[MCQ]

Q.1. If '→' denotes increasing order of intensity, then the meaning of the words [walk → jog → sprint] is analogous to [bothered → _____ → daunted]. Which one of the given options is appropriate to fill the blank?

(a) phased

(b) phrased

(c) fazed

(d) fused

Sol. **(c)**

To make somebody worried or nervous.

[MSQ]

Q.2. Sequence the following sentences in a coherent passage.

P: This fortuitous geological event generated a colossal amount of energy and heat that resulted in the rocks rising to an average height of 4 km across the contact zone.

Q: Thus, the geophysicists tend to think of the Himalayas as an active geological event rather than as a static geological feature.

R: The natural process of the cooling of this massive edifice absorbed large quantities of atmospheric carbon dioxide, altering the earth's atmosphere and making it better snited for life.

S: Many millennia ago, a breakaway chunk of bedrock from the Antarctic Plate collided with the massive Eurasian Plate.

(a) QSPR (b) SPRQ

(c) SRPQ (d) QPSR

Sol. **(b)**

[MCQ]

Q.3. Two wizards try to create a spell using all the four elements, water, air, fire, and earth. For this, they decide to mix all these elements in all possible orders. They also decide to work: independently. After trying all possible combination of elements, they conclude that the spell does not work.

How many attempts does each wizard make before coming to this conclusion. independently?

(a) 12 (b) 16

(c) 24 (d) 48

Sol. **(c)**

We use combination of $4 \times 3 \times 2 \times 1 = 24$

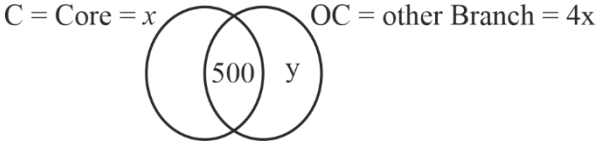
[MSQ]

Q.4. In an engineering college of 10,000 students. 1,500 like neither their core branches nor other branches. The number of students who like their core branches is 1 / 4th of the number of students who like other branches. The number of students who like both their core and other branches is 500 .
The number of students who like their core branches is

(a) 1.500 (b) 1.600
(c) 1.800 (d) 3.500

Sol. **(c)**

Number of students = 10000
Number of students not interested in both = 1500
∴ When diagram represent 10000 – 1500 = 8500



x = core, y = other branch (not core) = 4x
x + 4x = 8500 + 500
5x = 9000
x = 1800

[MSQ]

Q.5. In the 4 × 4 array shown below. each cell of the firs three tows has either a cross (X) or a number.
The number in a cell represents the count of the inundate neighbouring cells (left, right, top, bottom, diagonals) NOT planning a cross (X), Gives that the last row has no crosses (X), the sum of the four numbers to be filled in the las row is

1	×	4	3
×	5	5	4
3	×	6	×

(a) 12 (b) 9
(c) 11 (d) 10

Sol. **(c)**

1	×	4	3
×	5	5	4
3	×	6	×
2	4	3	2

Sum of fourth row = 2 + 4 + 3 + 2 = 11

[MSQ]

Q.6. A person sold two different items at the same price. He made 10 % profit in one item, and 10 % loss in the other item. In selling these two items, the person made a total of

(a) 1 % loss

(b) 1 % profit

(c) 2 % loss

(d) 2 % profit

Sol. **(a)**

$SP_1 = SP_2$

10% profit × 10% loss

$1.1 \times 0.9 = 0.99$

Less then 1 by 0.01

$\therefore$ 1% loss.

OR

When the selling price of the both item is equal and the profit and loss is same we get loss.

$$\text{Loss}\% = \frac{x^2}{100} = \frac{10^2}{100} = 1\% .$$

[MCQ]

Q.7. A cube is to be cut into 8 pieces of equal size and shape. Here, each cut should be straight and it should not stop till it reaches the other end of the cube.
The minimum number of such cuts required is.

(a) 3 (b) 7

(c) 8 (d) 4

Sol. (a) To cut a cube into 8 equal-sized and shaped pieces, the minimum number of straight cuts required is 3.
First cut: Make a straight cut through the middle of the cube, slicing it into 2 equal halves.

Second cut: Make another straight cut perpendicular to the first one, again cutting through the entire cube. Now you have 4 equal pieces.

Third cut: Make one more straight cut perpendicular to both the previous cuts, dividing the cube into 8 equal pieces.
Thus, a total of 3 cuts are required to divide a cube into 8 equal pieces.

[MCQ]

Q.8. In the sequence 6,9,14, x, 30,41, a possible value of x is

(a) 18 (b) 25

(c) 21 (d) 20

Sol. **(c)**

$$\underset{+3}{6}\quad\underset{+5}{9}\quad\underset{+7}{14}\quad\underset{+9}{x}\quad\underset{+11}{30}\quad 41$$

$x = 14 + 7 = 21$

[MCQ]

Q.9. For positive non-zero real variables x and y, if

$$ln\left(\frac{x+y}{2}\right) = \frac{1}{2}[ln(x) + ln(y)]$$

then, the value of $\frac{x}{y} + \frac{y}{x}$ is.

(a) 1 (b) 4

(c) 2 (d) ½

Sol. **(c)**

$$ln\left(\frac{x+y}{2}\right) = \frac{1}{2}[ln\ x + lny]$$

$$ln\left(\frac{x+y}{2}\right) = \frac{1}{2}[lnxy]$$

$$ln\left(\frac{x+y}{2}\right) = ln\sqrt{xy}$$

$$\frac{x+y}{2} = \sqrt{xy}$$

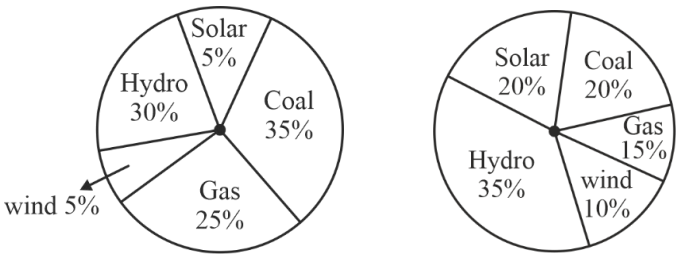
$$x^2 + y^2 + 2xy = 4xy$$

$$\frac{x}{y} + \frac{y}{x} + 2 = 4$$

$$\frac{x}{y} + \frac{y}{x} = 2$$

[MCQ]

Q.10. The pie charts depict the shares of various power generation technologies in the total electricity generation of a country for the years 2007 and 2023 .



The renewable sources of electricity generation consist of Hydro, Solar and Wind. Assuming that the total electricity generated remains the same from 2007 to 2023,

what is the percentage increase in the share of the renewable sources of electricity generation over this period?

(a) 25% (b) 50%

(c) 62.5% (d) 77.5%

Sol. **(c)**

For 2007

Renewable energy generate electricity

Hydro + Solar + Wind = 30% + 5% + 5% = 40%

For 2023

= 35% + 20% + 10% = 65%

$$\% \text{ increase in share } = \left(\frac{65-40}{40}\right)\% = 62.5\%$$

[MCQ]

Q.1. Consider the following C program. Assume parameters to a function are evaluated from right to left.

```
#include <stdio. h>
int g(int p) {printf("%d", p); return pr}
int h(int q) {print f("%d", q); return q;}
void f (int x, int y)
{
   g(x) :
   h(y),
}
int main()
{
    f(g(10), h(20));
}
```

Which one of the following options is the CORRECT output of the above C program?

(a) 20102010 (b) 10201020

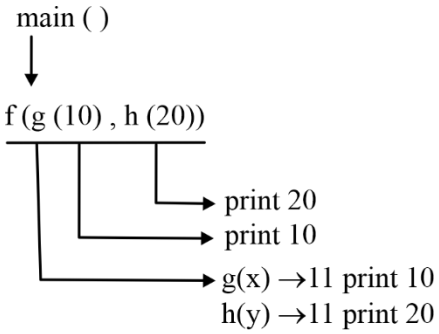
(c) 20101020 (d) 10202010

Sol. **(c)**

It is said that parameters are evaluated from left to right

So, f(g(10), h(20)) will print 20 10

and then, g(x) and h(y) will print 10 20 respectively)



$\therefore$ 20 10 10 20

Therefore, 20101020 will be printed option C is the correct answer.

[MCQ]

Q. 2. Once the DBMS informs the user that a transaction has been successfully completed, its effect should persist even if the system crashes before all its changes are reflected on disk. This property is called

(a) Consistency (b) Isolation

(c) Durability (d) Atomicity

Sol. **(d)**

Durability ensures that once a transaction is successfully completed, its effects are permanent, even if the system crashes before changes are written to disk.

[MCQ]

Q. 3. Let f(x) be a continuous function from $\mathbb{R}$ to $\mathbb{R}$ such that f(x)=1 – f(2-x)

Which one of the following options is the CORRECT value of $\int_0^2 f(x)\,dx$?

(a) –1 (b) 1

(c) 0 (d) 2

Sol. **(b)**

$$= \int_0^2 f(x)dx = \int_0^1 f(x)dx + \int_1^2 f(x)dx$$

$$= \int_0^1 f(x)dx + \int_0^1 (1 - f(x))dx$$

$$= \int_0^1 f(x)dx + \int_0^1 1dx - \int_0^1 f(x)dx$$

$$= \int_0^1 1dx = 1.$$

[MCQ]

Q. 4. Let A be the adjacency matrix of a simple undirected graph G. Suppose A is its own inverse. Which one of the following statements is always TRUE?

(a) G is a complete graph
(b) There is no such graph G
(c) G is a cycle
(d) G is a perfect matching

Sol. **(d)**

(1) For a matrix to be its own inverse, A * A = I, where I is the identity matrix.

(2) This means that for any two vertices i and j:

$\Sigma(A[i,k] * A[k,j]) = 1$ if i = j, and 0 otherwise.

(3) Since G is a simple undirected graph, A[i,j] is either 0 or 1, and A[i,j] = A[j,i].

(4) For the diagonal elements (i = j), we must have $\Sigma(A[i,k]^2) = 1$.

(5) This is only possible if each vertex is connected to exactly one other vertex.

(6) For non-diagonal elements ($i \neq j$), we must have $\Sigma(A[i,k] * A[k,j]) = 0$.

(7) This means that no two adjacent vertices can have a common neighbor.

Given these properties, let's evaluate each option:

(a) G is a complete graph

False. In a complete graph, each vertex is connected to all others, violating property 5.

(b) There is no such graph G

False. As we'll see, there is a graph that satisfies these properties.

(c) G is a cycle

False. In a cycle with more than 3 vertices, adjacent vertices would have common neighbors, violating property 7.

(d) G is a perfect matching

True. A perfect matching satisfies all the properties we derived:

- Each vertex is connected to exactly one other vertex.

- No two adjacent vertices have a common neighbor.

- The adjacency matrix of a perfect matching, when multiplied by itself, indeed produces the identity matrix.

Therefore, the correct answer is (d) G is a perfect matching.

This is the only structure that satisfies the condition of the adjacency matrix being its own inverse for a simple undirected graph.

[MCQ]

Q.5. Consider the following two sets:

Set X	Set Y
P. Lexical Analyzer	1. Abstract Syntax Tree
Q. Syntax Analyzer	2. Token
R. Intermediate Code Generator	3. Parse Tree
S. Code Optimizer	4. Constant Folding

Which one of the following options is the CORRECT match from Set X to Set Y ?

(a) P-4: Q-1: R-3 ; S-2
(b) P-2: Q-1: R-3 ; S-4
(c) P-2: Q-3: R-1 ; S-4
(d) P-4: Q-3: R-2 ; S-1

Sol. **(c)**

[MCQ]

Q. 6. Consider the following C function definition.

```
int fX (char *a)
{
    char *b = a;
    while (*b)
    b++;
    return b – a;
}
```

Which of the following statements is/are TRUE?

(a) The function call fX ("abcd") will always return a value
(b) Assuming a character array c is is declared as char c[] = “abcd” in main () the function call fX (c) will always return a value
(c) The code of the function will not compile
(d) Assuming a character pointer c is is declared as char *c = “abcd” in main () the function call fX (c) will always return a value

Sol. **(a, b, d)**

The function fX() returning length of string by calculating the difference between address of first and last character(pointer arithmetic is used).

Option A is TRUE , fX(“ABCD”) will return 4

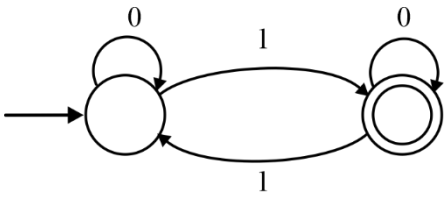
Option B is also TRUE, FX(c) will return 4

Option C is false , no compilation error

Option D is TRUE, character pointer will also return a value.

[MCQ]

Q. 7. Which one of the following regular expressions is equivalent to the language accepted by the DFA given below?



(a) 0*1 (0 + 10*1)
(b) 0* (10*11) *0*
(c) 0 (1 + 0*10*1) *0*
(d) 0*1(010*1) *0*

Sol. **(a)**

Minimum String getting accepted is 1.

[MCQ]

Q. 8. When six function dice are rolled simultaneously the probability of getting all distinct number (i.e., 1, 2,3,4,5 and 6) is

(a) 7/324
(b) 1/324
(c) 5/324
(d) 11/324

Sol. **(c)**

Total case for the throw of six device = 66 = 66.
Now, the number of forwardable outcomes
= 6!

$$\text{Thus } P(E) = \frac{6!}{6^6} = \frac{5\times4\times3\times2}{6^5}$$

$$= \frac{5\times4}{6^4} = \frac{5\times4}{6\times6}$$

$$= \frac{10}{3\times3\times2\times6^2} = \frac{5}{324}$$

[MSQ]

Q. 9. Which of the following statements is/are FALSE?

(a) An attribute grammar is a syntax-directed definition (SDD) in which the functions in the semantic rules have no side effects
(b) All L-attributed definitions based on LR(1) grammar can be evaluated using a bottom-up parsing strategy
(c) The attributes in a L-attributed definition cannot always be evaluated in a depth first order
(d) Synthesized attributes can be evaluated by a bottom-up parser as the input is parsed

Sol. **(b, c)**

(d) True: An attribute grammar is a form of syntax-directed definition (SDD), where the functions in the semantic rules do not have side effects.

(d) True: Synthesized attributes can be evaluated by a bottom-up parser as the input is parsed because they depend on the values of the attributes from the children nodes, which are available as the tree is built bottom-up.

Thus, the false statements are (b) and (c).

[NAT]

Q.10. Let A be an array containing integer values. The distance of A is defined as the minimum number of elements in A that must be replaced with another integer so that the resulting array is sorted in non-decreasing order. The distance of the array [2,5,3,1,4,2,6] is

Sol. **(3 to 3)**

First, let's sort the array in non-decreasing order:

Sorted A: [1, 2, 2, 3, 4, 5, 6]

Now, let's compare this sorted array with the original array A to find the differences:

Original A: [2, 5, 3, 1, 4, 2, 6]

Sorted A: [1, 2, 2, 3, 4, 5, 6]

The differences are:

1. A[0] needs to be replaced with 1.
2. A[2] needs to be replaced with 2.
3. A[5] needs to be replaced with 5.

So, the minimum number of replacements needed is 3. Thus, the distance of A is 3.

[MCQ]

Q.11. Which of the following file organizations is/are IO efficient for the scan operation in DBMS?

(a) Unclustered hash index
(b) Heap
(c) Sorted
(d) Unclustered tree index

Sol. **(c)**

(a) Unclustered hash index: Not IO efficient for scan operations. Hash indexes are optimized for equality searches, not for sequential scanning of the data.

(b) Heap: Not IO efficient for scan operations. In a heap, records are not stored in any particular order, so scanning requires reading through all the data without any optimization for sequential access.

(c) Sorted: IO efficient for scan operations. In a sorted file organization, records are stored in order, making it efficient for scanning as data can be read sequentially in the desired order with minimal random I/O.

(d) Unclustered tree index: Not IO efficient for scan operations. Like unclustered hash indexes, unclustered tree indexes may require reading data from different parts of the disk, causing random I/O and making the scan operation inefficient.

Thus, (c) Sorted is the most IO efficient file organization for scan operations in a DBMS.

[NAT]

Q.12. Let P be the partial order defined on the set {1,2,3,4} as follows

P = {(x, x) \ x (1, 2, 3, 4)} [(1,2), (3,2), (3,4)]

The number of total orders on {1,2,3,4} that contain P is _____

Sol. **(5)**

[NAT]

Q.13. The format of a single-precision floating-point number as per the IEEE 754 standard is-

Sign(1bit)	**Exponent (8 bits)**	**Mantissa(23 bits)**

Coose the largest floating-point number among the following option.

(a)

sign	Exponent	Mantissa
0	01111111	0000 0000 0000 0000 0000 0000

(b)

sign	Exponent	Mantissa
0	0111 1111	1111 1111 1111 1111 1111 1111

(c) sign Exponent Mantissa

0	1111 1110	1111 1111 1111 1111 1111 1111

(d)

sign	Exponent	Mantissa
0	1111 1110	1111 1111 1111 1111 1111 1111

Sol. **(c)**

Sign	Exponent	Mantissa
0	11111110	23 1's

Will give the maximum value in single precision (IEEE 754 format)

[MCQ]

Q.14. Which of the following statements about IPv 4 fragmentation is/are TRUE?

(a) The fragmentation of an IP datagram is performed only at the source of the datagram

(b) The fragmentation of an IP datagram is performed at any IP router which finds that the size of the datagram to be transmitted exceeds the MTU

(c) The reassembly of fragments is performed at all intermediate routers along the path from the source to the destination

(d) The reassembly of fragments is performed only at the destination of the datagram

Sol. **(b, d)**

- Fragmentation of IP datagram is performed at any intermediate IP router when size of datagram is greater the MTU of the network.
- Reassembly of fragments is performed only at the destination.

[MCQ]

Q.15. For a Boolean variable x, which of the following statements is/are FALSE?

(a) $x.x = 0$ (b) $x.1 = x$

(c) $x + 1 = x$ (d) $x + \bar{x} = 1$

Sol. **(a,c)**

(a) $x \cdot x = 0$ **[False]**

(b) $x + \bar{x} = 1$ **[True]**

(c) $1 + x = x$ **[False]**

(d) $x \cdot 1 = x$ **[True]**

[MCQ]

Q.16. Which of the following tasks is/are the responsibility/responsibilities of the memory management unit (MMU) in a system with paging-based memory management?

(a) Allocate a new page table for a newly created process

(b) Translate a virtual address to a physical address using the page table

(c) Raise a trap when a process tries to write to a page marked with read-only permission in the page table

(d) Raise a trap when a virtual address is not found in the page table

Sol. **(b, c, d)**

[MCQ]

Q.17. Let T(n) be the recurrence relation defined as follows:

$T(0) = 1$,
$T(1) = 2$, and
$T(n) = 5T(n-1) - 6T(n-2)$ for $n \geq 2$

Which one of the following statements is TRUE?

(a) $T(n) = \Theta(3n)$ (b) $T(n) = \Theta(3^n)$

(c) $T(n) = \Theta(2^n)$ (d) $T(n) = \Theta(n3^n)$

Sol. **(c)**

- $T(0) = 1 = 2^0$
- $T(1) = 2 = 2^1$
- $T(2) = 5T(1) - 6T(0) = 5 * 2 - 6 * 1 = 4 = 2^2$
- $T(3) = 5T(2) - 6T(1) = 5 * 4 - 6 * 2 = 8 = 2^3$
- $T(4) = 5T(3) - 6T(2) = 5 * 8 - 6 * 4 = 16 = 2^4$
- $T(5) = 5T(4) - 6T(3) = 5 * 16 - 6 * 8 = 32 = 2^5$

$T(n) = \theta(2^n)$, option (A) is correct.

[MCQ]

Q.18. Consider a computer with a 4MHz processor. Its DMA controller can transfer 8 bytes in 1 cycle from a device to main memory through cycle stealing at regular intervals. Which one of the following is the data transfer rate (in bits per second) of the DMA controller if 1% of the processor cycles are used for DMA?

(a) 25,60,000 (b) 2,56,000

(c) 32,00 (d) 32,000

Sol. **(a)**

[MCQ]

Q.19. In the context of owner and weak entity sets in the ER (Entity-Relationship) data model which one of the following statement is TRUE?

(a) Neither weak entity set nor owner entity set MUST have total participation in the identifying relationship

(b) Both weak and owner entity sets MUST have total participation in the identifying relationship

(c) The owner entity set MUST have total participation in the identifying relationship

(d) The weak entity set MUST have total participation in the identifying relationship

Sol. **(d)**

In a ER diagram, the weak entity must participate totally and the strong entity set may have partial or total participation.

[MCQ]

Q.20. Node X has a TCP connection open to node Y. The packets from X to Y go through and intermediate IP router R. Ethernet switch S is the first switch on the network path between X and R consider a packet sent from X to Y over this connection.

Which of the following statements is / are TRUE about the destination IP and MAC addresses on this packet at the time it leaves X?

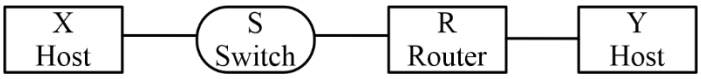
(a) The destination MAC address is the MAC address of Y

(b) The destination IP address is the IP address of R

(c) The destination IP address is the IP address of Y

(d) The destination MAC address is the MAC address of S

Sol. **(c)**



$\Rightarrow$X send packets to y

$\Rightarrow$ In IP datagram at x, destination IP address is always IP address of y.

[MCQ]

Q.21. Let p and q be the following propositions:
p: Fail grade can be given.
q: Student scores more than 50% marks
Consider the statement "Fail grade cannot be given when student scores more than 50% marks"
Which one of the following is the CORRECT representation of the above statement in propositional logic?

(a) $q \rightarrow \neg p$ (b) $q \rightarrow p$

(c) $\neg p \rightarrow q$ (d) $p \rightarrow q$

Sol. **(a)**

A when B

IF B then A

$B \rightarrow A$

$\neg p$

|

$\neg p$ when q

$\Rightarrow q \rightarrow \neg p$

[MCQ]

Q.22. Consider a process P running on CPU which one or more of the following events will always trigger a context switch by the OS that results in process P moving to a non-running state (e.g., ready blocked)?

(a) An interrupt is raised by the disk to deliver data requested by some other process

(b) A timer interrupt is raised by the hardware

(c) P tries to access a page that is the swap space triggering a page fault

(d) P make a blocking system call to read a block of data from the disk

Sol. **(c, d)**

[MCQ]

Q.23. Which of the following about the two phase locking (2PL) protocol is/are TRUE

(a) A deadlock is possible with 2PL

(b) 2PL permit only serializable schedules

(c) With 2PL, a transaction always a locks the data item being read or written just before every operation and always releases the lock just after the operation

(d) With 2PL, once a lock is released on any data item inside a transaction no more locks on any data item can be obtained inside that transaction

Sol. **(a , b, c)**

1. Transaction (T) not allowed to request lock on any data item during unlocking phase of T.
2. Always guaranteed for serializability.
3. Not free from deadlock.

[MCQ]

Q.24. An instruction format has the following structure

Instruction number: opcode destination reg, source reg-I, source red-2

Consider the following sequence of instruction to be executed in a pipelined processor

I1: DIV R3, R1, R2

I2: SUB R5, R3, R4

I3: ADD R3, R5, R6

I4: MUL R7, R3, R8

Which of the following statement is/are TRUE?

(a) There is a WAW dependency on R3 between I3 and I4

(b) There is a WAW dependency on R3 between I1 and I3

(c) There is a RAW dependency on R3 between I1 and I2

(d) There is a RAW dependency on R3 between I2 and I3

Sol. **(c)**

I_1 : $R_3 \leftarrow R_1 / R_2$

I_2 : $R_5 \leftarrow R_3 - R_4$

I_3 : $R_3 \leftarrow R_5 + R_6$

I_4 : $R_7 \leftarrow R_3 + R_8$

RAW dependencies: I_1 to I_2 for R_3

I_2 to I_3 for R_5

[MCQ]

Q.25. Which of the following fields of an IP header is/are always modified by any router before it forwards the IP packed?

(a) Source IP address (b) Header Checksum

(c) Time to Live (TTL) (d) Protocol

Sol. **(b, c)**

Time to live (TTL) field is always decremented by one at every intermediate router before forwarding it, to prevent looping of packets in the network.

- Any modification in IP(v4) header leads to new header checksum calculation.
- Protocol decided by source host only and can not be change by intermediate routers.
- Source IP address is not to be change at any intermediate router, it is determine by source network only.

[NAT]

Q.26. Consider an Ethernet segment with a transmission speed of 10^8 bits/sec and a maximum segment length of 500 meters. If the speed of propagation of the signal in the medium is 2×10^8 meters/sec, then the minimum frame size (in bits) required for collision detection is _____.

Sol. **(500 bits)**

Data transfer rate = 10^8 bit/sec.

Distance = 500 meter

Signal speed = 2×10^8 meter /sec.

Frame size = n bits

$$\text{Transmission time } (t_x) = \frac{\text{Frame length}}{D.T.R.}$$

$$t_x = \frac{n\ bits}{10^8\ bits/\sec.} = \frac{n}{10^8}\sec.$$

$$t_p = \frac{500\ \text{meter}}{2\times10^8\ meter/\sec.} = \frac{500}{2\times10^8}\sec.$$

For collision detection in ethernet $t_x \geq 2t_p$

$$\frac{n}{10^8}\sec. \geq 2\times\frac{500}{2\times10^8}\sec.$$

$$n \geq 500$$

[NAT]

Q.27. A non-pipelined instruction execution unit operating at 2 GHz takes an average of 6 cycles to execute an instruction of a program P. The unit is then redesigned to operate on a 5-stage pipeline at 2 GHz. Assume that the ideal throughput of the pipelined unit is 1 instruction per cycle. In the execution of program P. 20% instructions incur an average of 2 cycles stall due to data hazards and 20% instructions incur an average of 3 cycles stall due to control hazards. The speedup (rounded off to one decimal place) obtained by the pipelined design over the non-pipelined design is _____.

Sol. **(3)**

Pipeline

Non-pipeline:-

$$t_n = \frac{1}{2Gz}\times 6 = 3n\sec.$$

Sagemont (k) = 5

CPI of pipeline = 1 + 0.2 × 2 + 0.2 ×3

= 2

$$\text{Speed up} = \frac{3}{2\times0.5} = 3$$

[NAT]

Q.28. Let L_1 be the language represented by the regular expression b* ab* (ab* ab*)* and L_2 = {w ∈ (a + b)* | |w | ≤ 4}, where |w| denotes the length of string W. The number of strings in L_2 which are also in L_1 is _____.

Sol. **(15)**

As L2 is Any combination over a,b less than length 4, All the strings |w| < 4 in L_1 are also in L_2

$$L_1 = b^*\ ab^*\ (ab^*\ ab^*)^*$$

L_1 is b* ab* or b* ab* ab* ab*

The strings that can be formed from b* ab* with |w| < 4 are a, ba, b^2a, b^3 a, ab, ab^2, ab^3, baL bbab, babb i.e. 10 strings.

The strings that can be format from b* ab* ab* ab* with $|w| \leq 4$ are aaa, baaa, abaa, aaba, aaab i.e. 5 strings.

So, total strings that are common in L_1 and L_2 are 15.

[MCQ]

Q.29. Let A be an n × n matrix over the set of all real numbers $\mathbb{R}$. Let B be a matrix obtained from A by swapping two rows. Which of the following statements is/are TRUE?

(a) If A is invertible, then B is also invertible

(b) The determinant of B is the negative of the determinant of A

(c) If A is symmetric, then B is also symmetric

(d) If the trace of A is zero, then the trace of B is also zero

Sol. **(a, b)**

Swapping two rows of matrix changes the sign of the determinant therefore det(B) = –det(A).

And the new matrix remains invertible.

Hence option (a) & (b) are correct.

[MCQ]

Q.30. Consider a single processor system with four processes A, B, C. and D. represented as given below, where for each process the first value is its arrival time, and the second value is its CPU burst time.
A (0, 10), B (2, 6), C (4, 3), and D (6. 7).
Which one of the following options gives the average waiting times when preemptive Shortest Remaining Time First (SRTF) and Non-Preemptive Shortest Job First (NP-SJF) CPU scheduling algorithms are applied to the processes?

(a) SRTF = 6. NP - SJF = 7.5 (b) SRTF = 7. NP - SJF = 7.5

(c) SRTF = 7. NP - SJF = 8.5 (d) SRTF = 6. NP - SJF = 7

Sol. **(d)**

[NAT]

Q.31. Consider a disk with the following specifications: rotation speed of 6000 RPM, average seek time of 5 milliseconds, 500 sectors/track, 512-byte sectors. A file has content stored in 3000 sectors located randomly on the disk. Assuming average rotational latency, the total time (in seconds, rounded off to 2 decimal places) to read the entire file from the disk is _____.

Sol. **(30.06) [29.50 to 30 .50]**

Average seek time = 5ms

1 revolution time ⟷ 500 sectors

? ⟷ 1 sector

$$= \frac{10\text{ms}}{500} = 0.02\text{ms}$$

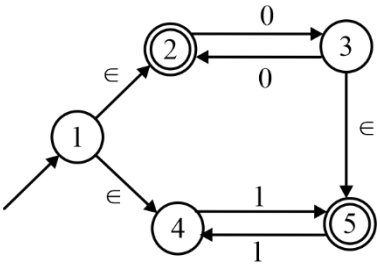
T_{avg} = Average seek time + Average Rotational latency + Transfer time + over head

T_{avg} = (5 ms + 5ms + 0.02 ms + 0) 3000

= 30060 ms = 30.06 sec.

[MCQ]

Q.32. Let M be the 5-state NFA with ∈ - transitions shown in the diagram below.
Which one of the following regular expressions represents the language accepted by M?



(a) 0* + (1 + 0 (00)*) (11)*
(b) 0+ + 1 (11)* + 0 (11)*
(c) (00)* + (1 + (00)*) (11)*
(d) (00)* + 1(11)*

Sol. **(a)**

2 and 5 are final states.

The given machine accepts all zeros i.e. 0*.

We can reach the final state 5 by either 0(00)* + (11)* or 1(11)*

∴ The result is

= 0* + 0(00)* (11)* + 1(11)*

= 0* + (0 (00)* + 1) (11)*

[MCQ]

Q.33. Which of the following is/are EQUAL to 224 in radix-5 (i.e., base-5) notation?

(a) 64 in radix-10
(b) 100 in radix-8
(c) 121 in radix-7
(d) 50 in radix-16

Sol. **(a, b, c)**

$(224)_5 = 2 \times 5^2 + 2 \times 5^1 + 4 \times 5^0$

$= 50 + 10 + 4 = (64)_{10}$

(a) $(121)_7 = 1 \times 7^2 + 2 \times 7^1 + 1 \times 7^0$

$= 49 + 14 + 1 = (64)_{10}$

(b) $(50)_{16} = 5 \times 16^2 + 0 \times 16^0$

$= (80)_{10}$

(c) $(100)_8 = 1 \times 8^2 + 0 \times 8^1 + 0 \times 8^0$

$= (64)_{10}$

hence (a), (b) (c)

[MCQ]

Q.34. Let S1 and S2 be two stacks. S1 has capacity of 4 elements. S2 has capacity of 2 elements. S1 already has 4 elements: 100, 200, 300. and 400. whereas S2 is empty, as shown below.

400 (Top)
300
200
100

Stack S1

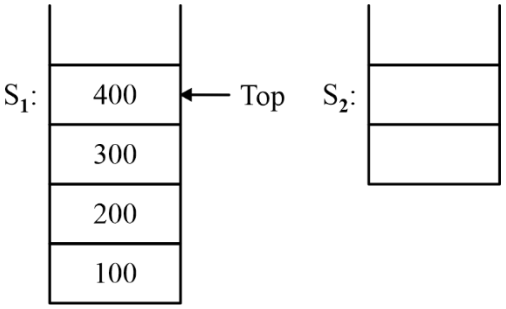
Stack S2

Only the following three operations are available:
PushToS2: Pop the top element from S1 and push it on S2.
PushToS1: Pop the top element from S2 and push it on S1.
Generate Output: Pop the top element from S1 and output it to the user.

Note that the pop operation is not allowed on an empty stack and the push operation is not allowed on a full stack.
Which of the following output sequences can be generated by using the above operations?

(a) 200, 300, 400, 100
(b) 400, 200, 100, 300
(c) 100, 200, 400, 300
(d) 300, 200, 400, 100

Sol. **(a, b, d)**



With the following operation sequence 200, 300, 400, 100 can be generated.

Push to S_2

Pust to s_2

Generate output. // 200

Push to S_1

Generated output // 300

Push to S_1

Generate output // 400

Push to S_1

Generate output // 100

With the following operation sequence 400, 200, 100, 300 can be generated.

Generate output // 400

Push to S_2

Generate output // 200

Generate output // 100

Push to S_1

Generated output // 300

With the following operation sequence 300, 200, 400, 100 can be generated.

Push to S_2

Generate output // 300

Generate output // 200

Push to S_1

Generate output // 400

Generate output // 100.

So, option A, B, and D can be generated.

Q.35. Which one of the following CIDR prefixes exactly represents the range of IP addresses 10.12.2.0 to 10.12.3.255?

(a) 10.12.2.0/24 (b) 10.12.2.0/22

(c) 10.12.0.0/22 (d) 10.12.2.0/23

Sol. **(d)**

10.12.2.0 to 10.12.3.255

10.12.0000001 0.00000000

10.12.0000001 1.11111111

23-bit common prefix and last 9 bits are all zero's to all one's

10.12.2.0/23

[MCQ]

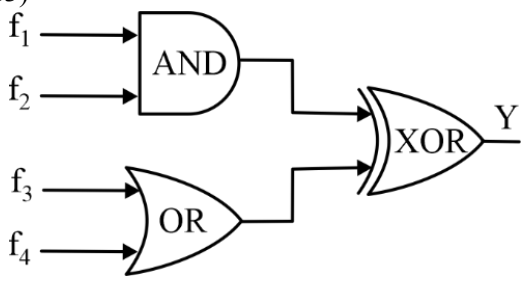
Q.36. Consider 4-variable functions f1, f2, f3, f4 expressed in sum-of-minterms form as given below.

f1 = ∑ (0, 2, 3, 5, 7, 8, 11, 13)

f2 = ∑ (1, 3, 5, 7, 11, 13, 15)

f3 = ∑ (0, 1, 4, 11)

f4 = ∑ (0, 2, 6, 13)



With respect to the circuit given above, which of the following options is/are CORRECT?

(a) Y = Π (8, 9, 10, 11, 12, 13, 14, 15)

(b) Y = ∑ (0, 1, 2, 11, 13)

(c) Y = ∑ (0, 1, 2, 3, 4, 5, 6, 7)

(d) Y = Π (3, 4, 5, 6, 7, 8, 9, 10, 12, 14, 15)

Sol. **(a,c)**

Y = Σ (0,1,2,3,4,5,6,7)

Y = π (8,9,10,11,12,13,14,15)

[MCQ]

Q.37. Let G be an undirected connected graph in which every edge has a positive integer weight. Suppose that every spanning tree in G has even weight. Which of the following statements is/are TRUE for every such graph G?

(a) In each cycle C in G, all edges in C have even weight

(b) All edges in G have even weight

(c) In each cycle C in G, either all edges in C have even weight OR all edges in C have odd weight

(d) All edges in G have even weight OR all edges in G have odd weight

Sol. **(c)**

In each cycle C in G, either all edges in C have even weight OR all edges in C have odd weight:

True. If every spanning tree in G has even weight, then in any cycle in G, either all edges have even weight (to maintain the even weight property of spanning trees) or all edges have odd weight

---

[MCQ]

Q.38. What is the output of the following C program?

```
#include <stdio.h>
int main() {
double a [2] = {20.0, 25.0), *p, *q;
p = a;
q = p + 1;
printf("%d, %d", (int) (q - p), (int) (*g - *p)); return 0;}
```

(a) 8, 5 (b) 1, 8

(c) 1, 5 (d) 4, 8

Sol. **(c)**

1.double a[2] = {20.0, 25.0};

Initializes an array a with two double values, 20.0 and 25.0.

2. double *p, *q;

Declares two pointers p and q to double.

3. p = a;

Assigns the address of the first element of array a to pointer p.

4. q = p + 1;

Assigns the address of the second element of array a to pointer q.

5. printf("(%d, %d)", (int)(q - p), (int)(*q - *p));

Prints the difference of the addresses (casting to int) and the difference of the values pointed to by q and p (casting to int).

The expression (q - p) calculates the difference in addresses, which is 1 (since q is one position ahead of p).

The expression (*q - *p) calculates the difference in values pointed to by q and p, which is 5 (25.0 - 20.0).

So, the correct output will be (1, 5). Therefore, the correct option is (c) 1, 5.

[MCQ]

Q.39. Consider the following expression: x[i] = (p + r) * -s[i] + u/w. The following sequence shows the list of triples representing the given expression, with entries missing for triples (1), (3), and (6).

(0)	+	P	r
(1)			
(2)	uminus	(1)	
(3)			
(4)	/	U	W
(5)	+	(3)	(4)
(6)			
(7)	=	(6)	(5)

Which one of the following options fills in the missing entries CORRECTLY?

(a) (1) []= si (3) - (0) (2) (6)=[] x (5)

(b) (1)=[] si (3) * (0) (2) (6) []= x (5)

(c) (1) = [] si (3)* (0) (2) (6) []= xi

(d) (1) []= si (3) - (0) (2) (6) = [] xi

Sol. **(c)**

(1) = [] s *i*

(2) *(0) (2)

(6) [] = x *i*

[NAT]

Q.40. A processor with 16 general purpose registers uses a 32-bit instruction format. The instruction format consists of an opcode field, an addressing mode field, two register operand fields, and a 16-bit scalar field. If 8 addressing modes are to be supported. the maximum number of unique opcodes possible for every addressing mode is _____.

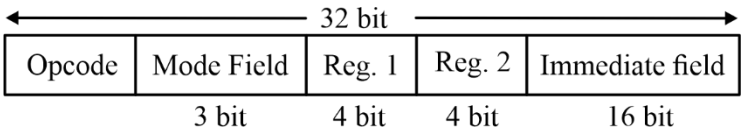
Sol. **(32)**

$Ins^{(n)}$ size = 32 bit

16 Register $\Rightarrow$ Reg. A.F = 4 bit

8 addressing mode $\Rightarrow$ mode field = 36 bit

Scaler field (immediate field) = 16 bit



Opcode $= 32 - (3 + 4 + 4 + 16)$

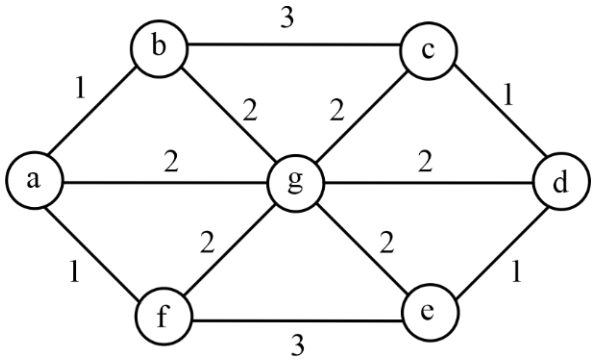
$= 32 - 27$

$= 5$ bits

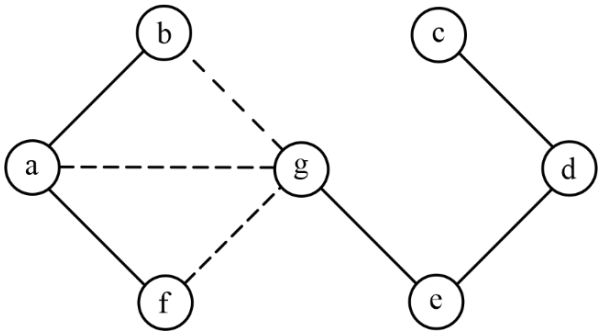
Number of opcode $= 2^5 = 32$

[NAT]

Q.41. The number of distinct minimum-weight spanning trees of the following graph is _____.



Sol. **(9 to 9)**



from vertex there are 3 possibilities for every edge from a, b, f = 3 + 3 + 3 = 9

[MCQ]

Q.42. Consider an array X that contains n positive integers. A subarray of X is defined to be a sequence of array locations with consecutive indices.
The C code snippet given below has been written to compute the length of the longest subarray of X that contains at most two distinct integers. The code has two missing expressions labelled (P) and (Q).

```
int first=0, second=0, lenl=0, len2=0, maxlen=0;
for (int i=0; i < n; i++)
{
        if (X[i] == first)
        {
              len2++; lenl++;
        } else if (X[i] == second)
        {
          len2++;
          lenl =  (P)  ;
          second = first;
        } else {
          len2 =  (Q)   ;
          lenl = 1; second = first;
)
if (len2 > maxlen)
{
        maxlen = lenl;
}
        first = X[i];
}
```

Which one of the following options gives the CORRECT missing expressions?
(Hint: At the end of the i-th iteration, the value of len 1 is the length of the longest subarray ending with X[i] that contains all equal values, and len2 is the length of the longest subarray ending with X[i] that contains at most two distinct values.)

(a) (P) 1 (Q) len 1 + 1

(b) (P) len 2 + 1 (Q) len 1 + 1

(c) (P) 1 (Q) len 2 + 1

(d) (P) len 1 + 1 (Q) len 2 + 1

Sol. **(c)**

The value of len1 is the length of the longest subarray ending with X [i] that contains all equal values, at the ith iteration. Hence length 1 will assign every time its equal to second value.
Hence len1 = 1
and len2 is the length of the longest subarray ending with X [i] that contains at most two distinct values. Hence if its equal to previous value then its updated to len2+1

[NAT]

Q.43. Consider a TCP connection operating at a point of time with the congestion window of size 12 MSS (Maximum Segment Size), when a timeout occurs due to packet loss. Assuming that all the segments transmitted in the next two RTTs (Round Trip Time) are acknowledged correctly, the congestion window size (in MSS) during the third RTT will be _____.

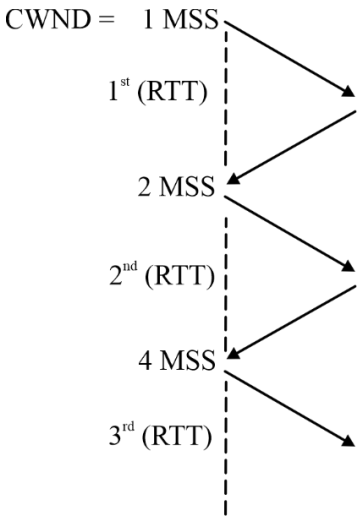
Sol. **(4 to 4)**

- CWND = 12 MSS

  Threshold occur

$$\text{Threshold} = \frac{\text{CWND}}{2} = 6 \text{ MSS}$$

CWND = 1 MSS



TCP congestion control enters into slow start phase (CWND< Thresholds), CWND increase by one after each segment acknowledged. In slow start phase CWND almost get double at the end of every RTT.

[NAT]

Q.44. Consider a 32-bit system with 4 KB page size and page table entries of size 4 bytes each. Assume 1 KB = 210 bytes. The OS uses a 2-level page table for memory management, with the page table containing an outer page directory and an inner page table. The OS allocates a page for the outer page directory upon process creation. The OS uses demand paging when allocating memory for the inner page table, i.e., a page of the inner page table is allocated only if it contains at least one valid page table entry. An active process in this system accesses 2000 unique pages during its execution, and none of the pages are swapped out to disk. After it completes the page accesses. let X denote the minimum and Y denote the maximum number of pages across the two levels of the page table of the process.

The value of X+Y is_____.

Sol. **(1028)**

[MCQ]

Q.45. Consider the following context-free grammar where the start symbol is S and the set of terminals is {a.b.c.d}.

S → AaAb | BbBa

A → cS | ∈

B → dS | ∈

The following is a partially-filled LL(1) parsing table.

	a	b	c	d	$
S	S→AaAb	S→BbBa	(1)	(2)	
A	A→∈	(3)	A→cS		
B	(4)	B→∈		B→dS	

Which one of the following options represents the CORRECT combination for the numbered cells in the parsing table?
Note: In the options, "blank" denotes that the corresponding cell is empty. ∈→

(a) (1) S→BbBa (2) S→AaAb (3) blank (4) blank
(b) (1) S→AaAb (2) S→BbBa (3) blank (4) blank
(c) (1) S→BbBa (2) S→ AaAb (3) A → ∈ (4) B→∈
(d) (1) S→AaAb (2) S→BbBa (3) A→∈ (4) B→∈

Sol. **(d)**

S → AaAb | BbBa
A → cS | ∈
B → dS | ∈

First (S) = {a, b, c, d}; Follow(S) = {a, b}

First (A) = {c, e); Follow(A) = {a, b}

First (B) = {d, e); Follow(B) = {a, b}

	a	b	c	d	$
S	S→AaAb	S→BbBa	(1)	(2)	
A	A→∈	(3)	A→cS		
B	(4)	B→∈		B→dS	

(1) S → AaAb
(2) S → BbBa
(3) A → cS | ∈
(4) B → dS | ∈

[NAT]

Q.46. A processor uses a 32-bit instruction format and supports byte-addressable memory access. The ISA of the processor has 150 distinct instructions. The instructions are equally divided into two types, namely R-type and I-type, whose formats are shown below.

R-type Instruction Format:				
OPCODE	UNUSED	DST Register	SRC Register 1	SRC Register 2
I-type Instruction Format:				
OPCODE	DST Register	SRC Register	# Immediate value/address	

In the OPCODE. 1 bit is used to distinguish between I-type and R-type instructions and the remaining bits indicate the operation. The processor has 50 architectural registers, and all register fields in the instructions are of equal size.
Let X be the number of bits used to encode the UNUSED field. Y be the number of bits used to encode the OPCODE field, and Z be the number of bits used to encode the immediate value/address field. The value of X + 2Y + Z is _____.

Sol. **(34)**

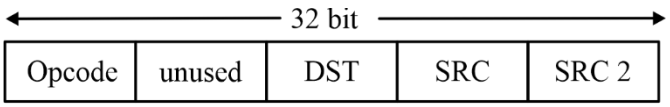
Number of instructions = 150

I – type instructions $= \frac{150}{2} = 75 \Rightarrow$ opcode $\Rightarrow 1 + 7 = 8$ bits

R – type instructions $= = \frac{150}{2} = 75 \Rightarrow$ opcode $\Rightarrow 1 + 7 =$ bits

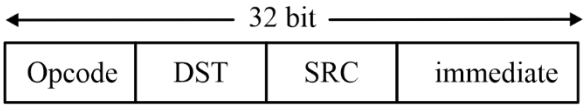
R– type instructions = 50 $\Rightarrow$ Number of bits for register reference = 6 bits

I– type instructions



Unused = 6

I– type instructions



Immediate value = 12 bits

X = 6

Y = 8

Z = 12

X + 2y + z = 6 + (2 * 8) + 12 = 36 bits

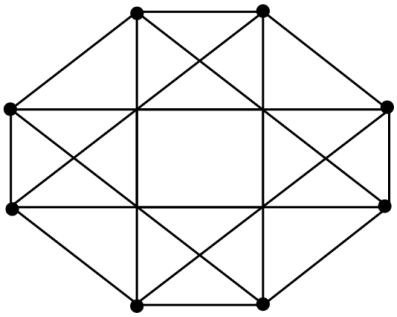
[NAT]

Q.47. Let Zn be the group of integers {0, 1, 2,..., n - 1} with addition modulo n as the group operation. The number of elements in the group Z2 × Z3 × Z4 that are their own inverses is _____.

Sol. **(8)**

[NAT]

Q.48. The chromatic number of a graph is the minimum number of colours used in a proper colouring of the graph. The chromatic number of the following graph is _____.



Sol. **(2 to 2)**

The chromatic number of given graph is 2.

[MCQ]

Q.49. Consider a multi-threaded program with two threads T_1 and T_2. The threads share two semaphores: s_1 (initialized to 1) and s_2 (initialized to 0). The threads also share a global variable x (initialized to 0). The threads execute the code shown below.

// code of Tl	// code of T2
wait (s1);	wait (s1);
x = x+1;	x = x+1;
print(x);	print(x) ;
wait(s2);	signal (s2);
signal(s1);	signal(s1);

Which of the following outcomes is/are possible when eads T_1 and T_2 execute concurrently?

(a) T_2 runs first and prints 1. T_1 does not print anything (deadlock)

(b) T_1 runs first and prints 1, T_2 runs next and prints 2

(c) T_2 runs first and prints 1, T_1 runs next and prints 2

(d) T_1 runs first and prints 1. T_2 does not print anything (deadlock)

Sol. **(c, d)**

[NAT]

Q.50. Consider the following augmented grammar, which is to be parsed with a SLR parser. The set of terminals is {a, b, c, d, #, @}

S' → S

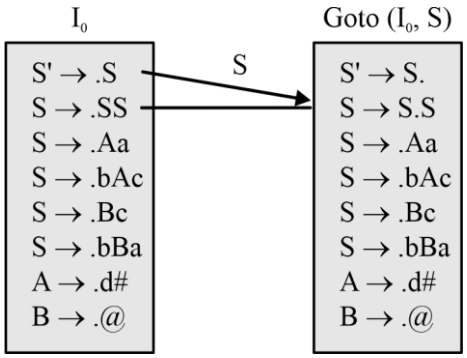
S → SS |Aa| |bAc. |Bc| |bBa

A → d#

B → @

Let I_o = CLOSURE({S' → •S)). The number of items in the set GOTO(I_o, S) is _____.

Sol. **(9)**



Toal 9 times

[MCQ]

Q.51. Let x and y be random variables, not necessarily independent, that take real values in the interval [0,1]. Let z = xy and let the mean values of x, y, z be $\bar{x}, \bar{y}, \bar{z}$ respectively. Which one of the following statements is TRUE?

(a) $\bar{z} \leq \bar{x}\,\bar{y}$ (b) $\bar{z} \geq \bar{x}\,\bar{y}$

(c) $\bar{z} < \bar{x}$ (d) $\bar{z} = \bar{x}\,\bar{y}$

Sol. **(c)**

[MCQ]

Q.52. You are given a set V of distinct integers. A binary search tree T is created by inserting all elements of V one by one, starting with an empty tree. The tree T follows the convention that, at each node, all values stored in the left subtree of the node are smaller than the value stored at the node. You are not aware of the sequence in which these values were inserted into T. and you do not have access to T.
Which one of the following statements is TRUE?

(a) Postorder traversal of T can be determined from V

(b) Inorder traversal of T can be determined from V

(c) Root node of T can be determined from V

(d) Preorder traversal of T can be determined from V

Sol. **(b)**

Since, it is given that we have distinct integers and at each node, all the values stored in left subtree are smaller than the node. We know, the inorder traversal of a tree is ascending order of the keys. So, Inorder traversal of T can be determined from V.

Therefore, option B is correct.

[MCQ]

Q.53. The relation schema. Person (pid, city), describes the city of residence for every person uniquely identified by pid. The following relational algebra operators are available: selection, projection, cross product, and rename.
To find the list of cities where at least 3 persons reside, using the above operators. the minimum number of cross product operations that must be used is

(a) 3 (b) 2

(c) 1 (d) 4

Sol. **(b)**

$$\pi_{city}(\sigma_{P1.city=P2.city \wedge P1.city=P3.city \wedge P1.pid \neq P2.pid \wedge P2.pid \neq P3.pid}(Person \times Person \times Person))$$

The minimum number of cross product operations required is **2**.

[MCQ]

Q.54. Consider a context-free grammar G with the following 3 rules.

$S \rightarrow as, S \rightarrow aSbS, S \rightarrow c$

Let w ∈ L(G). Let na (w), nb (w), nc (w) denote the number of times a, b, c occur in w, respectively. Which of the following statements is/are TRUE?

(a) $n_c(w) = n_b(w) * 2$ (b) $n_a(w) > n_b(w)$

(c) $n_a(w) > n_c(w) - 2$ (d) $n_c(w) = n_b(w) + 1$

Sol. **(d)**

$S \rightarrow as, S \rightarrow aSbS, S \rightarrow c$

$S \rightarrow aS$

$\rightarrow ac$

$S \rightarrow aSbS$

$\rightarrow aaSbSbS$

$\rightarrow aacbcbc$

By verficiation process

$n_c(w) = n_b(w) + 1$

Answer is option (d)

[NAT]

Q.55. A functional dependency F: X → Y is termed as a useful functional dependency if and only if it satisfies all the following three conditions:

X is not the empty set.

Y is not the empty set.

Intersection of X and Y is the empty set.

For a relation R with 4 attributes, the total number of possible useful functional dependencies is _____.

Sol. **(50)**

x → y

(1) $^4C_1 \times (1 \times (2^3 - 1))$

$4 \times 7 = 28$

(2) $^4C_2 \times (1 \times (2^2 - 1))$

$6 \times 3 = 18$

(3) $^4C_3 \times (1 \times (2^1 - 1))$

$4 \times 1 = 4$

Total useful FD's = 28 + 18 + 4 = 50