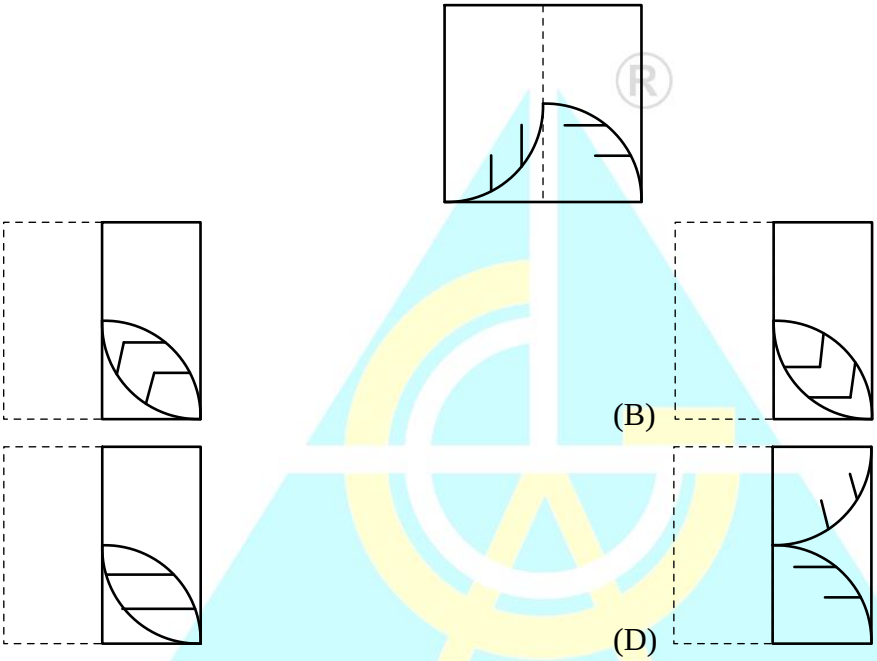
General Aptitude

**Question 1.** **MCQ (1M)**

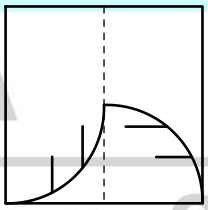
**Question ID : 8232513092**

A transparent square sheet shown above is folded along the dotted line. The folded sheet will look like_____

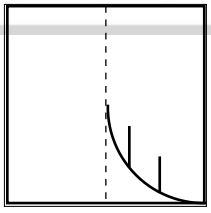



**Ans. (A)**

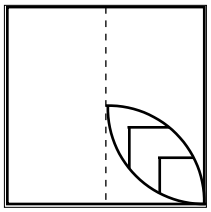
**Sol.** Given:



Mirror image of the left part of given image is



After combining both we get,



**Question 2.** **MCQ (1M)**

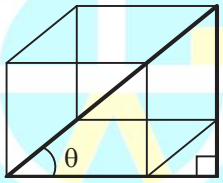
**Question ID : 8232513093**

If $\theta$ is the angle, in degree, between the longest diagonal of the cube and any one of the edges of the cube, then $\cos\theta =$

(A) $\frac{1}{\sqrt{3}}$ (B) $\frac{1}{\sqrt{2}}$ (C) $\frac{1}{2}$ (D) $\frac{\sqrt{3}}{2}$

**Ans.** **(A)**

**Sol.**




$\because \quad \cos\theta = \frac{\text{Adjacent side}}{\text{Hyp}}$

$\because$ Diagonal of a cube $= \sqrt{3}a$

Adjacent side = Each side = $a$

$\therefore \quad \cos\theta = \frac{a}{a\sqrt{3}} = \frac{1}{\sqrt{3}}$

**Question 3.** **MCQ (2M)**

**Question ID : 8232513098**

The number of students in three classes is in the ratio 3 : 13 : 6. If 18 students are added to each class, the ratio changes to 15 : 35 : 21.

The total number of students in all the three classes in the beginning was:

(A) 110 (B) 66 (C) 22 (D) 88

**Ans.** **(D)**

**Sol.** **Given :**

The ratio of number of students of three classes is $= 3:13:6$

Let the number of students in each class is $3x, 13x, 6x$

Therefore the ratio will become $3x:13x:6x$

After implementing the given condition,

$3x+18=15y$ …(i)

$13x+18=35y$

$x+18=21y$ …(ii)

$2\times3x+18\times2=15y\times2$

$6x+18=21y$

$6x+36=30y$

$6x+18=21y$

$x=4 \qquad y=2$

$\therefore$ The total number students in all the three classes in the beginning

$=22x=22\times4=88$

**Question 4.** **MCQ (1M)**

**Question ID : 8232513095**

Pen: Write :: Knife :_____

Which one of the following options maintains a similar logical relation in the above.

(A) Sharp (B) Cut (C) Blunt (D) Vegetables.

**Ans.** **(B)**

**Sol.** **Given:** relation is object and its purpose

Pen is used to Write,

Similarly, Knife is used to Cut.

**Question 5.** **MCQ (1M)**

**Question ID : 8232513094**

If $\left(x-\frac{1}{2}\right)^2-\left(x-\frac{3}{2}\right)^2=x+2$, then value of x is.

(A)6 (B) 4 (C) 8 (D) 2

**Ans.** **(B)**

**Sol.** **Given:**

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

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

$2x-2=x+2$

$\therefore \quad x=4$

**Question 6.** **MCQ (1M)**

**Question ID : 8232513091**

Gauri said that she can play the keyboard ___her sister.

(A) As worse as (B) As nicest as

(C) As better as (D) As well as

**Ans.** **(D)**

**Sol.** The structure as…as is used to compare things that are of similar proportion. In this case the first as acts as an adverb modifying the adjective or adverb that goes after it. The second as can act as a preposition or conjunction. If it is used as a preposition, it will be followed by a noun or pronoun.

"As X as" is a comparison of equals.

"Better than" is not.

Therefore, better, worse, nicest can not be used in equality comparison.

**Question 7.** **MCQ (2M)**

**Question ID : 8232513100**

Six students $P, Q, R, S, T$ and $U$ with distance height, compare their heights and make the following observations.

Observation I: S is taller than $R$

Observation II: $Q$ is shorter of all

Observation III: $U$ is taller than only 1 student

Observation IV: $T$ is taller than $S$ but is not tallest

The number of students that are taller than $R$ is the same as number of student shorter than_____.

(A) T (B) R (C) S (D) P

**Ans.** **(C)**

**Sol.** **Given:**

S is taller than $R$ S > R

$Q$ is shorter of all > > Q

$U$ is taller than only 1 student U > □

$T$ is taller than $S$ but is not tallest □ > T > S

Combining all drafted information & make possible case.

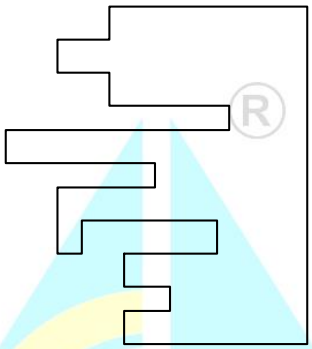
1- P
2- T
3- S
4- R

5- U
6- Q

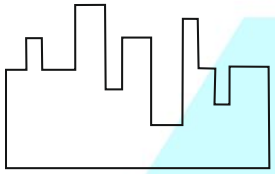
Hence it is clear that the numbers of students taller then R is the same as the numbers of students shorter than S.

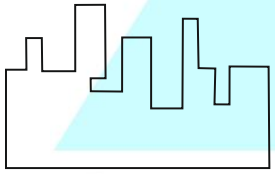
**Question 8.** **MCQ (2M)**

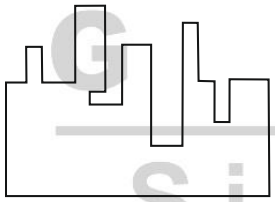
**Question ID : 8232513097**

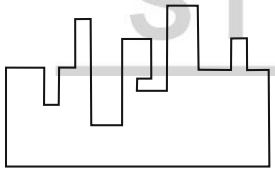


A jigsaw puzzle has 2 pieces. One of the pieces is shown above. Which one of the given options for the missing piece when assembled will form a rectangle? The piece can be moved, rotated or flipped to assemble with the above piece.

(A)


(B)


(C)


(D)


**Ans.** **(B)**

**Sol.** For assembling the 2 pieces to form a rectangle,

First; flip the figure to left side and rotate it to $90^0$ clock wise direction and assume to put it on question figure.

Hence, the correct option is (B).

**Question 9.** **MCQ (2M)**

**Question ID : 8232513096**

Listening to music during exercise improves exercise performance and reduces discomfort. Scientists researched whether listening to music while studying can help students learn better and the results were inconclusive. Students who needed external stimulation for studying fared worse while students who did not need any external stimulation benefited from music.

Which one of the following statements is the CORRECT inference of the above passage?

(A) Listening to music has a clear positive effect on physical exercise. Music has a positive effect on learning only in some students.

(B) Listening to music has a clear positive effect both on physical exercise and on learning.

(C) Listening to music has a clear positive effect on learning in all students. Music has a positive effect only in some students who exercise.

(D) Listening to music has no effect on learning and a positive effect 011 physical exercise.

**Ans.** **(A)**

**Sol.** **Given:**

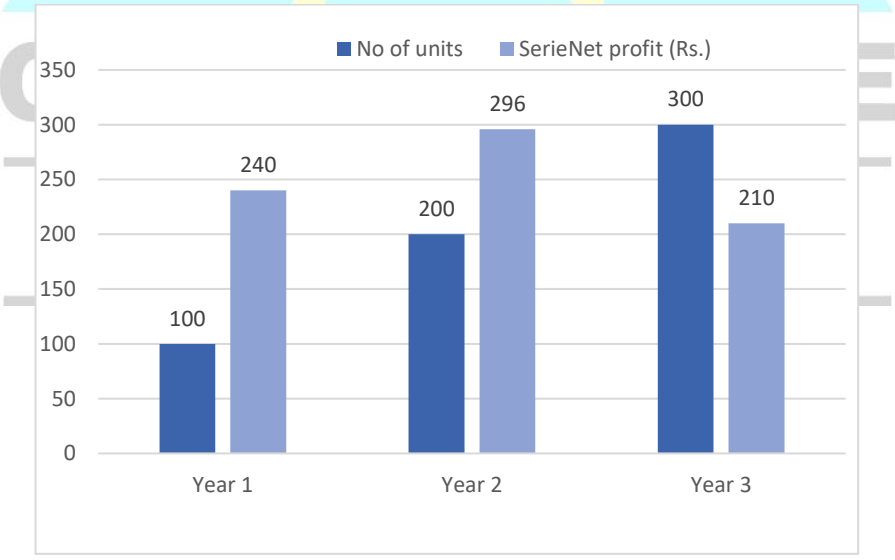
Listening to music during exercise improves exercise performance and reduces discomfort.

Effect of music on students depends on the type of students.

Therefore, listening to music has a clear positive effect on physical exercise. Music has a positive effect on learning only in some students.

**Question 10.** **MCQ (2M)**

**Question ID : 8232513099**




The number of units of a product sold in three different years and the respective net profits are presented in the figure above. The cost/unit in Year 3 was Rs.1, which was half the cost/unit in Year 2.

The cost/unit in Year 3 was one-third of the cost/unit in Year 1. Taxes were paid on the selling price at 10%. 13% and 15% respectively for the three years. Net profit is calculated as the difference between the selling price and the sum of cost and taxes paid in that year.

The ratio of the selling price in Year 2 to the selling price in Year 3 is_____

(A) 3 : 4 (B) 1 : 1

(C) 1 : 2 (D) 4 : 3

**Ans.** **(D)**

**Sol.** **Given :**

cost per unit of year 3 = Rs.1

and Cost per unit of year 3 = (cost per unit of year 2)/2

So, cost per unit of year 2 = 2*cost per unit of year 3 = 2*1 = 2.

Let selling price of year 2 = sp2 and selling price of year 3 = sp3.

we have taxes in year 2 and 3 as 13% and 15% of selling price respectively.

Tax in year 2 = 13*sp2/100 =.13*sp2

Tax in year 3 = 15*sp3/100 = 0 .15*sp3

profit in year 2 = selling price in year 2−(cost of all units +tax in year 2)

296 = sp2−(200*2+0.13*sp2)

296 = sp2−400−0.13sp2

296+400 = 0.87*sp2

696*100/87 = sp2

sp2 = 800.

profit in year 3 = selling price in year 3−(cost of all units +tax in year 3)

210 = sp3−(300*1+0.15*sp3)

210 = sp3−300−0.15sp3

210+300 = 0.85*sp3

510*100/85 = sp3

sp3 = 600.

Ratio of selling price in year 2 to selling price in year 3

= 800/600

= 4/3

Technical Section

**Question 11.** **NAT (1M)**

**Question ID : 8232513123**

Consider the following ANSI C function:

```
int SomeFunction (int x, int y)
{
    if (x == 1) || (y == 1)) return 1;
    if (x == y) return x;
    if (x > y) return SomeFunction(x - y, y);
    if (y > x) return SomeFunction(x, y - x);
}
```

The value returned by SomeFunction(15, 255) is _____

**Ans.** **15**

**Sol.** **Given:**

```
int SomeFunction (int x, int y)
{
    if (x == 1) || (y == 1)) return 1;          ...(1)
    if (x == y) return x;                       ...(2)
    if (x > y) return SomeFunction(x - y, y);   ...(3)
    if (y > x) return SomeFunction(x, y - x);   ...(4)
}
```

Now, after calling

SomeFunction(15, 255)

{255 > 15} Therefore line (3) will execute.

↳ SomeFunction(15, 240)

{240 > 15} Therefore line (3) will execute.

↳ SomeFunction(15, 225)

{225 > 15} Therefore line (3) will execute.

↳ SomeFunction(15, 210)

{210 > 15} Therefore line (3) will execute.

⋮

SomeFunction(15, 15)

{15 == 15} Therefore line (2) will execute.

Hence the function call will return 15

**Question 12.** **NAT (2M)**

**Question ID : 8232513149**

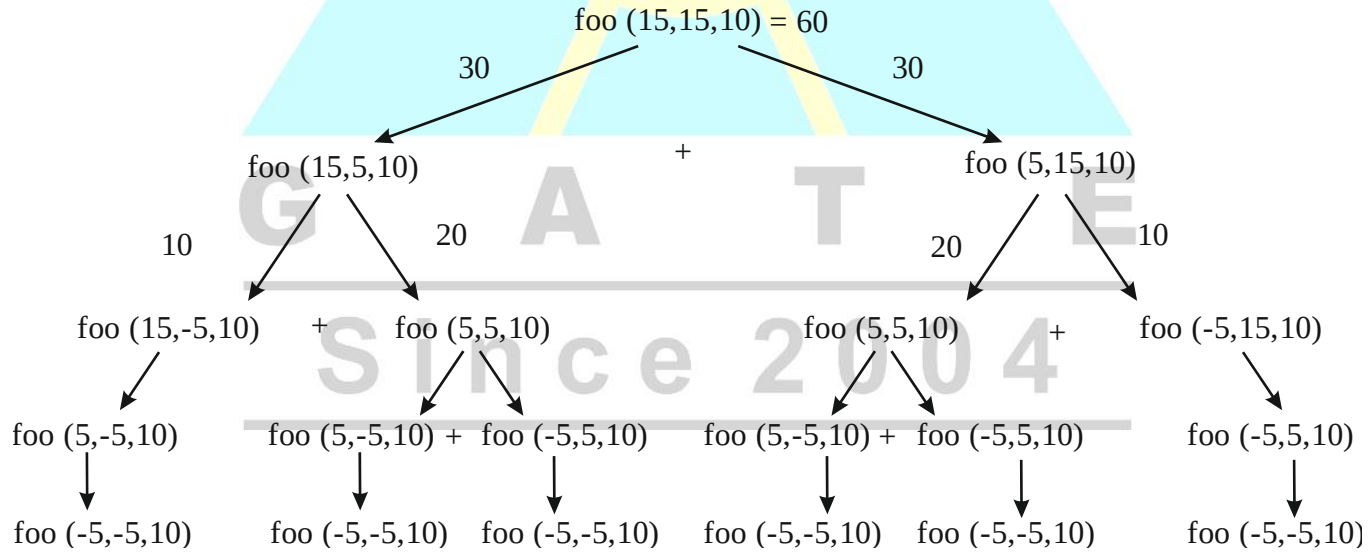
Consider the following ANSI C program.

```
#include <stdio.h>
int foo(int x, int y, int q)
{if ((x <= 0) && (y <= 0))
        return q;
    if (x <= 0)
        return foo(x, y-q, q);
    if (y <= 0)
        return foo(x-q, y, q);
        return foo(x, y-q, q) + foo(x-q, y,q)
int main()
{
    int r = foo(15,15,10);
    printf ("'/.d", r) ;
    return 0;
    }
```

The output of the program upon execution is _____

**Ans.** **60**

**Sol.**



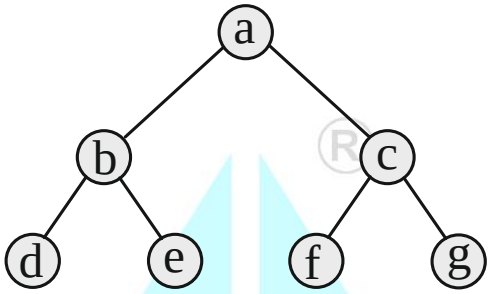

**Question 13.** **NAT (1M)**

**Question ID : 8232513116**

Consider a complete binary tree with 7 nodes. Let A denote the set of first 3 elements obtained by performing BFS starting from root. Let B denote the set of 3 elements obtained by performing DFS state starting from root. The value of $|A-B|$ is_____

**Ans** **1**

**Sol.** consider the following complete binary tree




A = set of first 3 elements obtained by BFS

A = {a, b, c}

B = set of first 3 elements obtained by DFS

B = {a, b, d}

A – B = {c}

| A – B| = 1

**Question 14.** **MCQ (2M)**

**Question ID : 8232513135**

Consider the following ANSI C program:

```
#include <stdio.h>
#include <stdlib.h>
struct Node{
int value;
struct Node *next;};
int main(){
struct Node *boxE, *head, *boxN; int index = 0;
boxE = head = (struct Node *) malloc(sizeof(struct Node));
head->value = index;
for (index = 1; index <= 3; index++)
{
        boxN = (struct Node *) malloc(sizeof(struct Node));
        boxE->next = boxN;
        boxN->value = index;
        boxE = boxN; }
for (index = 0; index <= 3; index++) {
```

printf ("Value at index %d is %d\n", index, head->value);

head = head->next;

printf ("Value at index %d is %d\n", index+1, head->value); } }

Which one of the statements below is correct about the program?

(A) Upon execution, the program goes into an infinite loop.

(B) It has a missing return which will be reported as an error by the compiler.

(C) Upon execution, the program creates a linked-list of five nodes.

(D) It dereferences an uninitialized pointer that may result in a run-time error.

**Ans.** **(D)**

**Sol.** The linked list of four nodes will be created.

First node: value = 0

Second node : value = 1

Third node : value = 2

Fourth node : value = 3

The last for loop will print the index number and the values

In the last iteration when index = 3

head = head-> next // typing to access the unknown memory location because the fifth node is not there.

Hence the segmentation fault or run time error will come here.

**Question 15.** **MCQ (1M)**

**Question ID : 8232513102**

Let H be a binary min-heap consisting of n elements implemented as an array. What is the worst case time complexity of an optimal algorithm to find the maximum element in *H*?

(A) $\Theta(\log n)$

(B) $\Theta(1)$

(C) $\Theta(n \log n)$

(D) $\Theta(n)$

**Ans.** **(D)**

**Sol.** In a min heap maximum element is present at leaf node we need to navigate through the leaf node i.e. n/2 node Hence O(n).

**Question 16.** **MCQ (1M)**

**Question ID : 8232513110**

Consider the following ANSI C program:

int main( )

```
{ int a[4][5];
int i, j;
for (i = 0; i < 4; i++)
for (J = 0; j < 5; j++)
a[i][j] = 10 * i + j;
printf ("%d",*(a[1] + 9));}
```

Find the output of the above problem

**(A)** 20 **(B)** 24 **(C)** 30 **(D)** 14

**Ans.** **(B)**

**Sol.** After the execution of program the content of the array will be

| | [0] | [1] | [2] | [3] | [4] |
|---|---|---|---|---|---|
| [0] | 0 | 1 | 2 | 3 | 4 |
| [1] | 10 | 11 | 12 | 13 | 14 |
| [2] | 20 | 21 | 22 | 23 | 24 |
| [3] | 30 | 31 | 32 | 33 | 34 |

*(a[1] + 9) = a[2][4] = 24

**Question 17.** **MCQ (2M)**

**Question ID : 8232513126**

Consider string aabbccddeee . Each letter of a string must be assigned a binary code satisfying the following properties.

1. For any two letters the code to one letter must be a prefix of code assigned to another letter.
2. For any two letters of the same frequency , the letter which occurs earlier in the dictionary order is assigned a code whose length is at most the length of code assigned to another letter.

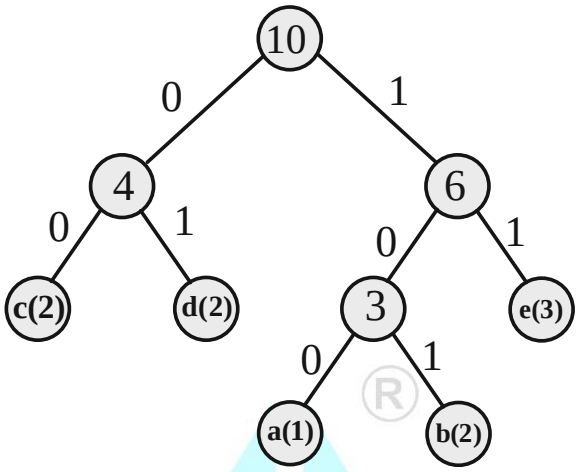
Among a set of all binary code assignments which satisfy above two properties. What is the length of the encoded string?

(A) 25 (B) 23

(C) 21 (D) 30

**Ans** **(B)**

**Sol.** Using Huffman Coding-




| Character | Frequency | Encoding |
|---|---|---|
| a | 1 | 100 |
| b | 2 | 101 |
| c | 2 | 00 |
| d | 2 | 01 |
| e | 3 | 11 |

Hence length of encode string is = 1*3+2*3+2*2+2*2+3*2 = 3+6+4+4+6 = 23

**Question 18.** **MCQ (2M)**

**Question ID : 8232513139**

For constants $a \geq 1$ and $b > 1$, consider the following recurrence defined on the non-negative integers:

$$T(n) = a \cdot T\left(\frac{n}{b}\right) + f(n)$$

Which of the following options is correct about the recurrence $T(n)$?

(A) if $f(n)$ is $\Theta(n^{\log_b(a)})$, then $T(n)$ is $\Theta(n^{\log_b(a)})$

(B) if $f(n)$ is $\Theta(n^{\log_b(a)-\varepsilon})$, for some $\varepsilon > 0$ then, $T(n)$ is $\Theta(n^{\log_b(a)})$

(C) if $f(n)$ is $\frac{n}{\log_2(n)}$, then $T(n)$ is $\Theta(\log_2(n))$

(D) if $f(n)$ is $n\log_2(n)$, then, $T(n)$ is $\Theta(n\log_2 n))$

**Ans.** **(B)**

**Sol.** If we take a = 2, b = 2, on applying extended master theorem A, C, D are false hence option B is correct.

**Question 19.** **MCQ (1M)**

**Question ID : 8232513101**

Let G be a connected undirected weighted graph consider the following to statements.

$S_1$. There exists a minimum edge weight in G which is present in every MST of G.

$S_2$. If every edge in G has distinct weights, then G has a unique MST.

Which of the following is true?

**(A)** $S_1$ is true and $S_2$ is false **(B)** $S_1$ is false and $S_2$ is true

**(C)** Both $S_1$ and II are true **(D)** Both $S_1$ and II are false

**Ans.** **(B)**

**Sol.** **Given:** G is a connected undirected weighted graph

By using Kruskal's algorithm to find MST, we sort the edges based on their weight and start selective edges from the smallest weight (w_small for example).
Problem with S1: If we have multiple copies of w_small, then a specific w_small weighted edge is not guaranteed to be selected by Kruskal.
S2 is Correct: If the sorted order of the edges contains only distinct values, the Kruskal algorithm will always select a unique set of edges resulting in an unique minimum spanning tree.

**Question 20.** **MCQ (1M)**

**Question ID : 8232513108**

What is the worst case number of arithmetic operations performed by recursive binary search on a sorted array of size n?

**(A)** $\Theta(n^2)$ **(B)** $\Theta(\log_2 n)$

**(C)** $\Theta(n)$ **(D)** $\Theta(\sqrt{n})$

**Ans.** **(B)**

**Sol.** The worst case occurs when we are searching for a key that is smaller than the smallest element of the array or larger than the largest element of the array.

**Question 21.** **NAT (2M)**

**Question ID : 8232513152**

Consider a Boolean function $f(w,x,y,z)$ such that

$f(w,0,0,z)$

$f(1,x,1,z) = x+2$

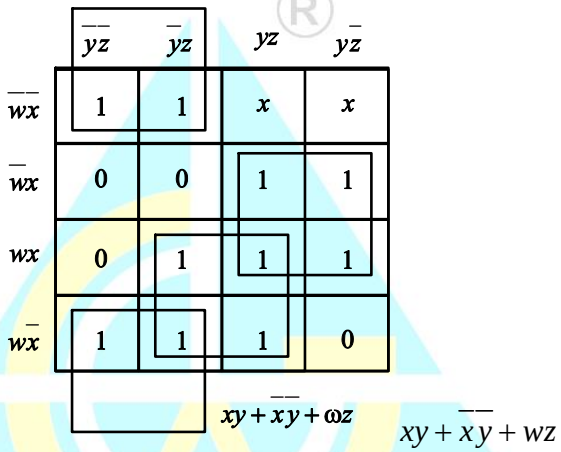
$f(w,1,y,z) = w2+y$

The number of literals in the minimal sum of products expression of f is _____.

**Ans.** **6**

**Sol.**

| $w$ | $x$ | $y$ | $z$ | $f$ |
|---|---|---|---|---|
| 0 | 0 | 0 | 0 | 1 |
| 0 | 0 | 1 | 0 | 1 |
| 0 | 0 | 1 | 1 | $x$ |
| 0 | 0 | 1 | 1 | $x$ |
| 0 | 1 | 0 | 0 | 0 |
| 0 | 1 | 0 | 1 | 0 |
| 0 | 1 | 1 | 0 | 1 |
| 0 | 1 | 1 | 1 | 1 |
| 1 | 0 | 0 | 0 | 1 |
| 1 | 0 | 0 | 1 | 1 |
| 1 | 0 | 1 | 0 | 0 |
| 1 | 0 | 1 | 1 | 1 |
| 1 | 1 | 0 | 0 | 0 |
| 1 | 1 | 0 | 1 | 1 |
| 1 | 1 | 1 | 0 | 1 |
| 1 | 1 | 1 | 1 | 1 |




Therefore, 6 literal are possible

**Question 22.** **NAT (1M)**

**Question ID : 8232513118**

If x and y are two decimal digits and $(0.1101)_2 = (0.8xy5)_{10}$, the decimal value of $x+y$ is

____

**Ans.** **3**

**Sol.**

$$(0.1101)_2$$

$$= 2^{-1} + 2^{-2} + 2^{-4}$$

$$= 0.0625 + 0.25 + 0.5$$

$$(0.8125)_{10}$$

$$x = 1$$

$$y = 2$$

$$x + y = 3$$

**Question 23.** **MCQ (2M)**

**Question ID : 8232513128**

Suppose we want to design a synchronous circuit that processes a string of 0's and 1's. Given a string, it produces another string by replacing the first 1 in any subsequence of consecutive 1's by a 0. Consider the following example.

Input sequence: 00100011000011100

Output sequence: 00000001000001100

A Mealy Machine is a state machine where both the next state and the output are functions of the present state and the current input.

The above mentioned circuit can be designed as a two-state Mealy machine. The states in the Mealv machine can be represented using Boolean values 0 and 1. We denote the current state, the next state, the next incoming bit, and the output bit of the Mealv machine by the variables s, t, b and y respectively. Assume the initial state of the Mealv machine is 0.

What are the Boolean expressions corresponding to t and y in terms of .s and b?

(A) $t = b$, $y = s\bar{b}$

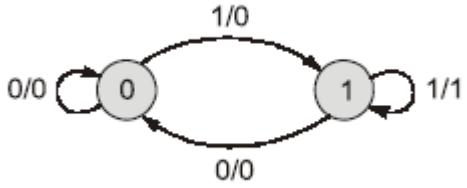
(B) $t = s + b$, $y = sb$

(C) $t = b$, $y = sb$

(D) $t = s + b$, $y = s\bar{b}$

**Ans. (C)**

**Sol.**




| Present State ($s$) | Next State ($t$) | O/P ($y$) |
|---|---|---|
| | $b = 0$ | $b = 1$ |
| 0 | 0,0 | 1,0 |
| 1 | 0,0 | 1,1 |

$t = \bar{s}b + sb = b$

$y = sb$

**Question 24.** **MCQ (1M)**

**Question ID : 8232513104**

The format of the single-precision floating-point representation of a real number as per the IEEE 754 standard is as follows:

| sign | exponent | mantissa |
|---|---|---|

Which one of the following choices is correct with respect to the smallest normalized positive number represented using the standard?

(A) exponent = 00000000 and mantissa = 00000000000000000000000

(B) exponent = 00000001 and mantissa = 00000000000000000000001

(C) exponent = 00000001 and mantissa = 00000000000000000000000

(D) exponent = 00000000 and mantissa = 00000000000000000000001

**Ans.** **(C)**

**Sol.** For smallest positives number, the value of sign bit, exponent, and mantissa will be

Sign bit $S = 0$

Exponent $E = 1 = 0000001$

Mantissa $M = 0 = 0.00$

Therefore, the number will be $+1.0$ to $2^{1-27} = 2^{-126}$

**Question 25.** **MSQ (2M)**

**Question ID : 8232513144**

If the numerical value of 2-byte unsigned integer on a little endian computer is 255 more than that on big endian computer, which of the following choice represent(s) the unsigned integer on a little endian

(A) $0 \times 4243$ (B) $0 \times 6665$ (C) $0 \times 0001$ (D) $0 \times 0100$

**Ans.** **(B), (D)**

**Sol.** (A) LE - 4243

=49161'3 + 2*16^2 + 4*16A1 + 3

= 16963 BE - 4342 = =4*16^3 + 3'161'2 + 416^1 + 2

= 17218 (incorrect)

(B) LE - 6665 = =6'161'3 + 6*16^2 + 6*16^1 + 5

= 26213 BE - 6566 –

=6*16^3 + 5*16^2 + 6*16^1 + 6

=25958 Difference

= 26213 - 25958 = 255 (correct)

(C) LE - 0001 - 1 BE - 0100 - 256 (larger hence incorrect)

(D) little endian

= 0100 = 16"2 = 256

Big endian = 0001 = 1 ,

difference = 256-1= 255 correct.

**Question 26.** **MSQ (2M)**

**Question ID : 8232513142**

Consider the following multi-threaded code segment (in a mix of C and pseudo-code), invoked by two processes P1 and P2, and each of the processes spawns two threads T1 and T2:

```
int x = 0;      // global
Lock L1;        // global
main() {
create a thread to execute foo();      // Thread T1
create a thread to execute foo();      // Thread T2
wait for the two threads to finish execution;
print (x);}

                foo() {
                    int y = 0;
                    Acquire L1;
                    x = x + 1;
                    y - y + 1;
                    Release L1;
                    print (y);}
```

Which of the following statement(s) is/are correct?

(A) At least one of P1 and P2 will print the value of x as 4.

(B) Both P1 and P2 will print the value of x as 2.

(C) At least one of the threads will print the value of y as 2.

(D) Both T1 and T2, in both the processes, will print the value of y as 1.

**Ans.** **(B), (D)**

**Sol.** Each process has its own address space.

1. P1:

   Two threads $T_{11}$,$T_{12}$ are created in main.

   Both execute foo function and threads don't wait for each other. Due to explicit locking mechanism here mutual exclusion is there and hence no race condition inside foo().

   y being thread local, both the threads will print the value of y as 1.

   Due to the wait in main, the print(x) will happen only after both the threads finish. So, x will have become 2.

   PS: Even if x was not assigned 0 explicitly in C all global and static variables are initialized to 0 value.

2. P2:

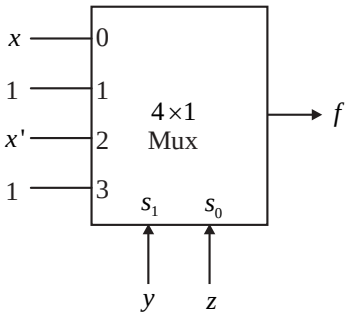
Same thing happens here as P1 as this is a different process. For sharing data among different processes mechanisms like shared memory, files, sockets etc must be used.

**Question 27.** **MCQ (1M)**

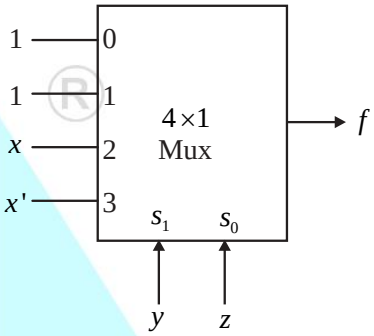
**Question ID : 8232513105**

Which one of the following circuits implements the Boolean function given below?

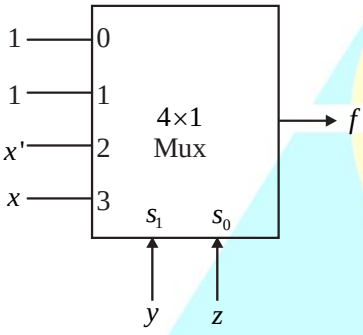
$f(x, y, z) = m_0 + m_1 + m_3 + m_4 + m_5 + m_6$, where $m_i$ is the $i^{th}$ minterm



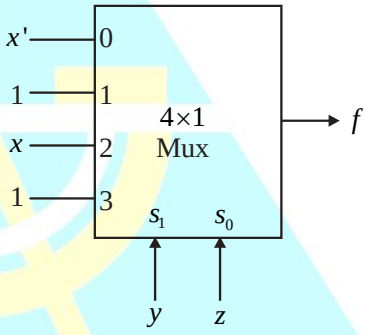

(A)




(B)




(C)




(D)

**Ans.** **(B)**

**Sol.** $\sum m = (0,1,3,4,5,6)$

| | $y_2$ | $y_2$ | $y_2$ | $y_2$ |
|---|---|---|---|---|
| | 00 | 01 | 10 | 11 |
| | $I_0$ | $I_1$ | $I_2$ | $I_3$ |
| $\bar{u}(0)$ | 1 | 1 | $x$ | $x$ |
| $\bar{u}(1)$ | 0 | 0 | 1 | 1 |
| | 1 | 1 | $x$ | $\bar{x}$ |

Hence, the correct option is (B)

**Question 28.** **MSQ (2M)**

**Question ID : 8232513143**

Consider a computer system with multiple shared resource types, with one instance per resource type. Each instance can be owned by only one process at a time. Owning and freeing of resources are done by holding a global lock (L). The following scheme is used to own a resource instance:

function OwnRESOURCE(Resource R)

Acquire lock L // a global lock

if R is available then

Acquire R

Release lock L

else

if R is owned by another process P then

Terminate P, after releasing all resources owned by P

Acquire R

Restart P

Release lock L

end if

end if

end function

Which of the following choice(s) about the above scheme is/are correct?

(A) The scheme ensures that deadlocks will not occur.

(B) The scheme violates the mutual exclusion property.

(C) The scheme may lead to live-lock.

(D) The scheme may lead to starvation.

**Ans.** **(A), (C),(D)**

**Sol.** Mutual exclusion is not violated.

Also, there will be no deadlock because of forceful preemption of resources.

This may lead to starvation if the process is keeps on coming and preempting each other like P1 is preempted by P2 and P2 is preempted by P3.

Live-lock is also possible due to continuous preemption of resources.

For option (c) consider two processes P1 and P2 now P1 enter the code acquires lock and resource.

Now P2 enters the else part kills P1 and acquire R and restart P1 Now P1 again acquire lock and kills the process P2 this continues creating a live lock scenario but there is ambiguity in the code since "Release R" is not written anywhere so ambiguity is regarding how the process will release Resource R. According to the code, the only way to release the resource is by getting killed.

**Question 29.** **MSQ (1M)**

**Question ID : 8232513114**

Which of the following statements is/are correct in the context of CPU scheduling?

(A) Round Robin policy can be used even when the CPU time required by each of the processes is not known in apriori.

(B) Implementing preemptive scheduling needs hardware support.

(C) The goal is to only maximize CPU utilization and minimize throughput.

(D) Turnaround time includes waiting time.

**Ans.** **(A), (B), (D)**

**Sol.** Option A: Round Robin policy can be used even when the CPU time required by each of the processes is not known in apriori. This is True because Round Robin policy depends on time quantum.

Option B: Implementing preemptive scheduling needs hardware support. This is True because preemption needs interrupt to occur.

Option C: The goal is to only maximize CPU utilization and minimize throughput, this is False

Option D: True, because turn around time = WT+BT

**Question 30.** **NAT (2M)**

**Question ID : 8232513153**

Consider a pipelined processor with 5 stages, Instruction Fetch (IF), Instruction Decode (ID). Execute (EX), Memory Access (MEM), and Write Back (WB). Each stage of the pipeline, except the EX-stage, takes one cycle. Assume that the ID stage merely decodes the instruction and the register read is performed in the EX-stage. The EX-stage takes one cycle for ADD instruction and two cycles for MUL instruction. Ignore pipeline register latencies.
Consider the following sequence of 8 instructions:

ADD, MUL, ADD, MUL, ADD, MUL, ADD, MUL

Assume that every MUL instruction is data-dependent on the ADD instruction just before it and every ADD instruction (except the first ADD) is data-dependent on the MUL instruction just before it. The Speedup is defined as follows:

$$\text{Speedup} = \frac{\text{Execution time without operand forwarding}}{\text{Execution time with operand forwarding}}$$

The Speedup achieved in executing the given instruction sequence 011 the pipelined processor (rounded to 2 decimal places) is_____

**Ans.** **1.87 to 1.88**

**Sol.** Execution cycle without operand forwarding = 30

Execution cycle with operand forwarding = 16

Speed up = 30/16 = 1.875

**Question 31.** **NAT (1M)**

**Question ID : 8232513120**

Consider a computer system with DMA support. The DMA module is transferring one 8-bit character in one CPU cycle from a device to memory through cycle stealing at regular intervals. Consider a 2 MHz processor. If 0.5% processor cycles are used for DMA, the data transfer rate of the device is bits per second.

**Ans.** **80000**

**Sol.** CPU cycles stolen in DMA is = data transfer time/data preparation time

⇨ 0.5% of processor cycles are used or stolen

processor speed= 2MHz

⇨ Cycle time = ½ MHz = 0.5 µs

⇨ In one sec = $1/0.5*10^{-6}$
= 2 MIPS

Time for One byte transfer =$(1/2*10^{6})$

Let X is the device transfer rate

⇨ 0.5 = data transfer time / data preparation time

⇨ 0.5 = $((1/2*10^{6})/ (1/X))*100$

⇨ 1 MIPS (in bytes)

Device transfer rate is $8*10^{4}$ bit per second.

**Question 32.** **NAT (2M)**

**Question ID : 8232513148**

Consider a three-level page table to translate a 39 bits virtual address to a physical address

As shown below:

| Level 1 offset | Level 2 offset | Level 3 offset | Page Offset |
|---|---|---|---|
| 9 bits | 9 bits | 9 bits | 12 bits |

The page size is 4KB (1 KB= 2^10 bytes) and page table entry size at every level is 8 bytes. A Process P is currently using 2GB (1 GB=2^30 bytes) virtual memory which is mapped to 2GB Of physical memory. The minimum amount of memory required for the page table of P across All level is____ KB.

**Ans.** **4108**

**Sol.** Given :
Virtual address(VA) = 39 bits
Page size = 4 KB
Physical address(PA) = 2 GB
Page table entry size(PTE) = 8 B
Three level pages tables with address division (9,9,9,12) :
Three level pages tables with address division (9,9,9,12) means :

9 most significant bits for indexing into the level-1(outer level) , 9 bits for the level-2 index, 9 bits for the level-3 index, and again 12 bits for the offset within a page. The entries of the level-1 page table are pointers to a level-2 page table, the entries of the level-2 page table are pointers to a level-3 page table, and the entries of the level-3 page table are PTEs that contain actual frame number where our desired word resides.
9 bits for a level means 29 entries in one page table of that level.
For our process P :
P is using 2 GB of its VM. The rest of its VM is unused.
2 GB VM will have 2GB/4KB=219Pages.
But level 3 page table has only 29 entries, so, one page table of level 3 can point to 29 pages of VM only, So, we need 210 level-3 page tables of process P.
So, at level-3, we have 210 page tables, So, we need 210 entries in Level-2 But level 2 page table has only 29 entries, so, one page table of level 2 can only point to 29 page tables of level-3, So, we need 2 level-2 page tables.
So, we need 1 Level-1 page table to point to level-2 page tables.
So, For process P, we need only 1 Level-1 page table, 2 level-2 page tables, and 210 level-3 page tables.
Note that All the page tables, at every level, have same size which is 29×8B=212B=4KB
(Because every page table at every level has 29 entries and Page table entry size at every level is 8B )
So, in total, we need 1+2+210 page tables (1 Level-1, 2 Level-2, 210 level-3), and each page table size is 4KB
So, total page tables size = 1027×4KB = 4108KB
So, answer is 4108.

**Question 33.** **MCQ (2M)**

**Question ID : 8232513136**

Consider the following two statements about regular languages:

$S_1$: For every infinite regular language there exists a subset of language which is undecidable.

$S_2$: Every finite language is regular.

Which of the following choices is correct?

(A) Both $S_1$ and $S_2$ are true

(B)Only $S_1$ is true

(C) Only $S_2$ is true

(D) Neither $S_1$ nor $S_2$ is true

**Ans.** **(A)**

**Sol.** **S1:**

Every infinite regular language contains an undecidable language as subset.

True

If we consider infinite regular language set as L. As per definition L has infinite many strings.

We know, $|L|<|P(L)|$, here $P(L)$ denote power set of language set, L by cantor theorem we know if L is infinite countable or infinite uncountable $P(L)$ power set of L is uncountable (Infinite) It's power set consist of decidable and some undecidable language both.

**S2:**

Every finite language is regular as we have finite number of strings for example $\{S_1, S_2, .....S_n\}$ , where $n \in N$.

We can have regular expression always

$R = S_1 + S_2 + ..... + S_n$

True

**Question 34.** **MSQ (2M)**

**Question ID : 8232513141**

For a string w, we define $w^R$ to be the reverse of $w$. If $w = 01101$ the $w^R = 10110$. Which of the following language is/are context-free?

(A) $\{wxw^Rx^R \mid w, x \in \{0,1\}^*\}$

(B) $\{wxx^Rw^R \mid w, x \in \{0,1\}^*\}$

(C) $\{ww^R xx^R \mid w, x \in \{0,1\}^*\}$

(D) $\{wxw^R \mid w, x \in \{0,1\}^*\}$

**Ans.** **(B), (C), (D)**

**Sol.** (A) $L = \left\{wxw^Rx^R \mid w, x \in \{0.1\}^*\right\}$

This is not CFL as if we push $w$ then $x$ then we can't match $w^R$ against $w$. similarly with $x$ and $x^R$.

(B)

$$L = \{ww^Rxx^R \mid w, x \in \{0,14^*\}\}$$

This is CFL, particularly NCFL. We need to guess for middle of w here, and we can compare w with $w^R$ and $x$ with $x^R$.

(C)

$$L = \{w\ x\ x^R\ w^R \mid w,\ x \in \{0,14^*\}\}$$

This is NCFL clearly.

(D) $L = \{wxw^R \mid w, x \in \{0,14^*\}\}$

Take $w = \varepsilon$ then $w^R = \varepsilon$

$x$ can be expanded to $(0+1)^*$

It is clearly regular

B, C, D are CFL language.

**Question 35.** **MCQ (1M)**

**Question ID : 8232513109**

Let $L \subseteq \{0,1\}^*$ be an arbitrary regular language accepted by a minimal DFA with k states. Which one of the following languages must necessarily be accepted by a minimal DFA with *k* states?

(A) $L \cdot L$

(B) $L \cup \{01\}$

(C) $\{0,1\}^* - L$

(D) $L - \{01\}$

**Ans.** **(C)**

**Sol.** Number of states in minimal DFA is same for language as well as it's complement

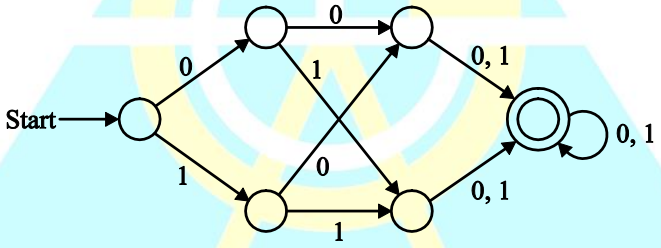
L and $\overline{L}$ has same number of states

$\overline{L} = \{0,14^* - L\}$

**Question 36.** **NAT (1M)**

**Question ID : 8232513117**

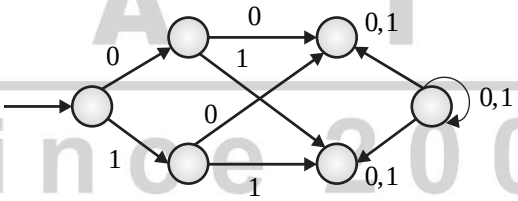
Consider the following DFA deterministic finite automaton




The number of strings of length 8 accepted by the above automation is _____.

**Ans.** **256**

**Sol.** **Given:**




On observing clearly, it is accepting every string of length 8.

$2^8 = 256$ string

**Question 37.** **MSQ (1M)**

**Question ID : 8232513112**

Let $L_1$ be a regular language and $L_2$ be a context-free language. Which of the following languages is/are context-free?

(A) $(L_1 \cap L_2) \cup (\overline{L_1} \cap L_2)$

(B) $L_1 \cap \overline{L_2}$

(C) $\overline{\overline{L_1} \cup \overline{L_2}}$

(D) $L_1 \cup (L_2 \cup \overline{L_2})$

**Ans.** **(A), (C), (D)**

**Sol.** $L_1$ regular language

$L_2$ context free language

(A) $(L_1 \cap L_2) \cup (\overline{L_1} \cap L_2)$

Regular is closed under complementation.

Any CFL union with regular is CFL.

Any CFL intersection with regular is CFL.

A. $(L_1 \cap L_2) \cup (\overline{L_1} \cap L_2)$

(Regular $\cap (FL) \cup L$ $\overline{\text{Regular}} \cap (FL)$

CFL

B. $L_1 \cap \overline{L_2}$

Regular $\cap \overline{CFL}$

$\overline{CFL}$ may not be CFL

C. $\overline{\overline{L_1} \cup \overline{L_2}}$

$\overline{\overline{L_1}} \cap \overline{\overline{L_2}}$

$L_1 \cap L_2$

Regular $\cap$ CFL = CFL

D. $L_1 \cup (L_2 \cup \overline{L_2})$

$L_2 \cup \overline{L_2} = \Sigma^*$

$L_1 \cup \Sigma^* = \Sigma^*$

Regular hence CFL

**Question 38.** **MSQ (2M)**

**Question ID : 8232513147**

Which of the following regular expressions is the set of all binary numbers is divisible by 3.

Assume that the string epsilon is also divisible by 3.

(A) (0*(1(01*0) *1) *) *

(B) (0 + 11+10(1 +00) *01) *

(C) (0 + 1(01*0) *1) *

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

**Ans.** **(A), (B), (C)**

**Sol.** A, B, C are correct

In option D

$(0+11+11(1+00)^{*}00)$

$\underset{4}{1}\,\underset{3}{1}\,\underset{2}{1}\,\underset{1}{0}\,\underset{0}{0}$ generated by D but not

Divisible by 3.

**Question 39.** **MCQ (2M)**

**Question ID : 8232513138**

For a statement S in a program, in the context of liveness analysis, the following sets are defined:

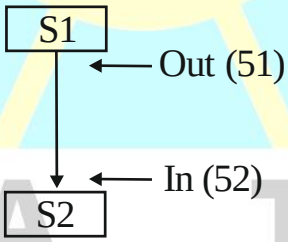
USE(S): the set of variables used in S

IN (S): the set of variables that are live at the entry of S

OUT(S): the set of variables that are live at the exit of S

Consider a basic block that consists of two statements. $S_1$ followed by $S_2$.

Which one of the following statements is correct?




Which of the following is true?

(A) Out (S1) = In (S2) U Use (S2)

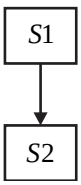
(B) Out (S1) = In (S2) n Use (S2)

(C) Out (S1) = In (S2)

(D) Out(S1)= ln(S1)U Use(S1)

**Ans.** **(C)**

**Sol.** Formula for in and out are



For basic block B other than exit,

$IN[B] = use\,B \cup [out(B)] - def(B)$

Out [B] = $U_S$ successor of B IN [B]

Out $(S1) = IN(S2)$

**Question 40.** **NAT (2M)**

**Question ID : 8232513151**

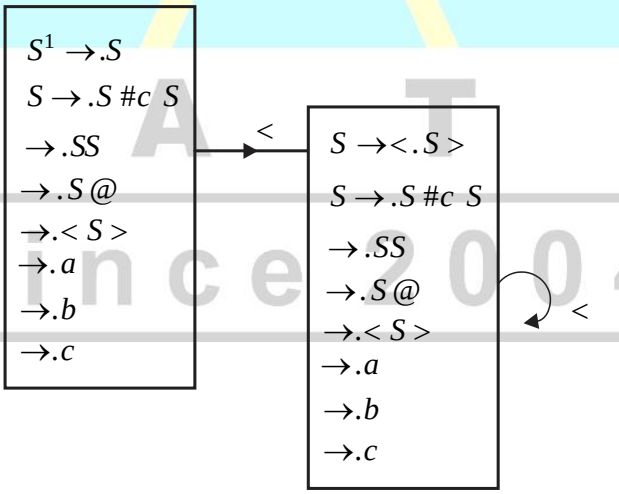
Consider the following augmented grammar with $\{\#, @, <, >, a, b, c\}$ as the set of terminals

$$S' \longrightarrow S$$
$$S \longrightarrow S\#cS$$
$$S \longrightarrow SS$$
$$S \longrightarrow S@$$
$$S \longrightarrow <S>$$
$$S \longrightarrow a$$
$$S \longrightarrow b$$
$$S \longrightarrow c$$

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

**Ans.** **8**

**Sol.**




Number of items in the set GO TO (GOTO (IO, <), <) is 8

**Question 41.** **MCQ (1M)**

**Question ID : 8232513103**

Consider the following ANSI C program:

```
int main  ( ) {
Integer x;
Return 0;
        }
```

which one of the following phases in a 7- phase C compiler will throw an error?

(A) Lexical analyzer (B) Semantic analyzer

(C) Machine dependent optimizer (D) Syntax analyzer

**Ans.** **(C)**

**Sol.** It is syntax error. As per ANSI C integer is not keyword for declaration of integer. We have int.

**Question 42.** **MSQ (1M)**

**Question ID : 8232513113**

In the context of compilers, which of the following is/are NOT an intermediate representation of the source program?

(A) 3 Address code (B) Symbol Table

(C) Control Flow Graph (D) Abstract Syntax Tree

**Ans.** **(B)**

**Sol.** Symbol table is data structure used to store information related to variables, function name etc.

**Question 43.** **MCQ (2M)**

**Question ID : 8232513130**

Consider the following ANSI C code segment:

```
z = x + 3 + y->f1 + y->f2;
for (i = 0; i < 200; i = i + 2){
 if (z > i) {
p = p + x + 3;
q = q + y->f1;
        } else {
                p = p + y- >f 2;
                q = q + x + 3;
            }
        }
```

Assume that the variable y points to a struct (allocated on the heap) containing two fields fl and f2. and the local variables x. y. z, p. q. and i are allotted registers. Common sub-expression elimination (CSE) optimization is applied on the code. The number of addition and dereference operations (of the form y->f 1 or y->f2 ) in the optimized code, respectively, are:

(A) 303 and 2

(B) 203 and 2
(C) 403 and 102
(D) 303 and 102

**Ans.** **(A)**

**Sol.** In compiler theory, common subexpression elimination is a compiler optimization that searches for instances for identical expressions (i.e, they all evaluate to the same value), and analyzes whether it is worthwhile replacing them with a single variable holding the computed value.

For example: Consider the following block of code

```
a = x+y+z;
r = p+q;
b = x+y+r;
```

The code after common subexpression elimination.

```
t=x+y;
a=t+z;
r=p+q;
b=t+r;
```

In the given code z = x + 3 + y -> f1 + y -> f2;

```
for (i = 0; i < 200; i = i+2) {
   if (z > i)
   {
      p = p + x + 3;
      q = q + y -> f1;
   }
  else
  {
       p = p + y -> f2;
      q = q + x + 3;
  }
}
```

X+3 is common subexpression, also y -> f1 & y -> f2 is found in first line itself so they are also like common subexpression. Hence the code after common subexpression

```
t1=x+3;
t2=y -> f1;
t3= y -> f2;
z = t1 + t2 + t3;
```

```
for (i = 0; i < 200; i = i+2){
  if (z > i) {
     p = p + t1;
    q = q + t2;
  }
  else{
      p = p + t3;
      q = q + t1;
   }
  }
```

Hence two dereference operations (of the form y->f1 or y->f2) in the optimized code. The number of additions in the optimized code are: Loop will execute for 100 times and in loop one addition (i+2) So 100 additions. Inside loop we have two additions (either in if block or in else block) so 200 additions inside loop.

Hence 300 additions in loop (loop body as well as inside)

First 2 lines contains 3 additions

```
t1=x+3;
z = t1 + t2 + t3;
```

Hence total 303 additions. So 303 and 2 are the answer.

**Question 44.** **MCQ (2M)**

**Question ID : 8232513127**

Assume a two-level inclusive cache hierarchy, L1 and L2, where L2 is the larger of the two.

Consider the following statements.

$S_1$ : Read misses in a write through L1 cache do not result in writebacks of dirty lines to the L2.

$S_2$ : Write allocate policy must be used in conjunction with write through caches and no-write allocate policy is used with writeback caches.

Which of the following statements is correct?

(A) $S_1$ is true and $S_2$ is true

(B) $S_1$ is false and $S_2$ is false

(C) $S_1$ is true and $S_2$ is false

(D) $S_1$ is false and $S_2$ is true

**Ans.** **(C)**

**Sol.** A cache with a write through policy (and write allocate) reads on entire block (cache line) from memory on a cache miss and writes only the updated item to memory for a store.

Evictions do not need to write to memory.

A cache with a write back policy (and write allocate) reads an entire block (cache line) from memory on a cache miss, and may need to write a dirty cache line first. Any writes to memory need to be entire cache lines since there is no way to distinguish which word was dirty with only a single dirty bit. Evictions of a dirty cache line cause a write to memory

S2: false

Write allocate policy is also used with write back cache.

**Question 45.** **MCQ (1M)**

**Question ID : 8232513106**

Consider the following statements S1 and S2 about the relational data model:

$S_1$: A relation cannot have more than one foreign key.

$S_2$: A foreign key in a relation scheme R cannot be used to refer the tuples of R.

Which one of the following choices is/are true?

(A) $S_1$ is true $S_2$ is false (B) $S_2$ is true $S_1$ is true

(C) Both $S_1$ and $S_2$ are true (D) Both $S_1$ and $S_2$ are false

**Ans.** **(D)**

**Sol.** A relation may have multiple foreign keys, and each foreign key can have a different parent table. Therefore, the statement I is incorrect. This statement is also incorrect because a self-referential relationship refers to its own attributes.

**Question 46.** **NAT (1M)**

**Question ID : 8232513121**

A data file consisting of 1,50,000 students' records is stored on a hard disk with block size of 4096 bytes. The data file is sorted on the primary key RollNo. The size of a record pointer for this disk is 7 bytes. Each student-record has a candidate key attribute called ANum of size 12 bytes. Suppose an index file with records consisting of two fields. ANum value and the record pointer to the corresponding student record, is built and stored on the same disk. Assume that the records of data file and index file are not split across disk blocks. The number of blocks in the index file is_____

**Ans.** **698 Blocks**

**Sol.** Given the total records = 1,50,000

Block size = 4096 bytes

Key size = 12 bytes

Record pointer size = 7 bytes

For a dense index, the number of indexes per block = floor (4096/(12+7)) = 215

Therefore, the total number of blocks = cell (1,50,000/215) = 698 blocks

**Question 47.** **MCQ (2M)**

**Question ID : 8232513132**

Let S be the following schedule of operation of three transactions $T_1$, $T_2$ and $T_3$ in a relational database system:

S: $R_2(y), R_1(x), R_3(z), R_1(y), W_1(x), R_2(z), W_2(y), R_3(x), W_3(z)$

P. S is conflict serializable.

Q. It $T_3$ commits before $T_1$ finishes, then schedule S is recoverable.

Which of the following is true ?

(A) Both P and Q are true

(B) P is true and Q is false

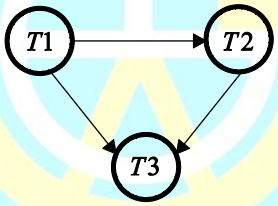
(C) Both P and Q are false

(D) P is false and Q is true

**Ans.** **(B)**

**Sol.**

i. The given schedule is a conflict serializable and the precedence graph for the given schedule is




ii.This statement is false. For the given condition it is irrecoverable. For this to be recoverable, the transaction T1 should have committed before T3 does.

**Question 48.** **MSQ (1M)**

**Question ID : 8232513140**

Suppose the following functional dependencies hold on a relation U with attributes P, Q, R, S, and T

$$P \rightarrow QR$$

$$RS \rightarrow T$$

Which of the following functional dependencies can be inferred from the above functional dependencies?

(A) $PS \rightarrow Q$ (B) $P \rightarrow R$ (C) $R \rightarrow T$ (D) $PS \rightarrow T$

**Ans.** **(A), (B), (D)**

**Sol.** For the given F'Ds, the closure of the attributes will be

$P+ = \{P, Q, R\}$

$RS+ = \{R, S, T\}$

$PS+=\{P,S,Q,R,T\}$

$R+=\{R\}$

Based on these, the FD's

$PS->T$

$P->R$

$PS->Q$

Holds for the given relation

**Question 49.** **MCQ (2M)**

**Question ID : 8232513131**

The relation scheme given below is used to store information about the employees of a company, where empId is the key and deptId indicates the department to which the employee is assigned. Each employee is assigned to exactly one department.

emp(empId, name, gender, salary, deptId)

Consider the following SQL Query:

```
select deptId, count (*)
from emp
where gender = "female" and salary > (select avg (salary) from emp)
group by deptId;
```

The above query gives, for each department in the company, the number of female employees whose salary is greater than the average salary of

(A) Employees in the department
(B) Female employees in the department
(C) Employees in the company
(D) Female employees in the company

**Ans.** **(B)**

**Sol.** The given query will return the department id and the count of female employees in each department whose salary is greater than the average salary of any employee.

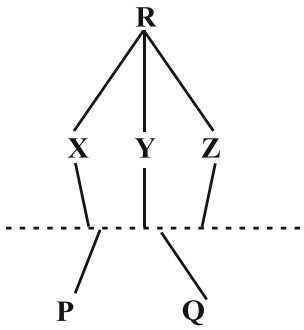
Here, the inner query will return the average salary of the employees. The group by clause will group the tuples based on dept id, count (*) will give us the count of tuples in each department where gender = female and the salary > average salary of any employee.

**Question 50.** **MSQ (2M)**

**Question ID : 8232513145**

Consider a computer network using the distance vector routing algorithm in its network layer.

The partial topology of the network is as shown below.




The objective is to find the shortest-cost path from the router R to routers P and Q. Assume that R does not initially know the shortest routes to P and Q. Assume that R has three neighbouring routers denoted as X, Y. and Z. During one iteration, R measures its distance to its neighbours X, Y, and Z as 3, 2, and 5, respectively. Router R gets routing vectors from its neighbours that indicate that the distance to router P from routers X, Y, and Z are 7, 6, and 5, respectively. The routing vector also indicates that the distance to router Q from routers X. Y, and Z are 4, 6, and 8 respectively. Which of the following statement(s) is/are correct with respect to the new routing table of R, after updation during this iteration?

(A) The distance from R to P will be stored as 10

(B) The next hop router for a packet from R to P is Y

(C) The distance from R to Q will be stored as 7

(D) The next hop router for a packet from R to Q is Z

**Ans.** **(B), (C)**

**Sol.** Frame size $(L) = 1000$ bits

Data rate $(R) = 1$ Mbps

$$t_f = \frac{L}{R} = \frac{10^3 \text{ bits}}{10^6 \text{ bits/sec}} = 1 \text{ ms}$$

Total no. of frames transmitted per sec = 1000

$\because t_f = 1$ ms

So $G = 1$

$$\text{Throughput} = G \times e^{-G}$$

$$= e^{-1}$$

$$= 0.367$$

**Note :** $G$ = no. of frames transmitted per frames to transmission time.

**Question 51.** **MCQ (2M)**

**Question ID : 8232513134**

Consider the cyclic redundancy check (CRC) based error detecting scheme having the generator polynomial $X^3 + X + 1$. Suppose the message $m_4 m_3 m_2 m_1 m_0 = 1100$ is to be transmitted. Check bits

$c_2c_1c_0$ are appended at end of the message by the transmitter using the above CRC scheme. The transmitted bit string is denoted by $m_4m_3m_2m_1m_0c_2c_1c_0$. The value of the check bit sequence $c_2c_1c_0$ is

(A) 111 (B) 110 (C) 101 (D) 100

**Ans.** **D**

**Sol.** Generator: $X^3 + X + 1 => 1011$

Data: 11000

```
1011 | 1 1 0 0 0 0 0 0
       1 0 1 1
         1 1 1 0
           1 0 1 1
             1 0 1 0
               1 0 1 1
       0   1 0 0  => CRC
```

**Question 52.** **MCQ (1M)**

**Question ID : 8232513107**

Consider the three-way handshake mechanism followed during TCP connection establishment between hosts P and Q. Let X and Y be two random 32-bit starting sequence numbers chosen by P and Q respectively. Suppose P sends a TCP connection request message to Q with a TCP segment having SYN bit = 1, SEQ number = X, and ACK bit = 0. Suppose Q accepts the connection request message to

(A) SYN bit = 1 , SEQ NO = X+1 , ACK bit =0 , ACK No =Y, FIN bit =0

(B) SYN bit = 1 , SEQ NO = Y, ACK bit = 1 , ACK No = X, FIN bit = 0

(C) SYN bit = 1 , SEQ NO = Y, ACK bit = 1 , ACK No = X+1, FIN bit = 0

(D) SYN bit = 0 , SEQ NO = X+ 1, ACK bit = 0 , ACK No = Y, FIN bit = 1

**Ans.** **(C)**

**Sol.** SYN =1 as Q also will establish a connection

SEQ Num = Y, representing if it wants to send data, its starting from Y sequence number

ACK bit = 1, as now it is acknowledging the sender for connection request

ACK No = X+1, the data it is expecting will now start from sequence number X+1, as 1 bit has already been consumed by the SYN request

FIN = 0, because it is establishing the connection to terminating.

**Question 53.** **NAT (2M)**

**Question ID : 8232513154**

Consider a network using pure aloha where frame length = 1000 bits, transmission rate= 1Mbps. The average number of transmissions across all nodes modeled as a Poisson process with a rate 1000 frames/sec. Throughput is an average number of transmissions per seconds then the throughput is ?

**Ans.** **130 to 140**

**Sol.** Frame size $(L) = 1000$ bits

Data rate $(R) = 1$ Mbps

$$t_f = \frac{L}{R} = \frac{10^3 \text{ bits}}{10^6 \text{ bits/sec}} = 1 \text{ ms}$$

Total no. of frames transmitted per sec = 1000

$\because t_f = 1$ ms

So $G = 1$

$\text{Throughput} = G \times e^{-2G}$

$= e^{-2}$

$= 0.1353$

For 1000 frames

Throughput $= 1000 \times 0.1353 = 135$

**Note :** $G =$ no. of frames transmitted per frames to transmission time.

**Question 54.** **NAT (1M)**

**Question ID : 8232513122**

For a given biased coin, the probability that the outcome of a toss is head is 0.4. This coin is tossed 1000 times. Let X denotes the random variable whose value is the number of times that head appeared in those 1000 tosses. The standard deviation of X (rounded to 2 decimal points) is_____

**Ans.** **15.0 to 16.0**

**Sol.** **Given :** Probability of head, $p = 0.4$

Probability of tail, $q = 1 - p = 0.6$

Coin is tossed 1000 times, $n = 1000$

Let X is a random variable whose value is number of times head appeared in those 1000 tosses

We know that, for binomial distribution

$\text{mean} = np$

$\text{variance} = npq$

Where $q = 1 - p$

So, standard deviation, $\sigma = \sqrt{npq}$

$\sigma = \sqrt{1000 \times 0.4 \times 0.6} = \sqrt{240} = 15.49$

Hence, the correct answer is 15.49.

**Question 55.** **NAT (1M)**

**Question ID : 8232513125**

Suppose that $f:R\to R$ is a continuous function on the interval $[-3,3]$ and a differentiable function in the interval $(-3,3)$ such that for every x in the interval, $f(x)\le 2$. If $f(-3)=7$ then $f(3)$ is at most____

**Ans.** **19**

**Sol.** **Given:** The function $f$ is continuous on interval [–3,3] and differentiable in interval (–3,3) and $f'(x)\le 2$.

By using Lagrange's mean value theorem,

$$f'(x)=\frac{f(b)-f(a)}{b-a}$$

Here, $a=-3$ and $b=3$

So, $f'(x)=\frac{f(3)-f(-3)}{3-(-3)}$

As, $f'(x)\le 2$ is given

$$2\ge\frac{f(3)-7}{3+3}$$

$$2\times 6\ge f(3)-7$$

$$f(3)\le 12+7$$

$$f(3)\le 19$$

Hence, the correct answer is 19.

**Question 56.** **NAT (1M)**

**Question ID : 8232513124**

Suppose that P is a $4\times 5$ matrix such that every solution of the equation $P_x=0$ is a scalar multiple of $[2\,5\,4\,3\,1]^T$. The rank of P is ____

**Ans.** **4**

**Sol.** Given:- P is 4 × 5 matrix

No. of Rows = 4

No of columns = 5

So , no of variable = No of columns = 5

Since, Px is a homogeneous.

And no of variables greater than Raw

$\therefore$ Rank = No of rows = 4

**Question 57.** **MCQ (2M)**

**Question ID : 8232513133**

A bag has r red balls and b black balls. All balls are identical except for their colours. In a trial, a ball is randomly drawn from the bag, its colour is noted and the ball is placed back into the bag along with another ball of the same colour. Note that the number of balls in the bag will increase by one, after the trial. A sequence of four such trials is conducted. Which one of the following choices gives the probability of drawing a red ball in the fourth trial?

(A) $\left(\frac{r}{r+b}\right)\left(\frac{r+1}{r+b+1}\right)\left(\frac{r+2}{r+b+2}\right)\left(\frac{r+3}{r+b+3}\right)$

(B) $\frac{r+3}{r+b+3}$

(C) $\frac{r}{r+b+3}$

(D) $\frac{r}{r+b}$

**Ans.** **(D)**

**Sol.** There are 10 favorable ways to calculate the probability of red ball in 4th trial

$(RBR)R = R(BRR)R = 1$ way

Or $(RRR) = 3$ ways or $(BBB)R = 3$ ways

$$P(RRRR) = \frac{r}{r+b} \times \frac{r+1}{r+1+b} \times \frac{r+2}{r+2+b} \times \frac{+2}{r+3+b} \quad \ldots (i)$$

$$P(BBBR) = \frac{b}{r+b} \times \frac{b+1}{r+b+1} \times \frac{b+2}{r+b+2} \times \frac{r}{r+b+3} \quad \ldots (ii)$$

$$P(RRBR) = \frac{3!}{2!} \times \frac{r}{r+b} \times \frac{r+1}{r+b+1} \times \frac{b}{r+b+2} \times \frac{r+2}{r+b+3} \quad \ldots (iii)$$

$$P(BBRR) = \frac{3!}{2!} \times \frac{b}{r+b} \times \frac{b+1}{r+b+1} \times \frac{r}{r+b+2} \times \frac{r+1}{r+b+3} \quad \ldots (iv)$$

Required probability = (i) + (ii) + (iii) + (iv)

$$r(r+1)(r+2)(r+3)+b(b+1)(b+2)$$
$$=\frac{r+3r(r+1)b(r+2)+3b(b+1)r(r+1)}{(r+b)(r+b+1)(r+b+2)(r+b+3)}$$

On solving it we get,

$$=\frac{r(r+1+b)}{(r+b)(r+b+1)}=\frac{r}{r+b}$$

Hence, the correct option is (A).

**Question 58.** **MCQ (2M)**

**Question ID : 8232513129**

In an examination, a student can choose the order in which two questions (QuesA and QuesB) must be attempted.

-If the first question is answered wrong, the student gets zero marks.

-If the first question is answered correctly and the second question is not answered correctly, the student gets the marks only for the first question.

-If both the questions are answered correctly, the student gets the sum of the marks of the two questions.

The following table shows the probability of correctly answering a question and the marks of the question respectively.

| question | probability of answering correctly | marks |
|---|---|---|
| QuesA | 0.8 | 10 |
| QuesB | 0.5 | 20 |

Assuming that the student always wants to maximize her expected marks in the examination, in which order should she attempt the questions and what is the expected marks for that order (assume that the questions are independent)?

(A)First QuesA and then QuesB. Expected marks 14.

(B)First QuesB and then QuesA. Expected marks 22.

(C)First QuesB and then QuesA. Expected marks 14.

(D)First QuesA and then QuesB. Expected marks 16.

**Ans.** **(D)**

**Sol.** Let $X$ be random variable which represents total marks record.

$P(x)$ be probability of getting those marks

$P$ (answering Ques A correctly) =0.8

$P$ (answering Ques B correctly) =0.5

| $X$ | 0 | 10 | 20 | 30 |
|---|---|---|---|---|
| $P(x)$ | $0.2\times0.5$ $=0.1$ | $0.8\times0.5$ $=0.4$ | $0.5\times0.2$ $=0.1$ | $0.8\times0.5$ $=0.4$ |
| $\sum P(x)=1$ | | | | |

Case I, if Question A is attempted first and it is correct.

$$E(x)=\Sigma(x)P(x)$$

$$E(x)=0.4\times10+0.4\times30$$

$$E(x)=4+12=16$$

Case II, If Question B is attempted first and is correct.

$$E(x)=\Sigma(x)P(x)$$

$$E(x)=0.1(20)+0.4(30)$$

$$E(x)=2+12=14$$

So, Case I is giving maximum expected marks.

Hence, the correct option is (D).

**Question 59.** **MSQ (1M)**

**Question ID : 8232513111**

Consider the following sets, where $n \geq 2$

S1: Set of all n x n matrices with entries from the set {a, b, c}

S2: Set of all functions from the set {0, 1, 2, …., $n^2$-1} to the set {0, 1, 2}

Which of the following is possible?

(A) There does not exist an injection from S1 to S2 .

(B) There exists a surjection from S1 to S2.

(C) There does not exist a bijection from S1 to S2.

(D) There exists a bijection from S1 to S2.

**Ans.** **(B), (D)**

**Sol.** S1: For n × n matrices $n^2$ entries will be there, for each entry we are having 3 choices, one of a, b and c. therefore total possible ways matrix can be built is $3^{n\wedge2}$, i.e., $3^{n\wedge2}$ elements in Set 1

S2: Set A consists element from 0 to $n^2 - 1$, in totality $n^2$ elements are there, in Set B only 3 elements are there namely 0,1,2. Therefore total number of functions possible from Set A to Set B are $3^{n\wedge2}$. i.e., $3^{n\wedge2}$ elements in Set 2

Therefore, both Bijection and Surjection may exist from Set1 to Set 2 as both are having same number of elements.

**Question 60.** **MCQ (2M)**

**Question ID: 8232513137**

For two n-dimensional real vectors *P* and Q. the operation s (*P*, *Q*) is defined as follows:

$$s(P,Q)=\sum_{i=1}^{n}\left(P[i]\cdot Q[i]\right)$$

Let £ be a set of 10-dimensional non-zero real vectors such that for every pair of distinct vectors $P, \in$ £, s (*P*, *Q*) = 0. What is the maximum cardinality possible for the set £?

(A) 10

(B) 11

(C) 9

(D) 100

**Ans.** **(A)**

**Sol.** **Given:**

$$s(P,Q)=\sum_{i=1}^{n}\left(P[i]\cdot Q[i]\right)$$

*S*(*P*, *Q*) is nothing but the dot product of two vectors.

The dot product of two vectors is zero when they are perpendicular, as we are dealing with 10 dimensional vectors the maximum number of mutually-perpendicular vectors can be 10.

Therefore, the maximum cardinality possible for the set £.

**Question 61.** **MSQ (1M)**

**Question ID: 8232513115**

Choose the correct choice(s) regarding the following propositional logic assertion S:

S: ((P ^ Q) → R) ((P ^ Q) → 4 (Q → R))

**(A)** S is a contradiction

**(B)** S is a tautology

**(C)** The antecedent of S is equal to consequent of S (doubtful)

**(D)** Neither tautology nor contradiction

**Ans.** **(B), (C)**

**Sol.** Antecedent (X): (PQ)' + R ==> P' + Q' + R --------- 1

Consequent (Y): ((PQ)' + (Q' + R)) ==> (P' + Q') + Q' + R ==> P' + Q' + Q' + R ==> P' + Q' + R ------2

Because Antecedent and Consequent are returning same expression, therefore X → Y, will be Tautology because X and Y are coming out to be same. For example

A→A ==> A' + A ==> 1

**Question 62.** **NAT (2M)**

**Question ID: 8232513150**

Let S be a set consisting of 10 elements. The of tuples of the form (A, B) such that A and B are subsets of S, and $A \subseteq B$ is ____

**Ans.** **59049**

**Sol.** As B is subset of S, B set can have any number of elements from set S, and for each type of B subset, further A can have any number of elements from B, therefore

All the possibilities can be summarised below: -

| Number of Elements in B | Number of elements in A |
|---|---|
| No element | No Element |
| 1 => $^{10}C_1$ | $^1C_0 + ^1C_1 = 2$ |
| 2 => $^{10}C_2$ | $^2C_0 + ^2C_1 + ^2C_2 = 2^2$ |
| . | . |
| . | . |
| . | . |
| 10 => 10C10 | $^{10}C_0 + ^{10}C_1X(2) + ^{10}C_2X(2^2) + --- + ^{10}C_{10}X(2^{10})$ |

Overall number of tuples will be:

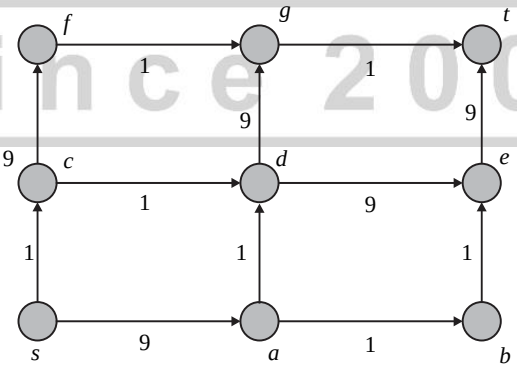
$$^{10}C_0 + ^{10}C_1X(2) + ^{10}C_2X(2^2) + --- + ^{10}C_{10}X(2^{10})$$

From binomial theorem, it is coming out to be $3^{10} = 59049$

**Question 63.** **NAT (2M)**

**Question ID : 8232513155**

In a directed acyclic graph with a source vertex s, the quality-score of a directed path is defined to be the product of the weights of the edges on the path. Further, for a vertex v other than s. the quality-score of v is defined to be the maximum among the quality-scores of all the paths from s to v. The quality-score of s is assumed to be 1.




The sum of the quality-score of all the vertices in the graph shown above is____

**Ans.** **929**

**Sol.** s → s = 1

s → a = 9

s → b = 9

s → c = 1

s → d = 9

s → e = 81

s → f = 9

s → g = 81

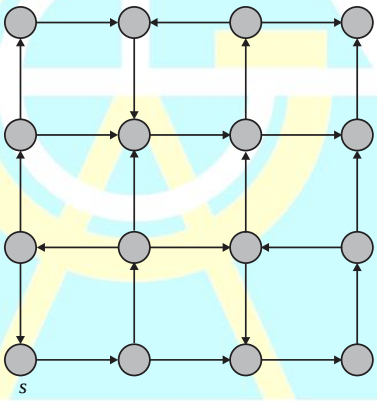
s → t = 729

Sum = 929

**Question 64.** **MSQ (2M)**

**Question ID : 8232513146**

Consider the following directed graph:




Which of the following is/are correct about the graph?

(A) A depth first traversal starting at vertex S classifies three directed edges as back edges.

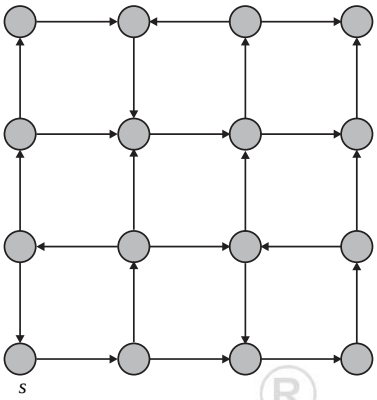
(B) The graph does not have strongly connected components.

(C) For each pair of vertices u and v, there is a directed path from u to v.

(D) The graph does not have a topological order.

**Ans.** **(A), (D)**

**Sol.** **Given:**




We can observe that,

A) There are only 3 back edges, if started from S.

B) The graph does have a strongly connected component, it has cycle.

C) Not all rectangular/square components form a cycle.

D) The graph does not have a topological order, because there's a cycle in the bottom left corner of the graph

**Question 65.** **NAT (1M)**

**Question ID : 8232513119**

Consider a set-associative cache of size 2KB (1KB = $2^{10}$ bytes) with the cache block size of 64 bytes. Assume that the cache is byte addressable and a 32-bit address is used for accessing the cache. If the width of tag field is 22 bits, the associativity of the cache is_____.

**Ans.** **2**

**Sol.** Number of cache lines = 2KB/64B = 32

Set Index bits are 32-(22+6) = 4 ⇒ 16 sets are there in the cache

⇒Bits of the cache line Index = 5 ⇒ 32 cache lines

⇒ 32/2 =16 set. We will have 2-way set associative memory

| TAG | Set Index | Offset |
|---|---|---|
| 22 | 4 | 6 |
| 32- bits | | |