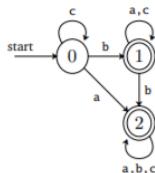


Q.1)

Consider the following DFA



Subject: Theory of Computation, Compiler Design

Max Marks: 1



The equivalent regular expression for the given DFA is

- A  $c^*a+c^*b(a+c)^*b(a+b+c)^*$
- B  $(c^*a+c^*b(a+c)^*b)(a+b+c)^*$
- C  $c^*b(a+c)^*b(a+b+c)^*$
- D  $c^*(b(a+c)^*+(a+b(a+c)^*b)(a+b+c)^*)$

Correct Option

Solution: (D)

Apply Arden's Lemma

State 0 =  $\epsilon + 0c \Rightarrow c^* \rightarrow (1)$ State 1 =  $0b + 1(a+c) \rightarrow (2)$ 

Substitute 0 in (2)

 $\Rightarrow 1 = c^*b + 1(a+c) \Rightarrow c^*b(a+c)^*$ 

State 2:

 $\Rightarrow 2 = 0a + 1b + 2(a+b+c) = c^*a + c^*b(a+c)^*b + 2(a+b+c)$  $\Rightarrow (c^*a + c^*b(a+c)^*b)(a+b+c)^*$ 

Both 1 and 2 are the final states

⇒ The RE for the given DFA is

$$\Rightarrow c^*b(a+c)^* + (c^*a + c^*b(a+c)^*b)(a+b+c)^*$$

$$\Rightarrow c^*(b(a+c)^* + (a+b(a+c)^*b)(a+b+c)^*)$$

Q.2)

Subject: C Programming

Max Marks: 1



What is the output of the following program?

```
int main()
{
    char *a = "appliedcourse.com";
    char *b;
    b = (char*)malloc(80);
    memset(b, 0, 80);
    while(*b++=*a++);
    printf("%s", b);
    return 0;
}
```

- A appliedcourse.com
- B Empty string
- C Compilation Error
- D Runtime Error

Correct Option

Solution: (B)

Q.3)

Which of the following statements is/are true?

Statement 1: FTP is not the client-server protocol. It is only a peer-to-peer protocol.

Subject: Computer Networks

Max Marks: 1



**Statement 2:** SMTP uses TCP with port number 25 and stateless protocol.  
**Statement 3:** HTTP 1.0 is a client-server protocol with port 80 and a stateless protocol.

- A All statements are true
- B Only St 1 is true
- C Only St 2 and St 3 is true
- D Only St 3 is true

**Correct Option**

**Solution:** (D)  
**Explanation:**  
St 1: The File Transfer Protocol (FTP) is a standard network protocol used for the transfer of computer files between a client and a server on a computer network. FTP is built on a client-server model architecture using separate control and data connections between the client and the server.  
St 2: SMTP servers commonly use the Transmission Control Protocol on port number 25, SMTP is generally implemented on top of TCP, however very little knowledge of TCP is needed. What you need to know is that SMTP is a stateful protocol that requires a client to initiate a connection with a server  
St 3: HTTP 1.0 is the client-server protocol that uses port number 80 and HTTP version 1.0 is a stateless protocol.

**Q.4)**

Subject: Computer Networks

Max Marks: 1

Consider the following statements:

- p. RSTP is slower than STP.
- q. The one having a max MAC address will be a root bridge.
- r. All root-port and Designated Ports will be in forwarding-state and all other ports will be in blocking state.
- s. A blocked port is used to prevent loops and didn't forward anything. Any port other than Root port and Designated port is a Block Port.

- A Only q,r,s is correct.
- B Only r,s is correct.

**Correct Option**

**Solution:** (B)  
**Explanation:**  
RSTP is faster than STP which ensures faster convergence in the network topology.  
In the spanning tree algorithm, the one having the least value of mac address will become the root bridge.  
Yes, the root port and designated ports will change its state from learning to forwarding state any other port will be in blocking state.  
Yes, correct, blocked port is used to prevent looping. The port other than root port and designated ports is the block port.

- C only p, r, s is correct.
- D only p, q is correct

**Q.5)**

Subject: Discrete Mathematics

Max Marks: 1

Let  $g$  be a function from  $\mathbb{R}$  to  $\mathbb{R}$  where  $g(x) = x^2 + 1$  for all  $x$ .

Which of the following is correct about  $g$ ?

- A  $g$  is one-to-one only
- B  $g$  is onto only
- C  $g$  is neither one-to-one nor onto

**Correct Option**

**Solution:** (C)  
**Explanation:**  
 $g$  is not one-to-one because  $g(-1)=g(1)=2$ , but  $-1 \neq 1$ .  
 $g$  is not onto because for all  $x \in \mathbb{R}$ ,  $g(x) > 0$ , and thus for  $y = -1$ , there is no  $x \in \mathbb{R}$  where  $g(x) = y$  because  $-1 < 0$ .

- D None of the above

**Q.6)**

Subject: DBMS

Max Marks: 1

Consider the given two schedules:

S1: W2(A), R1(A), W3(A), W2(B), R3(C), W3(A);

S2: R1(A), R2(A), W2(B), W3(A), R1(B), W1(A), W2(A);

Which of the following schedules are conflict serializable?

- A Only S1

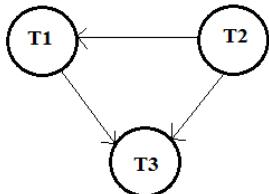
**Correct Option**

**Solution:** (A)  
**Solution:**

S1:

T1	T2	T3
	W(A)	
R(A)		
		W(A)
	W(B)	
		R(B)
		R(C)
		W(A)

The precedence graph of the above schedule is :

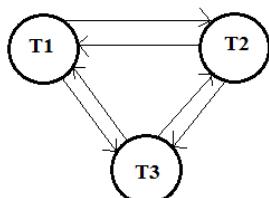


Since, there is no cycle in the above graph, hence, it is conflict serializable.

S2:

T1	T2	T3
R(A)		
	R(A)	
	W(B)	
		W(A)
R(B)		
W(A)		
	W(A)	

The precedence graph for the above schedule is:



Since, there are cycles in the graph. Hence, only S1 is conflict serializable.  
therefore, the correct answer is 1.



Only S2



Both S1 and S2



None of the above

Q.7)

Number of states in a Minimal DFA that accepts the given language contains set of all binary strings with difference between numbers of zeros and ones divisible by 3 is \_\_\_

Subject: Theory of Computation, Compiler Design

Max Marks: 1



Correct Answer

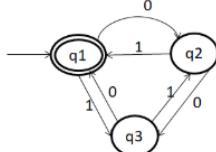
Solution: (3)

Answer: 3

Explanation:

The possible strings in the language = { ε, 000, 111, 101100, 000111, 111000, 100100100,... }

The DFA that accepts the given language is



Q.8)

Consider a two level cache system. For 100 memory references, 20 misses in the first level cache and 6 miss in the second level cache. Miss penalty from L<sub>2</sub> cache to memory is 40 cycles. The access time of L<sub>2</sub> cache is 4 cycles and access time of the L<sub>1</sub> cache is 1 clock cycle. What is the average memory access time (in cycle)?

Subject: computer organization

Max Marks: 1

- A 420
- B 6800
- C 6880
- D None of these

Correct Option

Solution: (D)

For a two level cache L1 and L2 :

$$\text{Average memory access time for one instruction} = 0.8 \times 1 + 0.2 \times (0.7 \times 4 + 0.3 \times (1+4+40)) = 4.2 \text{ cycles}$$

For 100 instructions it is 420 Cycles. But here we are calculating it for average memory access time.

Q.9)

Consider a set of functions A, and a relation defined over the set of functions as  $\Theta: A \rightarrow A$   $\Theta = \{f, g \in A \mid f(n) = \Theta(g(n)) \text{ if } \exists c_1, c_2 \text{ and } n_0 \text{ such that } c_1g(n) \leq f(n) \leq c_2g(n) \forall n > n_0\}$ . Then which of the following are true.

Subject: Algorithms

Max Marks: 1

Statement I.  $\Theta$  is a symmetric relation.  
Statement II.  $\Theta$  is a transitive relation.

- A Statement I is true.
- B Statement II is true.
- C Both Statement I and Statement II are true.

Correct Option

Solution: (C)

Solution:

Statement I: for any two functions f and g if  $f(n) = \Theta(g(n))$  then  $g(n) = \Theta(f(n))$  as  $\Theta$  notation acts as both an upper and lower bound for a function. Therefore it is a symmetric relation.

Statement II: if  $f(n) = \Theta(g(n))$  and  $g(n) = \Theta(h(n))$  then we can say that  $f(n) = \Theta(h(n))$  this is because according to the definition of the theta notation

$\Theta = \{f, g \in A \mid f(n) = \Theta(g(n)) \text{ if } \exists c_1, c_2 \text{ and } n_0 \text{ such that } c_1g(n) \leq f(n) \leq c_2g(n) \forall n > n_0\}$ , let us assume the constants  $c_3, c_4$  and  $n_1$  for the g and h, now for  $c'_1 = \min(c_1, c_3)$  and  $c'_2 = \max(c_2, c_4)$  and  $n'_0 = \max(n_0, n_1)$  we can say that  $c'_1g(n) \leq f(n) \leq c'_2g(n) \forall n > n'_0$  this holds because in this range  $c_1g(n) \leq f(n)$  and  $f(n) \leq c_2g(n)$ .

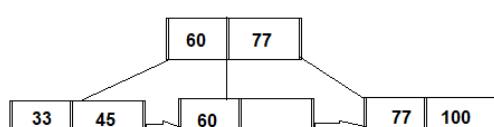
- D Neither Statement II nor Statement II is true.

Q.10)

Which is the correct insertion sequence of elements such that the following B+ tree is obtained? The order of the root node is 3 and of leaf node is 2.

Subject: DBMS

Max Marks: 1



Note: No redistribution will be done while building the tree.

A 33, 45, 60, 100, 77

B 45, 77, 60, 33, 100

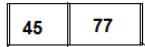
Correct Option

Solution: (B)

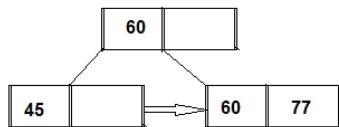
**Solution:**

The number of keys in the internal node will be 2 and each node can have a maximum of 3 children nodes.

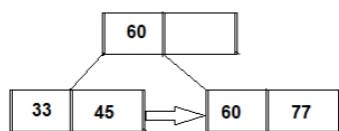
Step 1: inserting 45 and 77:



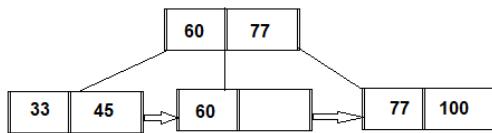
Step 2: inserting 60:



Step 3: inserting 33:



Step 4: inserting 100:



Therefore, correction option is (ii)

C 77, 45, 33, 100, 60

D None of the above

Q.11)

Let  $G$  be a finite group.

Subject: Discrete Mathematics

Max Marks: 1

S1: We can show that the number of elements in  $G$  of order greater than 2 must be even.

S2: We can conclude that any group of even order must contain an element of order 2.

Which of the above statements are correct?

A S1 is true, S2 is false

B S1 is false, S2 is true

C Both S1 and S2 are false

D None of the above

Correct Option

Solution: (D)

**Explanation:**

This is really just a simple counting argument. Let  $S$  be the set of all elements of  $G$  with order greater than two. If  $S = \emptyset$  then  $|S| = 0$  and we're finished. So assume  $S \neq \emptyset$ . Since  $|x| = |x^{-1}|$  for any  $x \in G$ , we see that  $x \in S$  if and only if  $x^{-1} \in S$ . Moreover, if  $x \in S$  then  $x^2 \neq e$  so that  $x \neq x^{-1}$ . It follows that  $S$  can be written as the disjoint union of two element sets of the form  $\{x, x^{-1}\}$ , and hence that  $|S|$  is even.

Suppose that  $|G|$  is even. Since  $e$  has order 1,  $e \notin S$ . It follows that  $G \setminus S \neq \emptyset$ . So  $0 < |G \setminus S| = |G| - |S|$ . Since  $|G|$  and  $|S|$  are both even, it follows that  $|G \setminus S|$  is a nonzero even integer, i.e. is at least 2. Thus, there is an  $x \in G \setminus S$ ,  $x \neq e$ . Since  $S$  consists of all elements in  $G$  of order greater than 2, it must be the case that  $|x| = 2$ .

Q.12)

Subject: Engineering-Mathematics

Max Marks: 1

Evaluate the limit

$$\lim_{x \rightarrow 1^+} \frac{x^3 - 4x + 4}{|x-1|}$$

Note: Here the correct answer is infinity and as not present in the options, therefore all those who have attempted are assigned marks.

 A

-1

 B

1

 C

Does not exist

Correct Option

**Solution:** (c)

Here we have to evaluate only the right-hand limit as in the question it is asked for the right neighbourhood of 1.

Evaluating the right-hand limit

$$\begin{aligned}\lim_{x \rightarrow 1^+} \frac{x^3 - 4x + 4}{|x-1|} &= \lim_{x \rightarrow 1^+} \frac{x^3 - 4x + 4}{(x-1)} \\ &= \frac{1}{0} \text{ Therefore the limit does not exist.}\end{aligned}$$

 D

0

Q.13)

Subject: computer organization

Max Marks: 1

Assuming a system cycle time for 500ns, Identifying percentage of idling/wastage due to refreshing a 32x32 dynamic MOS cell array used to build a 4Kx16 memory module. Dynamic cells are to be refreshed once every 1 msec.

Correct Answer

**Solution:** (1.6)**Answer:** 1.6**Explanation:**

During each refresh cycle, all the cells in a row of each cell array are refreshed.

In 1 msec, 32 refresh cycles are necessary for 32 rows in the 32x32 cell array.

⇒ Total time for refreshing all the cells =  $32 \times 500\text{ns} = 16\ \mu\text{s}$

Percentage idling =  $16\ \mu\text{s} / 1\text{ms} * 100 = 1.6\%$

Q.14)

Subject: Algorithms

Max Marks: 1

Consider the following fragment of code for an input of size  $4n$ , which of the following describes the time complexity of it.

```
for(i=0;i<n;i++)
{
    sum+=factorial(i);
    for(j=0;j<n;j++)
    {
        printf("\nApplied Course");
    }
}
```

Given that the function factorial is implemented using dynamic programming to calculate the factorial of that element

 A $O(n^2)$ 

Correct Option

**Solution:** (A)**Solution:**

Calculating Fibonacci using dynamic programming would require linear amount of time i.e.  $O(n)$  and this is done for  $i=0$  to  $n-1$  the time complexity would be

$$1+2+\dots+(n-1) = (n-1)*n/2 = O(n^2)$$

Also, the inner loop would require a similar time complexity

When  $i=0$  the inner loop will execute 1 time similarly for  $i=1$  it will

execute 2 times and then when i=2 it will execute 3 times and so on when i=n it will execute n times, also within this loop, there is only one printf statement which takes a constant amount of time.

$$\text{Sum} = 1+2+3\dots+n$$

$$=n(n+1)/2=O(n^2)$$

Therefore the total time complexity=O(n<sup>2</sup>).

B O(nlogn)

C O(n<sup>2</sup>logn)

D None of the above

Q.15)

Subject: operating systems

Max Marks: 1

A system implements Highest Response Ratio Next (HRRN), where the first tie break mechanism used is First Come First Served (FCFS). And if required then the second tie break mechanism used is the least burst time.

Process ID	Arrival Time (in units)	Burst Time (in units)
P1	0	3
P2	4	5
P3	4	3
P4	6	2
P5	6	3

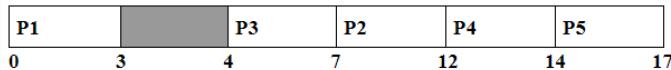
The throughput of the system is \_\_\_\_\_ (upto 2 decimal places)

Correct Answer

**Solution:** (0.29)

**Answer :** 0.29

**Explanation:**



Schedule Length = maximum completion time by any process - minimum Arrival time of any process.

Therefore, L = 17 - 0 = 17 units

So, throughput = number of processes / Schedule Length = n / L = 5 / 17 = 0.294 = 0.29

Q.16)

Subject: operating systems

Max Marks: 1

There are 6 processes in a system where each of them has a requirement of x resources. In the worst case, y number of resources would ensure that system is deadlock free. The system later on has 8 processes that require x resources each. In the worst case, (y + 4) resources would ensure that the system is deadlock free.

The value of x is \_\_\_\_\_

Correct Answer

**Solution:** (3)

**Explanation:**

The worst case allotment of resources to ensure that the system is in deadlock is (x-1) units to each process.

Therefore, 6 processes get (x-1) units = 6(x-1) would result in a deadlock.

Allotment of one more unit of resource will ensure the system is deadlock free.

$$6(x - 1) + 1 = y$$

$$6x - 5 = y \quad \dots \text{equation 1}$$

The system later on has 8 processes that require x resources each. In the worst case, (y + 4) resources would ensure that the system is deadlock free.

$8(x-1) + 1 = (y + 4)$   
 $8x - 7 = y + 4$   
 $8x - 11 = y \quad \dots \text{equation 2}$   
 Solving equations 1 and 2,  
 we get  $x = 3$ .

Q.17)

Consider the following intermediate code.

- (1)  $P := 0$
- (2)  $I := 1$
- (3)  $P := P + I$
- (4) IF  $P \leq 60$  GOTO (7)
- (5)  $P := 0$
- (6)  $I := 5$
- (7)  $T1 := I * 2$
- (8)  $I := T1 + 1$
- (9) IF  $I \leq 20$  GOTO (3)
- (10)  $K := P * 3$

The number of nodes(Basic Blocks) in the control flow graph

constructed for the given code are \_\_\_\_\_

Subject: Theory of Computation, Compiler Design

Max Marks: 1



Correct Answer

Solution: (5)

Explanation:

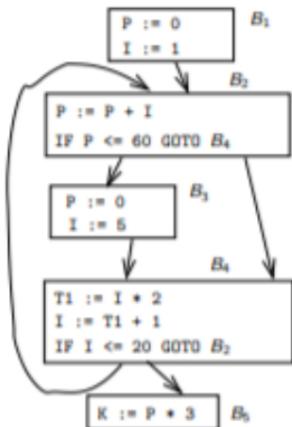
Instructions from intermediate code which are leaders are determined. Following are the rules used for finding leader:

The first three-address instruction of the intermediate code is a leader.

Instructions which are targets of jump or conditional jump are leaders.

Instructions which immediately follows jump are considered as leaders.

For each leader thus determined its basic block contains itself and all instructions up to excluding the next leader.



Q.18)

Which of the following languages are CFLs

- I.  $L = \{a^i b^j \mid 0 \leq i \leq j \leq 2i\}$
- II. The set of palindromes over  $\{a, b\}$
- III.  $\{a^i b^j c^k \mid i + k = j\}$

A I and II Only

B II and III Only

C I and III Only

D All are Context free

Subject: Theory of Computation, Compiler Design

Max Marks: 1



Solution: (D)

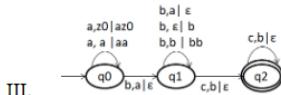
Explanation:

The context free grammar that generates the given language is

- I.  $S \rightarrow aSB \mid \epsilon$
- $B \rightarrow bb \mid b$
- $\{ab, abb, aabb, aabbb, aabbbb, \dots\}$

Correct Option

- II. The context free grammar that generates the given language is  
 $S \rightarrow aSa \mid bSb \mid a \mid b$



Q.19)

What is the output for the program given below

```
#include <stdio.h>
#include <stdlib.h>
typedef enum dateType{day, month, year;} month;
int main()
{
    month m1;
    m1=1;
    printf("%d", m1);
    return 0;
}
```

A 1

B Compilation Error

Correct Option

**Solution:** (B)

Solution:  
The name month is used in the two meanings. One means that it is a enumerator constant with value 1. The another use is that it is a type name (due to typedef) for enum dateType. Given a situation, the compiler cannot distinguish the meaning of month to know in what sense the month is used:

```
month m1;
m1=error;
```

C Runtime Error

D Garbage Value

Q.20)

Subject: Discrete Mathematics

Max Marks: 1

Let  $G$  be a graph which contains a simple circuit of odd length.

Given the  $\chi(G)$  represents the chromatic number of the graph  $G$ , which among the following options is correct?

A  $\chi(G) \leq 2$

B  $\chi(G) \geq 2$

C  $\chi(G) < 2$

D  $\chi(G) \geq 3$

Correct Option

**Solution:** (D)

**Explanation :**

Let's assume that  $\chi(G) \leq 2$ . Then there exists a 2-coloring of  $G$ . An arbitrary circuit of odd length has the form:

$$v_1 \rightarrow v_2 \rightarrow \dots \rightarrow v_{2n+1} \rightarrow v_1$$

Because  $G$  can be 2-colored, this means we can 2-color this circuit as well. We will use the colors 1 and 2 for this purpose. Without loss of generality, assume that  $v_1$  has color 1. Because  $v_1$  and  $v_2$  are neighbours, this leaves us no choice for  $v_2$  and it must be colored using color 2. But then,  $v_3$  must have color 1, because it and  $v_2$  are neighbours. By iterating this argument, we see that  $v_{2k+1}$  has color 1 and  $v_{2k}$  has color 2, for any choice of  $k$ . But then we get a contradiction, because  $v_{2n+1}$  and  $v_1$  have the same color and they are adjacent.

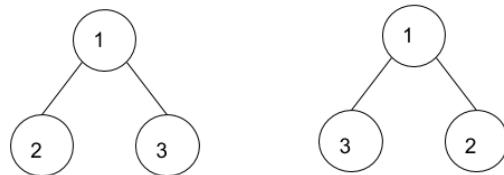
Therefore, our assumption is wrong and it must be the case that  $\chi(G) \geq 3$ .

Q.21)

Subject: Data Structures

Max Marks: 1

Given a set of values, there may exist multiple distinct min-heaps containing those values. For example, given a set of values {1, 2, 3}, there are two possible min-heaps:



suppose you have a min-heap with 100 nodes containing exactly the values {1, 2, 3, ..., 100}, but you don't know where each value is located. How many nodes could contain the value 100? For example, in a min-heap containing the values {1, 2, 3}, only 2 nodes could contain the value 3 (either child of the root, as seen in the diagram above).\_\_\_\_\_



Correct Answer

**Solution:** (50)**Solution:**100 must be at a leaf, of which there are  $100/2 = 50$ .

Q.22)

Subject: computer organization

Max Marks: 1

Control memory length can be minimized by



Encoding maximal compatible signals in the same control field



Encoding micro operations in different control fields which can be executed concurrently

Correct Option

**Solution:** (8)**Explanation:**

Encoding micro operations in different control fields which can be executed concurrently



Employing polyphase clock to resolve timing conflict which may exist for concurrent execution of micro operations



Encoding control signals for concurrent micro operations in same control field

Q.23)

Subject: operating systems

Max Marks: 1

An engineering student has worked up a solution for the Dining Philosophers problem. She got help from a consultant with a recent doctorate in algorithms.

Before eating, each philosopher will flip a coin to decide whether to pick up the left fork or the right fork first. If the second fork is taken, the philosopher will put the first fork down, then flip the coin again.

Which of the below options is correct about the above solution?



It is only deadlock free

Correct Option

**Solution:** (A)**Answer:**

This solution is deadlock-free, however it does not guarantee freedom from starvation. The philosophers are never stuck waiting and unable to do "useful work". However, a philosopher might not ever get a chance to eat because at least one of his/her forks is busy.



It is only starvation free



It is both starvation free and deadlock free



None of the above

Q.24)

Subject: Computer Networks

Max Marks: 1

Which of the following statements is incorrect about TCP state transition?



The one who sends the FIN first will go in the active close and other will go in passive close.



In the half-closed state one side has sent the FIN and waiting for another side to respond back to that FIN.



After sending the FIN from one side, both sides will get locked from sending the data.

Correct Option

**Solution:** (C)**Explanation:**

Either side may elect to close the connection, just as either party to a telephone call may elect to hang up. The first side to send a FIN takes the Active CLOSE path; the other side takes the Passive CLOSE path.

A TCP endpoint is half-closed if it has sent its FIN (thus promising not to send any more data) and is waiting for the other side's FIN; this corresponds to A in the diagram

above in states FIN\_WAIT\_1 and FIN\_WAIT\_2.

A simultaneous close – having both sides send each other FINs before receiving the other side's FIN.

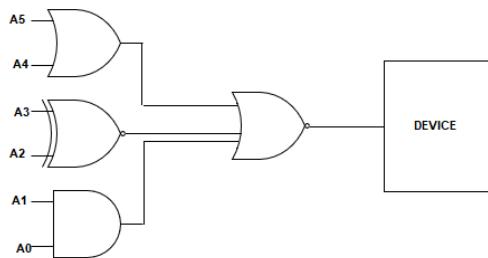
After sending the FIN from one side the other side may send the data until the FIN has been sent from the other side.

D

In the simultaneous close both sides send the FIN simultaneously.

Q.25)

Consider the following circuit:



The number of addresses which can enable the device using 6 address bits are \_\_\_\_\_

Subject: digital logic systems

Max Marks: 1

Correct Answer

Solution: (6)

**Solution:** 6

XOR will be active only when all the input given to it are 0. Therefore,  
For AND gate: Output will be 0 in 3 cases (A0 AND A1: 0 AND 0, 0 AND 1, 1 AND 0)  
For XNOR gate: Output will be 0 in 2 cases (A2 XNOR A3: 0 XNOR 1, 1 XNOR 0)  
For OR gate: Output will be 0 in 1 case only (A4 OR A5: 0 OR 0)  
Thus possible number of addresses which will enable the device are  $1 * 2 * 3 = 6$  addresses.

Q.26)

**Which of the following statements is/are True?**

- I. Converting an adjacency matrix representation to an adjacency list representation takes  $O(V + E)$  time.
- II. In any connected, undirected graph with exactly 5 simple cycles (that do not share any edges), there are at most 10 simple paths between every pair of vertices.

A

Only I

B

Only II

C

Both I and II

D

Neither I nor II

Correct Option

Solution: (D)

Solution:

- I. False. Constructing the adjacency list for each vertex takes  $\Theta(V)$  time in the worst case, so this conversion might take  $\Theta(V^2)$ .
- II. False: For each cycle, you might have two options for which direction to take. In the worst case, this is  $2^5 = 32$  paths between two vertices.

Q.27)

What is the value of a and b if  $(49)_a = (133)_b$

Subject: digital logic systems

Max Marks: 1

A

a = 10, b = 5

B

a = 16, b = 7

Correct Option

Solution: (B)

**Solution:**

For the given expression (49)<sub>a</sub> = (133)<sub>b</sub>,  $a > 9$  and  $b > 3$ . The equation could be written as:

$$\Rightarrow 4a + 9 = b^2 + 3b + 3$$

Now on substituting each of the options we will get:

(i)  $a = 10, b = 5$ :

$$\Rightarrow 40 + 9 = 25 + 15 + 3$$

$$\Rightarrow 49 \neq 43$$

(ii)  $a = 16, b = 7$

$$\Rightarrow 4 * 16 + 9 = 49 + 21 + 3$$

$$\Rightarrow 64 + 9 = 73$$

Hence, this is the correct option.

C

$a = 12, b = 7$

D

None of the above

Q.28)

Subject: DBMS

Max Marks: 2



On considering two relational schemas R1 (PQRSTU) and R2 (PQR) where PQ is the primary key for both the relation R1 and R2. Which of the following option is true about these two relations based on the given FD's and the fact that only atomic values are allowed in relation R1 and R2?

$$PQ \rightarrow R$$

$$R \rightarrow PQST$$

$$P \rightarrow U$$

A

R1 is in 1 NF and R2 is in 3 NF

B

R1 is in 2 NF and R2 is in BCNF

C

R1 is in 2 NF and R2 is in 3 NF

D

R1 is in 1 NF and R2 is in BCNF

Correct Option

Solution: (D)

**Solution:**

The relation R1 is not in 2 NF because it has a partial dependency  $P \rightarrow U$ . While R2 is in BCNF as it includes only 1 dependency  $PQ \rightarrow R$ .

Q.29)

Subject: Discrete Mathematics

Max Marks: 2



Consider the set  $\mathbb{N}_T = \mathbb{N} \cup \{\top\}$ . We define a binary relation  $\sqsubseteq$  on  $\mathbb{N}_T$  by:

$$n \sqsubseteq m \text{ iff } m = \top \text{ or } n \leq m$$

where  $n \leq m$  is the standard order on  $\mathbb{N}$ .

Note : Here  $\{\top\}$  is a set with an element T.

A

The relation is not reflexive

B

The relation is reflexive but not transitive

C

The relation is reflexive, antisymmetric and transitive

Correct Option

Solution: (C)

**Explanation:**

**Reflexivity:** If  $n \in \mathbb{N}$ , then clearly  $n \leq n$  and thus  $n \sqsubseteq n$ . Otherwise  $n = \top$  and then by definition  $n \sqsubseteq n$ .

**Antisymmetry:** Assume  $n \sqsubseteq m$  and  $m \sqsubseteq n$ . If  $m = \top$ , then the latter requires  $n = \top = m$ . If  $m \neq \top$ , then  $m \in \mathbb{N}$  and then  $n \sqsubseteq m$  implies  $n \in \mathbb{N}$  and  $n \leq m$ . But then,  $m \sqsubseteq n$  implies  $m \leq n$  and so we conclude  $m = n$ , as required.

**Transitivity:** Assume  $n \sqsubseteq m$  and  $m \sqsubseteq k$ . If  $k = \top$ , then by definition  $n \sqsubseteq k$ , as required. If  $k \neq \top$ , then  $k \in \mathbb{N}$  and thus the second hypothesis implies  $m \in \mathbb{N}$  with  $m \leq k$ . Because  $m \in \mathbb{N}$ , the first hypothesis implies  $n \in \mathbb{N}$  with  $n \leq m$ . Thus, we get  $n \leq m \leq k$  and therefore  $n \sqsubseteq k$ , as required.

D

None of the above

Q.30)

Subject: Computer Networks

Max Marks: 2



An organization has 4 subsidiaries [1 to 4] each subsidiary has its own subnetwork. The organization wants to close two subsidiaries and also wants to increase the size of the first and second subsidiary. Therefore there is a need to merge the 4 subnetworks to two subnetworks for these two subsidiaries. The host address of one of the subsidiary is 125.34.56.155/18. What is the new subnet address of the second subsidiary?

 A 125.34.0.0/17 B 125.34.128.0/18 C 125.34.64.0/17 D 125.34.128.0/17

Correct Option

**Solution:** (D)**Explanation:**

Host address = 125.34.56.155/18

Initial distribution:

Subnet 1 = 125.34.0.0/18

Subnet 2 = 125.34.64.0/18

Subnet 3 = 125.34.128.0/18

Subnet 4 = 125.34.192.0/18

We need to merge subsidiaries into two:

So we need only two subnets:

So subnet 1 = 125.34.0.0000000.0000000/17 = 125.34.0.0/17

Subnet 2 = 125.34.1.0000000.0000000/17 = 125.34.128.0/17

New subnet address of the second subsidiary is = 125.34.128.0/17

Q.31)

Subject: Theory of Computation, Compiler Design

Max Marks: 2



Which of the following languages is/are regular:

- I. A XOR B = {w | w is in exactly one of A or B}. Assume A and B are Regular languages.
- II. L = {x ∈ {a, b}^\* | x = a^m b^n, GCD(m, n) = 1}.

 A Only

Correct Option

**Solution:** (A)**Explanation:**

I. Given That A and B are the regular languages.

A xor B = A'B + AB'

⇒ Given A is regular A' is also regular and regular languages are closed under concatenation. ⇒ A'B is regular

⇒ Given B is regular ⇒ B' is also regular and regular languages are closed under concatenation. ⇒ AB' is Regular

⇒ A'B + AB' Regular languages are closed under union operation.

II. L = {x ∈ {a, b}^\* | x = a^m b^n, GCD(m, n) = 1}.

Suppose that L is regular, and let k > 1 be a pumping-lemma constant for L. Choose any prime p > k, and feed  $\alpha = \epsilon$ ,  $\beta = a^p$  and  $\gamma = b^{(p+1)(p+2)\dots(p+k)}$  to the pumping lemma. Since p is a prime larger than k, neither of p+i is divisible by p for i = 1, 2, ..., k, so that  $\gcd(p, (p+1)(p+2)\dots(p+k)) = 1$ , that is,  $\alpha\beta\gamma \in L$ . The pumping lemma supplies a decomposition of the form  $\beta = \beta_1\beta_2\beta_3$  with  $\beta_2 = a^t$  for some t in the range  $1 \leq t \leq k$ . Pumping in one occurrences of  $\beta_2$  gives the string  $\alpha\beta_1\beta_2^{t-1}\beta_3\gamma = a^{p+t}b^{(p+1)(p+2)\dots(p+k)} \in L$ . But  $\gcd(p+t, (p+1)(p+2)\dots(p+k)) = p+t \geq 3$  (since  $p \geq 2$  and  $t \geq 1$ ), a contradiction

 B II Only C Both I and II D Neither I nor II

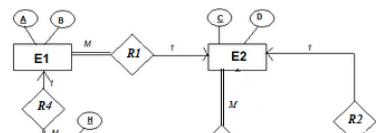
Q.32)

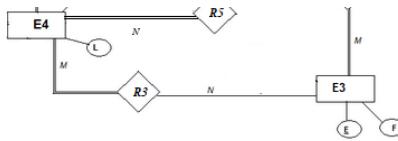
Subject: DBMS

Max Marks: 2



Consider the following E-R diagram:





What is the minimum number of relations required for the above E-R diagram?

A

4

B

5

C

3

Correct Option

**Solution:** (C)

**Solution:**

In total 3 relations are required. The analysis will be as follows:

- (i) Entity E1 and E2 will form 2 relations because of the many-to-one relation between them. Therefore, # of relations = 2.
- (ii) For Entity E2 and E3, E3 could not be merged with E2 due to one-to-many relation (R2) between them. hence, E3 will result in separate relation. Therefore, # of relations = 3.
- (iii) For Entity E2 and E4, E4 could be merged with E2 due to many-to-many relations (R5) with total participation on both sides in between them. Hence, the number of relations will remain the same. Therefore, # of relations = 3.
- (iv) For Entity E1 and E4, E4 could not be merged with E1 due to one-to-many relation (R4) between them. hence, E4 will result in separate relation. But E4 is already merged with E2, therefore, no new relation is being formed. Thus, # of relations = 3.

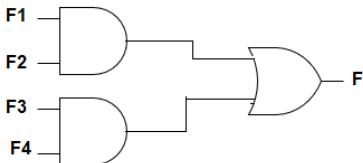
Hence, the total number of relations possible are 3.

D

None of the above

**Q.33)**

For the given circuit:



Where canonical sum of product form of F1, F2, F4 and F is given as:

$$F1(W, X, Y, Z) = \Sigma(1, 4, 5, 9, 12, 13)$$

$$F2(W, X, Y, Z) = \Sigma(1, 2, 9, 4, 5)$$

$$F3(W, X, Y, Z) = \Sigma(3, 6, 7, 10, 11)$$

$$F(W, X, Y, Z) = \Sigma(1, 3, 4, 5, 6, 7, 9, 11)$$

Subject: digital logic systems

Max Marks: 2

Which of the following is the correct canonical form for function F4?

A

$$F4(W, X, Y, Z) = \Sigma(3, 6, 15, 11, 14)$$

B

$$F4(W, X, Y, Z) = \Sigma(3, 6, 15, 11, 14, 10)$$

C

$$F4(W, X, Y, Z) = \Sigma(3, 6, 7, 15)$$

D

$$F4(W, X, Y, Z) = \Sigma(3, 6, 7, 11, 14)$$

Correct Option

**Solution:** (D)

**Solution:**

For AND gate we perform "intersection" of the minterms while for OR gate we perform "union" of the minterms". The following is a table showing intersection and union for all options given in the question:

Option number	$F3 \cdot F4$	$F1 \cdot F2$	F
(i)	$\Sigma(3, 6, 11)$	$\Sigma(1, 4, 5, 9)$	$\Sigma(1, 3, 4, 5, 6, 9)$

			,11)
(ii)	$\Sigma(3, 6, 10, 11)$	$\Sigma(1, 4, 5, 9)$	$\Sigma(1, 3, 4, 5, 6, 9,$ 10, 11)
(iii)	$\Sigma(3, 6, 7)$	$\Sigma(1, 4, 5, 9)$	$\Sigma(1, 3, 4, 5, 6, 7,$ 9)
(iv)	$\Sigma(3, 6, 7, 11)$	$\Sigma(1, 4, 5, 9)$	$\Sigma(1, 3, 4, 5, 6, 7,$ 9, 11)

Q.34)

A disk has a capacity of two tera-byte size. Say the file system uses a multi-level inode structure for locating the data blocks of a file.

The inode stores pointers to data blocks, including a single indirect block, a double indirect block, and several direct blocks in the 64 B of available space.

Now, it is given that the disk has a block size of 512 B. The maximum file size that can be stored in such a file system in \_\_\_\_ MB (round off upto 2 decimal places)

Subject: operating systems

Max Marks: 2

Correct Answer

**Solution:** (8.07)**Answer : 8.07 MB****Explanation:**

Number of data blocks =  $2^{41}/2^9 = 2^{32}$ ,  
so 32 bits or 4 bytes are required to store the number of a data block.

Number of data block pointers in the inode =  $64/4 = 16$ , of which 14 are direct blocks. The single indirect block stores pointers to  $512/4 = 128$  data blocks.

The double indirect block points to 128 single indirect blocks, which in turn point to 128 data blocks each.

So, the total number of data blocks in a file can be  $14 + 128 + 128*128 = 16526$ , and the maximum file size is  $16526*512$  bytes = 8461312 B = 8.06934 MB = 8.07 MB

Q.35)

Subject: Algorithms

Max Marks: 2

A recursive algorithm is designed in such a way that for size n it divides it into 2 subproblems in the ratio 3:2 and it takes linear time to integrate the solution from the 3 subproblems, Which of the following is most accurate in describing the time complexity of the above algorithm.

**A**  $\Theta(n^2)$ **B**  $\Omega(n)$ 

Correct Option

**Solution:** (B)

As the problem is divided in the ratio 3:2, therefore, the 2 resulting problems would be of size  $3n/5$  and  $2n/5$ .

The recurrence relation for the above algorithm can be given by

$$T(n) = T(2n/5) + T(3n/5) + O(n).$$

$$= T(n/(5/2)) + T(n/(5/3)) + O(n)$$

Solving by recursion tree method the tree will be of a height  $\log_{(5/3)}n$  and at each level, linear time of work is done therefore the time complexity is  $\Theta(n\log n)$  from the options the most appropriate one is  $\Omega(n)$  as  $n\log n$  grows faster than n.

**C**  $O(n)$ **D** None of the above.

Q.36)

Subject: Discrete Mathematics

Max Marks: 2

Given are three arbitrary sets A, B and C.

$$S1 : A - (B - C) = A \cap (C - B)$$

$$S2 : 2^{(A \cap B)} = 2^A \cap 2^B$$

For each of the above statements, which of the options are correct?

**A** S1 is true and S2 is false

**S** \$1 is false and \$2 is true

Correct Option

**Solution:** (B)

**Explanation:**

**S1:**

Proof by counter example:

Let  $A = \{a, b, c\}$ ,  $B = \{a, d, e\}$  and  $C = \{a, f, g\}$

Then we have,  $B - C = \{d, e\}$  and  $C - B = \{f, g\}$

Now,  $A - (B - C) = \{a, b, c\}$  and  $A \cap (C - B) = \emptyset$

$\therefore A - (B - C) \neq A \cap (C - B)$

**S2:**

**Proof:**

$X \in 2^{A \cap B} \Leftrightarrow X \subseteq A \cap B \Leftrightarrow X \subseteq A \wedge X \subseteq B \Leftrightarrow X \in 2^A \wedge X \in 2^B \Leftrightarrow X \in 2^A \cap 2^B$

$\therefore 2^{A \cap B} = 2^A \cap 2^B$

**c**

Both S1 and S2 are false

**d**

None of the above

**Q.37)**

Consider the following relations:

Subject: DBMS

Max Marks: 2



Relation A:

T1	T2
5	55
NULL	11
4	11

Relation B:

T1	T3
1	5
2	NULL
3	NULL

Given the SQL query:

```
SELECT *
FROM A
WHERE A.T1 NOT IN ( SELECT B.T3 FROM B);
```

The number of tuples returned by the above SQL query is \_\_\_\_\_

Correct Answer | Attempted

**Solution:** 0

**Solution:** 0 tuples

The inner query will return the output as (5, (null), (null)). Now this is compared by the output of the outer query which is (5, (null), 4).

We need to get (5, (null), 4) NOT IN (5, (null), (null)) = 0

As we know, NO two NULL values could be compared. Hence we can only check for value T1 = 5. Since it is present in the set of inner query output, therefore number of tuples given as output is equal to zero.

**Q.38)**

Subject: C Programming

Max Marks: 2



What is the output of the following C code?

```
void main()
{
    int i, j;
```

```

for(i=0,j=0;i<5,j<10;i++,j++){
    printf("i=%d \t j=%d\n", i, j);
}
}

```

**A Prints i and j value upto 9**

Correct Option

**Solution:** (A)

Solution:

**Prints i and j upto 9**

When we use “;” in condition the last condition will only be considered irrespective of the conditions present prior to that.

**B Prints i and j value upto 4**

**C Prints i upto 4 & j upto 9**

**D Run time error**

**Q.39)**

Subject: computer organization

Max Marks: 2

A memory system has 16M bytes. The memory is organized into blocks of 64bit/8 bytes each, and the cache has total 512K bytes, organized into cache lines of 8 bytes each:

If cache is organized into 4-way set associative cache, What are the Tag, Set and Word values for the byte addresses DB86E2h (Assume h represents the hexadecimal number)

**A Tag=6Dh, Set=30FCh, Word=2h**

**B Tag=6Dh, Set=30DCh, Word=2h**

Correct Option

**Solution:** (B)

**Explanation:**

We have 64K cache lines, 4-way associative, so we have  $64K / 4 = 16K$  cache set, each with 4 cache lines.  $16K \Rightarrow$  we need  $2^4 \times 2^{10} = 2^{14}$  cache sets. So we need 14 bits for cache set address.

3 bits for word selector, 14 bits for cache set, that leaves 7 bits for Tag.

Given Address is :DB86E2h

1101101, 11000011011100, 010  $\Rightarrow$  Tag=6Dh, Set=30DCh, Word=2h

**C Tag=1Bh, Set=70DCh, Word=2h**

**D None of these**

**Q.40)**

Subject: Algorithms

Max Marks: 2

Which of the following statements are true with respect to the DFS traversal of a graph.

**Statement I-** In case of an undirected graph, every edge that is a forward edge is also a back edge for a particular DFS traversal of that graph.

**Statement II-** In case of a stack-based implementation of DFS, a will never enter the stack more than once.

**A Statement I is true.**

**B Statement II is true.**

**C Both Statement I and Statement II are true.**

Correct Option

**Solution:** (C)

**Solution.**

**Statement I:** A forward edge is an edge connecting an edge which was discovered earlier to an edge which is discovered later in a DFS traversal since the graph is an undirected graph there is no particular direction, therefore if an edge is a forward edge it will be a back edge also.

**Statement II:** In case of a stack-based implementation a node/vertex once visited will never be visited again as it will be marked visited and never be added to the stack once it is marked as visited.

**D Neither Statement I nor Statement II is true.**

**Q.41)**

Subject: Theory of Computation,Compiler Design

Max Marks: 2

Which of the following statements is/are True

- If we add a finite set of strings to a regular language, the result is a regular language.
- If we remove a finite set of strings from a regular language, the result is a regular language.
- If we add a finite set of strings to a nonregular language, the result is a nonregular language
- If we remove a finite set of strings from a nonregular language, the result is a nonregular language

Note: Question has been asked for False instead of True.

**A I,II, III and IV**

Correct Option

**Solution:** (A)

**Explanation:**

- I. Let A be a regular language, and let B be a finite set of strings. We know from class (see page 1-95 of Lecture Notes for Chapter 1) that finite languages are regular, so B is regular. Thus, A ∪ B is regular since the class of regular languages is closed under union
- II. Let A be a regular language, and let B be a finite set of strings with B ⊆ A. Let C be the language resulting from removing B from A, i.e., C = A - B. As we argued in the previous part, B is regular. Note that C = A - B = A ∩ B̄. Since B is regular, B̄ is regular since the class of regular languages is closed under complement. We proved in an earlier homework that the class of regular languages is closed under intersection, so A ∩ B̄ is regular since A and B̄ are regular. Therefore, A - B is regular.
- III. Let A be a nonregular language, and let B be a finite set of strings. We want to add B to A, so we may assume that none of the strings in B are in A, i.e., A ∩ B = ∅. Let C be the language obtained by adding B to A, i.e., C = A ∪ B. Suppose that C is regular, and we now show this is impossible. Since A ∩ B = ∅, we have that A = C - B. Since C and B are regular, the previous part of this problem implies that C - B should be regular, but we assumed that A = C - B is nonregular, so we get a contradiction.
- IV. Let A be a nonregular language, and let B be a finite set of strings, where B ⊆ A. Let C be the language obtained by removing B from A, i.e., C = A - B. Suppose that C is regular, and we now show this is impossible. Since we removed B from A to get C, we must have that C ∩ B = ∅, so A = C ∪ B. Now C is regular by assumption and B is regular since it's finite, so C ∪ B must be regular by Theorem 1.25. But we assumed that A = C ∪ B is nonregular, so we get a contradiction.



I, II Only



III, IV Only



II, IV Only

**Q.42)**

Process P and C communicate by means of 3 semaphores and one buffer. The buffer size is given as 10. A semaphore M is used to implement mutual exclusion. Initial value of M is 1.

And value of M is decremented by any process that wants to enter its critical region (the code that adds or removes items from the buffer), and incremented back to 1 after leaving the critical region.

The semaphore F counts the number of full slots in the buffer. It is initially 0, then it is decremented by C before entering its critical region, and incremented by P after leaving its critical region. Semaphore E counts the number of empty slots in the buffer. It is initially 10, then it is decremented by P before entering its critical region, and incremented by C after leaving its critical region.

Before entering a critical region, a process first tries to decrement E or F, and then tries to decrement M. On leaving a critical region, a process first raises M and then E or F. Under these assumptions, which of the below combinations cannot exist.



M = 0, E = 5, F = 3



M = 0, E = 8, F = 0



M = 0, E = 7, F = 1



M = 1, E = 7, F = 0

Correct Option

**Solution:** (D)

**Explanation:**

When neither P nor C is in its critical region or attempting to enter its critical region, F+E=10 and M=1. If one tries to enter its critical region, it decrements E or F, in which case E+F=9, while M is still 1. It is possible that, at the same time, the other process also tries to enter its critical region, and decrements the other of E and F, resulting in E+F=8 with M=1.

Then, one of these processes must set M=0 and enter its critical region. On exiting the critical region, M becomes 1 again, while E and F are unchanged; their sum is either 8 or 9. However, the process exiting the critical region will increment one of E or F, resulting in M=1 and E+F=9 or 10. If E+F=9, the other process may set M=0 and enter its critical region. If E+F=10, then M will stay 1 until P or C decrements E or F.

The only other constraints are that neither E, F, nor M can be negative.

The conclusion is that if M=0, then E+F = 8 or 9, and if M=1, then E+F = 8, 9 or 10. Since executing P increments F and decrements E, while executing C does the opposite, we conclude that any of these combinations of M, E, and F described above are possible, subject only to the constraints of no negative value.

Q.43)

Subject: Theory of Computation, Compiler Design

Max Marks: 2

Consider the following grammar

$S \rightarrow SA \mid A$

$A \rightarrow a$

The given grammar is

 A

Both LL(1) and LALR(1)

 B

Neither LL(1) nor LALR(1)

 C

Not LL(1) but LALR(1)

Correct Option

**Solution:** (c)

**Explanation:**

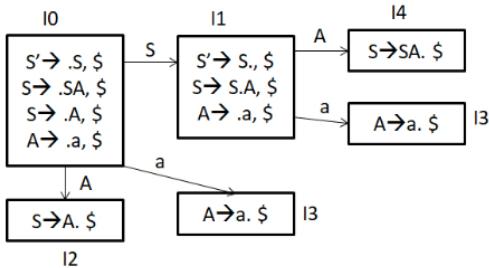
$S \rightarrow SA \mid A$

$A \rightarrow a$

$\text{First}(S) = \text{First}(S) \text{ intersection } \text{First}(A) = \{a\} \cap \{a\} \neq \emptyset$

Not LL(1)

No Conflicts in S/R and R/R conflicts  $\Rightarrow$  LALR(1)

 D

LL(1) but not LALR(1)

Q.44)

Subject: Computer Networks

Max Marks: 2

We have the 3 links mentioned in the table with their corresponding MTU.

Link	Maximum Transmission Unit(MTU)
A	200
B	400
C	1500

A 1400 bytes packet includes a 20-byte header is sending from Link C to Link B, the packet is fragmented according to the MTU given in the table. Link B is sending the fragments [F1, F2, ..Fn] that are received from link to C to link A according to the MTU of the table. What is the fragment offset of the second last fragment of Fn-1 which received on the link A? [ All the fragments follows the same path]

Correct Answer

**Solution:** (116)

**Ans 116**

**Explanation:**

packet size = 1400B

MTU = 400 B of link B

Number of fragments =  $1380/380 = 3.63 = 4$

First fragment offset (F1) = 0

Second fragment offset (F2) =  $376/8 = 47$

Third fragment offset (Fn-1 = F3) =  $(376 \times 2)/8 = 94$

Fourth fragment offset (Fn = F4) =  $(376 \times 3)/8 = 141$

$F_{n-1} = 376 + 20 = 396$  B, Fragment offset = 94

MTU of link A = 200 B

Number of fragments of (Fn-1) =  $376/180 = 2.08 = 3$  fragments

First fragment =  $176/8 = 94$ -115

Second last fragment =  $176/8 = 116$ -137

Q.45)

Which of the following corresponds to the IEEE 754 single precision floating point representation of 0x80400000 ?

Subject: digital logic systems

Max Marks: 2

A Normalized value  $-(1.1) \times 2^{-127}$

B Denormalized value  $-(0.1) \times 2^{-127}$

C Denormalized value  $-(0.1) \times 2^{-126}$

Correct Option

Solution: (C)

**Solution:**

On expanding the hexadecimal number, we will get:

0x80400000 => 1000 0000 0100 0000 0000 0000 0000 => 1 00000000  
1000...00 (total 32 bits, 1 for sign bit, 8 for exponent and 23 for mantissa)

Since all exponent bits are 0 and mantissa is non-zero, therefore, it will result in denormalized fraction representation of the number, which will be negative due to the presence of sign bit as 1.

The number will be of format  $(-1)^s \times (0.M) \times 2^{-126} => -(0.1) \times 2^{-126}$ .

D None of the above

Q.46)

A bag contains 50 tickets numbered 1, 2, 3 .., 50 of which five are drawn at random and arranged in ascending order of magnitude ( $x_1 < x_2 < x_3 < x_4 < x_5$ ).

Subject: Engineering-Mathematics

Max Marks: 2

The probability

that  $x_3 = 30$  is

A  $C(20,2)/C(50,5)$

B  $C(29,2)/C(50,5)$

C  $(C(20,2)*C(29,2))/C(50,5)$

Correct Option

Solution: (C)

**Solution:**

Since  $x_1 < x_2 < x_3 < x_4 < x_5$  and  $x_3 = 30$ , therefore  $x_1, x_2 < 30$ , i.e.  $x_1$  and  $x_2$  should come from tickets numbered 1 to 29 and this may happen in  $C(29,2)$  ways.  $x_4, x_5 > 30$ , should come from 20 tickets numbered 31 to 50 in  $C(20,2)$  ways. No of ways in which  $x_3=30$  along with our conditions=  $C(29,2)*C(20,2)$ .  
No of ways in which we can select 5 elements  $C(50,5)$ .

Therefore the required probability=  $(C(20,2)*C(29,2))/C(50,5)$ .

D None of the above

Q.47)

Subject: Engineering-Mathematics

Max Marks: 2

$$f(x) = \begin{vmatrix} \sec^2 x & 1 & 1 \\ \cos^2 x & \cos^2 x & \operatorname{cosec}^2 x \\ 1 & \cos^2 x & \cot^2 x \end{vmatrix}$$

The value of  $\int_0^{\pi/2} f(x) dx =$

A  $1/4$

B  $\pi/2$

C  $\pi/8$

D  $3\pi/16$

Correct Option

**Solution:** (D)

$$\begin{aligned}
 &= \sec^2 x (\cos^2 x * \cot^2 x - \cos^2 x * \cosec^2 x) - 1 (\cos^2 x * \cot^2 x - \cosec^2 x) + 1 (\cos^4 x - \cos^2 x) \\
 &= \cot^2 x - \cosec^2 x - \left[ \frac{\cot^4 x - 1}{\sin^2 x} \right] - \cos^2 x * \sin^2 x \\
 &= -1 + (\cos^2 x + 1) - \cos^2 x * \sin^2 x \\
 &= -1 + \cos^2 x (1 - \sin^2 x) = \cos^4 x \\
 \int_0^{\pi/2} f(x) dx &= \int_0^{\pi/2} \cos^4 x dx = \frac{3}{4} * \frac{1}{2} * \frac{\pi}{2} = \frac{3\pi}{16}.
 \end{aligned}$$

**Q.48)**

A DMA controller transfers character on a cycle stealing mode. It is connected to a terminal that transmits 1200 CPS (Characters per second). CPU on the average takes  $1\ \mu s$  to fetch and execute an instruction. How much percent the CPU will be slowed down due to DMA operation.

Subject: computer organization

Max Marks: 2

Correct Answer

**Solution:** (0.12)

**Answer:** 0.12

**Explanation:**

Terminal can able to transfer 1200 CPS  $\Rightarrow$  in 1 Sec it can transfer 1200 characters.  
 CPU on average takes  $1\ \mu s$  to fetch and execute an instruction.  $\Rightarrow$  In one sec it can execute  $10^6$  instructions.  
 The amount of time the CPU slowed down due to the DMA controller or data transfer is  $= (1200/10^6)*100 = 0.12\%$

**Q.49)**

The value of  $\lambda$  for which the system of equations has a non-trivial solution are

$$(\lambda+5)x + (\lambda-4)y + z = 0$$

$$(\lambda-2)x + (\lambda+3)y + z = 0$$

$$\lambda x + \lambda y + z = 0$$

Subject: Engineering-Mathematics

Max Marks: 2

**A**

-1, -2

**B**

0, -1

**C**

0

**D**

None of the above

Correct Option

**Solution:** (D)

**Solution:**

The determinant of the coefficient matrix for the above system of linear equations should be  $= 0$

$$\begin{vmatrix}
 \lambda + 5 & \lambda - 4 & 1 \\
 \lambda - 2 & \lambda + 3 & 1 \\
 \lambda & \lambda & 1
 \end{vmatrix} = 0$$

On simplification, we get the value of the above determinant is independent of the value of  $\lambda$ , determinant  $= 7$ , therefore None of the above is the appropriate option.

**Q.50)**

Consider the following set of tasks and their associated profits and deadlines, in a dual-core system wherein an incoming task is assigned in an alternate fashion i.e. the tasks are assigned to each core in an alternate fashion, what is the additional gain in the profit when compared to the single-core system \_\_\_\_\_.

Subject: Algorithms

Max Marks: 2

Task	Profit	Deadline
1	12	5
2	11	4
3	25	5

4	14	1
5	8	2
6	10	3
7	13	4
8	15	3
9	17	4
10	18	3

Correct Answer

**Solution:** (44)

Solution: 44

Let us consider the following tasks are assigned to the 1st core

<u>Task</u>	<u>Profit</u>	<u>Deadline</u>
1	12	5
3	25	5
5	8	2
7	13	4
9	17	4

The optimal schedule for the first core is as follows

Time	1	2	3	4	5	Total
Task	5	1	7	9	3	
Profit	8	12	13	17	25	75

The following tasks are assigned to the 2nd core

<u>Task</u>	<u>Profit</u>	<u>Deadline</u>
2	11	4
4	14	1
6	10	3
8	15	3
10	18	3

The optimal schedule for the second core is as follows

Time	1	2	3	4	5	Total
Task	4	8	10	2	-	
Profit	14	15	18	11	-	58

The total profit in a dual-core system = 75+58=133.

Now if a system is a single core system then the optimal schedule is as follows.

Time	1	2	3	4	5	Total
Task	4	8	10	9	3	
Profit	14	15	18	17	25	89

The total profit of a single-core system is 89.

Additional profit because of the dual-core system is=133-89=44.

Q.51)

What is the output of the following program?

int main()

{

    int a=4, b=7;

Subject: C Programming

Max Marks: 2

```

    b = b || a++ && printf("GATE");
    printf("%d %d", a, b);
    return 0;
}

```

**A** Compilation error

**B** 7, 4

**C** 1, 4

**D** 4, 1

Correct Option

**Solution:** (D)

Solution:

The boolean expressions need to be evaluated only till the truth value of the expression is not known. b is not equal to zero itself means the expression truth value is 1. Because it is followed by `||` and true `||` (anything)  $\geq$  True where (anything) will not be evaluated. So the remaining expressions are not evaluated and so the value of a remains the same.

Similarly when `&&` operator is involved in an expression, when any of the operands become false, the whole expression truth value becomes false and hence remaining expression will not be evaluated. False `&&(anything  $\geq$  False)` where anything will not be evaluated

Q.52)

Subject: Data Structures

Max Marks: 2



### Which of the following statements is/are False?

- Consider a hash table storing  $n$  items in  $m$  slots, with collisions resolved by chaining. Assume simple uniform hashing. Then SEARCH has expected running time  $O(1)$ .
- Consider a hash table storing  $n$  keys in  $m$  slots, with resolutions resolved by chaining, and hash function  $h(k) = ((k^2 + 3) \bmod 8) \bmod m$ . Then DELETE has expected running time  $\Theta(n/m)$ .

**A** Only I

**B** Only II

**C** Both I and II

Correct Option

**Solution:** (C)

Solution:

- False. Search requires finding the position of the element in the hash table ( $O(1)$ ), and then looking through the length of the chain at that location  $n$ . This yields an overall runtime (under uniform hashing, expected  $O(\alpha) = O(n/m)$  for search of  $O(1 + n/m)$ ). The previous expression only reduces to  $O(1)$  if  $n = \Theta(m)$ . For example, if  $n = \Theta(m^2)$ , then Search is expected-time  $O(n)$ .
- False. Because we're taking mod 8, there are a constant number of possible hash values (in particular, there are 3 possible values of  $k^2 + 3 \bmod 8$ ). For this reason, the expected number of values in each slot will be  $n/3$ , which makes the runtime of DELETE  $\Theta(n)$ .

**D** Neither I nor II

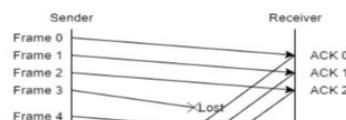
Q.53)

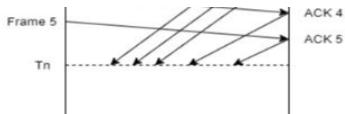
Subject: Computer Networks

Max Marks: 2



The sliding window protocol using the selective repeat ARQ where the sequence bits for the sequence number is 4 bits. The size of a sender and receiver window is 6. Consider the below figure what will be the position of the sender and receiver window at the time  $T_n$  amongst the following options?





A

SW = 

0	1	2	3	4	5
6	7	8			

 RW = 

0	1	2			
3	4	5	6	7	8
9	10				

Correct Option

**Solution:** (A)**Explanation:**

The size of sender and receiver window is the same in selective repeat protocol

$$SWS = RWS \leq 2^{(m-1)}$$

Here m = sequence bits = 4

So sequence numbers = 0 to 15

$$WS = 6$$

At time  $T_n$  sender has received the ACK for 0,1,2,4,5 frame

After  $T_n$ , the sender window will slide 0,1,2 that's why Option C is wrong.

The receiver window can slide after immediately sending the ACK's

Option b is wrong because after sending ACKs the receiver window is still constant.

B

SW = 

0	1	2	3	4	5
6	7	8	9		

RW = 

0	1	2	3	4	5
6	7	8	9		

C

SW = 

0	1	2			
3	4	5	6	7	8
9	10				

RW = 

0	1	2			
3	4	5	6	7	8
9	10				

D

None of the above

Q.54)

Consider an undirected graph  $G_4$  in which the weights of the edges are given by defined as  $e_{ij} = |2*i - 3*j|$  where  $i < j$  and  $|x|$  stands for the absolute value of x. If Floyd Warshall algorithm is applied on  $G_4$  to determine the weight shortest weight in between all pairs of vertices, the determinant of the matrix which is represented as  $D^2$  is \_\_\_\_\_. (Where  $D^i$  represents the cost of the matrix which has the shortest path in between all the vertices including vertices up to the  $i^{\text{th}}$  vertex.)

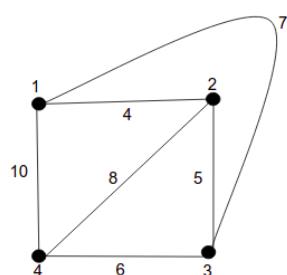
Subject: Algorithms

Max Marks: 2

Correct Answer

**Solution:** (-4476)**Solution -4476**

As per the description of the graph  $G_4$ , it looks as follows



$D^0$  is the same as the adjacency matrix of the above graph.

$D^0/\text{Vertex}$	1	2	3	4
1	0	4	7	10
2	4	0	5	8
3	7	5	0	6
4	10	8	6	0

4 | 10 | 8 | 0 | 0

$D^1$  and  $D^2$  are also identical to  $D^0$ , as there is no improvement by introducing the vertex 1 and vertex 2 in the shortest path, therefore  $|D^2|=|D^0|=4476$ .

Q.55)

Which of the following is/are decidable

- I.  $EQ_{DFA\_RE} = \{<D, R> \mid D \text{ is a DFA and } R \text{ is a regular expression and } L(D) = L(R)\}$
- II.  $A_{CFG} = \{<G> \mid G \text{ is a CFG that generates } \epsilon\}$
- III.  $ALL_{DFA} = \{<A> \mid A \text{ is a DFA that recognizes } \Sigma^*\}$

A I and II Only

B II and III Only

C III and I Only

D I, II and III

Subject: Theory of Computation, Compiler Design

Max Marks: 2



Solution: (D)

Explanation:

$EQ_{DFA\_RE} = \{<D, R> \mid D \text{ is a DFA and } R \text{ is a regular expression and } L(D) = L(R)\}$  Decidable

$A_{CFG} = \{<G> \mid G \text{ is a CFG that generates } \epsilon\}$  Decidable

$ALL_{DFA} = \{<A> \mid A \text{ is a DFA that recognizes } \Sigma^*\}$  Decidable

Correct Option

#### EQ<sub>DFA</sub>\_RE

We know that  $EQ_{DFA} = \{<A, B> \mid A \text{ and } B \text{ are DFAs and } L(A) = L(B)\}$  is decidable. Let M be a Turing machine that decides this language.

We construct a new TM M0 that uses M to decide  $EQ_{DFA\_RE}$  as follows:

M0 = “On input  $<D, R>$ , where D is a DFA and R is a regular expression:

1. Convert R to an equivalent DFA A by using the procedure for this conversion Theorem.
2. Run M on  $<D, A>$ .
3. If M accepts, accept; if M rejects, reject.” Since M accepts iff  $L(D) = L(A)$ , and since  $L(A) = L(R)$  this procedure is correct.

#### $A_{CFG}$

$A_{CFG} = \{<G> \mid G \text{ is a CFG that generates } \epsilon\}$

Solution: We know that  $A_{CFG} = \{<G, w> \mid G \text{ is a CFG that generates input string } w\}$  is decidable.

Let M be a Turing machine that decides this language. We can obviously construct a TM M0 that decides  $A_{CFG}$  as follows: M0 = “On input  $<G>$ , where G is a CFG:

1. Run M on  $<G, \epsilon>$ .
2. If M accepts, accept; if M rejects, reject.”

#### $ALL_{DFA}$ :

$ALL_{DFA} = \{<A> \mid A \text{ is a DFA that recognizes } \Sigma^*\}$

Solution: A DFA A recognizes  $\Sigma^*$  iff all states that are reachable from the initial state are goal states. This can easily be checked by a Turing machine. Alternatively, we can use that  $EQ_{DFA}$  is decidable. Let M be a TM that decides this language. We can obviously construct a TM M0 that decides  $ALL_{DFA}$  as follows: M0 = “On input  $<A>$ , where A is a DFA:

1. Create a DFA B that consists only of the initial state  $q_0$  which is a goal state. For each symbol of the alphabet there is a transition from  $q_0$  to  $q_0$ .
2. Run M on  $<A, B>$ .
3. If M accepts, accept; if M rejects, reject.” M0 decides  $ALL_{DFA}$ : M accepts iff  $L(A) = L(B)$ , and by construction  $L(B) = \Sigma^*$ .

Q.1)

Choose the most appropriate option on the basis of the given relationship.

Subject: General Aptitude

Max Marks: 1



Absent: present ::

A

pre: post

B

late: early

Correct Option

Solution: (B)

Solution: 'Absent' and 'Present' are antonyms. Similarly, 'late' and 'early' are synonyms. Option (a) is close, but since they are not complete words but prefixes, we will choose option (b).

C

monday: Sunday

D

swimming: walking

Q.2)

Choose the odd one out of the following

Allegory, parody, joke, lampoon

Subject: General Aptitude

Max Marks: 1

A

Allegory

Correct Option

Solution: (A)

Solution:

'Allegory' does not belong to the group. 'Allegory' means a story, poem, or picture that can be interpreted to reveal a hidden meaning, etc. 'Parody' means humorous, exaggerated imitation of an author, literary work, style, etc., 'joke' and 'lampoon' means a satirical attack on a person, they are all types of comedy.

B

Parody

C

Joke

D

Lampoon

Q.3)

Select the correct alternative to the given sentence below having the same meaning.

To show the white feather :

Subject: General Aptitude

Max Marks: 1

A

To show signs to cowardice

Correct Option

Solution: (A)

Solution: The given sentence is a phrase and the meaning of the phrase is behaving in a cowardly fashion.

B

To seek peace

C

To show arrogance

D

To become polite

Q.4)

It is given that average for any 46 numbers is 0. Among the 46 numbers how many numbers at most shall be more than 0.

Subject: General Aptitude

Max Marks: 1

A

0

B

23

C

45

Correct Option

Solution: (C)

Solution: At most 45 numbers can be more than 0.

Let's consider that the sum of all the 45 numbers be  $p$ .

The 26<sup>th</sup> number be  $-p$ .

Hence the average of the numbers will be  $\frac{p + (-p)}{46} = 0$

D

1

Q.5)

Find out the number of members in each of the two teams participated in a gaming event by the following information provided. ₹ 2,16,000 was the prize money won by the both teams comprising of total 36 members.

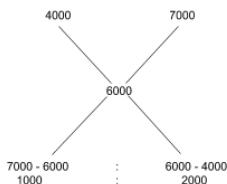
Subject: General Aptitude

Max Marks: 1

₹ 4,000 was awarded to each of the members of team entity and ₹ 7,000 was awarded to each of the members of team soul.

**Solution:** (A)

**Solution:** Average prize money received =  $\frac{216000}{36} = ₹ 6,000$



Ratio between the members of Team Entity to Team Soul =  $1000 : 2000 = 1 : 2$

Therefore, number of members in Team Entity =  $36 * \frac{1}{3} = 12$

Number of members of Team Soul =  $36 * \frac{2}{3} = 24$

**B** 18, 18**C** 20, 16**D** None of these**Q.6)**

Eshita plans to invest her savings of ₹ 25,000 for 5 years at 8% p.a.

Interest compounded annually. The income tax is deducted on the interest she earns on this investment at the rate of 15% at the end of every year.

What is the amount she can expect will get at the end of 5 years?

Subject: General Aptitude

Max Marks: 2

**A** 33,793.75**B** 34,725

Correct Option

**Solution:** (B)

**Solution:** We will first calculate the net rate of interest, i.e., after deducting the income tax.

The given rate of interest is 8%.

Income tax is charged 15%, so the amount left after income tax charged is 85%.

Hence, the net rate of interest will be  $85\% \text{ of } 8\% = 6.8\%$

Now we can calculate the amount she can expect by investing ₹ 25,000 for 5 years will be

$$\begin{aligned}
 A &= P(1 + \frac{r}{100})^n \\
 \Rightarrow A &= 25000(1 + \frac{6.8}{100})^5 \\
 \Rightarrow A &= 25000(1 + 0.068)^5 \\
 \Rightarrow A &= 25000 * 1.389 \\
 \Rightarrow A &= ₹ 34,725
 \end{aligned}$$

**C** 27,931.25**D** 33,756

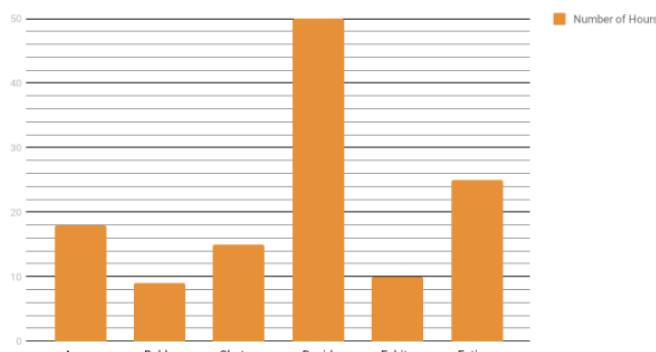
Subject: General Aptitude

Max Marks: 2

**Q.7)**

The following graph represents the number of hours taken by each of the mentors to finish their task of preparing questions for scholarship test. Tushar and Vinod are the new interns. Tushar's work efficiency is twice of Vinod. If they are working together then they can finish the work in exactly the same time taken by Chetan, Eshita and Bablu working together. How much time will Tushar take to complete the work alone?

Points scored



5.4 hrs

Correct Option

**Solution:** (A)

**Solution:** Let the number of hours taken by Tushar to complete the work alone be  $x$  hrs

Then the time taken by Vinod =  $2x$  hrs

Therefore as per the question we can say that,

$$\frac{1}{x} + \frac{1}{2x} = \frac{1}{9} + \frac{1}{10} + \frac{1}{15}$$

$$\Rightarrow \frac{3}{2x} = \frac{10+9+6}{90}$$

$$\Rightarrow 25 * 2x = 90 * 3$$

$$\Rightarrow x = \frac{90*3}{25*2}$$

$$\Rightarrow x = 5.4 \text{ hrs}$$

B

30 hrs

C

11.33 hrs

D

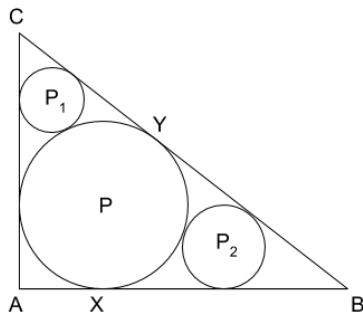
None of the above

Q.8)

In the figure given below  $\triangle ABC$  is a right angled triangle with  $\angle A = 90^\circ$ . The center of the incircle of the given triangle is  $P$ . Circles with centers  $P_1$  having radius  $r_1$  and  $P_2$  having radius  $r_2$  touch the circle and two sides as shown in the figure below. If the radius of the incircle of  $\triangle ABC$  is 1 cm and  $YC : YB = 2 : 3$ , then find the value of  $r_1 : r_2$ .

Subject: General Aptitude

Max Marks: 2



A

$$\frac{(33-11\sqrt{5}-6\sqrt{10}+10\sqrt{2})}{18}$$

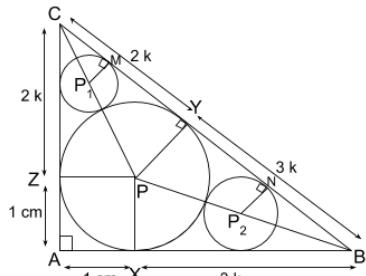
B

$$\frac{(33+11\sqrt{5}-6\sqrt{10}-10\sqrt{2})}{18}$$

C

$$\frac{(33-11\sqrt{5}-6\sqrt{10}-10\sqrt{2})}{18}$$

Correct Option

**Solution:** (C)**Solution:**Let  $CY = CZ = 2k$  $YB = XB = 3k$ 

$$\text{In } \triangle ABC \quad (2k+1)^2 + (3k+1)^2 = (2k+3k)^2$$

$$\Rightarrow 4k^2 + 1 + 4k + 9k^2 + 1 + 6k = 4k^2 + 9k^2 + 12k$$

$$\Rightarrow 12k - 10k = 2$$

$$\Rightarrow k = 1$$

So  $CY = CZ = 2 \text{ cm}$  $YB = XB = 3 \text{ cm}$  $AB = 1 + 3 = 4 \text{ cm}$  $AC = 1 + 2 = 3 \text{ cm}$  $CB = 2 + 3 = 5 \text{ cm}$

$$PB = \sqrt{3^2 + 1^2} = \sqrt{10} \text{ cm}$$

$$PC = \sqrt{2^2 + 1^2} = \sqrt{5} \text{ cm}$$

In the figure above we can see that

$$P_1M \perp CY, P_2N \perp YB$$

In  $\triangle PYC$  and  $\triangle P_1MC$ :

$$\frac{P_1M}{PY} = \frac{P_1C}{PC}$$

$$\Rightarrow \frac{r_1}{1} = \frac{PC - (r_1 + 1)}{PC}$$

$$\Rightarrow r_1 = \frac{\sqrt{5} - (r_1 + 1)}{\sqrt{5}}$$

$$\Rightarrow \sqrt{5} r_1 = \sqrt{5} - r_1 - 1$$

$$\Rightarrow \sqrt{5} r_1 + r_1 = \sqrt{5} - 1$$

$$\Rightarrow r_1(\sqrt{5} + 1) = \sqrt{5} - 1$$

$$\Rightarrow r_1 = \frac{\sqrt{5} - 1}{\sqrt{5} + 1}$$

Similarly we can say that,

$$r_2 = \frac{\sqrt{10} - 1}{\sqrt{10} + 1}$$

$$\text{Therefore, } \frac{r_1}{r_2} = \frac{\sqrt{5} - 1}{\sqrt{5} + 1} * \frac{\sqrt{10} + 1}{\sqrt{10} - 1} = \frac{(\sqrt{5} - 1)(\sqrt{5} - 1)}{(\sqrt{5} + 1)(\sqrt{5} - 1)} * \frac{(\sqrt{10} + 1)(\sqrt{10} + 1)}{(\sqrt{10} - 1)(\sqrt{10} + 1)}$$

$$\Rightarrow \frac{r_1}{r_2} = \frac{(\sqrt{5} - 1)^2}{5 - 1} * \frac{(\sqrt{10} + 1)^2}{10 - 1}$$

$$\Rightarrow \frac{r_1}{r_2} = \frac{(5 - 1 - 2\sqrt{5})}{4} * \frac{(10 + 1 + 2\sqrt{10})}{9}$$

$$\Rightarrow \frac{r_1}{r_2} = \frac{2(3 - \sqrt{5})}{4} * \frac{(11 + 2\sqrt{10})}{9}$$

$$\Rightarrow \frac{r_1}{r_2} = \frac{(3 - \sqrt{5})(11 + 2\sqrt{10})}{18}$$

$$\Rightarrow \frac{r_1}{r_2} = \frac{33 + 6\sqrt{10} - 11\sqrt{5} - 10\sqrt{2}}{18}$$

**D**

$$\frac{33 + 6\sqrt{10} - 11\sqrt{5} - 10\sqrt{2}}{18}$$

Subject: General Aptitude

Max Marks: 2

Q.9)

Make a meaningful paragraph out of the given sentences below.

- A. But in the industrial era destroying the enemy's productive capacity means bombing the factories which are located in the cities.
- B. So in the agrarian era, if you need to destroy the enemy's productive capacity, what you want to do is burn his fields, or if you're really vicious, salt them.
- C. Now in the information era, destroying the enemy's productive capacity means destroying the information infrastructure.
- D. How do you do battle with your enemy?
- E. The idea is to destroy the enemy's productive capacity and depending upon the economic foundation, that productive capacity is different in each case.
- F. With regard to defense, the purpose of the military is to defend the nation and be prepared to do battle with its enemy.

**A**

FDEBAC

Correct Option

Solution: (A)

Solution:

The given passage is basically about the purpose of the military with regard to defending from and attacking an enemy. After reading the given sentences, we can say that sentence E tells us the purpose of military for defense, whereas, sentences A, B, and C tell ways of battling with the enemy and these are the answers put forward in the question in sentence D (hence A, B, and C are bound to come after D), so we can say that sentences A, B, C, and D form a part of the paragraph, whereas F forms another part. So, the paragraph can either start with D or F (F forms a part of the sentence in itself as it is talking about something very different from the rest of the sentences, so it will either come in the beginning or in the end to form a paragraph which has a sequential order of information). As we have already said that F and D, & A, B, and C are two parts of a paragraph, so the probable beginnings are FD or DF. Now, we just have to decide the correct order between A, B and C to reach a unique option. Sentence A tells how to battle in the industrial era, B informs about battling in the agrarian era; whereas C talks say the way of battling an enemy in the present era. Hence, we just have to arrange these three sentences in terms of their respective time periods, which is called time sequencing. The industrial era came after the agrarian or agricultural era, and both of these belong to the past i.e. are not of the present, therefore the logical order is BAC.

**B**

FCABED

**C**

DEBACF

**D**

DFEBAC

Subject: General Aptitude

Max Marks: 2

Q.10)

Ritwik started walking from Financial District towards Mehdipatnam and at the same time Abdul started walking from Mehdipatnam towards Financial District. Ritwik's walking speed is  $\frac{4}{3}$  of Abdul's walking speed. Ritwik and Abdul met each other at Tolichowki and after the meeting Ritwik took  $\frac{9}{4}$  hr to reach Mehdipatnam. What is the time taken by Abdul to reach Financial District after meeting Ritwik?

**A**

3 hr

Correct Option

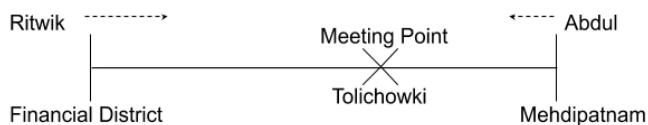
**B**

4 hr

Correct Option

**Solution:** (B)

**Solution:**



We will assume any random speed for Abdul say  $3 \text{ kmph}$ , then the speed of Ritwik will be  $3 * \frac{4}{3} = 4 \text{ kmph}$

Let the distance between Financial District and Medipatnam be  $x \text{ km}$ .

Distance between Tolichowki and Mehdipatnam =  $\frac{9}{4} * 4 = 9 \text{ km}$ .

Therefore the distance between Financial District and Tolichowki =  $(x - 9) \text{ km}$

We can say that the time they took to reach Tolichowki was the same, we get,

$$\frac{x-9}{4} = \frac{9}{3}$$

$$\Rightarrow \frac{x-9}{4} = 3$$

$$\Rightarrow x = 12 + 9$$

$$\Rightarrow x = 21 \text{ km}$$

Therefore Distance between Tolichowki and Financial District =  $21 - 9 = 12 \text{ km}$

Time Taken by Abdul to Travel from Tolichowki to Financial District =  $\frac{12}{3} = 4 \text{ hr}$

c

3.5 hr

d

3.7 hr

close