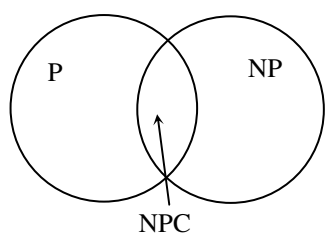
Therefore, bags labelled 1, 3 and 4 contain 11 gm coins $\Rightarrow$ Required Product = 1*3*4* = 12.

38. Suppose a polynomial time algorithm is discovered that correctly computes the largest clique in a given graph. In this scenario, which one of the following represents the correct Venn diagram of the complexity classes P, NP and NP Complete (NPC)?

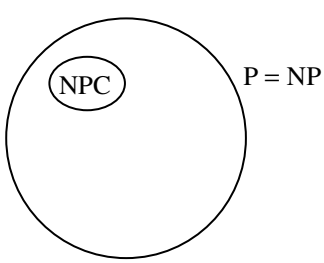
(A)



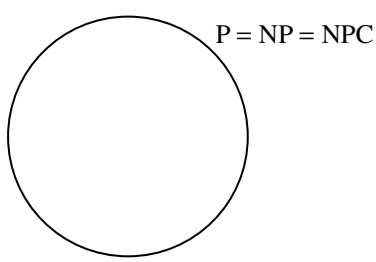
(B)



(B)



(D)



Answer: (D)

Exp: The most important open question in complexity theory is whether the **P = NP** , which asks whether polynomial time algorithms actually exist for **NP**-complete and all **NP** problems (since a problem "C" is in NP-complete, iff C is in NP and every problem in NP is reducible to C in polynomial time). In the given question it is given that some polynomial time algorithm exists which computes the largest clique problem in the given graph which is known NP-complete problem. Hence P=NP=NP-Complete.

39. The minimum number of comparisons required to find the minimum and the maximum of 100 numbers is _____.

Answer: (148)

Exp: From the list of given n numbers [say n is even],

Pick up first two elements, compare them

assign Current – min = min of two numbers

Current – max = max of two numbers

From the remaining $n-2$ numbers, take pairs wise and follow this process given below.

1. Compare two elements

   Assign min = min of two numbers

   max = max of two numbers

2. Compare min and current - min

   Assign $\text{current} - \text{min} = \min\{\text{current} - \text{min}, \text{min}\}$

3. Compare max and current - max

   Assign $\text{current} - \text{max} = \max\{\text{current} - \text{max}, \text{max}\}$

Repeat above procedure for all the remaining pairs of numbers. We can observe that each of pair requires 3 comparisons

1. for finding min and max
2. For updating current – min
3. for updating current – max

But for initial pair we need only one comparison not 3.

$$\therefore \text{total number of comparisons} = \frac{3(n-2)}{2} + 1 = \frac{3n}{2} - 3 + 1 = \frac{3n}{2} - 2$$

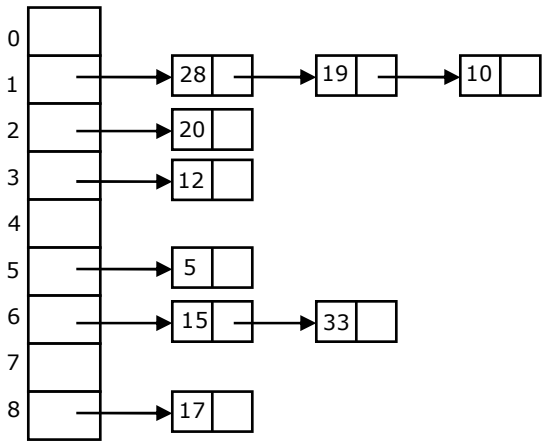
Here $n = 100$, so number of comparisons = 148.

40. Consider a hash table with 9 slots. The hash function is $h(k) = k \bmod 9$. The collisions are resolved by chaining. The following 9 keys are inserted in the order: 5, 28, 19, 15, 20, 33, 12, 17, 10. The maximum, minimum, and average chain lengths in the hash table, respectively, are

(A) 3, 0, and 1 (B) 3, 3, and 3 (C) 4, 0, and 1 (D) 3, 0, and 2

Answer: (A)

Exp:



$\therefore$ Maximum & minimum chain lengths are 3 & 0 respectively

$$\text{Average chain length} = \frac{0+3+1+1+0+1+2+0+1}{9} = 1$$

41. Consider the following C function in which **size** is the number of elements in the array **E**:

```
int MyX(int *E, unsigned int size)
{
  int Y = 0;
  int Z;
  int i, j, k;

for(i = 0; i < size; i++)
    Y = Y + E[i];
for(i = 0; i < size; i++)
   for(j = i; j < size; j++)
   {
Z = 0;
for(k = i; k <= j; k++)
Z = Z + E[k];
if (Z > Y)
   Y = Z;
}
   return Y;
}
```

The value returned by the function **MyX** is the

(A) maximum possible sum of elements in any sub-array of array **E**.

(B) maximum element in any sub-array of array **E**.

(C) sum of the maximum elements in all possible sub-arrays of array **E**.

(D) the sum of all the elements in the array **E**.

Answer: (A)

Exp:

```
int Myx (int *E, unsinged int sixe)
{
 int Y = 0;
int z;
int i, j, k;
for(i = 0;i < size;i++)        } Calculates sum of the elements
    Y = Y + E[i]               } of the array E and stores it in Y
for(i = 0; i < size; i++)
  for( j = i; j < size; j++)
    {                                  } calculates the sum of elements of
       z = 0;                          }      all posible subarrays of E
       for (k = i; k <= j; k++)        }
          z = z + E[k];                }
       if (z > Y) → Checks whether sum of elements of each subarray
          Y = z;   is greaer than the sum of elements of array if so, that sum
        }          is assigned to Y, if not 'Y' will be the sum of elements of
return Y;          complete array
}
```

Ultimately returns the maximum possible sum of elements in any sub array of given array E.

42. Consider the following pseudo code. What is the total number of multiplications to be performed?

```
D= 2
for i = 1 to n do
for j = i to n do
 for k = j + 1 to n do
 D = D * 3
```

(A) Half of the product of the 3 consecutive integers

(B) One-third of the product of the 3 consecutive integers.

(C) One-sixth of the product of the 3 consecutive integers.

(D) None of the above.

Answer: (C)

Exp: $i=1,\ j=1,\ k=2 \text{ to } n \Rightarrow n-1 \text{ times}$

$i=1,\ j=2,\ k=3 \text{ to } n \Rightarrow n-2 \text{ times}$

$i=1,\ j=3,\ k=4 \text{ to } n \Rightarrow n-3 \text{ times}$

$\vdots$

$i=1,\ j=n-2,\ k=n-1 \text{ to } n \Rightarrow 2 \text{ times}$ } $\sum(n-1)$ times

$i=1,\ j=n-1,\ k=n \text{ to } n \Rightarrow 1 \text{ time}$

$i=2,\ j=2,\ k=3 \text{ to } n \Rightarrow n-2 \text{ times}$

$i=2,\ j=3,\ k=4 \text{ to } n \Rightarrow n-3 \text{ times}$

$\vdots \quad \vdots$

$\vdots \quad \vdots$

$i=2,\ j=n-1,\ k=n \text{ to } n \Rightarrow 1 \text{ time}$ } $\sum(n-2)$ times

$\vdots$

$\vdots$

$i=n-1,\ j=n-1,\ k=n \text{ to } n \Rightarrow 1 \text{ time}$ } $\sum 1$ times

$\therefore$ Total number of multiplications

$$\Rightarrow \sum 1+\sum 2+\sum 3+.....\sum(n-1)$$

$$=\underset{\downarrow}{1}+\underset{\downarrow}{(1+2)}+\underset{\downarrow}{(1+2+3)}+....+\underset{\downarrow}{(1+2+3+..n-1)}$$
$$S_1 \quad S_2 \quad S_3 \quad S_{n-1}$$

$$=\sum_{i=1}^{n-1} S_i=\sum \frac{n(n-1)}{2}$$

$$=\frac{1}{2}\sum n^2-\frac{1}{2}\sum n$$

$$=\frac{1}{2}\frac{n(n+1)(2n+1)}{6}-\frac{1}{2}\frac{n(n+1)}{2}=\frac{(n-1)(n)(n+1)}{6}$$

43. Consider a 6-stage instruction pipeline, where all stages are perfectly balanced. Assume that there is no cycle-time overhead of pipelining. When an application is executing on this 6-stage pipeline, the speedup achieved with respect to non-pipelined execution if 25% of the instructions incur 2 pipeline stall cycles is _____.

Answer: (4)

Exp: For 6 stages, non- pipelining takes 6 cycles.

There were 2 stall cycles for pipelining for 25% of the instructions

$$\text{So pipe line time}=\left(1+\frac{25}{100}2\right)$$

$$=\frac{3}{2}=1.5$$

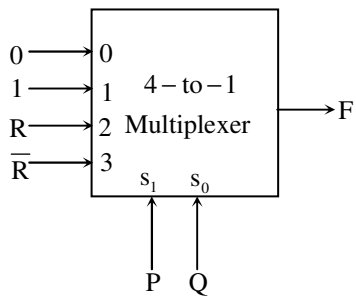
$$\text{Speed up}=\frac{\text{Non}-\text{pipeline time}}{\text{Pipeline time}}=\frac{6}{1.5}=4$$

44. An access sequence of cache block addresses is of length N and contains n unique block addresses. The number of unique block addresses between two consecutive accesses to the same block address is bounded above K. What is the miss ratio if the access sequence is passed through a cache of associativity $A \geq k$ exercising least-recently-used replacement policy?

(A) n/N (B) l/N (C) 1/A (D) k/n

Answer: (A)

45. Consider the 4-to-1 multiplexer with two lines S_1 and S_0 given below.



The minimal sum of-products form of the Boolean expression for the output F of the multiplexer is

(A) $\overline{P}Q + QR + P\overline{Q}R$ (B) $\overline{P}Q + \overline{P}Q\overline{R} + PQ\overline{R} + P\overline{Q}R$

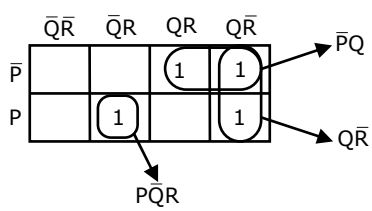
(C) $\overline{P}QR + \overline{P}Q\overline{R} + Q\overline{R} + P\overline{Q}R$ (D) $PQ\overline{R}$

Answer: (A)

Exp: $\overline{P}\,\overline{Q}.O + \overline{P}Q.1 + P\overline{Q}.R + PQ\overline{R}$

$= \overline{P}Q + P\overline{Q}.R + PQ\overline{R}$

Hence the minimized expression is $\overline{P}Q + Q\overline{R} + P\overline{Q}R$



46. The function f(x) = x sin x satisfies the following equation. f"(x) + f(x) +tcosx = 0. The value of t is_____.

Answer: -2

Exp: Given $f''(x) + f(x) + t\cos x = 0$

and $f(x) = x\sin x$

$f'(x) = x\cos x + \sin x$

$f''(x) = x(-\sin x) + \cos x + \cos x$

$= 2\cos x - x\sin x$

$= 2\cos x - f(x)$

$\therefore 2\cos x - f(x) + f(x) + t\cos x = 0$

$\Rightarrow 2\cos x = -t\cos x \Rightarrow t = -2$

47. A function f(x) is continuous the interval [0,2]. It is known that f(0) = f(2) = -1 and f(1) = 1. Which one of the following statements must be true?

(A) There exists a y in the interval (0,1) such that f(y) = f(y + 1)
(B) For every y in the interval (0,1), f(y) = f(2 - y)
(C) The maximum value of the function in the interval (0.2) is 1
(D) There exists a y in the interval (0,1) such that f(y) =f(2 – y)

Answer: (A)

Exp: Define g(x) =f(x)-f(x+1) in [0,1]. g(0) is negative and g(1) is positive. By intermediate value theorem there is y€(0,1) such that g(y)=0
That is f(y) =f(y+1).
Thus answer is (a)

48. For fair six-sided dice are rolled. The probability that the sum of the results being 22is $X/1296$. The value of X is _____

Answer: (10)

Exp: 22 occurred in following ways
6 6 6 4 $\rightarrow$ 4ways
6 6 5 5 $\rightarrow$ 6ways

Required probability = $\frac{6+4}{2296} = \frac{10}{2296} \Rightarrow x = 10$

49. A pennant is a sequence of numbers, each number being 1 or 2. An n-pennant is a sequence of numbers with sum equal to n. For example, (1,1,2) is a 4-pennant. The set of all possible 1-pennants is {(1)}, the set of all possible 2-pennants is {(2), (1,1)}and the set of all 3-pennants is {(2,1), (1,1,1), (1,2)}. Note that the pennant (1,2) is not the same as the pennant (2,1). The number of 10- pennants is _____.

Answer: (89)

Exp: No twos: 1111111111$\Rightarrow$1 pennant
Single two: 211111111$\Rightarrow$9!/8!1! = 9 pennants
Two twos: 22111111$\Rightarrow$8!/6!.2! = 28
Three twos: 2221111$\Rightarrow$7!/3!.4! = 35
Four twos: 222211$\Rightarrow$6!/4!.2! = 15
Five twos: 22222$\Rightarrow$1
Total = 89 pennants.

50. Let S denote the set of all functions $f:\{0,1\}^4 \rightarrow \{0,1\}$. Denote by N the number of functions from S to the set {0,1}. The value of $\log_2 \log_2 N$ is_____.

Answer: (16)

Exp: The number of functions from A to B where size of A = |A| and size of B = |B| is $|B|^{|A|}$
$\{0,1\}^4 = \{0,1\}X\{0,1\}X\{0,1\}X\{0,1\} = 16$
$|S| = 2^{16}$
$N = 2^{|S|}$
$\log\log N = \log\log 2^{|S|} = \log|S| = \log 2^{16} = 16$

51. Consider an undirected graph G where self-loops are not allowed. The vertex set of G is {i, f): $1 \le i \le 12$, $1 \le j \le 12$}. There is an edge between (a,b) and (c,d) if $|a-c| \le 1$ and $|b-d| \le 1$ The number of edges in the graph is _____.

Answer: (506)

Exp: The graph formed by the description contains 4 vertices of degree 3 and 40verices of degree 5 and 100 vertices of degree 8.

According to sum of the degrees theorem 4*3+40*5+100*8 = 2|E|

|E| = 1012/2 = 506

52. An ordered n-tuple $(d_1,d_2,\ldots,d_n)$ with $d_1 \ge d_2 \ge \ldots \ge d_n$ is called graphic if there exists a simple undirected graph with n vertices having degrees $d_1,d_2,\ldots,d_n$ respectively. Which of the following 6-tuples is NOT graphic?

(A) (1, 1, 1, 1, 1, 1) (B) (2, 2, 2, 2, 2, 2)

(C) (3, 3, 3, 1, 0, 0) (D) (3, 2, 1, 1, 1, 0)

Answer: (C)

Exp: According to havel-hakimi theorem

(1,1,1,1,1,1) is graphic iff<1,1,1,1,0> is graphic

(0,1,1,1,1) is graphic iff (0,1,1,0) is graphic

(0,0,1,1) is graphic iff (0,0,0) is graphic

Since (0,0,0) is graphic (1,1,1,1,1,1) is also graphic.

(The process is always finding maximum degree and removing it from degree sequence, subtract 1 from each degree for d times from right to left where d is maximum degree)

(2,2,2,2,2,2) is graphic iff (2,2,22-1,2-1) = (2,2,2,1,1) is graphic.

(1,1,2,2,2) is graphic iff (1,1,1,1) is graphic.

(1,1,1,1) is graphic iff (0,1,1)

(0,1,1) is graphic iff (0,0) is graphic.

Since (0,0) is graphic (2,2,2,2,2,2) is also graphic.

Consider option C now.

(3,3,3,1,0,0)→(0,0,1,3,3,3) is graphic iff (0,0,0,2,2) is graphic.

Note that before applying the havel-hakimi step degree sequence should be in non-increasing order.

(0,0,0,2,2) is graphic iff (0,0,-1,1) is graphic.

Since (0,0,-1,1) is not graphic (3,3,3,1,0,0) is also not graphic.

53. Which one of the following propositional logic formulas is TRUE when exactly two of p, q, and r are **TRUE**?

(A) $((p \leftrightarrow q) \wedge r) \vee (p \wedge q \wedge \sim r)$ (B) $(\sim (p \leftrightarrow q) \wedge r) \vee (p \wedge q \wedge \sim r)$

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

Answer: (B)

Exp: P = T q=F and r=T

Option A will become false.

Option C will become false.

Option D is always false.

54. Given the following schema:

employees(emp-id, first-name, last-name, hire-date,

dept-id, salary)

departments(dept-id, dept-name, manager-id, location-id)

You want to display the last names and hire dates of all latest hires in their respective departments in the location ID 1700. You issue the following query:

```
SQL>SELECT last-name, hire-date
FROM employees
WHERE (dept-id, hire-date) IN
(SELECT dept-id, MAX(hire-date)
FROM employees JOIN departments USING(dept-id)
WHERE location-id = 1700
GROUP BY dept-id);
```

What is the outcome?

(A) It executes but does not give the correct result.

(B) It executes and gives the correct result.

(C) It generates an error because of pairwise comparison.

(D) It generates an error because the GROUP BY clause cannot be used with table joins in a sub-query.

Answer: (B)

Exp: In the inner sub query, “employees” and “departments” tables are joined by “using” clause (first Cartesian product of those two tables will be done and then and wherever these is a match on the dept-ids that tuple will be filtered). After this, the tuples of the resultant table will be filtered by using the condition “location-id=1700” and then will grouped on dept-id(all the tuples having equal values under dept-id will come into one group). After grouping, the columns dept-id in location-id 1700 and maximum of hire dates in that respective dept-id will be selected. Format of the tuples in the resultant table will be dept-id in location-id 1700 along with the latest hire date in the respective dept (two columns). Outer query takes each tuple from “employees” table and it will check whether dept-id and hire-date pair for this tuple is contained in the table given by inner sub query. If this is the case it will display the last-name of respective employee

IN operator compares one or multiple expressions on the left side of the operator to a set of one or more values on the right side of the operator. When using multiple expressions (like 2 columns - pair wise comparison), the number and data types of expressions in the list must match on both sides of the operator.

55. Consider two processors P_1 and P_2 executing the same instruction set. Assume that under identical conditions, for the same input, a program running on P_2 takes 25% less time but incurs 20% more CPI (clock cycles per instruction) as compared to the program running on P_1. If the clock frequency of P_1 is 1GHz, then the clock frequency of P_2 (in GHz) is _____.

Answer: (1.6)

Exp: 1 cycle time for $p_1 = \frac{10^9}{1GH} = 1n.s$

Assume p_1 takes 5 cycles for a program then p_2 takes 20% more, means, 6 cycles.

p_2 Takes 25% less time, means, if p_1 takes 5 n.s, then p_2 takes 3.75 n.s.

Assume p_2 clock frequency is x GHz.

p_2 Taken 6 cycles, so $\frac{6\times10^9}{x\ GH} = 3.75,\ x = 1.6$

GATE- CS 2014

Paper-02

Q. No. 1 – 5 Carry One Mark Each

1. Choose the most appropriate phrase from the options given below to complete the following sentence.

India is a post-colonial country because

(A) it was a former British colony

(B) Indian Information Technology professionals have colonized the world

(C) India does not follow any colonial practices

(D) India has helped other countries gain freedom

Answer: (A)

2. Who _____ was coming to see us this evening?

(A) you said (B) did you say (C) did you say that (D) had you said

Answer: (B)

3. Match the columns.

Column 1	Column 2
(1) eradicate	(P) misrepresent
(2) distort	(Q) soak completely
(3) saturate	(R) use
(4) utilize	(S) destroy utterly

(A) 1:S, 2:P, 3:Q, 4:R (B) 1:P, 2:Q, 3:R, 4:S

(C) 1:Q, 2:R, 3:S, 4:P (D) 1:S, 2:P, 3:R, 4:Q

Answer: (A)

4. What is the average of all multiples of 10 from 2 to 198?

(A) 90 (B) 100 (C) 110 (D) 120

Answer: (B)

Exp:

$$\left.\begin{array}{l} 10+190 \rightarrow \\ 20-180 \rightarrow \\ : \\ : \\ 90-110 \\ 100 \end{array}\right\} \begin{array}{l} 200 \\ \\ 9 \end{array} \Rightarrow \frac{[(200)\times 9+100]}{19}=\frac{1900}{19}=100$$

5. The value of $\sqrt{12+\sqrt{12+\sqrt{12+....}}}$ is

(A) 3.464 (B) 3.932 (C) 4.000 (D) 4.444

Answer: (C)

Exp: $\text{let} = \sqrt{12+\sqrt{12+\sqrt{12+....}}} = y$

$\Rightarrow \sqrt{12+y} = y$

$\Rightarrow 12+y = y^2$

$\Rightarrow (y-4)(y+3) = 0$

$\Rightarrow y = 4,\ y = -3$

Q. No. 6 – 10 Carry Two Marks Each

6. The old city of Koenigsberg, which had a German majority population before World War 2, is now called Kaliningrad. After the events of the war, Kaliningrad is now a Russian territory and has a predominantly Russian population. It is bordered by the Baltic Sea on the north and the countries of Poland to the south and west and Lithuania to the east respectively. Which of the statements below can be inferred from this passage?

(A) Kaliningrad was historically Russian in its ethnic make up

(B) Kaliningrad is a part of Russia despite it not being contiguous with the rest of Russia

(C) Koenigsberg was renamed Kaliningrad, as that was its original Russian name

(D) Poland and Lithuania are on the route from Kaliningrad to the rest of Russia

Answer: (B)

7. The number of people diagnosed with dengue fever (contracted from the bite of a mosquito) in north India is twice the number diagnosed last year. Municipal authorities have concluded that measures to control the mosquito population have failed in this region.

Which one of the following statements, if true, does not contradict this conclusion?

(A) A high proportion of the affected population has returned from neighbouring countries where dengue is prevalent

(B) More cases of dengue are now reported because of an increase in the Municipal Office's administrative efficiency

(C) Many more cases of dengue are being diagnosed this year since the introduction of a new and effective diagnostic test

(D) The number of people with malarial fever (also contracted from mosquito bites) has increased this year

Answer: (D)

8. If x is real and $\left|x^2-2x+3\right| = 11$, then possible values of $\left|-x^3+x^2-x\right|$ include

(A) 2, 4 (B) 2, 14 (C) 4, 52 (D) 14, 52

Answer: (D)

Exp: $x^2 - 2x + 3 = 11$

$\Rightarrow (x-4)(x+2) = 0 \Rightarrow x = 4, x = -2$

Values of $\left|-x^3 + x^2 - x\right|$

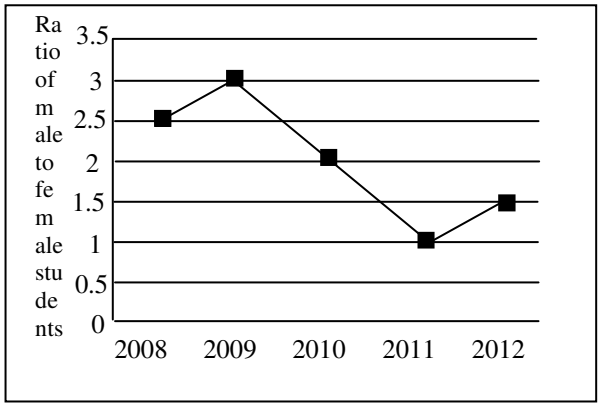
For $x = 4$

Value $= 52$

for $x = -2$

Value $= 14$

9. The ratio of male to female students in a college for five years is plotted in the following line graph. If the number of female students doubled in 2009, by what percent did the number of male students increase in 2009?



Answer: (140)

Exp: $\frac{m}{f} = 3$ $\frac{m}{f} = 2.5$ m=2.5f

$\frac{m'}{2f} = 3$

$m' = 6f$

$= \frac{m' - m}{m}$

$\% \uparrow = \frac{3.5f}{2.5f} \times 100$

$= \frac{7}{8} = 1.4$

$\boxed{\% \uparrow = 140\%}$

10. At what time between 6 *a.m.* and 7 *a.m* will the minute hand and hour hand of a clock make an angle closest to 60°?

(A) 6: 22 *a. m.* (B) 6:27 *a.m.* (C) 6: 38 *a.m.* (D) 6:45 *a.m.*

Answer: (A)

Exp: Angle by minute's hand

$60\ \text{min} \rightarrow 360^{\circ}$

$1\,\text{min} \rightarrow \frac{360}{60} = 6^{\circ}$

$8\,\text{min} \rightarrow 48^{\circ}$

Angle $\rightarrow 48^{\circ}$ with number '6'

Angle by hours hand

$60\ \text{min} = 30^{\circ}$

$22\ \text{min} \rightarrow \frac{30}{60} \times 22$

$= 11$

Total Angle=48+11=59°.

Q. No. 1 – 25 Carry One Mark Each

1. The security system at an IT office is composed of 10 computers of which exactly four are working. To check whether the system is functional, the officials inspect four of the computers picked at random (without replacement). The system is deemed functional if at least three of the four computers inspected are working. Let the probability that the system is deemed functional be denoted by p Then 100p= _____.

Answer: (11.85 - 11.95)

Exp: p= P [at least three computers are working]

= P (3 or 4 computers working)

$$= \frac{\left(4_{C_3}\right)\times\left(6_{C_1}\right)}{10_{C_4}} + \frac{4_{C_4}}{10_{C_4}} = \frac{5}{42}$$

$$\Rightarrow 100\,p = 11.9.$$

2. Each of the nine words in the sentence "**The quick brown fox jumps over the lazy og**" is written on a separate piece of paper. These nine pieces of paper are kept in a box. One of the pieces is drawn at random from the box. The *expected* length of the word drawn is _____. (The answer should be rounded to one decimal place.

Answer: (3.8889)

Exp: Given words are

THE, QUICK, BROWN, FOX, JUMPS, OVER, THE, LAXY, DOG

LET X be the random variable such that X =length of the word

The Length of the words THE, FOX, THE, DOG is 3

The Length of the words OVER, LAXY is 4

The length of the words QUICK, BROWN, JUMPS, is 5

The corresponding probabilities are given below

x	3	4	5
P(X)	4/9	2/9	3/9

Expected length of the word= $\sum xp(x) = 3\left(\frac{4}{9}\right) + 4\left(\frac{2}{9}\right) + 5\left(\frac{3}{9}\right) = 3.8889$

3. The maximum number of edges in a bipartite graph on 12 vertices is _____.

Answer: (36)

Exp: The number of edges in a bipartite graph on n-vertices is atmost $\frac{n^2}{4}$

The maximum number of edges in a bipartite graph on 12 –vertices is $\frac{n^2}{4} = \frac{12\times12}{4} = 36$

4. If the matrix A is such that

$$A = \begin{bmatrix} 2 \\ -4 \\ 7 \end{bmatrix} \begin{bmatrix} 1 & 9 & 5 \end{bmatrix}$$

Then the determinant of A is equal to _____.

Answer: (0)

Exp: $$A = \begin{bmatrix} 2 & 18 & 10 \\ -4 & -36 & 20 \\ 7 & 63 & 35 \end{bmatrix}$$

$\Rightarrow |A| = 0 \quad (\because R_2 = -2R_1)$.

5. A non-zero polynomial f(x) of degree 3 has roots at x = 1,x = 2 and x = 3. Which one of the following must be TRUE?

(A) f(0) f(4) < 0 (B) f(0) f(4) > 0

(C) f(0) + f(4) > 0 (D) f(0) + f(4) < 0

Answer: (A)

Exp: Since, the roots of f(x) = 0 i.e., x = 1, 2, 3 lies between 0 and 4 and f(x) is of degree 3

$\therefore$ f(0) and f(4) are of opposite signs

$\Rightarrow$ f(0).f(4)<0.

6. The dual of a Boolean function $F(x_1, x_2, ..., x_{n,} +, ., ')$, written as F^D, is the same expression as that of F with + and swapped. F is said to be self-dual if $F = F^D$. The number of self-dual functions with n Boolean variables is

(A) 2^n (B) 2^{n-1} (C) 2^{2^n} (D) $2^{2^{n-1}}$

Answer: (D)

Exp: A function F is self dual if it has equal number of minterms and maxterms, also mutually exclusive terms should not be included.

The number of mutually exclusive terms (pair wise) is $\frac{2^n}{2} = 2^{n-1}$

Number of functions possible by taking any of the one term from the above mentioned mutually exclusive pair is $= 2^{2^{n-1}}$.

7. Let $k = 2^n$. A circuit is built by giving the output of an n-bit binary counter as input to an n-to-2^n bit decoder. This circuit is equivalent to a

(A) k-bit binary up counter. (B) k-bit binary down counter.

(C) k-bit ring counter. (D) k-bit Johnson counter.

Answer: (C)

Exp: In case of decoder output, single output will be 1 and remaining will be zero at a time. The output that is high will give the count of the ring counter at that time.

8. Consider the equation $(123)_5 = (x8)_y$ with x and y as unknown. The number of possible solutions is _____ .

Answer: (3)

Exp : $(123)_5 = (x\,8)_y$

Converting both sides to decimal:

$\Rightarrow 25+10+3 = xy+8$

$\Rightarrow xy+8 = 38 \Rightarrow xy = 30$

$\Rightarrow x = 1, y = 30$

or , $x = 2, y = 15$ or, $x = 3, y = 10$

$\therefore$ Total number of solutions: 3

9. A 4-way set-associative cache memory unit with a capacity of 16 KB is built using a block size of 8 words. The word length is 32 bits. The size of the physical address space is 4 GB. The number of bits for the TAG field is _____

Answer: (20)

Exp: Physical address size = 32 bits

Cache size $= 16\,\text{k bytes} = 2^{14}$ Bytes

block size $= 8$ words $= 8\times 4$ Byte $= 32$ Bytes

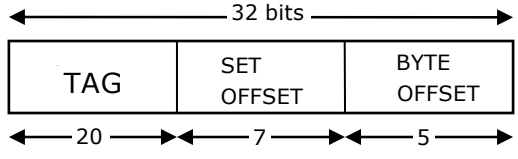
(where each word $= b$ Bytes)

No. of blocks $= \frac{2^{14}}{2^5} = 2^9$

block offset $= 9^{\text{bits}}$

No. of sets $= \frac{2^9}{4} = 2^7$

set ofset $= 7$ bits



Byte offset $= 8\times 4$ Bytes $= 32$ Byte $= 2^5 = 5$ bits

TAG $= 32-(7+5) = 20$ bits

10. Consider the function func shown below:

```
int func(int num) {
int count = 0;
    while (num) {
    count++;
     num>>= 1;
}
return (count);
}
```

The value returned by func(435)is _____.

Answer: (9)

Exp:
```
int func (int num)
{
int count = 0;
while (num)                //After each right shift, checks whether the num value is not zero//
    {
    count ++;
    num >>= 1;     //shifts all bits of num one slot to the right//
    }
return(count);
}
```

Initially num = 110110011, count = 0

count = 1; num = 101100110 after 1st right shift

count =2; num = 011001100 after 2nd right shift

:

:

Count = 9; num = 000000000 after 9th right shift.

After nine right shifts, num = 0; and while loop terminates count = 9 will be returned.

11. Suppose n and p are unsigned int variables in a C program. We wish to set p to ${}^{n}C_{3}$. If n is large, which one of the following statements is most likely to set p correctly?

(A) p = n * (n – 1) * (n-2) / 6;

(B) p = n * (n – 1) / 2 * (n-2) / 3;

(C) p = n * (n – 1) / 3 * (n-2) / 2;

(D) p = n * (n – 1) / 2 * (n-2) / 6.0;

Answer: (B)

Exp: $P = n_{C_3} = \frac{n(n-1)(n-2)}{6}$

It we multiply n, (n-1), (n-2) at once, it might go beyond the range of unsigned integer (resulting overflow). So options (A) and (D) are rested out. If n is even or odd n×(n-1)/2 will always result in integer value (no possibility of truncation, so more accuracy) where as incase of n*(n-1)/3, its not certain to get integer always (truncation possible, so less accuracy).

$$P = \underbrace{n*(n-1)/2}_{P_1} * \underbrace{(n-2)/3}_{P_2}$$

As P_1 will be having no error, resultant p will be more accurate.

$$P = \underbrace{n*(n-1)/3}_{P_1} * \underbrace{(n-2)/2}_{P_2}$$

As there is a possibility of truncation in P_1, there will be less accuracy in final result of P.

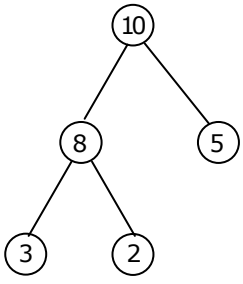
12. A priority queue is implemented as a Max-Heap. Initially, it has 5 elements. The level-order traversal of the heap is: 10, 8, 5, 3, 2. Two new elements 1 and 7 are inserted into the heap in that order. The level-order traversal of the heap after the insertion of the elements is:

(A) 10, 8, 7, 3, 2, 1, 5 (B) 10, 8, 7, 2, 3, 1, 5

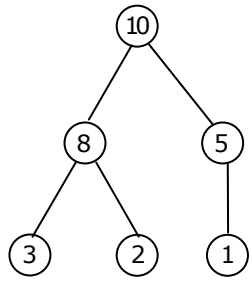
(C) 10, 8, 7, 1, 2, 3, 5 (D) 10, 8, 7, 5, 3, 2, 1

Answer: (A)

Exp: Initial max-heap is

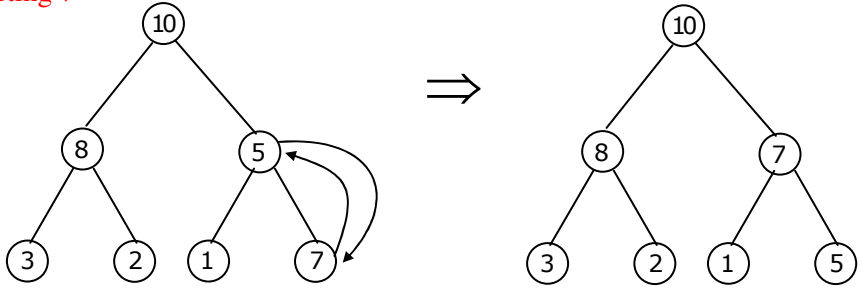


after inserting 1



Heapification is not required as it satisfies max-heap property

After inserting 7



Hence level order traversal is 10, 8, 7, 3, 2, 1, 5

13. Which one of the following correctly determines the solution of the recurrence relation with T(1) = 1?

$$T(n) = 2T\left(\frac{n}{2}\right) + \log n$$

(A) $\theta(n)$ (B) $\theta(n \log n)$ (C) $\theta(n^2)$ (D) $\theta(\log n)$

Answer: (A)

Exp: By Master's theorem case (i) $T(n)$ is $O(n)$

Here $a = 2,\ b = 2,\ f(n) = \log n$

$\log_b^a = \log_2^2 = 1$

we can choose $\epsilon > 0$, in such a way that

$f(n) = O\left(n \log_b^{a-\epsilon}\right)$; i.e., $\log n = O\left(n \log_b^{a-\epsilon}\right)$

By master theorem, If $f(n) = O\left(n \log_b^{a-\epsilon}\right)$ for some $\epsilon > 0$, then

$T(n) = \theta\left(n \log_b^a\right) = \theta(n)$

14. Consider the tree arcs of a BFS traversal from a source node **W** in an unweighted, connected, undirected graph. The tree **T** formed by the tree arcs is a data structure for computing

(A) the shortest path between every pair of vertices.

(B) the shortest path from **W** to every vertex in the graph.

(C) the shortest paths from **W** to only those nodes that are leaves of **T**.

(D) the longest path in the graph.

Answer: (B)

Exp: One of the application of BFS algorithm is to find the shortest path between nodes u and v.

But in the given question the BFS algorithm starts from the source vertex w and we can find the shortest path from w to every vertex of the graph

15. If $L_1 = \{a^n \mid n \geq 0\}$ and $L_2 = \{b^n \mid n \geq 0\}$, Consider

(I) $L_1.L_2$ is a regular language

(II) $L_1.L_2 = \{a^n b^n \mid n \geq 0\}$

Which one of the following is CORRECT?

(A) Only (I)

(B) Only (II)

(C) Both (I) and (II)

(D) Neither (I) nor (II)

Answer: (A)

Exp: L1.L2 is also regular since regular languages are closed under concatenation.

But L1.L2 is not $\{a^n b^n \mid n \geq 0\}$ because both the variable is independent in both languages.

16. Let $A \leq_m B$ denotes that language A is mapping reducible (also known as many-to-one reducible) to language B. Which one of the following is FALSE?

(A) If $A \leq_m B$ and B is recursive then A is recursive.

(B) If $A \leq_m B$ and A is undecidable then B is undecidable.

(C) If $A \leq_m B$ and B is recursively enumerable then A is recursively enumerable.

(D) If $A \leq_m B$ and B is not recursively enumerable then A is not recursively enumerable.

Answer: (D)

Exp: A language A is mapping reducible to a language B, if there is a computable function $f : \varepsilon^* \to \varepsilon^*$ where for every $w, w \in A \Leftrightarrow f(w) \in B$

If $A \leq mB$ and B is Turing recognizable then A is Turing recognizable.

If $A \leq mB$ and B is not recursively enumerable then A is not recursively enumerable

17. Consider the grammar defined by the following production rules, with two operators □ and +

$S \rightarrow T * P$

$T \rightarrow U \mid T * U$

$P \rightarrow Q + P \mid Q$

$Q \rightarrow Id$

$U \rightarrow Id$

Which one of the following is TRUE?

(A) + is left associative, while * is right associative

(B) + is right associative, while * is left associative

(C) Both + and * are right associative

(D) Both + and * are left associative

Answer: (B)

Exp: $S \rightarrow T \times P$

$T \rightarrow U \mid T \times U$

$P \rightarrow Q + P \mid Q$

$Q \rightarrow Id$

$U \rightarrow Id$

As the production rule $T \rightarrow T \times U$ is defined as left recursive rule, so * is left associate operator.

As the production rule $P \rightarrow Q + P$ is defined as right recursive rule, so + is right associative operator.

18. Which one of the following is **NOT** performed during compilation?

(A) Dynamic memory allocation (B) Type checking

(C) Symbol table management (D) Inline expansion

Answer: (A)

Exp: Symbol table management is done during compitation to store and retriew the information about tokens. Type checking is one of the check performed during semantic analysis of compitation.

Inline expansion is a compiler optimization that replaces a function call by the bodyof respective function.

Dynamic memory allocation is when an executing pregoram request the oprating system to give it a block of main memory, so ti is performed during sum time not during complete time.

Option (A) is answer

19. Which one of the following is TRUE?

(A) The requirements document also describes how the requirements that are listed in the document are implemented efficiently.

(B) Consistency and completeness of functional requirements are always achieved in practice.

(C) Prototyping is a method of requirements validation.

(D) Requirements review is carried out to find the errors in system design.

Answer: (C)

20. A FAT (file allocation table) based file system is being used and the total overhead of each entry in the FAT is 4 bytes in size. Given a 100 x 10^6 bytes disk on which the file system is stored and data block size is 10^3 bytes, the maximum size of a file that can be stored on this disk in units of 10^6 bytes is _____.

Answer: (99.55 to 99.65)

Exp: Number of entries in the FAT = Disk Capacity/Block size = $10^8/10^3 = 10^5$

- ⇨ Total space consumed by FAT = $10^5 * 4$ B = $0.4 * 10^6$ B
- ⇨ Maximum size of file that can be stored = $100 * 10^6 - 0.4 * 10^6 = 99.6 * 10^6$ B
- ⇨ Answer: 99.6

21. The maximum number of super keys for the relation schema R (E, F, G, H) with E as the key is _____.

Answer: (8)

Exp: The maximum number of super keys for the relation schema $R(E,F,G,H)$ with E as the key is $2^3 = 8$ as any subset of non key attributes along with key attribute will form the super key of R.

As we have 3 nonkey all (F, G and H) so subsets will be 2^3

22. Given an instance of the STUDENTS relation as shown below:

Student D	StudentName	Student Email	Student Age	CPI
2345	Shankar	Shankar@math	X	9.4
1287	Swati	swati@ee	19	9.5
7853	Shankar	Shankar@cse	19	9.4
9876	Swati	swati@mech	18	9.3
8765	Ganesh	ganesh@civil	19	8.7

For (StudentName, StudentAge) to be a key for this instance, the value X should NOT be equal to_____.

Answer: (19)

Exp: For (Student Name, student age) to be a key for given instance of STUDENTS relation, the pair value should not get repeated in any two tuples p and q (uniqueness in forced by the definition of key)

Tuple	Student Name	Student Age
P	Shankar	⊗ → should not be 19
Q	Shankar	19

23. Which one of the following is TRUE about the interior gateway routing protocols – Routing Information Protocol (RIP) and Open Shortest Path First (OSPF)?

(A) RILP uses distance vector routing and OSPF uses link state routing

(B) OSPF uses distance vector routing and RIP uses link state routing

(C) Both RIP and OSPF use link state routing

(D) Both RIP and OSPF use distance vector routing

Answer: (A)

Exp: RIP Uses Distance Vector Routing and OSPF uses Link State Routing.

24. Which one of the following socket API functions converts an unconnected active TCP socket into a passive socket?

(A) connect (B) bind (C) listen (D) accept

Answer: (C)

Exp:

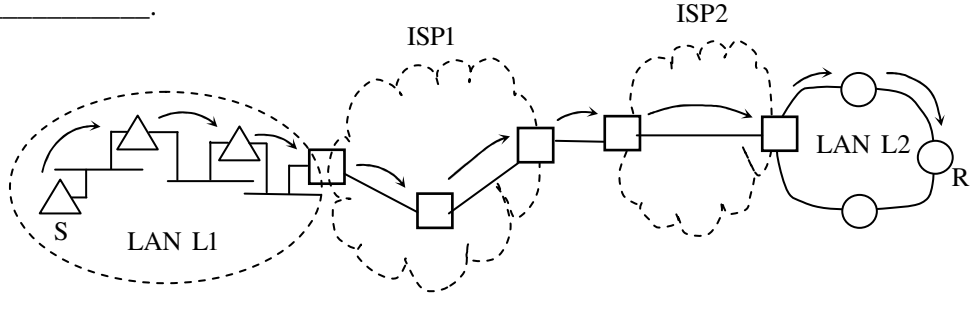
(a) The **connect function** is used by a TCP client to establish a connection with a TCP server.

(b) The **bind function** assigns a local protocol address to a socket. With the Internet protocols, the protocol address is the combination of either a 32-bit IPv4 address or a 128-bit IPv6 address, along with a 16-bit TCP or UDP port number.

(c) The **listen function** converts an unconnected socket into a passive socket, indicating that the kernel should accept incoming connection requests directed to this socket.

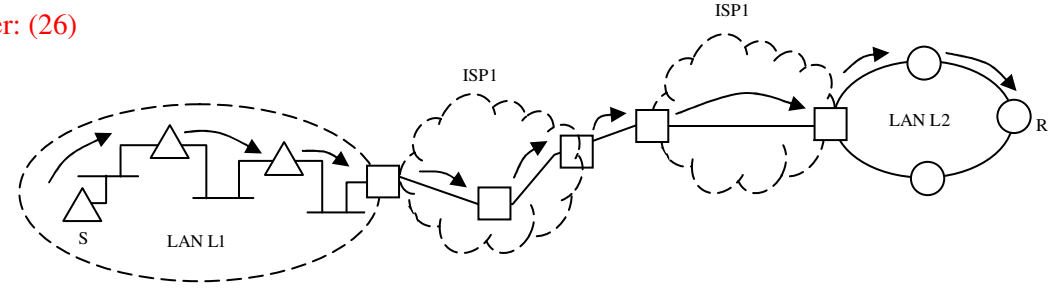
(d) The **accept function** is called by a TCP server to return the next completed connection from the front of the completed connection queue. If the completed connection queue is empty, the process is put to sleep (assuming the default of a blocking socket).

25. In the diagram shown below, L1 is an Ethernet LAN and L2 is a Token-Ring LAN. An IP packet originates from sender S and traverses to R, as shown. The links within each ISP and across the two ISPs, are all point-to-point' optical links. The initial value of the TTL field is 32. The maximum possible value of the TTL field when R receives the datagram is _____.



Answer: (26)

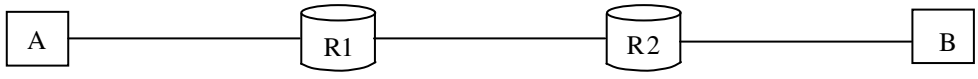
Exp:



The TTL field is set by the sender of the datagram, and reduced by every router on the route to its destination. So, there are 5visits at 5 routers and one visit at receiver R in above figure which leads 32 – 6 = 26.

Q. No. 26 – 55 Carry Two Marks Each

26. Consider the store and forward packet switched network given below. Assume that the bandwidth of each link is 10^6 bytes / sec. A user on host A sends a file of size 10^3 bytes to host B through routers R1 and R2 in three different ways. In the first case a single packet containing the complete file is transmitted from A to B. In the second case, the file is split into 10 equal parts, and these packets are transmitted from A to B. In the third case, the file is split into 20 equal parts and these packets are sent from A to B. Each packet contains 100 bytes of header information along with the user data. Consider only transmission time and ignore processing, queuing and propagation delays. Also assume that there are no errors during transmission. Let T1, T2 and T3 be the times taken to transmit the file in the first, second and third case respectively. Which one of the following is CORRECT?



(A) T1 < T2 < T3

(B) T1 > T2 > T3

(C) T2 = T3, T3 < T1

(D) T1 = T3, T3 > T2

Answer: (D)

Exp: Given Bandwidth = 10^6 bytes/sec

$L=10^3$ bytes

Case: 1

$L = 1000$ bytes

Header size $= 100$ bytes

Total Frame size $= 1000 + 100 = 1100$ bytes

$$\therefore T_x = \frac{1100 \times 8}{10^6 \times 8} = 1100\ \mu s$$

So, $T_1 = 3300\ \mu s$

Case: 2

$L = 100$ bytes

Header size $= 100$ bytes

Total Frame size $= 100 + 100 = 200$ bytes

$$\therefore T_x = \frac{200 \times 8}{10^6 \times 8} = 200\ \mu s \text{ for 1 packet}$$

For 10 packets $\Rightarrow$ Tx $= 2000\ \mu s$

So, $T_2 = 2000 + 200 + 200 = 2400\ \mu s$

Case: 3

$L = 50$ bytes

Header size $= 100$ bytes

Total Frame size $= 50 + 100 = 150$ bytes

$\therefore T_x = \frac{150 \times 8}{10^6 \times 8} = 150\,\mu s$ for 1 packet

For 20 packets $\Rightarrow$ Tx $= 3000\,\mu s$

So, $T_3 = 3000 + 150 + 150 = 3300\,\mu s$

$\therefore \; T_1 = T_3$

$T_3 > T_2$

27. An IP machine Q has a path to another IP machine H via three IP routers R1, R2, and R3.

Q—R1—R2—R3—H

H acts as an HTTP server, and Q connects to H via HTTP and downloads a file. Session layer encryption is used, with DES as the shared key encryption protocol. Consider the following four pieces of information:

[I1] The URL of the file downloaded by Q

[I2] The TCP port numbers at Q and H

[I3] The IP addresses of Q and H

[I4] The link layer addresses of Q and H

Which of I1, I2, I3, and I4 can an intruder learn through sniffing at R2 alone?

(A) Only I1 and I2 (B) Only I1 (C) Only I2 and I3 (D) Only I3 and I4

Answer: (C)

Exp: An Intruder can't learn [I1] through sniffing at R2 because URLs and Download are functioned at Application layer of OSI Model.

An Intruder can learn [I2] through sniffing at R2 because Port Numbers are encapsulated in the payload field of IP Datagram.

An Intruder can learn [I3] through sniffing at R2 because IP Addresses and Routers are functioned at network layer of OSI Model.

An Intruder can't learn [I4] through sniffing at R2 because it is related to Data Link Layer of OSI Model.

28. A graphical HTML browser resident at a network client machine *Q* accesses a static HTML webpage from a HTTP server *S*. The static HTML page has exactly one static embedded image which is also at *S*. Assuming no caching, which one of the following is correct about the HTML webpage loading (including the embedded image)?

(A) Q needs to send at least 2 HTTP requests to S, each necessarily in a separate TCP connection to server S

(B) Q needs to send at least 2 HTTP requests to S, but a single TCP connection to server S is sufficient

(C) A single HTTP request from Q to S is sufficient, and a single TCP connection between Q and S is necessary for this

(D) A single HTTP request from Q to S is sufficient, and this is possible without any TCP connection between Q and S

Answer: (B)

29. Consider the following schedule S of transactions T1, T2, T3, T4:

T1	T2	T3	T4
Writes [x] Commit	Reads[X]		
		Writes[X] Commit	
	Writes[Y] Reads [Z] Commit		
			Reads[X] Reads[Y] Commit

Which one of the following statements is CORRECT?

(A) S is conflict-serializable but not recoverable

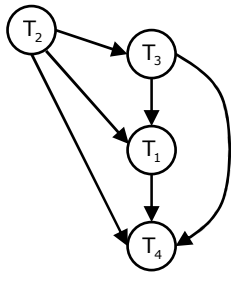
(B) S is conflict-serializable but is recoverable

(C) S is both conflict-serializable and recoverable

(D) S is neither conflict-serializable nor is it recoverable

Answer: (C)

Exp: The precedence graph of schedule s is a follows.



⇒ No cycle, so S is conflict serializable

In the schedule S of transactions T_1, T_2, T_3 and T_4 for each pair of transaction T_i and T_j, such that T_j reads a data item previously written by T_i the commit operation of T_j appears after the commit operation of T_i hence the schedule is recoverable schedule.

30. Consider a join (relation algebra) between relations r(R)and s(S) using the nested loop method. There are 3 buffers each of size equal to disk block size, out of which one buffer is reserved for intermediate results. Assuming size(r(R))<size(s(S)), the join will have fewer number of disk block accesses if

(A) relation r(R) is in the outer loop.

(B) relation s(S) is in the outer loop.

(C) join selection factor between r(R) and s(S) is more than 0.5.

(D) join selection factor between r(R) and s(S) is less than 0.5.

Answer: (A)

Exp: A join between r(R) and s (S) using nested loop method will be as follows.

For each tuple r in R do

For each tuple s in S do

If r and s satisfy the join condition then output the tuple <r,s>

This algorithm will involve $n_r*b_s+b_r$ block transfers and n_r+b_r seeks, where b_r and b_s are number of blocks in relations R and S respectively and n_r is number of tuple in relation R. Now to have less block accesses, n_r should be less and it is already given that |R|<|S|. Relation r(R) should be in the outer loop to have fewer number of disk block accesses.

31. Consider the procedure below for the *Producer-Consumer* problem which uses semaphores:

```
Semaphore n = 0;
Semaphore s = 1;
Void producer ( )
{
    while (true)
    {
    Produce ( );
    SemWait (s);
    addToBuffer ( );
    semSignal (s);
    semSignal (n);
    }
}
```

```
Void consumer( )
    {
    while(true)
    {
    semWait (s) ;
    semWait (n) ;
removeFromBuffer ( ) ;
    semsignal (s);
    consume ( ) ;
    }
     }
```

Which one of the following is TRUE?

(A) The producer will be able to add an item to the buffer, but the consumer can never consume it.

(B) The consumer will remove no more than one item from the buffer.

(C) Deadlock occurs if the consumer succeeds in acquiring semaphore **s** when the buffer is empty.

(D) The starting value for the semaphore **n** must be 1 and not 0 for deadlock-free operation.

Answer: (C)

Exp: (A) The producer will be able to add an item to the buffer, but the consumer can never consume if given statement is false, because once producer produces an item and places in buffer, the next turn to execute can be given to consumer ( ). [The value of s = 1 and n=1]. So consumer will be definitely able to consume it by performing successful down operations on s and n.

(B) The consumer will remove no more than one item from the buffer.

Given statement is false as if p( ) produces and adds to buffer, (c) will consume the added item, this sequence of alteration (p and c) will always make consumer to remove items from buffer.

This statement would have been true if it was said that the consumer will remove no more than one item from the buffer one after the other. (at a time).

(C) Dead lock occurs if the consumer succeeds in acquiring semaphore's' when the buffer is empty. Given statement is true as when buffer is empty initially if consumer gets the turn to execute as follows:-

```
S = 1,   n = 0;
consumer( )
{
  while (True)
  {
   p(s);[s = \0]
   p(s); [m = 0; it blocks consumer]
   }
}
producer( )
{
  while (True)
  {
   producer( );
   p(s);[s = 0; it blocks p( )]
   }
}
```

So from the above execution both producer and consumer goes in block state waiting for each other to wake them up and hence dead lock occurs.

(D) Even if the starting value for the semaphore 'n' becomes 1, there will be invalid execution of consumer on buffer empty condition, which should not happen. So statement is false.

32. Three processes A, B and C each execute a loop of 100 iterations. In each iteration of the loop, a process performs a single computation that requires t_c CPU milliseconds and then initiates a single I/O operation that lasts for t_{io} milliseconds. It is assumed that the computer where the processes execute has sufficient number of I/O devices and the OS of the computer assigns different I/O devices to each process. Also, the scheduling overhead of the OS is negligible. The processes have the following characteristics:

Process id	t_c	t_{io}
A	100ms	500ms
B	350ms	500ms
C	200ms	500ms

The processes A, B, and C are started at times 0, 5 and 10 milliseconds respectively, in a pure time sharing system (round robin scheduling) that uses a time slice of 50 milliseconds. The time in milliseconds at which process C would ***complete*** its first I/O operation is _____.

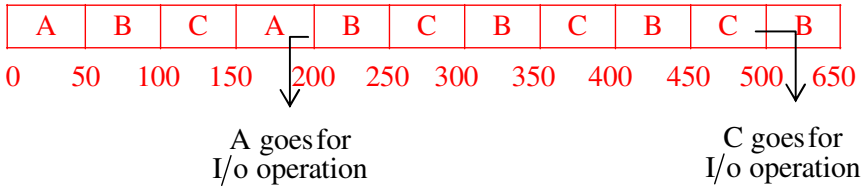
Answer: (1000)

Exp:

Process id	t_c	t_{io}	A.T	TQ = 50ms
A	100 ms	500 ms	0 ms	
B	350 ms	500 ms	5 ms	
C	200 ms	500 ms	10 ms	

The Gantt chart for Round robin algorithm for the first iteration execution for each of the 3 processes is as follows:

R .Q ~~A~~ ~~B~~ ~~C~~ A



After finishing t_c CPU ms at time 500ms, C goes for I/O operation, that needs 500ms more, so the time at which process C would complete its first I/O operations is 500+500 = 1000ms

33. A computer has twenty physical page frames which contain pages numbered 101 through 120. Now a program accesses the pages numbered 1, 2, …, 100 in that order, and repeats the access sequence THRICE. Which one of the following page replacement policies experiences the same number of page faults as the optimal page replacement policy for this program?

(A) Least-recently-used (B) First-in-first-out

(C) Last-in-first-out (D) Most-recently-used

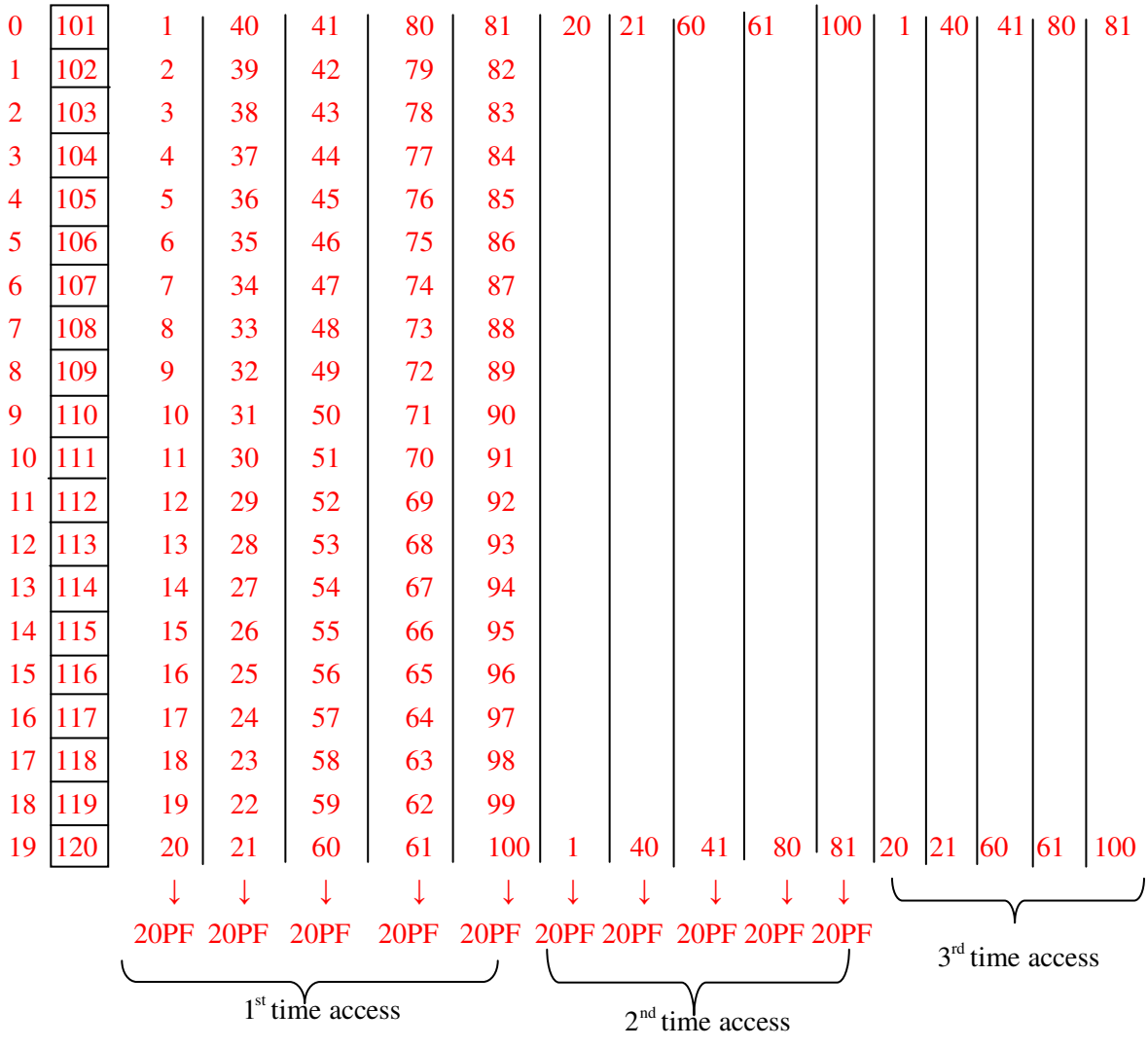
Answer: (D)

Exp: Page reference string for the program will be:-

1, 2, 3, 4, ----------100, 1, 2, 3, 4, ----------100, 1, 2, 3, 4, ----------100,

The current status of 20 frames shows page numbers from 101 to 120.

Implementation of optimal page replacement policy for above given page reference string would be as follows:



So there would be 300 page faults in total (each access 100 page faults).

Also it is visible that every time a replacement is done for the page which is most recently referred as it will be least recently referred in future. So for the given page reference string optimal page replacement policy is working same as most recently used policy and thus number of page faults will be same in both of them.

34. For a C program accessing **X[i] [j] [k]**, the following intermediate code is generated by a compiler. Assume that the size of an **integer** is 32 bits and the size of a **character** is 8 bits.

t0 = i * 1024

t1 = j * 32

t2 = k * 4

t3 = t1 + t0

t4 = t3 + t2

t5 = X[t4]

Which one of the following statements about the source code for the C program is **CORRECT**?

(A) X is declared as “int X[32] [32] [8]”.

(B) X is declared as “int X[4] [1024] [32]”.

(C) X is declared as “char X[4] [32] [8]”.

(D) X is declared as “char X[32] [16] [2]”.

Answer: (A)

Exp: It is given that Size of int is 4B and of char is 1B. The memory is byte addressable.

Let the array be declared as Type X[A][B][C] (where Type = int/char and A,B,C are natural numbers).

From t0 = i*1024, we conclude that B*C*(size of Type) = 1024.

From t1 = j*32, we conclude that C*(size of Type) = 32.

From t2 = k*4, we conclude that size of Type = 4.

⇨ Type = int, and

⇨ C = 8, and

⇨ B = 32.

35. Let < M > be the encoding of a Turing machine as a string over $\Sigma = \{0,1\}$. Let L = {<M> |M is a Turning machine that accepts a string of length 2014}. Then, L is

(A) decidable and recursively enumerable

(B) undecidable but recursively enumerable

(C) undecidable and not recursively enumerable

(D) decidable but not recursively enumerable

Answer: (B)

Exp: The language accepted by the Turing machine is recursively enumerable. If is undecidable as the Turing machine may halt or it may loop for the strings whose length is not equal to 2014.

36. Let $L_1 = w \in \{0,1\}^* | w$ has at least as many occurrences of (110)’s as (011)’s}. Let $L_2 = \{w \in \{0,1\}^* |$ w has at least as many occurrence of (000)’s as (111)’s}. Which one of the following is TRUE?

(A) L_1 is regular but not L_2

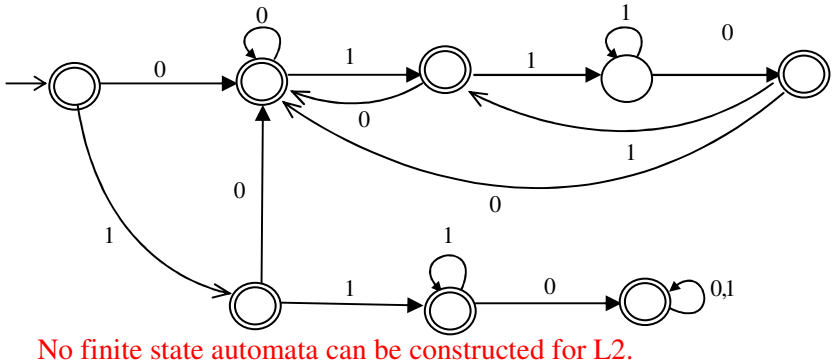
(B) L_2 is regular but not L_1

(C) Both L_1 and L_2 are regular

(D) Neither L_1 nor L_2 are regular

Answer: (A)

Exp: The automaton for L1 is as follows:



No finite state automata can be constructed for L2.

37. Consider two strings A = "q pqrr" and B = "pqprqrp". Let x be the length of the longest common subsequence (not necessarily contiguous) between A and B and let y be the number of such longest common subsequences between A and B. Then $x + 10y$ = ___.

Answer: (34)

Exp: Given is

A = “qpqrr” B = “pqprqrp”

The longest common subsequence (not necessarily contiguous) between A and B is having 4 as the length, so x=4 and such common subsequences are as follows:

(1) qpqr

(2) pqrr

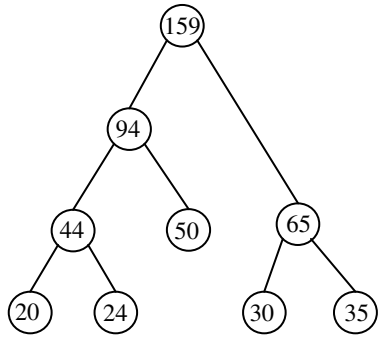
(3) qprr

So y = 3 (the number of longest common subsequences) hence x+10y = 4+10*3 = 34.

38. Suppose P, Q, R, S, T are sorted sequences having lengths 20, 24, 30, 35, 50 respectively. They are to be merged into a single sequence by merging together two sequences at a time. The number of comparisons that will be needed in the worst case by the optimal algorithm for doing this is ____.

Answer: (358)

Exp: The implementation of optimal algorithm for merging sequences is as follows.

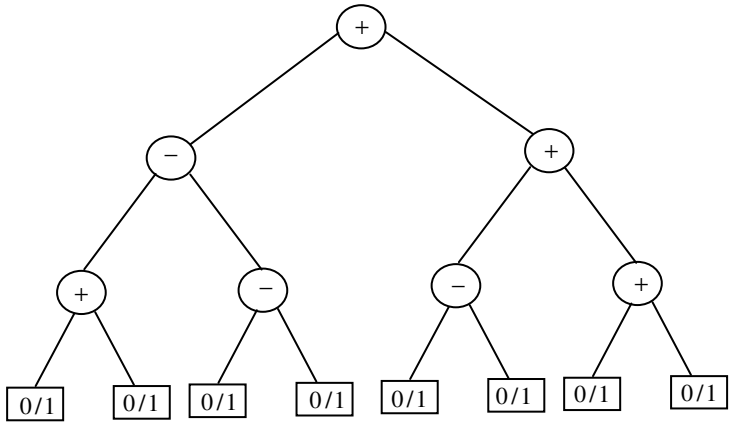


In the above implementation, total number of comparisons is

(44-1)+(94-1)+(65-1)+(159-1) = 358

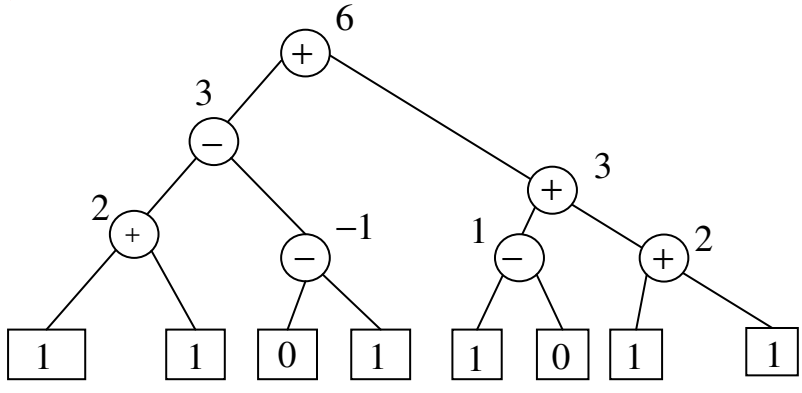
Hint: The number of comparisons for merging two sorted sequences of length m and n is m+n-1.

39. Consider the expression tree shown. Each leaf represents a numerical value, which can either be 0 or 1. Over all possible choices of the values at the leaves, the maximum possible value of the expression represented by the tree is ___.



Answer: (6)

Exp:



So as per the above tree where leaves have been given the values, the maximum possible value of the expression represented by the tree is 6.

40. Consider the following function

```
double  f (double x) {
if ( abs (x*x – 3) <  0. 01) return x;
else return f (x / 2 + 1.5/x);
}
```

Give a value q (to 2 decimals) such that f (q) will return q:_____

Answer: (1.72 to 1.74)

Exp: If condition given in function definition should be 'TRUE', for $f(q)$ to return value q.

The condition is as follows:

$\text{if } (\text{abs}(x \times x - 3) < 0.01) \text{ return } x;$

The above condition will be true when x=1.73.

41. Suppose a stack implementation supports an instruction REVERSE, which reverses the order of elements on the stack, in addition to the PUSH and POP instructions. Which one of the following statements is TRUE with respect to this modified stack?

(A) A queue cannot be implemented using this stack.

(B) A queue can be implemented where ENQUEUE takes a single instruction and DEQUEUE takes a sequence of two instructions.

(C) A queue can be implemented where ENQUEUE takes a sequence of three instructions and DEQUEUE takes a single instruction.

(D) A queue can be implemented where both ENQUEUE and DEQUEUE take a single instruction each.

Answer: (C)

Exp: Option (a) is false because queue can be implemented by using the modified stack as by reversing the stack. LIFO will become FIFO.

Implementation of ENQUEUE & DEQUEUE takes four sequence of instructions as follows:

1. Enqueue: Reverse, Push, Revesre
   Dequeue: POP
   (OR)
2. Enqueue: Push
   Dequeue: Reverse, POP, Reverse

42. Consider the C function given below

```
int f(int j)
{
static int i = 50;
int k;
if (i == j)
  {
printf("something");
k = f(i);
return 0;
}
else return 0;
}
```

Which one of the following is **TRUE**?

(A) The function returns 0 for all values of j.

(B) The function prints the string something for all values of j.

(C) The function returns 0 when j = 50.

(D) The function will exhaust the runtime stack or run into an infinite loop when j = 50.

Answer: (D)

Exp: For any value of 'j' other than 50 the function will return 0, for j=50, then condition (i==j) will be true, it will print "something" and function will be called recursively with same value till the run time stack overflows.

43. In designing a computer's cache system, the cache block (or cache line) size is an important Parameter. Which one of the following statements is correct in this context?

(A) A smaller block size implies better spatial locality

(B) A smaller block size implies a smaller cache tag and hence lower cache tag overhead

(C) A smaller block size implies a larger cache tag and hence lower cache hit time

(D) A smaller block size incurs a lower cache miss penalty

Answer: (D)

Exp: When a cache block size is smaller, it could accommodate more number of blocks, it improves the hit ratio for cache, so the miss penalty for cache will be lowered.

44. If the associativity of a processor cache is doubled while keeping the capacity and block size unchanged, which one of the following is guaranteed to be NOT affected?

(A) Width of tag comparator

(B) Width of set index decoder

(C) Width of way selection multiplexor

(D) Width of processor to main memory data bus

Answer: (D)

Exp: When associativity is doubled, then the set offset will be effected, accordingly, the number of bits used for TAG comparator be effected.

Width of set index decoder also will be effected when set offset is changed.

Width of wag selection multiplexer wil be effected when the block offset is changed.

With of processor to main memory data bus is guaranteed to be NOT effected.

45. The value of a *float* type variable is represented using the single-precision 32-bit floating point format of IEEE-754 standard that uses 1 bit for sign, 8 bits for biased exponent and 23 bits for mantissa. A *float* type variable X is assigned the decimal value of -14.25. The representation of X in hexadecimal notation is

(A) C1640000H (B) 416C0000H (C) 41640000H (D) C16C0000H

Answer: (A)

Exp: (A)

S	E	M
1 bit	8 bits	23 bits

$(14.25)_{10} = (1110.01)_2$

1110.01×2^0

$= 1.11001 \times 2^3$

$S : 1$

$E : (3+127)_{10} = (10000010)_2$

$M : 11001000 - - - - -$

Value stored:

$\underbrace{1\,1\,0\,0\,0\,0\,0}_{[C}\ \underbrace{1}_{1}\ \underbrace{0\,1\,1\,0}_{6}\ \underbrace{0\,1\,0\,0}_{4}\ \underbrace{0\,0}_{0\ 0\ 0\ 0\ ]_H} - - -$

46. In the Newton-Raphson method, an initial guess of $x_0 = 2$ is made and the sequence $x_0, x_1, x_2 \ldots$ is obtained for the function

$$0.75x^3 - 2x^2 - 2x + 4 = 0$$

Consider the statements

(I) $x_3 = 0$.

(II) The method converges to a solution in a finite number of iterations.

Which of the following is TRUE?

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

Answer: (A)

Exp: $f(x) = 0.75\,x^3 - 2x^2 - 2x + 4; f'(x) = 2.25x^2 - 4x - 2$

$x_0 = 2, f_0 = -2; f_0' = -1$

$\therefore x_1 = x_0 - \dfrac{f_0}{f_0'} = 0$

$\Rightarrow f_1 = 4; f_1' = -2$

$\therefore x_2 = x_1 - \dfrac{f_1}{f_1'} = 2$

$\Rightarrow f_2 = -2, f_2' = -1$

$\therefore x_3 = x_2 - \dfrac{f_2}{f_2'} = 0$

Also, root does not lies between 0 and 1.

So, the method diverges if $x_0 = 2$

$\therefore$ only (I) is true.

47. The product of the non-zero eigenvalues of the matrix

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

is_____.

Answer: (6)

Exp: Let $A = \begin{pmatrix} 1 & 0 & 0 & 0 & 1 \\ 0 & 1 & 1 & 1 & 0 \\ 0 & 1 & 1 & 1 & 0 \\ 0 & 1 & 1 & 1 & 0 \\ 1 & 0 & 0 & 0 & 1 \end{pmatrix}$

Let $X = \begin{pmatrix} x_1 \\ x_2 \\ x_3 \\ x_4 \\ x_5 \end{pmatrix}$ be eigen vector

By the definition of eigen vector, $AX = \lambda X$

$$\begin{pmatrix} 1 & 0 & 0 & 0 & 1 \\ 0 & 1 & 1 & 1 & 0 \\ 0 & 1 & 1 & 1 & 0 \\ 0 & 1 & 1 & 1 & 0 \\ 1 & 0 & 0 & 0 & 1 \end{pmatrix} \begin{pmatrix} x_1 \\ x_2 \\ x_3 \\ x_4 \\ x_5 \end{pmatrix} = \lambda \begin{pmatrix} x_1 \\ x_2 \\ x_3 \\ x_4 \\ x_5 \end{pmatrix}$$

$x_1 + x_5 = \lambda x_5$

$x_2 + x_3 + x_4 = \lambda x_2$

$x_2 + x_3 + x_4 = \lambda x_3$

$x_2 + x_3 + x_4 = \lambda x_4$

$x_1 + x_5 = \lambda x_4 \Rightarrow x_1 + x_5 = \lambda x_5 = \lambda x_4$

and $x_2 + x_3 + x_4 = \lambda x_2 = \lambda x_3 = \lambda x_4$

(1) If $\lambda \neq 0$ say $x_1 = x_5 = a$

$x_2 = x_3 = x_4 = b$

$\Rightarrow x_1 + x_5 = \lambda a \Rightarrow 2a = \lambda a \Rightarrow \lambda = 2$

$x_2 + x_3 + x_4 = \lambda a \Rightarrow 3a = \lambda a \Rightarrow \lambda = 3$

(2) if $\lambda = 0 \Rightarrow$ eigen value =0

$\therefore$ Three distinct eigen values are 0,2,3 product of non zero eigen values =2×3=6

48. The probability that a given positive integer lying between 1 and 100 (both inclusive) is NOT divisible by 2, 3 or 5 is _____ .

Answer: (0.259 to 0.261)

Exp: Let A = divisible by 2, B = divisible by 3 and C = divisible by 5, then

$n(A) = 50$, $n(B) = 33$, $n(C) = 20$

$n(A \cap B) = 16$, $n(B \cap C) = 6$, $n(A \cap C) = 10$

$n(A \cap B \cap C) = 3$

$P(A \cup B \cup C) = P(A)+P(B)+P(C) - P(A \cap B)-P(B \cap C)-P(A \cap C)+P(A \cap B \cap C) = 74/100$

$\therefore$ Required probability is $P\left(\overline{A} \cap \overline{B} \cap \overline{C}\right) = 1 - P\left(A \cup B \cup C\right) = 0.26.$

49. The number of distinct positive integral factors of 2014 is _____

Answer: (8)

Exp: 2014 = 2×19×53 i.e., product of prime factors

$\therefore$ Number of distinct positive integral factors of 2014 is (2)×(2)×(2) = 8.

50. Consider the following relation on subsets of the set S of integers between 1 and 2014. For two distinct subsets U and V of S we say U < V if the minimum element in the symmetric difference of the two sets is in U.

Consider the following two statements:

S1: There is a subset of S that is larger than every other subset.
S2: There is a subset of S that is smaller than every other subset.

Which one of the following is CORRECT?

(A) Both S1 and S2 are true
(B) S1 is true and S2 is false
(C) S2 is true and S1 is false
(D) Neither S1 nor S2 is true

Answer: (A)

Exp: From given data S1 is true ,since null set is larger than every other set ,and S2 is true since the universal set {1,2,...,2014} is smaller than every other set.

Both s1 and s2 are true.

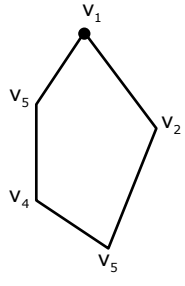
51. A cycle on *n* vertices is isomorphic to its complement. The value of *n* is _____.

Answer: (5)

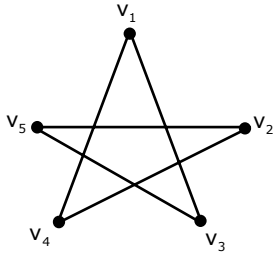
Exp: The number of edges in C_n is n where as the number of edges in C_n' is $n_{c_2} - n$

Cycle graph C_n and its complement C_n' have different number of edges if $n \neq 5$

Consider a cycle on five vertices C_5



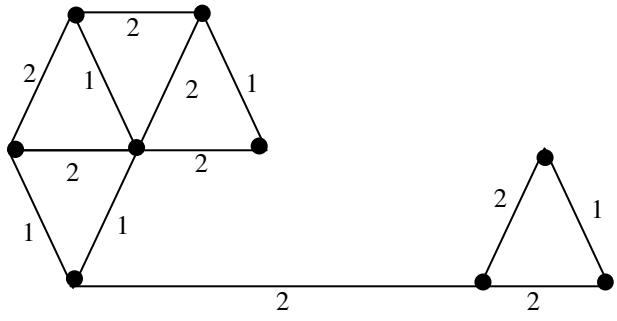
C_5



C_5 and C_5' are isomorphic
$\therefore n = 5$

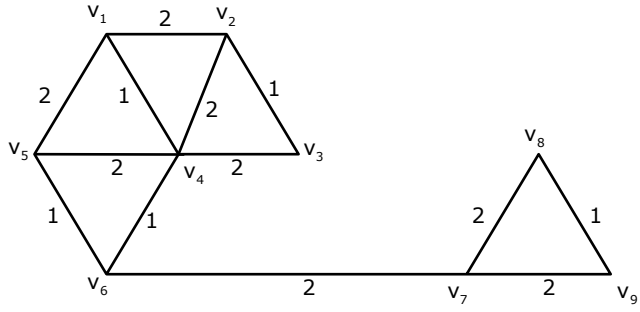
$(\text{complement of } C_5) = C_5'$

52. The number of distinct minimum spanning trees for the weighted graph below is



Answer: (6)

Exp: Consider the connected weighted graph (Application of Kruskal's Algorithm)



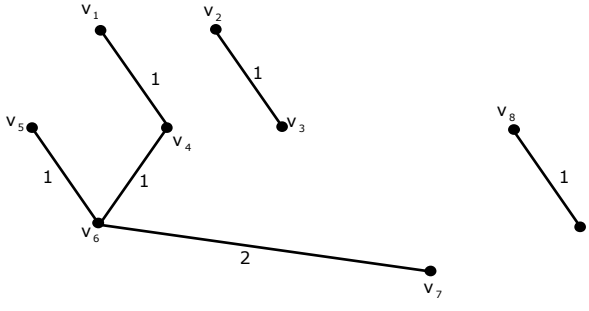
Sort the edges by increasing edges costs (weights)

$[\{v_1, v_4\}, \{v_2, v_3\}, \{v_4, v_6\}, \{v_5, v_6\}, \{v_8, v_9\}(\text{Cost}-1)$

$[\overline{\{v_1, v_2\}, \{v_2, v_4\}, \{v_4, v_3\}}^{3}, \cancel{\{v_4, v_5\}}, \cancel{\{v_1, v_5\}}$

$\cancel{\{v_6, v_7\}}, \underline{\{v_7, v_8\}, \{v_7, v_9\}}_{2}(\text{cost}-2)]$

Selection of edges of cost-1, will not form a cycle, so



Selection of $\{v_4, v_5\}$ and $\{v_1, v_5\}$ forms a cycle, so we will not consider the edges. The edge $\{v_6, v_7\}$ can be choosen because of connectedness.

Selection of $\{v_1, v_2\}$ and $\{v_7, v_8\}$ forms one minimum spanning tree.

Selection of $\{v_1, v_2\}$ and $\{v_7, v_9\}$ forms one minimum spanning tree.

Selection of $\{v_2, v_4\}$ and $\{v_7, v_8\}$ forms one minimum spanning tree.

Selection of $\{v_2, v_4\}$ and $\{v_7, v_9\}$ forms one minimum spanning tree.

$\left.\begin{array}{l}\text{Selection of } \{v_3, v_4\} \text{ and } \{v_7, v_8\} \\ \text{Selection of } \{v_3, v_4\} \text{ and } \{v_7, v_9\}\end{array}\right\}$ forms two minimum spanning trees

$\therefore$ There are 6 distinct minimum spanning trees.

53 Which one of the following Boolean expressions is NOT a tautology?

(A) $((a \to b) \wedge (b \to c)) \to (a \to c)$

(B) $(a \leftrightarrow c) \to (\sim b \to (a \wedge c))$

(C) $(a \wedge b \wedge c) \to (c \wedge a)$

(D) $a \to (b \to a)$

Answer: (B)

Exp: (D) $a \to (b \to a) (\Rightarrow \neg a \vee (b \to a)) (\Rightarrow \neg a \vee (\neg b \vee a)) \Leftrightarrow T(\text{tautology})$

(C) $(a \wedge b \wedge c) \to (c \vee a) \Leftrightarrow \neg(a \wedge b \wedge c) \vee (c \vee a)$

$\Leftrightarrow (\neg a \vee \neg b \vee \neg c) \vee (c \vee a)$

$\Leftrightarrow (\neg a \vee a) \vee P$ (where P is disjunction of literals)

$\Leftrightarrow T \vee P \Rightarrow T$

(a) $\dfrac{\begin{array}{l} a \to b \\ b \to c \end{array}}{\therefore a \to c}$ by hypothetical syllogism

$((a \to b) \wedge (b \to c)) \to (a \to c)$ is a tautology

Answer is B which is not tautology.

54 SQL allows duplicate tuples in relations, and correspondingly defines the multiplicity of tuples in the result of joins. Which one of the following queries always gives the same answer as the nested query shown below:

Select * from R where a in (select S. a from S)

(A) Select R. * from R, S where R. a=S. a

(B) Select distinct R. * from R,S where R. a=S. a

(C) Select R. * from R, (select distinct a from S) as S1 where R. a=S1.a

(D) Select R. * from R, S where R.a = S. a and is unique R

Answer: (C)

Exp: Consider the following instances of R & S

a	b	c
1	2	3
1	2	3
3	4	5
3	4	5

a	d	e

1	2	3
2	3	4
3	4	6
3	4	6

O/P of given nested query is

a b c

1	2	3
1	2	3
3	4	5
3	4	5

(A) O/P:- multiplicity of tuples is disturbed

a b c

1	2	3
1	2	3
3	4	5
3	4	5
3	4	5
3	4	5

(B) O/P:-

a b c

1	2	3
3	4	5

(C) O/P:-

a b c Multiplicity of tuples is maintained

1	2	3
1	2	3
3	4	5
3	4	5

Multiplicity of duplicate tuples will be distributed when there is a match between R.a and S.a and for that match S.a's value is repeated.

55 Consider a main memory system that consists of 8 memory modules attached to the system bus, which is one word wide. When a write request is made, the bus is occupied for 100 nanoseconds (ns) by the data, address, and control signals. During the same 100 ns, and for 500 ns thereafter, the addressed memory module executes one cycle accepting and storing the data. The (internal) operation of different memory modules may overlap in time, but only one request can be on the bus at any time. The maximum number of stores (of one word each) that can be initiated in 1 millisecond is _____

Answer: (10000)

Exp: Each write request, the bus is occupied for 100 n.s

Storing of data requires 100 n.s.

In 100 n.s – 1 store

$$\frac{100}{10^6}\text{ n.s} = 1\text{ store}$$

$$1\text{ m.s} = \frac{10^6}{100}\text{ stores}$$

$$= 10000\text{ stores}$$

GATE- CS 2014

Paper-03

Q. No. 1 – 5 Carry One Mark Each

1. While trying to collect an envelope from under the table, Mr. X fell down and was losing consciousness.

   I II III IV

   Which one of the above underlined parts of the sentence is NOT appropriate?

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

Answer: (D)

2. If she _____ how to calibrate the instrument, she _____ done the experiment.

   (A) knows, will have (B) knew, had

   (C) had known, could have (D) should have known, would have

Answer: (C)

3. Choose the word that is opposite in meaning to the word "coherent".

   (A) sticky (B) well-connected (C) rambling (D) friendly

Answer: (C)

4. Which number does not belong in the series below?

   2, 5, 10, 17, 26, 37, 50, 64

   (A) 17 (B) 37 (C) 64 (D) 26

Answer: (C)

5. The table below has question-wise data on the performance of students in an examination. The marks for each question are also listed. There is no negative or partial marking in the examination.

Q.No	Marks	Answered Correctly	Answered Wrongly	Not Attempted
1	2	21	17	6
2	3	15	27	2
3	2	23	18	3

What is the average of the marks obtained by the class in the examination?

(A) 1.34 (B) 1.74 (C) 3.02 (D) 3.91

Answer: (C)

Exp: Total question

$44 \times 2 = 88$

$44 \times 3 = 132$

$144 = 88$

$132 \quad 308$

Total marks obtained= $(21 \times 2) + (15 \times 3) + (23 \times 2) = 133$

Total Number of students=44

$$\text{Average} = \frac{133}{44} = 3.02$$

Q. No. 6 – 10 Carry One Mark Each

6. A dance programme is scheduled for 10.00 a.m. Some students are participating in the programme and they need to come an hour earlier than the start of the event. These students should be accompanied by a parent. Other students and parents should come in time for the programme. The instruction you think that is appropriate for this is

(A) Students should come at 9.00 a.m. and parents should come at 10.00 a.m.

(B) Participating students should come at 9.00 a.m. accompanied by a parent, and other parents and students should come by 10.00 a.m.

(C) Students who are not participating should come by 10.00 a.m. and they should not bring their parents. Participating students should come at 9.00 a.m.

(D) Participating students should come before 9.00 a.m. Parents who accompany them should come at 9.00 a.m. All others should come at 10.00 a.m.

Answer: (B)

7. By the beginning of the 20th century, several hypotheses were being proposed, suggesting a paradigm shift in our understanding of the universe. However, the clinching evidence was provided by experimental measurements of the position of a star which was directly behind our sun.

Which of the following inference(s) may be drawn from the above passage?

(i) Our understanding of the universe changes based on the positions of stars

(ii) Paradigm shifts usually occur at the beginning of centuries

(iii) Stars are important objects in the universe

(iv) Experimental evidence was important in confirming this paradigm shift

(A) (i), (ii) and (iv) (B) (iii) only (C) (i) and (iv) (D) (iv) only

Answer: (D)

8. The Gross Domestic Product (GDP) in Rupees grew at 7% during 2012-2013. For international comparison, the GDP is compared in US Dollars (USD) after conversion based on the market exchange rate. During the period 2012-2013 the exchange rate for the USD increased from Rs. 50/ USD to Rs. 60/ USD. India's GDP in USD during the period 2012-2013

(A) increased by 5 %
(B) decreased by 13%
(C) decreased by 20%
(D) decreased by 11%

Answer: (D)

Exp: Per 100 Rs final value 107 Rs

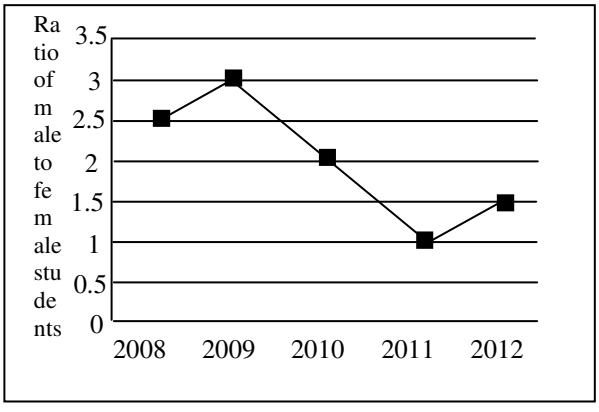
$\Rightarrow$ Per $\frac{100}{50}$ Dollars final value $\frac{107}{60}$

for 100 dollars____?

$= \frac{100 \times 50}{100} \times \frac{107}{60} = 89.16$

Decreased by 11%.

9. he ratio of male to female students in a college for five years is plotted in the following line graph. If the number of female students in 2011 and 2012 is equal, what is the ratio of male students in 2012 to male students in 2011?



(A) 1:1
(B) 2:1
(C) 1.5:1
(D) 2.5:1

Answer: (C)

Exp: Take number of female students in 2011=100

$\therefore$ Number of male in 2011=100

No. of female in 2012=100

No. of male in 2012=150

$\text{Ratio} = \frac{150}{100}$ = 1.5: 1

10. Consider the equation: $(7526)_8 - (Y)_8 = (4364)_8$, where $(X)_N$ stands for X to the base N. Find Y.

(A) 1634
(B) 1737
(C) 3142
(D) 3162

Answer: (C)

Q. No. 1 – 25 Carry One Mark Each

1. Consider the following statements:

P: Good mobile phones are not cheap

Q: Cheap mobile phones are not good

L: P implies Q

M: Q implies P

N: P is equivalent to Q

Which one of the following about L, M, and N is **CORRECT**?

(A) Only L is TRUE. (B) Only M is TRUE.

(C) Only N is TRUE. (D) L, M and N are TRUE.

Answer: (D)

Exp: g : mobile is good c : mobile is cheap

P : Good mobile phones are not cheap $\cong g \to \neg c \cong (\neg g \vee \neg c)$ $[\because a \to b \equiv \neg a \vee b]$

Q : Cheap mobile phones are not good $\cong c \to \neg g \cong (\neg c \vee \neg g)$

$\therefore$ Both P and Q are equivalent which means P and Q imply each other

2. Let X and Y be finite sets and $f : X \to Y$ be a function. Which one of the following statements is TRUE?

(A) For any subsets A and B of X, $|f(A \cup B)| = |f(A)| + |f(B)|$

(B) For any subsets A and B of X, $f(A \cap B) = f(A) \cap f(B)$

(C) For any subsets A and B of X, $|f(A \cap B)| = \min\{|f(A)|, |f(B)|\}$

(D) For any subsets S and T of Y, $f^{-1}(S \cap T) = f^{-1}(S) \cap f^{-1}(T)$

Answer: (D)

Exp: $f : X \to Y$ defined by $f(a) = 1, f(b) = 1, f(c) = 2$ where

$X = \{a, b, c\}$ $Y = \{1, 2\}$

Let $A = \{a, c\}, B = \{b, c\}$ be subsets of X

then $|f(A \cup B)| = 2$; $|f(A)| = 2$; $|f(B)| = 2$

$f(A \cap B) = \{2\}$; $f(A) = \{1, 2\}$; $f(B) = \{1, 2\}$

$f(A) \cap f(B) = \{1, 2\}$

$|f(A \cap B)| = 1$

$\therefore$ Options (A), (B), (C) are not true

Hence, option (D) is true

3. Let G be a group with 15 elements. Let L be a subgroup of G. It is known that $L \neq G$ and that the size of L is at least 4. The size of L is _____.

Answer: (5)

Exp: Order of subgroup divides order of group (Lagrange's theorem).

3, 5 and 15 can be the order of subgroup. As subgroup has atleast 4 elements and it is not equal to the given group, order of subgroup can't be 3 and 15. Hence it is 5.

4. Which one of the following statements is TRUE about every $n \times n$ matrix with only real eigenvalues?

(A) If the trace of the matrix is positive and the determinant of the matrix is negative, at least one of its eigenvalues is negative.

(B) If the trace of the matrix is positive, all its eigenvalues are positive.

(C) If the determinant of the matrix is positive, all its eigenvalues are positive.

(D) If the product of the trace and determinant of the matrix is positive, all its eigenvalues are positive.

Answer: (A)

Exp: If the trace of the matrix is positive and the determinant of the matrix is negative then atleast one of its eigen values is negative.

Since determinant = product of eigen values.

5. If V_1 and V_2 are 4-dimensional subspaces of a 6-dimensional vector space V, then the smallest possible dimension of $V_1 \cap V_2$ is _____.

Answer: (2)

Exp: Let the basis of 6-dimensional vector space be {e1, e2, e3,e4, e5, e6}. In order for $V1 \cap V2$ to have smallest possible dimension V1 and V2 could be, say, {e1, e2, e3,e4} and {e3, e4, e5, e6} respectively. The basis of $V1 \cap V2$ would then be {e3, e4}. => Smallest possible dimension = 2.

6. If $\int_0^{2\pi} |x \sin x|\, dx = k\pi$, then the value of k is equal to _____.

Answer: (4)

Exp: $$\int_0^{2\pi} |x\sin x|\,dx = K\pi \Rightarrow \int_0^{\pi} x\sin x\,dx + \int_{\pi}^{2\pi} -(x\sin x)\,dx = K\pi \quad \left[\because |\sin x| = -\sin x,\ \pi < x < 2\pi\right]$$

$$\Rightarrow x(-\cos x) - 1(-\sin x)\Big|_0^{\pi} - (-x\cos x + \sin x)\Big|_{\pi}^{2\pi} = K\pi$$

$$\Rightarrow (-\pi\cos\pi + \sin\pi) - 0 - \left[(-2\pi\cos 2\pi + \sin 2\pi) - (-\pi\cos\pi + \sin\pi)\right] = K\pi$$

$$\Rightarrow \pi + 0 - \left[-2\pi + 0 - (\pi + 0)\right] = K\pi \Rightarrow 4\pi = K\pi \Rightarrow k = 4$$

7. Consider the following minterm expression for F.

$F(P,Q,R,S) = \sum 0, 2, 5, 7, 8, 10, 13, 15$

The minterms 2, 7, 8 and 13 are 'do not care terms. The minimal sum of-products form for F is

(A) $Q\overline{S} + \overline{Q}S$

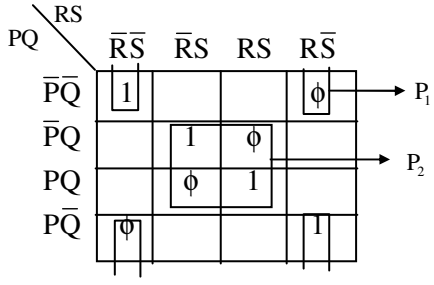
(B) $\overline{Q}\,\overline{S} + QS$

(C) $\overline{Q}\,\overline{R}\,\overline{S} + \overline{Q}\,R\,\overline{S} + Q\overline{R}S + QRS$

(B) $\overline{P}\overline{Q}\overline{S} + \overline{P}QS + PQS + P\overline{Q}\overline{S}$

Answer: (B)

Exp: The K-map for the function F is as follows:-



$P_1 = \overline{Q}\,\overline{S}$ and $P_2 = QS$

$\therefore F(P,Q,R,S) = P_1 + P_2$

$= \overline{Q}\,\overline{S} + QS$

8. Consider the following combinational function block involving four Boolean variables x, y, a, b where x, a, b are inputs and y is the output.

```
f (x, y, a, b)
{
    if (x is 1) y = a;
    else y = b;
}
```

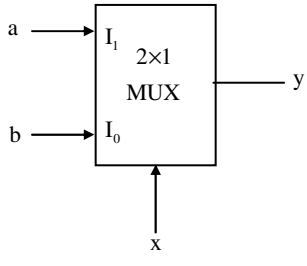
Which one of the following digital logic blocks is the most suitable for implementing this function?

(A) Full adder (B) Priority encoder (C) Multiplexor (D) Flip-flop

Answer: (C)

Exp: $y = \overline{x}b + xa$

'x' is working as selection line, where the two input lines are 'a' and 'b', so the function $F(x,y,a,b)$ can be implemented using (2×1) multiplexer as follows:



9. Consider the following processors (ns stands for nanoseconds). Assume that the pipeline registers have zero latency.

P1: Four-stage pipeline with stage latencies 1 ns, 2 ns, 2 ns, 1 ns.

P2: Four-stage pipeline with stage latencies 1 ns, 1.5 ns, 1.5 ns, 1.5 ns.

P3: Five-stage pipeline with stage latencies 0.5 ns, 1 ns, 1 ns, 0.6 ns, 1 ns.

P4: Five-stage pipeline with stage latencies 0.5 ns, 0.5 ns, 1 ns, 1 ns, 1.1 ns.

Which processor has the highest peak clock frequency?

(A) P1 (B) P2 (C) P3 (D) P4

Answer: (C)

Exp: Clock period (CP) = max stage delay + overhead

So $CP_{P1} = Max(1,2,2,1) = 2ns$

$CP_{P2} = Max(1, 1.5, 1.5, 1.5) = 1.5ns$

$CP_{P3} = Max(0.5, 1, 1, 0.6, 1) = 1ns$

$CP_{P4} = Max(0.5, 0.5, 1, 1, 1.1) = 1.1ns$

As frequency $\alpha \frac{1}{C.P}$, so least clock period will give the highest peak clock frequency.

So, $f_{p3} = \frac{1}{1ns} = 1GHz$

10. Let A be a square matrix size $n \times n$. Consider the following pseudocode. What is the expected output?

```
C = 100;
for i = 1 to n do
for j = 1 to n do
{
  Temp = A[ i ] [ j ] + C ;
  A [ i ] [ j ] = A [ j ] [ i ] ;
  A [ j ] [ i ] = Temp – C ;
}
for i = 1 to n do
 for j = 1 to n do
  output (A[ i ] [ j ]);
```

(A) The matrix A itself

(B) Transpose of the matrix A

(C) Adding 100 to the upper diagonal elements and subtracting 100 from lower diagonal elements of A

(D) None of these

Answer: (A)

Exp: In the computation of given pseudo code for each row and column of Matrix A, each upper triangular element will be interchanged by its mirror image in the lower triangular and after that the same lower triangular element will be again re-interchanged by its mirror image in the upper triangular, resulting the final computed Matrix A same as input Matrix A.

11. The minimum number of arithmetic operations required to evaluate the polynomial $P(X) = X^5 + 4X^3 + 6x + 5$ for a given value of X, using only one temporary variable is _____.

Answer: (7)

Exp: $P(x)=x^5+4x^3+6x+5$ can be re written as follows

$P(x)=x^3(x^2+4)+6x+5$

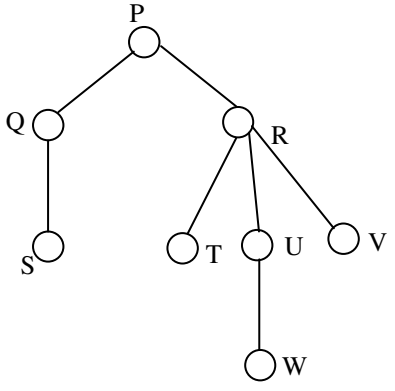
Now using only one temporary variable t and any number of data transfer as well as memory related operation the polynomial can be evaluated as follows

1. $t=x*x$ [Evaluate x^2 and store in memory]
2. $t=t+4$ [Evaluate (x^2+4) and store in memory]
3. $t=x^2$ [Retinue x^2 from memory]
4. $t=t*.X$ [Evaluate x^3 and store in memory]
5. $t=t*(x^2+4)$ [Evaluate $x^3(x^2+4)$ and store in memory]
6. $t=6*x$ [Evaluate 6x and store in memory]
7. $t=t+5$ [Evaluate $(6x+5)$ and store in memory]
8. $t=t+x^3(x^2+4)$ [Retrieve $x^2(x^2+4)$ from memory and evaluate $\{x^3(x^2+4)+6x+5\}$

In the above 8 steps of evaluation, the total number of arithmetic operations required and 7 [4 Multiplications, 3 Additions]

So answer is 7 arithmetic operations.

12. Consider the following rooted tree with the vertex labelled P as the root



The order in which the nodes are visited during an in-order traversal of the tree is

(A) SQPTRWUV (B) SQPTUWRV

(C) SQPTWUVR (D) SQPTRUWV

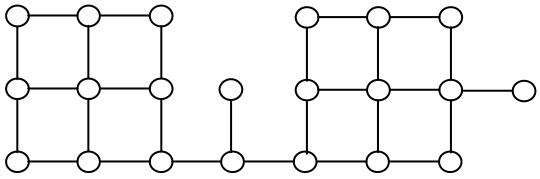
Answer: (A)

Exp: The In order Traversal of Ternary Tree is done as follows:

$\text{Left} \rightarrow \text{Root} \rightarrow \text{Middle} \rightarrow \text{Right}$

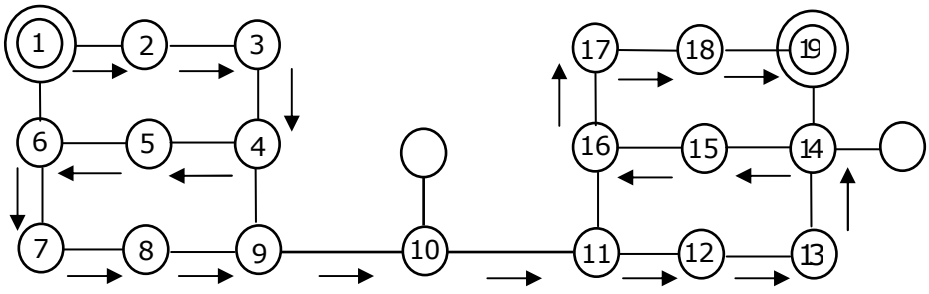
So the nodes are visited in SQPTRWUV order.

13. Suppose depth first search is executed on the graph below starting at some unknown vertex. Assume that a recursive call to visit a vertex is made only after first checking that the vertex has not been visited earlier. Then the maximum possible recursion depth (including the initial call) is _____.



Answer: 19

Exp:



Suppose, we start DFS at vertex numbered as 1 and continue calling recursive function for DFS on subsequent nodes numbered in ascending order.

The recursive calling sequence is shown as marked line in the above diagram which shows maximum possible recursion depth including the initial call is 19.

14. You have an array of n elements. Suppose you implement quick sort by always choosing the central element of the array as the pivot. Then the tightest upper bound for the worst case performance is

$(A)\ 0(n^2)$ $(B)\ 0(n\log n)$ $(C)\ \theta(n\log n)$ $(D)\ 0(n^2)$

Answer: (A)

Exp: The Worst case time complexity of quick sort is O (n^2). This will happen when the elements of the input array are already in order (ascending or descending), irrespective of position of pivot element in array.

15. The length of the shortest string NOT in the language $(\text{over } \Sigma = \{a,b\})$ of the following regular expression is _____. a*b* (ba)* a*

Answer: (3)

Exp: R.E= $a*b*(ba)*a*$

Length 0 is present as it accepts $\in$ all length 1 strings are present (a,b) also aa, ab, ba, bb are present, But 'bab' is not present. So it is 3

16. Let Σ be a finite non-empty alphabet and let 2^{Σ^*} be the power set of Σ^*. Which one of the following is **TRUE**?

(A) Both 2^{Σ^*} and Σ^* are countable

(B) 2^{Σ^*} is countable Σ^* is uncountable

(C) 2^{Σ^*} is uncountable and Σ^* is countable

(D) Both 2^{Σ^*} and Σ^* are uncountable

Answer: (C)

Exp: 2^{ε^*} is the power set of ε^*

ε^* is countabily infinite.

The power set of countabily infinite set is uncountable.

So 2^{ε^*} is uncountable, and ε^* is countable.

17. One of the purposes of using intermediate code in compilers is to

(A) make parsing and semantic analysis simpler.

(B) improve error recovery and error reporting

(C) increase the chances of reusing the machine-independent code optimizer in other compliers.

(D) improve the register allocation.

Answer: (C)

Exp: Intermediate code is machine independent code which makes it easy to retarget the compiler to generate code for newer and different processors.

18. Which of the following statements are CORRECT?

1) Static allocation of all data areas by a compiler makes it impossible to implement recursion.
2) Automatic garbage collection is essential to implement recursion.
3) Dynamic allocation of activation records is essential to implement recursion.
4) Both heap and stack are essential to implement recursion.

(A) 1 and 2 only (B) 2 and 3 only (C) 3 and 4 only (D) 1 and 3 only

Answer: (D)

Exp: To implement recursion, activation record should be implemented by providing dynamic memory allocation. This dynamic allocation is done from runtime stack. Heap is essential to allocate memory for data structures at run-time, not for recursion.

So statement 1 and 3 are correction.

19. In the context of modular software design, which one of the following combinations is desirable?

(A) High cohesion and high coupling (B) High cohesion and low coupling

(C) Low cohesion and high coupling (D) Low cohesion and low coupling

Answer: (B)

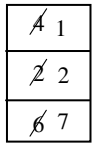
Exp: Cohesion is a measure of internal strength within a module, whereas coupling is a measure of inter dependency among the modules. So in the context of modular software design there should be high cohesion and low coupling.

20. A system uses 3 page frames for storing process pages in main memory. It uses the Least Recently Used (LRU) page replacement policy. Assume that all the page frames are initially empty. What is the total number of page faults that will occur while processing the page reference string given below?

4, 7, 6, 1, 7, 6, 1, 2, 7, 2

Answer: (6)

Exp: Page reference string is
4, 7, 6, 1, 7, 6, 1, 2, 7, 2
Implementing LRU using 3 page frames
Total page faults = 6



21. What is the optimized version of the relation algebra expression $\pi_{A1}(\pi_{A2}(\sigma_{F1}(r)))$,, where A1, A2 are sets of attributes in with $A_1 \subset A_2$ and F1, F2 are Boolean expressions based on the attributes in r?

(A) $\pi_{A_1}(\sigma(F1 \wedge F2)(r))$ (B) $\pi_{A_1}(\sigma(F1 \vee F2)(r))$

(C) $\pi_{A_2}(\sigma(F1 \wedge F2)(r))$ (D) $\pi_{A2}(\sigma(F1 \vee F2)(r))$

Answer: (A)

Exp: π is used to select a subset of attributes and σ_p is used to select subset of tuples matching the predicate P.

$$\Pi_{A_1}\left(\Pi_{A_2}\left(\sigma_{F_1}\left(\sigma_{F_2}(r)\right)\right)\right) = \Pi_{A_1}\left(\Pi_{A_2}\left(\sigma(F_1 \wedge F_2)(r)\right)\right)$$

and as $A_1 \subset A_2$, so final relation will be displaying values for attributes present in set A.

$$\Pi_{A_1}\left(\Pi_{A_2}\left(\sigma(F_1 \wedge F_2)(r)\right)\right) = \Pi_{A_1}\left(\sigma(F_1 \wedge F_2)(r)\right)$$

22. A prime attribute of a relation scheme R is an attribute that appears

(A) in all candidate keys of R. (B) in some candidate key of R.

(C) in a foreign keys of R. (D) only in the primary key of R.

Answer: (B)

Exp: A prime attribute or key attribute of a relation scheme R is an attribute that appears in any of the candidate key of R, remaining attributes are known as non-prime or non-key tribute

23. In the following pairs of OSI protocol layer/sub-layer and its functionality, the **INCORRECT** pair is

(A) Network layer and Routing

(B) Data Link Layer and Bit synchronization

(C) Transport layer and End-to-end process communication

(D) Medium Access Control sub-layer and Channel sharing

Answer: (B)

Exp: (a) One of the main functionality of Network Layer is Routing. So Option (a) is CORRECT.

(b) Bit Synchronization is always handled by Physical Layer of OSI model but not Data Link Layer. So

Option (b) is INCORRECT.

(c) End – to – End Process Communication is handled by Transport Layer. So Option (c) is CORRECT.

(d) MAC sub layer have 3 types of protocols (Random, Controlled and Channelized Access).

24. A bit-stuffing based framing protocol uses an 8-bit delimiter pattern of 01111110. If the output bit-string after stuffing is 01111100101, then the input bit-string is

(A) 0111110100 (B) 0111110101

(C) 0111111101 (D) 0111111111

Answer: (B)

Exp: Given 8 – bit delimiter pattern of 01111110.

Output Bit string after stuffing is 01111100101

⇓

StuffedBit

Now, Input String is 0111110101

25. Host A (on TCP/IP v4 network A) sends an IP datagram D to host B (also on TCP/IP V4 network B). Assume that no error occurred during the transmission of D. When D reaches B, which of the following IP header field(s) may be different from that of the original datagram D?

(i) TTL (ii) Checksum (iii) Fragment Offset

(A) (i) only (B) (i) and (ii) only

(C) (ii) and (iii) only (D) (i), (ii) and (iii)

Answer: (D)

Exp: While an IP Datagram is transferring from one host to another host, TTL, Checksum and Fragmentation Offset will be changed.

Q. No. 26 – 55 Carry Two Marks Each

26. An IP router implementing Classless Inter-domain routing (CIDR) receives a packet with address 131.23.151.76. The router's routing table has the following entries:

Prefix	Output Interface Identifier
131.16.00/12	3
131.28.0.0/14	5
131.19.0.0/16	2
131.22.0.0/15	1

The identifier of the output interface on which this packet will be forwarded is _____.

Answer: (1)

Exp: Given address 131.23.151.76.coming to the first field of given routing table

⇒ 131.16.0.0/12

131.0001 0111.151.76

131.0001 0000.0.0 (∵ given mask bits = 12)

⇒ 131.16.0.0 Matched

Coming to the 2nd field of given Routing table

⇒ 131.28.0.0/14

131.0001 0111.151.76

131.0001 0100.0.0 (∵ given mask bits = 14)

⇒ 131.20.0.0 Not matched.

Coming to the 3rd field of given Routing table

Error! Not a valid link. 131.19.0.0/16

131.0001 0111.151.76

131.0001 0111.0.0 (∵ given mask bits = 16)

⇒ 131.23.0.0 Not matched

Coming to the 4th field of given Routing table

⇒ 131.22.0.0/15

131.0001 0111.151.76

131.0001 0110.0.0 (∵ given mask bits = 15)

⇒ 131.22.0.0 Matched

We are getting 1st and 4th entries are matched so among them we have to picked up the longest mask bit , so output interface identifier is 1.

27. Every host in an IPv4 network has a 1-second resolution real-time clock with battery backup. Each host needs to generate up to 1000 unique identifiers per second. Assume that each host has a globally unique IPv4 address. Design a 50-bit globally unique ID for this purpose. After what period (in seconds) will the identifiers generated by a host wrap around?

Answer: (256)

Exp: Given that each host has a globally unique IPv4 Address and we have to design 50 – bit unique Id. So, 50 – bit in the sense (32 + 18). So, It is clearly showing that IP Address (32 – bit) followed by 18 bits.

1000 unique Ids => 1Sec

2^{18} unique Ids => $2^{18} / 1000 = 2^8 = 256$

28. An IP router with a Maximum Transmission Unit (MTU) of 1500 bytes has received an IP packet of size 4404 bytes with an IP header of length 20 bytes. The values of the relevant fields in the header of the third IP fragment generated by the router for this packet are

(A) MF bit: 0, Datagram Length: 1444; Offset: 370

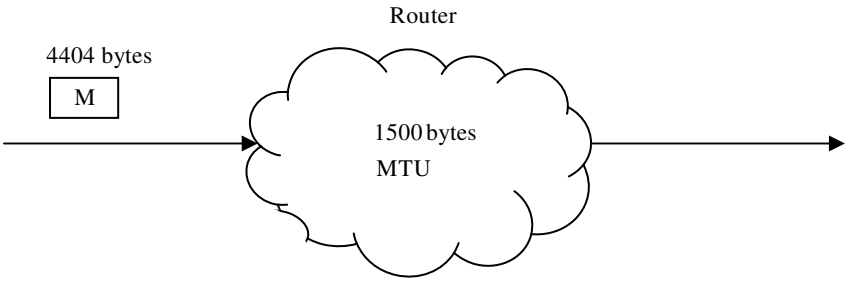
(B) MF bit: 1, Datagram Length: 1424; Offset: 185

(C) MF bit: 1, Datagram Length: 1500; Offset: 370

(D) MF bit: 0, Datagram Length: 1424; Offset: 2960

Answer: (A)

Exp:



DataLength	1480	1480	1444
	+	+	
HeaderLength	20	20	
MF	1	1	0

29. Consider the transactions T1, T2, and T3 and the schedules S1 and S2 given below.

T1 : r1 (X) ; r1 (z) ; w1 (X) ; w1 (z)

T2 : r2 (X) ; r2 (z) ; w2 (z)

T3 : r3 (X) ; r3 (X) ; w3 (Y)

S1: r1(X); r3(Y); r3(X); r2(Y); r2(Z); w3(Y); w2(Z); r1(Z); w1(X); w1(Z)

S2: r1(X); r3(Y); r2(Y); r3(X); r1(Z); r2(Z); w3(Y); w1(X); w2(Z); w1(Z)

Which one of the following statements about the schedules is **TRUE**?

(A) Only S1 is conflict-serializable.

(B) Only S2 is conflict-serializable.

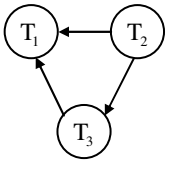
(C) Both S1 and S2 are conflict-serializable.

(D) Neither S1 nor S2 is conflict-serializable.

Ans: (A)

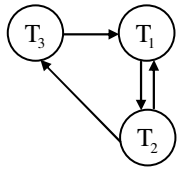
Exp: Precedence graph for S_1 & S_2 are as follows

S_1 :



No cycle

S_2 :



cycle

$\therefore$ Only S_1 is conflict serializable.

30. Consider the relational schema given below, where eId of the relation dependentis a foreign key referring to empId of the relation employee. Assume that every employee has at least one associated dependent in the dependent relation.

employee (empId, empName, empAge)

dependent (depId, eId, depName, depAge)

Consider the following relational algebra query

$$\Pi_{empId}(employee) - \Pi_{empId}(employee \triangleright\triangleleft (empId=eID) \wedge (empAge \leq depAge) dependent)$$

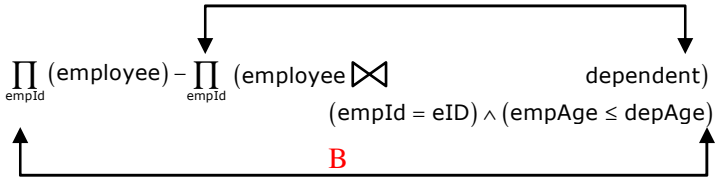
The above query evaluates to the set of empIds of employees whose age is greater than that of

(A) some dependent. (B) all dependents.

(C) some of his/her dependents. (D) all of his/her dependents

Answer: (D)

Exp:



Part A of the above given relational algebra query will give the set of empIds of those employees whose age is less than or equal to the age of some of his/her dependents.

Now when set of empIds of all employees minus set of empIds obtained from part A is done, then we get the set of empIds of employees whose age is greater than that of all of his/her dependents.

31. A system contains three programs and each requires three tape units for its operation. The minimum number of tape units which the system must have such that deadlocks never arise is _____.

Answer: (7)

Exp:

	Maximum	Allocate	Need	Available
P_1	-3	2	1	1
P_2	-3	2	1	
P_3	-3	2	1	

With the above given data, after allocating 2 units of tape to each process, with 1 available unit any of the 3 process can be satisfied in such a way, that No dead lock will be there.

So answer is 7 tape units.

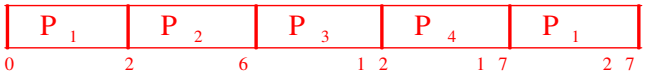
Q.32 An operating system uses *shortest remaining time first* scheduling algorithm for pre-emptive scheduling of processes. Consider the following set of processes with their arrival times and CPU burst times (in milliseconds):

Process	Arrival Time	Burst Time
P1	0	12
P2	2	4
P3	3	6
P4	8	5

The average waiting time (in milliseconds) of the processes is _____.

Answer: (5.5)

Exp: The Gantt chart for SRTF scheduling algorithm is as follows:



Average waiting time = $\frac{15+0+3+4}{4} = \frac{22}{4} = 5.5$

33. Consider a paging hardware with a TLB. Assume that the entire page table and all the pages are in the physical memory. It takes 10 milliseconds to search the TLB and 80 milliseconds to access the physical memory. If the TLB hit ratio is 0.6, the effective memory access time (in milliseconds) is _____.

Answer: (122)

Exp: $T_{ave} = H_1 \times (T_{TLB} + T_M) + (1 - H_1) \times (T_{TLB} + 2 \times T_M)$

T_{TLB} = time to search in TLB = 10ms

T_M=time to access physical memory = 30ms

H_1 = TLB hit ratio = 0.6

$T_{ave} = 0.6 \times (10+80) + (1-0.6)(10+2\times80)$

$T_{ave} = 0.6 \times 90\,ms + 0.4(170)\,ms$

$T_{ave} = 54\,ms + 68\,ms = 122\,ms$

34. Consider the basic block given below.

$a = b + c$

$c = a + d$

$d = b + c$

$e = d - b$

$a = e + b$

The minimum number of nodes and edges present in the DAG representation of the above basic block respectively are

(A) 6 and 6 (B) 8 and 10 (C) 9 and 12 (D) 4 and 4

Answer: (A)

Exp:

The given basic block can be rewritten as

$a = b + c$ $\quad$ $a = b + c$

$c = a + d$ $\quad$ $c = b + c + d$

$d = b + c \Rightarrow$ $\quad$ $d = b + b + c + d = 2b + c + d$

$e = d - b$ $\quad$ $e = \cancel{b} + b + c + d - \cancel{b} = b + c + d$

$a = e + b$ $\quad$ $a = b + b + c + d = 2b + c + d$

From above simplification it is visible that e is same as c and final value of a is same as d. So the final basic block can be written as follows:

$a = b + c$

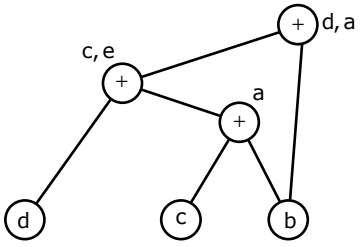
$c = a + d$

$d = 2b + c + d$

$e = c$

$a = d$

The DAG generated for the above basic block in as



Maximum number of modes and edges in above DAG is $(6,6)$

35. Which one of the following problems is undecidable?

(A) Deciding if a given context-free grammar is ambiguous.

(B) Deciding if a given string is generated by a given context-free grammar.

(C) Deciding if the language generated by a given context-free grammar is empty.

(D) Deciding if the language generated by a given context-free grammar is finite.

Answer: (A)

Exp: There were algorithms to find the membership of CFG (using CYK algorithm) and finiteness of CFG (using CNF graph) and emptiness. But there is no algorithm for ambiguity of CFG, so it is undecidable.

36. Consider the following languages over the alphabet $\Sigma = \{0,1,c\}$

$L_1 = \{0^n 1^n \mid n \geq 0\}$

$L_2 = \{wcw^r \mid w \in \{0,1\}^*\}$

$L_3 = \{ww^r \mid w \in \{0,1\}^*\}$

Here w^r is the reverse of the string w. Which of these languages are deterministic Context-free languages?

(A) None of the languages

(B) Only L_1

(C) Only L_1 and L_2

(D) All the three languages

Answer: (C)

Exp: For the languages L_1 and L_2 we can have deterministic push down automata, so they are DCFL's, but for L_3 only non-deterministic PDA possible. So the language L_3 is not a deterministic CFL.

37. Suppose you want to move from 0 to 100 on the number line. In each step, you either move right by a unit distance or you take a shortcut. A shortcut is simply a pre-specified pair of integers i,j with

$i < j$. Given a shortcut i, j if you are at position i on the number line, you may directly move to j. Suppose T(k) denotes the smallest number of steps needed to move from k to 100. suppose further that there is at most 1 shortcut involving any number, and in particular from 9 there is a shortcut to 15. Let y and z be such that T(9) = 1 + min(T(y), T(z)). Then the value of the product yz is_____.

Answer: (150)

Exp: By definition, T(9) = Dist. From 9 to 100

As given, T(9) = 1+min (T(y), T()z) = 1+min (Dist. from y to 100, Dist. From z to 100)

$\Rightarrow$1=Dist. from 9 to y/Dist. From 9 to z

$\Rightarrow$ There are only two such values-one is the simple one step on number line i.e. 10, and the other is the shortcut associated with 9 i.e. 15.

$\Rightarrow$ Therefore, y and z are 10 and 15 (in any order)

$\Rightarrow$ Product yz = 150. Answer

38. Consider the decision problem 2CNFSAT defined as follows:

{ ϕ | ϕ is a satisfiable propositional formula in CNF with at most two literal per clause}

For example, $\phi = (x_1 \vee x_2) \wedge (x_1 \vee \overline{x_3}) \wedge (x_2 \vee x_4)$ is a Boolean formula and it is in 2CNFSAT.

The decision problem 2CNFSAT is

(A) NP-Complete.

(B) solvable in polynomial time by reduction to directed graph reachability.

(C) solvable in constant time since any input instance is satisfiable.

(D) NP-hard, but not NP-complete.

Answer: (B)

Exp: 2 SAT is in P. This we can prove by reducing 2 SAT to directed graph reachability problem which is known to be in P.

Procedure for reducing 2 SAT to reachability problem:

1. Let φ be CNF with clauses of length 2 and let P be the set of propositional variables(literals) in φ
2. Build a graph G=(V,E) with $V = P \cup \{\neg p | p \in P\}$ and $(x, y) \in E$ iff there is a clause in φ that is equivalent to $x \rightarrow y$ (all the clauses are converted to equivalent implications and the graph built is called as implication graph)
3. Observe that φ is unsatisfiable iff there is a $p \in P$ such that there is both a path from p to to $\neg p$ and from $\neg p$ to p in G.

   This condition can be tested by running the reachability algorithm several times.

39. Suppose we have a balanced binary search tree T holding n numbers. We are given two numbers L and H and wish to sum up all the numbers in T that lie between L and H. Suppose there are m such numbers in T. If the tightest upper bound on the time to compute the sum is $O(n^a \log^b n + m^c \log^d n)$, the value of a + 10b + 100c + 1000d is _____.

Answer: (110)

Exp: It takes (log n) time to determine numbers n_1 and n_2 in balanced binary search tree T such that

1. n_1 is the smallest number greater than or equal to L and there is no predecessor n'_1 of n_1 such that n'_1 is equal to n_1.
2. n_2 is the largest number less than or equal to H and there is no successor of n'_2 of n_2 such that is equal to n_2.

Since there are m elements between n_1 and n_2, it takes 'm' time to add all elements between n_1 and n_2.

So time complexity is O (log n + m)

So the given expression becomes O (n^o log' n + m' $\log^o$ n)

And a+ 10b+ 100c+1000d = 0 + 10*1 + 100*1 + 1000*1 = 10 + 100 = 110

Because a = 0, b = 1, c = 1 and d =0

40. Consider a hash table with 100 slots. Collisions are resolved using chaining. Assuming simple uniform hashing, what is the probability that the first 3 slots are unfilled after the first 3 insertions?

(A) $(97 \times 97 \times 97)/100^3$ (B) $(99 \times 98 \times 97)/100^3$

(C) $(97 \times 96 \times 95)/100^3$ (D) $(97 \times 96 \times 95)/(3! \times 100^3)$

Answer: (A)

Exp:**A**

P(First insertion in such a way that first 3 slots are unfilled) $= \frac{97C_1}{100C_1} = \frac{97}{100}$

B

P(second insertion in such a way that first 3 slots are unfilled) $= \frac{97C_1}{100C_1} = \frac{97}{100}$ [$\because$ chaining is used to resolve collision, so second insertion can be done at same index as first index]

C

P(Third insertion in such a way that first 3 slots are unfilled) $= \frac{97C_1}{100C_1} = \frac{97}{100}$ [$\because$ Third insertion can be done at same index as first or second index]

So Total prob. $P(A) \times P(B) \times P(C)$

$$= \frac{97}{100} \times \frac{97}{100} \times \frac{97}{100} = \frac{(97 \times 97 \times 97)}{100^3}$$

41. Consider the pseudocode given below. The function Dosomething () takes as argument a pointer to the root of an arbitrary tree represented by the leftMostChild-rightSibling representation. Each node of the tree is of type treeNode.

```
typedef struct treeNode* treeptr;
Struct treeNode
{
    Treeptr leftMostchild, rightSibiling;
};
Int Dosomething (treeptr tree)
{
    int value =0;
    if (tree ! = NULL)  {
       If  (tree -> leftMostchild = = NULL)
else
    value = Dosomething (tree->leftMostchild);
value = value + Dosometing (tree->rightsibiling);
}
return (value);
}
```

When the pointer to the root of a tree is passed as the argument to **DoSomething**, the value returned by the function corresponds to the

(A) number of internal nodes in the tree.

(B) height of the tree.

(C) number of nodes without a right sibling in the tree.

(D) number of leaf nodes in the tree.

Answer: (D)

Exp: The key to solving such questions is to understand or detect where/by what condition the value (or the counter) is getting incremented each time.

Here, that condition is if (tree→leftMostchild == Null)

⇒ Which means if there is no left most child of the tree (or the sub-tree or the current node- as called in recursion)

⇒ Which means there is no child to that particular node (since if there is no left most child, there is no child at all).

⇒ Which means the node under consideration is a leaf node.

⇒ The function recursively counts, and adds to value, whenever a leaf node is encountered.

⇒ The function returns the number of leaf nodes in the tree.

42. Consider the C function given below. Assume that the array listA contains n (> 0) elements, sored in ascending order.

```
int ProcessArray (int * listA, int x, int n)
```

```
{
 Int  1,   j,   k;
i  =  0;
j = n – 1;
do  {
     k = (i + j) /2;
  if (x < = listA [k])
       j = k – 1;
If (listA [k]  < = x)
     i = k+1;
}while (1  < = j);
If (listA [k]  = = x)
     return (k) ;
else
   return  -1;
}
```

Which one of the following statements about the function **ProcessArray is CORRECT**?

(A) It will run into an infinite loop when x is not in listA.

(B) It is an implementation of binary search

(C) It will always find the maximum element in listA.

(D) It will return – 1 even when x is present in listA.

Answer: (B)

Exp: By the logic of the algorithm it is clear that it is an attempted implementation of Binary Search. So option C is clearly eliminated. Let us now check for options A and D.

A good way to do this is to create small dummy examples (arrays) and implement the algorithm as it is. One may make any array of choice. Running iterations of the algorithm would indicate that the loop exits when the x is not present. So option A is wrong. Also, when x is present, the correct index is indeed returned. D is also wrong. Correct answer is B. It is a correct implementation of Binary Search.

43. An instruction pipeline has five stages, namely, instruction fetch (IF), instruction decode and register fetch (ID/RF), instruction execution (EX), memory access (MEM), and register write back (WB) with stage latencies 1 ns, 2.2 ns, 2 ns, 1 ns, and 0.75 ns, respectively (ns stands for nanoseconds). To gain in terms of frequency, the designers have decided to split the ID/RF stage into three stages (ID, RF1, RF2) each of latency 2.2/3 ns. Also, the EX stage is split into two stages (EX1, EX2) each of latency 1 ns. The new design has a total of eight pipeline stages. A program has 20% branch instructions which execute in the EX stage and produce the next instruction pointer at the end of the EX stage in the old design and at the end of the EX2 stage in the new design. The IF stage stalls after fetching a branch instruction until the next instruction pointer is computed. All instructions other than the branch instruction have an average CPI of one in both the designs. The execution times of this program on the old and the new design are P and Q nanoseconds, respectively. The value of P/Q is _____

Answer: (1.54)

Exp:

	No. of stages	Stall cycle	Stall frequency	Clock period	Avg. access time
Old design	5	2	20%	2.2ns	P
New design	8	5	20%	1 ns	Q

$$P = \left[80\%(1\text{clock}) + 20\%\left(\underset{\text{completion}}{1} + \underset{\text{stall clock}}{2} \right) \right] \times T_{c-p}$$

$$P = (.8 + .6) \times 2.2\,\text{ns} = 3.08\,\text{ns}$$

$$Q = \left[80\%(1\text{clock}) + 20\%\left(\underset{\text{completion}}{1} + \underset{\text{stall clock}}{5} \right) \right] \times T_{c-p}$$

$$P = (.8 + .12) \times 1\,\text{ns} = 2\,\text{ns}$$

$$\text{So the value of } \frac{P}{Q} = \frac{3.08\,\text{ns}}{2\,\text{ns}} = 1.54$$

44. The memory access time is 1 nanosecond for a read operation with a hit in cache, 5 nanoseconds for a read operation with a miss in cache, 2 nanoseconds for a write operation with a hit in cache and 10 nanoseconds for a write operation with a miss in cache. Execution of a sequence of instructions involves 100 instruction fetch operations, 60 memory operand read operations and 40 memory operand write operations. The cache hit-ratio is 0.9. The average memory access time (in nanoseconds) in executing the sequence of instructions is _____.

Answer: (1.68)

Exp: $\text{Total instruction} = \underset{\text{fetch operation}}{100\text{ instruction}} + \underset{\text{operand read + operation}}{60\,\text{memory}} + \underset{\text{operand write op}}{40\,\text{memory}}$

$= 200\text{ instructions (operations)}$

Time taken for fetching 100 instructions (equivalent to read)

$= 90 * 1\,\text{ns} + 10 * 5\,\text{ns} = 140\,\text{ns}$

$$\text{Memory operand Read operations} = 90\%(60) * 1\,\text{ns} + 10\%(60) \times 5\,\text{ns}$$

$$= 54\,\text{ns} + 30\,\text{ns} = 84\,\text{ms}$$

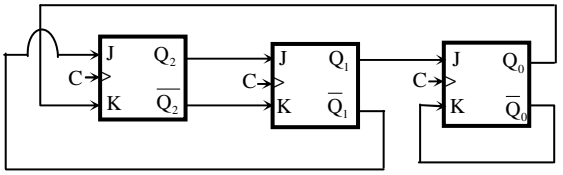
$$\text{Memory operands write operation time} = 90\%(40) * 2\,\text{ns} + 10\%(40) * 10\,\text{ns}$$

$$= 72\,\text{ns} + 40\,\text{ns} = 112\,\text{ns}$$

$$\text{Total time taken for executing 200 instructions} = 140 + 84 + 112 = 336\,\text{ns}$$

$$\therefore \text{Average memory access time} = \frac{336\text{ ns}}{200} = 1.68\,\text{ns}$$

45.



The above synchronous sequential circuit built using JK flip-flops is initialized with $Q_2Q_1Q_0 = 000$. The state sequence for this circuit for the next 3 clock cycles is

(A) 001, 010, 011 (B) 111, 110, 101

(C) 100, 110, 111 (D) 100, 011, 001

Answer: (C)

Exp:

P.S.			FFinputs						N.S.		
Q_2	Q_1	Q_0	J_2	K_2	J_1	K_1	J_0	K_0	Q_2^+	Q_1^+	Q_0^+
			$(\overline{Q}_1)$	(Q_0)	(Q_2)	$(\overline{Q}_2)$	(Q_1)	$(\overline{Q}_0)$			
0	0	0	1	0	0	1	0	1	1	0	0
1	0	0	1	0	1	0	0	1	1	1	0
1	1	0	0	0	1	0	1	1	1	1	1

46. With respect to the numerical evaluation of the definite integral, $K = \int_a^b x^2 dx$, where a and b are given, which of the following statements is/are TRUE?

(I) The value of K obtained using the trapezoidal rule is always greater than or equal to the exact value of the definite integral.

(II) The value of K obtained using the Simpson's rule is always equal to the exact value of the definite integral.

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

Answer: (C)

Exp: $\int_a^b x^2\,dx$

let $a = 0,\ b = 1$

let $n = 4$

$\Rightarrow h = \frac{b-a}{n} = \frac{1-0}{4} = 0.25$

x	0	0.25	0.5	0.75	1
$y = x^2$	0	0.625	0.25	0.5625	1
	y_0	y_1	y_2	y_3	y_4

I. By Trapezoidal rule

$$\int_0^1 x^2\,dx = \frac{h}{2}\left[(y_0+y_4)+2(y_1+y_2+y_3)\right]$$

$$= \frac{0.25}{2}\left[(0+1)+2(0.0625+0.25+0.5625)\right] = 0.34375$$

II. By Simpson's $\frac{1}{3}$ rule

$$\int_0^1 x^2 dx = \frac{h}{3}\left[(y_0+y_4)+2(y_2)+4(y_1+y_3)\right]$$

$$= \frac{0.25}{3}\left[(0+1)+2(0.25)+4(0.0625+0.5625)\right] = \frac{1}{3}$$

Exact value $\int_0^1 x^2\,dx = \frac{x^3}{3}\Big|_0^1 = \frac{1}{3}$

47. The value of the integral given below is

$$\int_0^{\pi} x^2 \cos x\,dx$$

(A) -2π (B) π (C) $-\pi$ (D) 2π

Answer: (A)

Exp: $\int_0^{\pi} x^2\cos x\,dx = x^2(\sin x) - 2x(-\cos x) + 2(-\sin x)\Big|_0^{\pi}$

$$= \left(\pi^2\sin\pi + 2\pi\cos\pi - 2\sin\pi\right) - (0+0+0) = -2\pi$$

48. Let S be a sample space and two mutually exclusive events A and B be such that $A \cup B = S$. If $P(.)$ denotes the probability of the event, the maximum value of P(A)P(B) is _____

Answer: (0.25)

Exp: Given

$A \cup B = S$

$\Rightarrow P(A \cup B) = P(S) = 1$

$\Rightarrow P(A)+P(B)=1$ ($\because$ A & B are mutually exclusive)

$\Rightarrow P(B)=1-P(A)$

Maximum value of $P(A)P(B) = ?$

Maximum value of P (A) [1- P (A)] =?

Let $P(A) = X$

Let $f(x) = x(1-x) = x - x^2$

for $f(x)$ maximum $\Rightarrow f'(x)=0 \Rightarrow 1-2x=0 \Rightarrow x=\frac{1}{2}$

$f''(x)=-2;\quad f''\left(\frac{1}{2}\right)<0$

$\therefore f(x)$ has maximum

At $x=\frac{1}{2}$ and maximum value

$=f\left(\frac{1}{2}\right)=\frac{1}{2}\left(1-\frac{1}{2}\right)=\frac{1}{2}.\frac{1}{2}=\frac{1}{4}=0.25$

49. Consider the set of all functions $f:\{0,1,...,2014\}\rightarrow\{0,1...,2014\}$ such that $f(f(i))=i$, for $0\le i\le 2014$. Consider the following statements.

P. For each such function it must be the case that for every i, f(i) = i,

Q. For each such function it must be the case that for some i,f(i) = i,

R. Each such function must be onto.

Which one of the following is CORRECT?

(A) P, Q and R are true (B) Only Q and R are true

(C) Only P and Q are true (D) Only R is true

Answer: (B)

Exp: Let us consider a function (counter example) as

$f(0)=1, f(1)=0, f(2)=3, f(3)=2, ..., f(2012)=2013,$

$f(2013)=2012$ and $f(2014)=2014$

Clearly $f(f(i))=i$ for $0\le i\le 2014$

Here $f(i)\neq i$ for every i and $f(i)=i$ for some i

Also f is onto

Hence, only Q and R are true

50. There are two elements x,y in a group (G,*) such that every element in the group can be written as a product of some number of x's and y's in some order. It is known that

$$x*x=y*y=x*y*x*y=y*x*y*x=e$$

where e is the identity element. The maximum number of elements in such a group is _____.

Answer: (4)

Exp: $x\times x=e \quad \Rightarrow x$ is its own inverse

$y \times y = e \quad \Rightarrow y$ is its own inverse

$(x \times y) \times (x \times y) = e \Rightarrow (x \times y)$ is its own inverse

$(y \times x) \times (y \times x) = e \Rightarrow (y \times x)$ is its own inverse

also $x \times x \times e = e \times e$ can be rewritten as follows

$x \times y \times y \times x = e \times y \times y \times e = e [\because y \times y = e]$

$(x \times y) \times (y \times x) = e$ shows that $(x \times y)$ and $(y \times x)$

Are each other's inverse and we already know that

$(x \times y)$ and $(y \times x)$ are inverse of its own.

As per $(G, *)$ to be group any element should have

only one inverse element (unique)

This process $x \times y = y \times x$ (is one element)

So the elements of such group are 4 which are $\{x, y, e, x \times y\}$

51. If G is a forest with *n* vertices and *k* connected components, how many edges does *G* have?

(A) $\lceil n/k \rceil$ (B) $\lceil n/k \rceil$ (C) $n - k$ (D) $n - k + 1$

Answer: (C)

Exp: Let $n_1, n_2, ...n_k$ be the number of vertices respectively in K connected components of a forest G, then $n_1 - 1, n_2 - 1, ..., n_k - 1$ be the number of edges respectively in K connected components and $n_1 + n_2 + ... + n_k = n$ (number of vertices in G)

Hence, number of edges in G = number of edges in K connected components

$= (n_1 - 1) + (n_2 - 1) + ... + (n_k - 1) = n - k$

52. Let δ denote the minimum degree of a vertex in a graph. For all planar graphs on n vertices with $\delta \geq 3$, which one of the following is **TRUE**?

(A) In any planar embedding, the number of faces is at least $\frac{n}{2} + 2$

(B) In any planar embedding, the number of faces is less than $\frac{n}{2} + 2$

(C) There is a planar embedding in which the number of faces is less than $\frac{n}{2} + 2$

(D) There is a planar embedding in which the number of faces is at most $\frac{n}{\delta + 1}$

Answer: (A)

Exp: We know that $v+r=e+2 \Rightarrow e=n+r-2 \quad ...(1)$

Where $V=n(\text{number of vertices}); r=\text{number of faces and}$

$e=\text{number of edges}$

Given, $\delta \geq 3$ then $3n \leq 2e$

$\Rightarrow e \geq \frac{3n}{2}$

$\Rightarrow n+r-2 \geq \frac{3n}{2}(\text{using}(1))$

$\Rightarrow r \geq \frac{3n}{2}-n+2 \Rightarrow r \geq \frac{n}{2}+2$

$\therefore$ Number of faces is atleast $\frac{n}{2}+2$

53. The CORECT formula for the sentence, "not all rainy days are cold" is

(A) $\forall d\left(\text{Rainy}(d) \wedge \sim \text{Cold}(d)\right)$ (B) $\forall d\left(\sim \text{Rainy}(d) \rightarrow \text{Cold}(d)\right)$

(C) $\exists d\left(\sim \text{Rainy}(d) \rightarrow \text{Cold}(d)\right)$ (D) $\exists d\left(\text{Rainy}(d) \wedge \sim \text{Cold}(d)\right)$

Answer: (D)

Exp: Given statement is $\sim \forall d\left[r(d) \rightarrow c(d)\right]$

$\equiv \sim \forall d\left[\sim r(d) \vee c(d)\right]$

$\equiv \exists d\left[r(d) \wedge \sim c(d)\right]$

(Since $p \rightarrow q \equiv \sim p \vee q$ and let r(d) be rainy day, c(d) be cold day)

54. Consider the following relational schema:

Employee (<u>empId</u>, empName, empDept)

Customer (<u>custId</u>, custName, salesRepId, rating)

SalesRepId is a foreign key referring to empId of the employee relation. Assume that each employee makes a sale to at least one customer. What does the following query return?

```
SELECT empName
FROM employee E
WHERE NOT EXISTS (SELECT custId
                  FROM customer C
                  WHERE C. salesRepId = E. empId
                  AND C. rating < > 'GOOD')
```

(A) Names of all the employees with at least one of their customers having a 'GOOD' rating.

(B) Names of all the employees with at most one of their customers having a 'GOOD' rating.

(C) Names of all the employees with none of their customers having a 'GOOD' rating.

(D) Names of all the employees with all their customers having a 'GOOD' rating.

Answer: (D)

Exp: The outer query will return the value (names of employees) for a tuple in relation E, only if inner query for that tuple will return no tuple (usage of NOT EXISTS).

The inner query will run for every tuple of outer query. It selects cust-id for an employee e, if rating of customer is NOT good. Such an employee should not be selected in the output of outer query.

So the query will return the names of all those employees whose all customers have GOOD rating.

55. Let $\oplus$ denote the Exclusive OR (XOR) operation. Let '1' and '0' denote the binary constants. Consider the following Boolean expression for F over two variables P and Q.

$$F(P,Q) = \big((1 \oplus P) \oplus (P \oplus Q)\big) \oplus \big((P \oplus Q) \oplus (Q \oplus 0)\big)$$

The equivalent expression for F is

(A) $P + Q$ (B) $\overline{P + Q}$ (C) $P \oplus Q$ (D) $\overline{P \oplus Q}$

Answer: (D)

Exp:

$$F(P,Q) = \big((1 \oplus P) \oplus (P \oplus Q)\big) \oplus \big((P \oplus Q) \oplus (Q \oplus 0)\big)$$

$$= \big(\bar{P} \oplus (P\bar{Q} + \bar{P}Q)\big) \oplus \big((P\bar{Q} + \bar{P}Q) \oplus Q\big)$$

$$= \big[\bar{P}(PQ + \bar{P}\bar{Q}) + P(P\bar{Q} + \bar{P}Q)\big] \oplus \big[(PQ + \bar{P}\bar{Q})Q + (P\bar{Q} + \bar{P}Q)\bar{Q}\big]$$

$$= (\bar{P}\bar{Q} + P\bar{Q}) \oplus (PQ + P\bar{Q}) \qquad = \bar{Q} \oplus P \qquad = PQ + \bar{P}\bar{Q} = \overline{P \oplus Q}$$

GATE- CS 2013

Paper

Q. No. 1 – 25 Carry One Mark Each

1. Consider an undirected random graph of eight vertices. The probability that there is an edge between a pair of vertices is ½. What is the expected number of unordered cycles of length three?

(A) 1/8 (B) 1 (C) 7 (D) 8

Answer:-(C)

Exp:- $P(\text{edge}) = \frac{1}{2}$

Number of ways we can choose the vertices out of 8 is 8_{c_3}

(Three edges in each cycle)

Expected number of unordered cycles of length $3 = 8_{C_3} \times \left(\frac{1}{2}\right)^3 = 7$

2. Which of the following statements is/are **TRUE** for undirected graphs?

P: Number of odd degree vertices is even.

Q: Sum of degrees of all vertices is even.

(A) P only (B) Q only

(C) Both P and Q (D) Neither P nor Q

Answer:- (C)

Exp:- Q: Sum of degrees of all vertices $= 2 \times (\text{number of edges})$

3. Function f is known at the following points:

x	0	0.3	0.6	0.9	1.2	1.5	1.8	2.1	2.4	2.7	3.0
f(x)	0	0.09	0.36	0.81	1.44	2.25	3.24	4.41	5.76	7.29	9.00

The value of $\int_0^3 f(x)dx$ computed using the trapezoidal rule is

(A) 8.983 (B) 9.003 (C) 9.017 (D) 9.045

Answer:- (D)

Exp:- $\int_0^3 f(x)dx = \frac{h}{2}\left[f(x_0) + f(x_{10}) + 2\left(f(x_1) + f(x_2) + \ldots + f(x_9)\right)\right]$

$= \frac{0.3}{2}\left[9.00 + 2(25.65)\right] = 9.045$

4. Which one of the following functions is continuous at x = 3 ?

(A) $f(x)=\begin{cases} 2, \text{ if } x=3 \\ x-1, \text{ if } x>3 \\ \dfrac{x+3}{3}, \text{ if } x<3 \end{cases}$

(B) $f(x)=\begin{cases} 4, & \text{if } x=3 \\ 8-x & \text{if } x\neq 3 \end{cases}$

(C) $f(x)=\begin{cases} x+3, & \text{if } x\leq 3 \\ x-4 & \text{if } x>3 \end{cases}$

(D) $f(x)=\dfrac{1}{x^3-27}, \quad \text{if } x\neq 3$

Answer:-(A)

Exp:- $\lim\limits_{x\to 3+} f(x)=\lim\limits_{x\to 3+}(x-1)=2=f(3)$

$\lim\limits_{x\to 3-} f(x)=\lim\limits_{x\to 3-}\left(\dfrac{x+3}{3}\right)=2=f(3)$

$\therefore f(x)$ is continuous at $x=3$

5. Which one of the following expressions does **NOT** represent exclusive NOR of x and y?

(A) $xy+x'y'$ (B) $x\oplus y'$ (C) $x'\oplus y$ (D) $x'\oplus y'$

Answer: -(D)

Exp:- (A) $x\odot y=xy+\bar{x}\,\bar{y}$

(B) $x\oplus y=x\bar{y}+\bar{x}\,\bar{y}=xy+\bar{x}\bar{y}=x\odot y$

(C) $\bar{x}\oplus y=(\bar{x})\bar{y}+\bar{x}\,y=\bar{x}\bar{y}+xy=x\odot y$

(D) $\bar{x}\oplus\bar{y}=(\bar{x})y+x\bar{y}=x\oplus y$

6. In a k-way set associative cache, the cache is divided into v sets, each of which consists of k lines. The lines of a set are placed in sequence one after another. The lines in set s are sequenced before the lines in set (s+1). The main memory blocks are numbered 0 onwards. The main memory block numbered j must be mapped to any one of the cache lines from

(A) $(j \bmod v)*k$ to $(j \bmod v)*k+(k-1)$

(B) $(j \bmod v)$ to $(j \bmod v)+(k-1)$

(C) $(j \bmod k)$ to $(j \bmod k)+(v-1)$

(D) $(j \bmod k)*v$ to $(j \bmod k)*v+(v-1)$

Answer: -(A)

Exp:- Position of main memory block in the cache (set) = (main memory block number) MOD (number of sets in the cache).

As the lines in the set are placed in sequence, we can have the lines from 0 to (K – 1) in each set.

Number of sets = v, main memory block number = j

First line of cache = (j mod v)*k; last line of cache = (j mod v)*k + (k – 1)

7. What is the time complexity of Bellman-Ford single-source shortest path algorithm on a complete graph of n vertices?

(A) $\Theta(n^2)$ (B) $\Theta(n^2 \log n)$ (C) $\Theta(n^3)$ (D) $\Theta(n^3 \log n)$

Answer:-(C)

Exp:- Bellman-ford time complexity: $\Theta(|V| \times |E|)$

For complete graph: $|E| = \frac{n(n-1)}{2}$

$|V| = n$

$\therefore \Theta\left(n \times \frac{n(n-1)}{2}\right) = \Theta(n^3)$

8. Which of the following statements are **TRUE**?

(1) The problem of determining whether there exists a cycle in an undirected graph is in P.

(2) The problem of determining whether there exists a cycle in an undirected graph is in NP.

(3) If a problem A is NP-Complete, there exists a non-deterministic polynomial time algorithm to solve A.

(A) 1,2 and 3 (B) 1 and 2 only (C) 2 and 3 only (D) 1 and 3 only

Answer: -(A)

Exp:- 1. Cycle detection using DFS: $O(V+E) = O(V^2)$ and it is polynomial problem

2. Every P-problem is NP $(\text{since } P \subset NP)$

3. $NP - \text{complete} \in NP$

Hence, NP-complete can be solved in non-deterministic polynomial time

9. Which of the following statements is/are **FALSE**?

(1) For every non-deterministic Turing machine, there exists an equivalent deterministic Turing machine.

(2) Turing recognizable languages are closed under union and complementation.

(3) Turing decidable languages are closed under intersection and complementation

(4) Turing recognizable languages are closed under union and intersection.

(A) 1 and 4 only (B) 1 and 3 only (C) 2 only (D) 3 only

Answer: -(C)

Exp:- (1) NTM $\cong$ DTM

(2) RELs are closed under union & but not complementation

(3) Turing decidable languages are recursive and recursive languages are closed under intersection and complementation

(4) RELs are closed under union & intersection but not under complementation

10. Three concurrent processes X, Y, and Z execute three different code segments that access and update certain shared variables. Process X executes the P operation (i.e., wait) on semaphores a, b and c; process Y executes the P operation on semaphores b, c and d; process Z executes the P operation on semaphores c, d, and a before entering the respective code segments. After completing the execution of its code segment, each process invokes the V operation (i.e., signal) on its three semaphores. All semaphores are binary semaphores initialized to one. Which one of the following represents a deadlock-free order of invoking the P operations by the processes?

(A) X:P(a)P(b)P(c) Y:P(b)P(c)P(d) Z:P(c)P(d)P(a)

(B) X:P(b)P(a)P(c) Y:P(b)P(c)P(d) Z:P(a)P(c)P(d)

(C) X:P(b)P(a)P(c) Y:P(c)P(b)P(d) Z:P(a)P(c)P(d)

(D) X:P(a)P(b)P(c) Y:P(c)P(b)P(d) Z:P(c)P(d)P(a)

Answer:-(B)

Exp:- Suppose X performs P(b) and preempts, Y gets chance, but cannot do its first wait i.e., P(b), so waits for X, now Z gets the chance and performs P(a) and preempts, next X gets chance. X cannot continue as wait on 'a' is done by Z already, so X waits for Z. At this time Z can continue its operations as down on c and d. Once Z finishes, X can do its operations and so Y. In any of execution order of X, Y, Z one process can continue and finish, such that waiting is not circular. In options (A),(C) and (D) we can easily find circular wait, thus deadlock

11. An index is clustered, if

(A) it is on a set of fields that form a candidate key

(B) it is on a set of fields that include the primary key

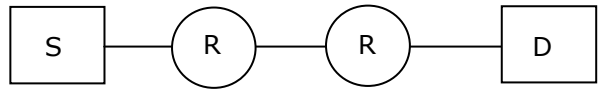
(C) the data records of the file are organized in the same order as the data entries of the index

(D) the data records of the file are organized not in the same order as the data entries of the index

Answer:-(C)

Exp:- Clustered index is built on ordering non key field and hence if the index is clustered then the data records of the file are organized in the same order as the data entries of the index.

12. Assume that source S and destination D are connected through two intermediate routers labeled R. Determine how many times each packet has to visit the network layer and the data link layer during a transmission from S to D.



(A) Network layer – 4 times and Data link layer-4 times

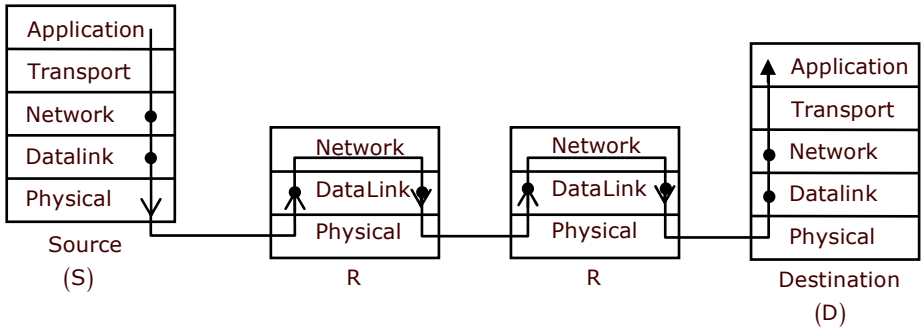
(B) Network layer – 4 times and Data link layer-3 times

(C) Network layer – 4 times and Data link layer-6 times

(D) Network layer – 2 times and Data link layer-6 times

Answer:-(C)

Exp:-



From above given diagram, its early visible that packet will visit network layer 4 times, once at each node [S, R, R, D] and packet will visit Data Link layer 6 times. One time at S and one time at D, then two times for each intermediate router R as data link layer is used for link to link communication.

Once at packet reaches R and goes up from physical –DL-Network and second time when packet coming out of router in order Network – DL- Physical

13. The transport layer protocols used for real time multimedia, file transfer, DNS and email, respectively are

(A) TCP, UDP, UDP and TCP
(B) UDP, TCP, TCP and UDP
(C) UDP, TCP, UDP and TCP
(D) TCP, UDP, TCP and UDP

Answer:- (C)

Exp:- Real time multimedia needs connectionless service, so under lying transport layer protocol used is UDP

File transfer rums over TCP protocol with port no-21

DNS runs over UDP protocol within port no-53

Email needs SMTP protocol which runs over TCP protocol within port no – 25

14. Using public key cryptography, X adds a digital signature σ to message M, encrypts <M, σ>, and sends it to Y, where it is decrypted. Which one of the following sequences of keys is used for the operations?

(A) Encryption: X's private key followed by Y's private key; Decryption: X's public key followed by Y's public key

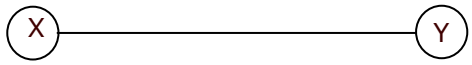
(B) Encryption: X's private key followed by Y's public key; Decryption: X's public key followed by Y's private key

(C) Encryption: X's public key followed by Y's private key; Decryption: Y's public key followed by X's private key

(D) Encryption: X's private key followed by Y's public key; Decryption: Y's private key followed by X's public key

Answer:-(D)

Exp:-



X – public
X – private

Y – public
Y – private

Encryption
- Source has to encrypt with its private key for forming Digital signature for Authentication.
- source has to encrypt the $\langle M, \sigma \rangle$ with Y's public key to send it confidentially

Decryption
- Destination Y has to decrypt first with its private key, then decrypt using source public key

15. Match the problem domains in **Group I** with the solution technologies in **Group II**.

Group I	Group II
(p) Services oriented computing	(1) Interoperability
(q) Heterogeneous communicating systems	(2) BPMN
(R) Information representation	(3) Publish-find bind
(S) Process description	(4) XML

(A) P – 1, Q – 2, R – 3, S – 4
(B) P – 3, Q – 4, R – 2, S – 1
(C) P – 3, Q – 1, R – 4, S – 2
(D) P – 4, Q – 3, R – 2, S – 1

Answer:-(C)

16. A scheduling algorithm assigns priority proportional to the waiting time of a process. Every process starts with priority zero(the lowest priority). The scheduler re-evaluates the process priorities every T time units and decides the next process to schedule. Which one of the following is TRUE if the processes have no I/O operations and all arrive at time zero?

(A) This algorithm is equivalent to the first-come-first-serve algorithm
(B) This algorithm is equivalent to the round-robin algorithm
(C) This algorithm is equivalent to the shortest-job-first algorithm
(D) This algorithm is equivalent to the shortest-remaining-time-first algorithm

Answer:-(B)

Exp:- The given scheduling definition takes two parameters, one is dynamically assigned process priority and the other is 'T' time unit to re-evaluate the process priorities.

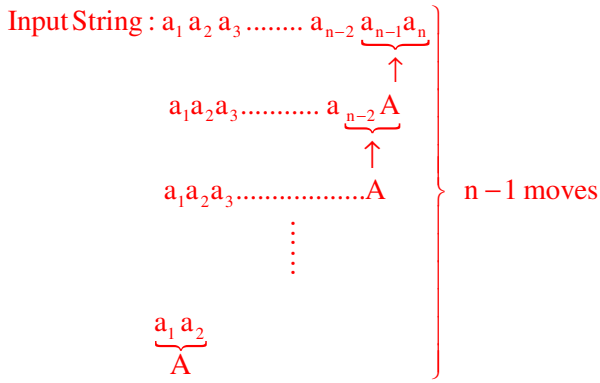
This dynamically assigned priority will be deciding processes order in ready queue of round robin algorithm whose time quantum is same as 'T' time units. As all the processes are arriving at the same time, they will be given same priority but soon after first 'T' time burst remaining processes will get higher priorities

17. What is the maximum number of reduce moves that can be taken by a bottom-up parser for a grammar with no epsilon- and unit-production $(\text{i.e., of type } A \to \in \text{ and } A \to a)$ to parse a string with n tokens?

(A) n/2 (B) n-1 (C) 2n-1 (D) 2^n

Answer: -(B)

Exp:- To have maximum number of reduce moves, all the productions will be of the $\text{type } A \to \alpha\beta$ (where α and β could be terminals or non-terminals). Consider the following illustration then:



18. Consider the languages $L_1 = \Phi$ and $L_2 = \{a\}$. Which one of the following represents $L_1 L_2^* \cup L_1^*$?

(A) $\{\in\}$ (B) Φ (C) a * (D) $\{\varepsilon, a\}$

Answer: -(A)

Exp:- Concatenation of empty language with any language will give the empty language and $L_1^* = \Phi^* = \in$. Hence $L_1 L_2^* \cup L_1^* = \{\in\}$

19. Which one of the following is the tightest upper bound that represents the time complexity of inserting an object into a binary search tree of n nodes?

(A) O(1) (B) O(log n) (C) O(n) (D) O(n log n)

Answer:-(C)

Exp:- For skewed binary search tree on n nodes, the tightest upper bound to insert a node is O(n)

20. Which one of the following is the tightest upper bound that represents the number of swaps required to sort n numbers using selection sort?

(A) O(log n) (B) O(n) (C) O(n log n) (D) $O(n^2)$

Answer:-(B)

Exp:- The maximum number of swaps that takes place in selection sort on n numbers is n

21. In the following truth table, V = 1 if and only if the input is valid.

	Inputs			Outputs		
D_0	D_1	D_2	D_3	X_0	X_1	V
0	0	0	0	X	X	0
1	0	0	0	0	0	1
X	1	0	0	0	1	1
X	X	1	0	1	0	1
X	X	X	1	1	1	1

What function does the truth table represent?

(A) Priority encoder (B) Decoder

(C) Multiplexer (D) Demultiplexer

Answer: -(A)

Exp:- 4 to 2 priority encoder.

22. The smallest integer than can be represented by an 8-bit number in 2's complement form is

(A) -256 (B) -128 (C) -127 (D) 0

Answer: -(B)

Exp:- $-2^{8-1} = -128$. Range is $-2^{(n-1)}$ to $+2^{(n-1)}-1$

23. Which one of the following does **NOT** equal $\begin{vmatrix} 1 & x & x^2 \\ 1 & y & y^2 \\ 1 & z & z^2 \end{vmatrix}$?

(A) $\begin{vmatrix} 1 & x(x+1) & x+1 \\ 1 & y(y+1) & y+1 \\ 1 & z(z+1) & z+1 \end{vmatrix}$ (B) $\begin{vmatrix} 1 & x+1 & x^2+1 \\ 1 & y+1 & y^2+1 \\ 1 & z+1 & z^2+1 \end{vmatrix}$

(C) $\begin{vmatrix} 0 & x-y & x^2-y^2 \\ 0 & y-z & y^2-z^2 \\ 1 & z & z^2 \end{vmatrix}$ (D) $\begin{vmatrix} 2 & x+y & x^2+y^2 \\ 2 & y+z & y^2+z^2 \\ 1 & z & z^2 \end{vmatrix}$

Answer:- (A)

Exp:- If matrix B is obtained from matrix A by replacing the l^{th} row by itself plus k times the m^{th} row, for $l \neq m$ then det(B)=det(A). With this property given matrix is equal to the matrices given in options (B),(C) and (D).

24. Suppose p is number of cars per minute passing through a certain road junction between 5 PM and 6PM, and p has a Poisson distribution with mean 3. What is the probability of observing fewer than 3 cars during any given minute in this interval?

(A) $8/(2e^3)$ (B) $9/(2e^3)$ (C) $17/(2e^3)$ (D) $26/(2e^3)$

Answer:-(C)

Exp:- $P(p<3)=P(p=0)+P(p=1)+P(p=2)$

$$=\frac{e^{-\lambda}\lambda^{0}}{0!}+\frac{e^{-\lambda}\lambda^{1}}{1!}+\frac{e^{-\lambda}\lambda^{2}}{2!}\ (\text{where } \lambda=3)$$

$$=e^{-3}+e^{-3}\times 3+\frac{e^{-3}\times 9}{2}$$

$$=e^{-3}\left(1+3+\frac{9}{2}\right)=\frac{17}{2e^{3}}$$

25. A binary operation $\oplus$ on a set of integers is defined as $x\oplus y=x^2+y^2$. Which one of the following statements is **TRUE** about $\oplus$?

(A) Commutative but not associative (B) Both commutative and associative

(C) Associative but not commutative (D) Neither commutative nor associative

Answer:- (A)

Exp:- $x\oplus y=x^2+y^2=y^2+x^2=y\oplus x$

$\therefore$ commutative

Not associative, since, for example

$(1\oplus 2)\oplus 3\neq 1\oplus(2\oplus 3)$

Q. No. 26 – 51 Carry Two Marks Each

26. Which one of the following is **NOT** logically equivalent to $\neg\exists x(\forall y(\alpha)\wedge\forall z(\beta))$?

(A) $\forall x(\exists z(\neg\beta)\rightarrow\forall y(\alpha))$ (B) $\forall x(\forall z(\beta)\rightarrow\exists y(\neg\alpha))$

(C) $\forall x(\forall y(\alpha)\rightarrow\exists z(\neg\beta))$ (D) $\forall x(\exists y(\neg\alpha)\rightarrow\exists z(\neg\beta))$

Answer: -(A) and (D) [marks to all]

Exp:- $\neg\exists x(\forall y(\alpha)\wedge\forall z(\beta))$

$\equiv\forall x\left[\forall y(\alpha)\rightarrow\exists z(\neg\beta)\right]$ option "C" $\left[\because\neg(p\wedge q)\equiv p\Rightarrow\neg q\right]$

$\equiv\forall x\left[\forall z(\beta)\rightarrow\exists y(\neg\alpha)\right]$ option "B" $\left[\because p\Rightarrow q\equiv\neg q\Rightarrow\neg p\right]$

27. A RAM chip has a capacity of 1024 words of 8 bits each $(1K\times 8)$. The number of 2×4 decoders with enable line needed to construct a $16K\times 16$ RAM from $1K\times 8$ RAM is

(A) 4 (B) 5 (C) 6 (D) 7

Answer: -(B)

Exp:- RAM chip size = $1k \times 8$[1024 words of 8 bits each]

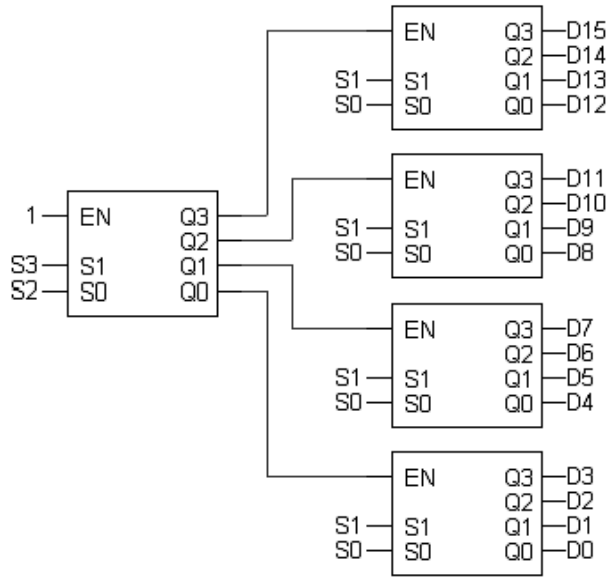
RAM to construct $=16k \times 16$

Number of chips required = $\frac{16k \times 16}{1k \times 8} = 16 \times 2$ [16 chips vertically with each having 2 chips horizontally]

So to select one chip out of 16 vertical chips, we need 4 x 16 decoder.

Available decoder is – 2 x 4 decoder

To be constructed is 4 x 16 decoder



So we need 5, 2 x 4 decoder in total to construct 4 x 16 decoder.

28. Consider an instruction pipeline with five stages without any branch prediction: Fetch Instruction (FI), Decode Instruction (DI), Fetch Operand (FO), Execute Instruction (EI) and Write Operand (WO). The stage delays for FI, DI, FO, EI and WO are 5 ns, 7 ns, 10 ns, 8 ns and 6 ns, respectively. There are intermediate storage buffers after each stage and the delay of each buffer is 1 ns. A program consisting of 12 instructions $I_1, I_2, I_3, ...I_{12}$ is executed in this pipelined processor. Instruction I_4 is the only branch instruction and its branch target is I_9. If the branch is taken during the execution of this program, the time (in ns) needed to complete the program is

(A) 132 (B) 165 (C) 176 (D) 328

Answer: - (B)

Exp:- Clock period=Maximum stage delay+ overhead (Buffer) =10+1=11 ns

Assume FI-1, DI-2, FO-3, EI-4, WO-5

I_1 :	1	2	3	4	5										
I_2 :	–	1	2	3	4	5									
I_3 :	–	–	1	2	3	4	5								
I_4 :	–	–	–	1	2	3	4	5							
I_5 :	–	–	–	–	1	2	3	4	5						
I_6 :	–	–	–	–	–	1	2	3	4	5					
I_7 :	–	–	–	–	–	–	1	2	3	4	5				
I_8 :	–	–	–	–	–	–	–	1	2	3	4	5			
I_9 :	–	–	–	–	–	–	–	–	1	2	3	4	5		
I_{10} :	–	–	–	–	–	–	–	–	–	1	2	3	4	5	
I_{11}	–	–	–	–	–	–	–	–	–	–	1	2	3	4	5
I_{12}	–	–	–	–	–	–	–	–	–	–	–	1	2	3	4	5

So number of clocks required to complete the program is = 15 clocks and time taken is = 15 ×11 ns=165 ns.

29. Consider the following operation along with Enqueue and Dequeue operations on queues, where k is a global parameter

```
MultiDequeue(Q) {
    m = k
    while (Q is not empty) and (m > 0) {
        Dequeue (Q)
        m = m – 1
    }
}
```

What is the worst case time complexity of a sequence of n queue operations on an initially empty queue?

(A) $\Theta(n)$ (B) $\Theta(n+k)$ (C) $\Theta(nk)$ (D) $\Theta(n^2)$

Answer:- (A)

Exp:- Initially the queue is empty and we have to perform n operations.

i) One option is to perform all Enqueue operations i.e. n Enqueue operations. Complexity will be θ(n)

or

ii) We can perform a mix of Enqueue and Dequeue operations. It can be Enqueue for first n/2 times and then Dequeue for next n/2, or Enqueue and Dequeue alternately, or any permutation of Enqueues and Dequeues totaling 'n' times. Complexity will be θ(n)

or

iii) We can perform Enqueues and MultiDequeues. A general pattern could be as follows:

Enqueue Enqueue … (ktimes) MultiDequeue Enqueue Enqueue … (ktimes) MultiDequeue … Up to total n

---- k items enqueued -----k items deleted----k items enqueued----k items deleted -- and so on.

The number of times this k-Enqueues, MutiDequeue cycle is performed = $n/k+1$

So, Complexity will be k times Enqueue + 1 MultiDequeue) $\times$ $n/k+1$

Which is $\theta\left(2k \times n/k+1\right) = \theta(n)$

or

iv) We can just perform n MultiDequeues (or n Dequeues for that matter):

Each time the while condition is false (empty queue), condition is checked just once for each of the 'n' operations. So θ(n).

30. The preorder traversal sequence of a binary search tree is 30, 20, 10, 15, 25, 23, 39, 35, 42. Which one of the following is the postorder traversal sequence of the same tree?

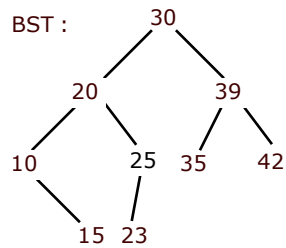
(A) 10,20,15,23,25,35,42,39,30 (B) 15,10,25,23,20,42,35,39,30

(C) 15,20,10,23,25,42,35,39,30 (D) 15,10,23,25,20,35,42,39,30

Answer:-(D)

Exp:- Preorder : 30,20,10,15,25,23,39,35,42

Inorder : 10,15,20,23,25,30,35,39,42



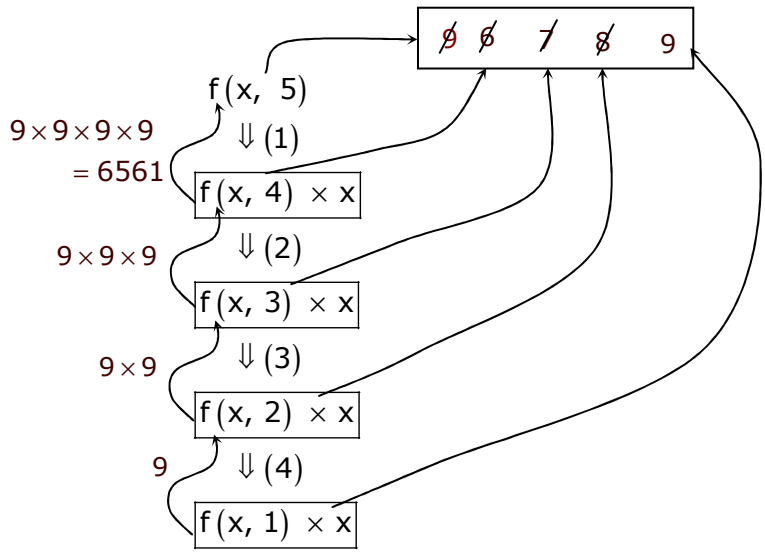
31. What is the return value of $f(p,p)$ if the value of p is initialized to 5 before the call? Note that the first parameter is passed by reference, whereas the second parameter is passed by value.

```
int f (int & x, int c) {
  c = c - 1;
  if (c == 0) return 1;
  x = x + 1;
  return f (x,c) * x;
}
```

(A) 3024 (B) 6561 (C) 55440 (D) 161051

Answer:-(B)

Exp:-



32. Which of the following is/are undecidable?

1. G is a CFG. Is $L(G) = \Phi$?
2. G is a CFG. IS $L(G) = \Sigma^*$?
3. M is a Turning machine. Is L(M) regular?
4. A is a DFA and N is a NFA. Is $L(A) = L(N)$?

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

Answer: -(D)

Exp:- There is an algorithm to check whether the given CFG is empty, finite or infinite and also to convert NFA to DFA hence 1 and 4 are decidable

33. Consider the following two sets of LR(1) items of an LR(1) grammar

$X \to c.X, c/d$ $X \to c.X, \$$
$X \to .cX, c/d$ $X \to .cX, \$$
$X \to .d, c/d$ $X \to .d, \$$

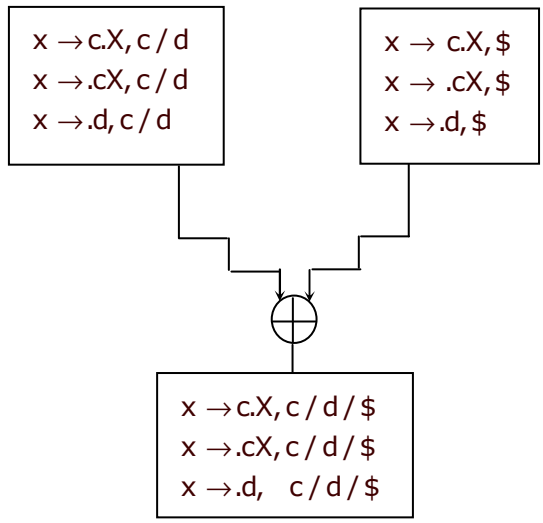
Which of the following statements related to merging of the two sets in the corresponding LALR parser is/are **FALSE**?

1. Cannot be merged since look aheads are different
2. Can be merged but will result in S–R conflict
3. Can be merged but will result in R–R conflict
4. Cannot be merged since goto on c will lead to two different sets

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

Answer:-(D)

Exp:-



1. Merging of two states depends on core part (production rule with dot operator), not on look aheads.
2. The two states are not containing Reduce item ,So after merging, the merged state can not contain any S-R conflict
3. As there is no Reduce item in any of the state, so can't have R-R conflict.
4. Merging of stats does not depend on further goto on any terminal.

So all statements are false.

34. A certain computation generates two arrays a and b such that $a[i] = f(i)$ for $0 \le i < n$ and $b[i] = g(a[i])$ for $0 \le i < n$. Suppose this computation is decomposed into two concurrent processes X and Y such that X computes the array a and Y computes the array b. The processes employ two binary semaphores R and S, both initialized to zero. The array a is shared by the two processes. The structures of the processes are shown below.

```
Process X;                    Process Y;
private i;                    private i;
for(i = 0; i < n; i++) {        for(i = 0; i < n; i++) {
    a[i] = f(i);                  EntryY(R, S);
    ExitX(R, S);                  b[i] = g(a[i]);
}                             }
```

Which one of the following represents the **CORRECT** implementations of ExitX and EntryY?

(A)
```
ExitX(R, S) {
    P(R);
    V(S);
}
EntryY(R, S) {
    P(S);
    V(R);
}
```

(B)
```
ExitX(R, S) {
    V(R);
    V(S);
}
EntryY(R, S) {
    P(R);
    P(S);
}
```

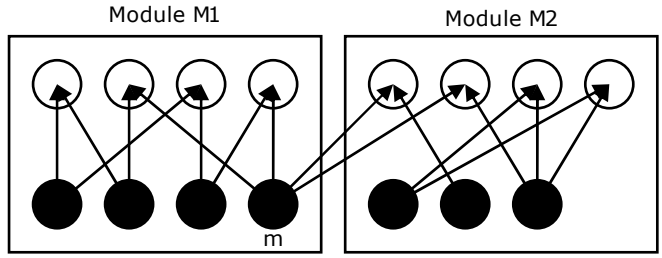
(C)
```
ExitX(R, S) {
    P(S);
    V(R);
}
EntryY(R, S) {
    V(S);
    P(R);
}
```

(D)
```
ExitX(R, S) {
    V(R);
    P(S);
}
EntryY(R, S) {
    V(S);
    P(R);
}
```

Answer:-(C)

Exp:- For computing both the array a[] and b[], first element a[i] should be computed using which b[i] can be computed. So process X and Y should run in strict alteration manner, starting with X. This requirement meets with implementation of ExitX and EntryY given in option C.

35. The following figure represents access graphs of two modules M1 and M2. The filled circles represent methods and the unfilled circles represent attributes. IF method m is moved to module M2 keeping the attributes where they are, what can we say about the average cohesion and coupling between modules in the system of two modules?



(A) There is no change

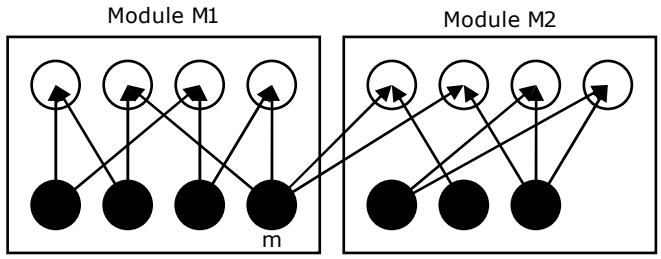
(B) Average cohesion goes up but coupling is reduced

(C) Average cohesion goes down and coupling also reduces

(D) Average cohesion and coupling increase

Answer:-(A)

Exp:-

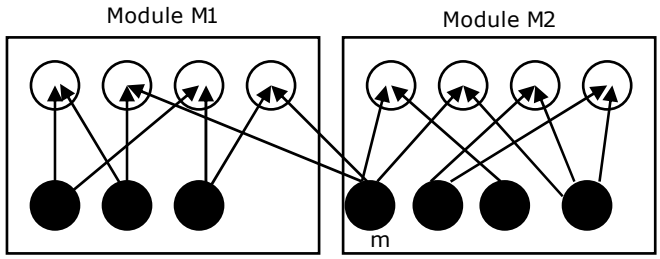


$$\text{Coupling} = \frac{\text{number of external links}}{\text{number of modules}} = \frac{2}{2}$$

$$\text{Cohesion of a module} = \frac{\text{number of internal links}}{\text{number of methods}}$$

$$\text{Cohesion of } M_1 = \frac{8}{4}; \quad \text{Cohesion of } M_2 = \frac{6}{3}; \quad \text{Average cohesion}=2$$

After moving method m to M2, graph will become



Coupling $= \frac{2}{2}$

Cohesion of $M_1 = \frac{6}{3}$; Cohesion of $M_2 = \frac{8}{4}$; Average cohesion=2

$\therefore$ answer is no change

36. In an IPv4 datagram, the M bit is 0, the value of HLEN is 10, the value of total length is 400 and the fragment offset value is 300. The position of the datagram, the sequence numbers of the first and the last bytes of the payload, respectively are

(A) Last fragment, 2400 and 2789 (B) First fragment, 2400 and 2759

(C) Last fragment, 2400 and 2759 (D) Middle fragment, 300 and 689

Answer:-(C)

Exp:- M= 0 – Means there is no fragment after this, i.e. Last fragment

HLEN=10 - So header length is 4×10=40, as 4 is constant scale factor

Total Length = 400(40 Byte Header + 360 Byte Payload)

Fragment Offset = 300, that means 300×8 Byte = 2400 bytes are before this last fragment

So the position of datagram is last fragment

Sequence number of First Byte of Payload = 2400 (as 0 to 2399 Sequence no are used)

Sequence number of Last Byte of Payload = 2400+360-1=2759

37. Determine the maximum length of cable (in km) for transmitting data at a rate of 500 Mbps in an Ethernet LAN with frames of size 10,000 bits. Assume the signal speed in the cable to be 2,00,000 km/s

(A) 1 (B) 2 (C) 2.5 (D) 5

Answer:-(B)

Exp:- 500×10^6 bits $------$ 1 sec

$\therefore 10^4$ bits $------ \frac{5\times10^8}{10^4} = \frac{10^4}{5\times10^8}\text{ sec} = \frac{1}{5\times10^4}\text{ sec}$

1 sec $------ 2\times10^5$ km

$\therefore \frac{1}{5\times10^4}\text{ sec} ----- \frac{2\times10^5}{5\times10^4} = 4\text{ km}$

$\therefore$ Maximum length of cable $= \frac{4}{2} = 2$ km

38. Consider the following relational schema.

Students(rollno: integer, sname: string)

Courses(courseno: integer, cname: string)

Registration(rollno: integer, courseno; integer, percent: real)

Which of the following queries are equivalent to this query in English?

"Find the distinct names of all students who score more than 90% in the course numbered 107"

(I) SELECT DISTINCT S.sname
FROM Students as S, Registration as R
WHERE R.rollno=S.rollno AND R.Courseno=107 AND R.percent>90

(II) $\Pi_{sname}\left(\sigma_{courseno=107} \wedge percent > 90(Registration \quad Students)\right)$

(III) $\{T \mid \exists S \in Students, \exists R \in Registration\ (S.rollno = R.rollno \wedge$
$R.courseno = 107 \wedge R.percent > 90 \wedge T.sname = S.name)\}$

(IV) $\left\{< S_N > \mid \exists S_R \exists R_P\left(< S_R, S_N > \in Students \wedge < S_R, 107, R_P > \in Registration \wedge R_P > 90\right)\right\}$

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

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

Answer:- (A)

Exp:- Four queries given in SQL, RA, TRC and DRC in four statements respectively retrieve the required information.

39. A shared variable x, initialized to zero, is operated on by four concurrent processes W, X, Y, Z as follows. Each of the processes W and X reads x from memory, increments by one, stores it to memory, and then terminates. Each of the processes Y and Z reads x from memory, decrements by two, stores it to memory, and then terminates. Each process before reading x invokes the P operation (i.e., wait) on a counting semaphore S and invokes the V operation (i.e., signal) on the semaphore S after storing x to memory. Semaphore S is initialized to two. What is the maximum possible value of x after all processes complete execution?

(A) –2 (B) –1 (C) 1 (D) 2

Answer:-(D)

Exp:-

	W	X	Y	Z
1	R(x)	R(x)	R(x)	R(x)
2	x++	x++	x=x-2;	x=x-2;
3	w(x)	w(x)	w(x)	w(x)

R(x) is to read x from memory, w(x) is to store x in memory

(I) $w_1\left(x\boxed{0}\right)$ [W is Preempted]

(II) $Y_1, Y_2, Y_3\left(x\boxed{-2}\right)$ [Y is completed]

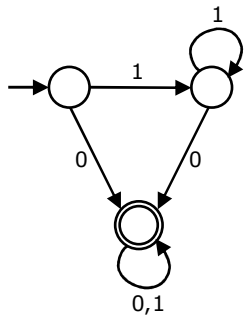
(III) Z_1, Z_2, Z_3 $(x \boxed{-4})$ [Z is completed]

(IV) W_2, W_3 $(x \boxed{1})$ [It increments local copy of x and stores & W is completed]

(V) X_1, X_2, X_3 $(x \boxed{2})$ [X is completed]

Maximum value of x = 2

40. Consider the DFA given below.



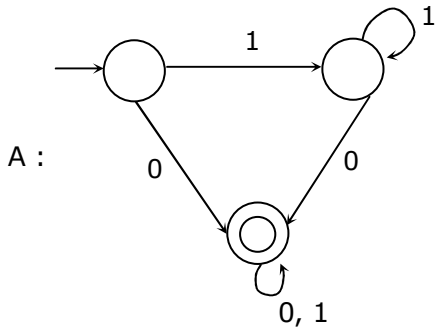
Which of the following are FALSE?

1. Complement of L(A) is context–free
2. $L(A) = L((11*0+0)(0+1)*0*1*)$
3. For the language accepted by A, A is the minimal DFA
4. A accepts all strings over {0, 1} of length at least 2

(A) 1 and 3 only (B) 2 and 4 only (C) 2 and 3 only (D) 3 and 4 only

Answer: - (D)

Exp:-



(1) L(A) is regular, its complement is also regular and if it is regular it is also context free.

(2) $L(A) = (11*0+0)(0+1)*0*1* = 1*0(0+1)*$

Language has all strings where each string contains '0'.

(3) A is not minimal, it can be constructed with 2 states

(4) Language has all strings, where each string contains '0'. (atleast length one)

41. Consider the following languages

$L_1 = \{0^p 1^q 0^r \mid p,q,r \geq 0\}$

$L_2 = \{0^p 1^q 0^r \mid p,q,r \geq 0,\ p \neq r\}$

Which one of the following statements is FALSE?

(A) L_2 is context–free

(B) $L_1 \cap L_2$ is context–free

(C) Complement of L_2 is recursive

(D) Complement of L_1 is context–free but not regular

Answer: -(D)

Exp:- $L_1 = \{0^P 1^q 0^r \mid p,q,r \geq 0\}$ is regular

$L_2 = \{0^P 1^q 0^r \mid p,q,r \geq 0,\ p \neq r\}$ is CFL

(A) L_2 is CFL (True)

(B) $L_1 \cap L_2$ = CFL (True)

(C) L_2 complement is recursive (True)

(D) L_1 complement is CFL but not regular (False) as L_1 is regular $\overline{L_1}$ is regular

42. Consider the following function

```
int unknown(int n){
        int i, j, k = 0;
        for (i = n / 2; i <= n; i++)
            for (j = 2; j <= n; j = j * 2)
            k = k + n / 2;
        return (k);
}
```

The return value of the function is

(A) $\Theta(n^2)$ (B) $\Theta(n^2 \log n)$ (C) $\Theta(n^3)$ (D) $\Theta(n^3 \log n)$

Answer:- (B)

Exp:- $i = \left(\frac{n}{2}, \frac{n}{2}+1, \frac{n}{2}+2, -----n\right)$

Repeats $\frac{n}{2}$ to $n = \left(\frac{n}{2}+1\right)$ times $\left\{\begin{array}{l} J = (2, 2^2, 2^3, 2^4, -----n) \\ k = k + \frac{n}{2} \end{array}\right\} k = \Theta(n \log n)$

$k = \frac{n}{2} + \frac{n}{2} + ----\log n \text{ times} = \frac{n}{2} \log n$

$$= \frac{n}{2}\log n + \frac{n}{2}\log n + \frac{n}{2}\log n - - - - \left(\frac{n}{2}+1\right) \text{times}$$

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

$$= \Theta\left(n^2 \log n\right)$$

43. The number of elements that can be sorted in $\Theta(\log n)$ time using heap sort is

(A) $\Theta(1)$ (B) $\Theta\left(\sqrt{\log}\ n\right)$ (C) $\Theta\left(\frac{\log n}{\log \log n}\right)$ (D) $\Theta(\log n)$

Answer:-(A)

Exp:- After constructing a max-heap in the heap sort , the time to extract maximum element and then heapifying the heap takes $\Theta(\log n)$ time by which we could say that $\Theta(\log n)$ time is required to correctly place an element in sorted array. If $\Theta(\log n)$ time is taken to sort using heap sort, then number of elements that can be sorted is constant which is $\Theta(1)$

44. Consider a hard disk with 16 recording surfaces $(0-15)$ having 16384 cylinders $(0-16383)$ and each cylinder contains 64 sectors $(0-63)$. Data storage capacity in each sector is 512 bytes. Data are organized cylinder–wise and the addressing format is <cylinder no., sector no.>. A file of size 42797 KB is stored in the disk and the starting disk location of the file is <1200, 9, 40>. What is the cylinder number of the last sector of the file, if it is stored in a contiguous manner?

(A) 1281 (B) 1282 (C) 1283 (D) 1284

Answer: -(D)

Exp:- $42797 \text{ KB} \equiv \frac{42797 \times 1024}{512} = 85594 \text{ sectors}$

Starting is $\langle 1200, 9, 40\rangle$ contains total $24 + (6 \times 64) = 408$ sectors

Next, 1201, --------, 1283 cylinders contains total $1024 \times 83 = 84992$ sectors

$(\because$ each cylinder contains $16 \times 64 = 1024$ sectors$)$

$\therefore$ Total $= 408 + 84992 = 85400$ sectors

$\therefore$ The required cylinder number is $\langle 1284\rangle$ which will contain the last sector of the file

45. Consider the following sequence of micro–operations

MBR ← PC

MAR ← X

PC ← Y

Memory ← MBR

Which one of the following is a possible operation performed by this sequence?

(A) Instruction fetch (B) Operand fetch

(C) Conditional branch (D) Initiation of interrupt service

Answer:-(D)

Exp:- PC content is stored in memory via MBR and PC gets new address from Y. It represents a function call (routine), which is matching with interrupt service initiation

46. The line graph L(G) of a simple graph G is defined as follows:

- There is exactly one vertex v(e) in L(G) for each edge e in G.
- For any two edges e and e' in G, L(G) has an edge between v(e) and v(e'), if and only if e and e' are incident with the same vertex in G.

Which of the following statements is/are **TRUE**?

(P) The line graph of a cycle is a cycle.

(Q) The line graph of a clique is a clique.

(R) The line graph of a planar graph is planar.

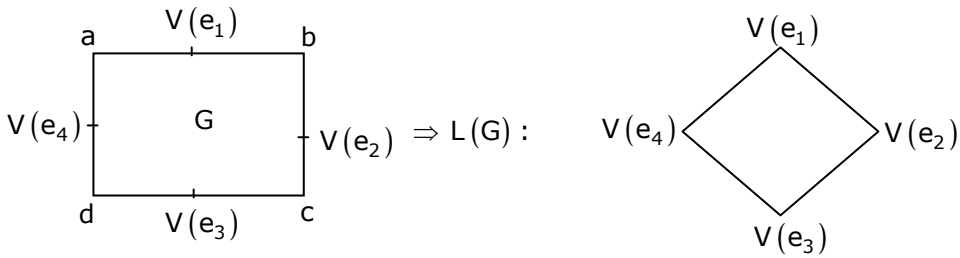
(S) The line graph of a tree is a tree.

(A) P only (B) P and R only

(C) R only (D) P, Q and S only

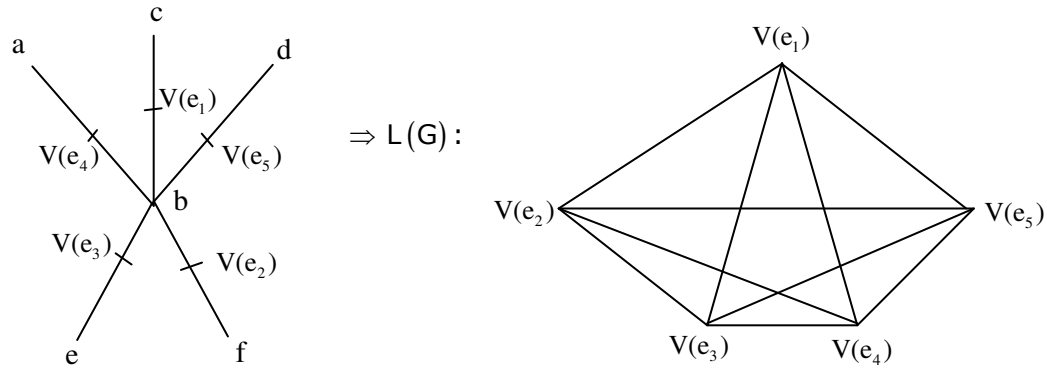
Answer: -(A)

Exp:- P) The line graph of a cycle is a cycle

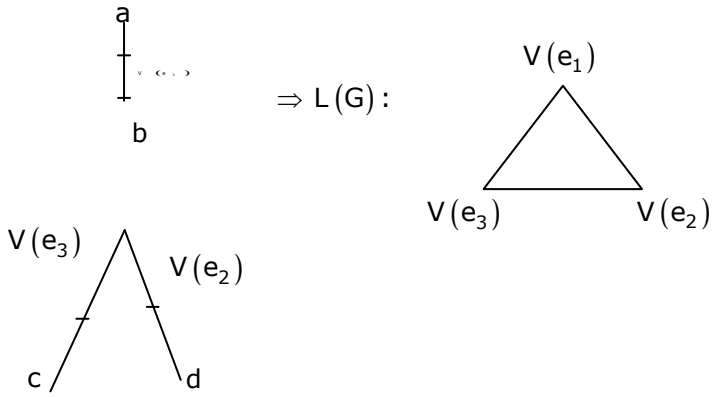


is also cycle graph

R) Line graph of planar graph need not be planar always. Consider the following example. Consider the following planar graph (star graph)



S) Hence line graph of planar graph need not be planar(Here we got K_5 which is not planar).



The line graph of a tree need not be tree.

47. What is the logical translation of the following statement?

"None of my friends are perfect."

(A) $\exists x\left(F(x)\wedge\neg P(x)\right)$ (B) $\exists x\left(\neg F(x)\wedge P(x)\right)$

(C) $\exists x\left(\neg F(x)\wedge\neg P(x)\right)$ (D) $\neg\exists x\left(F(x)\wedge P(x)\right)$

Answer: -(D)

Exp:- "None of my friends are perfect"

$=\forall x\left(F(x)\rightarrow\neg P(x)\right)$

$=\forall x\left(\neg F(x)\vee\neg P(x)\right)$

$=\neg\exists x\left(F(x)\wedge P(x)\right)$

Common Data Questions: 48 & 49

The procedure given below is required to find and replace certain characters inside an input character string supplied in array A. The characters to be replaced are supplied in array oldc, while their respective replacement characters are supplied in array newc. Array A has a fixed length of five characters, while arrays oldc and newc contain three characters each. However, the procedure is flawed

```
void find_and_replace (char *A, char *oldc, char *newc) {
        for (int i=0; i<5; i++)
            for (int j=0; j<3; j++)
                if (A[i]== oldc[j])  A[i]=newc[j];
}
```

The procedure is tested with the following four test cases

(1) oldc = "abc", newc = "dab" (2) oldc = "cde", newc = "bcd"

(3) oldc = "bca", newc = "cda" (4) oldc = "abc", newc = "bac"

48. The tester now tests the program on all input strings of length five consisting of characters 'a', 'b', 'c', 'd' and 'e' with duplicates allowed. If the tester carries out this testing with the four test cases given above, how many test cases will be able to capture the flaw?

(A) Only one (B) Only two (C) Only three (D) All four

Answer:-(B)

Exp:- Flaw in this given procedure is that one character of Array 'A' can be replaced by more than one character of newc array, which should not be so.Test case (3) and (4) identifies this flaw as they are containing 'oldc' and 'newc' array characters arranged in specific manner. Following string can reflect flaw, if tested by test case (3).

initially i = j = 0

```
A = "bcda"      oldc = "bca"      newc = "cda"
     ↑               ↑                 ↑
    i = 0           j = 0             j = 0
```

b = b so replaced by c

Next i = 0 & j = 1

```
A = "ccda"      oldc = "bca"      newc = "cda"
     ↑               ↑                 ↑
    i = 0           j = 1             j = 1
```

c = c so replaced by d

Likewise single character 'b' in A is replaced by 'c' and then by 'd'.
Same way test case (4) can also catch the flaw

49. If array A is made to hold the string "abcde", which of the above four test cases will be successful in exposing the flaw in this procedure?

(A) None (B) 2 only (C) 3 and 4 only (D) 4 only

Answer:-(C)

Exp:- Now for string "abcde" in array A, both test case (3) and (4) will be successful in finding the flaw, as explained in above question.

Common Data Questions: 50 & 51

The following code segment is executed on a processor which allows only register operands in its instructions. Each instruction can have almost two source operands and one destination operand. Assume that all variables are dead after this code segment

```
c = a + b;
d = c * a;
e = c + a;
x = c * c;
if (x > a) {
   y = a * a;
}
else {
   d = d * d;
   e = e * e;
}
```

50. Suppose the instruction set architecture of the processor has only two registers. The only allowed compiler optimization is code motion, which moves statements from one place to another while preserving correctness. What is the minimum number of spills to memory in the compiled code?

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

Answer:- (B)

Exp:- After applying the code motion optimization the statement d=c*a; and e=c+a; can be moved down to else block as d and e are not used anywhere before that and also value of a and c is not changing.

$c = a + b;$	$R_2 \leftarrow R_1 + R_2$
$x = c * c;$	$R_2 \leftarrow R_2 * R_2$ $[spill_c]$ 1 memory spill to store the value of c in memory
$if\ (x > a)$	$CMP\ R_2\ R_1$
$\{\ y = a * a;\ \}$	$R_2 \leftarrow R_1 * R_1$

else{
 	
$d = c * a;$
$d = d * d;$
 	
$e = c + a;$
$e = e * e;$
}
	$R_2 \leftarrow [spill_c]$
	$R_2 \leftarrow R_2 * R_1$
	$R_2 \leftarrow R_2 * R_2$
	
	$R_2 \leftarrow [spill_c]$
	$R_2 \leftarrow R_2 + R_1$
	$R_2 \leftarrow R_2 * R_2$

In the above code total number of spills to memory is 1

51. What is the minimum number of registers needed in the instruction set architecture of the processor to compile this code segment without any spill to memory? Do not apply any optimization other than optimizing register allocation

(A) 3 (B) 4 (C) 5 (D) 6

Answer:- (B)

Exp:-

$c = a + b;$	$R_2 \leftarrow R_1 + R_2$
$d = c * a;$	$R_3 \leftarrow R_2 * R_1$
$e = c + a;$	$R_4 \leftarrow R_2 + R_1$
$x = c * c;$	$R_2 \leftarrow R_2 * R_2$

if $(x > a)$	CMP R_2 R_1
{ y = a * a; }	$R_1 \leftarrow R_1 * R_1$

else {
d = d * d;
e = e * e;
}
	
	$R_3 \leftarrow R_3 * R_3$
	$R_4 \leftarrow R_4 * R_4$

In the above code minimum number of registers needed are = 4

Linked Answer Questions: Q.52 to Q.55 Carry Two Marks Each

Statement for Linked Answer Questions: 52 & 53

Relation R has eight attributes ABCDEFGH. Fields of R contain only atomic values.

$F = \{CH \rightarrow G, A \rightarrow BC, B \rightarrow CFH, E \rightarrow A, F \rightarrow EG\}$ is a set of functional dependencies (FDs) so that F^+ is exactly the set of FDs that hold for R

52. How many candidate keys does the relation R have?

(A) 3 (B) 4 (C) 5 (D) 6

Answer:-(B)

Exp:- Candidate keys are AD, BD, ED and FD

53. The relation R is

(A) in INF, but not in 2NF (B) in 2NF, but not in 3NF

(C) in 3NF, but not in BCNF (D) in BCNF

Answer:-(A)

Exp:- $A \rightarrow BC, B \rightarrow CFH$ and $F \rightarrow EG$ are partial dependencies. Hence it is in 1NF but not in 2NF

Statement for Linked Answer Questions: 54 & 55

A computer uses 46–bit virtual address, 32–bit physical address, and a three–level paged page table organization. The page table base register stores the base address of the first–level table (T_1) ,which occupies exactly one page. Each entry of T_1 stores the base address of a page of the second–level table (T_2). Each entry of T_2 stores the base address of a page of the third–level table (T_3) Each entry of T_3 stores a page table entry (PTE). The PTE is 32 bits in size. The processor used in the computer has a 1 MB 16 way set associative virtually indexed physically tagged cache. The cache block size is 64 bytes.

54. What is the size of a page in KB in this computer?

(A) 2 (B) 4 (C) 8 (D) 16

Answer:-(C)

Exp:- Let the page size be 2^X Bytes.

Then, the page offset = X bits

46-x	x

Now, we are using 3-level paging. First level page table is contained in one page. Each page table entry is 32-bit.

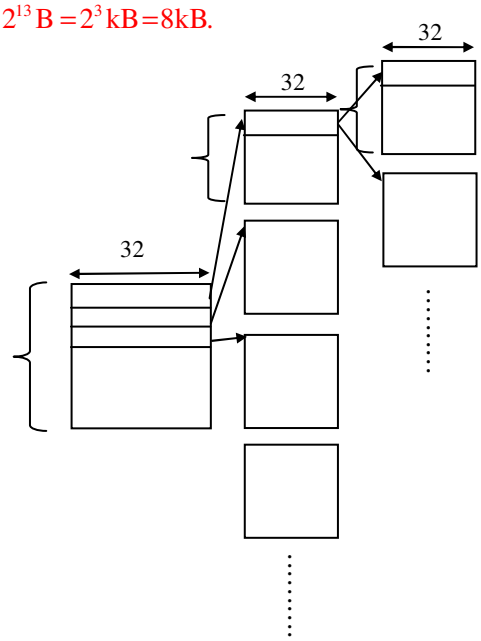
The size of T_3 is = $\frac{2^{46} * 2^2}{2^x} = 2^{46+2-x}$ [$\because$ PTE=32 bit = 4B = 2^2B]

The size of T_2 is = $\frac{2^{46+2-x} * 2^2}{2^x} = 2^{46+4-2x}$

The size of T_1 is = $\frac{2^{46+4-2x} * 2^2}{2^x} = 2^{46+6-3x} = 2^X$ [$\because$ T_1 occupies exactly one page]

$\therefore\ 46+6-3x=x \Rightarrow x=13$

So, page size = 2^{13}B = 2^3kB = 8kB.



55. What is the minimum number of page colours needed to guarantee that no two synonyms map to different sets in the processor cache of this computer?

(A) 2 (B) 4 (C) 8 (D) 16

Answer:- (C)

Exp:- As the page size is 2^{13} Bytes and page coloring is asked so we divide cache size by page size and group 16 pages in one set.

Number of pages in cache=1MB/8KB=128 pages

Number of set in cache=128/16=8 sets

Take any page of LAS, it will be mapped with cache on any one of these 8 sets (set association mapping).For any two synonym to map with same set they should be colored with same color of that respective set. So minimum we need 8 colors for this mapping.

Q. No. 56 – 60 Carry One Mark Each

56. Complete the sentence:
Universalism is to particularism as diffuseness is to _____
(A) specificity (B) neutrality (C) generality (D) adaptation

Answer:-(A)

Exp:- The relation is that of antonyms

57. Were you a bird, you _____ in the sky.
(A) would fly (B) shall fly
(C) should fly (D) shall have flown

Answer:-(A)

58. Which one of the following options is the closest in meaning to the word given below?
Nadir
(A) Highest (B) Lowest (C) Medium (D) Integration

Answer:-(B)

Exp:- Nadir in the lowest point on a curve

59. Choose the grammatically INCORRECT sentence:
(A) He is of Asian origin (B) They belonged to Africa
(C) She is an European (D) They migrated from India to Australia

Answer:-(C)

60. What will be the maximum sum of 44, 42, 40, ... ?
(A) 502 (B) 504 (C) 506 (D) 500

Answer:-(C)

Exp:- The maximum sum is the sum of 44, 42,- - - - -2.
The sum of 'n' terms of an AP

$$=\frac{n}{2}\left[2a+(n-1)d\right]$$

In this case, n = 22, a = 2 and d = 2

$$\therefore \text{Sum} = 11\left[4+21\times 2\right] = 11\times 46 = 506$$

Q. No. 61 – 65 Carry Two Marks Each

61. Out of all the 2-digit integers between 1 and 100, a 2-digit number has to be selected at random. What is the probability that the selected number is not divisible by 7?
(A) 13/90 (B) 12/90 (C) 78/90 (D) 77/90

Answer:- (D)

Exp:- The number of 2 digit multiples of 7 = 13

$\therefore$ Probability of choosing a number

Not divisible by $7 = \frac{90-13}{90} = \frac{77}{90}$

62. A tourist covers half of his journey by train at 60 km/h, half of the remainder by bus at 30 km/h and the rest by cycle at 10 km/h. The average of the tourist in km/h during his entire journey is

(A) 36 (B) 30 (C) 24 (D) 18

Answer:- (C)

Exp:- Let the total distance covered be 'D'

Now, average speed = $\frac{D}{\text{Total time taken}}$

$$= \frac{D}{\left(\frac{\frac{D}{2}}{60} + \frac{\frac{D}{4}}{30} + \frac{\frac{D}{4}}{10}\right)} = \frac{1}{\frac{1}{120} + \frac{1}{120} + \frac{1}{40}} = \frac{120}{5} = 24\,\text{km/hr}$$

63. Find the sum of the expression

$$\frac{1}{\sqrt{1}+\sqrt{2}} + \frac{1}{\sqrt{2}+\sqrt{3}} + \frac{1}{\sqrt{3}+\sqrt{4}} + \ldots\ldots + \frac{1}{\sqrt{80}+\sqrt{81}}$$

(A) 7 (B) 8 (C) 9 (D) 10

Answer:- (B)

Exp:- The expression can be written as

$$\frac{1}{\sqrt{1}+\sqrt{2}} + \frac{1}{\sqrt{2}+\sqrt{3}} + \frac{1}{\sqrt{3}+\sqrt{4}} + \ldots\ldots + \frac{1}{\sqrt{80}+\sqrt{81}}$$

$$= \frac{\sqrt{2}-\sqrt{1}}{\left(\sqrt{2}\right)^2-\left(\sqrt{1}\right)^2} + \frac{\sqrt{3}-\sqrt{2}}{\left(\sqrt{3}\right)^2-\left(\sqrt{2}\right)^2} + \frac{\sqrt{4}-\sqrt{3}}{\left(\sqrt{4}\right)^2-\left(\sqrt{3}\right)^2} + \ldots\ldots + \frac{\sqrt{81}-\sqrt{80}}{\left(\sqrt{81}\right)^2-\left(\sqrt{80}\right)^2}$$

$$= \sqrt{81}-\sqrt{1} = 8$$

64. The current erection cost of a structure is Rs. 13,200. If the labour wages per day increase by 1/5 of the current wages and the working hours decrease by 1/24 of the current period, then the new cost of erection in Rs. is

(A) 16,500 (B) 15,180 (C) 11,000 (D) 10,120

Answer:- (B)

Exp:- Let 'W' be the labour wages, and 'T' be the working hours.

Now, total cost is a function of $W \times T$

Increase in wages = 20%

$\therefore$ Revised wages = 1.2 W

Decrease in labour time $= \left(\frac{100}{24}\right)\%$

$\therefore$ Revised time $= \left(1 - \frac{1}{24}\right)T = \frac{23}{24}T$

$\therefore$ Revised Total cost $= 1.2 \times \frac{23}{24} WT = 1.15\,WT$

$= 1.15 \times 13200 = 15180$

65. After several defeats in wars, Robert Bruce went in exile and wanted to commit suicide. Just before committing suicide, he came across a spider attempting tirelessly to have its net. Time and again, the spider failed but that did not deter it to refrain from making attempts. Such attempts by the spider made Bruce curious. Thus, Bruce started observing the near-impossible goal of the spider to have the net. Ultimately, the spider succeeded in having its net despite several failures. Such act of the spider encouraged Bruce not to commit suicide. And then, Bruce went back again and won many a battle, and the rest is history.

Which one of the following assertions is best supported by the above information?

(A) Failure is the pillar of success
(B) Honesty is the best policy
(C) Life begins and ends with adventures
(D) No adversity justifies giving up hope

Answer:- (D)

GATE- CS 2012

Paper

Q. No. 1 – 25 Carry One Mark Each

1. Which of the following problems are decidable?
   1) Does a given program ever produce an output?
   2) If L is context-free language, then, is $\overline{L}$ also context-free?
   3) If L is regular language, then, is $\overline{L}$ also regular?
   4) If L is recursive language, then, is $\overline{L}$ also recursive?

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

Answer:- (D)

Exp:- CFL's are not closed under complementation. Regular and recursive languages are closed under complementation.

2. Given the language L-{ab, aa, baa}, which of the following strings are in L*?
   1) abaabaaabaa
   2) aaaabaaaa
   3) baaaaabaaaab
   4) baaaaabaa

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

Answer:-(C)

Exp:- $L = \{ab,\ aa,\ baa\}$

Let S1 = ab , S2 = aa and S3 =baa

abaabaaabaa can be written as S1S2S3S1S2

aaaabaaaa can be written as S1S1S3S1

baaaaabaa can be written as S3S2S1S2

3. In the IPv4 addressing format, the number of networks allowed under Class C addresses is

   (A) 2^{14} (B) 2^{7} (C) 2^{21} (B) 2^{24}

Answer:-(C)

Exp:- For class C address, size of network field is 24 bits. But first 3 bits are fixed as 110; hence total number of networks possible is 2^{21}

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

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

Answer:-(C)

Exp:- E-mail uses SMTP, application layer protocol which intern uses TCP transport layer protocol.

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

   (A) 0 and 0.5 (B) 0 and 1

(C) 0.5 and 1 (D) 0.25 and 0.75

Answer:-(C)

Exp:- The cumulative distribution function

$$F(x) = P(X \le x)$$

$$F(-1) = P(X \le -1) = P(X = -1) = 0.5$$

$$F(+1) = P(X \le +1) = P(X = -1) + P(X = +1) = 0.5 + 0.5 = 1$$

6. Register renaming is done is pipelined processors

(A) as an alternative to register allocation at compile time

(B) for efficient access to function parameters and local variables

(C) to handle certain kinds of hazards

(D) as part of address translation

Answer:-(C)

Exp:- Register renaming is done to eliminate WAR/WAW hazards.

7. The amount of ROM needed to implement a 4 bit multiplier is

(A) 64 bits (B) 128 bits (C) 1 Kbits (D) 2 Kbits

Answer:-(D)

Exp:- For a 4 bit multiplier there are $2^4 \times 2^4 = 2^8 = 256$ combinations.

Output will contain 8 bits.

So the amount of ROM needed is $2^8 \times 8$ bits $= 2$ Kbits.

8. Let W(n) and A(n) denote respectively, the worst case and average case running time of an algorithm executed on an input of size n. Which of the following is **ALWAYS TRUE**?

(A) $A(n) = \Omega(W(n))$ (B) $A(n) = \Theta(W(n))$

(C) $A(n) = O(W(n))$ (D) $A(n) = o(W(n))$

Answer:-(C)

Exp:- The average case time can be lesser than or even equal to the worst case. So A(n) would be upper bounded by W(n) and it will not be strict upper bound as it can even be same (e.g. Bubble Sort and merge sort).

$\therefore A(n) = O(W(n))$

9. Let G be a simple undirected planar graph on 10 vertices with 15edges. If G is a connected graph, then the number of **bounded** faces in any embedding of G on the plane is equal to

(A) 3 (B) 4 (C) 5 (D) 6

Answer:-(D)

Exp:- We have the relation V-E+F=2, by this we will get the total number of faces,

F = 7. Out of 7 faces one is an unbounded face, so total 6 bounded faces.

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

(A) $T(n) = 2T(n-2) + 2$ (B) $T(n) = 2T(n-1) + n$

(C) $T(n) = 2T(n/2) + 1$ (D) $T(n) = 2T(n-1) + 1$

Answer:-(D)

Exp:- Let the three pegs be A,B and C, the goal is to move n pegs from A to C using peg B
The following sequence of steps are executed recursively
1.move $n-1$ discs from A to B. This leaves disc n alone on peg A --- **T(n-1)**
2.move disc n from A to C---------**1**
3.move $n-1$ discs from B to C so they sit on disc n----- **T(n-1)**
So, T(n) = 2T(n-1) +1

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

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

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

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

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

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

Answer:-(B)

Exp:- If we use a HAVING clause without a GROUP BY clause, the HAVING condition applies to all rows that satisfy the search condition. In other words, all rows that satisfy the search condition make up a single group. So, option P is true and Q is false.

S is also true as an example consider the following table and query.

Id	Name
1	Ramesh
2	Ramesh
3	Rajesh
4	Suresh

```
Select count (*)
From student
Group by Name
```

Output will be

Count (*)
2
1

1

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

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

(B) An attribute of an entity can be composite

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

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

Answer:-(C)

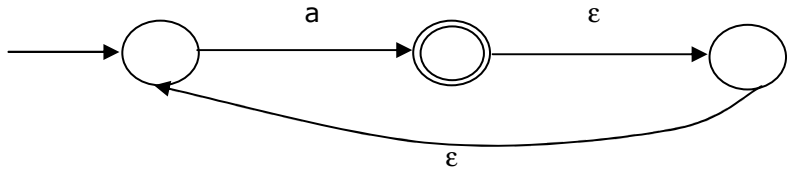
Exp:- The term 'entity' belongs to ER model and the term 'relational table' belongs to relational model.

Options A and B both are true since ER model supports both multivalued and composite attributes.

As multivalued attributes are not allowed in relational databases, in a row of a relational (table), an attribute cannot have more than one value.

13. What is the complement of the language accepted by the NFA show below?

Assume $\Sigma = \{a\}$ and ε is the empty string.



(A) $\varnothing$ (B) $\{\varepsilon\}$ (C) a^* (D) $\{a, \varepsilon\}$

Answer:- (B)

Exp:- Language accepted by NFA is a^+, so complement of this language is $\{\epsilon\}$

14. What is the correct translation of the following statement into mathematical logic?

"Some real numbers are rational"

(A) $\exists x \left(\text{real}(x) \text{ v rational } (x)\right)$ (B) $\forall x \left(\text{real}(x) \rightarrow \text{rational } (x)\right)$

(C) $\exists x \left(\text{real}(x) \wedge \text{rational } (x)\right)$ (D) $\exists x \left(\text{rational}(x) \rightarrow \text{real } (x)\right)$

Answer:- (C)

Exp:- Option A: There exists x which is either real or rational and can be both.

Option B: All real numbers are rational

Option C: There exists a real number which is rational.

Option D: There exists some number which is not rational or which is real.

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

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

(C) $4\sqrt{2}$ and $-4\sqrt{2}$ (D) $512\sqrt{2}$ and $-512\sqrt{2}$

Answer:-(D)

Exp:- Characteristic equation of A is $|A-\lambda I|=0$ where λ is the eigen value

$$\begin{vmatrix} 1-\lambda & 1 \\ 1 & -1-\lambda \end{vmatrix} = 0 \Rightarrow \lambda^2 - 2 = 0 \Rightarrow \lambda^2 = \pm\sqrt{2}$$

Every matrix satisfies its characteristic equation

Therefore $A^2 - 2I = 0 \Rightarrow A^2 = 2I$

$A^{19} = A^{18} \times A = \left(A^2\right)^9 \times A = (2I)^9 \times A = 512 \times A$

Hence eigen values of A^{19} are $\pm 512\sqrt{2}$

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

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

Answer:-(C)

Exp:- The PDU for Datalink layer, Network layer , Transport layer and Application layer are frame, datagram, segment and message respectively.

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

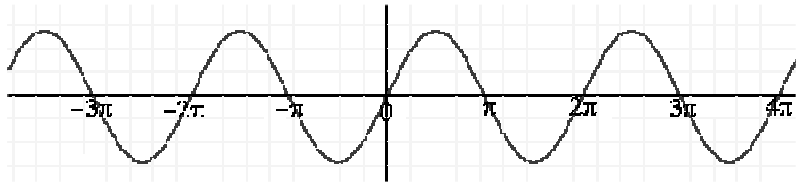
(A) One, at $\pi/2$ (B) One, at $3\pi/2$

(C) Two, at $\pi/2$ and $3\pi/2$ (D) Two, at $\pi/4$ and $3\pi/2$

Answer:-(B)

Exp:- Sin x has a maximum value of 1 at $\frac{\pi}{2}$, and a minimum value of –1 at $\frac{3\pi}{2}$ and at all angles conterminal with them.

The graph of $f(x) = \sin x$ is



$\therefore$ In the interval $\left[\frac{\pi}{4}, \frac{7\pi}{4}\right]$, it has one local minimum at $x = \frac{3\pi}{2}$

18. A process executes the code

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

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

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

Answer:- (C)

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

19. The decimal value 0.5 in IEEE single precision floating point representation has

(A) fraction bits of 000…000 and exponent value of 0

(B) fraction bits of 000…000 and exponent value of -1

(C) fraction bits of 100…000 and exponent value of 0

(D) no exact representation

Answer:-(B)

Exp:- $(0.5)_{10} = (1.0)_2 \times 2^{-1}$

So, exponent = -1 and fraction is 000 - - - 000

20. The truth table

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

represents the Boolean function

(A) X (B) X + Y (C) $X \oplus Y$ (D) Y

Answer:- (A)

Exp:- $XY' + XY = X(Y' + Y) = X$

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

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

Answer:-(C)

Exp:- The worst case search time in a balanced BST on '*x*' nodes is logx. So, if $x = n2^n$, then $\log(n2^n) = \log n + \log(2^n) = \log n + n = \theta(n)$

22. Assuming $P \neq NP$, which of the following is **TRUE**?

(A) NP-complete = NP

(B) NP-complete $\cap$ P = $\varnothing$

(C) NP-hard = NP

(D) P = NP-complete

Answer:-(B)

Exp:- If P!=NP, then it implies that no NP-Complete problem can be solved in polynomialtime which implies that the set P and the set NPC are disjoint.

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

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

(A) No choice

(B) Choice A

(C) Choice A
Choice B No choice

(D) Program gives no output as it is erroneous

Answer:-(C)

Exp:- Since there is no 'break' statement , the program executes all the subsequent case statements after printing "choice A"

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

(A) Every relation is 3NF is also in BCNF

(B) A relation R is in 3NF if every non-prime attribute of R is fully functionally dependent on every key of R

(C) Every relation in BCNF is also in 3NF

(D) No relation can be in both BCNF and 3NF

Answer:-(C)

Exp:- Option A is false since BCNF is stricter than 3NF (it needs LHS of all FDs should be candidate key for 3NF condition)

Option B is false since the definition given here is of 2NF

Option C is true, since for a relation to be in BCNF it needs to be in 3NF, every relation in BCNF satisfies all the properties of 3NF.

Option D is false, since if a relation is in BCNF it will always be in 3NF.

25. Consider the following logical inferences.

I_1 : If it rains then the cricket match will not be played.
The cricket match was played.
Inference: There was no rain.

I_2 : If it rains then the cricket match will not be played.
It did not rain.
Inference: The cricket match was played.

Which of the following is **TRUE**?

(A) Both I_1 and I_2 are correct inferences

(B) I_1 is correct but I_2 is not a correct inference

(C) I_1 is not correct but I_2 is a correct inference

(D) Both I_1 and I_2 are not correct inferences

Answer:- (B)

Exp:-

I_1 : $R \rightarrow \sim C \approx \sim R \vee \sim C$

C

$\sim R$ (there was no rain)

I_2 : $R \rightarrow \sim C \approx \sim R \vee \sim C$

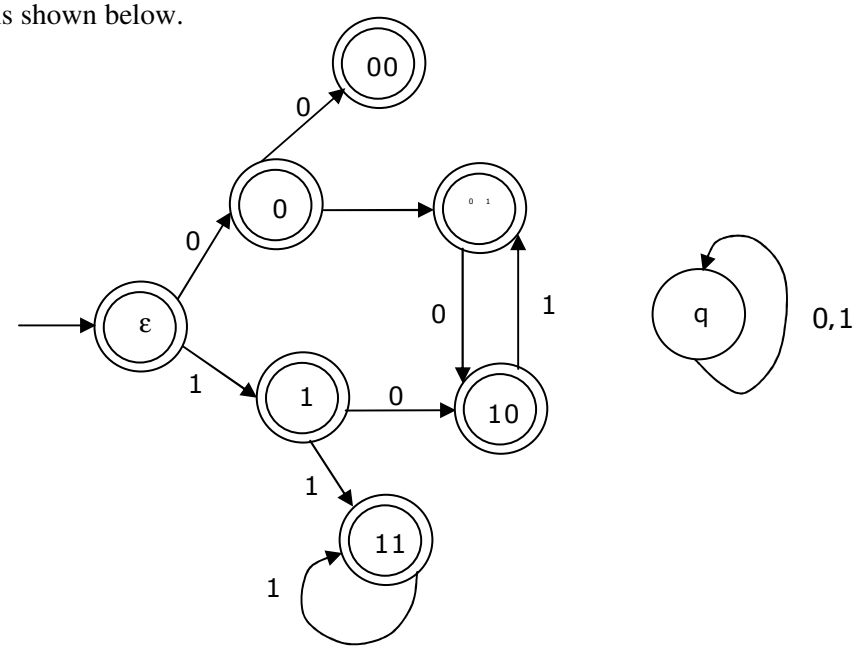
$\sim R$ $\sim R$

$\sim R \vee C$

(I_1 is correct and I_2 is not correct inference)

Q. No. 26 – 51 Carry Two Marks Each

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



The missing arcs in the DFA are

(A)

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

(B)

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

(C)

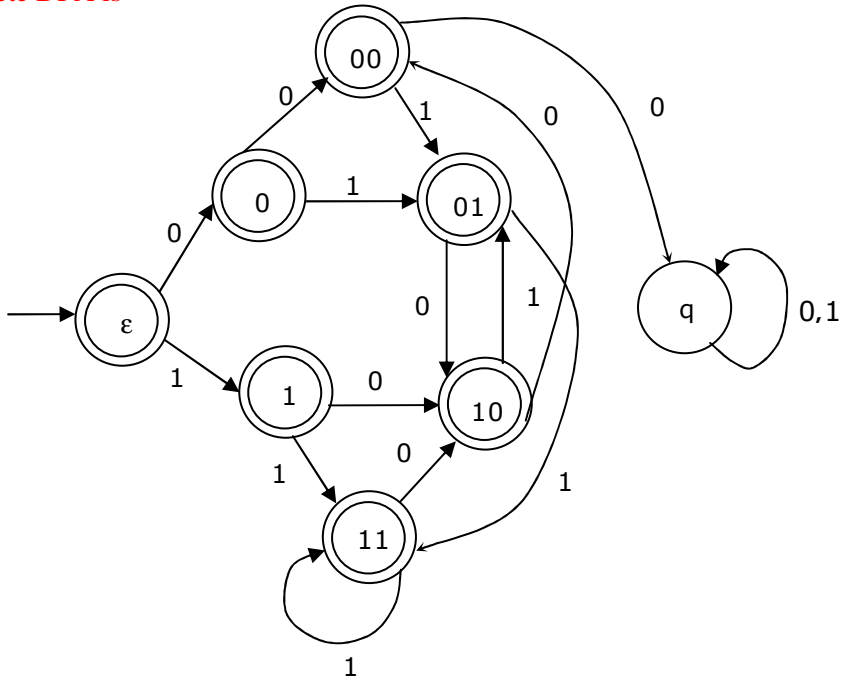
	00	01	10	11	q
00		1			0
01		1			
10			0		
11		0			

(D)

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

Answer:-(D)

Exp:- The complete DFA is



27. The height of a tree is defined as the number of edges on the longest path in the tree. The function shown in the pseudocode below is invoked as height (root) to compute the height of a binary tree rooted at the tree pointer root.

```
int height (treeptr n)
{ if (n== NULL) return -1;
  if (n → left == NULL)
```

```
    if (n → right == NULL) return 0;
    else return [B1];                                   // Box 1
else {h1 = height (n → left);
    if (n → right == NULL) return (1+h1);
    else {h2 = height (n → right);
                return [B2] ;                           // Box 2
                }
}
}
```

The appropriate expressions for the two boxes B1 and B2 are

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

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

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

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

Answer:-(A)

Exp:-

```
int height (treeptr n)

{       if (n = = nu11) return – 1;
                → /*  If there is no node, return -1  */

        if (n → left == NULL) → /* If there is no left child for node 'n' */

            if (n → right == NULL) return O;
                → /*If no left child & no right child for 'n', return */
            else return (1+height (n → right));
                → /*  If no left child, but there is a right child, then compute height
                for right sub tree. Therefore total height is 1+ height (n → right) */

        else { → /*  If there exist left child node for node 'n' */

            h1 = height (n → left);
                → /* First Find the height of left sub tree for node 'n' */

            If (n → right == NULL) return (1+h1);
```

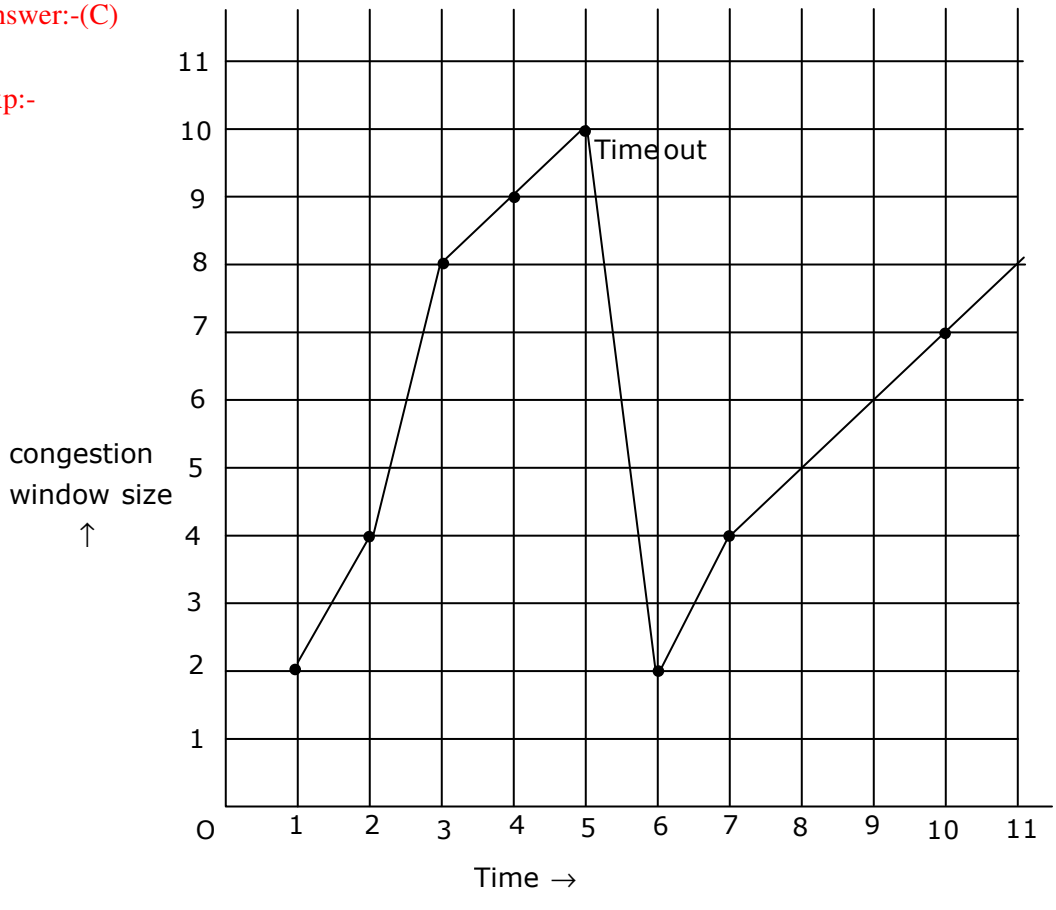
```
                    → /* If there exist left child and no right child and no right child
                    for a node 'n', then total height
                    = height from (n to n → left ) + left sub tree height
                    =1 + height (n → left) = 1 + h1          */
            else {h2 = height (n → right);
                    → /*  If there exist right child also, then compute height of right
                    sub tree for a node 'n'  */
            return (1+ max (h1,h2));
                    → /*          Total height for node 'n'=
                    1 + Max (Left Subtree height, Right sub tree height)
                    = 1 + Max (h1, h2)                    */
            }
    }
```

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

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

Answer:-(C)

Exp:-



Given, initial threshold = 8

Time = 1, during 1st transmission,Congestion window size = 2 (slow start phase)

Time = 2, congestion window size = 4 (double the no. of acknowledgments)

Time = 3, congestion window size = 8 (Threshold meet)

Time = 4, congestion window size = 9, after threshold (increase by one Additive increase)

Time = 5, transmits 10 MSS, but time out occurs congestion window size = 10

Hence threshold = (Congestion window size)/2 = $10/2 = 5$

Time = 6, transmits 2

Time = 7, transmits 4

Time = 8, transmits 5 (threshold is 5)

Time = 9, transmits 6, after threshold (increase by one Additive increase)

Time = 10, transmits 7

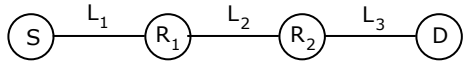
$\therefore$ During 10^{th} transmission, it transmits 7 segments hence at the end of the tenth transmission the size of congestion window is 7 MSS.

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

(A) 1005ms (B) 1010ms (C) 3000ms (D) 3003ms

Answer:- (A)

Exp:-



Transmission delay for 1 packet from each of S, R_1 and R_2 will take 1ms

Propagation delay on each link L_1, L_2 and L_3 for one packet is 1ms

Therefore the sum of transmission delay and propagation delay on each link for one packet is 2ms.

The first packet reaches the destination at 6^{th}ms

The second packet reaches the destination at 7^{th}ms

So inductively we can say that 1000^{th} packet reaches the destination at 1005^{th} ms

30. Suppose R1 $(\underline{A}, B)$ and R_2 $(\underline{C}, D)$ are two relation schemas. Let r_1 and r_2 be the corresponding relation instances. B is a foreign key that refers to C in R_2. If data in r_1 and r_2 satisfy referential integrity constrains, which of the following is **ALWAYS TRUE**?

(A) $\Pi_B(r_1) - \Pi_C(r_2) = \varnothing$ (B) $\Pi_C(r_2) - \Pi_B(r_1) = \varnothing$

(C) $\Pi_B(r_1) = \Pi_C(r_2)$ (D) $\Pi_B(r_1) - \Pi_C(r_2) \neq \varnothing$

Answer:-(A)

Exp:- Since B is a foreign key referring C,values under B will be subset of values under C ($\Pi_B(r_1) \subseteq \Pi_C(r_2) \Rightarrow \Pi_B(r_1) - \Pi_C(r_2) = \varnothing$)

31. Consider the virtual page reference string

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

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

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

Answer:- (B)

Exp:- FIFO

1 1 1 4 4 4
2 2 2 1 1 → (6) faults
3 3 3 2

Optimal

1 1 1 1 1
2 2 4 4 → (5) faults
3 3 2

LRU

1 1 1 4 4 4 2 2 2
2 2 2 2 3 3 3 1 → (9) faults
3 3 1 1 1 4 4

Optimal < FIFO < LRU

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

(A) 3 KBytes
(B) 35 KBytes
(C) 280 KBytes
(D) dependent on the size of the disk

Answer:-(B)

Exp:- Each block size = 128 Bytes

Disk block address = 8 Bytes

$\therefore$ Each disk can contain = $\frac{128}{8} = 16$ addresses

Size due to 8 direct block addresses: 8 x 128

Size due to 1 indirect block address: 16 x 128

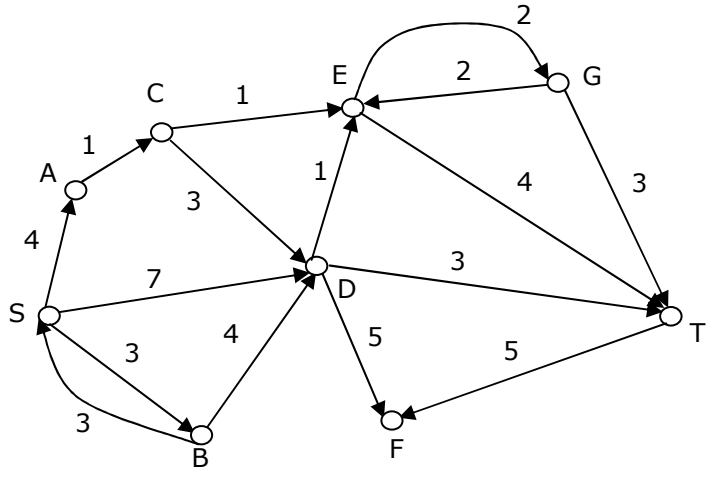
Size due to 1 doubly indirect block address: 16 x 16 x 128

Size due to 1 doubly indirect block address: 16 x 16 x 128

So, maximum possible file size:

$= 8 \times 128 + 16 \times 128 + 16 \times 16 \times 128 = 1024 + 2048 + 32768 = 35840$ Bytes $= 35$ KBytes

33. Consider the directed graph shown in the figure below. There are multiple shortest paths between vertices S and T. Which one will be reported by Dijkstra's shortest path algorithm? Assume that, in any iteration, the shortest path to a vertex *v* is updated only when a strictly shorter path to *v* is discovered.



(A) SDT (B) SBDT (C) SACDT (D) SACET

Answer:- (D)

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

Initially d[S]=0, d[A] = ∞, $d[B] = \infty . - - - -, d[T] = \infty$

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

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

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

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

We will use the following procedure

Repeat until Q is empty

{

1 u = choose a vertex from Q with minimum d[u] value

2. $Q = Q - u$

3. update all the adjacent vertices of u

4. W = W U{u}

}

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

Iteration 1

Step 1 : $u = S$

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

Step 3: final values after adjustment

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

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

Step 4 : $W = \{S\}$

Iteration 2:

Step 1: $u = B$

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

step 3: final values after adjustment

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

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

Step 4: $W = \{S, B\}$

Iteration 3:

Step 1: $u = A$

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

step 3: final values after adjustment

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

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

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

Iteration 4:

Step 1: $u = C$

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

step 3: final values after adjustment

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

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

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

Iteration 5:

Step 1: $u = E$

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

step 3: final values after adjustment

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

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

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

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

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

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

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

Answer:-(B)

Exp:- The height of the recursion tree using merge sort is logn and n^2 comparisons are done at each level, where at most n pairs of strings are compared at each level and n comparisons are required to compare any two strings, So the worst case running time is $O(n^2 \log n)$

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

(A) 15 (B) 30 (C) 90 (D) 360

Answer:- No option matching (marks to all)

Exp:- 4 vertices from 6 vertices can be chosen in in ${}^6c_4$. Number of cycles of length 4 that can be formed from those selected vertices is (4-1)!/2 (left or right/ up or down does not matter), so total number of 4 length cycles are $({}^6c_4.3!)/2 = 45$.

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

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

Answer:- (C)

Exp:- Total number of functions is 2^n, out of which there will be exactly two functions where all elements map to exactly one element, so total number of onto functions is $2^n - 2$

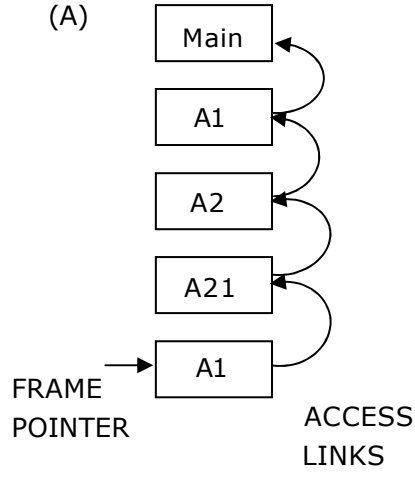
37. Consider the program given below, in a block-structured pseudo-language with lexical scoping and nesting of procedures permitted.

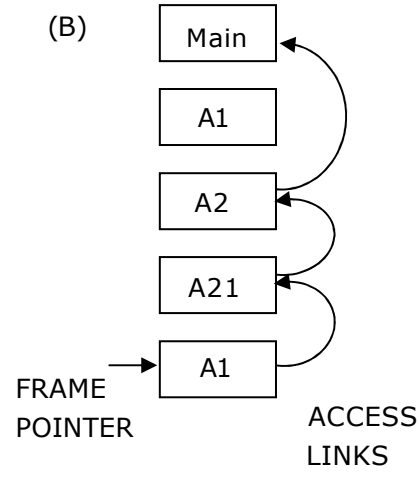
```
Program main;
  Var . . .
  Procedure A1;
    Var ….
```

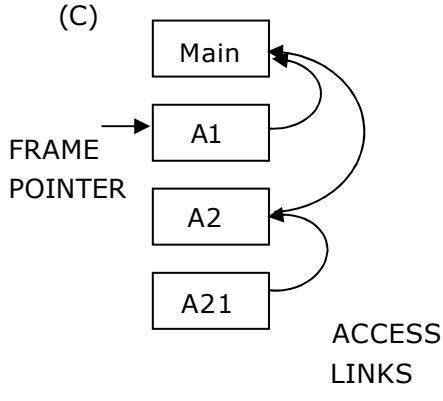
```
    Call A2;
  End A1
  Procedure A2;
    Var . . .
    Procedure A21;
        Var . . .
       Call A1;
   End A21
   Call A21;
End A2
  Call A1;
End main.
```

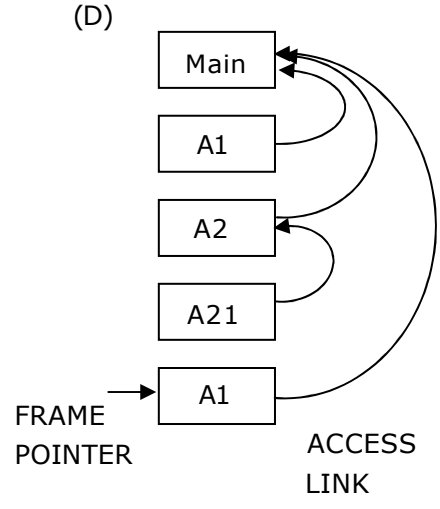
Consider the calling chain: Main → A1 → A2 → A21 → A1

The correct set of activation records along with their access links is given by









Answer:-(D)

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

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

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

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

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

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

Answer:- (A)

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

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

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

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

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

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

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

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

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

(A) 245.248.136.0/21 and 245.248.128.0/22

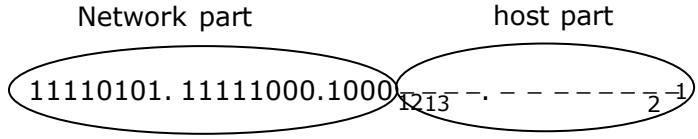
(B) 245.248.128.0/21 and 245.248.128.0/22

(C) 245.248.132.0/22 and 245.248.132.0/21

(D) 245.248.136.0/24 and 245.248.132.0/21

Answer:- (A)

Exp:-



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

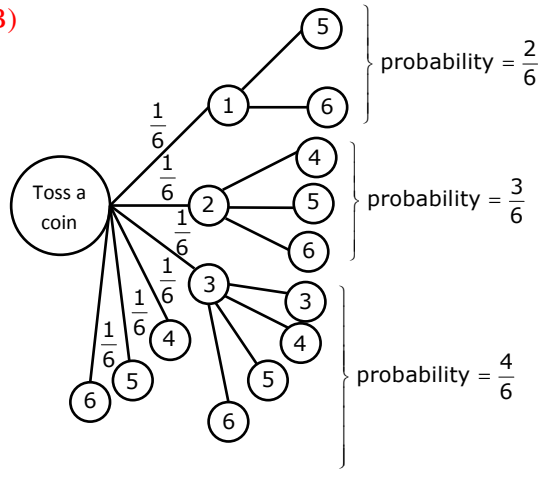
Now for organization B, 12th bit is set to '0' but since we need only half of 2048 addresses, 13th bit can be set to '0' and include that bit into network part of organization B so the valid allocation of addresses to B is 245.248.128.0/22

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

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

Answer:- (B)

Exp:-



$$\therefore \text{Required probability} = \frac{1}{6}\times\frac{2}{6}+\frac{1}{6}\times\frac{3}{6}+\frac{1}{6}\times\frac{4}{6}+\frac{1}{6}=\frac{15}{36}=\frac{5}{12}$$

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

```
AcquireLock(L){
    While (Fetch_And_Add(L,1))
                L = 1;
}
Release Lock(L){
    L = 0;
}
```

This implementation

(A) fails as L can overflow

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

(C) works correctly but may starve some processes

(D) works correctly without starvation

Answer:- (B)

Exp:- 1. Acquire lock (L) {

2. While (Fetch_And_Add(L, 1))

3. L = 1.

}

4. Release Lock (L) {

5. L = 0;

6. }

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

P executes 1,2,3 then Q executes 1 and 2 then P executes 4,5,6 then L=0 now Q executes 3 by which L will be set to 1 and thereafter no process can set

L to zero, by which all the processes could starve.

42. Consider the 3 process, P1, P2 and P3 shown in the table.

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

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

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

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

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

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

Answer:-(C)

Exp:- For FCFS Execution order will be order of Arrival time so it is P1,P2,P3

Next For RR with time quantum=2,the arrangement of Ready Queue will be as follows:

RQ: P1,P2,P1,P3,P2,P1,P3,P2

This RQ itself shows the order of execution on CPU(Using Gantt Chart) and here it gives the completion order as P1,P3,P2 in Round Robin algorithm.

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

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

(A) $\overline{b}\,\overline{d}$

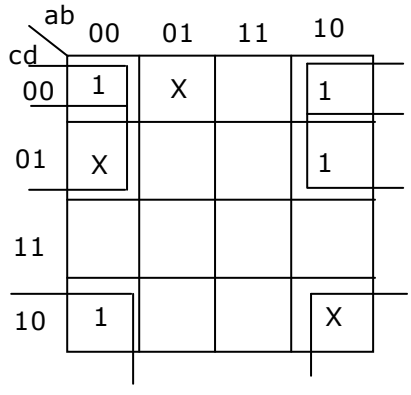
(B) $\overline{b}\,\overline{d} + \overline{b}\,\overline{c}$

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

(D) $\overline{b}\,\overline{d} + \overline{b}\,\overline{c} + \overline{c}\,\overline{d}$

Answer:- (B)

Exp:-



d'b'+ c'b'

44. Let G be a weighted graph with edge weights greater than one and G' be the graph constructed by squaring the weights of edges in G. Let T and T' be the minimum spanning trees of G and G' respectively, with total weights t and t'. Which of the following statements is **TRUE**?

(A) T' = T with total weight $t' = t^2$

(B) T' = T with total weight $t' < t^2$

(C) T' ≠ T but total weight $t' = t^2$

(D) None of these

Answer:-(D)

Exp:-

Graph G is counter example for options (B) and (C) and Graph G_1 is counter example for option (A)

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

(A) 1 (B) 3 (C) 5 (D) 7

Answer:- (B)

Exp:-

$$f(x) = x^4 - x^3 - x^2 - 4$$

$$f(1) < 0 \text{ and } f(9) > 0 \therefore x_0 = \frac{1+9}{2} = 5$$

$$f(5) > 0 \quad \therefore \text{ root lies in } [1,5]$$

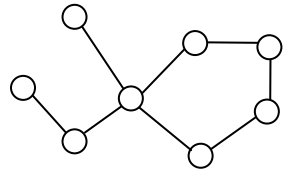
$$x_1 = \frac{1+5}{2} = 3$$

$$f(3) > 0 \therefore \text{ root lies in } [1,3]$$

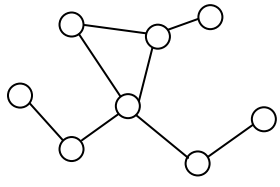
$$x_2 = \frac{1+3}{2} = 2$$

$$f(2) = 0 \therefore \text{ root is } 2$$

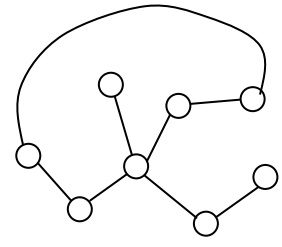
46. Which of the following graph is isomorphic to



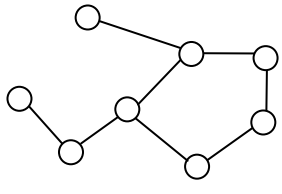
(A)



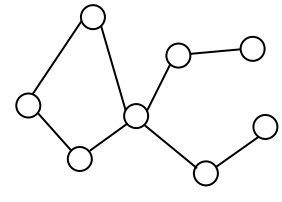
(B)



(C)



(D)



Answer:-(B)

Exp:- The graph in option (A) has a 3 length cycle whereas the original graph does not have a 3 length cycle

The graph in option (C) has vertex with degree 3 whereas the original graph does not have a vertex with degree 3

The graph in option (D) has a 4 length cycle whereas the original graph does not have a 4 length cycle

47. Consider the following transactions with data items P and Q initialized to zero:

$\mathbf{T_1}$: read (P) ;
read (Q) ;
if P = 0 then Q : = Q + 1 ;
write (Q).

$\mathbf{T_2}$: read (Q) ;
read (P)
if Q = 0 then P : = P + 1 ;
write (P).

Any non-serial interleaving of T1 and T2 for concurrent execution leads to

(A) a serializable schedule

(B) a schedule that is not conflict serializable

(C) a conflict serializable schedule

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

Answer:-(B)

Exp:- Let S be a non-serial schedule, without loss of generality assume that T1 has started earlier than T2. The first instruction of T1 is read(P) and the last instruction of T2 is write(P), so the precedence graph for S has an edge from T1 to T2, now since S is a non-serial schedule the first instruction of T2(read(Q)) should be executed before last instruction of T1(write(Q)) and since read and write are conflicting operations, the precedence graph for S also contains an edge from T2 to T1, So we will have a cycle in the precedence graph which implies that any non serial schedule with T1 as the earliest transaction will not be conflict serializable.

In a similar way we can show that if T2 is the earliest transaction then also the schedule is not conflict serializable.

Common Data Questions: 48 & 49

Consider the following relations A, B and C:

A

Id	**Name**	**Age**
12	Arun	60
15	Shreya	24
99	Rohit	11

B

Id	**Name**	**Age**
15	Shreya	24
25	Hari	40

98	Rohit	20
99	Rohit	11

C

Id	**Phone**	**Area**
10	220	02
99	2100	01

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

SELECT A.Id
FROM A
WHERE A.Age > **ALL**(**SELECT** B.Age
FROM B
WHERE B.Name = 'Arun')

(A) 4 (B) 3 (C) 0 (D) 1

Answer:-(B)

Exp:- As the result of subquery is an empty table, '>ALL' comparison is true . Therefore, all the three row id's of A will be selected from table A.

49. How many tuples does the result of the following relational algebra expression contain? Assume that the schema of $A \cup B$ is the same as that of A.

$(A \cup B) \triangleright\!\triangleleft_{A.Id>40 \ v \ C.Id<15} C$

(A) 7 (B) 4 (C) 5 (D) 9

Answer:-(A)

Exp:- The final table is

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

Common Data Questions: 50 & 51

Consider the following C code segment:

```
int a,  b,  c = 0;
void prtFun(void);
```

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

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

50. What output will be generated by the given code segment if:
Line 1 is replaced by **auto int a = 1**;
Line 2 is replaced by **register int a = 2**;

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

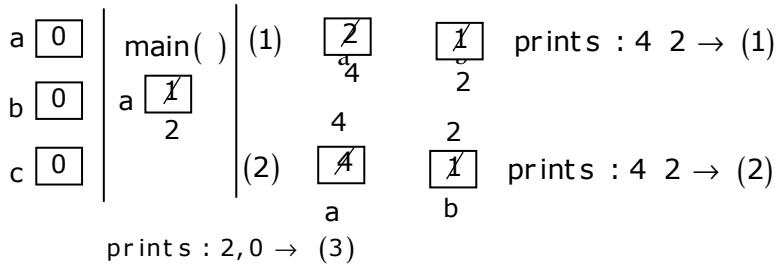
Answer:-(D)

Exp:- **Static local variables:** Scope is limited to function/block but life time is entire program.

Automatic local variables:

Storage allocated on function entry and automatically deleted or freed when the function is exited.

Register variables: Same as automatic variables except that the register variables will not have addresses Hence may not take the address of a register variable.

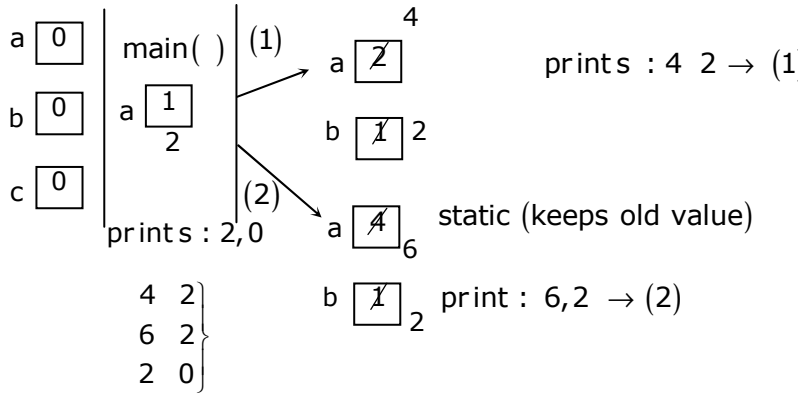


51. What output will be generated by the given code segment?

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

Answer:- (C)

Exp:-



Linked Answer Questions: Q.52 to Q.55 Carry Two Marks Each

Statement for Linked Answer Questions: 52 & 53

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

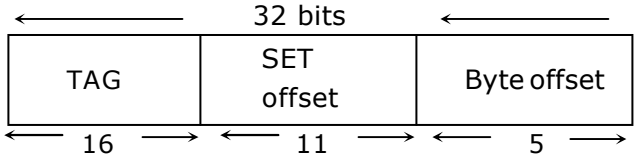
52. The number of bits in the tag field of an address is

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

Answer:- (C)

Exp:- Number of blocks = $\frac{256\,\text{KB}}{32\,\text{Bytes}} = \frac{2^{18}}{2^5} = 2^{13}$ blocks

As it is 4–way set associative, number of sets = $\frac{2^{13}}{2^2} = 2^{11}$



53. The size of the cache tag directory is

(A) 160 Kbits (B) 136 Kbits (C) 40 Kbits (D) 32 Kbits

Answer:-(A)

Exp:- TAG controller maintains 16 + 4 = 20 bits for every block

Hence, size of cache tag directory $= 20 \times 2^{13}$ bits $= 160$ K bits

Statement for Linked Answer Questions: 54 & 55

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

$S \rightarrow a\,A\,b\,B \mid b\,A\,a\,B \mid \varepsilon$

$A \rightarrow S$

$B \rightarrow S$

	a	b	$
S	**E1**	**E2**	$S \rightarrow \varepsilon$
A	$A \rightarrow S$	$A \rightarrow S$	error
B	$B \rightarrow S$	$B \rightarrow S$	**E3**

54. The First and Follow sets for the non-terminals A and B are

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

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

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

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

Answer:- (A)

Exp:- $\text{First}(A) = \text{First}(S) = \text{First}(aAbB) \cup \text{First}(bAaB) \cup \text{First}(\in)$

$= \{a\} \cup \{b\} \cup \{\in\} = \{\in, a, b\}$

$\text{First}(B) = \text{First}(S) = \{\in, a, b\}$

$\text{Follow}(A) = \text{First}(bB) \cup \text{First}(aB) = \{a, b\}$

$\text{Follow}(B) = \text{Follow}(S) = \{\$\} \cup \text{Follow}(A) = \{\$, a, b\}$

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

(A) E1: $S \to aAbB,\ A \to S$
E2: $S \to bAaB,\ B \to S$
E3: $B \to S$

(B) E1: $S \to aAbB,\ S \to \varepsilon$
E2: $S \to bAaB,\ S \to \varepsilon$
E3: $S \to \varepsilon$

(C) E1: $S \to aAbB,\ S \to \varepsilon$
E2: $S \to bAaB,\ S \to \varepsilon$
E3: $B \to S$

(D) E1: $A \to S,\ S \to \varepsilon$
E2: $B \to S,\ S \to \varepsilon$
E3: $B \to S$

Answer:- (C)

Exp:-

$\text{First}(S) = \{\in, a, b\},\ \text{Follow}(S) = \{\$, a, b\}$

	a	b	$
S	$S \to aAbB$ $S \to \in$	$S \to bAaB$ $S \to \in$	$S \to \in$

$B \to S$ to be placed in LL(1) Parsing table as follows:-

$\text{First}(S) = \{\in, a, b\},\ \text{Follow}(B) = \{\$, a, b\}$

	a	b	$
B	$B \to S$	$B \to S$	$B \to S$

Q. No. 56 – 60 Carry One Mark Each

56. The cost function for a product in a firm is given by $5q^2$, where q is the amount of production. The firm can sell the product at a market price of Rs.50 per unit. The number of units to be produced by the firm such that the profit is maximized is

(A) 5 (B) 10 (C) 15 (D) 25

Answer:- (A)

Exp:-

$P = 50q - 5q^2$

$\frac{dp}{dq} = 50 - 10q;\ \frac{d^2p}{dq^2} < 0$

$\therefore$ p is maximum at $50 - 10q = 0$ or, $q = 5$

Else check with options

57. Choose the most appropriate alternative from the options given below to complete the following sentence:

Suresh's dog is the one _____ was hurt in the stampede.

(A) that (B) which (C) who (D) whom

Answer:- (A)

58. Choose the grammatically **INCORRECT** sentence:

(A) They gave us the money back less the service charges of Three Hundred rupees.

(B) This country's expenditure is not less than that of Bangladesh.

(C) The committee initially asked for a funding of Fifty Lakh rupees, but later settled for a lesser sum.

(D) This country's expenditure on educational reforms is very less

Answer:-(D)

59. Which one of the following options is the closest in meaning to the word given below?

Mitigate

(A) Diminish (B) Divulge (C) Dedicate (D) Denote

Answer:- (A)

60. Choose the most appropriate alternative from the options given below to complete the following sentence:

Despite several _____ the mission succeeded in its attempt to resolve the conflict.

(A) attempts (B) setbacks (C) meetings (D) delegations

Answer:- (B)

Q. No. 61 – 65 Carry Two Marks Each

61. Wanted Temporary, Part-time persons for the post of Field Interviewer to conduct personal interviews to collect and collate economic data. Requirements: High School-pass, must be available for Day, Evening and Saturday work. Transportation paid, expenses reimbursed.

Which one of the following is the best inference from the above advertisement?

(A) Gender-discriminatory (B) Xenophobic

(C) Not designed to make the post attractive (D) Not gender-discriminatory

Answer:- (C)

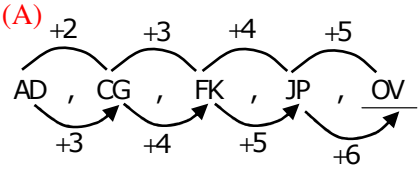
Exp:- Gender is not mentioned in the advertisement and (B) clearly eliminated

62. Given the sequence of terms, AD CG FK JP, the next term is

(A) OV (B) OW (C) PV (D) PW

Answer:- (A)

Exp:-



63. Which of the following assertions are CORRECT?

P: Adding 7 to each entry in a list adds 7 to the mean of the list

Q: Adding 7 to each entry in a list adds 7 to the standard deviation of the list

R: Doubling each entry in a list doubles the mean of the list

S: Doubling each entry in a list leaves the standard deviation of the list unchanged

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

Answer:-(C)

Exp:- P and R always hold true

Else consider a sample set {1, 2, 3, 4} and check accordingly

64. An automobile plant contracted to buy shock absorbers from two suppliers X and Y. X supplies 60% and Y supplies 40% of the shock absorbers. All shock absorbers are subjected to a quality test. The ones that pass the quality test are considered reliable Of X's shock absorbers, 96% are reliable. Of Y's shock absorbers, 72% are reliable.

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

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

Answer:-(B)

	x	y
Supply	60%	40%
Reliable	96%	72%
Overall	0.576	0.288

$$\therefore P(x) = \frac{0.288}{0.576 + 0.288} = 0.334$$

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

(A) 8 meters (B) 10 meters (C) 12 meters (D) 14 meters

Answer:-(B)

Exp:-

$$y = 2x - 0.1x^2$$

$$\frac{dy}{dx} = 2 - 0.2x$$

$$\frac{d^2y}{dx^2} < 0 \therefore y \text{ maximises at } 2 - 0.2x = 0$$

$$\Rightarrow x = 10$$

$$\therefore y = 20 - 10 = 10\,\text{m}$$

GATE- CS 2011

Paper

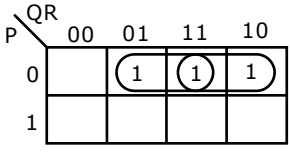
Q. No. 1 – 25 Carry One Mark Each

1. The simplified SOP (Sum of Product) form of the Boolean expression $(P+\bar{Q}+\bar{R}).(P+\bar{Q}+R).(P+Q+\bar{R})$ is

(A) $(\bar{P}Q+\bar{R})$ (B) $(P+\bar{Q}\bar{R})$ (C) $(\bar{P}Q+R)$ (D) $(PQ+R)$

Answer: - (B)

Exp: -



$f=(P+\bar{R})(P+\bar{Q})$

$=P+\bar{Q}\bar{R}$

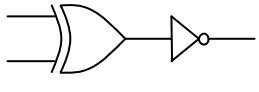
Alternate method

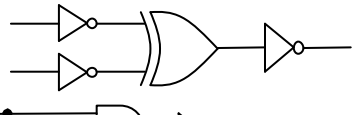
$$(P+\bar{Q}+\bar{R}).(P+\bar{Q}+R).(P+Q+\bar{R})=\overline{\overline{(P+\bar{Q}+\bar{R}).(P+\bar{Q}+R).(P+Q+\bar{R})}}$$

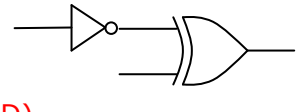
$$=\overline{\bar{P}QR+\bar{P}Q\bar{R}+\bar{P}\bar{Q}R}=\overline{\bar{P}Q(R+\bar{R})+\bar{P}\bar{Q}R}=\overline{\bar{P}Q+\bar{P}\bar{Q}R}=\overline{\bar{P}(Q+\bar{Q}R)}$$

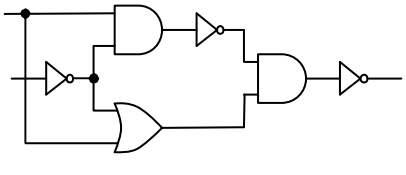
$$=\overline{\bar{P}(Q+R)}=P+\bar{Q}\,\bar{R}$$

2. Which one of the following circuits is NOT equivalent to a 2-input XNOR (exclusive NOR) gate?

(A) 

(B) 

(C) 

(D) 

Answer: - (D)

Exp: - All options except option 'D' gives EX-NOR gates

3. The minimum number of D flip-flops needed to design a mod-258 counter is

(A) 9 (B) 8 (C) 512 (D) 258

Answer: - (A)

Exp: - $2^n \geq 258 \Rightarrow n=9$

4. A thread is usually defined as a 'light weight process' because an operating system (OS) maintains smaller data structures for a thread than for a process. In relation to this, which of the followings is TRUE?

(A) On per-thread basis, the OS maintains only CPU register state

(B) The OS does not maintain a separate stack for each thread

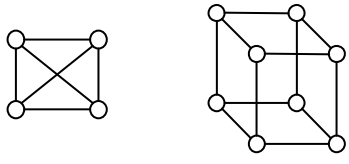
(C) On per-thread basis, the OS does not maintain virtual memory state

(D) On per thread basis, the OS maintains only scheduling and accounting information

Answer: - (A)

5. K4 and Q3 are graphs with the following structures

K4 Q3



Which one of the following statements is TRUE in relation to these graphs?

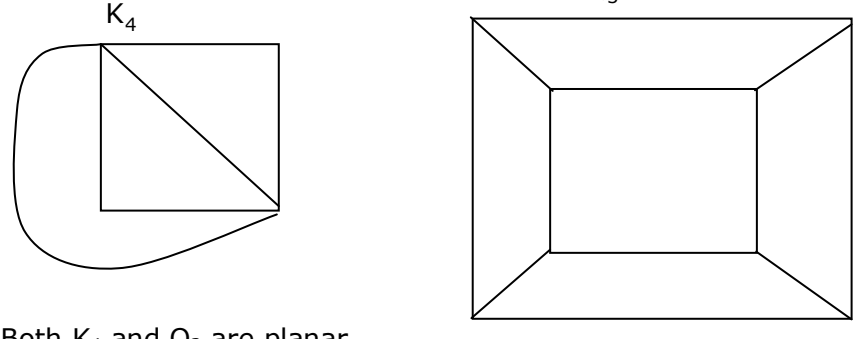
(A) K4 is planar while Q3 is not (B) Both K4 and Q3 are planar

(C) Q3 is planar while K4 is not (D) Neither K4 not Q3 is planar

Answer: - (B)

Exp: -

K_4 Q_3



$\therefore$ Both K_4 and Q_3 are planar

6. If the difference between the expectation of the square of random variable $\left(E\left[X^2\right]\right)$ and the square of the expectation of the random variable $\left(E\left[X^2\right]\right)$ is denoted by R then

(A) $R = 0$ (B) $R<0$ (C) $R \geq 0$ (D) $R>0$

Answer: - (C)

7. The lexical analysis for a modern computer language such as Java needs the power of which one of the following machine models in a necessary and sufficient sense?

(A) Finite state automata

(B) Deterministic pushdown automata

(C) Non-Deterministic pushdown automata

(D) Turing machine

Answer: - (A)

Exp: - Lexical Analysis is implemented by finite automata

8. Let the page fault service time be 10ms in a computer with average memory access time being 20ns. If one page fault is generated for every 10^6 memory accesses, what is the effective access time for the memory?

(A) 21ns (B) 30ns (C) 23ns (D) 35ns

Answer: - (B)

Exp: - P = page fault rate

EA = p × page fault service time

$+(1-p)\times$ Memory access time

$$=\frac{1}{10^6}\times 10\times 10^6+\left(1-\frac{1}{10^6}\right)\times 20\cong 29.9\,\text{ns}$$

9. Consider a hypothetical processor with an instruction of type LW R1, 20(R2), which during execution reads a 32-bit word from memory and stores it in a 32-bit register R1. The effective address of the memory location is obtained by the addition of constant 20 and the contents of register R2. Which of the following best reflects the addressing mode implemented by this instruction for the operand in memory?

(A) Immediate Addressing (B) Register Addressing

(C) Register Indirect Scaled Addressing (D) Base Indexed Addressing

Answer: - (D)

Exp: - Here 20 will act as base and content of R_2 will be index

10. What does the following fragment of C-program print?

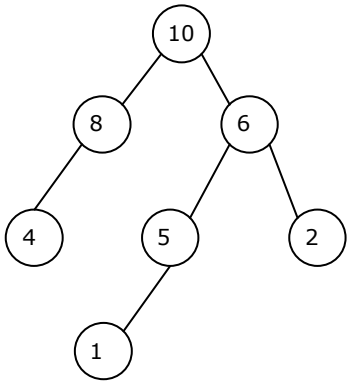
```
char c[ ]="GATE2011";
char *p =c;
printf("%s", p+p[3]-p[1]);
```

(A) GATE2011 (B) E2011 (C) 2011 (D) 011

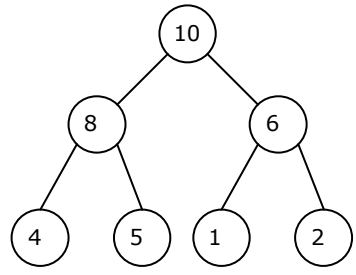
Answer: - (C)

11. A max-heap is a heap where the value of each parent is greater than or equal to the value of its children. Which of the following is a max-heap?

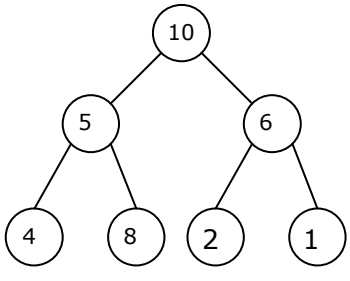
(A)



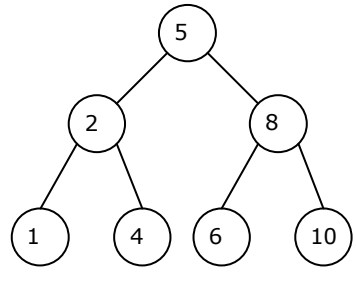
(B)



(C)



(D)



Answer: - (B)

Exp: - Heap is a complete binary tree

12. An algorithm to find the length of the longest monotonically increasing sequence of numbers in an array $A[0:n-1]$ is given below.

Let L_i denote the length of the longest monotonically increasing sequence starting at index i in the array

Initialize $L_{n-1} = 1$

For all i such that $0 \le i \le n-2$

$$L_i = \begin{cases} 1 + L_{i+1} & \text{if } A[i] < A[i+1] \\ 1 & \text{Otherwise} \end{cases}$$

Finally the length of the longest monotonically increasing sequence is $\text{Max}(L_0, L_1, \ldots, L_{n-1})$. Which of the following statements is TRUE?

(A) The algorithm uses dynamic programming paradigm

(B) The algorithm has a linear complexity and uses branch and bound paradigm

(C) The algorithm has a non-linear polynomial complexity and uses branch and bound paradigm

(D) The algorithm uses divide and conquer paradigm.

Answer: - (A)

13. Let P be a regular language and Q be a context free language such that $Q \subseteq P$. (For example, let P be the language represented by the regular expression p*q* and Q be $\{p^n q^n \mid n \in N\}$). Then which of the following is ALWAYS regular?

(A) $P \cap Q$ (B) $P - Q$ (C) $\Sigma^* - P$ (D) $\Sigma^* - Q$

Answer: - (C)

Exp: - $\Sigma^* - P$ is the complement of P so it is always regular,

since regular languages are closed under complementation

14. In a compiler, keywords of a language are recognized during

(A) parsing of the program (B) the code generation

(C) the lexical analysis of the program (D) dataflow analysis

Answer: - (C)

Exp: - Any identifier is also a token so it is recognized in lexical Analysis

15. A layer-4 firewall (a device that can look at all protocol headers up to the transport layer) CANNOT

(A) block entire HTTP traffic during 9:00PM and 5:00AM

(B) block all ICMP traffic

(C) stop incoming traffic from a specific IP address but allow outgoing traffic to the same IP address

(D) block TCP traffic from a specific user on a multi-user system during 9:00PM and 5:00AM

Answer: - (A)

Exp: - Since it is a layer 4 firewall it cannot block application layer protocol like HTTP.

16. If two fair coins are flipped and at least one of the outcomes is known to be a head, what is the probability that both outcomes are heads?

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

Answer: - (A)

Exp: - Sample space = $\{HH, HT, TH\}$

Required probability $= \frac{1}{3}$

17. Consider different activities related to email.

m1: Send an email from a mail client to a mail server

m2: Download an email from mailbox server to a mail client

m3: Checking email in a web browser

Which is the application level protocol used in each activity?

(A) m1:HTTP m2:SMTP m3:POP (B) m1:SMTP m2:FTP m3:HTTP

(C) m1: SMTP m2: POP m3: HTTP (D) m1: POP m2: SMTP m3:IMAP

Answer: - (C)

Exp: - Sending an email will be done through user agent and message transfer agent by SMTP, downloading an email from mail box is done through POP, checking email in a web browser is done through HTTP

18. A company needs to develop a strategy for software product development for which it has a choice of two programming languages L1 and L2. The number of lines of code (LOC) developed using L2 is estimated to be twice the LOC developed with L1. the product will have to be maintained for five years. Various parameters for the company are given in the table below.

Parameter	Language L1	Language L2
Man years needed for development	LOC / 10000	LOC / 10000
Development Cost per year	Rs. 10,00,000	Rs. 7,50,000
Maintenance time	5 years	5 years
Cost of maintenance per year	Rs. 1,00,000	Rs. 50,000

Total cost of the project includes cost of development and maintenance. What is the LOC for L1 for which the cost of the project using L1 is equal to the cost of the project using L2?

(A) 4000 (B) 5000 (C) 4333 (D) 4667

Answer: - (B)

Exp: - LOC $L_1 = x$

$L_2 = 2x$

Total cost of project

$$\frac{x}{10000} \times 1000000 + 5 \times 100000 = \frac{2x}{10000} \times 750000 + 50000 \times 5$$

$$100x + 500000 = 150x + 250000$$

$$\Rightarrow 50x = 500000 - 250000$$

$$\therefore \quad x = \frac{250000}{50} \Rightarrow x = 5000$$

19. Let the time taken to switch between user and kernel modes of execution be t_1 while the time taken to switch between two processes be t_2. Which of the following is TRUE?

(A) $t_1 > t_2$

(B) $t_1 = t_2$

(C) $t_1 < t_2$

(D) Nothing can be said about the relation between t_1 and t_2

Answer: - (C)

Exp: - Process switching also involves mode changing.

20. A company needs to develop digital signal processing software for one of its newest inventions. The software is expected to have 40000 lines of code. The company needs to determine the effort in person-months needed to develop this software using the basic COCOMO model. The multiplicative factor for this model is given as 2.8 for the software development on embedded systems, while the exponentiation factor is given as 1.20. What is the estimated effort in person-months?

(A) 234.25 (B) 932.50 (C) 287.80 (D) 122.40

Answer: - (A)

Exp: - Effort person per month

$= \alpha.(\text{kDSI})^{B}$

KDSI = Kilo LOC

$= 2.8 \times (40)^{1.20}$

$= 2.8 \times 83.6511$

$= 234.22$ person per month

21. Which of the following pairs have DIFFERENT expressive power?

(A) Deterministic finite automata (DFA) and Non-deterministic finite automata (NFA)

(B) Deterministic push down automata (DPDA) and Non-deterministic push down automata (NPDA)

(C) Deterministic single-tape Turing machine and Non-deterministic single tape Turing machine

(D) Single-tape Turing machine and multi-tape Turing machine

Answer: - (B)

Exp: - NPDA is more powerful than DPDA.

Hence answer is (B)

22. HTML (Hyper Text Markup Language) has language elements which permit certain actions other than describing the structure of the web document. Which one of the following actions is NOT supported by pure HTML (without any server or client side scripting) pages?

(A) Embed web objects from different sites into the same page

(B) Refresh the page automatically after a specified interval

(C) Automatically redirect to another page upon download

(D) Display the client time as part of the page

Answer: - (D)

23. Which of the following is NOT desired in a good Software Requirement Specifications (SRS) document?

(A) Functional Requirements

(B) Non Functional Requirements

(C) Goals of Implementation

(D) Algorithms for Software Implementation

Answer: - (D)

24. A computer handles several interrupt sources of which the following are relevant for this question.

Interrupt from CPU temperature sensor

Interrupt from Mouse

Interrupt from Keyboard
Interrupt from Hard Disk

(A) Interrupt from Hard Disk
(B) Interrupt from Mouse
(C) Interrupt from Keyboard
(D) Interrupt from CPU temp sensor

Answer: - (D)

25. Consider a relational table with a single record for each registered student with the following attributes.

1. Registration_Number: Unique registration number for each registered student
2. UID: Unique Identity number, unique at the national level for each citizen
3. BankAccount_Number: Unique account number at the bank. A student can have multiple accounts or joint accounts. This attributes stores the primary account number
4. Name: Name of the Student
5. Hostel_Room: Room number of the hostel

Which of the following options is INCORRECT?

(A) BankAccount_Number is a candidate key
(B) Registration_Number can be a primary key
(C) UID is a candidate key if all students are from the same country
(D) If S is a superkey such that $S \cap UID$ is NULL then $S \cup UID$ is also a superkey

Answer: - (A)

Exp: - In case two students hold joint account then BankAccount_Num will not uniquely determine other attributes.

Q. No. 26 – 51 Carry Two Marks Each

26. Which of the given options provides the increasing order of asymptotic complexityoffunctionsf_1,f_2,$f_3$andf_4?

$f_1(n) = 2^n$; $f_2(n) = n^{3/2}$; $f_3(n) = n\log_2 n$; $f_4(n) = n^{\log_2 n}$

(A) f_3, f_2, f_4,f_1 (B) f_3, f_2, f_1,f_4 (C) f_2, f_3, f_1,f_4 (D) f_2, f_3, f_4,f_1

Answer: - (A)

Let $n = 1024$

$f_1(n) = 2^{1024}$

$f_2(n) = 2^{15}$

$f_3(n) = 10 \times 2^{10}$

$f_4(n) = 1024^{10} = 2^{100}$

$\therefore f_3, f_2, f_4, f_1$ is the rquired increasing order

27. Four matrices M_1, M_2, M_3 and M_4 are dimensions $p \times q$, $q \times r$, $r \times s$ and $s \times t$ respectively can be multiplied in several ways with different number of total scalar multiplications. For example When multiplied as $((M_1 \times M_2) \times (M_3 \times M_4))$ the total number of scalar multiplications is pqr+rst+prt. When multiplied as $(((M_1 \times M_2) \times M_3) \times M_4)$, the total number of scalar multiplications is pqr+prs+pst.

If p=10, q=100, r=20, s=5 and t=80, then the minimum number of scalar multiplications needed is

(A) 248000 (B) 44000 (C) 19000 (D) 25000

Answer: - (C)

Exp: - Multiply as $(M_1 \times (M_2 \times M_3)) \times M_4$

The total number of scalar multiplication is

$= qrs + pqs + pst$

$= 10000 + 5000 + 4000 = 19000$

28. Consider a relational table r with sufficient number of records, having attributes A_1, A_2,..., A_n and let $1 \le p \le n$. Two queries Q1 and Q2 are given below.

Q1 : $\pi_{A1...A_n}(\sigma_{A_p=c}(r))$ where c is a const

Q2: $\pi_{A1...A_n}(\sigma_{c_1 \le A_p \le c_2}(r))$ where c_1 and c_2 are constants

The database can be configured to do ordered indexing on A_p or hashing on A_p. Which of the following statements is TRUE?

(A) Ordered indexing will always outperform hashing for both queries

(B) Hashing will always outperform ordered indexing for both queries

(C) Hashing will outperform ordered indexing on Q1, but not on Q2

(D) Hashing will outperform ordered indexing on Q2, but not on Q1.

Answer: - (C)

29. Consider the matrix as given below.

$$\begin{bmatrix} 1 & 2 & 3 \\ 0 & 4 & 7 \\ 0 & 0 & 3 \end{bmatrix}$$

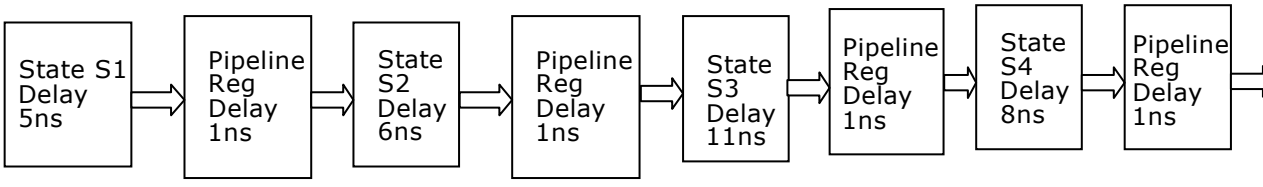
Which one of the following provides the CORRECT values of eigenvalues of the matrix?

(A) 1,4,3 (B) 3,7,3 (C) 7,3,2 (D) 1,2,3

Answer: - (A)

Exp: - Given matrix is upper triangular matrix and its diagonal elements are its eigen values = 1, 4, 3

30. Consider an instruction pipeline with four stages (S1, S2, S3 and S4) each with combinational circuit only. The pipeline registers are required between each stage and at the end of the last stage. Delays for the stages and for the pipeline registers are as given in the figure.



What is the approximate speed up of the pipeline in steady state under ideal conditions when compared to the corresponding non-pipeline implementation?

(A) 4.0 (B) 2.5 (C) 1.1 (D) 3.0

Answer: - (B)

Exp: - $\frac{(5+6+11+8)}{(11+1)} = \frac{30}{12} = 2.5$

31. Definition of a language L with alphabet {a} is given as following

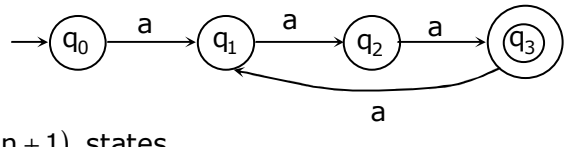
$L = \{a^{nk} \mid k > 0,$ and n is a positive integer constant$\}$

What is the minimum number of states needed in a DFA to recognize L?

(A) k+1 (B) n+1 (C) 2^{n+1} (D) 2^{k+1}

Answer: - (B)

Exp: - Let n = 3 and k=1



$(n+1)$ states

32. An 8KB direct mapped write-back cache is organized as multiple blocks, each of size 32-bytes. The processor generates 32-bit addresses. The cache controller maintains the tag information for each cache block comprising of the following.

1 Valid bit

1 Modified bit

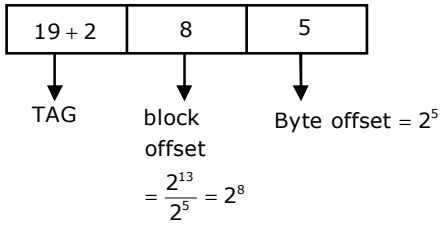
As many bits as the minimum needed to identify the memory block mapped in the cache.

What is the total size of memory needed at the cache controller to store meta-data (tags) for the cache?

(A) 4864 bits (B) 6144bits (C) 6656bits (D) 5376bits

Answer: - (D)

Exp: -



Required answer $= 256 \times (19 + 2) = 5376$ bits

33. An application loads 100 libraries at startup. Loading each library requires exactly one disk access. The seek time of the disk to a random location is given as 10ms. Rotational speed of disk is 6000rpm. If all 100 libraries are loaded from random locations on the disk, how long does it take to load all libraries? (The time to transfer data from the disk block once the head has been positioned at the start of the block may be neglected)

(A) 0.50s (B) 1.50s (C) 1.25s (D) 1.00s

Answer: - (B)

Exp: - 6000 rotations _____ 60 sec

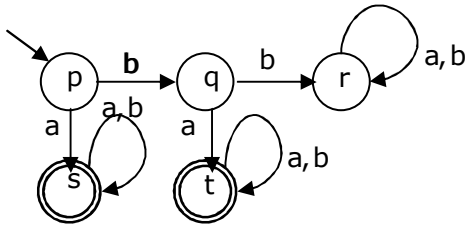
1 rotation _____ 10 ms

$\therefore$ Rotational latency = 5ms

Time for one disk access = 15 ms

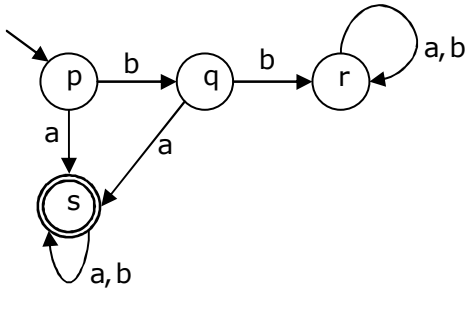
Time to load all libraries $= 15 \times 100 = 1500\,\text{ms} = 1.5\,\text{sec}$

34. A deterministic finite automation (DFA) D with alphabet $\Sigma = \{a, b\}$ is given below

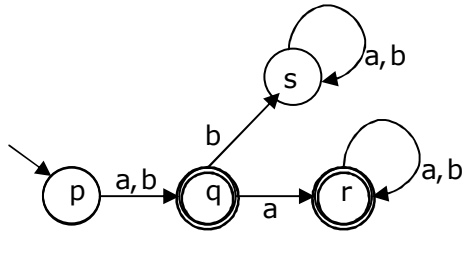


Which of the following finite state machines is a valid minimal DFA which accepts the same language as D?

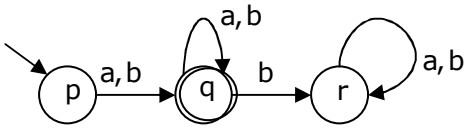
(A)



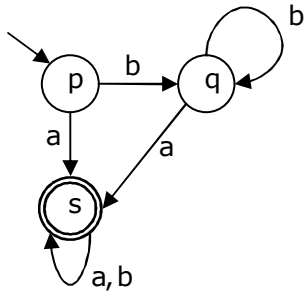
(B)



(C)



(D)



Answer: - (A)

Exp: - Options B and C will accept the string b

Option – D will accept the string "bba"

Both are invalid strings.

So the minimized DFA is option A

35. The following is comment written for a C function

```
/*  This function computes the roots of a quadratic equation
a.x^2+b.x+c=0. The function stores two real roots
in *root1 and *root2 and returns the status of validity of
roots. It handles four different kinds of cases.
(i)  When coefficient a is zero irrespective of discriminant
(ii)  When discriminant is positive
(iii)  When discrimanant is zero
(iv)  When discrimanant is negative
Only in cases (ii) and (iii), the stored roots are valid.
Otherwise 0 is stored in the roots. the function returns 0 when
the roots are valid and -1 otherwise.
The functin also ensures root1>=root2.
int get_QuadRoots(float a, float b, float c, float *root1, float *root2);
*/
```

A software test engineer is assigned the job of doing black box testing. He comes up with the following test cases, many of which are redundant.

Test Case	Input set			Expected Output set		
	a	b	C	Root1	Root2	Return Value
T1	0.0	0.0	7.0	0.0	0.0	-1
T2	0.0	1.0	3.0	0.0	0.0	-1
T3	1.0	2.0	1.0	-1.0	-1.0	0
T4	4.0	-12.0	9.0	1.5	1.5	0
T5	1.0	-2.0	-3.0	3.0	-1.0	0
T6	1.0	1.0	4.0	0.0	0.0	-1

Which one of the following options provide the set of non-redundant tests using equivalence class partitioning approach from input perspective for black box testing?

(A) T1,T2,T3,T6 (B) T1,T3,T4,T5 (C) T2,T4,T5,T6 (D) T2,T3,T4,T5

Answer: - (C)

Exp: - T_1 and T_2 checking same condition a = 0 hence, any one of T_1 and T_2 is redundant.

T_3, T_4: in both case discriminant $(D)=b^2-4ac=0$. Hence any one of it is redundant.

T_5 : D>0

T_6 : D<0

36. Database table by name Loan_Records is given below.

Borrower	Bank_Manager	Loan_ Amount
Ramesh	Sunderajan	10000.00
Suresh	Ramgopal	5000.00
Mahesh	Sunderajan	7000.00

What is the output of the following SQL query?

```
SELECT count(*)
FROM(
(SELECT Borrower. Bank_Manager FROM Loan_Records) AS S
NATURAL JOIN
(SELECT Bank_Manager, Loan_Amount FROM Loan_Records) AS T
);
```

(A) 3 (B) 9 (C) 5 (D) 6

Answer: - (C)

Exp: - S

Borrower	Bank _ Manager
Ramesh	Sunderajan
Suresh	Ramgqpal
Mahesh	Sunderjan

T

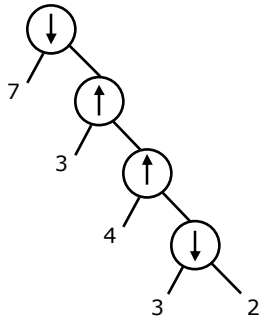
Bank _ Manager	Loan _ Amount
Sunderajan	10000.00
Ramgopal	5000.00
Sunderjan	7000.00

After executing the given query, the output would be

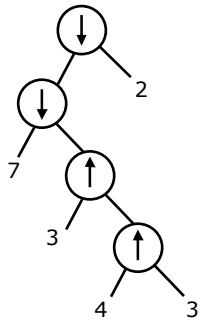
Borrower	Bank_Manager	Load_Amount
Ramesh	Sunderajan	10000.00
Ramesh	Sunderajan	7000.00
Suresh	Ramgopal	5000.00
Mahesh	Sunderajan	10000.00
Mahesh	Sunderajan	7000.00

37. Consider two binary operators '$\uparrow$' and '$\downarrow$' with the precedence of operator $\downarrow$ being lower than that of the operator $\uparrow$. Operator $\uparrow$ is right associative while operator $\downarrow$, is left associative. Which one of the following represents the parse tree for expression $(7 \downarrow 3 \uparrow 4 \uparrow 3 \downarrow 2)$?

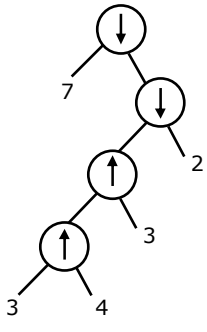
(A)



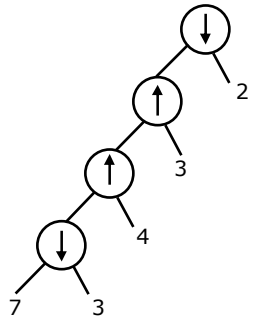
(B)



(C)



(D)



Answer: - (B)

Exp: - $7 \downarrow 3 \uparrow 4 \uparrow 3 \downarrow 2$

$\Rightarrow 7 \downarrow 3 \uparrow (4 \uparrow 3) \downarrow 2$ as $\uparrow$ is right associative

$\Rightarrow 7 \downarrow (3 \uparrow (4 \uparrow 3)) \downarrow 2$

$\Rightarrow (7 \downarrow (3 \uparrow (4 \uparrow 3))) \downarrow 2$ as $\downarrow$ is left associative

38. Consider the languages L1, L2 and L3 as given below

$L1 = \{0^p 1^q \mid p, q \in N\}$

$L2 = \{0^p 1^q \mid p, q \in N \text{ and } p = q\}$ and

$L3 = \{0^p 1^q 0^r \mid p, q, r \in N \text{ and } p = q = r\}$

Which of the following statements is NOT TRUE?

(A) Push Down Automata (PDA) can be used to recognize L1 and L2

(B) L1 is a regular language

(C) All the three languages are context free

(D) Turing machines can be used to recognize all the languages

Answer: - (C)

Exp: - L1: regular language

L2: context free language

L3: context sensitive language

39. On a non-pipelined sequential processor, a program segment, which is a part of the interrupt service routine, is given to transfer 500 bytes from an I/O device to memory.

Initialize the address register

Initialize the count to 500

LOOP: Load a byte from device

Store in memory at address given by address register

Increment the address register

Decrement the count

If count != 0 go to LOOP

Assume that each statement in this program is equivalent to a machine instruction which takes one clock cycle to execute if it is a non-load/store instruction. The load-store instructions take two clock cycles to execute.

The designer of the system also has an alternate approach of using the DMA controller to implement the same transfer. The DMA controller requires 20 clock cycles for initialization and other overheads. Each DMA transfer cycle takes two clock cycles to transfer one byte of data from the device to the memory.

What is the approximate speedup when the DMA controller based design is used in place of the interrupt driven program based input-output?

(A) 3.4 (B) 4.4 (C) 5.1 (D) 6.7

Answer: - (A)

Exp: - No. of clock cycles required by using load-store approach = 2 + 500 × 7 = 3502 and that of by using DMA = 20 + 500 × 2 = 1020

Required speed up $= \frac{3502}{1020} = 3.4$

40. We are given a set of n distinct elements and an unlabeled binary tree with n nodes. In how many ways can we populate the tree with the given set so that it becomes a binary search tree?

(A) 0 (B) 1 (C) n! (D) $\frac{1}{n+1}.{}^{2n}C_n$

Answer: - (D)

41. Which one of the following options is CORRECT given three positive integers x, y and z, and a predicate

$$P(x) = \neg(x = 1) \wedge \forall y\left(\exists z\left(x = y * z\right) \Rightarrow (y = x) \vee (y = 1)\right)$$

(A) P(x) being true means that x is a prime number

(B) P(x) being true means that x is a number other than 1

(C) P(x) is always true irrespective of the value of x

(D) P(x) being true means that x has exactly two factors other than 1 and x

Answer: - (A)

42. Given $i = \sqrt{-1}$, what will be the evaluation of the definite integral $\int_0^{\pi/2} \frac{\cos x + i \sin x}{\cos x - i \sin x} dx$?

(A) 0 (B) 2 (C) $-i$ (D) i

Answer: - (D)

Exp: - $\int_0^{\pi/2} \frac{e^{ix}}{e^{-ix}} dx = \int_0^{\pi/2} e^{2ix} dx$

$$= \left(\frac{e^{2ix}}{2i} \right)_0^{\pi/2} = \frac{1}{2i} \left[e^{i\pi} - 1 \right] = \frac{1}{2i} \left[\cos \pi + i \sin \pi - 1 \right] = \frac{1}{2i} \left[-1 + 0 - 1 \right] = \frac{-2}{2i} = \frac{-1}{i} \times \frac{i}{i} = \frac{-i}{-1} = i$$

43. Consider a database table T containing two columns X and Y each of type integer. After the creation of the table, one record (X= 1, Y=l) is inserted in the table.

Let MX and MY denote the respective maximum values of X and Y among all records in the table at any point in time. Using MX and MY, new records are inserted in the table 128 times with X and Y values being MX+1, 2*MY+1 respectively. It may be noted that each time after the insertion, values of MX and MY change.

What will be the output of the following SQL query after the steps mentioned above are carried out?

SELECT Y FROM T WHERE X=7;

(A) 127 (B) 255 (C) 129 (D) 257

Answer: - (A)

Exp: -

X	Y
1	1
2	3
3	7
4	15
5	31
6	63
7	127

44. Consider a finite sequence of random values $X = [x_1, x_2, \ldots x_n]$. Let μ_x be the mean and σ_x be the standard deviation of X .Let another finite sequence Y of equal length be derived from this as $y_i = a * x_i + b$, where a and b are positive constants. Let μ_y be the mean and σ_y be the standard deviation of this sequence. Which one of the following statements is INCORRECT?

(A) Index position of mode of X in X is the same as the index position of mode of Y in Y.

(B) Index position of median of X in X is the same as the index position of median of Y in Y.

(C) $\mu_y = a\mu_x + b$

(D) $\sigma_y = a\sigma_x + b$

Answer: - (D)

45. A deck of 5 cards (each carrying a distinct number from 1 to 5) is shuffled thoroughly. Two cards are then removed one at a time from the deck. What is the probability that the two cards are selected with the number on the first card being one higher than the number on the second card?

(A) 1/5 (B) 4/25 (C) 1/4 (D) 2/5

Answer: - (A)

Exp: - (2,1), (3,2), (4,3), (5,4)

Required probability = $\frac{4}{5 \times 4} = \frac{4}{20} = \frac{1}{5}$

46. Consider the following table of arrival time and burst time for three processes P0, P1 and P2.

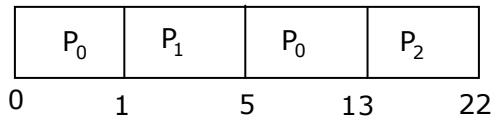
Process	Arrival time	Burst Time
P0	0 ms	9 ms
P1	1 ms	4ms
P2	2 ms	9ms

The pre-emptive shortest job first scheduling algorithm is used. Scheduling is carried out only at arrival or completion of processes. What is the average waiting time for the three processes?

(A) 5.0 ms (B) 4.33 ms (C) 6.33 ms (D) 7.33 ms

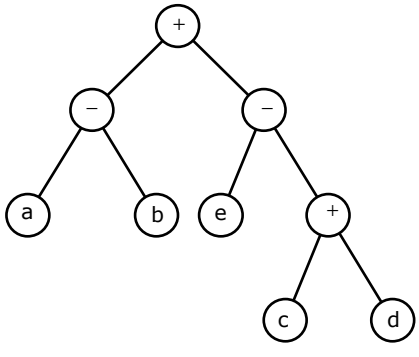
Answer: - (A)

Exp: -



$$\text{Average waiting time} = \frac{4+11}{3} = 5 \text{ ms}$$

47. Consider evaluating the following expression tree on a machine with load-store architecture in which memory can be accessed only through load and store instructions. The variables a, b, c, d and e are initially stored in memory. The binary operators used in this expression tree can be evaluated by the machine only when the operands are in registers. The instructions produce result only in a register. If no intermediate results can be stored in memory, what is the minimum number of registers needed to evaluate this expression?



(A) 2 (B) 9 (C) 5 (D) 3

Answer: - (D)

Exp: - Load R_1, a ; $R_1 \leftarrow M[a]$

Load R_2, b ; $R_2 \leftarrow M[b]$

Sub R_1, R_2 ; $R_1 \leftarrow R_1 - R_2$

Load R_2, c ; $R_2 \leftarrow M[c]$

Load R_3, d ; $R_3 \leftarrow M[d]$

Add R_2, R_3 ; $R_2 \leftarrow R_2 + R_3$

Load R_3, e ; $R_3 \leftarrow M[e]$

Sub R_3, R_2 : $R_3 \leftarrow R_3 - R_2$

Add R_1, R_3 ; $R_1 \leftarrow R_1 + R_3$

Total 3 Registers are required minimum

Common Data Questions: 48 & 49

Consider the following recursive C function that takes two arguments

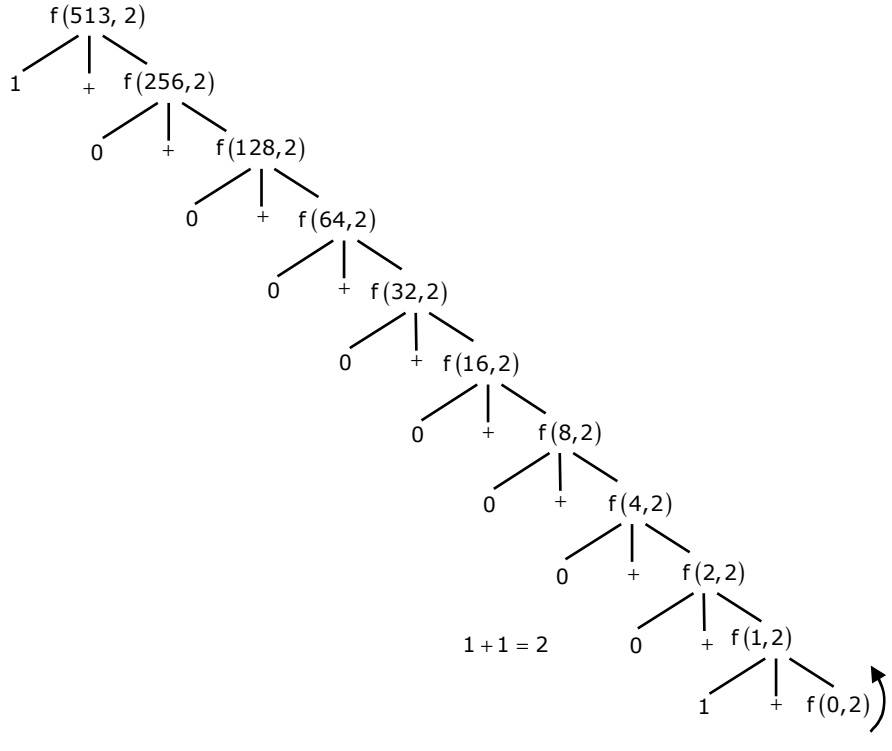
```
unsigned int foo(unsigned int n, unsigned int r) {
    if (n > 0) return (n%r) + foo (n/r, r));
    else return 0;
}
```

48. What is the return value of the function foo when it is called as foo (513, 2)?

(A) 9 (B) 8 (C) 5 (D) 2

Answer: - (D)

Exp: -

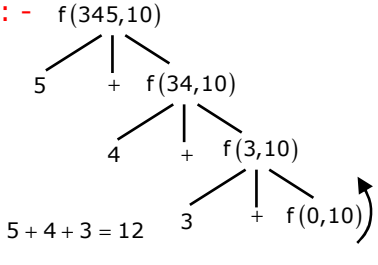


49 What is the return value of the function foo when it is called as foo (345, 10) ?

(A) 345 (B) 12 (C) 5 (D) 3

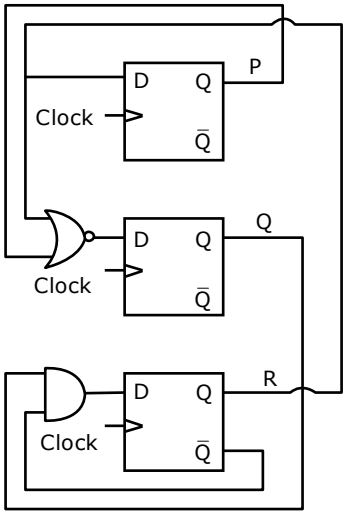
Answer: - (B)

Exp: -



Common Data Questions: 50 & 51

Consider the following circuit involving three D-type flip-flops used in a certain type of counter configuration.



50. If all the flip-flops were reset to 0 at power on, what is the total number of distinct outputs (states) represented by PQR generated by the counter?

(A) 3 (B) 4 (C) 5 (D) 6

Answer: - (B)

Exp: -

CLOCK	Inputs			Outputs		
	$D_1 = R$	$D_2 = \overline{(P + R)}$	$D_3 = Q\,\bar{R}$	P	Q	R
1	0	1	0	0	1	0
2	0	1	1	0	1	1
3	1	0	0	1	0	0
4	0	0	0	0	0	0

So Total number of distinct outputs is 4

51. If at some instance prior to the occurrence of the clock edge, P. Q and R have a value 0, 1 and 0 respectively, what shall be the value of PQR after the clock edge?

(A) 000 (B) 001 (C) 010 (D) 011

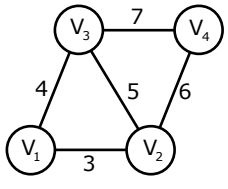
Answer: - (D)

Exp: -From the Table Shown in the explanation of question 50, if first state is 010 next State is 011

Linked Answer Questions: Q.52 to Q.55 Carry Two Marks Each

Statement for Linked Answer Questions: 52 & 53

An undirected graph G(V,E) contains $n\,(n>2)$ nodes named $v_1, v_2, \ldots v_n$. Two nodes v_i, v_j are connected if and only if $0 < |i-j| \le 2$. Each edge (v_i, v_j) is assigned a weight i + j. A sample graph with n = 4 is shown below



52. What will be the cost of the minimum spanning tree (MST) of such a graph with n nodes?

(A) $\frac{1}{12}(11n^2 - 5n)$ (B) $n^2 - n + 1$

(C) $6n - 11$ (D) $2n + 1$

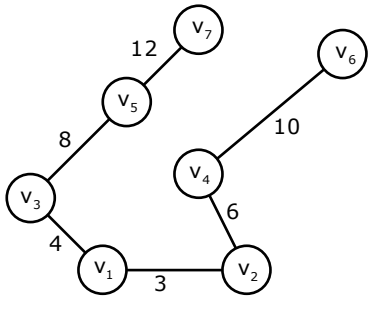
Answer: - (B)

53. The length of the path from v_5 to v_6 in the MST of previous question with n = 10 is

(A) 11 (B) 25 (C) 31 (D) 41

Answer: - (C)

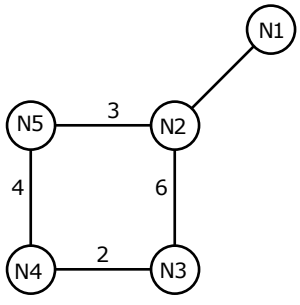
Exp: -



$12 + 8 + 4 + 3 + 6 + 10 = 31$

Statement for Linked Answer Questions: 54 & 55

Consider a network with five nodes, N1 to N5, as shown below



The net work uses a Distance Vector Routing protocol. Once the routes have stabilized, the distance vectors at different nodes are as following

N1 : (0, 1, 7, 8, 4)

N2 : (1, 0, 6, 7, 3)

N3 : (7, 6, 0, 2, 6)

N4 : (8, 7, 2, 0, 4)

N5 : (4, 3, 6, 4, 0)

Each distance vector is the distance of the best known path at that instance to nodes, N1 to N5, where the distance to itself is 0. Also, all links are symmetric and the cost is identical in both directions. In each round, all nodes exchange their distance vectors with their respective neighbors. Then all nodes update their distance vectors. In between two rounds, any change in cost of a link will cause the two incident nodes to change only that entry in their distance vectors

54. The cost of link N2-N3 reduces to 2 in (both directions). After the next round of updates, what will be the new distance vector at node, N3?

(A) (3. 2, 0, 2, 5) (B) (3, 2, 0, 2, 6)

(C) (7, 2, 0, 2, 5) (D) (7, 2, 0, 2, 6)

Answer: - (A)

Exp: -

	N_3	
N_1	3	$\rightarrow 1+2$
N_2	2	
N_3	0	
N_4	2	
N_5	5	$\rightarrow 2+3$

55. After the update in the previous question, the link N1-N2 goes down. N2 will reflect this change immediately in its distance vector as cost, ∞. After the NEXT ROUND of update, what will be the cost to N1 in the distance vector of N3?

(A) 3 (B) 9 (C) 10 (D) ∞

Answer: - (C)

Exp: - N_3 has neighbors N_2 and N_4

N_2 has made entry ∞

N_4 has the distance of 8 to N_1

N_3 has the distance of 2 to N_4

So 2 + 8 = 10

Q. No. 56 – 60 Carry One Mark Each

56. If Log (P) = (1/2)Log (Q) = (1/3) Log (R), then which of the following options is TRUE?

(A) $P^2 = Q^3R^2$ (B) $Q^2 = PR$ (C) $Q^2 = R^3P$ (D) $R = P^2Q^2$

Answer: - (B)

Exp:- $\log P = \frac{1}{2}\log Q = \frac{1}{3}\log(R) = k$

$\therefore P = b^k, Q = b^{2k}, R = b^{3k}$

Now, $Q^2 = b^{4k} = b^{3k}\, b^k = PR$

57. Choose the most appropriate word(s) from the options given below to complete the following sentence.

I contemplated_____Singapore for my vacation but decided against it.

(A) To visit (B) having to visit (C) visiting (D)for a visit

Answer: - (C)

Exp: - Contemplate is a transitive verb and hence is followed by a gerund Hence the correct usage of contemplate is verb+ ing form.

58. Choose the most appropriate word from the options given below to complete the following sentence.

If you are trying to make a strong impression on your audience, you cannot do so by being understated, tentative or_____.

(A) Hyperbolic (B) Restrained

(C) Argumentative (D) Indifferent

Answer: - (B)

Exp: - The tone of the sentence clearly indicates a word that is similar to understated is needed for the blank. Alternatively, the word should be antonym of strong (fail to make strong impression). Therefore, the best choice is restrained which means controlled/reserved/timid.

59. Choose the word from the options given below that is most nearly opposite in meaning to the given word: **Amalgamate**

(A) Merge (B) Split (C) Collect (D) Separate

Answer: - (B)

Exp: - Amalgamate means combine or unite to form one organization or structure. So the best option here is split. Separate on the other hand, although a close synonym, it is too general to be the best antonym in the given question while Merge is the synonym; Collect is not related.

60. Which of the following options is the closest in the meaning to the word below:

Inexplicable

(A) Incomprehensible (B) Indelible

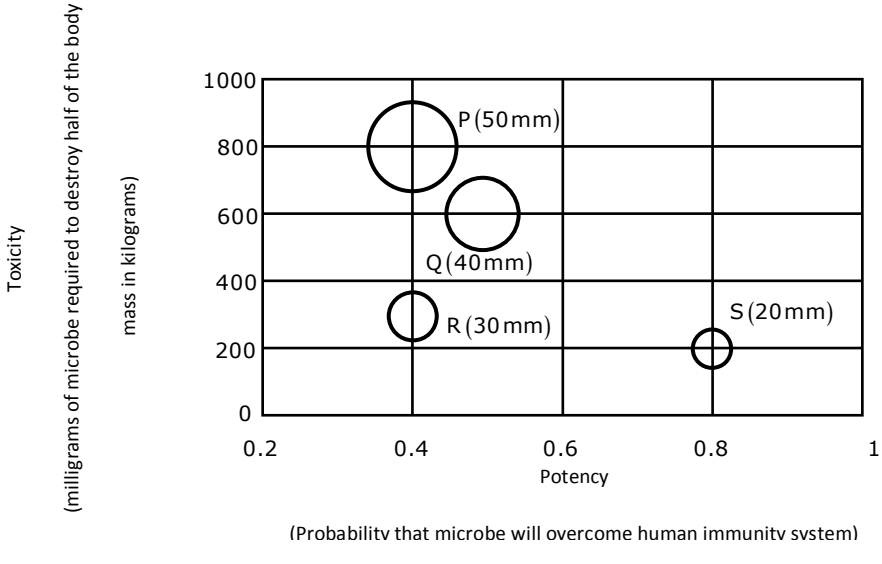
(C) Inextricable (D) Infallible

Answer: - (A)

Exp: - Inexplicable means not explicable; that cannot be explained, understood, or accounted for. So the best synonym here is incomprehensible.

Q. No. 61 – 65 Carry Two Marks Each

61. P, Q, R and S are four types of dangerous microbes recently found in a human habitat. The area of each circle with its diameter printed in brackets represents the growth of a single microbe surviving human immunity system within 24 hours of entering the body. The danger to human beings varies proportionately with the toxicity, potency and growth attributed to a microbe shown in the figure below



A pharmaceutical company is contemplating the development of a vaccine against the most dangerous microbe. Which microbe should the company target in its first attempt?

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

Answer: - (D)

Exp: - By observation of the table, we can say S

	P	Q	R	S
Requirement	800	600	300	200
Potency	0.4	0.5	0.4	0.8

62. The variable cost (V) of manufacturing a product varies according to the equation V= 4q, where q is the quantity produced. The fixed cost (F) of production of same product reduces with q according to the equation F = 100/q. How many units should be produced to minimize the total cost (V+F)?

(A) 5 (B) 4 (C) 7 (D) 6

Answer: (A)

Exp: - Checking with all options in formula: (4q+100/q) i.e. (V+F). Option A gives the minimum cost.

63. A transporter receives the same number of orders each day. Currently, he has some pending orders (backlog) to be shipped. If he uses 7 trucks, then at the end of the 4th day he can clear all the orders. Alternatively, if he uses only 3 trucks, then all the orders are cleared at the end of the 10th day. What is the minimum number of trucks required so that there will be no pending order at the end of the 5th day?

(A) 4 (B) 5 (C) 6 (D) 7

Answer: - (C)

Exp: - Let each truck carry 100 units.

$2800 = 4n + e$ n = normal

$3000 = 10n + e$ e = excess/pending

$\therefore n = \frac{100}{3}, e = \frac{8000}{3}$

$5\text{days} \Rightarrow 500x = \frac{5.100}{3} + \frac{8000}{3}$

$\Rightarrow 500x = \frac{8500}{3} 17 \Rightarrow x > 5$

Minimum possible = 6

64. A container originally contains 10 litres of pure spirit. From this container 1 litre of spirit is replaced with 1 litre of water. Subsequently, 1 litre of the mixture is again replaced with 1 litre of water and this process is repeated one more time. How much spirit is now left in the container?

(A) 7.58 litres (B) 7.84 litres (C) 7 litres (D) 7.29 litres

Answer: - (D)

Exp:- $10\left(\frac{10-1}{10}\right)^3 = 10\left(\frac{9}{10}\right)^3 = \frac{729}{1000}$

$\therefore \frac{729}{1000} \times 1 = 7.29$ litres

65. **Few school curricula include a unit on how to deal with bereavement and grief, and yet all students at some point in their lives suffer from losses through death and parting.**

Based on the above passage which topic would not be included in a unit on bereavement?

(A) how to write a letter of condolence

(B) what emotional stages are passed through in the healing process

(C) what the leading causes of death are

(D) how to give support to a grieving friend

Answer: - (C)

Exp: - The given passage clearly deals with how to deal with bereavement and grief and so after the tragedy occurs and not about precautions. Therefore, irrespective of the causes of death, a school student rarely gets into details of causes—which is beyond the scope of the context. Rest all are important in dealing with grief.