Detailed Analysis of GATE 2015 Papers

GATE CSIT Solved Paper 2015 (Set 1) Detailed Analysis

Subject	Topic	1 Mark Questions	2 Marks Questions	Total Questions	Total Marks
General Aptitude	Numerical Ability	1	2	3	5
	Verbal Ability	4	3	7	10
Total Marks					**15**
Engineering Maths	Linear Algebra	1	1	2	3
	Calculus	1	1	2	3
	Numerical Method	0	1	1	2
	Probability and Distribution	1	1	2	3
Total Marks					**11**
Digital	Number System and Code Conversion	0	1	1	2
	Boolean Algebra and KMap	0	2	2	4
	Logic GATE Families	1	0	1	1
Total Marks					**7**
Computer Organization	Memory Hierarchy and Mapping	1	0	1	1
	Pipeline	0	2	2	4
Total Marks					**5**
DS Algorithm and Programming	Data Structure and Algorithm Analysis	1	1	2	3
	Stack And Queues	1	0	1	1
	Trees	2	0	2	2
	Height Balanced Tree (AVL Tree, B-Tree)	0	1	1	2
	Priority Queues (Heaps)	1	0	1	1
	Sorting Algorithm	0	1	1	2
	C Programming	1	5	6	11
	Hashing	1	0	1	1
Total Marks					**23**
DBMS	Functional Dependency and Normalization	1	0	1	1
	SQL	1	0	1	1
	Transaction and Concurrency Control	0	1	1	2
Total Marks					**4**

Theory of Computation	Regular Expression and Languages	1	0	1	1
	Properties of CFL	0	1	1	2
	P, NP, NPH, NPC	0	1	1	2
Total Marks					**5**
Compiler Design	Parsing	1	1	2	3
Total Marks					**3**
Operating System	CPU Scheduling	1	1	2	3
	Deadlocks and Synchronization	1	1	2	3
Total Marks					**6**
Software Engineering	HTML Structure	1	0	1	1
	Validation and Verification	1	1	2	3
	Testing	1	0	1	1
Total Marks					**5**
DMGT	Graph Theory	0	1	1	2
	Sets, Function and Relations	1	1	2	3
	Combinatorics	1	0	1	1
Total Marks					**6**
Computer-Network	The Data Link Layer	1	2	3	5
	TCP/IP, UDP and Socket, IPV4	1	2	3	5
Total Marks					**10**

GATE CSIT Solved 2015 Paper (Set 2) Detailed Analysis

Subject	Topic	1 Mark Questions	2 Marks Questions	Total Questions	Total Marks
General Aptitude	Numerical Ability	2	3	5	8
	Verbal Ability	3	2	5	7
Total Marks					**15**
Engineering Maths	Linear Algebra	1	1	2	3
	Calculus	2	2	4	6
Total Marks					**9**
Digital	Boolean Algebra and KMap	0	1	1	2
	Logic Gates	0	1	1	2
	Sequential circuits	1	1	2	3
Total Marks					**7**

Computer Organization	Pipeline	0	1	1	2
	Instruction Types	1	0	1	1
	Miscellaneous	0	1	1	2
Total Marks					**5**
DS Algorithm and Programming	Data Structure and Algorithm Analysis	1	2	3	5
	Stack, Queues, Linklist	0	1	1	2
	Trees	3	0	3	3
	Priority Queues (Heaps)	0	1	1	2
	Sorting Algorithm	1	0	1	1
	Graph Algorithm	1	2	3	5
	C Programming	1	2	3	5
Total Marks					**23**
DBMS	E-R Diagram	0	1	1	2
	SQL	1	1	2	3
Total Marks					**5**
Theory of Computation	Finite Automata	0	1	1	2
	PDA	0	1	1	2
	Turning of Machine	1	0	1	1
Total Marks					**5**
Compiler Design	Parsing	1	0	1	1
Total Marks					**1**
Operating System	CPU Scheduling	0	1	1	2
	Deadlocks and Synchronization	1	0	1	1
	Memory Management and Virtual Memory	1	1	2	3
	Disc Management	0	2	2	4
Total Marks					**10**
Software Engineering	Validation and Verification	0	2	2	4
	XML	1	0	1	1
	Testing	1	0	1	1
Total Marks					**6**
DMGT	Graph Theory	0	1	1	2
	Sets, Function and Relations	1	1	2	3
	Mathematic Logic	1	0	1	1
Total Marks					**6**

Computer Network	The Data Link Layer	0	2	2	4
	TCP/IP, UDP and Socket, IPV4	3	0	3	3
	Cryptography	1	0	1	1
Total Marks					**8**

GATE CSIT Solved 2015 Paper (Set 3) Detailed Analysis

Subject	Topic	1 Mark Questions	2 Marks Questions	Total Questions	Total Marks
General Aptitude	Numerical Ability	2	4	6	10
	Verbal Ability	3	1	4	5
Total Marks					**15**
Engineering Maths	Linear Algebra	1	1	2	3
	Calculus	0	1	2	2
Total Marks					**5**
Digital	Boolean Algebra and KMap	0	1	1	2
	Combinational Digital Circuit	0	1	1	2
	Sequential Circuits	1	0	1	1
Total Marks					**5**
Computer Organization	Pipeline	0	1	1	2
	Memory Hierarchy	1	0	1	1
	Miscellaneous	0	1	1	2
Total Marks					**5**
DS Algorithm and Programming	Data Structure and Algorithm Analysis	0	2	2	4
	Height Balanced Tree (AVL Tree, B-Tree)	3	0	3	3
	Sorting Algorithm	1	0	1	1
	C Programming	2	3	5	8
	Hashing	0	1	1	2
Total Marks					**18**
DBMS	Relational Algebra and Relational Calculus	0	1	1	2
	Transaction and Concurrency Control	1	1	2	3
	File Structure	1	0	1	1
Total Marks					**6**
Theory of Computation	Regular Expression and Languages	0	2	2	4

	CGF and CFL	0	1	1	2
	Turning of machine	1	0	1	1
	P, NP, NP-HARD, NPC	1	0	1	1
Total Marks					**8**
Compiler Design	Introduction to Compiler	1	0	1	1
	Run Time Environment	0	1	1	2
Total Marks					**3**
Operating System	Process Management	1	0	1	1
	Deadlocks	1	0	1	1
	Memory Management and Virtual Memory	1	2	3	5
	I/O System	0	1	1	2
Total Marks					**9**
Software Engineering	Introduction	1	0	1	1
	Process and Module	1	0	1	1
	Testing	0	1	1	2
Total Marks					**4**
DMGT	Graph Theory	0	2	2	4
	Sets, Function and Relations	2	1	3	4
	Combinatorics	1	1	2	3
	Mathematic Logic	1	1	2	3
Total Marks					**14**
Computer-Network	The Data Link Layer	1	0	1	1
	TCP/IP, UDP and Socket, IPV4	0	3	3	6
	Application Layer	1	0	1	1
Total Marks					**8**

GATE 2015 Solved Paper
CSIT: Computer Science and Information Technology
Set – I

Number of Questions: 65 **Total Marks:100.0**

Wrong answer for MCQ will result in negative marks, (–1/3) for 1 Mark Questions and (–2/3) for 2 Marks Question.

General Aptitude

Number of Questions: 10 **Section Marks: 15.0**

Question 1 to Question 5 carry 1 mark each and Question 6 to Question 10 carry 2 marks each.

Question Number: 1 **Question Type: MCQ**

Alexander turned his attention towards India, since he had conquered Persia.

Which one of the statements below is logically valid and can be inferred from the above sentence?

(A) Alexander would not have turned his attention towards India and had he not conquered Persia.

(B) Alexander was not ready to rest on his laurels, and wanted to march to India.

(C) Alexander was completely in control of his army and could command it to move towards India.

(D) Since Alexander's kingdom extended to Indian borders after the conquest of Persia, he was keen to move further.

Solution: The logically consistent form of the above given statement is implicit only from (A).

Hence, the correct option is (A).

Question Number: 2 **Question Type: MCQ**

Most experts feel that in spite of possessing all the technical skills required to be a batsman of the highest order, he is unlikely to be so due to lack of requisite temperament. He was guilty of throwing away his wicket several times after working hard to lay a strong foundation. His critics pointed out that until he addressed this problem, success at the highest level will continue to elude him.

Which of the statement(s) below is/are logically valid and can be inferred from the above passage?

(i) He was already a successful batsman at the highest level.

(ii) He has to improve his temperament in order to become a great batsman.

(iii) He failed to make many of his good starts count.

(iv) Improving his technical skills will guarantee success.

(A) (iii) and (iv) (B) (ii) and (iii)

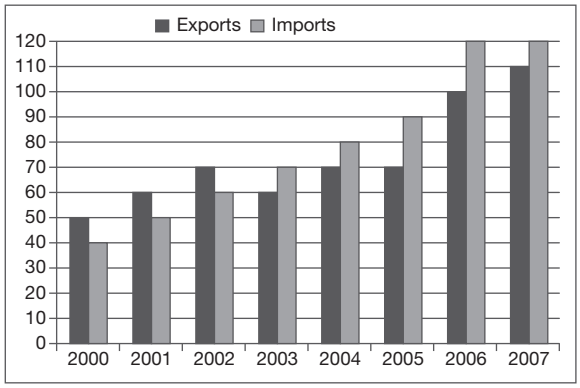
(C) (i), (ii) and (iii) (D) (ii) only

Solution: Form the given passage only statement (ii) and (iii) can be inferred. Whereas, statement (i) is contradicting the main essence of the passage and (iv) is a farfetched conclusion.

Hence, the correct option is (B).

Question Number: 3 **Question Type: NAT**

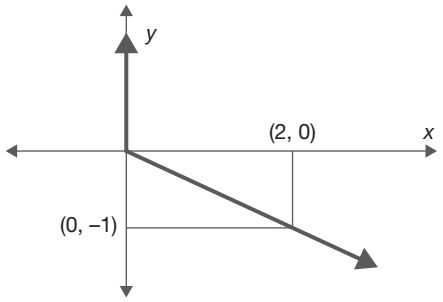
The exports and imports (in crores of Rs.) of a country from the year 2000 to 2007 are given in the following bar chart. In which year is the combined percentage increase in imports and exports the highest?



Solution: From 2005 to 2006, the combined imports and exports increased by ₹60 crores. ∴ The combined percentage increase in imports and imports in 2006 (over the previous year) was $\frac{60}{160}$ (100) % i.e., (37.5). This was the maximum combined percentage increase in imports and exports in any year over the given period.

Hence, the correct Answer is (2006).

Question Number: 4 **Question Type: MCQ**



Choose the most appropriate equation for the function drawn as a thick line, in the plot below.

(A) $x = y - |y|$ (B) $x = -(y - |y|)$

(C) $x = y + |y|$ (D) $x = -(y + |y|)$

Solution: Given,

$$x = 0 \quad \text{for} \quad y > 0$$

$$x = -2y \quad \text{for} \quad y \le 0$$

Going from the options,

Choice (A) $\Rightarrow$ $x = 0$ for $y \ge 0$

$x = 2y$ for $y \le 0$

Choice (B) $\Rightarrow$ $x = 0$ for $y \ge 0$

$x = -2y$ for $y \le 0$

Choice (C) $\Rightarrow$ $x = 2y$ for $y \ge 0$

$x = 0$ for $y \le 0$

Choice (D) $\Rightarrow$ $x = -2y$ for $y \ge 0$

$x = 0$ for $y \le 0$

$\therefore$ $x = -\left(y - |y|\right)$

Hence, the correct option is (B).

Question Number: 5 **Question Type: MCQ**

The head of a newly formed government desires to appoint five of the six selected members *P*, *Q*, *R*, *S*, *T* and *U* to portfolios of Home, Power, Defense, Telecom and Finance. *U* does not want any portfolio if *S* gets one of the five. *R* wants either Home or Finance or no portfolio. *Q* says that if *S* gets either Power or Telecom, then she must get the other one. *T* insists on a portfolio if *P* gets one.

Which is the valid distribution of portfolios?

(A) *P*-Home, *Q*-Power, *R*-Defense, *S*-Telecom, *T*-Finance.

(B) *R*-Home, *S*-Power, *P*-Defense, *Q*-Telecom, *T*-Finance.

(C) *P*-Home, *Q*-Power, *T*-Defense, *S*-Telecom, *U*-Finance.

(D) *Q*-Home, *U*-Power, *T*-Defense, *R*-Telecom, *P*-Finance.

Solution: Only option (B) is complying with all the rules and constrictions.

Hence, the correct option is (B).

Question Number: 6 **Question Type: MCQ**

Extreme focus on syllabus and studying for tests has become such a dominant concern of Indian students that they close their minds to anything _____ to the requirements of the exam.

(A) related (B) extraneous

(C) outside (D) useful

Solution: The sentence implies that students study only that which is prescribed within the syllabus and nothing beyond it. 'Extraneous' means 'not important'. 'Outside; cannot be used as 'to' is present after the blank. 'Outside to' is ungrammatical. The other choices are irrelevant to the given sentence.

Hence, the correct option is (B).

Question Number: 7 **Question Type: MCQ**

Select the pair that best expresses a relationship similar to that expressed in the pair:

Children: Pediatrician

(A) Adult: Orthopedist

(B) Females: Gynecologist

(C) Kidney: Nephrologist

(D) Skin: Dermatologist

Solution: A pediatrician treats children. In the same context, a gynecologist treats females. Though a nephrologist treats kidneys and a dermatologist treats the skin, kidneys and skin are not living beings or humans.

Hence, the correct option is (B).

Question Number: 8 **Question Type: MCQ**

The Tamil version of _____ John Abraham-starrer Madras Café _____ cleared by the Censor Board with no cuts last week, but the film's distributor's _____ no takers among the exhibitors for a release in Tamil Nadu _____ this Friday.

(A) Mr., was, found, on (B) a, was, found, at
(C) the, was, found, on (D) a, being, find, at

Solution: The use of 'the' shows that only a certain John Abraham is being referred to 'Was' and 'found' fit the next two blanks. 'On' is correct over 'at'. Though, the last blank can be deleted as well.

Hence, the correct option is (C).

Question Number: 9 Question Type: MCQ

If ROAD is written as URDG, then SWAN should be written as:

(A) VXDQ (B) VZDQ
(C) VZDP (D) UXDQ

Solution: R O A D is written as U R D G

R	O	S	D
+ 3	+3	+3	+3
↓	↓	↓	↓
U	R	D	G

Applying the same logic to SWAN

Then,

S	W	A	N
+3	+3	+3	+3
↓	↓	↓	↓
V	Z	D	Q

Hence, the correct option is (B).

Question Number: 10 Question Type: MCQ

A function $f(x)$ is linear and has a value of 29 at $x = -2$ and 39 at $x = 3$. Find its value at $x = 5$.

(A) 59 (B) 45 (C) 43 (D) 35

Solution: Let $f(x) = ax + b$ where a and b are constants

$$f(-2) = 29 \quad \text{and} \quad f(3) = 39$$

$$a(-2) + b = 29 \quad \text{and} \quad a(3) + b = 39$$

Solving these,

$$a = 2 \quad \text{and} \quad b = 33$$

$$\Rightarrow \quad f(x) = 2x + 33$$

$$\therefore \quad f(5) = 2(5) + 33 = 43$$

Hence, the correct option is (C).

Computer Science and Information Technology

Number of Questions: 55 **Section Marks: 85.0**

Question 11 to Question 35 carry 1 mark each and Question 36 to Question 65 carry 2 marks each.

Question Number: 11 Question Type: MCQ

Consider a CSMA/CD network that transmits data at a rate of 100 Mbps (10^8 bits per second) over a 1 km (kilometer) cable with no repeaters. If the minimum frame size required for this network is 1250 bytes, what is the signal speed (km/sec) in the cable?

(A) 8000 (B) 10000
(C) 16000 (D) 20000

Solution: The condition for the minimum packet size in Ethernet (CSMA/CD) is

Transmission delay = Round trip time

$$\frac{L}{B} = 2 \times \frac{d}{V}$$

$$V = 2 \times d \times \frac{B}{L}$$

$$= 2 \times 1 \times \frac{10^8}{1250 \times 8}$$

$$V = 20000 \text{ km/sec}$$

Hence, the correct option is (D).

Question Number: 12 Question Type: NAT

The velocity v (in kilometer/minute) of a motorbike which starts from rest is given at fixed intervals of time t (in minutes) as follows:

t	2	4	6	8	10	12	14	16	18	20
v	10	18	25	29	32	20	11	5	2	0

The approximate distance (in kilometers) rounded to two places of decimals covered in 20 minutes using Simpson's 1/3rd rule is _____.

Solution: The velocity V of a motorcycle at fixed intervals of time t is given as

t	2	4	6	8	10	12	14	16	18	20
V	10	18	25	29	32	20	11	5	2	0

The distance travelled in 20 minutes = $\int_{t=0}^{20} V dt$

By Simpson's $\frac{1}{3}$ – rule, we have

$$\int_0^{20} V dt = \frac{h}{3}\left[\left(V_0 + V_{10}\right) + 4\left(V_1 + V_3 + V_5 + V_7 + V_9\right) + 2\left(V_2 + V_4 + V_6 + V_8\right)\right]$$

Here, $h = 2$, $V_0 = V_{\text{at } t=0} = 0$ ($\because$ starting from rest)

$\therefore$ from (1),

$$\int_0^{20} V dt = \frac{2}{3}[(0 + 0) + 4(10 + 25 + 32 + 11 + 2) + 2\,(18 + 29 + 20 + 5)]$$

$$= 309.33 \text{ km}$$

Hence, the correct Answer is (308 to 310).

Question Number: 13 Question Type: MCQ

Assume that a merge-sort algorithm in the worst case takes 30 seconds for an input of size 64. Which of the following most closely approximates the maximum input size of a problem that can be solved in 6 minutes?

(A) 256 (B) 512

(C) 1024 (D) 2048

Solution: Time complexity of merge sort is $\theta(n \log n)$

For 64 elements, the algorithm took 30 seconds to sort

$\Rightarrow$ $(n \log n) = 30$ seconds

$(64 \log 64) = 30$ seconds

Lets convert the time taken to sort 'n' element into some time units.

$64 \log 64 = 30$

$$64 = \frac{30}{\log 64}$$

$\Rightarrow$ $64 = \frac{30}{6} =$ 5 time units

Options (A)

$256 \log_2 256 = 6$ minutes

$256 \log 256 = 360$ seconds

$$256 = \frac{360}{8} = 45 \text{ time units}$$

Option (B)

$512 \log 512 = 360$ seconds

$$512 = \frac{360}{9} = 40 \text{ time units}$$

Elements – $64 = 2^6 = 5$ time units

Elements – $128 = 2^7 = 10$ time units

Elements – $256 = 2^8 = 20$ time units

Elements – $512 = 2^9 – 40$ time units

Therefore, 512 is the maximum input size of a problem that can be solved in 6 minutes.

Hence, the correct option is (B).

Question Number: 14 Question Type: MCQ

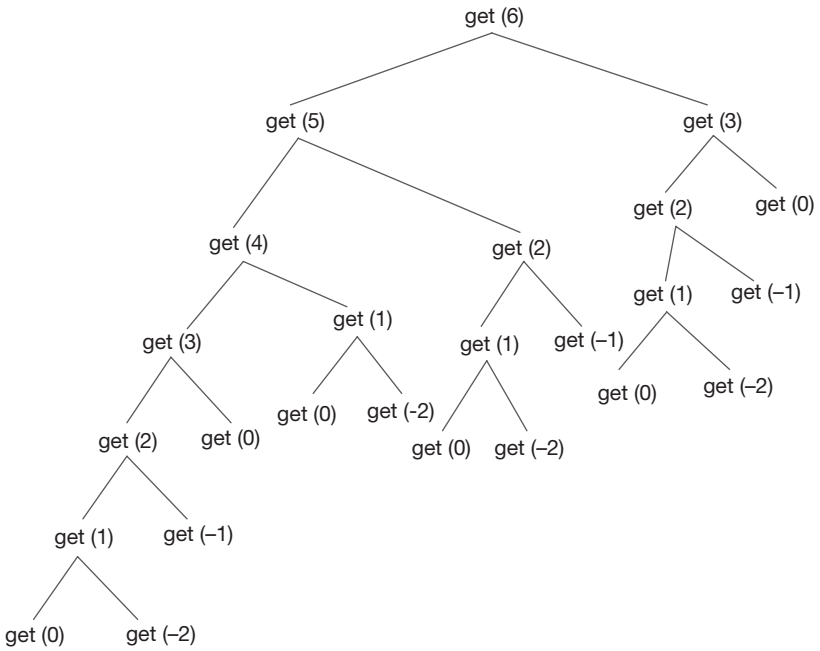
Consider the following recursive C function

```
void get (int n)
{
        if (n < 1) return;
        get (n - 1);
        get (n - 3);
        printf("%d", n);
}
```

If get (6) function is being called in main ( ) then how many times will the get ( ) function be invoked before returning to the main ( )?

(A) 15 (B) 25

(C) 35 (D) 45



Solution: Total calls: 25

Hence, the correct option is (B).

Question Number: 15 **Question Type: NAT**

Consider a B+ tree in which the search key is 12 bytes long, block size is 1024 bytes, record pointer is 10 bytes long and block pointer is 8 bytes long. The maximum number of keys that can be accommodated in each non-leaf node of the tree is _____.

Solution: Search key = 12 bytes

Block size = 1024 bytes

Record pointer = 10 bytes

Block pointer = 8 bytes

The order (P) of the internal node in a B^{+} tree,

$$P * 8 + (P - 1)(12) \leq 1024$$

$$8P + 12P - 12 \leq 1024$$

$$20p \leq 1024 + 12$$

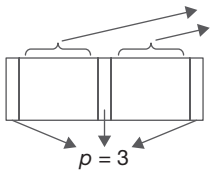
$$P \leq \frac{1036}{20} = 51.8 \cong 51$$

$$P = 51$$

If the order $p = 51$, then the keys would be 50.

Example:

Keys = 2



Hence, the correct Answer is (50).

Question Number: 16 **Question Type: MCQ**

Given the function $F = P' + QR$, where F is a function in three Boolean variables P, Q and R and $P' = !P$, consider the following statements.

($S1$) $F = \Sigma(4,5,6)$

($S2$) $F = \Sigma(0,1,2,3,7)$

($S3$) $F = \prod(4,5,6)$

($S4$) $F = \prod(0,1,2,3,7)$

Which of the following is true?

(A) ($S1$) – False, ($S2$) – True, ($S3$) – True, ($S4$) – False

(B) ($S1$) – True, ($S2$) – False, ($S3$) – False, ($S4$) – True

(C) ($S1$) – False, ($S2$) – False, ($S3$) – True, ($S4$) – True

(D) ($S1$) – True, ($S2$) – True, ($S3$) – False, ($S4$) – False

Solution: $F = P' + QR$

The given statements are in canonical form, by converting F to canonical form.

$$F = P'(Q + Q')(R + R') + (P + P')QR$$

$$= P'(QR + Q'R + QR' + Q'R') + PQR + P'QR$$

$$= P'QR + PQ'R + P'Q\,R' + P'Q'R' + PQR$$

$$= \sum \text{m}(0, 1, 2, 3, 7)$$

$$= \pi M(4, 5, 6)$$

only ($S2$) and ($S3$) are true.

Hence, the correct option is (A).

Question Number: 17 **Question Type: MCQ**

Language L_1 is polynomial time reducible to language L_2. Language L_3 is polynomial time reducible to L_2, which in turn is polynomial time reducible to language L_4. Which of the following is/are true?

(A) if $L_4 \in P$, then $L_2 \in P$

(B) if $L_1 \in P$ or $L_3 \in P$, then $L_2 \in P$

(C) $L_1 \in P$, if and only if $L_3 \in P$

(D) if $L_4 \in P$, then $L_1 \in$ P and $L_3 \in P$

Solution:

$$L_1 \to L_2$$

$$L_3 \to L_2$$

$$L_3 \to L_4$$

$$L_2 \leq_p L_4$$

$$L1 \leq_p L_2$$

Hence, the correct option is (C).

Question Number: 18 **Question Type: NAT**

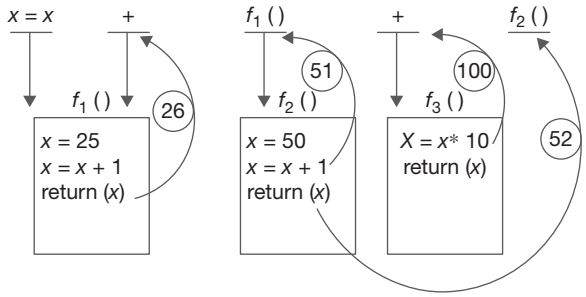
Consider the following C program

```
#include<stdio.h>
int f1(void);
int f2(void);
int f3(void);
int x = 10;

int main ( )
{
    int x = 1;
    x += f1( ) + f2 ( ) + f3 ( )
    + f2 ( );
    printf("%d", x);
    return 0;
}
int f1 () {int x = 25; x++;
           return x;}
int f2 () {static int x = 50;
           x++; return x;}
int f3 () {x *= 10; return x};
```

The output of the program is _____.

Solution:



In $f2(\,)$, x is a static variable it is initialized only once i.e., $x = 50$ it increments the x with '1'. ($x = 51$). When $f2(\,)$ is called once again, x retains the previous value and is incremented.

In $f3\,(\,)$, 'x' is not declared, but 'C' implements static scoping, it takes global value of 'x' [which is 10].

$\therefore\ x = 1 + 26 + 51 + 100 + 52 \Rightarrow 230$

Hence, the correct Answer is (230).

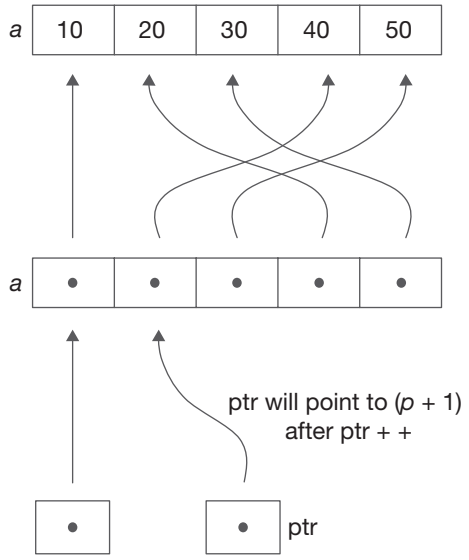
Question Number: 19 **Question Type: NAT**

Consider the following C program

```
#include<stdio.h>
int main ( )
{
   static int a[ ] = {10, 20, 30,
   40, 50};
   static int *p[ ] = {a, a+3,
   a+4, a+1, a+2};
   int **ptr = p;
   ptr++;
printf("%d%d", ptr-p, **ptr);
}
```

The output of the program is _____

Solution:



ptr – p = [pointer Arithmetic]

**ptr will contain 140

∴ it prints 140.

Hence, the correct Answer is (140).

Question Number: 20 Question Type: MCQ

Which of the following languages are context-free?

$$L_1 = \{a^m b^n a^n b^m \mid m, n \geq 1\}$$

$$L_2 = \{a^m b^n a^m b^n \mid m, n \geq 1\}$$

$$L_3 = \{a^m b^n \mid m = 2n + 1\}$$

(A) L_1 and L_2 only (B) L_1 and L_3 only

(C) L_2 and L_3 only (D) L_3 only

Solution: $L_1 = \{a^m\ b^n\ a^n\ b^m | m, n \geq 1\}$

L_1 is context free language

Consider a stack, push the '*a*' elements followed by '*b*' element, then for every '*a*' pop the elements should be '*b*'], for every *b* pop the elements [The element should be '*a*']

$$L_2 = \{a^m\ b^n\ a^m\ b^n | m, n \geq 1\}$$

L_2 is not context free

Two stacks should be maintained for the element count of '*a*' and '*b*'.

$$L_3 = \{a^m\ b^n | m = 2n + 1\}$$

L_3 is context free language.

Hence, the correct option is (B).

Question Number: 21 Question Type: MCQ

Consider the following policies for preventing deadlock in a system with mutually exclusive resources.

I. Processes should acquire all their resources at the beginning of execution. If any resource is not available, all resources acquired so far are released.

II. The resources are numbered uniquely, and processes are allowed to request for resources only in increasing resource numbers.

III. The resources are numbered uniquely, and processes are allowed to request for resources only in decreasing resource numbers.

IV. The resources are numbered uniquely. A process is allowed to request only for a resource with resource number larger than it's currently held resources.

Which of the above policies can be used for preventing deadlock?

(A) Any one of I and III but not II or IV

(B) Any one of I, III and IV but not II

(C) Any one of II and III but not I or IV

(D) Any one of I, II, III and IV

Solution: Option I, II, III and IV are deadlock prevention policies. Implementing any one of these can make system deadlock free.

Hence, the correct option is (D).

Question Number: 22 Question Type: NAT

In the network 200.10.11.144/27, the fourth octet (in decimal) of the last IP address of the network which can be assigned to a host is _____

Solution: Given network 200.10.11.144/27

To find the last IP-address of the network

Set ((32 – 27) = 5) the last 5 bits to '1' in the given IP-address.

200.10.11.144

200.10.11.100 10000

Last 5 bits set to 1

200.10.11.100 11111

$\underbrace{200}_{\text{Octet 1}}$. $\underbrace{10}_{\text{octet 2}}$. $\underbrace{11}_{\text{octet 3}}$. $\underbrace{159}_{\text{octet 4}}$

The fourth octet value in the last IP-address is 159, but last address cannot be assigned to a host hence we have to assign 158 to a host.

Hence, the correct Answer is (158).

Question Number: 23 **Question Type: NAT**

Consider a network connecting two systems located 8000 kilometers apart. The bandwidth of the network is 500×10^6 bits per second. The propagation speed of the media is 4×10^6 meters per second. It is needed to design a Go-Back-N sliding window protocol for this network. The average packet size is 10^7 bits. The network is to be used to its full capacity. Assume that processing delays at nodes are negligible. Then, the minimum size in bits of the sequence number field has to be _____

Solution: $T_T = \frac{\text{packet size}}{\text{Bandwidth}} = \frac{L}{B} = \frac{10 \times 10^6}{500 \times 10^6} = 0.02 \text{ sec}$

$$T_P = \frac{\text{distance}}{\text{velocity}} = \frac{d}{v} = \frac{8000 \times 10^3}{4 \times 10^6} = \frac{8 \times 10^6}{4 \times 10^6} = 2 \text{ sec}$$

Link utilization is 100% ($\eta = 100$)

$$a = \frac{T_P}{T_T} = \frac{2}{0.02} = 100$$

In Go-Back-N-Protocol, Efficiency = $\eta = \frac{W}{1+2a}$

$$(W = 2^n - 1) \qquad (\eta = 100\%)$$

$$\eta = \frac{2^n - 1}{1+2a}$$

$$1 = \frac{2^n - 1}{1+2a}$$

$$\Rightarrow \quad 1 + 2a = 2^n - 1$$

$$1 + 2(100) = 2^n - 1$$

$$201 + 1 = 2^n$$

$$2^n = 202$$

$$2^n \cong 2^8$$

$$n = 8$$

In sequence number, minimum bit required is 8.

Hence, the correct Answer is (8).

Question Number: 24 **Question Type: NAT**

Consider the following reservation table for a pipeline having the stages S_1, S_2 and S_3.

Time →

	1	2	3	4	5
S_1	X				X
S_2		X		X	
S_3			X		

The minimum average latency (MAL) is _____.

Solution: The time slot info for stage 1 – 10001

Time Slot info for stage 2 – 1010

Time slot info for stage 3 – 00100

From the above, the average latency will be 3.

Hence, the correct Answer is (3).

Question Number: 25 **Question Type: MCQ**

Consider the following code sequence having five instructions I_1 to I_5. Each of these instructions has the following format.

OP Ri, Rj, Rk

Where operation OP is performed on contents of registers Rj and Rk and the result is stored in register Ri.

I_1: ADD R1, R2, R3

I_2: MUL R7, R1, R3

I_3: SUB R4, R1, R5

I_4: ADD R3, R2, R4

I_5: MUL R7, R8, R9

Consider the following three statements.

*S*1: There is an anti-dependence instruction between instructions I_2 and I_5

*S*2: There is an anti-dependence between instructions I_2 and I_4

*S*3: Within an instruction pipeline anti-dependence always creates one or more stalls

Which one of the above statements is/are correct?

(A) Only *S*1 is true

(B) Only *S*2 is true

(C) Only *S*1 and *S*3 are true

(D) Only *S*2 and *S*3 are true

Solution: An anti–dependency between instructions can also be refereed as WAR hazard. There is no WAR between I_2 and I_5 .There is anti–dependency between I_2 and I_4 as I_4 writes R_3 which is read by I_2.

An anti–dependency may or may not create a stall.

Hence, the correct option is (B).

Question Number: 26 **Question Type: MCQ**

Consider the following two C code segments. Y and X are one and two dimensional arrays of size n and n × n respectively, where $2 \le n \le 10$. Assume that in both code segments, elements of Y are initialized to 0 and each element X[i] [j] of array X is initialized to i + j. Further assume that when stored in main memory all elements of X are in same main memory page frame.

Code segment 1:

```
//initialize elements of Y to 0
//initialize elements X[i] [j] of
X to i + j

for (i = 0; i < n; i++)
        Y[i] += X[0] [i];
```

Code Segment 2:

```
//initialize elements of Y to 0
//initialize elements X[i] [j] of
X to i + j

for (i = 0; i < n; i++)
        Y[i] += X[i] [0];
```

Which of the following statements is/are correct?

*S*1: Final contents of array Y will be same in both code segments

*S*2: Elements of array X accessed inside the for loop shown in code segment 1 are contiguous in main memory

*S*3: Elements of array X accessed inside the for loop shown in code segment 2 are contiguous in main memory.

(A) Only S2 is correct

(B) Only S3 is correct

(C) Only S1 and S2 are correct

(D) Only S1 and S3 are correct

Solution: Both the code segments will be initialized first [Y to 0, & X[i][j] with i + j] the values of Y[i] will be same in both segments as it is assigned i + j values to Y[i].

As the elements of X are in page frame, in code segment 1 the elements of X belong to same row, therefore they are stored in one frame.

In code segment 2 the elements of X belong to different column, it needs to access different page frames.

Hence, the correct option is (C).

Question Number: 27 Question Type: MCQ

Consider the following partial schedule S involving two transactions T1 and T2. Only the read and the write operations have been shown. The read operation on data item P is denoted by read(P) and the write operation on data item P is denoted by write(P)

	Transaction – id	
Time Instance	**T1**	**T2**
1	read(A)	
2	write(A)	
3		read(C)
4		write(C)
5		read(B)
6		write(B)
7		read(A)
8		commit
9	read(B)	

Schedule S

Suppose that the transaction T1 fails immediately after time instance 9. Which one of the following statements is correct?

(A) T2 must be aborted and then both T1 and T2 must be re-started to ensure transaction atomicity.

(B) Schedule S is non-recoverable and cannot ensure transaction atomicity.

(C) Only T2 must be aborted and then re-started to ensure transaction atomicity.

(D) Schedule S is recoverable and can ensure atomicity and nothing else needs to be done.

Solution:

	Transaction-Id	
	T_1	T_2
1	read(A)	
2	write(A)	
3		read(C)
4		write(C)
5		read(B)
6		write(B)
7		read(A)
8		Commit
9	read(B)	

There is one RW-conflict (2 → 7)

In the RW-conflict, the transaction T_1 is performing write operation, so T_1 has to commit first, T_2 is performing read operation so it has to commit later.

⇒ It is not recoverable.

Hence, the correct option is (B).

Question Number: 28 **Question Type: MCQ**

If the following system has non-trivial solution,

$$px + qy + rz = 0$$
$$qx + ry + pz = 0$$
$$rx + py + qz = 0,$$

then which one of the following options is TRUE?

(A) $p - q + r = 0$ or $p = q = -r$

(B) $p + q - r = 0$ or $p = -q = r$

(C) $p + q + r = 0$ or $p = q = r$

(D) $p - q + r = 0$ or $p = -q = -r$

Solution: Given system of equations is

$$px + qy + rz = 0$$
$$qx + ry + pz = 0 \quad (1)$$
$$rx + py + qz = 0$$

which can be written in matrix form as

$$AX = 0$$

Where $A = \begin{bmatrix} p & q & r \\ q & r & p \\ r & p & q \end{bmatrix}; X = \begin{bmatrix} x \\ y \\ z \end{bmatrix} and\ O = \begin{bmatrix} 0 \\ 0 \\ 0 \end{bmatrix}$

Given (1) has non-trivial solutions

$$\Rightarrow \quad \text{Det } A = 0 \Rightarrow \begin{vmatrix} p & q & r \\ q & r & p \\ r & p & q \end{vmatrix} = 0$$

$$\Rightarrow \quad pqr - p^3 - q^3 + pqr + pqr - r^3 = 0$$

$$\Rightarrow \quad p^3 + q^3 + r^3 - 3\,pqr = 0$$

$$\Rightarrow \quad p^3 + q^3 + r^3 = 3pqr$$

which is possible only when

$$p + q + r = 0 \text{ (OR) } p = q = r.$$

Hence, the correct option is (C).

Question Number: 29 **Question Type: NAT**

Consider the following C program:

```
#include<stdio.h>
int main( )
{
   int i, j, k = 0;
   j = 2 * 3 / 4 + 2.0 / 5 + 8 / 5;
   k -= --j;
   for (i = 0; i < 5; i ++)
   {
      switch(i + k)
      {
         case 1:
         case 2: printf
         ("\n%d", i + k);
         case 3: printf
         ("\n%d", i + k);
         default: printf(
         ("\n%d", i + k);
      }
   }
return 0;
}
```

The number of times printf statement is executed is _____.

Solution:

j = 2 * 3 / 4 + 2.0 / 5 + 8 / 5;

6 | 4 + 2.0 | 5 + 8 | 5

↓ ↓ ↓

1 + 0 + 1

1 + 0 + 1

= 2

K = K– (– – j)

K = 0 – 1

K = – 1

i = 0

i + k ⇒ 0 – 1 ⇒ – 1

only one print f( ) is executed

i = 1

i + k ⇒ –1 + 1 ⇒ 0

only one printf( ) is executed

i = 2

i + k ⇒ 2 – 1 ⇒ 1

the printf( ) is executed 3 times.

i = 3

i + k ⇒ 3 – 1 ⇒ 2

The printf( ) is executed 3 times

i = 4

i + k ⇒ 4 – 1 ⇒ 3

the printf( ) is executed 2 times

∴ The printf( ) is executed 10 times.

Hence, the correct Answer is (10).

Question Number: 30 **Question Type: MCQ**

If for non-zero x, $af(x) + bf\left(\frac{1}{x}\right) = \frac{1}{x} - 25$ where $a \neq b$ then $\int_1^2 f(x)\,dx$ is

(A) $\frac{1}{a^2-b^2}\left[a(\ln 2 - 25) + \frac{47b}{2}\right]$

(B) $\frac{1}{a^2-b^2}\left[a(2\ln 2 - 25) - \frac{47b}{2}\right]$

(C) $\frac{1}{a^2-b^2}\left[a(2\ln 2 - 25) + \frac{47b}{2}\right]$

(D) $\frac{1}{a^2-b^2}\left[a(\ln 2 - 25) - \frac{47b}{2}\right]$

Solution: Given $af(x) + b\ f\left(\frac{1}{x}\right) = \frac{1}{x} - 25$ (1)

Replacing x by $\frac{1}{x}$, we have $af\left(\frac{1}{x}\right) + b\,f(x)$

$$= x - 25 \quad (2)$$

$a(1) - b(2) \Rightarrow$

$$a^2 f(x) + abf\left(\frac{1}{x}\right) = a\left(\frac{1}{x} - 25\right)$$

$$abf\left(\frac{1}{x}\right) + b^2 f(x) = b(x - 25)$$

$$a^2 f(x) - b^2 f(x) = a\left(\frac{1}{x} - 25\right) - b(x - 25)$$

$$\Rightarrow \quad (a^2 - b^2) f(x) = \left(\frac{a}{x} - bx\right) - (a - b)25$$

$$\Rightarrow \quad f(x) = \frac{1}{a^2-b^2}\left[\frac{a}{x} - bx - (a-b)25\right]$$

Now

$$\int_1^2 f(x)\,dx = \int_1^2 \left[\frac{1}{a^2-b^2}\left(\frac{a}{x} - bx - (a-b)25\right)\right]$$

$$= \frac{1}{a^2-b^2}\left[a\ln x - \frac{b}{2}x^2 - (a-b)25x\right]_1^2$$

$$= \frac{1}{a^2-b^2}\left[a(\ln 2 - 25) + \frac{47b}{2}\right]$$

Hence, the correct option is (A).

Question Number: 31 **Question Type: NAT**

Let G be a connected undirected graph of 100 vertices and 300 edges. The weight of a minimum spanning tree of G is 500. When the weight of each edge of G is increased by five, the weight of a minimum spanning tree becomes_____.

Solution: Vertices = 100

Edges = 300

Minimum spanning tree weight = 500

In minimum spanning tree, if there are n-vertices there will be $(n - 1)$ edges.

$\therefore$ For 100 vertices, we will have 99 edges in the minimum spanning tree.

99 Edges, Weight is 500,

Now each edge weight is increased by 5

$\Rightarrow$ $99 \times 5 = 495$

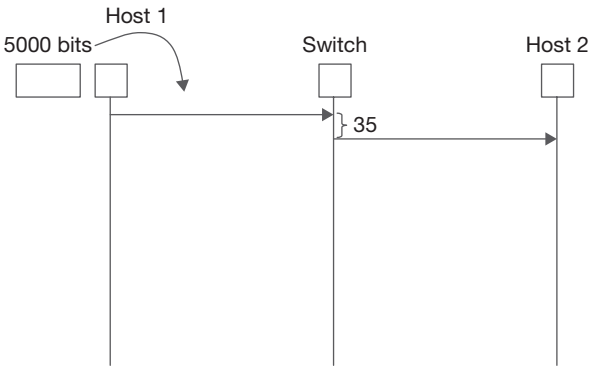
Total weight = 500 + 495 = 995

Hence, the correct Answer is (995).

Question Number: 32 **Question Type: NAT**

Two hosts are connected via a packet switch with 10^7 bits per second links. Each link has a propagation delay of 20 microseconds. The switch begins forwarding a packet 35 microseconds after it receives the same. If 10000 bits of data are to be transmitted between the two hosts using a packet size of 5000 bits, the time elapsed between the transmission of the first bit of data and the reception of the last bit of the data in microseconds is _____.

Solution:



Transmission Time (TT) = The time taken to put the packet on line:

$$TT = \frac{\text{packet size}}{\text{Bandwidth}} = \frac{5000}{10^7} = 500 \text{ micro seconds}$$

T_p = 20 micro seconds

T_p = The amount of time taken for the packet to transfer from one end to another.

1. One packet is kept on line in 500 micro seconds.
2. Immediately second packet is also kept on line (T_p = 20 micro seconds of first packet is merged with TT = 500 micro seconds of second packet)

   ⇒ 500 micro seconds
3. First packet's, processing delay 35 micro seconds is also merged with TT = 500 micro seconds of second packet.
4. Second packet takes T_P = 20 micro seconds to switch (mean while packet 1 will be traversing towards host 2)
5. At switch, second packet is held for 35 micro seconds, then sent for T_P = 20 micro seconds.
6. Last bit of second packet takes TT = 500 micro seconds to reach host 2.

   Total time = 500 + 500 + 20 + 35 + 20 + 500

   = 1575

Hence, the correct Answer is (1575).

Question Number: 33 **Question Type: MCQ**

For the processes listed in the following table, which of the following scheduling schemes will give the lowest average turnaround time?

Process	Arrival Time	Processing Time
A	0	3
B	1	6
C	4	4
D	6	2

(A) First come first serve

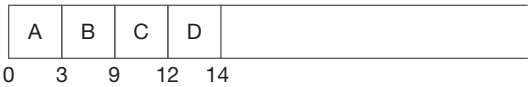
(B) Non-preemptive shortest job first

(C) Shortest remaining time

(D) Round Robin with quantum value two

Solution:

FCFS



Process	Arrival Time	Burst Time	Completion Time	Turnaround Time (TAT)
A	0	3	3	3
B	1	6	9	8
C	4	4	13	9
D	6	2	15	9

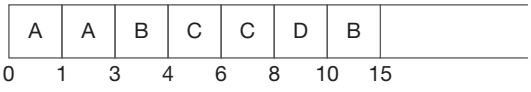
Average TAT = $\frac{29}{4}$ = 7.25

SJF

Process	Arrival Time (A.T)	Burst Time (B.T)	Completion Time (C.T)	Turnaround Time (TAT)
A	0	3	3	3
B	1	6	9	8
C	4	4	15	11
D	6	2	11	5

Average TAT = $\frac{27}{4}$ = 6.75

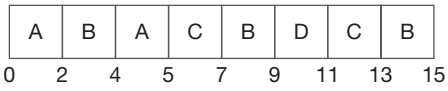
SRTF



Process	A.T	B.T	C.T	T.A.T
A	0	3	5	3
B	1	6	15	14
C	4	4	8	4
D	6	2	10	4

Average T.A.T = $\frac{25}{4}$ = 6.25

Round Robin



Process	A.T.	B.T.	C.T.	T.A.T.
A	0	3	5	5
B	1	6	15	14
C	4	4	13	9
D	6	2	11	5

Average T.A.T. = $\frac{33}{4} = 8.25$

Shortest remaining first has less average T.A.T.

Hence, the correct option is (C).

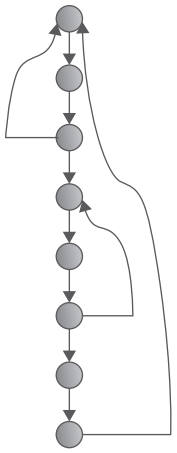
Question Number: 34 **Question Type: MCQ**

Consider three software items: Program-X, Control Flow Diagram of Program-Y and Control Flow Diagram of Program-Z as shown below:

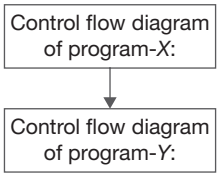
Program-*X*:

```
Sumcal (int maxint, int value)
{
      int result=0, i=0;
      if (value < 0)
      {
         value = –value;
      }
      while ((i<value) AND (result
<= maxint))
      {
         i=i+1;
        result = result + 1;
      }
      if (result <= maxint)
      {
         print (result);
      }
      else
      {
         print (”large”);
      }
      printf (”end of program”);
}
```

Control flow diagram of program-*Y*:



Control flow diagram of program-*Z*:



The value of McCabe's Cyclomatic complexity of program-X, Program-Y, and Program-Z respectively are

(A) 4, 4, 7 (B) 3, 4, 7

(C) 4, 4, 8 (D) 4, 3, 8

Solution:

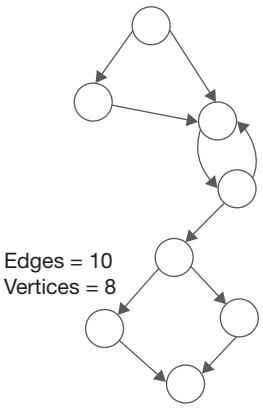
Program X:

Cyclomatic complexity of program X is the number of conditions +1.

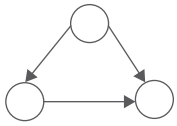
There are 2 'if' conditions and 1 'while' condition

∴ program 'X' = 4

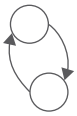
Control flow diagram for program – X:



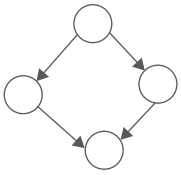
If condition



While condition



If-else condition:



Program y:

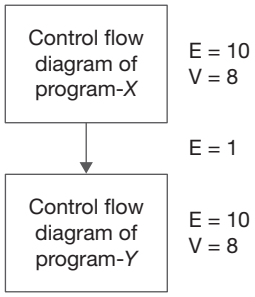
Edges = 10

Vertices = 8

Cyclomatic complexity = 10 – 8 + 2 = 4

∴ program 'Y' = 4

Program Z:



Cyclomatic complexity

Total number of edges = 10 + 1 + 10 = 21

Total number of vertices = 8 + 8 = 16

$\Rightarrow$ 21 – 16 + 2 = 7

$\therefore$ program 'Z' = 7

Hence, the correct option is (A).

Question Number: 35 Question Type: MCQ

Consider the equation $(43)_x = (y3)_8$ where x and y are unknown. The number of possible solutions is _____.

Solution: $(43)_x = (y3)_8$

By converting to decimal system

$$4x^1 + 3.x^0 = y.8^1 + 3.8^\circ$$

$$4x + 3 = 8y + 3$$

$$4x = 8y$$

$$x = 2y$$

x is base of number system $x > 4$

y is number in the number system with base 8, so $y < 8$.

x	y
6	3
8	4
10	5
12	6
14	7

Number of possible solutions = 5

Question Number: 36 Question Type: MCQ

Let R be a relation on the set of ordered pairs of positive integers such that $((p, q),(r, s)) \in R$ if and only if $p – s = q – r$. Which one of the following is true about R?

(A) Both reflexive and symmetric

(B) Reflexive but not symmetric

(C) Not reflexive but symmetric

(D) Neither reflexive nor symmetric

Solution: The relation R on the set of ordered pairs of positive integers given by

$$R = \{((p, q), (r, s))/p – s = q – r\}$$

Consider $((a, b), (a, b))$

$$((a, b), (a, b)) \in R \text{ only if } a – b = b – a$$

which is NOT true always

$\therefore$ R is NOT reflexive (1)

Let $((a, b), (c, d)) \in R$

$\Rightarrow$ $a – d = b – c$

(By definition of R)

$\Rightarrow$ $d – a = c – b$

$\Rightarrow$ $c – b = d – a$

$\Rightarrow$ $((c, d), (a, b)) \in R$

$\Rightarrow$ R is symmetric (2)

Hence from (1) and (2), R is NOT reflexive but symmetric.

Hence, the correct option is (C).

Question Number: 37 Question Type: NAT

Suppose X_i for $i = 1,2,3$ are independent and identically distributed random variables whose probability mass functions are $Pr[X_i = 0] = Pr[X_i = 1] = ½$ for $i = 1,2,3$. Define another random variable $Y = X_1 X_2 \oplus X_3$, where $\oplus$ denotes XOR. Then,

$Pr[Y = 0|X_3 = 0]$ = _____.

Solution:

x_1	x_2	x_3	x_1x_2	$x_1x_2 \oplus x_3$
0	0	0	0	0
0	0	1	0	1
0	1	0	0	0
0	1	1	0	1
1	0	0	0	0
1	0	1	0	1
1	1	0	1	1
1	1	1	1	0

$P_r[Y = 0/x_3 = 0]$ is the probability of $Y = 0$, when $x_3 = 0$ from the truth table, $x_3 = 0$, 4 times, and $Y = x_1 x_2 \oplus x_3 = 0$ 3 times.

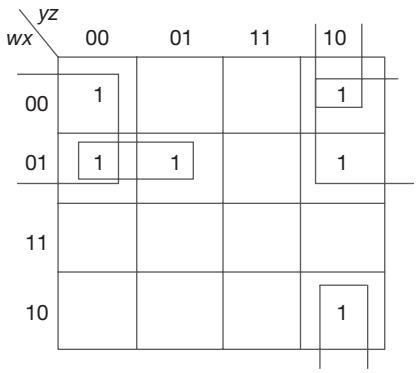
So $P_r[Y = 0/x_3 = 0] = \frac{3}{4} = 0.75$

Hence, the correct Answer is (0.75).

Question Number: 38 **Question Type: NAT**

The total number of prime implicants of the function $f(w, x, y, z) = \Sigma(0, 2, 4, 5, 6, 10)$ is _____.

Solution: $f(w, x, y, z) = \Sigma m(0, 2, 4, 5, 6, 10)$



$f = w'xy' + w'z' + x'yz'$

3 prime implicants (2 pairs, 1 Quad)

Hence, the correct Answer is (3).

Question Number: 39 **Question Type: NAT**

Suppose $c = <c[0], \ldots, c[k-1]>$ is an array of length k, where all the entries are from the set {0, 1}. For any positive integers a and n, consider the following pseudo code.

```
DOSOMETHING (c, a, n)
   z ← 1
for i ← 0 to k – 1
     do z ← z^2 mod n
        if c[i] = 1
           then z ← (z × a) mod n
return z
```

If $k = 4$, $c = <1,0,1,1>$, $a = 2$ and $n = 8$, then the output of DOSOMETHING(c, a, n) is _____.

Solution:

```
K = 4; C = <1, 0, 1, 1>; a = 2; n = 8
z = 1

at i = 0:-
   z = 1^2 mod 8 = 1
if (C[0] = 1)
   z = 1 × 2 mod 8 = 2

i = 1:-
   z = 2^2 mod 8 = 4
i = 2
   z = 4^2 mod 8 = 0
   z = (0 × 2)mod 8 = 0
   i = 3
   z = 0^2 mod 8 = 0
   z = (0 × 2) mod 8 = 0
z = 0
```

Hence, the correct Answer is (0).

Question Number: 40 **Question Type: MCQ**

Let $f(n) = n$ and $g(n) = n^{(1 + \sin n)}$, where n is a positive integer. Which of the following statements is/are correct?

I. $f(n) = O(g(n))$

II. $f(n) = \Omega(g(n))$

(A) Only I (B) Only II

(C) Both I and II (D) Neither I nor II

Solution: $f(n) = n$

$$g(n) = n^{(1+\sin n)}$$

n = positive integer

$$-1 \le \sin n \le 1$$

Suppose if we take '–1' in the place of (sin n) then $g(n) = n^\circ = 1$

Suppose If we take '1' in the place of (sin n) then $g(n) = n^2$

$g(n)$ value keeps changing. So neither I nor II can be correct.

Hence, the correct option is (D).

Question Number: 41 **Question Type: MCQ**

Consider the following grammar G

$$S \rightarrow F \mid H$$
$$F \rightarrow p \mid c$$
$$H \rightarrow d \mid c$$

Where S, F and H are non-terminal symbols, p, d and c are terminal symbols. Which of the following statement(s) is/are correct?

S1. LL(1) can parse all strings that are generated using grammar G

S2. LR(1) can parse all strings that are generated using grammar G

(A) Only S1

(B) Only S2

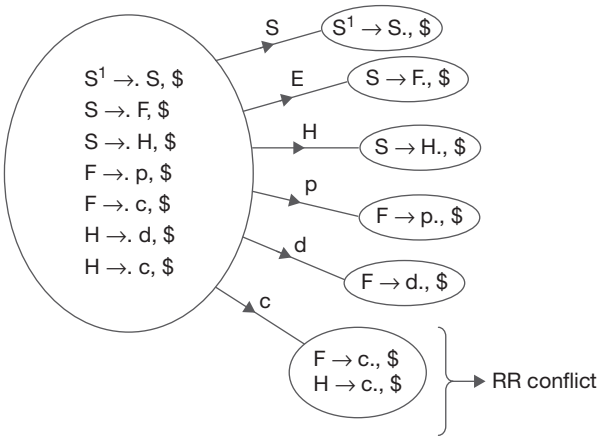
(C) Both S1 and S2

(D) Neither S1 nor S2

Solution:

$$S \rightarrow F|H$$
$$F \rightarrow |C$$
$$H \rightarrow d|c$$

LR(1)



The above grammar is having RR conflict therefore it is not LR(1) grammar.

LL(1)

$$S \rightarrow F$$
$$S \rightarrow H$$
$$F \rightarrow p|c$$
$$H \rightarrow d|c$$

First (S) = {p, c, d}

The productions of S → F, S → H will be at

M[S, c]

i.e., at M[S, c] there will be multiple productions.

∴ it is not LL(1).

Hence, the correct option is (D).

Question Number: 42 Question Type: MCQ

Consider the following C program segment.

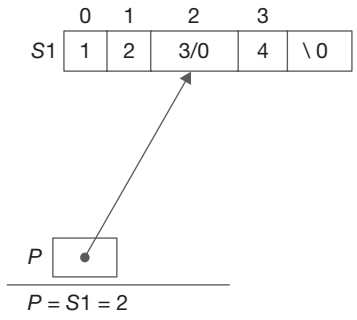
```
#include <stdio.h>
int main()
{
   char s1[7] = "1234", *p;
   p = s1 + 2;
   *p = '0';
   printf("%s", s1);
}
```

What will be printed by the program?

(A) 12 (B) 120400

(C) 1204 (D) 1034

Solution:



P is a pointer pointing to the 3rd character of S1

$$* P = '0';$$

it rewrites the value of S1[2] ('3' is replaced with 0)

S1 had '1204', when S1 is printed, it prints 1204.

Hence, the correct option is (C).

Question Number: 43 Question Type: MCQ

Suppose U is the power set of the set $S = \{1,2,3,4,5,6\}$. For any $T \in U$, let $|T|$ denote the number of elements in T and T' denote the complement of T. For any T, $R \in U$, let $T \setminus R$ be the set of all elements in T which are not in R. Which one of the following is true?

(A) $\forall X \in U\,(|X| = |X'|)$

(B) $\exists X \in U \exists Y \in U\,(|X| = 5, |Y| = 5 \text{ and } X \cap Y = \phi)$

(C) $\forall X \in U \forall Y \in U(|X| = 2, |Y| = 3 \text{ and } X \setminus Y = \phi)$

(D) $\forall X \in U \forall Y \in U\,(X \setminus Y = Y' \setminus X')$

Solution: Given $S = \{1, 2, 3, 4, 5, 6\}$

$$U = P(S)$$

Consider the set $X \setminus Y = \{x/x \in S, x \in X \text{ and } x \notin Y\}$

$= \{x/x \in S, x \in X \text{ and } x \notin Y'\}$

$= \{x/x \in S, x \in Y' \text{ and } x \notin X'\}$

$= Y' \setminus X', \forall X \in U, \forall Y \in U$

Hence, the correct option is (D).

Question Number: 44 **Question Type: MCQ**

Consider the relation $X(P, Q, R, S, T, U)$ with the following set of functional dependencies

$$F = \{ \{P, R\} \rightarrow \{S, T\} \quad \{P, S, U\} \rightarrow \{Q, R\} \}$$

Which of the following is the trivial functional dependency in F^+, where F^+ is closure of F?

(A) $\{P, R\} \rightarrow \{S, T\}$ (B) $\{P, R\} \rightarrow \{R, T\}$

(C) $\{P, S\} \rightarrow \{S\}$ (D) $\{P, S, U\} \rightarrow \{Q\}$

Solution:

Trivial:

If $A \rightarrow B$

B has to be subset of A

$\{P, S\} \rightarrow \{S\}$

$\{S\}$ is subset of $\{P, S\}$

Hence, the correct option is (C).

Question Number: 45 **Question Type: MCQ**

The maximum number of processes that can be in Ready state for a computer system with n CPUs is

(A) n (B) n^2

(C) 2^n (D) Independent of n

Solution: The maximum number of processes that are running will be 'n', with each process assigned to CPU, but the number of processes present in ready queue is independent of the number of CPU's.

Hence, the correct option is (D).

Question Number: 46 **Question Type: MCQ**

Among simple LR (SLR), canonical LR, and look-ahead LR (LALR), which of the following pairs identify the method that is very easy to implement and the method that is the most powerful, in that order?

(A) SLR, LALR

(B) Canonical LR, LALR

(C) SLR, canonical LR

(D) LALR, canonical LR

Solution: CLR is more powerful among all the parsers. SLR parser is easy to implement, as it works on only LR(0) items, CLR parser works on LR(0) items and their corresponding look – ahead's.

Hence, the correct option is (C).

Question Number: 47 **Question Type: MCQ**

Let # be a binary operator defined as

$X \# Y = X' + Y'$ where X and Y are Boolean variables.

Consider the following two statements.

(S1) $(P \# Q) \# R = P \# (Q \# R)$

(S2) $Q \# R = R \# Q$

Which of the following is/are true for the Boolean variables P, Q and R?

(A) Only S1 is true

(B) Only S2 is true

(C) Both S1 and S2 are true

(D) Neither S1 nor S2 are true

Solution: $X \# Y = X' + Y' = (XY)'$ – this is NAND gate.

$$(S1) = (P \# Q) \# R \neq P \# (Q \# R)$$

NAND gate does not obey associative law

$$((PQ)'.R)' \neq (P.(QR)')'$$

$$PQ + R' \neq P' + QR$$

$$(S2)\ Q \# R = R \# Q$$

Commutative law is, true for NAND gate

$$(QR)' = (RQ)'$$

$$Q' + R' = R' + Q'$$

(S2) is true.

Hence, the correct option is (B).

Question Number: 48 **Question Type: NAT**

Consider a software project with the following information domain characteristics for calculation of function point metric.

Number of external inputs (I) = 30

Number of external outputs (O) = 60

Number of external inquiries (E) = 23

Number of files (F) = 08

Number of external interfaces (N) = 02

It is given that the complexity weighting factors for I, O, E, F and N are 4, 5, 4, 10 and 7, respectively. It is also given that, out of fourteen value adjustment factors that influence the development effort, four factors are not applicable, each of the other four factors has value 3, and each of the remaining factors has value 4. The computed value of function point metric is _____.

Solution: Number of external inputs (I) = 30

Number of external outputs (O) = 60

Number of external enquires (E) = 23

Number of files (F) = 08

Number of external interfaces (N) = 2

The weighting factors for I, O, E, F and N are 4, 5, 4, 10 and 7.

Total Count = $30 \times 4 + 60 \times 5 + 23 \times 4 + 8 \times 10 + 2 \times 7$

$= 120 + 300 + 92 + 80 + 14$

$= 606$

Function Point = Total Count $*$ EAF

Effort adjustment factor (EAF) = $0.65 + 0.01 * \Sigma f_i$

$$EAF = 0.65 + 0.01 * \Sigma f_i$$

Σf_i = sum of the fourteen adjustment factors

Out of 14, we will consider only 10 [given in problem, 4 are neglected]

$\Sigma f_i = 3 + 3 + 3 + 3 + 4 + 4 + 4 + 4 + 4 + 6$

$\Sigma f_i = 4 \times 3 + 6 \times 4$

$= 12 + 24$

$= 36$

$EAF = 0.65 + 0.01 \times 36$

$= 1.01$

$FP = 606 * 1.01$

$= 612.06$

Hence, the correct Answer is (612 to 613).

Question Number: 49 **Question Type: MCQ**

In a web server, ten web pages are stored with the URLs of the form http://www.yourname.com/var.html; where, var is a different number from 1 to 10 for each web page. Suppose, the client stores the web page with var = 1 (say W1) in local machine, edits and then tests. Rest of the web pages remain on the web server. W1 contains several relative URLs of the form 'var.html' referring to the other web pages. Which one of the following statements needs to be added in W1, so that all the relative URLs in W1 refer to the appropriate web pages on the web server?

(A) <a href:http://www.yourname.com/", href: "var.html">

(B) <base href:http://www.yourname.com/">

(C) <a href:http://www.yourname.com/">

(D) <base href:http://www.yourname.com/", range: "var.html">

Solution: <base href: "http: //www.yourname.com/">

It reflects to the given data;

Hence, the correct option is (B).

Question Number: 50 **Question Type: MCQ**

Consider the following statements

I. TCP connections are full duplex

II. TCP has no option for selective acknowledgement

III. TCP connections are message streams

(A) Only I is correct

(B) Only I and III are correct

(C) Only II and III are correct

(D) All of I, II and III are correct

Solution: TCP connections are full duplex.

Hence, the correct option is (A).

Question Number: 51 **Question Type: MCQ**

Consider the equality $\sum_{i=0}^{n} i^3 = X$ and the following choices for X

I. $\theta(n^4)$ II. $\theta(n^5)$

III. $O(n^5)$ IV. $\Omega(n^3)$

The equality above remains correct if X is replaced by

(A) Only I

(B) Only II

(C) I or III or IV but not II

(D) II or III or IV but not I

Solution: $\sum_{i=0}^{n} i^3$

$\Rightarrow \quad 0^3 + 1^3 + 2^3 + 3^3 + 4^3 + \ldots + n^3$

$\Rightarrow \quad 1^3 + 2^3 + \ldots + n^3$

It is sum of cubes of 1st 'n' natural numbers

$\Rightarrow \quad \frac{n^2(n+1)^2}{4}$

It is $\theta(n^4)$ as $n^4 \le \frac{n^2(n+1)^2}{4} \le 4n^4$

It is $O(n^5)$ as $\frac{n^2(n+1)^2}{4} \le C n^5$

(C = constant, $C > 0$)

It is $\Omega(n^3)$ as $\frac{n^2(n+1)^2}{4} \ge n^3$

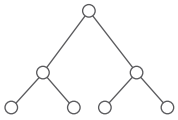
But it is not $\theta(n^5)$

Hence, the correct option is (C).

Question Number: 52 **Question Type: NAT**

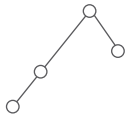
Consider a binary tree T that has 200 leaf nodes. Then, the numbers of nodes in T that have exactly two children are _____.

Solution: Let us consider the following Trees.



4 – leaves

(3 – nodes has exactly 2 children)



2 – leaves

(1 – node has exactly 2 children)

$\therefore$ 200 leaf nodes $\Rightarrow$ 199 nodes will have exactly 2 – children

Hence, the correct Answer is (199).

Question Number: 53 **Question Type: NAT**

Given a hash table T with 25 slots that stores 2000 elements, the load factor $\propto$ for T is _____ .

Solution:

$$\text{Load factor} = \frac{\text{Number of elements}}{\text{slots}} = \frac{2000}{25} = 80$$

Hence, the correct Answer is (80).

Question Number: 54 **Question Type: MCQ**

In the given matrix $\begin{bmatrix} 1 & -1 & 2 \\ 0 & 1 & 0 \\ 1 & 2 & 1 \end{bmatrix}$, one of the Eigen values is 1. The eigenvectors corresponding to the Eigen value 1 are

(A) $\{\infty(4, 2, 1) | \infty \neq 0, \infty \in R\}$

(B) $\{\infty(-4, 2, 1) | \infty \neq 0, \infty \in R\}$

(C) $\{\infty(\sqrt{2}, 0, 1) | \infty \neq 0, \infty \in R\}$

(D) $\{\infty(-\sqrt{2}, 0, 1) | \infty \neq 0, \infty \in R\}$

Solution: Let $A = \begin{bmatrix} 1 & -1 & 2 \\ 0 & 1 & 0 \\ 1 & 2 & 1 \end{bmatrix}$

Given $\lambda = 1$ is an eigen value of A.

Let $X = \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix}$ be an Eigen vector of A corresponding to the Eigen value $\lambda = 1$

$$\Rightarrow \quad (A - \lambda I) X = 0$$

$$\Rightarrow \quad (A - I)X = 0$$

$$\Rightarrow \quad \begin{bmatrix} 0 & -1 & 2 \\ 0 & 0 & 0 \\ 1 & 2 & 0 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix} = \begin{bmatrix} 0 \\ 0 \\ 0 \end{bmatrix}$$

$$\Rightarrow \quad -x_2 + 2x_3 = 0$$

$$\Rightarrow \quad x_3 = \frac{x_2}{2}$$

and $\quad x_1 + 2x_2 = 0$

$$\Rightarrow \quad x_1 = -2x_2$$

Let $x_2 = k$, where K is arbitrary

$$\therefore \quad x_1 = -2k \quad \text{and} \quad x_3 = \frac{k}{2}$$

$\therefore$ The Eigen vector of A corresponding to the Eigen value $\lambda = 1$ is $X = \begin{bmatrix} -2k \\ k \\ \frac{k}{2} \end{bmatrix} \Rightarrow = \begin{bmatrix} -4\alpha \\ 2\alpha \\ \alpha \end{bmatrix}$,

where $k = 2\alpha$, α being arbitrary

$$= \alpha \begin{bmatrix} -4 \\ 2 \\ 1 \end{bmatrix}$$

Hence, the correct option is (B).

Question Number: 55 **Question Type: MCQ**

The value of $\lim_{x \to \infty} \left(1 + x^2\right)^{e^{-x}}$ is

(A) 0 (B) $\frac{1}{2}$

(C) 1 (D) ∞

Solution: Let $y = \underset{x \to \infty}{Lim} \left(1 + x^2\right)^{e^{-x}}$

$$\Rightarrow \quad \ln y = \ln \left(\lim_{x \to \infty} \left(1 + x^2\right)^{e^{-x}} \right)$$

$$= \lim_{x \to \infty} \left[\ln \left(\left(1 + x^2\right)^{e^{-x}} \right) \right]$$

$$\Rightarrow \quad = \lim_{x\to\infty}\left[e^{-x}\ln\left(1+x^2\right)\right]$$

$$= \lim_{x\to\infty}\left[\frac{\ln\left(1+x^2\right)}{e^x}\right]$$

$$\Rightarrow \quad = \lim_{x\to\infty}\left[\frac{2x/\left(1+x^2\right)}{e^x}\right]$$

(By L'Hospitals Rule)

$$= \lim_{x\to\infty}\left[\frac{1}{e^x}\cdot\frac{2/x}{\left(1+\frac{1}{x^2}\right)}\right]$$

$$\Rightarrow \quad \ln y = 0$$

$$\Rightarrow \quad y = e^0 = 1$$

$$\Rightarrow \quad \lim_{x\to\infty}\left(1+x^2\right)^{e^{-x}} = 1$$

Hence, the correct option is (C).

Question Number: 56 Question Type: NAT

The number of 4 digit numbers having their digits in non-decreasing order (from left to right) constructed by using the digits belonging to the set {1, 2, 3} is _____.

Solution: Following are the 4 digit numbers having their digits in non-decreasing order (from left to right) constructed by using the digits 1, 2 and 3.

1111	1122	1222	1333	2233
1112	1123	1223	2222	2333
1113	1133	1233	2223	3333

∴ The number of such 4 digit numbers = 15.

Hence, the correct Answer is (15).

Question Number: 57 Question Type: MCQ

In a room there are only two types of people, namely Type 1 and Type 2. Type 1 people always tell the truth and Type 2 people always lie. You give a fair coin to a person in that room, without knowing which type he is from and tell him to toss it and hide the result from you till you ask for it. Upon asking, the person replies the following

'The result of the toss is head if and only if I am telling the truth.'

Which of the following options is correct?

(A) The result is head

(B) The result is tail

(C) If the person is of Type 2, then the result is tail

(D) If the person is of Type 1, then result is tail

Solution: Let us assume that the person is of Type 1 – a truth teller. His statement is 'The result of the toss is head if and only if I am telling the truth.' We can symbolize this as S: 'p if q'.

S is true, q is true.

∴ p is true.

Let us assume that the person is of Type 2 – a liar.

His statement is S: 'p iff q'

S is false, q is false.

∴ p has to be true.

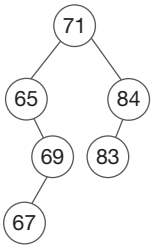
In either case, P is true, the result of the toss is head.

Hence, the correct option is (A).

Question Number: 58 Question Type: MCQ

While inserting the elements 71, 65, 84, 69, 67, 83 in an empty binary search tree (BST) in the sequence shown, the element in the lowest level is

(A) 65 (B) 67 (C) 69 (D) 83



Solution: The element in the lowest level is 67.

Hence, the correct option is (B).

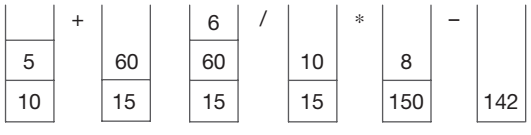
Question Number: 59 Question Type: MCQ

The result of evaluating the postfix expression 10 5 + 60 6 / * 8 – is

(A) 284 (B) 213 (C) 142 (D) 71

Solution:

10 5 + 60 6 / * 8 –



Result: 142

Hence, the correct option is (C).

Question Number: 60 **Question Type: MCQ**

Consider the following relation

Cinema (theater, address, capacity)

Which of the following options will be needed at the end of the SQL QUERY?

SELECT P1.address

FROM Cinema P1

such that it always finds the addresses of theaters with maximum capacity?

(A) WHERE P1.capacity >= All (select P2. Capacity from Cinema P2)

(B) WHERE P1.capacity >= Any (select P2. Capacity from Cinema P2)

(C) WHERE P1.capacity > All (select max(P2. capacity) from Cinema P2)

(D) WHERE P1.capacity > Any (select max(P2. capacity) from Cinema P2)

Solution: Consider the Relation cinema, with some sample tuples:

Theater	Address	Capacity
T_1	A_1	100
T_2	A_2	200
T_3	A_3	150
T_4	A_4	200

P_1 capacity ≥ ALL (P_2. Capacity)

T_1	A_1	100	≥	100 ✓
				200 ×
$\therefore A_1$ is not retrieved				150 ×
				200 ×
T_2	A_2	200	≥	100 ✓
				200 ✓
$\therefore A_2$ is retrieved				150 ✓
				200 ✓
T_3	A_3	150	≥	100 ✓
				200 ×
$\therefore A_3$ is not retrieved				150 ✓
				200 ×
T_4	A_4	200	≥	100 ✓
				200 ✓
$\therefore A_4$ is retrieved				150 ✓
				200 ✓

Option (A) always finds the addresses of theaters with maximum capacity.

Hence, the correct option is (A).

Question Number: 61 **Question Type: MCQ**

Consider the following array of elements

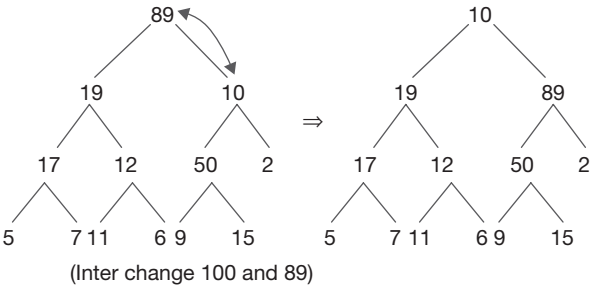
<89, 19, 50, 17, 12, 15, 2, 5, 7, 11, 6, 9, 100>

The minimum number of interchanges needed to convert it into a max-heap is

(A) 4 (B) 5

(C) 2 (D) 3

Solution:



(Inter change 100 and 89)

∴ 3 Interchanges are required to convert it into a max – Heap.

Hence, the correct option is (D).

Question Number: 62 **Question Type: MCQ**

Two processes X and Y need to access a critical section. Consider the following synchronization construct used by both the processes.

Process X	Process Y

`/* other code for process X */`
`while (true)`
`{`
`varP = true;`
`while(varQ == true)`
	`/* other code for process Y */`
	`while (true)`
	`{`
	`varQ = true;`
	`while (varP == true)`

```
        {                          |        {
        /*                         |        /*
Critical Section                   | Critical Section
*/                                 | */
   varP = false;                   |    varQ = false;
   }                               |    }
}                                  | }
/* other code                      | /* other code
for process X */                    | for process Y */
```

Here, varP and varQ are shared variables and both are initialized to false. Which one of the following statements is true?

(A) The proposed solution prevents deadlock but fails to guarantee mutual exclusion.

(B) The proposed solution guarantees mutual exclusion but fails to prevent deadlock.

(C) The proposed solution guarantees mutual exclusion and prevents deadlock.

(D) The proposed solution fails to prevent deadlock and fails to guarantee mutual exclusion.

Solution:

```
    Process X                  |    Process Y
while (true)                   | while(true)
{                              | {
1. var P = true;               | 1. var Q = true;
2. while (var Q                | 2. while(varP =
   = = true)                   | = true)
    {                          |    {
     /* critical                |      /*critical
     section"/                 |      section */
       var P =                 |       varQ =
       false;                  |       false;
  }                            |   }
}                              | }
```

The process X has executed instruction (1) and got preempted and given chance to process Y, similar to process X it executes instruction (1) and got preempted, given chance to process X. Process X executes (2) instruction and enters into critical section, and got preempted when it is in critical section and given chance to process Y. Process Y executes (2) instruction and enters into critical section in which process X and Y are in critical section which violates mutual exclusion principle. There is no deadlock between process X and Y with these solution.

Hence, the correct option is (A).

Question Number: 63 **Question Type: MCQ**

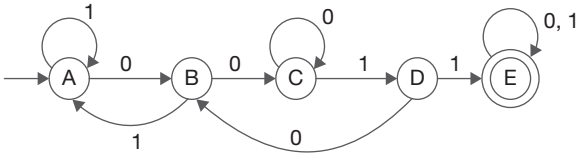
Let L be the language represented by the regular expression Σ^* 0011 Σ^* where $\Sigma = \{0, 1\}$. What is the minimum number of states in a DFA that recognizes $\overline{L}$ (complement of L)?

(A) 4 (B) 5

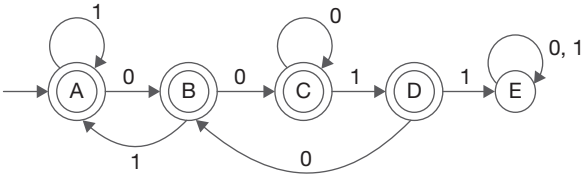
(C) 6 (D) 8

Solution: The language 'L' accepts all the strings with the substring 0011.

The DFA for language 'L' is



The DFA for $\overline{L}$ will be



Number of states for $\overline{L}$ is 5.

Hence, the correct option is (B).

Question Number: 64 **Question Type: NAT**

Consider a software program that is artificially seeded with 100 faults. While testing this program, 159 faults are detected, out of which 75 faults are from those artificially seeded faults. Assuming that both real and seeded faults are of same nature and have same distribution, the estimated number of undetected real faults is _____.

Solution: Number of artificial seeds = 100 faults

Number of faults detected (artificial) = 75

Number of faults detected = 159

Number of real faults = 159 – 75

= 84

As the real and seeded faults are of same nature then number of undetected real faults $= \frac{1}{3} \times 84$

$= 28$

Hence, the correct Answer is (28).

Question Number: 65 Question Type: MCQ

Consider a machine with a byte addressable main memory of 2^{20} bytes, block size of 16 bytes and a direct mapped cache having 2^{12} cache lines. Let the addresses of two consecutive bytes in main memory be $(E201F)_{16}$ and $(E2020)_{16}$. What are the tag and cache line address (in hex) for main memory address $(E201F)_{16}$?

(A) E, 201 (B) F, 201

(C) E, E20 (D) 2, 01F

Solution: Given,

Block size = 2^4 B

So word offset = 4 bits

Number of lines = 2^{12} so line field length = 12 bits

Main memory address is $(E201F)_{16}$ and main memory has 20–bits length address:

TAG	Lines	Offset

In the address last 4 bits will be offset that is F

Next 12 bits from and will be line field that is 201 and remaining bits, tag as E.

Hence, the correct option is (A).

GATE 2015 Solved Paper
CSIT: Computer Science and Information Technology
Set – 2

Number of Questions: 65 **Total Marks:100.0**

Wrong answer for MCQ will result in negative marks, (–1/3) for 1 Mark Questions and (–2/3) for 2 Marks Question.

General Aptitude

Number of Questions: 10 **Section Marks: 15.0**

Question 1 to Question 5 carry 1 mark each and Question 6 to Question 10 carry 2 marks each.

Question Number: 1 **Question Type: MCQ**

Select the alternative meaning of the underlined part of the sentence.

The chain snatchers took to their heels when the police party arrived.

(A) took shelter in a thick jungle

(B) open indiscriminate fire

(C) took to flight

(D) unconditionally surrendered

Solution: 'Took to their heels' means to run away. This supports choice (C) and the other answer choices are incorrect.

Hence, the correct option is (C).

Question Number: 2 **Question Type: MCQ**

The given statement is followed by some courses of action. Assuming the statement to be true, decide the correct option.

Statement:

There has been significant drop in the water level in the lakes supplying water to the city.

Course of action:

(I) The water supply authority should impose a partial cut in supply to tackle the situation.

(II) The government should appeal to all the residents through mass media for minimal use of water.

(III) The government should ban the water supply in lower areas.

(A) Statements I and II follow.

(B) Statements I and III follow.

(C) Statements II and III follow.

(D) All statements follow.

Solution: When there is a significant drop in the water level in the lakes supplying water in the city. The plausible course of action has to be the ones which are practically possible.

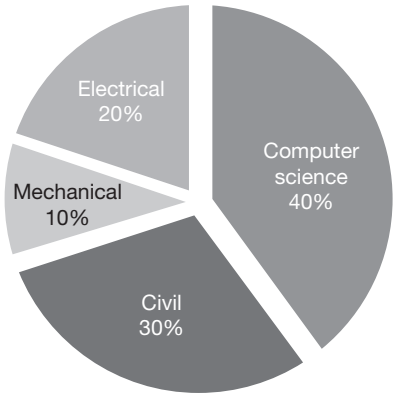
Among the three given courses of action, only I and II are practically possible. III speaks about banning the water supply in lower areas.

This is not an appropriate solution to the existing problem. And stopping or banning water in the lower areas for proper supply in the city is unethical as well.

Hence, the correct option is (A).

Question Number: 3 **Question Type: NAT**

The pie chart below has the breakup of the number of students from different departments in an engineering college for the year 2012. The proportion of male to female students in each department is 5:4. There are 40 males in Electrical Engineering. What is the difference between the numbers of female students in the Civil department and the female students in the Mechanical department?



Solution: Number of students in the Electrical Engineering department = $40\left(\frac{9}{5}\right) = 72$.

Number of students in the Civil department

$$= \frac{30}{20}(72) = 108$$

Number of students in the Mechanical department

$$= \frac{10}{20}(72) = 36$$

Number of female students in the Civil and the Mechanical departments are $108\left(\frac{4}{9}\right)$ and $36\left(\frac{4}{9}\right)$ respectively

i.e., 48 and 16 respectively.

Difference is 48 – 16 i.e., 32.

Hence, the correct Answer is (32).

Question Number: 4 **Question Type: MCQ**

The probabilities that a student passes in Mathematics, Physics and Chemistry are m, p and c respectively. Of these subjects, the student has 75% chance of passing in at least one, a 50% chance of passing in at least two and a 40% chance of passing in exactly two. Following relations are drawn in m, p, c:

(I) $p + m + c = 27/20$

(II) $p + m + c = 13/20$

(III) $(p) \times (m) \times (c) = 1/10$

(A) Only relation I is true.

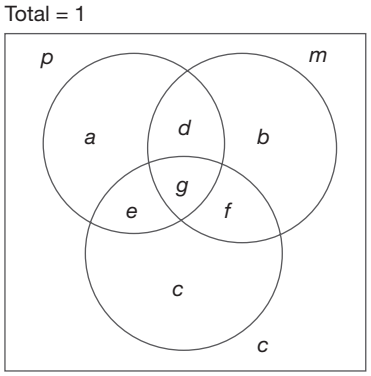
(B) Only relation II is true.

(C) Relations II and III are true.

(D) Relations I and III are true.

Solution:

VD for probabilities



$$p + m + c = a + b + c + 2(d + e + f) + 3g$$

$$= (a + b + c + d + e + f + g) + (d + e + f + 2g)$$

$$= \frac{75}{100} + \frac{40}{100} + \frac{20}{100} = \frac{27}{20}$$

$\Rightarrow$ I is true and II is not true.

$(p)\,(m)\,(c)$ = probability (The student passing in all the three subjects) $= \frac{50}{100} - \frac{40}{100} = \frac{10}{100} = \frac{1}{10}$

Hence, I and III are true.

Hence, the correct option is (D).

Question Number: 5 **Question Type: MCQ**

The number of students in a class who have answered correctly, wrongly, and not attempted each question in an exam are listed in the table below. The marks for each question are also listed. There is no negative or partial marking.

Q.No.	Marks	Answered Correctly	Answered Wrongly	Not Attempted
1	2	21	17	6
2	3	15	27	2
3	1	11	29	4
4	2	23	18	3
5	5	31	12	1

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

(A) 2.290 (B) 2.970

(C) 6.795 (D) 8.795

Solution: Average of the marks obtained by the class

$$= \frac{2(21) + 3(15) + 1(11) + 2(23) + 5(31)}{\text{Total number of students}}$$

$$= \frac{299}{44} = 6.795$$

Hence, the correct option is (C).

Question Number: 6 **Question Type: MCQ**

Didn't you buy _____ when you went shopping?

(A) any paper (B) much paper

(C) no paper (D) a few paper

Solution: The use of 'any paper' is correct. The use of 'a few' would have been correct had it been followed by 'papers' and 'not paper'. The rest of the choices render the sentence incorrect.

Hence, the correct option is (A).

Question Number: 7 **Question Type: MCQ**

Which of the following options is the closest in meaning to the sentence below?

She enjoyed herself immensely at the party.

(A) She had a terrible time at the party

(B) She had a horrible time at the party

(C) She had a terrific time at the party

(D) She had a terrifying time at the party

Solution: The question statement means that the girl had a very good time at the party. Choice (C) brings this out. 'Terrific' means extremely good and is used in a positive connotation. The other choices have negative contexts.

Hence, the correct option is (C).

Question Number: 8 **Question Type: MCQ**

Which one of the following combinations is incorrect?

(A) Acquiescence – Submission

(B) Wheedle – Roundabout

(C) Flippancy – Lightness

(D) Profligate – Extravagant

Solution: 'Acquiescence' means 'submission' 'Wheedle' is to persuade someone to do something for you. 'Roundabout' means indirect. 'Flippancy' means a lack of seriousness in grave matters. 'Lightness' means the same. 'Profligate' means 'extravagant'. Thus, choice (B) is the incorrect option.

Hence, the correct option is (B).

Question Number: 9 **Question Type: MCQ**

Based on the given statements, select the most appropriate option to solve the given question.

If two floors in a certain building are 9 feet apart, how many steps are there in a set of stairs that extends from the first floor to the second floor of the building?

Statements:

(I) Each step is ¾ foot high.

(II) Each step is 1 foot wide.

(A) Statement I alone is sufficient but statement II alone is not sufficient.

(B) Statement II alone is sufficient, but statement I alone is not sufficient.

(C) Both statements together are sufficient, but neither statement alone is sufficient.

(D) Statement I and II together are not sufficient.

Solution: The distance between the 2 floors of the building is 9 feet. And we are asked to find the number of steps from first floor to second floor.

From I:

If each step is $3/4^{th}$ foot.

Let there be a total of n steps from first floor to record floor.

$$\frac{3}{4} \times n = 9$$

$$\Rightarrow \quad n = \frac{4 \times 9}{3} = 12$$

So, I alone give this answer

II speaks about the width of each step. From width, we cannot get the number of steps between 1st and 2nd floors.

Hence, the correct option is (A).

Question Number: 10 **Question Type: MCQ**

Given Set $A = \{2, 3, 4, 5\}$ and Set $B = \{11, 12, 13, 14, 15\}$, two numbers are randomly selected, one from each set. What is the probability that the sum of the two numbers equals 16?

(A) 0.20 (B) 0.25

(C) 0.30 (D) 0.33

Solution: Let the numbers randomly selected from set A and set B be a and b respectively.

The number of (a, b) that can be formed taking a from A and b from B is $4 \times 5 = 20$. And the (a, b) for which $a + b = 16$ are (2, 14), (3, 13), (4, 12), (5, 11).

Number of favorable selections = 4

Required probability = $\frac{4}{20} = 0.2$

Hence, the correct option is (A).

Computer Science and Information Technology

Number of Questions: 55 **Section Marks: 85.0**

Question 11 to Question 35 carry 1 mark each and Question 36 to Question 65 carry 2 marks each.

Question Number: 11 **Question Type: MCQ**

What are the worst-case complexities of insertion and deletion of a key in a binary search tree?

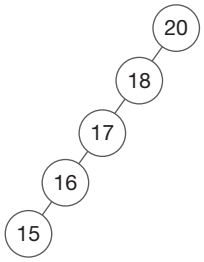
(A) $\theta(\log n)$ for both insertion and deletion

(B) $\theta(n)$ for both insertion and deletion

(C) $\theta(n)$ for insertion and $\theta(\log n)$ for deletion

(D) $\theta(\log n)$ for insertion and $\theta(n)$ for deletion

Solution: Worst case binary search tree, consider the following:



$vn = 5$ elements

To insert an element '14' (Worst case)

We need to compare with First 5 elements

$\therefore \quad \theta(n)$

To delete an element, first we have to search for that element.

Assume that element to be deleted is 15(Worst case), to search for 15, we need 5 comparisons.

$\therefore \quad \theta(n)$

Hence, the correct option is (B).

Question Number: 12 **Question Type: NAT**

Suppose that the stop-and-wait protocol is used on a link with a bit rate of 64 kilobits per second and 20 milliseconds propagation delay. Assume that the transmission time for the acknowledgement and the processing time at nodes are negligible. Then the minimum frame size in bytes to achieve a link utilization of at least 50% is _____.

Solution: Propagation delay $T_P = 20$ m sec

(B) Bit rate = 64 K bits/sec

To achieve 50% link utilization

The minimum frame size in bytes should be

$$L \geq BR \qquad (R = 2\ T_P)$$

$$L = 64 \times 10^3 \times 2 * 20 * 10^{-3}$$

$$= 2560 \text{ bits}$$

$$= 320 \text{ bytes}$$

$$= \frac{320}{2} = 160$$

Hence, the correct Answer is (160).

Question Number: 13 **Question Type: MCQ**

Consider a max heap, represented by the array: 40, 30, 20, 10, 15, 16, 17, 8, 4

Array Index	1	2	3	4	5	6	7	8	9
Value	40	30	20	10	15	16	17	8	4

Now consider that a value 35 is inserted into this heap. After insertion, the new heap is

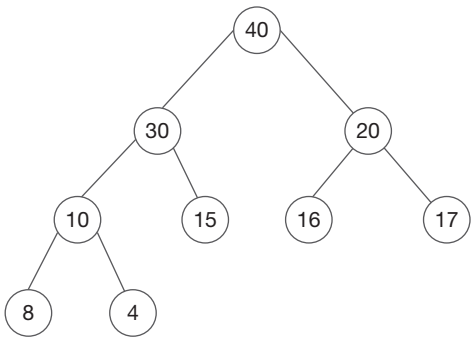
(A) 40, 30, 20, 10, 15, 16, 17, 8, 4, 35

(B) 40, 35, 20, 10, 30, 16, 17, 8, 4, 15

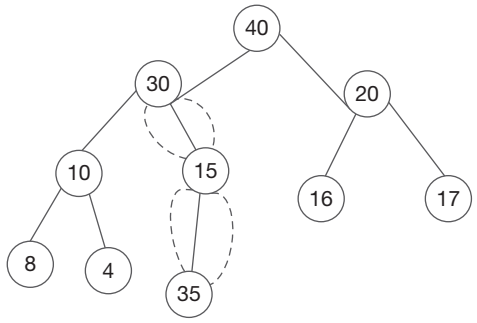
(C) 40, 30, 20, 10, 35, 16, 17, 8, 4, 15

(D) 40, 35, 20, 10, 15, 16, 17, 8, 4, 30

Solution: The given heap is

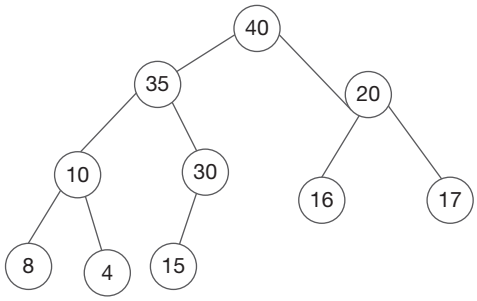


When 35 is inserted into the heap



It is not following ordering property, requires swaps. There are 2 swaps i.e., swap (15, 35) and swap (30, 35)

The resultant heap is



The new heap is

40, 35, 20, 10, 30, 16, 17, 8, 4, 15

Hence, the correct option is (B).

Question Number: 14 **Question Type: NAT**

Consider the following C program segment.

```
while(first <= last)
{
   if (array[middle] < search)
      first = middle + 1;
   else if (array[middle] ==
   search)
         found = TRUE;
      else last = middle - 1;
   middle = (first + last)/2;
}
if (first > last) notPresent =
TRUE;
```

The cyclomatic complexity of the program segment is _____.

Solution: Cyclomatic complexity of the program is (number of conditions in the program) + 1;

$$4 + 1 = 5$$

In the program, there is 1 while condition and 3 if conditions.

Hence, the correct Answer is (5).

Question Number: 15 **Question Type: NAT**

Consider a LAN with four nodes S_1, S_2, S_3 and S_4. Time is divided into fixed-size slots, and a node can begin its transmission only at the beginning of a slot. A collision is said to have occurred if more than one node transmit in the same slot. The probabilities of generation of a frame in a time slot by S_1, S_2, S_3 and S_4 are 0.1, 0.2, 0.3 and 0.4, respectively. The probability of sending a frame in the first slot without any collision by any of these four stations is _____.

Solution: When S_1 is sending remaining nodes have to listen.

The probability for S_1 is (0.1) (1 – 0.2) (1 – 0.3) (1 – 0.4) = 0.0336.

For $S_2 \Rightarrow$ (1 – 0.1) (0.2) (1 – 0.3) (1 – 0.4) = 0.0756

For $S_3 \Rightarrow$ (1 – 0.1) (1 – 0.2) (0.3) (1 – 0.4) = 0.1296

For $S_4 \Rightarrow$ (1 – 0.1) (1 – 0.2) (1 – 0.3) (0.4) = 0.2016

The probability of sending a frame in the first slot without any collision by any of these 4 stations is

$\therefore$ 0.0336 + 0.0756 + 0.1296 + 0.2016 = 0.4404

Hence, the correct Answer is (0.40 to 0.46).

Question Number: 16 **Question Type: MCQ**

The binary operator ≠ is defined by the following truth table:

p	q	p ≠ q
0	0	0
0	1	1
1	0	1
1	1	0

Which one of the following is true about the binary operator ≠?

(A) Both commutative and associative

(B) Commutative but not associative

(C) Not commutative but associative

(D) Neither commutative nor associative

Solution: $p \neq q \Rightarrow x$ or operation

$p \oplus q = q \oplus p$, so commutative

$p \oplus (q \oplus r) = (p \oplus q) \oplus r$, so associative.

Hence, the correct option is (A).

Question Number: 17 **Question Type: NAT**

$$\sum_{x=1}^{99} \frac{1}{x(x+1)} = \_\_\_\_\_.$$

Solution: We have $\sum_{x=1}^{99} \frac{1}{x(x+1)} = \sum_{x=1}^{99} \left(\frac{1}{x} - \frac{1}{x+1}\right)$

$$= \left(\frac{1}{1} - \frac{1}{1+1}\right) + \left(\frac{1}{2} - \frac{1}{2+1}\right) + \left(\frac{1}{3} - \frac{1}{3+1}\right) + \ldots$$

$$+ \left(\frac{1}{98} - \frac{1}{98+1}\right) + \left(\frac{1}{99} - \frac{1}{99+1}\right)$$

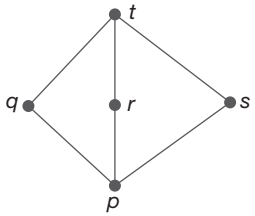
$$= 1 - \frac{1}{100}$$

$$= \frac{99}{100} = 0.99$$

Hence, the correct Answer is (0.99).

Question Number: 18 **Question Type: MCQ**

Suppose $\mathcal{L} = \{p, q, r, s, t\}$ is a lattice represented by the following Hasse diagram:

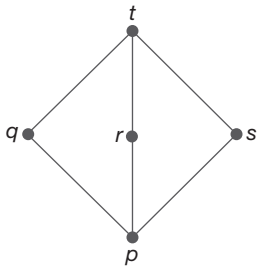


For any $x, y \in \mathcal{L}$, not necessarily distinct, $x \vee y$ and $x \wedge y$ are join and meet of x, y, respectively. Let $\mathcal{L}^3 = \{(x, y, z): x, y, z \in \mathcal{L}\}$ be the set of all ordered triplets of the elements of $\mathcal{L}$. Let p_r be the probability that an element $(x, y, z) \in \mathcal{L}^3$ chosen equi-probably satisfies $x \vee (y \wedge z) = (x \vee y) \wedge (x \vee z)$. Then

(A) $p_r = 0$ (B) $p_r = 1$

(C) $0 < p_r \leq \frac{1}{5}$ (D) $\frac{1}{5} < p_r < 1$

Solution: Given that $L = \{p, q, r, s, t\}$ is a lattice with Hasse diagram as shown below.



Given, $L^3 = \{(x, y, z)/x, y, z \in L\}$

$\therefore$ The total number elements of L^3 = The number of ordered triples that can be formed using 5 elements = $5^3 = 125$.

Of all these ordered triples, all ordered triples satisfy the condition.

$$x \vee (y \wedge z) = (x \vee y) \wedge (x \vee z)$$

except those in which all the three elements q, r and s are present in any order.

For, take $x = q$, $y = r$ and $z = s$

$$\therefore \quad x \vee (y \wedge z) = q \vee (r \wedge s) = q \vee p = q \qquad (1)$$

and

$$(x \vee y) \wedge (x \vee z) = (q \vee r) \wedge (q \vee s) = t \wedge t = t \qquad (2)$$

From (1) and (2),

$$x \vee (y \wedge z) \neq (x \vee y) \wedge (x \vee z)$$

The number of ordered triples involving all the three elements in any order = 3! = 6

$\therefore$ Probability that an element $(x, y, z) \in L^3$ chosen equi-probably satisfies $x \vee (y \wedge z) = (x \vee y) \wedge (x \vee z)$ is

$$P_r = \frac{125 - 6}{125} = \frac{119}{125}$$

Hence, $\frac{1}{5} < P_r < 1.$

Alternative Solution: The total number of elements (ordered triples) of

$$L^3 = 125.$$

Of these, the ordered triples, which start p, or t definitely satisfies the given condition. The 50 elements in L^3 that starts either with p or t. and also the ordered triples consisting of the three elements q, r, and s does not satisfy the condition.

$\therefore$ $\frac{1}{5} < P_r < 1.$

Hence, the correct option is (D).

Question Number: 19 **Question Type: MCQ**

Consider the operations

$$f(X, Y, Z) = X'YZ + XY' + Y'Z'$$

and

$$g(X, Y, Z) = X'YZ + X'YZ' + XY.$$

Which one of the following is correct?

(A) Both $\{f\}$ and $\{g\}$ are functionally complete

(B) Only $\{f\}$ is functionally complete

(C) Only $\{g\}$ is functionally complete

(D) Neither $\{f\}$ nor $\{g\}$ is functionally complete

Solution:

$$f(X, Y, Z) = X'YZ + XY' + Y'Z'$$

$$g(X, Y, Z) = X'YZ + X'YZ' + XY$$

$$= Y(X'Z + X'Z' + X) = Y$$

$$f(X, Y, Z) = X'YZ + XY'Z + XY'Z' + Y'Z'$$

$$= (X'Y + XY')Z + Y'Z'$$

by using $\{f\}$, we can implement the functions AND, OR, NOT, so only $\{f\}$ is functionally complete.

Hence, the correct option is (B).

Question Number: 20 **Question Type: NAT**

Let G be a connected planar graph with 10 vertices. If the number of edges on each face is three then the number of edges in G is _____.

Solution: We have, the no. of vertices of $G = |V| = 10$

Let $|E|$ and $|R|$ denote the no. of edges and the no. of regions of the connected planar graph G respectively.

By Euler's formula, we have

$$|V| + |R| - |E| = 2 \qquad (1)$$

Given the number of edges on each face (region) is 3.

We know that the sum of the degrees of all faces of a planar graph = 2 × the no. of edges.

i.e., $3\,|R| = 2\,|E|$

$$\Rightarrow \quad |R| = \frac{2}{3}|E|$$

$\therefore$ (1) becomes,

$$|V| + \frac{2}{3}|E| - |E| = 2$$

$$\Rightarrow \quad 10 - \frac{1}{3}|E| = 2$$

$$\Rightarrow \quad \frac{1}{3}|E| = 8$$

$$\Rightarrow \quad |E| = 24$$

Hence, the correct Answer is (24).

Question Number: 21 **Question Type: MCQ**

Let a_n represent the number of bit strings of length n containing two consecutive 1s. What is the recurrence relation for a_n?

(A) $a_{n-2} + a_{n-1} + 2^{n-2}$

(B) $a_{n-2} + 2a_{n-1} + 2^{n-2}$

(C) $2a_{n-2} + a_{n-1} + 2^{n-2}$

(D) $2a_{n-2} + 2a_{n-1} + 2^{n-2}$

Solution:

$a_1 = (0)$

$a_2 = 11\ (1)$

$a_3 = 110, 011, 111\ (3)$

$a_4 = 1100, 1101, 0110, 0011, 1110, 1111, 0111, 1011\ (8)$

Option (A)

If we take $n = 4$

$$\Rightarrow \quad a_{n-2} + a_{n-1} + 2^{n-2}$$

$$a_4 = a_2 + a_3 + 2^{4-2}$$

$$= 1 + 3 + 2^2$$

$$a_4 = 8$$

If we take $n = 3$

$$a_3 = 3$$

$$a_3 = a_{n-2} + a_{n-1} + 2^{n-2}$$

$$= a_1 + a_2 + 2^{3-2}$$

$$= 0 + 1 + 2$$

$$= 3$$

$$a_3 = 3$$

Hence, the correct option is (A).

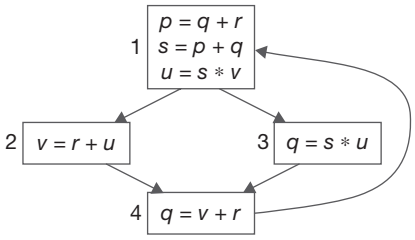
Question Number: 22 **Question Type: MCQ**

A variable x is said to be live at a statement S_i in a program if the following three conditions hold simultaneously:

i. There exists a statement S_j that uses x

ii. There is a path from S_i to S_j in the flow graph corresponding to the program.

iii. The path has no intervening assignment to x including at S_i and S_j.



The variables which are live both at the statement in basic block 2 and at the statement in basic block 3 of the above control flow graph are

(A) p, s, u (B) r, s, u

(C) r, u (D) q, v

Solution: Initially the variables which are live on entry to block 1 are $\{q, r, u\}$ as these variables are required to get the values defined in that block

- On exit from block 1 live variables are $\{r, u, v\}$ as p, q and s values are not required by other blocks.
- Live variables on entry to block 2 are $\{r, u\}$ as these variables are required to get v, and v is not live as it is defined in block 2
- On exit from block 2 live variables are $\{r, v\}$ as 4 is no where used and v is used in block 4
- On entry to block 3, live variables are $\{r, u, v\}$ and on exit live variables are $\{r, q, v\}$ as U is no where used and q is used in block 4
- On entry to block 4 live variables are $\{r, v\}$ and q is not live as q is defined inside block 4
- On exit from block 4 live variables are $\{q, r, v\}$ as q is defined in block 4.

Hence $\{r, u\}$ both are live at block 2 and block 3

Hence, the correct option is (C).

Question Number: 23 **Question Type: NAT**

The least number of temporary variables required to create a three-address code in static single assignment form for the expression $q + r/3 + s - t * 5 + u * v/w$ is _____.

Solution: $q + r/3 + s - t * 5 + u * v/w$

The 3-address code for above expression is

$$t_1 = r/3$$
$$t_2 = t * 5$$
$$t_3 = u * v$$
$$t_4 = t_3/w$$
$$t_5 = q + t_1$$
$$t_6 = t_5 + s$$
$$t_7 = t_6 - t_2$$
$$t_8 = t_7 + t_4$$

The temporary variables required = 8

Hence, the correct Answer is (8).

Question Number: 24 **Question Type: NAT**

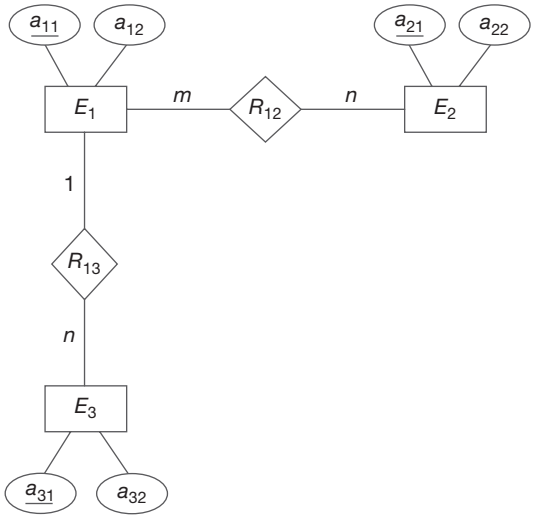
Consider an Entity-Relationship (ER) model in which entity sets E_1 and E_2 are connected by an $m : n$ relationship R_{12}. E_1 and E_3 are connected by a $1 : n$ (1 on the side of E_1 and n on the side of E_3) relationship R_{13}.

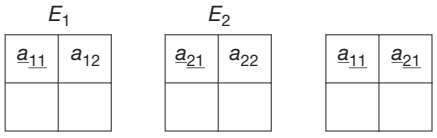
E_1 has two single-valued attributes a_{11} and a_{12} of which a_{11} is the key attribute. E_2 has two single-valued attributes a_{21} and a_{22} of which a_{21} is the key attribute. E_3 has two single-valued attributes a_{31} and a_{32} of which a_{31} is the key attribute. The relationships do not have any attributes.

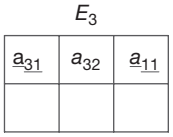
If a relational model is derived from the above ER model, then the minimum number of relations that would be generated if all the relations are in 3 NF is _____.

Solution: R_{12} has $m : n$ Relation

Extra table is needed to store all the primary keys of participating Entities in R_{12}.





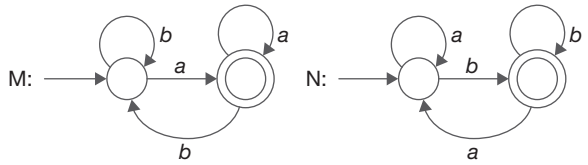


R_{13} has 1 : n relation, place 1's side primary key into n's side table.

Hence, the correct Answer is (4).

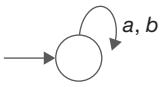
Question Number: 25 **Question Type: NAT**

Consider the DFAs M and N given above. The number of states in a minimal DFA that accepts the language $L(M) \cap L(N)$ is _____.



Solution: M is a DFA which accepts language with strings ends with 'a' over $\Sigma = \{a, b\}$ i.e., $M = \{a, aa, ba, baa, aaa\ldots.\}$

N is a DFA which accepts a language with strings ends with 'b' over $\Sigma = \{a, b\}$, i.e., $N = \{b, bb, ab, bbb,\ldots\}$ then $L(M) \cap L(N)$ is an empty language i.e., $L(M) \cap L(N) = \varnothing$. The automata for $L(M) \cap L(N)$

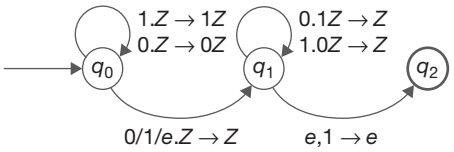


Number of states = 1

Hence, the correct Answer is (1).

Question Number: 26 **Question Type: MCQ**

Consider the NPDA $< Q = \{q_0, q_1, q_2\}, \Sigma = \{0, 1\}, \Gamma = \{0, 1, \perp\}, \delta, q_0, \perp, F = \{q_2\}>$, where (as per usual convention) Q is the set of states, Σ is the input alphabet, Γ is the stack alphabet, δ is the state transition function, q_0 is the initial state, $\perp$ is the initial stack symbol, and F is the set of accepting states. The state transition is as follows:



Which one of the following sequences must follow the string 1011 00 so that the overall string is accepted by the automation?

(A) 10110 (B) 10010

(C) 01010 (D) 01001

Solution: In the question, on information given about 'z'. If we assume z as any stack symbol (either 0 or 1) then we can able to solve the problem.

Given input is 101100

Push till last but one is zero.

The PDA will be q_0 state till this input then, the stack will have

	1	0	1	1	0

With last zero it will move to q_1, without pushing or popping anything

Hence, the correct option is (A).

1 0 1 1 0

– With input 1, it checks 0 as top of stack, as 0 is in top, it pops that symbol, with next input 0, and it will check 1 as top. As 1 is top, pop that 1.
– With next input 1 as input, it checks for 0 as top of the stack but top is 1

∴ Choice (A) is not the answer

Choice (A)

1 0 0 1 0

– With input 1, it checks 0 as top of stack. As 0 is top of stack, it pops that symbol
– With next input 0, it will check 1 as top As 1 is top, pop that 1
– With next input 0 as input, it checks for 1 as top of the stack as top is 1 pop it similarly with the next inputs 1 and 0 it pops 0 and 1 respectively
– With left-out initial stack symbol on epsilon-input it riches final state

Hence choice (B) is the answer

Hence, the correct option is (B).

Question Number: 27 **Question Type: MCQ**

Let $G = (V, E)$ be a simple undirected graph, and s be a particular vertex in it called the source. For $x \in V$, let $d(x)$ denote the shortest distance in G from s to x. A breadth first search (BFS) is performed starting at s. Let T be the resultant BFS tree. If (u, v) is an edge of G that is not in T, then which one of the following CANNOT be the value of $d(u) - d(v)$?

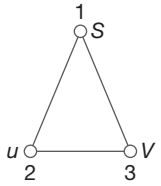
(A) –1 (B) 0

(C) 1 (D) 2

Solution:

Example:

Case 1:



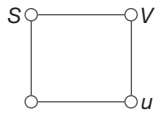
From source (S)

The distance to $u = D(u) = 1$

The distance to $V = D(v) = 1$

$$D(u) - D(v) = 0$$

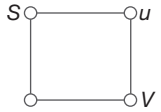
Case 2:



$$D(u) = 2, D(v) = 1$$

$$D(u) - D(v) = 2 - 1 = 1$$

Case 3:



$$D(u) = 1, D(v) = 2$$

$$D(u) - D(v) = 1 - 2 = -1$$

$\therefore$ $D(u) - D(v) = 2$ is not possible.

Hence, the correct option is (D).

Question Number: 28 **Question Type: NAT**

Consider a uni-processor system executing three tasks T_1, T_2 and T_3, each of which is composed of an infinite sequence of jobs (or instances) which arrive periodically at intervals of 3, 7 and 20 milliseconds, respectively. The priority of each task is the inverse of its period, and the available tasks are scheduled in order of priority, with the highest priority task schedule first. Each instance of T_1, T_2 and T_3 requires an execution time of 1, 2 and 4 milliseconds, respectively. Given that all tasks initially arrive at the beginning of the 1st millisecond and task preemptions are allowed, the first instance of T_3 completes its execution at the end of _____ milliseconds.

Solution:

		Arrival times	Burst time	Priority
T_1	–	0, 3, 6, 9, 12…	1	1
T_2	–	0, 7, 14, 21….	2	0.5
T_3	–	0, 20, 40, …	4	0.25

The Gantt chart with above Tasks is

T_1	T_2	T_2	T_1	T_3	T_3	T_1	T_2	T_2	T_1	T_3	T_3

0 1 2 3 4 5 6 7 8 9 10 11 12

The first instance of task (T_3) completes at 12th milli second.

Hence, the correct Answer is (12).

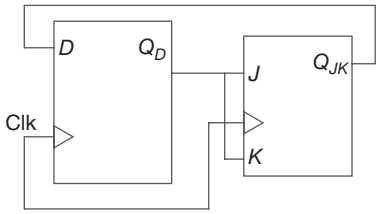
Question Number: 29 **Question Type: MCQ**

A positive edge-triggered D–flip-flop is connected to a positive edge-triggered JK flip-flop as follows. The Q output of the D flip-flop is connected to both the J and K inputs of the JK flip-flop, while the Q output of the JK flip-flop is connected to the input of the D flip-flop. Initially, the output of the D flip-flop is set to logic one and the output of the JK flip-flop is cleared. Which one of the following is the bit sequence (including the initial state) generated at the Q output of the JK flip-flop when the flip-flops are connected to a free-running common clock? Assume that $J = K = 1$ is the toggle mode and $J = K = 0$ is the state-holding mode of the JK flip-flop. Both the flip-flops have non-zero propagation delays.

(A) 0110110… (B) 0100100…

(C) 011101110… (D) 011001100…

Solution:



The given problem is shown in the above figure initially $Q_D = 1$, $Q_{JK} = 0$

			D	J	K
Clk	Q_D	Q_{JK}	Q_{JK}	Q_D	Q_D
0	1	0	0	1	1
1	0	1	1	0	0
2	1	1	1	1	1
3	1	0			

After 3 Clk pulses, the circuit came back to original state, mod-3 counter.

Sequence at Q_{JK} = 011011011…..

Hence, the correct option is (A).

Question Number: 30 **Question Type: NAT**

Consider a disk pack with a seek time of 4 milliseconds and rotational speed of 10000 rotations per minute (RPM). It has 600 sectors per track and each sector can store 512 bytes of data. Consider a file stored in the disk. The file contains 2000 sectors. Assume that every sector access necessitates a seek, and the average rotational latency for accessing each sector is half of the time for one complete rotation. The total time (in milliseconds) needed to read the entire file is _____.

Solution: Given seek time = 4 m sec

Given rotational speed = 10000 rotations/minute

$$\text{Number of rotations in one second} = \frac{60}{10000} = 6 \text{ ms}$$

$$\text{Rotational latency} = \frac{1}{2} \times 6 \text{ ms} = 3 \text{ ms}$$

Given that there are 600 sectors/track

So, to access 600 sectors it takes 6 ms.

$$\text{To access 1 sector} = \frac{6 \text{ ms}}{600} = 0.01 \text{ ms}$$

For accessing 2000 sectors it takes 2000 (0.01) = 20 ms

$\therefore$ total time needed to read the entire file

= (2000(4 + 3) + 20)ms

= 14020 ms

Hence, the correct Answer is (14020).

Question Number: 31 **Question Type: NAT**

Consider a non-pipelined processor with a clock rate of 2.5 gigahertz and average cycles per instruction of four. The same processor is upgraded to a pipelined processor with five stages; but due to the internal pipeline delay, the clock speed is reduced to 2 gigahertz. Assume that there are no stalls in the pipeline. The speed up achieved in this pipelined processor is _____.

Solution: $\text{Speed-up} = \frac{nk}{(K+n-1)}$

Assume that $n = 16$

$k = 5$ (stages)

$$S \text{ (for 5 stages)} = \frac{16*5}{(5+16-1)} = \frac{80}{20} = 4$$

The frequency is reduced in pipe lined processor by a factor of $\left(\frac{2}{2.5}\right) = 0.8$

$\therefore$ $4 * 0.8 = 3.2$

Hence, the correct Answer is (3.2).

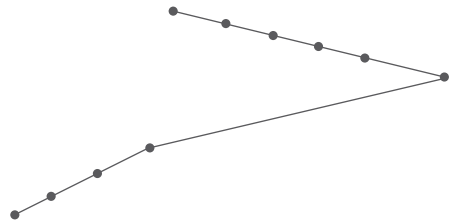
Question Number: 32 **Question Type: NAT**

Suppose the following disk request sequence (track numbers) for a disk with 100 tracks is given: 45, 20, 90, 10, 50, 60, 80, 25, 70. Assume that the initial position of the R/W head is on track 50. The additional distance that will be traversed by the R/W head when the Shortest Seek Time First (SSTF) algorithm is used compared to the SCAN (Elevator) algorithm (assuming that SCAN algorithm moves towards 100 when it starts execution) is _____ tracks.

Solution:

SCAN

10 20 25 45 50 60 70 80 90 100

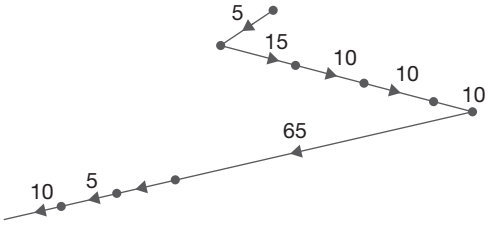


Total head movements = 10 + 10 + 10 + 10 + 10 + 55 + 20 + 5 + 10

$\Rightarrow$ 140.

SSTF

1 10 20 25 45 50 60 70 80 90 100



$\therefore$ Total head movements = 5 + 15 + 10 + 10 + 10 + 65 + 5 +10

$\Rightarrow$ 130

$\therefore$ The extra distance that is traversed

= 140 – 130

= 10

Hence, the correct Answer is (10).

Question Number: 33 **Question Type: MCQ**

Consider a main memory with five page frames and the following sequence of page references: 3, 8, 2, 3, 9, 1, 6, 3, 8, 9, 3, 6, 2, 1, 3. Which one of the following is true with respect to page replacement policies First In First Out (FIFO) and Least Recently Used (LRU)?

(A) Both incur the same number of page faults

(B) FIFO incurs 2 more page faults than LRU

(C) LRU incurs 2 more page faults than FIFO

(D) FIFO incurs 1 more page faults than LRU

Solution: The page references are

3, 8, 2, 3, 9, 1, 6, 3, 8, 9, 3, 6, 2, 1, 3

No. of page faults using FIFO

~~3~~ 6
~~8~~ 3
~~2~~ 8
~~9~~ 2
1

✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓

3, 8, 2, 3, 9, 1, 6, 3, 8, 9, 3, 6, 2, 1, 3

= 9 page faults

LRU

~~3~~
~~8~~ 6
~~2~~ 8
~~9~~ 1
~~1~~ 2

✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓

3, 8, 2, 3, 9, 1, 6, 3, 8, 9, 3, 6, 2, 1, 3

= 9 page faults

Both LRU and FIFO incur same number of page faults.

Hence, the correct option is (A).

Question Number: 34 **Question Type: NAT**

$$\int_{1/\pi}^{2/\pi} \frac{\cos(1/x)}{x^2}\,dx = \_\_\_\_\_.$$

Solution: Consider the integral

$$\int_{1/\pi}^{2/\pi} \frac{\cos\left(1/x\right)}{x^2}\,dx = \int_{1/\pi}^{2/\pi} \left[\cos\left(1/x\right)\right] \frac{1}{x^2}\,dx \qquad (1)$$

put, $\frac{1}{x} = t$

$\Rightarrow \frac{-1}{x^2}\,dx = dt$

$\Rightarrow \frac{1}{x^2}\,dx = -dt$

$x = \frac{1}{\pi}$

$\Rightarrow t = \pi$ and $x = \frac{2}{\pi}$

$\Rightarrow t = \frac{\pi}{2}$

$\therefore$(1) becomes,

$$\int_{1/\pi}^{2/\pi} \frac{\cos\left(1/x\right)}{x^2}\,dx = \int_{\pi}^{\pi/2} \cos t\,(-dt)$$

$$= -\int_{\pi}^{\pi/2} \cos t\,dt$$

$$= \int_{\pi/2}^{\pi} \cos t\,dt$$

$$= \sin t\,\Big]_{\pi/2}^{\pi}$$

$$= \sin\pi - \sin\frac{\pi}{2} = -1$$

Hence, the correct Answer is (–1).

Question Number: 35 **Question Type: MCQ**

Consider the following 2×2 matrix A, where two elements are unknown and are marked by a and b. The Eigen values of this matrix are −1 and 7. What are the values of a and b?

$$A = \begin{bmatrix} 1 & 4 \\ b & a \end{bmatrix}$$

(A) $a = 6, b = 4$ (B) $a = 4, b = 6$

(C) $a = 3, b = 5$ (D) $a = 5, b = 3$

Solution: Given matrix is $A = \begin{bmatrix} 1 & 4 \\ b & a \end{bmatrix}$

Given the Eigen values of A are –1 and 7. We know that the sum of the Eigen values of A.

= Trace of A

$\Rightarrow -1 + 7 = 1 + a$

$\Rightarrow a = 5$

The product of the Eigen values of A = The determinant of A.

$$\Rightarrow \quad (-1)(7) = \begin{vmatrix} 1 & 4 \\ b & a \end{vmatrix}$$

$$\Rightarrow \quad -7 = -a - 4b$$

$$\Rightarrow \quad 5 - 4b = -7$$

$$\Rightarrow \quad 4b = 12$$

$$\Rightarrow \quad b = 3$$

$$\therefore \quad a = 5 \quad \text{and} \quad b = 3$$

Hence, the correct option is (D).

Question Number: 36 Question Type: MCQ

An algorithm performs $(\log N)^{1/2}$ find operations, N insert operations, $(\log N)^{1/2}$ delete operations, and $(\log N)^{1/2}$ decrease-key operations on a set of data items with keys drawn from a linearly ordered set. For a delete operation, a pointer is provided to the record that must be deleted for the decrease–key operation; a pointer is provided to the record that has its key decreased. Which one of the following data structures is the most suited for the algorithm to use, if the goal is to achieve the best total asymptotic complexity considering all the operations?

(A) Unsorted array

(B) Min-heap

(C) Sorted array

(D) Sorted doubly linked list

Solution:

MIN-HEAP:

– To insert 'N' elements it takes ($N \log N$) time

– To delete $(\log N)^{1/2}$ elements, it takes $((\log N)^{1/2} * \log N)$

– To find $(\log N)^{1/2}$ elements it takes $((\log N)^{1/2} * \theta(N \log N))$ time

Because, when we apply heap property, position of elements change.

Sorted array:

Takes same asymptotic times mentioned above.

Unsorted array:

– $(\log N)^{1/2}$ find operations will take $(\log N)^{1/2} * \theta(N) \Rightarrow \theta(N(\log N)^{1/2})$

– N insertions will take $N * \theta(1) = \theta(N)$ (element is inserted at last place)

– $(\log N)^{1/2}$ delete operations will take, (pointer is provided to particular element) $(\log N)^{1/2} * \theta(1) = \theta(\log N)^{1/2}$

– $(\log N)^{1/2}$ decrease key operations will take $\theta(\log N)^{1/2}$

$\therefore$ The best total asymptotic complexity is achieved through unsorted array.

Hence, the correct option is (A).

Question Number: 37 Question Type: NAT

Consider the following relations:

Student

Roll No	Student Name
1	Raj
2	Rohit
3	Raj

Performance

Roll No	Course	Marks
1	Math	80
1	English	70
2	Math	75
3	English	80
2	Physics	65
3	Math	80

Consider the following SQL query.

```
SELECT S.Student_Name, sum (P.Marks)
FROM Student S, Performance P
WHERE S.Roll_No = P.Roll_No
GROUP BY S.Student_Name
```

The number of rows that will be returned by the SQL query is _____.

Solution: In SQL query, order of evaluation is, "FROM", "WHERE", "GROUP-BY" and "SELECT".

Student X performance (where S.Roll No. = P. Roll No.)

S. Roll No	Student Name	P. Roll No.	Course	Marks
1	Raj	1	Math	80
1	Raj	1	English	70
2	Rohit	2	Math	75
2	Rohit	2	Physics	65
3	Raj	3	English	80
3	Raj	3	Math	80

Group by Student- Name:

1	Raj	1	Math	80
1	Raj	1	English	70
3	Raj	3	English	80
3	Raj	3	Math	80

2	Rohit	2	Math	75
2	Rohit	2	Physics	65

Output:

Student Name	sum (marks)
Raj	310
Rohit	140

$\therefore$ 2 tuples

Hence, the correct Answer is (2).

Question Number: 38 Question Type: MCQ

What is the output of the following *C* code? Assume that the address of *x* is 2000 (in decimal) and an integer requires four bytes of memory.

```
int main ( )       {
   unsigned int x[4] [3] =
   {{1. 2, 3}, {4, 5, 6}, {7, 8, 9},
   {10, 11, 12}};
   printf ("%u, %u, %u", x + 3,
   *(x + 3), *(x + 2) + 3);
}
```

(A) 2036, 2036, 2036 (B) 2012, 4, 2204

(C) 2036, 10, 10 (D) 2012, 4, 6

Solution: All the expressions

$(x + 3)$, $*(x + 3)$, $*(x + 2) + 3$ points to the same address

It prints the address of the first element of fourth row in an array i.e., $x[3][0]$ (or) $x[3]$ (i.e., element 10)

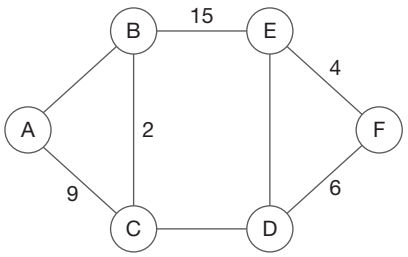
The address of $x[3]$ is 2036

$\therefore$ It prints 2036 2036 2036.

Hence, the correct option is (A).

Question Number: 39 Question Type: NAT

The graph shown below has 8 edges with distinct integer edge weights. The minimum spanning tree (MST) is of weight 36 and contains the edges: {(A, C), (B, C), (B, E), (E, F), (D, F)}. The edge weights of only those edges which are in the MST are given in the figure shown below. The minimum possible sum of weights of all 8 edges of this graph is _____.



Solution: The edge weight of $\overline{AB}$ is 10 (It has to be >9)

The edge weight of $\overline{CD}$ (has to be >15) is 16

$\overline{ED}$ Edge weight is 7 (It has to be >6)

All edge weights =

$\overline{AB} = 10$

$\overline{CD} = 16$

$\overline{ED} = 7$

$\overline{AC} = 9$

$\overline{BC} = 2$

$\overline{BE} = 15$

$\overline{EF} = 4$

$\overline{DF} = 6$

Total = $\underline{69}$

Hence, the correct Answer is (69).

Question Number: 40 Question Type: MCQ

Consider the following C function.

```
int fun1(int n) {
   int i, j, k, p, q=0;
   for (i=1; i<n; ++i) {
      p=0;
      for (j=n; j>1; j=j/2)
            ++p;
      for (k=1; k<p; k=k*2)
            ++q;
      }
      return q;
   }
```

Which one of the following most closely approximates the return value of the function fun1?

(A) n^3 (B) $n(\log n)^2$

(C) $n\log n$ (D) $n\log(\log n)$

Solution:

```
for (i = 1; i < n; ++i) → loop 1
{
   p = 0;
   for(j = n; j > 1; j = j/2) →
   loop 2
      + + p;
   for (k = 1; k < p; k = k * 2) →
   loop 3
      + + q;
}
return q;
}
```

Loop 1 will iterate for about 'n' times [i.e, 'i' value takes 'n' values]

Loop 2 will iterate for about (log n) times, therefore, the 'p' value will be (log n) approximately, loop 3 will iterate for about (log p) times i.e., log(log n) times, the 'q' will increment log(log n) times for every value of i. Therefore loop will iterate for about 'n' times, therefore the 'q' will increment for n(log(log n)) times. return q; will return n(log (log n)).

Hence, the correct option is (D).

Question Number: 41 **Question Type: MCQ**

Consider the following pseudo code, where x and y are positive integers

```
begin
   q := 0
   r := x
   while r ≥ y do
         begin
               r := r - y
               q := q + 1
         end
   end
```

The post condition that needs to be satisfied after the program terminates is

(A) $\{r = qx + y \wedge r < y\}$

(B) $\{x = qy + r \wedge r < y\}$

(C) $\{y = qx + r \wedge 0 < r < y\}$

(D) $\{q + 1 < r - y \wedge y > 0\}$

Solution: Let $x = 17$.

So, $r = 17$

Let, $y = 12$

So, $17 \geq 12$

$r = 17 - 12 = 5$

$q = 1$

Let's cross check with the options.

Option (A)

$r = qx + y = 1 \times 17 + 12 = 29$

(False)

Option (B)

$x = qy + r = 1 \times 12 + 5 = 17$

(True)

Option (C)

$y = qx + r = 1 \times 17 + 5 = 22$

(False)

Option (D)

$q + 1 < r - y$

(Not always true)

Hence, the correct option is (B).

Question Number: 42 **Question Type: MCQ**

If $g(x) = 1 - x$ and $h(x) = \dfrac{x}{x-1}$, then $\dfrac{g(h(x))}{h(g(x))}$ is

(A) $\dfrac{h(x)}{g(x)}$ (B) $\dfrac{-1}{x}$

(C) $\dfrac{g(x)}{h(x)}$ (D) $\dfrac{x}{(1-x)^2}$

Solution: Given $g(x) = 1 - x$ and $h(x) = \dfrac{x}{x-1}$

Consider $\dfrac{g(h(x))}{h(g(x))} = \dfrac{g\left(\dfrac{x}{x-1}\right)}{h(1-x)}$

$$= \frac{\left[1-\left(\dfrac{x}{x-1}\right)\right]}{\left[\dfrac{(1-x)}{(1-x)-1}\right]}$$

$$\Rightarrow \quad = \frac{\left[\dfrac{-1}{(x-1)}\right]}{\left[\dfrac{(1-x)}{-x}\right]}$$

$$= \frac{\left[\frac{x}{(x-1)}\right]}{[1-x]}$$

$$= \frac{h(x)}{g(x)}$$

Hence, the correct option is (A).

Question Number: 43 **Question Type: MCQ**

$\text{Lim}_{x\to\infty} x^{1/x}$ is

(A) ∞ (B) 0

(C) 1 (D) Not defined

Solution: Let $y = \underset{x\to\infty}{Lim}\, x^{1/x}$

$$\Rightarrow \quad \ln y = \ln\left(\underset{x\to\infty}{Lim}\, x^{1/x}\right)$$

$$\Rightarrow \quad = \underset{x\to\infty}{Lim}\left[\ln\left(x^{1/x}\right)\right]$$

$$= \underset{x\to\infty}{Lim}\left[\frac{1}{x}\ln(x)\right]$$

$$\Rightarrow \quad = \underset{x\to\infty}{Lim}\left[\frac{\ln x}{x}\right]$$

$$= \underset{x\to\infty}{Lim}\left[\frac{1/x}{1}\right] \quad \text{[By L' Hospital's Rule]}$$

$$\therefore \quad \ln y = 0$$

$$\Rightarrow \quad y = 1$$

$$\Rightarrow \quad \underset{x\to\infty}{Lim}\, x^{1/x} = 1$$

Hence, the correct option is (C).

Question Number: 44 **Question Type: MCQ**

Match the following:

(P)	Prim's algorithm for minimum spanning tree	(i)	Backtracking
(Q)	Floyd-Warshall algorithm for All Pairs Shortest Paths	(ii)	Greedy method
(R)	Merge sort	(iii)	Dynamic programming
(S)	Hamiltonian circuit	(iv)	Divide and conquer

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

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

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

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

Solution: Prim's algorithm for minimum spanning tree

– Greedy Method.

– Floyd-Warshall algorithm for all pairs shortest paths – Dynamic programming.

– Merge sort – Divide and conquer

– Hamiltonian circuit – Back tracking.

Hence, the correct option is (C).

Question Number: 45 **Question Type: MCQ**

Which one of the following is the recurrence equation for the worst case time complexity of the Quick sort algorithm for sorting n (≥2) numbers? In the recurrence equations given in the options below, c is a constant.

(A) $T(n) = 2T(n/2) + cn$

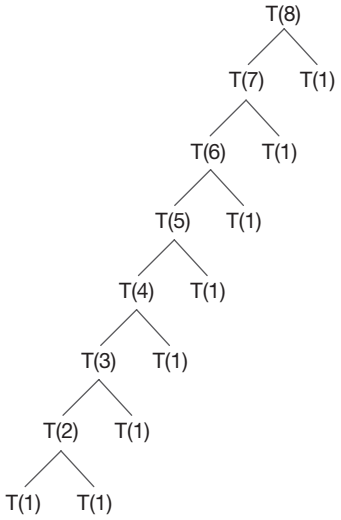
(B) $T(n) = T(n-1) + T(1) + cn$

(C) $T(n) = 2T(n-1) + cn$

(D) $T(n) = T(n/2) + cn$

Solution: The worst quick sort recurrence tree:

Example: Suppose $n = 8$



The Recurrence equation is $T(n)$

$$= T(n-1) + T(1) + cn.$$

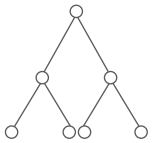
Hence, the correct option is (B).

Question Number: 46 **Question Type: MCQ**

The height of a tree is the length of the longest root-to-leaf path in it. The maximum and minimum numbers of nodes in a binary tree of height 5 are

(A) 63 and 6, respectively
(B) 64 and 5, respectively
(C) 32 and 6, respectively
(D) 31 and 5, respectively

Solution: Height = 2 (max nodes = 7)



Maximum number of nodes $2^{h+1} - 1$
$\therefore$ Height = 5(max nodes 63)

Height = 2(min nodes = 3)
$\therefore$ Height = 5 (min nodes = 6)
$\therefore$ Minimum number of nodes = $h + 1$
$\therefore$ 63 and 6
Hence, the correct option is (A).

Question Number: 47 **Question Type: MCQ**
Match the following:

(P) Condition coverage	(i) Black-box testing
(Q) Equivalence class partitioning	(ii) System testing
(R) Volume testing	(iii) White-box testing
(S) Alpha testing	(iv) Performance testing

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

Solution: Condition coverage – White-Box testing
Equivalence class partitioning – Black-Box testing
Volume testing – Performance testing
Alpha testing – System testing
Hence, the correct option is (C).

Question Number: 48 **Question Type: MCQ**
Which of the following is/are correct in order traversal sequence(s) of binary search tree(s)?

(I) 3, 5, 7, 8, 15, 19, 25
(II) 5, 8, 9, 12, 10, 15, 25
(III) 2, 7, 10, 8, 14, 16, 20
(IV) 4, 6, 7, 9, 18, 20, 25

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

Solution: The in order traversal of binary search tree results in ascending order of the node elements.
In given question, option (I) and (IV) are sorted in ascending order.
$\therefore$ Option (I) and (IV) are correct in-order traversal.
Hence, the correct option is (A).

Question Number: 49 **Question Type: MCQ**
Which one of the following is true at any valid state in shift-reduce parsing?

(A) Viable prefixes appear only at the bottom of the stack and not inside.
(B) Viable prefixes appear only at the top of the stack and not inside.
(C) The stack contains only a set of viable prefixes.
(D) The stack never contains viable prefixes.

Solution: The prefixes of right sentential forms that can appear on the stack of a shift-reduce parser are called viable prefixes.
The stack will contain only a set of viable prefixes.
Hence, the correct option is (C).

Question Number: 50 **Question Type: MCQ**
Which one of the following is NOT equivalent to $p \leftrightarrow q$?

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

Solution: $p \leftrightarrow q$ biconditional or xnor

$$(p \leftrightarrow q) = (\rightharpoondown p \vee q) \wedge (p \vee \rightharpoondown q)$$
$$= (p \wedge q) \vee (\rightharpoondown p \wedge \rightharpoondown q)$$
$$= (\rightharpoondown p \vee q) \wedge (q \rightarrow p)$$
$$[\because q \rightarrow p = (\rightharpoondown q \vee p)]$$

Hence, the correct option is (C).

Question Number: 51 **Question Type: MCQ**

For a set A, the power set of A is denoted by 2^A. If $A = \{5, \{6\}, \{7\}\}$, which of the following options are true?

I. $\varnothing \in 2^A$ II. $\varnothing \subseteq 2^A$

III. $\{5, \{6\}\} \in 2^A$ IV. $\{5, \{6\}\} \subseteq 2^A$

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

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

Solution: Given $A = \{5, \{6\}, \{7\}\}$

$\Rightarrow$ The power set of $A = 2^A = \{\varnothing, \{5\}, \{\{6\}\}, \{\{7\}\}, \{5,\{6\}\}, \{\{6\}, \{7\}\}, \{\{7\}, 5\}, \{5,\{6\}, \{7\}\}\}$

Clearly, $\varnothing \in 2^A$

$\therefore$ I is TRUE

Because the null set $\varnothing$ is a subset of every set,

$$\varnothing \subseteq 2^A$$

$\therefore$ II is TRUE

As $\{5, \{6\}\}$ is an element of 2^A

$$\{5, \{6\}\} \in 2^A$$

$\therefore$ III is TRUE

An element of a set cannot be subset of that set.

$\therefore$ $\{5, \{6\}\} \not\subseteq 2^A$

$\therefore$ IV is NOT TRUE.

Note that $\{5, \{6\}\} \not\subseteq 2^A$, but $\{\{5, \{6\}\}\} \in 2^A$

Hence, I, II and III are only TRUE.

Hence, the correct option is (C).

Question Number: 52 **Question Type: MCQ**

Consider a 4-bit Johnson counter with an initial value of 0000. The counting sequence of this counter is

(A) 0, 1, 3, 7, 15, 14, 12, 8, 0

(B) 0, 1, 3, 5, 7, 9, 11, 13, 15, 0

(C) 0, 2, 4, 6, 8, 10, 12, 14, 0

(D) 0, 8, 12, 14, 15, 7, 3, 1, 0

Solution: 4 bit Johnson counter (or) twisted ring counter

Clk	Q_3	Q_2	Q_1	Q_0	Value
0	0	0	0	0	0
1	1	0	0	0	8
2	1	1	0	0	12
3	1	1	1	0	14
4	1	1	1	1	15
5	0	1	1	1	7
6	0	0	1	1	3
7	0	0	0	1	1
8	0	0	0	0	0

Hence, the correct option is (D).

Question Number: 53 **Question Type: MCQ**

For computers based on three-address instruction formats, each address field can be used to specify which of the following:

(S1) A memory operand

(S2) A processor register

(S3) An implied accumulator register

(A) Either S1 or S2

(B) Either S2 or S3

(C) Only S2 and S3

(D) All of S1, S2 and S3

Solution: Computer with 3 address instruction format can use each address field to specify either processor register (or) memory operand.

Example:

ADD R_1, A, B $R_1 \leftarrow M[A] + M[B]$

ADD R_2, C, D $R_2 \leftarrow M[C] + M[D]$

MUL X, R_1, R_2 $M[X] \leftarrow R_1 * R_2$

Hence, the correct option is (A).

Question Number: 54 **Question Type: MCQ**

Suppose two hosts use a TCP connection to transfer a large file. Which of the following statements is/are FALSE with respect to the TCP connection?

I. If the sequence number of a segment is m, then the sequence number of the sub sequent segment is always $m + 1$.

II. If the estimated round trip time at any given point of time is t sec, the value of the retransmission timeout is always set to greater than or equal to t sec.

III. The size of the advertised window never changes during the course of the TCP connection.

IV. The number of unacknowledged bytes at the sender is always less than or equal to the advertised window.

(A) III only (B) I and III only

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

Solution:

I. The sequence number of the subsequent segment depends on the number of 8 byte characters of the current segment (False)

II. Window will keep changing depending on network traffic and processing capability.

Hence, the correct option is (B).

Question Number: 55 **Question Type: MCQ**

Suppose that everyone in a group of N people wants to communicate secretly with the N-1 others, using symmetric key cryptographic system. The communication between any two persons should not be decodable by the others in the group. The number of keys required in the system as a whole to satisfy the confidentiality requirement is

(A) $2N$ (B) $N(N-1)$

(C) $N(N-1)/2$ (D) $(N-1)^2$

Solution: In symmetric key cryptography,

If there are 'n' numbers of users, then we need $\frac{n(n-1)}{2}$ keys.

Hence, the correct option is (C).

Question Number: 56 **Question Type: MCQ**

Which of the following statements is/are false?

I. XML overcomes the limitations in HTML to support a structured way of organizing content.

II. XML specification is not case sensitive while HTML specification is case sensitive.

III. XML supports user defined tags while HTML uses pre-defined tags.

IV. XML tags need not be closed while HTML tags must be closed.

(A) II only (B) I only

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

Solution:

- XML over comes the limitations in HTML (TRUE)
- HTML is not case sensitive
- XML is case sensitive
- XML supports user defined tags (TRUE)
- XML tags must be closed.

Hence, the correct option is (C).

Question Number: 57 **Question Type: MCQ**

Which one of the following fields of an IP header is not modified by a typical IP router?

(A) Checksum (B) Source address

(C) Time to Live (TTL) (D) Length

Solution:

Checksum:

Checksum is calculated at each router, because the value of TTL will be decremented at each router.

TTL: (Time-to-Live)

The value of TTL will be decremented at each router, once the value of TTL becomes '0', the packet will be discarded.

Length:

The maximum header length is 15 words (i.e., 60 bytes) minimum is 20 bytes, but the options may make it bigger.

Example:

When a packet is fragmented at a router, having the router put in an IP address of a router and a time stamp, the final destination knows how long it took to get to each hop.

$\therefore$ The source and destination in the IP header is the original source and the final destination.

Hence, the correct option is (B).

Question Number: 58 **Question Type: MCQ**

In one of the pairs of protocols given below, both the protocols can use multiple TCP connections between the same client and the server. Which one is that?

(A) HTTP, FTP (B) HTTP, TELNET

(C) FTP, SMTP (D) HTTP, SMTP

Solution:

HTTP, FTP:

Both protocols are used to transfer files from one host to another.

- HTTP transfers files from web server to web user agent (The browser)
- FTP can send multiple files over the same TCP connection.
- HTTP is a "pull protocol" (users use HTTP to pull the information off the server).

Hence, the correct option is (A).

Question Number: 59 **Question Type: MCQ**

For any two languages L_1 and L_2 such that L_1 is context-free and L_2 is recursively enumerable but not recursive, which of the following is/are necessarily true?

I. $\overline{L}_1$ (complement of L_1) is recursive

II. $\overline{L}_2$ (complement of L_2) is recursive

III. $\overline{L}_1$ is context-free

IV. $\overline{L}_1 \cup L_2$ is recursively enumerable

(A) I only (B) III only

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

Solution: Context free language (CFL) is not closed under complement.

If Language 'L' is recursive enumerable but not recursive, then $\overline{L}$ is not recursive enumerable.

Option-I is true

If L_1 is CFL then $\overline{L_1}$ is not CFL, but the language $\overline{L_1}$ is recursive, so this is true.

Option-II is false

L_2 is recursive enumerable but 'not recursive', i.e., $\overline{L_2}$ is not recursive enumerable. So, it is not recursive.

Option-III is false

$\overline{L_1}$ is not context free.

Option-IV is true

$\overline{L_1}$ is recursive and L_2 is Recursive Enumerable.

Union of recursive and recursive enumerable is recursive enumerable.

Hence, the correct option is (D).

Question Number: 60 **Question Type: NAT**

Consider a system with byte-addressable memory, 32-bit logical addresses, and 4 kilobyte page size and page table entries of 4 bytes each. The size of the page table in the system in megabytes is _____.

Solution: Logical address = 32 bits

Page size = 4 K byte (4 KB)

Page table entry = 4 bytes each

Logical address space = 2^{32} = 4 GB

$$\text{Number of pages} = \frac{\text{Logical address space}}{\text{page size}}$$

$$= \frac{4\text{ GB}}{4\text{ KB}} = 1\text{ MB}$$

Page table size = 1 MB × page table Entry

= 1 MB × 4B = 4 MB

Hence, the correct Answer is (4).

Question Number: 61 **Question Type: NAT**

The following two functions P1 and P2 that share a variable B with an initial value of 2 execute concurrently.

```
P1 ( )      {      P2 ( )      {
   C = B - 1;            D = 2 * B;
   B = 2 * C;            B = D - 1;
}                     }
```

The number of distinct values that B can possibly take after the execution is _____

Solution: The functions P1 and P2

```
P1( )                      P2( )
{                          {
C = B - 1 ; → 1    D = 2 * B ; → 3
B = 2 * C ;→ 2     B = D - 1 ; → 4
}                          }
```

Let us number the instructions in P1( ) and P2( ) as 1, 2, 3, 4.

The possible execution sequence of instructions and the value of B is

(I) 1, 2, 3, 4 ⇒ $B = 3$

(II) 1, 3, 2, 4 ⇒ $B = 3$

(III) 1, 3, 4, 2 ⇒ $B = 2$

(IV) 3, 1, 2, 4 ⇒ $B = 2$

(V) 3, 1, 4, 2 ⇒ $B = 2$

(VI) 3, 4, 1, 2 ⇒ $B = 4$

The value of B can be 2, 3, 4.

Hence, the correct Answer is (3).

Question Number: 62 **Question Type: MCQ**

SELECT operation in SQL is equivalent to

(A) the selection operation in relational algebra.

(B) the selection operation in relational algebra, except that SELECT in SQL retains duplicates.

(C) the projection operation in relational algebra.

(D) the projection operation in relational algebra, except that SELECT in SQL retains duplicates.

Solution: Let us consider the following

```
SELECT NAME
FROM Student
WHERE Grade = 'A'
```

$$\pi_{NAME}\,(\sigma_{Grade='A',}{}^{(student)})$$

∴ π – eliminates duplicates from the result.

∴ To eliminate duplicates in SQL query, we have to use DISTINCT keyword in SELECT clause.

Hence, the correct option is (D).

Question Number: 63 **Question Type: MCQ**

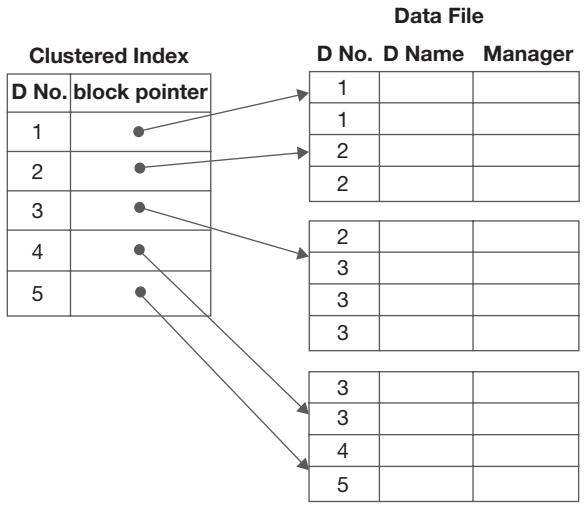
A file is organized so that the ordering of data records is similar to that of the ordering of data entries in some index. Then that index is called

(A) Dense (B) Sparse

(C) Clustered (D) Unclustered

Solution: Clustered index is constructed on a non-key field which is ordered.

Example:



Hence, the correct option is (C).

Question Number: 64 **Question Type: NAT**

If the LU decomposition of the matrix $\begin{bmatrix} 2 & 2 \\ 4 & 9 \end{bmatrix}$, if the diagonal elements of U are both 1, then the lower diagonal entry l_{22} of L is _____.

Solution: Let $A = \begin{bmatrix} 2 & 2 \\ 4 & 9 \end{bmatrix}$

Let the LU decomposition of A be

$$A = LU$$

Where $L = \begin{bmatrix} l_{11} & 0 \\ l_{21} & l_{22} \end{bmatrix}$ and $U = \begin{bmatrix} 1 & u_{12} \\ 0 & 1 \end{bmatrix}$

$$A = LU$$

$$\Rightarrow \quad \begin{bmatrix} 2 & 2 \\ 4 & 9 \end{bmatrix} = \begin{bmatrix} l_{11} & 0 \\ l_{21} & l_{22} \end{bmatrix} \begin{bmatrix} 1 & u_{12} \\ 0 & 1 \end{bmatrix}$$

$$\Rightarrow \quad \begin{bmatrix} l_{11} & l_{11}\mu_{12} \\ l_{21} & l_{21}u_{12} + l_{22} \end{bmatrix} = \begin{bmatrix} 2 & 2 \\ 4 & 9 \end{bmatrix}$$

Comparing the corresponding elements on both sides, we have $l_{11} = 2$, $l_{21} = 4$

$$l_{11}\, u_{12} = 2$$

$$\Rightarrow \quad u_{12} = \frac{2}{l_{11}} = \frac{2}{2} = 1$$

$$\Rightarrow \quad u_{12} = 1$$

$$l_{21}\, u_{12} + l_{22} = 9$$

$$\Rightarrow \quad 4 \times 1 + l_{22} = 9$$

$$\Rightarrow \quad l_{22} = 9 - 4 = 5$$

$$\therefore \quad l_{22} = 5$$

Hence, the correct Answer is (5).

Question Number: 65 **Question Type: NAT**

The output of the following C program is _____.

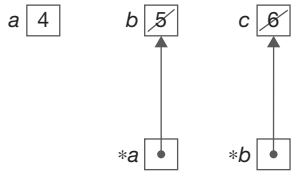
```
void f1 (int a, int b)      {
   int c;
   c=a; a=b; b=c;
}
void f2(int  *a, int  *b)   {
   int c;
   c=*a; *a=*b; *b=c;
}
int main ( ) {
   int a=4, b=5, c=6;
   f1 (a, b);
   f2 (&b, &c);
   printf("%d", c-a-b);
}
```

Solution: The values of a, b, c are 4, 5, 6

a [4] [5] b [6] c

f1(a, b) doesn't affect the a, b, c values, because parameters are passed by call by value.

f2(&b, &c) reflects the values of b and c (it swaps the b, c values)



The value of ($c - a - b$) is (5 – 4 – 6).

$\therefore$ –5

It prints –5

Hence, the correct Answer is (–5).

GATE 2015 Solved Paper
CSIT: Computer Science and Information Technology
Set – 3

Number of Questions: 65 **Total Marks:100.0**

Wrong answer for MCQ will result in negative marks, (–1/3) for 1 Mark Questions and (–2/3) for 2 Marks Question.

General Aptitude

Number of Questions: 10 **Section Marks: 15.0**

Question 1 to Question 5 carry 1 mark each and Question 6 to Question 10 carry 2 marks each.

Question Number: 1 **Question Type: MCQ**

Out of the following four sentences, select the most suitable sentence with respect to grammar and usage:

(A) Since the report lacked needed information, it was of no use to them.

(B) The report was useless to them because there were no needed information in it.

(C) Since the report did not contain the needed information, it was not real useful to them.

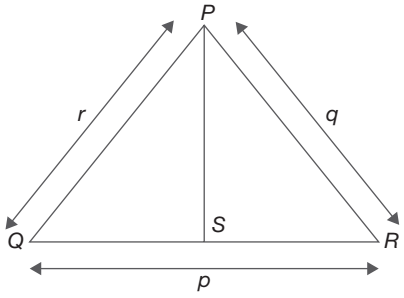
(D) Since the report lacked needed information, it would not have been useful to them.

Solution: Choice (A) is free of all errors. Though the article 'the' before 'needed' would render it correct, but of the given choices, (A) is correct. The use of 'there were' in (B) is incorrect. 'Real useful' is ungrammatical in (C). 'Not had been' is ungrammatical in (D).

Hence, the correct option is (A).

Question Number: 2 **Question Type: MCQ**

In a triangle PQR, PS is the angle bisector of $\angle QPR$ and $\angle QPS = 60^{o}$. What is the length of PS?



(A) $\frac{(q+r)}{qr}$ (B) $\frac{qr}{(q+r)}$

(C) $\sqrt{(q^2+r^2)}$ (D) $\frac{(q+r)^2}{qr}$

Solution: Area of triangle PQR = Area of triangle PQS+

Area of triangle PSR

Area of triangle $PQR = \frac{1}{2}(r)(q)\sin\angle P$

$= \frac{1}{2}(r)(q)\sin(2\angle QPS) = \frac{rq}{2}\sin 120°$

($\because$ PS is the angle bisector of $\angle QPR$)

$\therefore \frac{1}{2}(r\ q\ \sin 120°) = \frac{1}{2}(r\ (PS)\ \sin 60°) + \frac{1}{2}(q\ (PS)\sin 60°)$

$r\ q\left(\frac{\sqrt{3}}{2}\right) = r\ (PS)\ \frac{\sqrt{3}}{2}\ PS = \frac{rq}{r+q}$

Hence, the correct option is (B).

Question Number: 3 **Question Type: NAT**

If p, q, r, s are distinct integers such that:

$f(p, q, r, s) = max(p, q, r, s)$

$g(p, q, r, s) = min(p, q, r, s)$

$h(p, q, r, s) =$ remainder of $(p \times q)/(r \times s)$ if $(p \times q) > (r \times s)$ or remainder of $(r \times s)/(p \times q)$ if $(r \times s) > (p \times q)$

Also a function $fgh(p, q, r, s) = f(p, q, r, s) \times g(p, q, r, s) \times h(p, q, r, s)$

Also the same operations are valid with two variable functions of the form $f(p, q)$

What is the value of $fg(h(2,5,7,3), 4,6,8)$?

Solution: $h\ (2,\ 5,\ 7,\ 3)$ = remainder of $\left(\frac{21}{10}\right) = 1$ ($\because (r \times s) > (p \times q)$)

$fg(h\ (2,5,7,3),4,6,8) = fg(1,4,6,8)$

$= f(1,4,6,8) \times g\ (1,4,6,8)$

$= max\ (1, 4, 6, 8) \times min\ (1, 4, 6, 8) = 8 \times 1 = 8$

Hence, the correct Answer is (8).

Question Number: 4 **Question Type: MCQ**

If the list of letters P, R, S, T, U is in arithmetic sequence, which of the following are also in arithmetic sequence?

(I) $2P, 2R, 2S, 2T, 2U$

(II) $P\text{-}3, R\text{-}3, S\text{-}3, T\text{-}3, U\text{-}3$

(III) P^2, R^2, S^2, T^2, U^2

(A) I only (B) I and II

(C) II and III (D) I and III

Solution: P, R, S, T, U is an arithmetic sequence

$\therefore R - P = S - R = T - S = U - T$. Let each of these equal values be k.

I. $2(R - P) = 2(S - R) = 2(T\text{-}S) = 2(U - T) = 2k$

$\therefore 2P, 2R, 2S, 2T, 2U$ is an arithmetic sequence.

II. $R - 3 - (P - 3) = S - 3 - (R - 3) = T - 3 - (S\text{-}3) = U - 3 - (T - 3) = k$.

$\therefore P - 3, R - 3, S - 3, T\text{-}3, U - 3$ is an arithmetic sequence.

Hence, the correct option is (B).

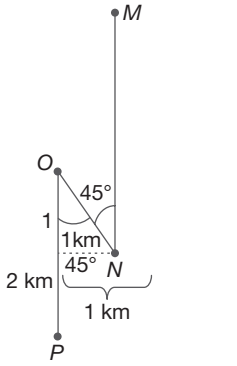
Question Number: 5 **Question Type: MCQ**

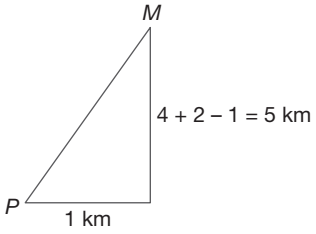
Four branches of a company are located at M, N, O and P. M is north of N at a distance of 4 km; P is south of O at a distance of 2 km; N is southeast of O by 1 km. What is the distance between M and P in km?

(A) 5.34 (B) 6.74

(C) 28.5 (D) 45.49

Solution: Line diagram





So MP = $\sqrt{(5)^2 + (1)^2} = \sqrt{25+1} = \sqrt{26} = 5.34$ Kms.

Hence, the correct option is (A).

Question Number: 6 **Question Type: MCQ**

We _____ our friend's birthday and we _____ how to make it up to him

(A) completely forgot — don't just know

(B) forgot completely — don't just know

(C) completely forgot — just don't know

(D) forgot completely — just don't know

Solution: The correct answer is choice (C). Here, 'completely', modifies 'forgot', which is to say that an action was missed out on. The same rule applies to the second blank as well. 'Don't know' come together, showing a misinformation and 'just' modifies it, showing an extent.

Hence, the correct option is (C).

Question Number: 7 **Question Type: MCQ**

Choose the statement where underlined word is used correctly.

(A) The industrialist had a personnel jet.

(B) I write my experience in my personnel diary.

(C) All personnel are being given the day off.

(D) Being religious is a personnel aspect.

Solution: The word 'personnel' means a group of people who work for a company or an organization. Choice (C) uses the word correctly. The rest of the choices should use 'personal'.

Hence, the correct option is (C).

Question Number: 8 **Question Type: MCQ**

A generic term that includes various items of clothing such as a skirt, a pair of trousers and a shirt is

(A) fabric (B) textile

(C) fibre (D) apparel

Solution: The correct answer is (D) apparel. (A) refers to the type of apparel. (B) refers to the business that makes apparels. (C) is again a material used to make an apparel.

Hence, the correct option is (D).

Question Number: 9 **Question Type: MCQ**

Based on the given statements, select the most appropriate option to solve the given question.

What will be the total weight of 10 poles each of same weight?

Statements:

(I) One fourth of the weight of a pole is 5 kg.

(II) The total weight of these poles is 160 kg more than the total weight of two poles.

(A) Statement I alone is not sufficient.

(B) Statement II alone is not sufficient.

(C) Either I or II alone is sufficient.

(D) Both statements I and II together are not sufficient.

Solution: We are asked to find the total height 10 notes, each of same height

From (I) alone we know that one fourth weight of a pole = 5 kg

Let us assume each pole to be of height W units

$$\frac{1}{4}\text{W} = 5 \text{ kg}$$

$$\boxed{\text{W} = 20 \text{ Kg}}$$

Weight of each pole = 20K

Then, 10 poles = 200 kgs

So, (I) alone can give us the answer (II) alone tells us let us assume each pole to be of height 'W'

$$10\text{W} = 160 + 2\text{W}$$

$$8\text{W} = 160$$

$$\boxed{\text{W} = 20 \text{ kg}}$$

So $10\text{W} = 200$ kg

(II) alone also is sufficient to arrive at the answer.

So, both (I) and (II) alone are sufficient to answer the question.

Hence, the correct option is (C).

Question Number: 10 **Question Type: MCQ**

Consider a function $f(x) = 1 - |x|$ on $-1 \le x \le 1$. The value of x at which the function attains a maximum and the maximum value of the function are:

(A) 0, –1 (B) –1, 0

(C) 0, 1 (D) –1, 2

Solution: $f(x)$ is maximum when $|x|$ is minimum i.e. when $|x|$ is zero i.e. when x is zero.

Maximum value of $f(x) = 1 - 0 = 1$. Which occurs at $x = 0$.

Hence, the correct option is (C).

Computer Science and Information Technology

Number of Questions: 55 **Section Marks: 85.0**

Question 11 to Question 35 carry 1 mark each and Question 36 to Question 65 carry 2 marks each.

Question Number: 11 **Question Type: NAT**

A link has a transmission speed of 10^6 bits/sec. It uses data packets of size 1000 bytes each. Assume that the acknowledgement has negligible transmission delay, and the propagation delay is the same as that of data propagation delay. Also assume that the processing delays at nodes are negligible. The efficiency of the stop-and-wait protocol in this setup is exactly 25%. The value of the one-way propagation delay (in milliseconds) is _____

Solution: The efficiency of the stop and wait protocol is $\eta = \frac{L}{L + BR}$

L = Length of the packet

B = Bandwidth of the link

R = Round trip delay if $\eta = 25\%$ then $L = \frac{BR}{3}$

i.e., $3L = BR$

$$3 \times 1000 \times 8 = 10^6 \times R$$

$$R = 24 \times 10^{-3} \text{ [}\because R = 2 \times \text{propagation delay]}$$

$$2 \times \text{Propagation delay} = 24 \times 10^{-3}$$

$$\text{Propagation delay} = 12 \times 10^{-3}$$

$$= 12 \text{ ms}$$

Hence, the correct Answer is (12).

Question Number: 12 **Question Type: MCQ**

Which one of the following statements is not correct about HTTP cookies?

(A) A cookie is a piece of code that has the potential to compromise the security of an internet user.

(B) A cookie gains entry to the user's work area through an HTTP header.

(C) A cookie has an expiry date and time.

(D) Cookies can be used to track the browsing pattern of a user at a particular site.

Solution: A cookie is a piece of code which is sent from a website and stored in web browser. It has the potential to compromise the security of a user.

Hence, the correct option is (A).

Question Number: 13 **Question Type: MCQ**

Consider the following routing table at an IP router:

Network No.	Net Mask	Next Hop
128.96.170.0	255.255.254.0	Interface 0
128.96.168.0	255.255.254.0	Interface 1
128.96.166.0	255.255.254.0	R2
128.96.164.0	255.255.252.0	R3
0.0.0.0	Default	R4

For each IP address in group I identify the correct choice of the next hop from group II using the entries from the routing table above.

Group I	Group II
(i) 128.96.171.92	(a) Interface 0
(ii) 128.96.167.151	(b) Interface 1
(iii) 128.96.163.151	(c) R2
(iv) 128.96.165.121	(d) R3
	(e) R4

(A) i-a, ii-c, iii-e, iv-d (B) i-a, ii-d, iii-b, iv-e

(C) i-b, ii-c, iii-d, iv-e (D) i-b, ii-c, iii-e, iv-d

Solution: (i) Given IP address 128.96.171.92

Perform AND operation with given masks. If the result gives any specific network number, the next hop of that network will be chosen.

```
128.96.171.92
255.255.254.0
128.96.170.0        Perform AND operation
```

∴ The next hop will be Interface 0.

(ii)
```
128.96.167.151
255.255.254.0
                    Perform AND operation
```

```
128.96.1010 0111.1001 0110
255.255.1111 1110. 0000 0000
128.96.  166                .0
```

∴ The next hop will be R_2

i – a, ii – c, iii – e, iv – d

Hence, the correct option is (A).

Question Number: 14 **Question Type: MCQ**

Host A sends a UDP datagram containing 8880 bytes of user data to host *B* over an Ethernet LAN. Ethernet frames may carry data up to 1500 bytes (i.e., MTU = 1500 bytes). Size of UDP header is 8 bytes and size of IP header is 20 bytes. There is no option field in IP header. How many total number of IP fragments will be transmitted and what will be the contents of offset field in the last fragment?

(A) 6 and 925 (B) 6 and 7400

(C) 7 and 1110 (D) 7 and 8880

Solution: User data = 8880 bytes

MTU = 1500 bytes

UDP header = 8 bytes

IP header = 20 bytes

Header length = (20 + 8) = 28 bytes

Actual data in each fragment = 1500 – 28 = 1472 bytes

Data	Header	Offset	
1st fragment	1472	28	0/8 = 0
2nd fragment	1472	28	1472/8 = 184
3rd fragment	1472	28	$\frac{2*1472}{8}=368$
4th fragment	1472	28	$\frac{3*1472}{8}=552$
5th fragment	1472	28	$\frac{4*1472}{8}=736$
6th fragment	1472	28	$\frac{5*1472}{8}=920$
7th fragment	48	28	$\frac{6*1472}{8}=1104$

Number of IP fragments will be 7.

Offset field of last fragment is 1104.

Hence, the correct option is (C).

Question Number: 15 **Question Type: MCQ**

Assume that the bandwidth for a TCP connection is 1048560 bits/sec. Let α be the value of RTT in milliseconds (rounded off to the nearest integer) after which the TCP window scale option is needed. Let β be the maximum possible window size with window scale option. Then the values of α and β are

(A) 63 milliseconds, 65535×2^{14}

(B) 63 milliseconds, 65535×2^{16}

(C) 500 milliseconds, 65535×2^{14}

(D) 500 milliseconds, 65535×2^{16}

Solution: In TCP connection, default window size is 64 kilobytes.

If then, Round Trip Time (RTT) is the main factor to decide TCP throughput between 2 locations.

If, RTT = 10 msec $\Rightarrow$ TCP throughput = 52428000 bps

RTT = 20 msec $\Rightarrow$ TCP throughput = 26214000 bps

RTT = 100 msec $\Rightarrow$ TCP throughput = 5242800 bps

RTT = 200 msec $\Rightarrow$ TCP throughput = 2621400 bps

RTT = 300 msec $\Rightarrow$ TCP throughput = 1747600 bps

RTT = 500 msec $\Rightarrow$ TCP throughput = 1048560 bps

α = 500 msec

If we are not using TCP window scaling option, TCP window size will be used as 64 kilobytes $\Rightarrow$ 65536 bytes.

Actual window size, using TCP window scaling, is

$$= (\text{window size}) * 2^{(\text{window scale})}$$
$$= 65535 \times 2^{14}$$

The window scaling option may be sent only once during a connection by each host, in its SYN packet. The maximum valid scale value is 14 (RFC 1323).

Hence, the correct option is (C).

Question Number: 16 **Question Type: MCQ**

Consider a simple check pointing protocol and the following set of operations in the log.

(start, T4); (write, T4, *y*, 2, 3); (start, T1); (commit, T4); (write, T1, *z*, 5, 7);

(checkpoint);

(start, T2); (write, T2, *x*, 1, 9); (commit, T2); (start, T3), (write, T3, *z*, 7, 2);

If a crash happens now and the system tries to recover using both undo and redo operations. What are the contents of the undo list and the redo list?

(A) Undo: T3, T1; Redo: T2

(B) Undo: T3, T1; Redo: T2, T4

(C) Undo: none; Redo: T2, T4, T3, T1

(D) Undo: T3, T1, T4; Redo: T2

Solution: Check point:

The automatic recovery processes by identifying a point at which all completed transactions are guaranteed have been written to the database device.

A check point creates a known good point from which the SQL server database engine can start applying changes contained in the log during recovery after an unexpected crash.

Before checkpoint:

$\rightarrow$ T_4 is committed

No need to REDO T_4

$\rightarrow$ T_1 is not committed

Need to UNDO T_1

After checkpoint:

$\rightarrow$ T_2 is committed, but for recovery, we should REDO from the point of 'checkpoint'.

$\rightarrow$ T_3 is not committed,

Need to UNDO.

Hence, the correct option is (A).

Question Number: 17 **Question Type: MCQ**

Consider two relations R_1(A, B) with the tuples (1, 5), (3, 7) and R_2(A, C) = (1, 7), (4, 9). Assume that R(A, B, C) is the full natural outer join of R_1 and R_2. Consider the following tuples of the form (A, B, C): *a* = (1,5, null), *b* = (1, null, 7), *c* = (3, null, 9), *d* = (4,7,null), *e* = (1,5,7), *f* = (3,7, null), *g* = (4,null, 9). Which one of the following statements is correct?

(A) R contains *a*, *b*, *e*, *f*, *g* but not *c*, *d*.

(B) R contains all of *a*, *b*, *c*, *d*, *e*, *f*, *g*.

(C) R contains *e*, *f*, *g* but not *a*, *b*.

(D) R contains *e* but not *f*, *g*.

Solution: R_1

A	C
1	7
4	9

R_2

A	B
1	5
3	7

R_1 FULL OUTER JOIN R_2

A	B	C
1	5	7
3	7	NULL
4	NULL	9

a = (1, 5, Null) Not Present
b = (1, Null, 7) Not present
c = (1, 5, 7) present
f = (3, 7, Null) present
g = (4, Null, 9) Present
Hence, the correct option is (C).

Question Number: 18 **Question Type: MCQ**

Consider six memory partitions of sizes 200 kB, 400 kB, 600 kB, 500 kB, 300 kB and 250 kB, where kB refers to kilobyte. These partitions need to be allotted to four processes of sizes 357 kB, 210 kB, 468 kB and 491 kB in that order. If the best fit algorithm is used, which partitions are not allotted to any process?

(A) 200 kB and 300 kB
(B) 200 kB and 250 kB
(C) 250 kB and 300 kB
(D) 300 kB and 400 kB

Solution: The memory map from the question is

Block 1 -		200 kB
Block 2 -		400 kB
Block 3 -		600 kB
Block 4 -		500 kB
Block 5 -		300 kB
Block 6 -		250 kB

The process P_1, P_2, P_3, P_4 requested for sizes 357 kB, 210 kB, 468 kB and 491 kB.

$\therefore$ the process P_1 is allocated to Block 2, P_2 is allocated to Block 6, P_3 is allocated to Block 4 and P_4 is allocated in Block 3.

So, Block 1 and Block 5 are not allocated to any process, i.e., Block 1 (200 kB) and Block 5 (300 kB) is not allotted.

Hence, the correct option is (A).

Question Number: 19 **Question Type: NAT**

Consider a typical disk that rotates at 15000 rotations per minute (RPM) and has a transfer rate of 50×10^6 bytes/sec. If the average seek time of the disk is twice the average rotational delay and the controller's transfer time is 10 times the disk transfer time, the average time (in milliseconds) to read or write a 512-byte sector of the disk is _____.

Solution: 60 sec $\rightarrow$ 15000 rotations

$$\frac{60}{15000} = 4 \text{ ms} \leftarrow 1 \text{ rotation}$$

$$\therefore \text{ Average rotational delay} = \frac{1}{2} \times 4 = 2 \text{ ms}$$

$$\text{Average seek time} = 2 \times \text{Average rotational delay}$$
$$= 2 \times 2 \Rightarrow 4 \text{ ms}$$

$$1 \text{ sec} \rightarrow 50 \times 10^6 \text{ bytes}$$

$$0.01 \text{ ms} \rightarrow \frac{512}{50 \times 10^6} \Rightarrow 512 \text{ bytes}$$

Transfer time = 10×0.01 ms
= 0.1 ms

Average time = 4 ms + 0.1 ms + 2 ms
= 6.1 ms

Hence, the correct Answer is (6.1 to 6.2).

Question Number: 20 **Question Type: NAT**

A computer system implements 8 kilobyte pages and a 32-bit physical address space. Each page table entry contains a valid bit, a dirty bit, three permission bits, and the translation. If the maximum size of the page table of a process is 24 megabytes, the length of the virtual address supported by the system is _____ bits.

Solution: Page – Table size = $(n \times e)$

$n \rightarrow$ number of pages

$e \rightarrow$ page entry size (in bytes)

Page size = 8 kB $\Rightarrow 2^{13}$

given page-entry contains a valid bit, dirty bits, three permission bits and the translation. i.e., 5 bits are reserved, the translation requires 19 bits

$$\left[\text{frames} = \frac{2^{32}}{2^{13}} \Rightarrow 2^{19}\right]$$

page entry size = (5 + 19) bits
= 24 bits
$\Rightarrow$ 3 bytes

Number of pages are

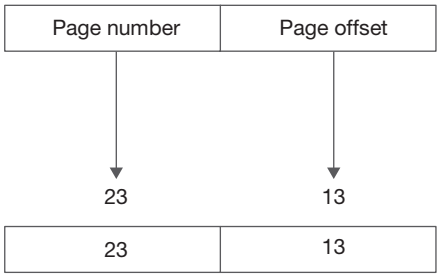
$n \times e$ = page table size
$n \times (3) = 24$ MB
3n = 24 MB

$$n = \frac{24 \times 2^{20}}{3}$$

$$n = 2^{23}$$

Number of pages = 2^{23}

Virtual address



= 23 + 13

= 36 bits

Virtual address = 36 bits

Hence, the correct Answer is (36).

Question Number: 21 **Question Type: MCQ**

Consider the intermediate code given below.

```
(1) i = 1
(2) j = 1
(3) t1 = 5 * i
(4) t2 = t1 + j
(5) t3 = 4 * t2
(6) t4 = t3
(7) a[t4] = -1
(8) j = j + 1
(9) if j <=5 goto (3)
(10) i=i+1
(11) if i<5 goto (2)
```

The number of nodes and edges in the control-flow-graph constructed for the above code, respectively, are

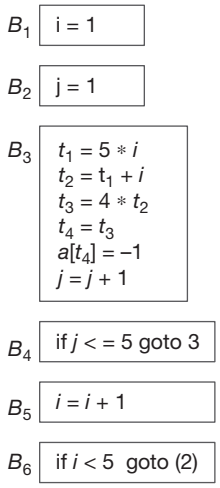
(A) 5 and 7 (B) 6 and 7

(C) 5 and 5 (D) 7 and 8

Solution:

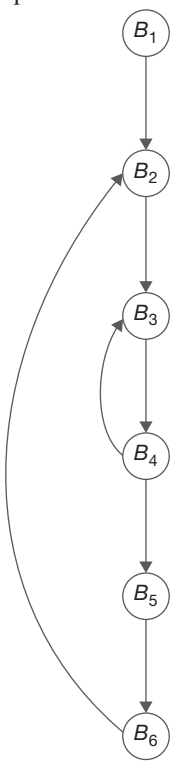
```
(1) i = 1
(2) j = 1
(3) t1 = 5 * i
(4) t2 = t1 + j
(5) t3 = 4 * t2
(6) t4 = t3
(7) a[t4] = -1
(8) j = j + 1
(9) if j < = 5 goto (3) → leader
(10) i = i + 1 → leader
(11) if i < 5 goto (2) → leader
```

The basic blocks for the above code.



There are 6 basic blocks.

The control flow graph is



There are 6 nodes and 7 edges.

Hence, the correct option is (B).

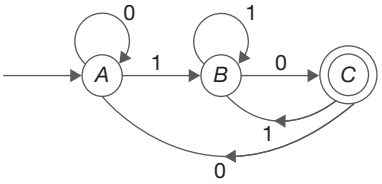
Question Number: 22 **Question Type: NAT**

The number of states in the minimal deterministic finite automation corresponding to the regular expression (0 + 1)*(10) is _____.

Solution: (0 + 1) * (10)

The language for the above regular expression is all the strings which are ending with 10.

The minimal finite automaton is



The number of states in minimal FA for the above language is 3.

Hence, the correct Answer is (3).

Question Number: 23 **Question Type: MCQ**

Which of the following languages is/are regular?

L_1: $\{wxw^R | w_1 \text{ x} \in \{a, b\}^* \text{ and } |w|, |x| > 0\}$, w^R is the reverse of string w

L_2: $\{a^n b^m | m \neq n \text{ and } m, n \geq 0\}$

L_3: $\{a^p b^q c^r | p, q, r \geq 0\}$

(A) L_1 and L_3 only (B) L_2 only

(C) L_2 and L_3 only (D) L_3 only

Solution: $\{W X W^R / W, \text{x} \in \{a, b\}^*$

Assume that $W = a\ b\ a$

$X = a\ b\ b$

$W^R = a\ b\ a$

WXW^R

Assume as

X

a | $a\ b\ a\ a\ b\ b$ | a

We can write this language as, set of all strings starting and ending with same symbol.

$\therefore L_1$ is Regular

L_2:

$\{a^n b^m / m \neq n\}$

We need a stack to compare, that every time $m \neq n$.

$\therefore L_2$ is not Regular

L_3: $\{a^p b^q c^r / p, q, r \geq 0\}$

We can generate a's independently need not check (or) save (or) count, again same for b's and c's also.

Regular Expression = $aa^*\ bb^*\ cc^*$

$\therefore L_3$ is Regular.

Hence, the correct option is (A).

Question Number: 24 **Question Type: MCQ**

Given below are some algorithms, and some algorithm design paradigms.

1. Dijkstra's shortest path	i. Divide and conquer
2. Floyd-Warshall algorithm to compute all pairs shortest path	ii. Dynamic programming
3. Binary search on a sorted array	iii. Greedy design
4. Backtracking search on a graph	iv. Depth-first search
	v. Breadth-first search

Match the above algorithms on the left to the corresponding design paradigm they follow.

(A) 1-i, 2-iii, 3-i, 4-v (B) 1-iii, 2-iii, 3-i, 4-v

(C) 1-iii, 2-ii, 3-i, 4-iv (D) 1-iii, 2-ii, 3-i, 4-v

Solution:

Greedy design → Dijkstra's shortest path

Dynamic programming → Floyd- Warshall algorithm to compute all pairs shortest path.

Divide and conquer → Binary search on a sorted array.

Depth First search → Back tracking, search on a graph.

Hence, the correct option is (C).

Question Number: 25 **Question Type: NAT**

A Young tableau is a 2D array of integers increasing from left to right and from top to bottom. Any unfilled entries are marked with ∞, and hence there cannot be any entry to the right of, or below a ∞. The following Young tableau consists of unique entries.

1	2	5	14
3	4	6	23
10	12	18	25
31	∞	∞	∞

When an element is removed from a Young tableau, other elements should be moved into its place so that the resulting table is still a Young tableau (unfilled

entries maybe filled in with a ∞). The minimum number of entries (other than 1) to be shifted, to remove 1 from the given Young tableau is _____.

Solution:

2		5	14
3	4	6	23
10	12	18	25
31	∞	∞	∞

2	4	5	14
3	6		23
10	12	18	25
31	∞	∞	∞

2	4	5	14
3	6	18	23
10	12	25	∞
31	∞	∞	∞

2	4	5	14
3	6	18	23
10	12		25
31	∞	∞	∞

2	4	5	14
3		6	23
10	12	18	25
31	∞	∞	∞

∴ 5 elements should be moved.

Hence, the correct Answer is (5).

Question Number: 26 **Question Type: MCQ**

Suppose you are provided with the following function declaration in the C programming language.

```
int partition (int a[ ], int n);
```

The function treats the first element of *a* [ ] as a pivot, and rearranges the array so that all elements less than or equal to the pivot is in the left part of the array, and all elements greater than the pivot is in the right part in addition, it moves the pivot so that the pivot is the last element of the left part. The return value is the number of elements in the left part.

The following partially given function in the C programming language is used to find the k^{th} smallest element in an array *a* [ ] of size *n* using the partition function. We assume $k \le n$.

```
int kth_smallest (int a [ ], int n,
int k)
{
  int left_end = partition(a, n);
  if (left_end+1 == k) {
  return a [left_end];
)
  if (left_end+1 > k) {
return kth_smallest ( _____ ) ;
} else {
return kth_smallest ( _____ ) ;
}
}
```

The missing argument lists are respectively

(A) (a, left_end, k) and (a+left_end+1, n-left_end-1, k-left_end-1)

(B) (a, left_end, k) and (a, n-left_end-1, k-left_end-1)

(C) (a+left_end+1, n-left_end-1, k-left_end-1) and (a, left_end, k)

(D) (a, n-left_end-1, k-left_end-1) and (a, left_end, k)

Solution: The above program gets the k^{th} smallest element using the concept of quick sort and the binary search [using divide and conquer strategy]

When the condition, left end +1 > *k* is true, the k^{th} smallest element is present left to the pivot, therefore we have to search to the left of pivot. i.e., k^{th} smallest (a, left-end, *k*)

When the condition left end +1 < *k* is true, the k^{th} smallest element is present right to the pivot, therefore we have to search between the left end and k^{th} element.

k^{th} smallest (a+left-end+1, n – left_end – 1,
k – left_end – 1)

Hence, the correct option is (A).

Question Number: 27 **Question Type: MCQ**

Which one of the following hash functions on integers will distribute keys most uniformly over 10 buckets numbered 0 to 9 for i ranging from 0 to 2020?

(A) $h(i) = i^2 \bmod 10$

(B) $h(i) = i^3 \bmod 10$

(C) $h(i) = (11 * i^2) \bmod 10$

(D) $h(i) = (12 * i) \bmod 10$

Solution: Let's take first 10 elements that is 0, 1, 2, 3, 4, 5, 6, 7, 8, 9 bucket numbers (0 – 9)

Option (A)

$h(i) = i^2 \bmod 10$

$0^2 \bmod 10 \Rightarrow 0 \bmod 10 = 0$

$1^2 \bmod 10 \Rightarrow 1 \bmod 10 = 1$

$2^2 \bmod 10 \Rightarrow 4 \bmod 10 = 4$

$3^2 \bmod 10 \Rightarrow 9 \bmod 10 = 9$

$4^2 \bmod 10 \Rightarrow 16 \bmod 10 = 6$
$5^2 \bmod 10 \Rightarrow 25 \bmod 10 = 5$
$6^2 \bmod 10 \Rightarrow 36 \bmod 10 = 6$
$7^2 \bmod 10 \Rightarrow 49 \bmod 10 = 9$
$8^2 \bmod 10 \Rightarrow 64 \bmod 10 = 4$
$9^2 \bmod 10 \Rightarrow 81 \bmod 10 = 1$

Hash table:

0	0	
1	1	9 collision
2		
3		
4	2	8 collision
5	5	
6	4	6 collision
7		
8		
9	3	7 collision

Let us consider the numbers from 0 to 9.
Perform hash function $h(i) = i^3 \bmod 10$

$0^3 \bmod 10 \rightarrow 0$
$1^3 \bmod 10 \rightarrow 1$
$2^3 \bmod 10 \rightarrow 8$
$3^3 \bmod 10 \rightarrow 7$
$4^3 \bmod 10 \rightarrow 4$
$5^3 \bmod 10 \rightarrow 5$
$6^3 \bmod 10 \rightarrow 6$
$7^3 \bmod 10 \rightarrow 3$
$8^3 \bmod 10 \rightarrow 2$
$9^3 \bmod 10 \rightarrow 9$

From 0 to 9 the numbers are stored in hash table without any collision, similarly from 10 – 19, 20 – 29, ….. The numbers are stored uniformly with the above sequence [0, 1, 8, 7, 4, 5, 6, 3, 2, 9]
Hence, the correct option is (B).

Question Number: 28 **Question Type: MCQ**

The secant method is used to find the root of an equation $f(x) = 0$. It is started from two distinct estimates x_a and x_b for the root. It is an iterative procedure involving linear interpolation to a root. The iteration stops if $f(x_b)$ is very small and then x_b is the solution. The procedure is given below. Observe that there is an expression which is missing and is marked by? Which is the suitable expression that is to put in place of? So that it follows all steps of the Secant method?

Secant

```
Initialize: xa, xb, ε, N // ε =
convergence indicator
// N = maximum no. of iterations
fb = f(xb)
i = 0
while (i < N and |fb| > ε) do
  i = i + 1  // update counter
  xt = ?     // missing expression
for
  // intermediate value
  xa = xb    // reset xa
  xb = xt    // reset xb
  fb = f(xb) // function value at new xb
end while
if |fb| > ε then  // loop is terminated
with i = N
write "Non-convergence"
else
write "return xb"
end if
```

(A) $x_b - (f_b - f(x_a)) f_b / (x_b - x_a)$
(B) $x_a - (f_a - f(x_a)) f_a / (x_b - x_a)$
(C) $x_b - (x_b - x_a) f_b / (f_b - f(x_a))$
(D) $x_a - (x_b - x_a) f_a / (f_b - f(x_a))$

Solution: It is secant method direct formula
Hence, the correct option is (C).

Question Number: 29 **Question Type: NAT**

Consider the C program below

```
#include <stdio.h>
int *A, stkTop;
int stkFunc (int opcode, int val)
{
static int size=0, stkTop=0;
switch (opcode) {
case -1: size = val; break;
case 0: if (stkTop < size)
A[stkTop++] =     val; break;
default: if (stkTop) return
A[--stkTop];
}
return -1;
}
int main ( )
{
int B[20]; A = B; stkTop = -1;
```

```
stkFunc (-1, 10);
stkFunc (0, 5);
stkFunc (0, 10);
printf ("%d\n", stkFunc(1, 0) + stk-
Func(1, 0));
}
```

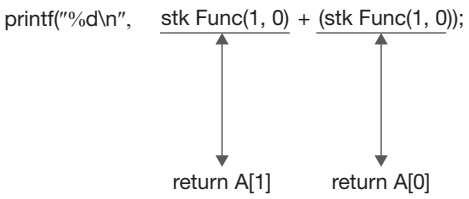
The value printed by the above program is _____.

Solution:

The values of size and sktTop will be 10 and 0 when stkFunc(–1, 10) is called.

The values of size and stkTop will be 0 and 1 with $A[0] = 5$, when stkFunc(0, 5) is called.

The value of size and stkTop will be 10 and 2 with $A[1] = 10$, when stkFunc(0, 10) is called.



$\therefore$ it prints 15

Hence, the correct Answer is (15).

Question Number: 30 **Question Type: NAT**

Consider the sequence of machine instructions given below:

MUL R5, R0, R1
DIV R6, R2, R3
ADD R7, R5, R6
SUB R8, R7, R4

In the above sequence, R0 to R8 are general purpose registers. In the instructions shown, the first register stores the result of the operation performed on the second and the third registers. This sequence of instructions is to be executed in a pipelined instruction processor with the following 4 stages: (1) Instruction fetch and decode (IF), (2) Operand fetch (OF), (3) Perform operation (PO) and (4) Write back the result (WB). The IF, OF and WB stages take 1 clock cycle each for any instruction. The PO stage takes 1 clock cycle for ADD or SUB instruction, 3 clock cycles for MUL instruction and 5 clock cycles for DIV instruction. The pipelined processor uses operand forwarding from the PO stage to the OF stage. The number of clock cycles taken for the execution of the above sequence of instructions is _____.

Solution: I – Instruction fetch and decode
O – Operand fetch
P – Perform operation.
W – Write back the result.

1	2	3	4	5	6	7	8	9	10	11	12	13
I	O I	P O I	P – – I	P – – –	W P O –	P – –	P – –	P – –	P – –	W P –	W P	W

Hence, the correct Answer is (13).

Question Number: 31 **Question Type: MCQ**

Consider a processor with byte-addressable memory. Assume that all registers, including Program Counter (PC) and Program Status Word (PSW), are of size 2 bytes. A stack in the main memory is implemented from memory location $(0100)_{16}$ and it grows upward. The Stack Pointer (SP) points to the top element of the stack. The current value of SP is $(016E)_{16}$. The CALL instruction is of two words, the first word is the op-code and the second word is the starting address of the subroutine (one word = 2 bytes). The CALL instruction is implemented as follows:

- Store the current value of PC in the stack
- Store the value of PSW register in the stack
- Load the starting address of the subroutine in PC

The content of PC just before the fetch of a CALL instruction is $(5FA0)_{16}$. After execution of the CALL instruction, the value of the stack pointer is

(A) $(016A)_{16}$ (B) $(016C)_{16}$
(C) $(0170)_{16}$ (D) $(0172)_{16}$

Solution: To execute CALL instruction, the contents of PC and PSW will be stored on to the stack

Both PC and PSW are of 2 bytes in size

Given top of stack is $(016E)_{16}$

Hence, the correct option is (D).

We need to add 4 bytes to the stack address to get stack pointer address after execution of CALL instruction

$$(016E)_{16} + 4 = (0172)_{16}.$$

Question Number: 32 **Question Type: NAT**

The number of min-terms after minimizing the following Boolean expression is _____.

$$[D^1 + AB^1 + A^1C + AC^1 D + A^1C^1D]^1$$

Solution: Number of min terms

$$[D^1 + AB^1 + A^1C + AC^1D + A^1C^1D]^1$$

If we consider $f = D^1 + AB^1 + A^1C + C^1D$

We need to find minimum terms of f^1, which are same as max terms of f.

AB \ CD	00	01	11	10
00	1	1	1	1
01	1	1	1	1
11	1	1	1	1
10	1	1	1	1

D^1 = X X X 0
(0, 2, 4, 6, 8, 10, 12, 14)

AB^1 = 10XX
(8, 9, 10, 11)

A^1C = 0 X 1 X
(2, 3, 6, 7)

C^1D = XX01
(1, 5, 9, 13)

So the only maximum term of f = 1111

So no. of minimum terms of f^1 = 1

Hence, the correct Answer is (1).

Question Number: 33 Question Type: MCQ

Let $f(x) = x^{-(1/3)}$ and A denote the area of the region bounded by $f(x)$ and the x-axis, when x varies from –1 to 1. Which of the following statements is/are true?

(i) f is continuous in [–1, 1]
(ii) f is not bounded in [–1, 1]
(iii) A is nonzero and finite

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

Solution: Given $f(x) = x^{-(1/3)}$

Clearly $f(x) = x^{-(1/3)} \to \infty$ as $x \to 0$

$\Rightarrow f(x)$ is not bounded in [–1, 1]

$\therefore$ (ii) is TRUE (1)

$\Rightarrow f(x)$ is NOT continuous in [–1, 1]

$\therefore$ (i) is NOT TRUE (2)

The area bounded by the curve $f(x)$, x- axis and the lines $x = -1$ to $x = 1$

$$= A = \int_{-1}^{1} f(x)\,dx = \int_{-1}^{1} x^{-(1/3)}\,dx = -\int_{-1}^{0} x^{-(1/3)}\,dx + \int_{0}^{1} x^{-(1/3)}\,d$$

$$= \frac{x^{2/3}}{2/3}\Big]_{-1}^{0} + \frac{x^{2/3}}{2/3}\Big]_{0}^{1} = \frac{-3}{2}x^{2/3}\Big]_{-1}^{0} + \frac{3}{2}x^{2/3}\Big]_{0}^{1}$$

$$= \frac{-3}{2}(0-1) + \frac{3}{2}(1-0) = \frac{3}{2} + \frac{3}{2}$$

$\therefore A = 3$

$\therefore A$ is non-zero and finite.

$\therefore$ (iii) is TRUE (3)

From the statements (1), (2) and (3)

(ii) and (iii) only are true.

Hence, the correct option is (C).

Question Number: 34 Question Type: NAT

Perform the following operations on the matrix

$$\begin{bmatrix} 3 & 4 & 45 \\ 7 & 9 & 105 \\ 13 & 2 & 195 \end{bmatrix}$$

(i) Add the third row to the second row
(ii) Subtract the third column from the first column

The determinant of the resultant matrix is _____.

Solution: Let $A = \begin{bmatrix} 3 & 4 & 45 \\ 7 & 9 & 105 \\ 13 & 2 & 195 \end{bmatrix}$

(i) Add the third row to the second row
(ii) Subtract the third column from the first column.

We know that operations of the type (i) and (ii) on a matrix cannot change its determinant.

$\therefore$ The determinant of the matrix obtained by applying the operations (i) and (ii) on A

$$= \text{Det of } A = \begin{vmatrix} 3 & 4 & 45 \\ 7 & 9 & 105 \\ 13 & 2 & 195 \end{vmatrix}$$

$$= 15\begin{vmatrix} 3 & 4 & 3 \\ 7 & 9 & 7 \\ 13 & 2 & 13 \end{vmatrix} = 15 \times 0 = 0$$

Hence, the correct Answer is (0).

Question Number: 35 **Question Type: NAT**

The number of onto functions (subjective functions) from set $X = \{1,2,3,4\}$ to set $Y = (a, b, c\}$ is _____.

Solution: Given $X = \{1, 2, 3, 4\}$ and $Y = \{a, b, c\}$

$$\therefore n(X) = 4 \text{ and } n(Y) = 3$$

The number of onto functions from set A to set B, where $n(A) \geq n(B)$ is $\sum_{r=0}^{n-1} (-r)^r n_{c_r} (n-r)^m$

where $n(A) = m$ and $n(B) = n$

Here $m = n(X) = 4$ and $n = n(Y) = 3$

$\because$ The number of onto functions from X to Y is

$$\sum_{r=0}^{n-1} (-1)^r \ {}^nC_0 (n-r)^m = \sum_{r=0}^{3-1} (-1)^r \ {}^3C_r (3-r)^4$$

$$= {}^3C_0 3^4 - {}^3C_1 2^4 + {}^3C_2 1^4$$

$$= 81 - 48 + 3 = 36$$

Hence the correct Answer is (36).

Question Number: 36 **Question Type: NAT**

Let X and Y denote the sets containing 2 and 20 distinct objects respectively and F denote the set of all possible functions from X to Y. Let f be randomly chosen from the probability of f being one-to-one is _____.

Solution: Given $n(X) = 2$ and $n(Y) = 20$

$n(F)$ = The number of elements in F

= The number of functions that can be defined from X to Y.

$$= n(Y)^{n(X)} = 20^2 = 400$$

The number of one-one functions from X to

$$Y = {}^{n(Y)} P_{n(X)}$$

$$= {}^{20} P_2 = 380$$

The probability that a randomly chosen function f from F is one-one $= \frac{380}{400} = 0.95$

Hence the correct Answer is (0.95).

Question Number: 37 **Question Type: MCQ**

Consider the alphabet $\Sigma = \{0, 1\}$, the null/empty string λ and the sets of strings X_0, X_1 and X_2 generated by the corresponding non-terminals of a regular grammar. X_0, X_1 and X_2 are related as follows

$$X_0 = 1 X_1$$

$$X_1 = 0X_1 + 1 X_2$$

$$X_2 = 0 X_1 + \{\lambda\}$$

Which one of the following choices precisely represents the strings in X_0?

(A) $10(0^* + (10)^*)1$

(B) $10(0^* + (10)^*)^*1$

(C) $1(0 + 10)^*1$

(D) $10(0 + 10)^*1 + 110(0 + 10)^*1$

Solution: $X_0 \to 1 X_1$

$X_1 \to 0 X_1 \mid 1 X_2$

$X_2 \to 0 X_1 \mid \in$

The above grammar represents a language with the strings starts and ends with '1', with 0's as substring [10*1] (or) with (10)'s as substring [1(10)*1]

The regular expression is

$$10^* 1 + 1 (10)^* 1$$

$$\Downarrow$$

$$1(0 + 10)^* 1$$

Hence, the correct option is (C).

Question Number: 38 **Question Type: MCQ**

A graph is self-complementary if it is isomorphic to its complement. For all self-complementary graphs on n vertices, n is

(A) A multiple of 4

(B) Even

(C) Odd

(D) Congruent to 0 mod 4, or, 1 mod 4

Solution: Let G be a graph of n vertices which is isomorphic to its complement $\overline{G}$.

$\therefore$ G and $\overline{G}$ should have same no. of edges. This is possible only when the no. of edges in G and $\overline{G}$ must be half of the no. of edges in the complete graph of n vertices K_n.

The no. of edges of $G = |E_G| = \frac{1}{2} \left|E_{k_n}\right|$

$$= \frac{1}{2}\left(\frac{n(n-1)}{2}\right) = \frac{n(n-1)}{4}$$

As $|E_G|$ being a positive integer, $\frac{n(n-1)}{4}$ is a positive integer.

$\Rightarrow n(n-1)$ is a multiple of 4.

$\Rightarrow n$ is a multiple of 4 (or) $n-1$ is a multiple of 4.

$\Rightarrow n \equiv 0 \pmod 4$ (or) $n - 1 \equiv 0 \pmod 4$

$\Rightarrow n \equiv 0 \pmod 4$ (or) $n \equiv 1 \pmod 4$

$\therefore$ n is congruent to 0 mod 4 or n is congruent to 1 mod 4.

Hence, the correct option is (D).

Question Number: 39 **Question Type: MCQ**

In a connected graph, a bridge is an edge whose removal disconnects a graph. Which one of the following statements is true?

(A) A tree has no bridges

(B) A bridge cannot be part of a simple cycle

(C) Every edge of a clique with size ≥ 3 is a bridge (A clique is any complete subgraph of a graph)

(D) A graph with bridges cannot have a cycle

Solution: In a simple cycle of a connected graph, the graph cannot be disconnected by removing any edge of that cycle.

Hence, edge of a simple cycle cannot be a bridge.

Hence, the correct option is (B).

Question Number: 40 **Question Type: MCQ**

Which one of the following well formed formulae is a tautology?

(A) $\forall x\, \exists y\, R(x, y) \leftrightarrow \exists y\, \forall x\, R(x, y)$

(B) $(\forall x\, [\exists y\, R(x, y) \rightarrow S(x, y)] \rightarrow \forall x \exists y\, S(x, y)$

(C) $[\forall x\, \exists y\, (P(x, y) \rightarrow R(x, y)] \leftrightarrow [\forall x\, \exists y\, (P(x, y) \vee R(x, y)]$

(D) $\forall x\, \forall y\, P(x, y) \rightarrow \forall x\, \forall y\, P(y, x)$

Solution: Consider $\forall x\, \exists y\, (P(x, y) \rightarrow R(x, y))$

$$\forall x\, \exists y\, (\neg P(x, y) \vee R(x, y))$$

$$(\neg P \rightarrow Q \Leftrightarrow \neg P \vee Q)$$

$$\therefore [\forall x\, \exists y (P(x, y) \rightarrow R(x, y))] \leftrightarrow [\forall x\, \exists y (\neg P(x, y) \vee R(x,y))]$$

is a tautology.

Hence, the correct option is (C).

Question Number: 41 **Question Type: MCQ**

Which one of the following assertions concerning code inspection and code walkthrough is true?

(A) Code inspection is carried out once the code has been unit tested.

(B) Code inspection and code walkthrough are synonyms.

(C) Adherence to coding standards is checked during code inspection.

(D) Code walkthrough is usually carried out by independent test team.

Solution: Inspection is used to verify the compliance of the product with specified standards and requirements, it is done by examining, meetings are needed, on the basis of feedback, rework is done.

Walkthrough is different from inspections.

In walkthrough author presents their artifacts to audience of peers. Peer questions and comments on these, to identify as many as possible.

Inspection is done by examining comparing the product with design, code, artifacts and any other documentation available.

Hence, the correct option is (C).

Question Number: 42 **Question Type: NAT**

A half adder is implemented with XOR and AND gates. A full adder is implemented with two half adders and one OR gate. The propagation delay of an XOR gate is twice that of an AND/OR gate. The propagation delay of an AND/OR gate is 1.2 microseconds. A 4-bit ripple-carry binary adder is implemented by using four full adders. The total propagation time of this 4-bit binary adder in microseconds is _____.

Solution: Half adder → XOR gate, AND gate

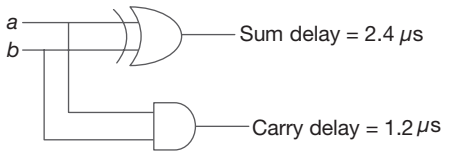
Full adder → 2 Half adder, OR gate

Propagation delay of XOR = 2 × propagation delay of AND/OR

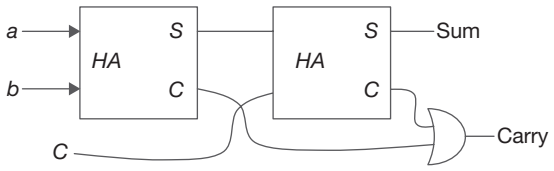
$$= 2 \times 1.2\ \mu s$$

$$= 2.4\ \mu s$$

Half adder delay



Full adder delay



$$\text{Sum delay} = 2 \text{ XOR} = 4.8\ \mu s$$
$$\text{Carry delay} = \text{XOR} + \text{AND} + \text{OR}$$
$$= 4.8\ \mu s$$

For 4 bit ripple carry adder

$$t_{delay} = (n-1)t_{carry} + t_{sum} = 3 \times 4.8 + 4.8$$
$$= 19.2\ \mu s$$

Hence, the correct Answer is (19.2).

Question Number: 43 Question Type: MCQ

Consider the following two statements.

S1: If a candidate is known to be corrupt, then he will not be elected.

S2: If a candidate is kind, he will be elected.

Which one of the following statements follows from S1 and S2 as per sound inference rules of logic?

(A) If a person is known to be corrupt, he is kind
(B) If a person is not known to be corrupt, he is not kind
(C) If a person is kind, he is not known to be corrupt.
(D) If a person is not kind, he is not known to be corrupt.

Solution: Given

S_1: If a candidate is known to be corrupt, then he will not be elected.

S_2: If a candidate is kind, he will be elected.

Let P: A candidate is known to be corrupt.

Q: A candidate will be elected.

and R: A candidate is kind

then S_1 and S_2 in symbolic form are

$S_1: P \to \neg Q$ and $S_2: R \to Q$

$\Rightarrow Q \to \neg P \qquad (\neg A \to B \Rightarrow \neg B \to \neg A)$

Now, $R \to Q$, $Q \to \neg P \Rightarrow R \to \neg P$ (By hypothetical syllogism)

i.e., If a candidate is kind, he is not known to be corrupt.

Hence, the correct option is (C).

Question Number: 44 Question Type: NAT

The cardinality of the power set of {0, 1, 2,…, 10} is _____.

Solution: Let $A = \{0,1, 2, 3,….., 10\}$

The cardinality of the power set of A = The number of elements in the power set of $A = 2^{n(A)} = 2^{11} = 2048$.

Hence, the correct Answer is (2048).

Question Number: 45 Question Type: MCQ

Let R be the relation on the set of positive integers such that a R b if and only if a and b are distinct and have a common divisor other than 1. Which one of the following statements about R is true?

(A) R is symmetric and reflexive but not transitive
(B) R is reflexive but not symmetric and not transitive
(C) R is transitive but not reflexive and not symmetric
(D) R is symmetric but not reflexive and not transitive

Solution: Given R is a relation on the set of positive integers Z^+ defined by R = $\{(a, b)/a$ and b are distinct and have a common divisor other than 1$\}$

(i) R is NOT reflexive because $(a, b) \in R \Rightarrow a \neq b$
$\Rightarrow (a, a) \notin R, \qquad a \in Z^+$

(ii) R is symmetric.
For, let $(a, b) \in R \Rightarrow a$ and b are distinct and have a common divisor other than 1.
$\Rightarrow b$ and a are distinct and have a common divisor other than 1.
$\Rightarrow (b, a) \in R$

(iii) R is NOT symmetric
For, $(2, 6) \in R$ and $(6, 9) \in R$ but $(2, 9) \in R$

$\therefore$ R is symmetric, but not reflexive and not transitive.

Hence, the correct option is (D).

Question Number: 46 Question Type: NAT

The number of divisors of 2100 is _____.

Solution: We have $2100 = 2^2 \times 3 \times 5^2 \times 7$

$\therefore$ The number of divisors of 2100 is $(2 + 1)(1 + 1)$

$$(2 + 1)(1 + 1)$$
$$= 36.$$

Hence, the correct Answer is (36).

Question Number: 47 Question Type: NAT

The larger of the two Eigen values of the matrix $\begin{bmatrix} 4 & 5 \\ 2 & 1 \end{bmatrix}$ is_____.

Solution: Let $A = \begin{bmatrix} 4 & 5 \\ 2 & 1 \end{bmatrix}$

The characteristic equation of A is $|A - \lambda I| = 0$

$$\Rightarrow \begin{vmatrix} 4-\lambda & 5 \\ 2 & 1-\lambda \end{vmatrix} = 0$$

$\Rightarrow (4 - \lambda)(1 - \lambda) - 10 = 0$
$\Rightarrow \lambda^2 - 5\lambda - 6 = 0$
$\Rightarrow \lambda^2 + \lambda - 6\lambda - 6 = 0$
$\Rightarrow (\lambda + 1)(\lambda - 6) = 0$
$\Rightarrow \lambda = -1, \lambda = 6$

$\therefore$ The larger of the two Eigen values is 6.

Hence the correct Answer is (6).

Question Number: 48 **Question Type: MCQ**

An unordered list contains n distinct elements. The number of comparisons to find an element in this list that is neither maximum nor minimum is

(A) $\theta(n \log n)$ (B) $\theta(n)$
(C) $\theta(\log n)$ (D) $\theta(1)$

Solution: Consider the following list of elements

10 6 8 9 4 11 12 2

First compare 10, 6 (1 comparison)
Assign minimum element to MIN variable
Assign maximum element to MAX variable
MIN = 6
MAX = 10
Now compare 8 with MIN and with MAX, nothing got updated, so 8 could be that element.

$\therefore \theta(1)$

Hence, the correct option is (D).

Question Number: 49 **Question Type: NAT**

The minimum number of JK flip-flops required to construct a synchronous counter with the count sequence (0,0,1,1,2,2,3,3,0,0,…) is _____.

Solution: The sequence has 4 different states each repeats time 0, 0, 1, 1, 2, 2, 2, 3, 3, 0, 0…..

So total 8 states, no. of JK flip flops = 3 ($8 = 2^3$)

Hence, the correct Answer is (3).

Question Number: 50 **Question Type: NAT**

Assume that for a certain processor, a read request takes 50 nanoseconds on a cache miss and 5 nanoseconds on a cache hit. Suppose while running a program, it was observed that 80% of the processor's read requests result in a cache hit. The average read access time in nanoseconds is _____.

Solution: Average read access time =

$$H(T_1) + (1 - H)(T_2)$$

H – cache Hit ratio
T_1 – Time to access cache
T_2 – Time taken to access read request (on cache miss)

$$\text{Hit ratio (H)} = 80\% \Rightarrow \frac{80}{100} \Rightarrow 0.8$$

$T_1 = 5$ ns
$T_2 = 50$ ns

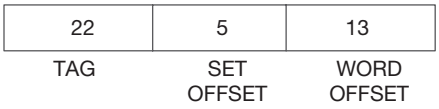
$\therefore$ Average read access time =
$= [0.8(5) + 0.2(50)]$ ns
$= (4 + 10)$ ns
$= 14$ ns

Hence, the correct Answer is (14).

Question Number: 51 **Question Type: NAT**

A computer system implements a 40-bit virtual address, page size of 8 kilobytes, and a 128-entry Translation Look-aside Buffer (TLB) organized into 32 sets each having four ways. Assume that the TLB tag does not store any process id. The minimum length of the TLB tag in bits is _____.

Solution: TAG bit will be 22-bits



Hence the correct Answer is (22).

Question Number: 52 **Question Type: MCQ**

Consider the following statements.

I. The complement of every Turing decidable language is Turing decidable.
II. There exists some language which is in NP but is not Turing decidable.
III. If L is a language in NP, L is Turing decidable.

Which of the above statements is/are true?

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

Solution: Every Turing decidable is a recursive language

Every Turing recognizable is a recursive – enumerable language.

Every Turing recognizable is a recursive enumerable language.

$\rightarrow$ Complement of Turing decidable languages is decidable which is TRUE.

$\rightarrow$ if the language is in NP, then it is turing decidable.

Hence, the correct option is (D).

Question Number: 53 **Question Type: MCQ**

Consider the following function written in the C programming language.

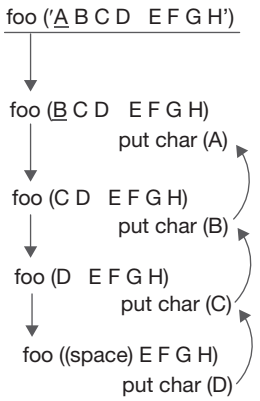
```
void foo(char *a {
      if ( *a && *a != ' '){
            foo(a + 1);
            putchar(*a);
      }
   }
```

The output of the above function on input 'ABCD EFGH' is

(A) ABCD EFGH (B) ABCD

(C) HGFE DCBA (D) DCBA

Solution: The function foo is a recursive function. The function reads the input string, character by character until the end of string (or) until the space is encountered.



It prints in reverse order of the string "A B C D" i.e., D C B A

Hence, the correct option is (D).

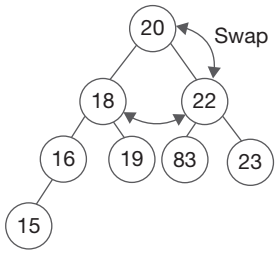
Question Number: 54 **Question Type: MCQ**

Consider a complete binary tree where the left and the right sub-trees of the root are max-heaps. The lower bound for the number of operations to convert the tree to a heap is

(A) $\Omega(\log n)$ (B) $\Omega(n)$

(C) $\Omega(n \log n)$ (D) $\Omega(n^2)$

Solution: Left and right sub trees are max-heaps



($\log n$) operations (2 comparisons, 1 swap)

$\Omega(\log n)$

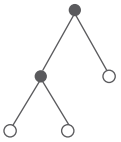
Hence, the correct option is (A).

Question Number: 55 **Question Type: NAT**

A binary tree T has 20 leaves. The number of nodes in T having two children is _____.

Solution: Consider the following trees.

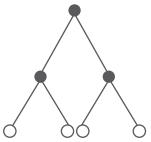
Case 1:



3 – leaves

2 – (nodes with 2 children)

Case 2:



4 – leaves

3(nodes with 2 – children)

$\therefore$ For 20 – leaves, the number of nodes having 2 – children will be 19.

Hence, the correct Answer is (19).

Question Number: 56 **Question Type: NAT**

Consider the following C function

```
int fun(int n) {
int x=1, k;
if (n==1) return x;
for (k=1; k<n; ++k)
x = x + fun(k) * fun(n - k);
return x;
}
```

The return value of fun(5) is _____.

Solution: Recurrence relation for above function is

$$f(n)=\begin{cases}1 & \text{if } n=1\\ 1+\sum_{k=1}^{n-1} f(k)\cdot f(n-k) & \text{if } n>1\end{cases}$$

n	1	2	3	4	5	6
f(n)	1	2	5	15	51	188

Hence, the correct Answer is (51)

Question Number: 57 Question Type: MCQ

A software requirements specification (SRS) document should avoid discussing which one of the following?

(A) User interface issues

(B) Non-functional requirements

(C) Design specification

(D) Interfaces with third party software

Solution: Design specifications are not specified in SRS documents it is done in software design phase.

Hence, the correct option is (C).

Question Number: 58 Question Type: MCQ

Consider two decision problems Q_1, Q_2 such that Q_1 reduces in polynomial time to 3-SAT and 3-SAT reduces in polynomial time to Q_2. Then which one of the following is consistent with the above statement?

(A) Q_1 is in NP, Q_2 is *NP*-Hard.

(B) Q_2 is in NP, Q_1 is NP-Hard.

(C) Both Q_1 and Q_2 are in NP.

(D) Both Q_1 and Q_2 are NP-Hard.

Solution: 3-SAT is a *NP*-complete problem if $Q_1 \leq_P 3 - \text{SAT} \leq_P Q_2$

then Q_1 is in *NP*, but Q_2 is not given in *NP*.

Therefore Q_2 is in *NP*-Hard.

Hence, the correct option is (A).

Question Number: 59 Question Type: MCQ

Match the following

P. Lexical analysis	1. Graph coloring
Q. Parsing	2. DFA minimization
R. Register allocation	3. Post-order traversal
S. Expression evaluation	4. Production tree

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

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

Solution: Lexical Analyzer is a finite automaton which is constructed from pattern recognizing rules.

Parsing of string is done using the production trees.

Register allocation is similar to that of graph coloring.

Expression evaluation is done using post order traversal.

Hence, the correct option is (C).

Question Number: 60 Question Type: MCQ

In the context of abstract-syntax-tree (AST) and control-flow-graph (CFG), which one of the following is true?

(A) In both AST and CFG, let node N_2 be the successor of node N_1. In the input program, the code corresponding to N_2 is present after the code corresponding to N_1.

(B) For any input program, neither AST nor CFG will contain a cycle.

(C) The maximum number of successors of a node in an AST and a CFG depends on the input program.

(D) Each node in AST and CFG corresponds to at most one statement in the input program.

Solution: CFG may contain cycles, then option (A) is false.

The CFG can contain cycle; therefore option (B) is false.

Single node contains a block of statements, so option (D) is false.

The maximum number of successors in AST and CFG depends on the input program.

Hence, the correct option is (C).

Question Number: 61 Question Type: MCQ

Consider the basic COCOMO model where E is the effort applied in person-months, D is the development time in chronological months, KLOC is the estimated number of delivered lines of code (in thousands) and a_b, b_b, c_b, d_b have their usual meanings. The basic COCOMO equations are of the form

(A) $E = a_b(KLOC)\exp(b_b)$, $D = c_b(E)\exp(d_b)$

(B) $D = a_b(KLOC)\exp(b_b)$, $E = c_b(D)\exp(d_b)$

(C) $E = a_b\exp(b_b)$, $D = c_b(KLOC)\exp(d_b)$

(D) $E = a_b\exp(d_b)$, $D = c_b(KLOC)\exp(b_b)$

Solution: Basic COCOMO model take the form effort applied $(E) = a_b(KLOC)^b$