

**General Aptitude****Question 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?

[Verbal Ability, 1]

- (A) Phased (B) Phrased
(C) Fazed (D) Fused

Ans. (C)

Sol. Given :

[walk → jog → sprint]

'→' denote increasing order of intensity

[bothered → _____ → daunted]

Meaning of given words

walk → to move or go somewhere by putting one foot in front of the other on the ground, but without running

jog → to run slowly especially as a form of exercise

sprint → to run a short distances as fast as you can

bothered → worried about something

daunted → to frighten or to worry some body by being too big or difficult

From options

- (A) Phased → carried out in gradual stages, staggered
(B) Phrased → to express something in a particular way.
(C) Fazed → to make some body worried or nervous
(D) Fused → joined or blended to form a single entity.

From the above options and there meaning use see that options (A), (B) and (D) are not appropriate for given analogy and option (C) is logical in the analogy

Hence, correct option is (C).

Question 2

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?

[Numerical Ability, 4]

- (A) 24 (B) 48
(C) 16 (D) 12

Ans. (A)



Sol. Combination of $= 4! = 24$
4 element

(water, air, fire and earth)

Hence, the correct option is (A).

Question 3

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 $\frac{1}{4}$ th of the number of students who like other branches. The number of students who like both their core and other branches is 500.

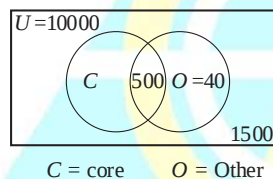
The number of students who like their core branches is

[Logical reasoning, 1]

- (A) 1,800 (B) 3,500
(C) 1,600 (D) 1,500

Ans. (A)

Sol.



$$C \cap O = 500$$

$$C = \frac{1}{4}O$$

$$O = 4C$$

$$\overline{(C \cup O)} = 1500$$

$$C \cup O = 10000 - 1500 = U - \overline{(C \cup O)} = 8500$$

$$C \cup O = 8500$$

$$C \cup O = C + O - C \cap O$$

$$8500 = C + 4C - 500$$

$$5C = 9000$$

$$C = 1800$$

Hence, the correct option is (A).



Question 4

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

[Logical reasoning, 3]

- (A) 1 (B) $\frac{1}{2}$
(C) 2 (D) 4

Ans. (C)

Sol. Given : For positive non-zero real variables x and y ,

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

$$2\ln\left(\frac{x+y}{2}\right) = [\ln(x) + \ln(y)] \quad [\because \ln(m) + \ln(n) = \ln(mn)]$$

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

$$\ln\left(\frac{x+y}{2}\right)^2 = \ln(xy) \quad [\because k\ln(m) = \ln(m)^k]$$

Taking antilog both sides,

$$\left(\frac{x+y}{2}\right)^2 = xy \quad [\because (a+b)^2 = a^2 + b^2 + 2ab]$$

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

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

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

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

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

Hence, the correct option is (C).

Question 5

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

[Numerical Ability, 1]

- (A) 25 (B) 21
(C) 18 (D) 20

Ans. (B)



Sol. Given : Sequence of numbers

$$\begin{array}{cccccc} 6, & 9, & 14, & x, & 30, & 41 \\ & +3 & +5 & +7 & +9 & +11 \end{array}$$

Here each number is obtained by adding consecutive odd number in the previous number.

i.e., $6+3=9$

$$9+5=14$$

$$14+7=x$$

$$x+9=30$$

$$30+11=41$$

$$41+13=54\ldots\ldots$$

Hence, $14+7=x$

$$21=x$$

Or

$$x+9=30$$

$$x=30-9$$

$$x=21$$

Possible value of x is 21.

Hence, the correct options is (B).

Q.6 to Q.10 Carry TWO Marks Each

Question 6

Sequence the following sentences in a coherent passage.

[Verbal Ability, 6]

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 suited for life.

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

(A) QPSR

(B) QSPR

(C) SPRQ

(D) SRPQ

Ans. (C)

Sol. The correct sequence is (C) SPRQ. It begins with the explanation (s) of the fortuitous geological event where a chunk of bedrock collided, followed by the geophysicists perspective (P) of the Himalayas as an



active geological event then, it discusses the natural process of cooling (R) and concludes with the impact on the earth's atmosphere (Q) . Providing a coherent flow of geological events.

Hence, the correct option is (C).

Question 7

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 **[Numerical Ability, 2]**

- (A) 1% profit (B) 2% profit
(C) 1% loss (D) 2% loss

Ans. (C)

Sol. Common selling price = 's' each

one at profit = $p\%$

another at Loss = $p\%$

then overall Loss% = $\left(\frac{p^2}{100}\right)\%$

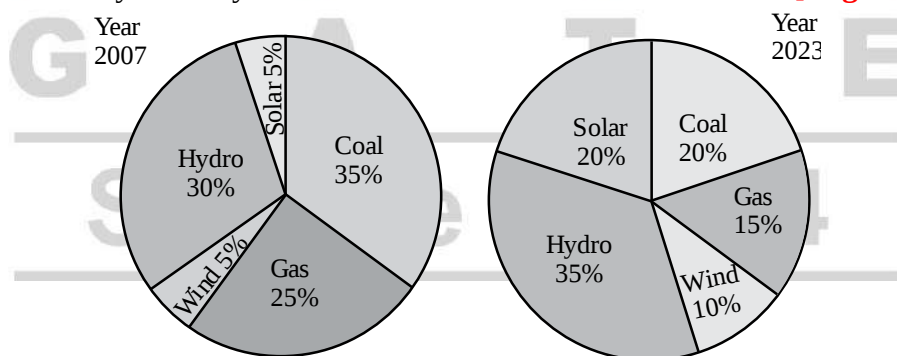
here $p = 10$

Loss % = $\left(\frac{(10)^2}{100}\right)\% = 1\% \text{ Loss}$

Hence, the correct option is (C).

Question 8

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. **[Logical Reasoning, 1]**



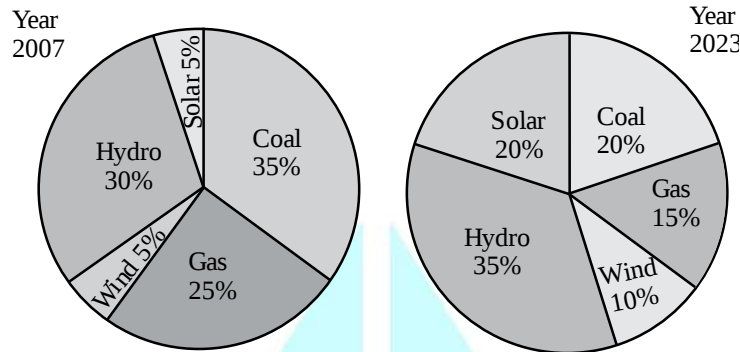
The renewable sources of electricity generation consist of Hydro, Solar and Wind.

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) 77.5% (D) 62.5 %

**Ans. (D)****Sol. Given :**

Pie charts depicts the shares of various power generating technologies in the total electricity generation of the country for the years 2007 and 2023.



Share of renewable sources of electricity in year 2007

$$\begin{aligned} &= \text{Hydro } 30\% + \text{Solar } 5\% + \text{Wind } 5\% \\ &= 40\% \end{aligned}$$

Share of renewable sources of electricity in year 2023

$$\begin{aligned} &= \text{Hydro } 35\% + \text{Solar } 20\% + \text{Wind } 10\% \\ &= 65\% \end{aligned}$$

Percentage increase in the share of renewable sources of electricity from 2007 to 2023

$$\begin{aligned} &= \frac{65 - 40}{40} \times 100 \\ &= \frac{25}{40} \times 100 \\ &= 62.5\% \end{aligned}$$

Hence, the correct option is (D).

Question 9

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) 4
(C) 7 (D) 8

[Logical Reasoning, 3]

Ans. (A)

Sol. Only 3 cuts are required to cut a cube into 8 equal size cubes. One along the x -axis, one along the y -axis and one along the z -axis.

Hence, the correct option is (A).

Question 10

In the 4×4 array shown below, each cell of the three rows has either a cross (x) or a number.



1	×	4	3
×	5	5	4
3	×	6	×

The number in a cell represents the count of the immediate neighboring cells (left, right, top, bottom, diagonals) NOT having a cross (X). Given that the last row has no crosses (X), the sum of the four numbers to be filled in the last row is

[Logical Reasoning, 3]

(A) 11

(B) 10

(C) 12

(D) 9

Ans. (A)
Sol.

1	×	4	3
×	5	5	4
3	×	6	×

1st 2nd 3rd 4th

Whatever element came on this box's boundary that all are neighbors are of circled = 5

total neighbors of = 5

Ist place : It has 2 neighbors so value = 2

IInd place : It has 4 neighbors so value = 4

IIIrd place : It has 3 neighbors so value = 3

IVth place : It has 2 neighbor so value = 2

2	4	3	2
---	---	---	---

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

Hence, the correct option is (A).

Q.11 – Q.35 Carry ONE mark Each

Question 11

[Computer Organization & Architecture (Input Output Organization)]

Consider a computer with a 4 MHz 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) 32,00

(C) 25,60,000

(D) 32,000

Ans. (C)

Sol. To transfer 8 bytes, it requires 1 cycle time.



$$1 \text{ cycle} = \frac{1}{4} \text{ MHZ} = 0.25 \text{ micro sec.}$$

$$\% \text{ of time CPU Block} = \frac{\text{Transfer time to memory}}{\text{Preparation time}}$$

$$0.01 = \frac{0.25}{\text{prep.time}}$$

$$\text{Prep.time} = 25 \text{ microsecond}$$

∴ In $25\mu\text{s}$ 8 Byte data transferred

∴ In $25\mu\text{s}$ 8×8 bit data transferred

∴ In 1 second data transferred

$$= \frac{8 \times 8 \text{ bit}}{25 \times 10^{-6}} \text{ second}$$

$$= 2.56 \times 10^6 \text{ bps}$$

$$= 25,60,0000 \text{ bit per second}$$

Hence, the correct option is (C)

Question 12**[Digital Logic (Boolean Algebra)]**

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) $p \rightarrow q$

(D) $\neg p \rightarrow q$

Ans. (A)

Sol. Q when P means $= P \rightarrow Q$

Given statement

p : Fail grade can be given

q : Student scores more then 50% marks

$\sim p$: Fail grade cannot be given



So, Fail grade cannot be given when student score more than 50 % marks

$(Q \rightarrow \sim P)$

Hence, the correct option is (A).

Question 13**[C-Programming]**

Consider the following C program. Assume parameter to function are evaluated from right to left.

```
#include <stdio.h>
```

```
int g(int p) {printf ("%d", p); return p;}
```

```
int h (int q) {printf ("%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) 20101020

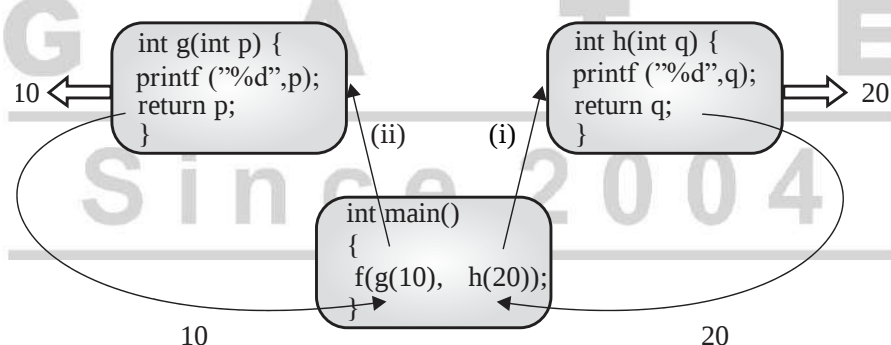
(B) 10202010

(C) 20102010

(D) 10201020

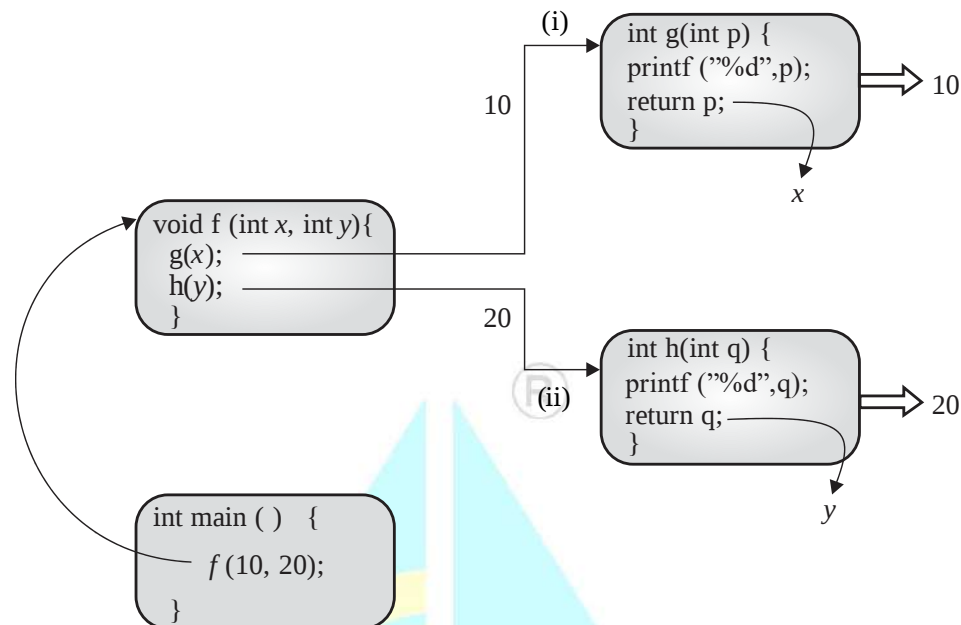
Ans. (A)

Sol.



As its mentioned “parameters to a function are evaluated from right to left”

So, `h()` will be will be evaluated first, and it will print 20 first then `g()` will be evaluated and it will



Now as $g()$ and $h()$ both function will return 10 and 20 respectively, So now $F(10, 20)$ will be called from then again $g()$ and $h()$ will be called and 10 and 20 will be pointed respectively.

Hence, the correct option is (A).

Question 14 [Computer Organization & Architecture (Machine Instruction and Addressing)]

The format of a single – precision floating – point number as per the IEEE 754 standard is :

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

Choose the largest floating - point number among the following options.

(A)

Sign	Exponent	Mantissa
0	0111 1111	1111 1111 1111 1111 1111 1111

(B)

Sign	Exponent	Mantissa
0	1111 1110	1111 1111 1111 1111 1111 1111

(C)

Sign	Exponent	Mantissa
0	1111 1111	1111 1111 1111 1111 1111 111

(D)

Sign	Exponent	Mantissa
0	0111 1111	0000 0000 0000 0000 0000 000

Ans. (B)



Sol. As per described IEEE 754

Single precision format

Sign : 0

Exponent : 11111110

Mantissa : 23 1's

Will give maximum value.

Hence, the correct option is (B).

Question 15**[Algorithm (Complexity Analysis & Asymptotic Notation)]**

Let $T(n)$ be the recurrence relation defined as follows :

$$T(0) = 1,$$

$$T(1) = 2, \text{ and}$$

$$T(n) = 5T(n-1) - 6T(n-2) \text{ for } n \geq 2$$

Which one of the following statements is TRUE ?

(A) $T(n) = \Theta(2^n)$

(B) $T(n) = \Theta(n2^n)$

(C) $T(n) = \Theta(3^n)$

(D) $T(n) = \Theta(n3^n)$

Ans. (A)

Sol. **Method 1**

$$T(0) = 1 = 2^0$$

$$T(1) = 2 = 2^1$$

$$T(2) = 5T(1) - 6T(0) = 5 \times 2 - 6 \times 1 = 10 - 6 = 4 = 2^2$$

$$T(3) = 5T(2) - 6T(1) = 5 \times 4 - 6 \times 2 = 20 - 12 = 8 = 2^3$$

$$\therefore T(n) = \Theta(2^n)$$

Hence, the correct option is (A).

Method 2

$$T(0) = 1$$

$$T(1) = 2$$

$$T(n) = 5T(n-1) - 6T(n-2)$$



$$T(n) - 5T(n-1) + 6T(n-2) = 0$$

Recurrence relation :

$$P^2 - 5P + 6 = 0$$

$$P^2 - 3P - 2P + 6 = 0$$

$$P(P-3) - 2(P-3) = 0$$

$$(P-2)(P-3) = 0$$

$$P = 2 \quad P = 3$$

$$T(n) = C_1 \cdot P^n + C_2 P^n$$

$$T(n) = C_1 2^n + C_2 3^n \quad \dots(i)$$

$$n = 0 \quad T(0) = C_1 2^0 + C_2 3^0$$

$$1 = C_1 + C_2 \quad \dots(iii)$$

$$n = 1 \quad T(1) = C_1 2^1 + C_2 3^1$$

$$2 = 2C_1 + 3C_2 \quad \dots(iv)$$

Solve equation (iii) and (iv)

$$C_1 = 1 \quad C_2 = 0$$

$$T(n) = C_1 2^n + C_2 3^n$$

$$T(n) = 2^n$$

$$T(n) = \theta(2^n)$$

Hence, the correct option is (A).

Question 16

Let $f(x)$ be a continuous function from $\mathbf{R}$ to $\mathbf{R}$ such that $f(x) = 1 - f(2-x)$

Which one of the following options is the CORRECT value of $\int_0^2 f(x) dx$? (1 Mark)

[Engineering Mathematics, Calculus]

(A) 0 (B) 1

(C) 2 (D) -1

Ans. (B)

Sol. Given :



$f(x)$ is a continuous function from R to R .

$$f(x) = 1 - f(2 - x)$$

Note :

$$\bullet \int_a^b f(x) dx = \int_a^b f(a + b - x) dx$$

Now according to question

$$I = \int_0^2 f(x) dx = \int_0^2 f(2 - x) dx \quad \dots(i)$$

$$I = \int_0^2 [1 - f(2 - x)] dx$$

$$I = \int_0^2 1 dx - \int_0^2 f(2 - x) dx$$

From equation (i)

$$I = [x]_0^2 - I$$

$$2I = 2$$

$$I = 1$$

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

Hence, the correct option is (B).

Question 17

[Data Structure (Graph)]

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 cycle (B) G is a perfect matching
(C) G is a complete graph (D) There is no such graph G

Ans. (B)

Sol. We know that

Every adjacent matrix is symmetric.

$$A = A^T = A^{-1}$$

$$A^2 = AA^T = A^T A = I_n$$

Above results in the orthogonal matrix as given, the graph is simple which means that it consists of only 0 and 1.

From this we can conclude that if any vertex V_i is connected to vertex V_j then similarly vertex V_j should also connected to vertex V_i , hence it will cover the entire graph. Hence, it will results in perfect matching.



Hence, the correct option is (B).

Question 18

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

[Engineering Mathematics, Probability]

(1 Mark)

(A) $\frac{1}{324}$

(B) $\frac{5}{324}$

(C) $\frac{7}{324}$

(D) $\frac{11}{324}$

Ans. (B)

Sol. Given : Six unbiased dice are rolled simultaneously.

$$\text{Total case of six dice} = (6)^6$$

$$\text{Number of favorable out comes} = 6!$$

Therefore, the probability of such events

$$= \frac{6!}{(6)^6} = \frac{6 \times 5 \times 4 \times 3 \times 2 \times 1}{(46656)}$$

$$= \frac{5}{324}$$

Hence the correct option is (B).

Question 19

[Database (ER Model)]

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) Durability

(B) Atomicity

(C) Consistency

(D) Isolation

Ans. (A)

Sol. ACID property

Changes to database made by committed transaction must persist in spite of any failure.

Responsibility of durability = Recovery management system

Hence, the correct option is (A).

Question 20

[Database (ER Model)]

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

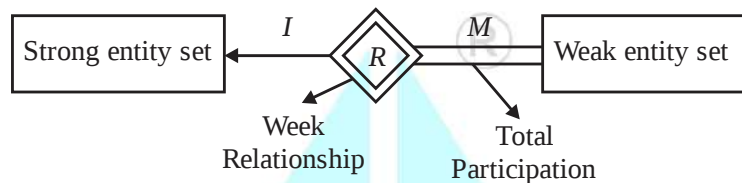
(A) The weak entity set MUST have total participation in the identifying relationship



- (B) The owner entity set MUST have total participation in the identifying relationship
 (C) Both weak and owner entity sets MUST have total participation in the identifying relationship
 (D) Neither weak entity set nor owner entity set MUST have total participation in the identifying relationship

Ans. (A)

Sol. The weak entity set must participate totally in the identify weak relationship usually, there exist one to many relationship between strong entity and weak entity thus total participation from weak entity set.



Hence, the correct option is (A).

Question 21

[Compiler Design (Lexical Analysis)]

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-3; R-1; S-4
 (C) P-2; Q-1; R-3; S-4 (D) P-4; Q-3; R-2; S-1

Ans. (B)

Sol. Lexical analysis → tokens

Syntax analysis → parse tree

ICG → abstract syntax tree

Code optimizer → Constant folding

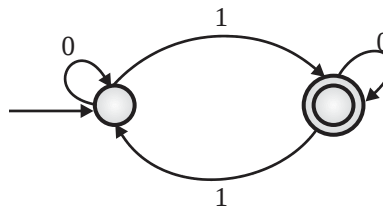
Hence, the correct option is (B).

Question 22

[Theory of Computation (Finite Automata)]



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



(A) $0^*1(0+10^*1)^*$

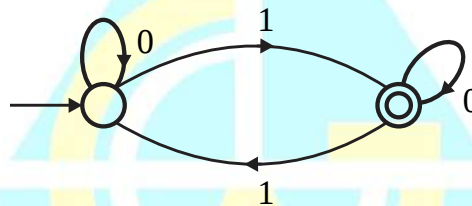
(B) $0^*(10^*11)^*0^*$

(C) $0^*1(010^*1)^*0^*$

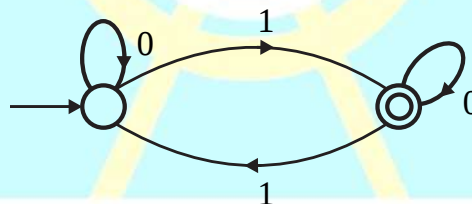
(C) $0(1+0^*10^*1)^*0^*$

Ans. (A)

Sol.



The given of DFA accepts all and only binary string containing odd number of 1'S.



Go to the final state by reading 0^*1 then stay in the final state by making either loop (0) or loop (10^*1) in any order, any number of times.

Regular expression :

$0^*1(0+10^*1)^*$

Option B : Counter example :

Generates empty string

Option C : Counter example :

Does not generates 1 0 0 1 1

Option D Counter examples :

Does not generates 1.



Hence, the correct option is (A).

Question 23**[Computer Network (Transport Layer)]**

Node X has a TCP connection open to node Y . The packets from X to Y go through an 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 S
- (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 Y

Ans. (B)

Sol. Host – Switch – Router – Host

X S R Y

X send packet to Y . considered IP datagram, IP address of destination is IP address of host (Y). But X send packet always default gateway router R and in path comes switch only forwarding the packet.

Hence, the correct option is (B).

Question 24**[Operating System (Memory management and Virtual Memory)]**

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 virtual address is not found in the page table.
- (D) Raise a trap when a process tries to write to a page marked with read - only permission in the page table.

Ans. (B, C, D)

Sol. As per property and function of memory management unit (MMU)

- (A) False as OS or kernel provides page table, and the MMU uses the page tables to translate virtual addresses into physical addresses for the OS.
- (B) True as it is main function of MMU
- (C) True as MMU will raise the trap when valid says invalid
- (D) True as MMU raise trap when process tries to write but protection says 'read only'.

Hence, the correct option (B), (C) and (D).

**Question 25****[Operating System (Process Management-II)]**

Consider a process P running on a 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) P makes a blocking system call to read a block of data from the disk
- (B) P tries to access a page that is in the swap space, triggering a page fault
- (C) An interrupt is raised by the disk to deliver data requested by some other process
- (D) A timer interrupt is raised by the hardware

Ans. (A, B)

Sol. Option A : TRUE

If a process itself makes a block () call then it will be blocked until input/output.

Option B : TRUE

If a page is not in the physical memory then the OS invokes the page faults handler and the process remains blocked until the page is read (Disk i/o is complete).

Option C : False

That kind of request will be served by DMA and the CPU does not need to get invoked hence the current program will keep on using the CPU.

Option D : False

Timer interrupts will be ignored in many cases and will not lead to a context switch.

Hence, the correct option is (A) and (B).

Question 26**[Database (File Structure)]**

Which of the following file organizations is/are I/O efficient for the scan operation in DBMS?

- (A) Sorted
- (B) Heap
- (C) Unclustered tree index
- (D) Unclustered hash index

Ans. (A, B)

Sol. The file organization that are I/O efficient for the scan operation in DBMS are

- (1) Sorted
- (2) Heap

Hence, the correct option is (A) and (B)

Question 27**[Database (Transactions and Concurrency Control)]**

Which of the following statements about the Two Phase Locking (2PL) protocol is/are TRUE ?

- (A) 2PL permits only serializable schedules



- (B) With 2PL, a transaction always locks the data item being read or written just before every operation and always releases the lock just after the operation
- (C) 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
- (D) A deadlock is possible with 2PL

Ans. (A, C, D)

Sol. (A) 2PL permits serial schedule

- (C) No lock can be taken in the shrinking phase of transaction once a lock has been released
- (D) 2 or more transaction can wait for each other to release locks. This concludes that deadlock can occur.

Hence, the correct option is (A), (C) and (D).

Question 28

[Computer Network (Network Layer)]

Which of the following statements about IPv4 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 only at the destination of the datagram
- (D) The reassembly of fragments is performed at all intermediate routers along the path from the source to the destination

Ans. (B,C)

Sol. Option B : TRUE

Fragmentation can indeed occurs at any router along the path if the packet size exceeds the MTU, but it depends on whether the “Do not fragment” flag is set, the router will not fragments the packet and will instead drop it, sending an ICMP “Fragmentation needed” message back to the source.

Option C : TRUE

Reassembly of fragments is typically performed only at the destination of the datagram the destination is responsible for putting the fragments back together to reconstruct the original packets.

Hence, the correct option is (B) and (C).

Question 29

[Compiler Design (Syntax Directed Translation)]

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) The attributes in a L-attributed definition cannot always be evaluated in a depth- first order
- (C) Synthesized attributes can be evaluated by a bottom-up parser as the input is parsed



- (D) All L-attributed definitions based on LR(1) grammar can be evaluated using a bottom-up parsing strategy

Ans. (B, D)

- Sol.** (B) There is no fixed procedure of evaluating L – attribute in depth – First order
(D) There is a fixed procedure which all L -attributed which all L -attributed definitional based on LR (1) using bottom-up parsing.

Hence, the correct option is (B) and (D).

Question 30

[Digital Logic (Boolean Algebra)]

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

- (A) $x.1 = x$ (B) $x+1 = x$
(C) $x.x = x$ (D) $x+\bar{x} = 1$

Ans. (B, C)

- Sol.** (1) $x.1 = x \rightarrow$ identity law (T)
(2) $x+1 = x \rightarrow x+1=1$
(3) $x.x = 0 \rightarrow x.x = x$ [Idempotent law]
(4) $x+\bar{x} = 1 \rightarrow$ compliment law (T)

Hence, the correct option (B) and (C).

Question 31

[Computer Organization & Architecture (Machine Instruction and Addressing)]

An instruction format has the following structure :

Instruction Number : *Opcode destination reg, source reg – 1, source reg – 2*

Consider the following sequence of instructions 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 statements is/are TRUE ?

- (A) There is a RAW dependency on $R3$ between $I1$ and $I2$
(B) There is a WAR dependency on $R3$ between $I1$ and $I3$
(C) There is a RAW dependency on $R3$ between $I2$ and $I3$
(D) There is a WAW dependency on $R3$ between $I3$ and $I4$

Ans. (A)

Sol. Given :



$$I_1 : R_3 \leftarrow R_1 / R_2$$

$$I_2 : R_5 \leftarrow R_3 - R_4$$

$$I_3 : R_3 \leftarrow R_5 + R_6$$

$$I_4 : R_7 \rightarrow R_3 + R_8$$

RAW Dependency

I_1 to I_2 for R_3

I_2 to I_3 for R_5

I_3 for I_4 for R_3

Hence, the correct option is (A).

Question 32**[Computer Network (Concepts of Layering and LAN Technologies)]**

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

- (A) Source IP Address (B) Protocol
(C) Time to Live (TTL) (D) Header Checksum

Ans. (C, D)

Sol.

- (A) Source IP remains unchanged
(B) Protocol indicates type of data carried [TCP, UDP] and is not altered by routers.
(C) TTL value is decremented by 1 by each router that forward packet.
(D) As TTL value of IP header is changed by every router, corresponding header checksum is recalculated based on the new value of TTL.

Hence, the correct option is (C) and (D).

Question 33**[C-Programming]**

Consider the following C function definition

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

Which of the following statement is /are TRUE ?



- (A) The function call fX (“abcd”) will always return a value
- (B) Assuming a character array c 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 declared as char *C = “abcd” in main (), the function call fX(c) will always return a value

Ans. (A, B, D)

Sol. We can try run the code to get the result

Question 34

Let P be the partial order defined on the set $\{1, 2, 3, 4\}$ as follows

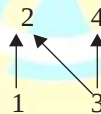
$$P = \{(x, x) \mid x \in \{1, 2, 3, 4\}\} \cup \{(1, 2), (3, 2), (3, 4)\}$$

The number of total order on $\{1, 2, 3, 4\}$ that contain P is _____.

[Discrete Mathematics & Graph theory, 4 Set theory & Algebra]

Ans. (5 to 5)

Sol. Hasse diagram



Total Order

(1) $1 \rightarrow 3 \rightarrow 2 \rightarrow 4$

(2) $1 \rightarrow 3 \rightarrow 4 \rightarrow 2$

(3) $3 \rightarrow 1 \rightarrow 2 \rightarrow 4$

(4) $3 \rightarrow 1 \rightarrow 4 \rightarrow 2$

(5) $3 \rightarrow 4 \rightarrow 1 \rightarrow 2$

Hence, the correct answer is 5.

Question 35

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 _____.

[Data Structure, 1 Array]

Ans. (3 to 3)

Sol. The array with sorted indices

Value	2	2	3	3	4	4	6
Index	0	1	2	3	4	5	6

No of elements out of order = 3

Hence, the correct answer is 3.

Q.36 – Q.65 Carry TWO marks Each

Question 36

What is the output of the following C program ?

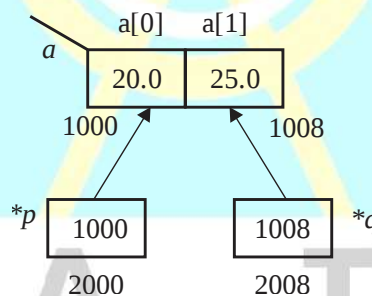
```
#include <stdio.h>

Int main () {
    double a[2] = {20.0, 25.0}, *p, *q;
    p = a;
    q = p + 1;
    printf ("%d, %d", (int) (q - p), (int) (*q - *p));
    return 0; }
```

[C program]

- (A) 4,8 (B) 1,5
(C) 8,5 (D) 1,8

Ans. (B)
Sol.



$$\text{int}(q-p) = \frac{2008-2000}{8} = \frac{8}{8} = 1$$

$$\text{int}(*q - *p) = \text{int}(25.0 - 20.0) \\ = 5$$

Hence, the correct option is (B).

Question 37

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.

$$A(0,10), B(2,6), C(4,3), \text{ and } D(6,7)$$



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 ?

[Operating System, 2 Process Management II]

- (A) $SRTF = 6, NP - SJF = 7$ (B) $SRTF = 6, NP - SJF = 7.5$
(C) $SRTF = 7, NP - SJF = 7.5$ (D) $SRTF = 7, NP - SJF = 8.5$

Ans. (B)

Sol. SJF CPU Scheduling

P	A.T	B.T	C.T	TAT	WT
A	0	10	10	10	0
B	2	6	19	17	11
C	4	3	13	9	6
D	6	7	26	20	13

$$\text{Total average waiting time} = \frac{0+11+6+13}{4} = \frac{30}{4} = 7.5$$

SRTF CPU scheduling

P	A.T	B.T	C.T	TAT	WT
A	0	10	26	26	16
B	2	6	11	9	3
C	4	3	7	3	0
D	6	7	18	12	5

$$\text{Total average waiting time} = \frac{16+3+0+5}{4} = \frac{24}{4} = 6$$

Hence, the correct option is (B).

Question 38

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

[Computer Network, 1 Concept of Layering and LAN Technologies]

- (A) 10.12.2.0/23 (B) 10.12.2.0/24
(C) 10.12.0.0/22 (D) 10.12.2.0/22

Ans. (A)

Sol. We know that IP address are contiguous, block size is power of 2, and starting address is divisible by block size so, they can form a block.

$$10.12.2.0 \text{ to } 10.12.2.255 = 256$$

$$10.12.3.0 \text{ to } 10.12.3.255 = 256$$

Total IP address [10.12.2.0 to 10.12.3.255]

$$= 256 + 256 = 512 = 2^9$$

Number of bit for Host id = 9 bit



Number of bit for Net id (NiD) = $32 - 9 = 23$ bit

CIDR notation represented as

10.12.2.0/23

Hence, the correct option is (A)

Question 39

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?

[Data Structure, 5 tree]

- (A) Inorder traversal of T can be determined from V
- (B) Root node of T can be determined from V
- (C) Preorder traversal of T can be determined from V
- (D) Postorder traversal of T can be determined from V

Ans. (A)

Sol. As per convention given, we can derive the in order traversal of the nodes in the left root right and also give the data in ascending order.

Hence, the correct option is (A).

Question 40

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

$S \rightarrow AaAb \mid BbBa$

$A \rightarrow cS \mid \epsilon$

$B \rightarrow dS \mid \epsilon$

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

	a	b	c	d	\$
S	$S \rightarrow AaAb$	$S \rightarrow BbBa$	(1)	(2)	
A	$A \rightarrow \epsilon$	(3)	$A \rightarrow cS$		
B	(4)	$B \rightarrow \epsilon$		$B \rightarrow dS$	

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.

[Compiler Design, 2 Parsing Technique]

- (A) (1) $S \rightarrow AaAb$ (2) $S \rightarrow BbBa$ (3) $A \rightarrow \epsilon$ (4) $B \rightarrow \epsilon$



- (B) (1) $S \rightarrow BbBa$ (2) $S \rightarrow AaAb$ (3) $A \rightarrow \epsilon$ (4) $B \rightarrow \epsilon$
 (C) (1) $S \rightarrow AaAb$ (2) $S \rightarrow BbBa$ (3) blank (4) blank
 (D) (1) $S \rightarrow BbBa$ (2) $S \rightarrow AaAb$ (3) blank (4) blank

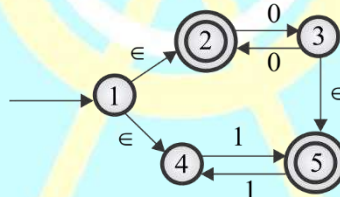
Ans. (A)

Sol.

	First	Follow
$S \rightarrow AaAb \mid BbBa$	$\{a, b, c, d\}$	$\{\$, a, b\}$
$A \rightarrow CS \mid E$	$\{C, E\}$	$\{a, b\}$
$B \rightarrow dS \mid E$	$\{d, E\}$	$\{a, b\}$

	a	b	c	d	\$
S	$S \rightarrow AaAb$	$S \rightarrow BbBa$	$S \rightarrow AaAb = (1)$	$S \rightarrow BbBa = (2)$	
A	$A \rightarrow \epsilon$	$A \rightarrow \epsilon$ (iii)	$A \rightarrow CS$		
B	$B \rightarrow \epsilon$ (iv)	$B \rightarrow \epsilon$		$B \rightarrow dS$	

Hence, the correct option is (A).

Question 41Let M be the 5-state NFA with ϵ -transitions shown in the diagram below.Which one of the following regular expressions represents the language accepted by M ?

[Theory of Computation, 1 Finite Automata]

- (A) $(00)^* + 1(11)^*$ (B) $0^* + (1 + 0(00)^*)(11)^*$
 (C) $(00)^* + (1 + (00)^*)(11)^*$ (D) $0^+ + 1(11)^* + 0(11)^*$

Ans. (B)

Sol. Counter example

For option A : 0 1 1 is not generated.

For option C : 0 0 0 is not generated

For option D : Empty string is not generated

Hence, the correct option is (B)

Question 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, len1 = 0, len2 = 0, maxlen = 0;
for (int i = 0; i < n; i++) {
    if (X[i] == first) {
        len2++; len1++;
    } else if (X[i] == second) {
        len2++;

        len1 = __(P)__;
        second = first;
    } else {
        len2 = __(Q)__;
        len1 = 1; second = first;
    }
    if (len2 > maxlen) {
        maxlen = len2;
    }
    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 $len1$ 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.)

[Data Structure, 1 Array]

- (A) (P) $len1+1$ (Q) $len2+1$
(B) (P) 1 (Q) $len1+1$
(C) (P) 1 (Q) $len2+1$
(D) (P) $len2+1$ (Q) $len1+1$

Ans. (B)

Sol. In the given program we keep track of the atmost two distinct values allowed in the subarray using the variables first and second.

The variable first stores the latest [or the second] distinct value in the subarray.

While the variable second stores the second latest [or the first] distinct value we see in the subarray.



We can try run the code

Hence, the correct option is (B).

Question 43

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).

[Data Structure, 2 Stack Queue]

(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) = [] s i (3) * (0)(2) (6) [] = xi
 (B) (1) [] = s i (3) - (0)(2) (6) = [] x(5)
 (C) (1) = [] s i (3) * (0)(2) (6) [] = x(5)
 (D) (1) [] = s i (3) - (0)(2) (6) = [] xi

Ans. (A)

Sol. Going from left to right we resolve the bracket first. $(P + r)$ is already given now we solve $s[i]$. Then comes unary minus as per operator preference then we solve $*$ which acts (0 and 2) and $/, +$ subsequently then $x[i]$ address is calculated (step - 6) where the final results (obtain in step 5) is stored in the last step (7). The assignment operator has lowest preference so it is done at last.

Hence, the correct option is (A).

Question 44

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 ?

[Engineering Mathematics, Probability]

- (A) $\bar{z} = \bar{x} \bar{y}$ (B) $\bar{z} \leq \bar{x} \bar{y}$
 (C) $\bar{z} \geq \bar{x} \bar{y}$ (D) $\bar{z} \leq \bar{x}$

Ans. (D)



Sol. Let us first give counter example for (C) and (A)

Let us assume X is a random variable uniformly distributed is $[0,1]$ and Y is $1-X$

$$\text{So, } E(X) = \frac{1}{2} \text{ and } E(Y) = E(1 - X) = E(1) - E(X) = 1 - \frac{1}{2} = \frac{1}{2}$$

Now, Given $Z = XY$

$$E(Z) = E(XY) = \int_0^1 x(1-x)dx = \frac{1}{6}$$

$$\text{So, } E(Z) \leq E(X)E(Y)$$

[Note here covariance is negative]

Counter Example for (B):

Let us assume X is random variable uniformly distributed in $[0,1]$ and $Y = X$

$$\text{So, } E(X) = \frac{1}{2}$$

$$E(Y) = \frac{1}{2}$$

Now Given $Z = XY$

$$\text{So, } E(Z) = E(XY) = \int_0^1 x \times x dx = \frac{1}{2}$$

$$\text{So, } E(Z) \geq E(X)E(Y)$$

[Note here Covariance is positively]

Now, why does option (D) is correct?

$\Rightarrow$ It is given, X and Y takes value in the range $[0, 1]$

So, we can write, $0 \leq Y \leq 1$

Multiply this inequality by X .

$$\text{So, } 0 \leq XY \leq X$$

Now take expectation of this inequality

$$\text{So, } E(0) \leq E(XY) \leq E(X)$$

$$\text{So, } 0 \leq E(XY) \leq E(X)$$

Which proof the option (D)



Note this inequality holds true because X and Y takes value in the range between $[0,1]$

Hence the correct option is (D)

Question 45

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 **[Database, 3 relational Model Relational Algebra]**

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

Ans. (B)

Sol. $R_1 \leftarrow \sigma(R \times S)$
 $R.city = S.city \wedge R.pid \neq S.pid$
 $R_2 \leftarrow \sigma(R_1 \times P)$
 $R_1.city = P.city \wedge R_1.pid \neq P.pid$
 $R_3 \leftarrow \pi(R_2)$
city

Hence, we need 3 table and 2 cross product

Hence, the correct option is (B).

Question 46

Consider a multi-threaded program with two threads $T1$ and $T2$. The threads share two semaphores : $s1$ (initialized to 1) and $s2$ (initialized to 0). The threads also share a global variable x (initialized to 0). The threads execute the code shown below.

// code of T1	// code of T2
wait ($s1$);	wait ($s1$);
$x = x + 1$;	$x = x + 1$;
print (x);	print (x);
wait ($s2$);	wait ($s2$);
signal ($s1$);	signal ($s1$);

Which of the following outcomes is/are possible when thread $T1$ and 2 execute concurrently ?

[Operating System, 3 Deadlock]

- (A) $T1$ runs first and prints 1. $T2$ runs next and prints 2



- (B) T_2 runs first and prints 1. T_1 runs next and prints 2
(C) T_1 runs first and prints 1. T_2 does not print anything (deadlock)
(D) T_2 runs first and prints 1. T_1 does not print anything (deadlock)

Ans. (B, C)

Sol. Initially $S_1 = 1$ and both threads are performing wait operation on S_1 . So, only one thread will succeed and run.

If thread T_1 runs first then T_1 gets blocked when it executes wait (S_2). Also, T_2 cannot run as it would get blocked when it executes wait (S_1). So deadlock occurs.

Hence, the correct option is (B) and (C).

Question 47 [MSQ]

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

[Engineering Mathematics, Linear Algebra]

- (A) The determinant of B is the negative of the determinant of A
(B) If A is invertible, then B is also invertible
(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

Ans. (A, B)

Sol. Let us take 2×2 matrix

$$A = \begin{bmatrix} 3 & 2 \\ 2 & -3 \end{bmatrix}$$

$$\text{then } B = \begin{bmatrix} 2 & -3 \\ 3 & 2 \end{bmatrix}$$

From option (A) :

Determinant of A and B is

$$|A| = -9 - 4 = -13$$

$$|B| = 4 + 9 = 13$$

Hence, determinant of B is the negative of the determinant of A .

Hence, option (A) is correct.

From option (B) :

Invertible matrix : An invertible matrix is a square matrix that has an inverse.

For inverse of matrix to exist, its determinant does not equal to zero.

Here, $|A| = -13$



$$|B| = 13$$

Hence, both A and B invertible matrix.

Hence, option (B) is correct.

From option (C) :

Symmetric matrix,

$$A^T = A$$

For $A = \begin{bmatrix} 3 & 2 \\ 2 & -3 \end{bmatrix}$

$$A^T = \begin{bmatrix} 3 & 2 \\ 2 & -3 \end{bmatrix}$$

$$\therefore A^T = A$$

and $B = \begin{bmatrix} 2 & -3 \\ 3 & 2 \end{bmatrix}$

$$B^T = \begin{bmatrix} 2 & 3 \\ -3 & 2 \end{bmatrix}$$

$$\therefore B^T \neq B$$

Hence, A is symmetric and B is not symmetric.

Hence, option (C) is not correct.

Form option (D) :

$$\text{Trace } (A) = 3 - 3 = 0$$

$$\text{Trace } (B) = 2 + 2 = 4$$

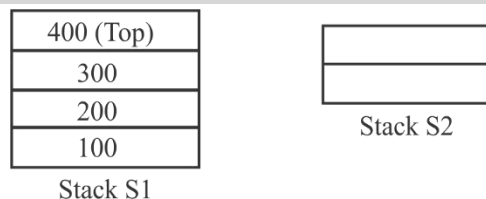
Hence, if trace A is zero, then its not necessary that trace B is also zero.

Hence, option (D) is not correct.

Hence, the correct options are (A) and (B).

Question 48

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.



Only the following three operations are available :

PushTo $S2$: Pop the top element from $S1$ and push it on $S2$

PushTo $S1$: Pop the top element from $S2$ and push it on $S1$



GenerateOutput: Pop the top element from S_1 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 ?

[Data Structure, 2 Stack queue]

- (A) 100, 200, 400, 300 (B) 200, 300, 400, 100
(C) 400, 200, 100, 300 (D) 300, 200, 400, 100

Ans. (B, C, D)

Sol. **Option B :** First pop two items 400, 300 from S_1 and push it to S_2

$S_1 = 200, 100$ $S_2 = 300, 400$ print 200 as output

Pop 300 from S_2 and push it into S_1 print 300.

Now $S_1 = 100$ and $S_2 = 400$ pop 400 from S_2 and push it back to S_1

Output: 200, 300, 400, 100

Option C : (400, 200, 100, 300) print 400 from S_1

Pop 300 from S_1 and push to S_2 print 200, 100 from S_1

Pop 300 from S_2 and push it to S_1 print 300

Output: 400, 200, 100, 300

Option D : 300, 200, 400, 100

Pop 400 from S_1 and push to S_2

Print 300, 200

Pop 400 from S_2 and push to S_1

$S_1 = 400, 100$

Print 400, 100

Output: 300, 200, 400, 100

Hence, the correct option (B), (C) & (D).

Question 49

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

[Digital Logic, 1 Number System]

- (A) 64 in radix-10 (B) 100 in radix-8



(C) 50 in radix-16

(D) 121 in radix-7

Ans. (A, B, D)**Sol.** $(224)_5 = 4 \times 5^0 + 2 \times 5^1 + 2 \times 5^2 = (4 + 10 + 50)_{10}$

$$= (64)_{10}$$

$$(100)_8 = 0 \times 8^0 + 0 \times 8^1 + 1 \times 8^2 = (0 + 0 + 64)_{10}$$

$$= (64)_{10}$$

$$(50)_{16} = 0 \times 16^0 + 5 \times 16^1 = (0 + 80)$$

$$= (80)_{10}$$

$$(121)_7 = 1 \times 7^0 + 2 \times 7^1 + 1 \times 7^2 = (1 + 14 + 49)_{10} = (64)_{10}$$

Hence, the correct option are (A), (B) and (D).

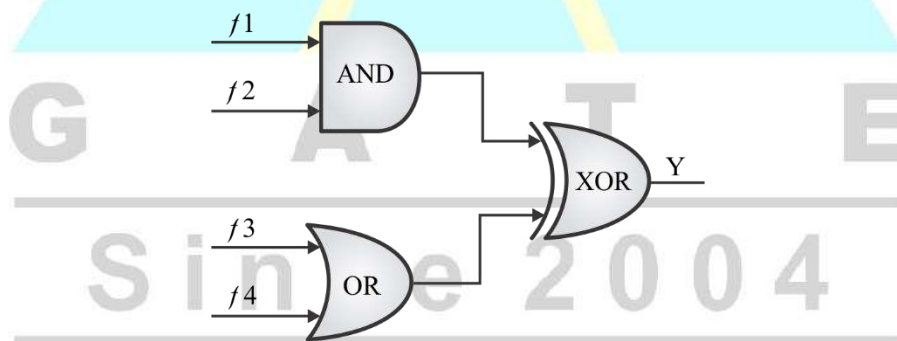
Question 50Consider 4-variable functions f_1, f_2, f_3, f_4 expressed in sum-of-minterms form as given below :

$$f_1 = \sum(1, 2, 3, 5, 7, 8, 11, 13)$$

$$f_2 = \sum(1, 3, 5, 7, 11, 13, 15)$$

$$f_3 = \sum(0, 1, 4, 11)$$

$$f_4 = \sum(0, 2, 6, 13)$$



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

(Digital logic, 2 Boolean Algebra)

(A) $Y = \sum(0, 1, 2, 11, 13)$

(B) $Y = \prod(3, 4, 5, 6, 7, 8, 9, 10, 12, 14, 15)$

(C) $Y = \sum(0, 1, 2, 3, 4, 5, 6, 7)$

(D) $Y = \prod(8, 9, 10, 11, 12, 13, 14, 15)$

Ans. (C, D)



Sol. As per given diagram (f_1, f_2) and (f_3, f_4) will go for AND product and then, they will go for XOR function.

$$Y = \sum(0, 1, 2, 3, 4, 5, 6, 7)$$

$$Y = \pi(8, 9, 10, 11, 12, 13, 14, 15)$$

Hence, the correct option are (C) and (D).

Question 51

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 ?

[Data Structure, 6 Graph]

- (A) All edges in G have even weight
- (B) All edges in G have even weight OR all edges in G have odd weight
- (C) In each cycle C in G , all edges in C have even weight
- (D) In each cycle C in G , either all edges in C have even weight OR all edges in C have odd weight

Ans. (D)

Sol. Given tree is spanning tree, not about minimum spanning tree. Hence for every spanning tree in G has an even weight or all edges in C have odd weight.

Hence, the correct option is (D).

Question 52

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

$$S \rightarrow aS, S \rightarrow aSbS, S \rightarrow c$$

Let $w \in L(G)$. Let $n_a(w), n_b(w), n_c(w)$ denote the number of times a, b, c occur in w , respectively. Which of the following statements is/are TRUE ?

[Theory of Computation, 1 finite Automata]

- (A) $n_a(w) > n_b(w)$
- (B) $n_a(w) > n_c(w) - 2$
- (C) $n_c(w) = n_b(w) + 1$
- (D) $n_c(w) = n_b(w) * 2$

Ans. (B, C)

Sol. $L = \{c, ac, aac, acbc, aacbaac, acbaacba, \dots\}$

- (A) Not mentioned about C , where C is minimum string $acbc$ number of a 's and b 's are equal so always not greater than. string of language.
- (B) $aacbc, 2 > (2-1)$ true for any string of language
- (C) True for any string
- (D) $ac, 1 \neq 0*2, acbaacbc, 3 \neq 2*2$. false

Hence, the correct option are (B) and (C).

**Question 53**

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 _____.

[Operating System, 5 File System and Device Management]

Ans. (29.50 to 30.50)

Sol. Total time (T) = No. of sectors × (Avg. time per sector for random access)

$$T = 3000 \times (\text{Avg. seek time} + \text{Avg. rotational latency} + \text{transfers time})$$

$$T = 3000 \times \left(5 + \frac{10}{2} + \frac{1}{50} \right) \text{ms}$$

$$T = 30.06 \text{ sec}$$

Hence, the correct answer is 30.06 sec.

Question 54

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 _____.

[Computer Network, 4 Transport Layer]

Ans. (4 to 4)

Sol. Given cwnd = 12 MSS

Now timeout occurs which makes, cwnd = 1 and ssthreshold = $\frac{12}{2} = 6 \text{ MSS}$

Again slow start phase will begin.

After 1 RTT, cwnd = 1 MSS.

After 2 RTT, cwnd = 2 MSS.



During 3rd RTT cwnd will be 4 MSS.

Hence, the correct answer is 4.

Question 55



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 _____.

[Computer Network, 4 Transport Layer]

Ans. (500 to 500)

Sol. $B_w = 10^8$ bits/sec

$$d = 500 \text{ m}$$

$$v = 2 \times 10^8 \text{ m/sec}$$

For ethernet $T_t \geq 2.T_p$ $\left(\begin{array}{l} T_t = \text{Transmission Time} \\ T_p = \text{Propagation Time} \end{array} \right)$

$$\Rightarrow \frac{f_s}{B_w} \geq 2 \times \frac{d}{v}$$

$$f_s \geq 2 \times \frac{d}{v} \times B_w$$

$$f_s \geq \frac{2 \times 500 \text{ m}}{2 \times 10^8 \text{ m/sec}} \times 10^8 \text{ bits/sec}$$

$$f_s \geq 500 \text{ bits}$$

$$\therefore f_{s\min} = 500 \text{ bit}$$

Hence, the correct answer is 500 bit.

Question 56

A functional dependency $F : X \rightarrow Y$ is termed as a useful function 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 _____.

[Database, 2 Database Design Functional]

Ans. (50 to 50)

Sol. $F : X \rightarrow Y$

Case I: when one element is present on the left side



$$4_{C_1} \times (2^3 - 1) = 4 \times 7 = 28$$

Case II: When 2 element are present on the left side

$$4_{C_2} \times (2^2 - 1) = 6 \times 3 = 18$$

Case III: When 3 element are present on left side.

$$4_{C_3} \times (2^1 - 1) = 4 \times 1 = 4$$

$$\begin{aligned} \text{Total functional dependency} &= 28 + 18 + 4 \\ &= 50 \end{aligned}$$

Hence, the correct answer is 50.

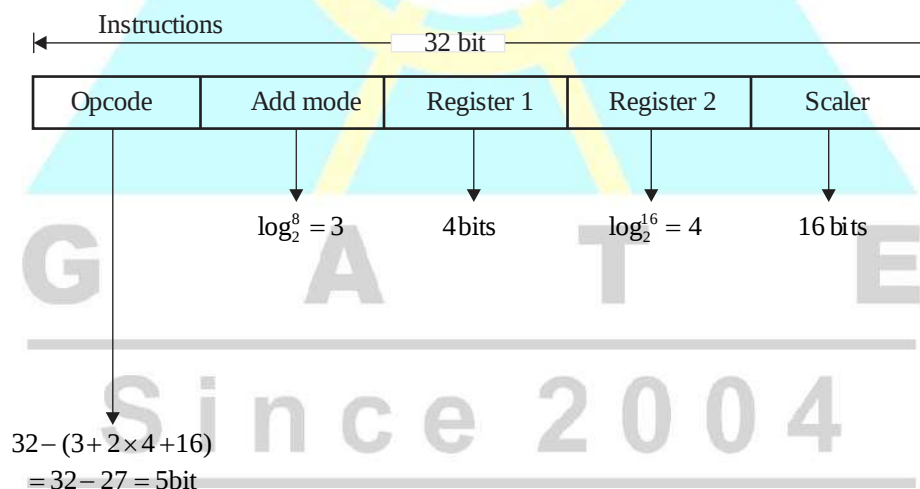
Question 57

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 _____.

[Computer Organization & Architecture, 1 Machine Instruction & Addressing Format]

Ans. (32 to 32)

Sol.



So, maximum no. of unique opcode possible $= 2^5 = 32$

Hence, the correct answer is 32.

Question 58

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 _____.

[Computer Organization & Architecture, 3 Instruction Pipelining]

Ans. 3 (2.9 to 3.1)

Sol. For non-pipelined :

$$T_n = \frac{1}{\text{Frequency}} = \frac{1}{2 \text{ GHz}} = \frac{1}{2 \times 10^9} \text{ second} = 0.5 \text{ ns}$$

Average instruction execution time (non-pipelined)

$$CPI_{\text{non-pipelined}} * T_n$$

$$6 * 0.5 \text{ ns} = 3.0 \text{ ns}$$

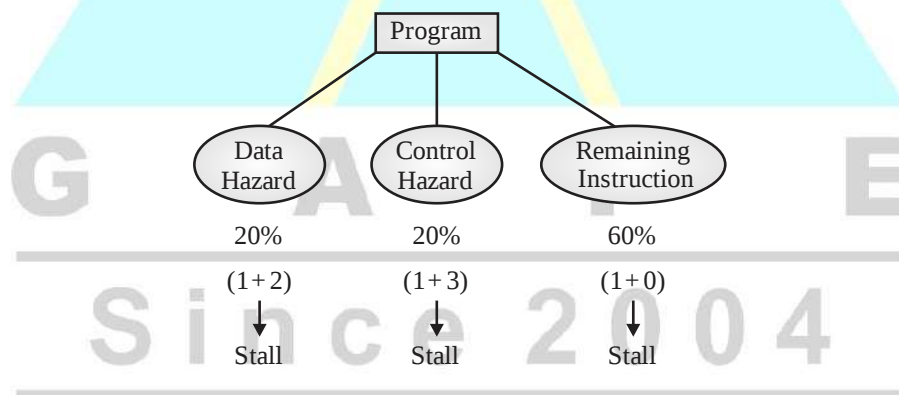
For pipelined :

$$T_p = \frac{1}{\text{Frequency}} = \frac{1}{2 \text{ GHz}} = \frac{1}{2 \times 10^9} \text{ second} = 0.5 \text{ ns}$$

Average instruction execution time (pipelined)

$$CPI_{\text{pipelined}} * T_p$$

$$2 * 0.5 \text{ ns} = 1 \text{ ns}$$



$$CPI_{\text{pipelined}} = 0.6(1+0) + 0.2(1+3) + 0.2(1+2)$$

$$CPI_{\text{pipelined}} = 0.6 \times 1 + 0.2 \times 4 + 0.2 \times 3$$

$$CPI_{\text{pipelined}} = 0.6 + 0.8 + 0.6 = 2.0$$

$$\text{Speed up} = \frac{T_n}{T_p} = \frac{3 \text{ ns}}{1 \text{ ns}} = 3$$

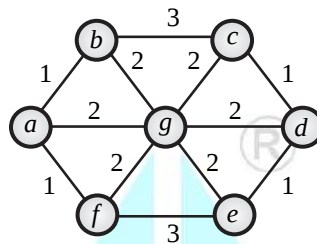


Hence, the correct answer is 3.

Question 59

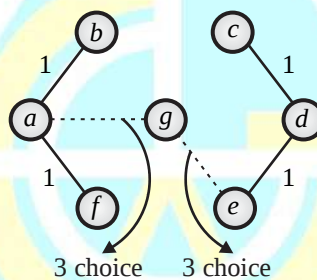
The number of distinct minimum-weight spanning trees of the following graph is _____.

[Data Structure, Graph]



Ans. (9 to 9)

Sol.



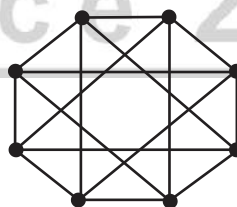
$$\begin{aligned}\text{No. of MST} &= {}^3C_1 \times {}^3C_1 \\ &= 3 \times 3 = 9\end{aligned}$$

Hence, the correct answer is 9.

Question 60

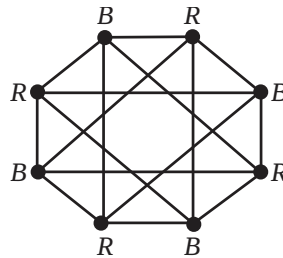
The chromatic number of a graph is the minimum number of colours used in a proper colouring of the graph. The chromatic number of the following graph is _____.

[Discrete Mathematics, 4 Graph Theory]



Ans. (2 to 2)

Sol.



Given : graph is bipartite, where alternating 4 vertices can be put in one part and remaining alternation 4 vertices in the second part.

A bipartite graph with at least 1 edge always has chromatic No. 2.

Question 61

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 _____.

[Computer Organization & Architecture, 1 Machine Instruction & Addressing Format]

Ans. (34 to 34)

Sol. Opcode field (Y) :

There are 150 instructions, and they are equally divided into two types. Therefore, there are 75 I-type instructions and 75 R-type instructions. Since one bit is used to distinguish between instruction types, the number of bits used to encode opcode field is $Y = (1 + 7) = 8$

Register field :

There are 50 architectural registers and all register fields in the instructions are of equal size. Therefore, the number of bits used to encode register field is 6.



Unused field (X) :

The number of bits used to encode unused field in R -type instructions is $X = 32 - (8 + 6 + 6 + 6) = 6$

Immediate value/address field (Z) :

The number of bits used to encode immediate value/address field in I -type instructions is $Z = 32 - (8 + 6 + 6) = 12$

Therefore, the values of X , Y , and Z are :

$X = 6$ bits (UNUSED field)

$Y = 8$ bits (OPCODE field)

$Z = 12$ bits (immediate value/address field)

So, the answer is $6 + 2 \times 8 + 12 = 34$

Hence, the correct answer is 34.

Question 62

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

[Theory of Computation – Finite Automata]

Ans. (15 to 15)

Sol. $b^*ab^*(ab^*ab^*)^*$

Length 1 $\rightarrow a$... (i)

Length 2 $\rightarrow ba, ab$... (ii)

Length 3 $\rightarrow bba, abb, bab, aaa$... (iv)

Length 4 $\rightarrow \frac{4!}{3!} = 4 (3b|a)$

Length 4 $\rightarrow 3a|b = \frac{4!}{3!} = 4$

Total $1 + 2 + 4 + 4 + 4 = (15)$

Hence, the correct answer is 15.

Question 63

Let Z_n be the group of integers $\{0, 1, 2, \dots, n-1\}$ with addition modulo n as the group operation. The number of elements in the group $Z_2 \times Z_3 \times Z_4$ that are their own inverses is _____.



[Discrete Mathematics, 3 Combinatorics]

Ans. (4 to 4)**Sol. Explanation :**

We will solve this question via the brute force approach, as it will help in understand this problem easily :

Consider $Z_2 * Z_3 * Z_4 = \{(0, 0, 0), (0, 1, 0), (0, 2, 0), (1, 0, 0), (1, 1, 0), \dots, (1, 1, 3), (1, 2, 3)\}$

There are a total 24 cases possible.

We have to check each and every element in the form whether they are satisfying $x^2 = (0, 0, 0)$ or not.

Example : $(0, 0, 0) \oplus (0, 0, 0) = (0 \oplus_2 0, 0 \oplus_3 0, 0 \oplus_4 0) = (0, 0, 0)$. Hence, it is valid and it is also an identity.

Upon doing on all 24 elements, you will get these sets satisfy the condition: $(0, 0, 0), (1, 0, 0), (0, 0, 2)$ and $(1, 0, 2)$.

Therefore, the total number of possible cases are 4.

Hence, the correct answer is 4.

Question 64

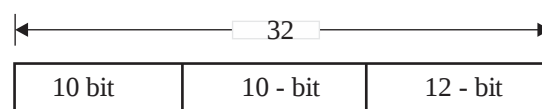
Consider a 32-bit system with 4 KB page size and page table entries of size 4 bytes each. Assume $1\text{KB} = 2^{10}$ bytes. The OS uses a 2-level page table for memory management, with the page table containing an outer page directory and an inner page table. The OS allocates a page for the outer page 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 _____.

[Operating System, 4 Memory Management & Virtual Memory]

Ans. 1028 (1028 to 1028)**Sol.** Page size = 4 kB

No. of bits = $\log_2^{2^{12}} = 12 \log_2^2 = 12 \text{ bit}$



X = Minimum No. of page



Y = Maximum No. of page

For X , there will be Minimum of 3 page and for Y there will be $= 1 + 1024 = 1025$

Hence, the total No. of page i.e $X + Y = 1025 + 3 = 1028$

Hence, the correct answer is 1028.

Question 65

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

$$S' \rightarrow S$$

$$S' \rightarrow SS \mid Aa \mid bAc \mid Bc \mid bBa$$

$$A \rightarrow d \#$$

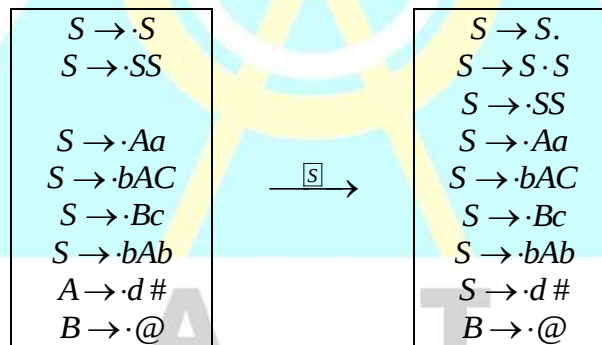
$$B \rightarrow @$$

Let $I_0 = \text{CLOSURE}(\{S' \rightarrow \bullet S\})$. The number of items in the set GOTO (I_0, S) is _____.

[Compiler Design, 2 Parsing technique]

Ans. (9 to 9)

Sol.



From above DFA we can see that Goto (closure (I_0), s) contain 9 items.

Hence, the correct answer is 9.

