GENERAL APTITUDE

Q. No. 1 - 5 Carry One Mark Each

1. Two cars start at the same time from the same location and go in the same direction. The speed of the first car is 50 km/h and the speed of the second car is 60 km/h. The number of hours it takes for the distance between the two cars to be 20 km is _________.

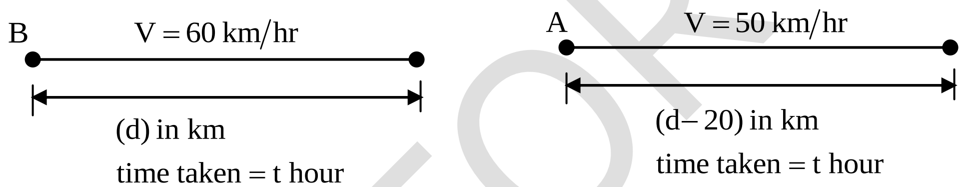
(A) 1 (B) 3 (C) 2 (D) 6

Key: **(C)**

Sol: Let us take two cars A and B

$V_A = 50 \text{ km/hr}$

$V_B = 60 \text{ km/hr}$



$$\text{Time taken} = \frac{\text{distance}}{\text{velocity}}$$

$$t = \frac{d}{60} \qquad \ldots(i)$$

$$t = \frac{d-20}{50} \qquad \ldots(ii)$$

(i) = (ii)

$$\frac{d}{60} = \frac{d-20}{50} \Rightarrow (d-20)60 = 50d$$

$$60d - 50d = 1200$$

$$d = 120\text{km}$$

$$\text{Time taken} = \frac{d}{60} = \frac{120}{60} = 2 \text{ hours}$$

2. The expenditure on the project _______ as follows: equipment Rs.20 lakhs, salaries Rs.12 lakhs, and contingency Rs.3 lakhs.

(A) break (B) break down (C) breaks (D) breaks down

Key: **(D)**

3. Ten friends planned to share equally the cost of buying a gift for their teacher. When two of them decided not to contribute, each of the other friends had to pay Rs 150 more. The cost of the gift was Rs __________.

(A) 12000 (B) 3000 (C) 6000 (D) 666

Key: **(C)**

Sol: Let us consider cost of gift = X

If 10 friends contributes then share $=\frac{X}{10}$

Two friends denied to contribute then remaining are 8 each of remaining to be given 150 more

$$\left(\frac{X}{10}+150\right)\times 8 = X$$

$$\frac{8X}{10}+150\times 8 = X$$

$$0.8X+150\times 8 = X$$

$$0.2X = 1200$$

$$X=\frac{1200}{0.2}=6000\text{ Rs}$$

4. A court is to a judge as ________ is to a teacher.

(A) a syllabus (B) a student (C) a school (D) a punishment

Key: **(C)**

5. The search engine's business model ________ around the fulcrum of trust.

(A) sinks (b) bursts (C) revolves (D) plays

Key: **(C)**

Q. No. 6 - 10 Carry Two Marks Each

6. Three of the five students allocated to a hostel put in special requests to the warden. Given the floor plan of the vacant rooms, select the allocation plan that will accommodate all their requests.

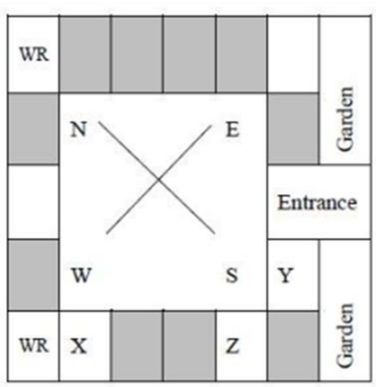
Request X: Due to pollen allergy, I want to avoid a wing next to the garden.

Request by Y: I want to live as far from the washrooms as possible, since I am very sensitive to smell.

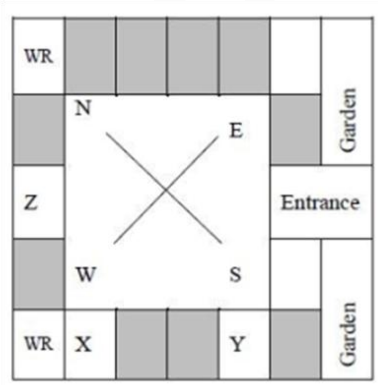
Request by Z: I believe in Vaastu and so want to stay in the South-west wing.

The shaded rooms are already occupied. WR is washroom.

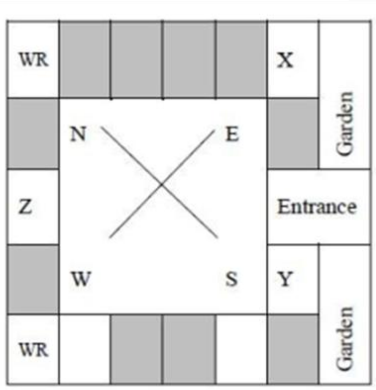
(A)



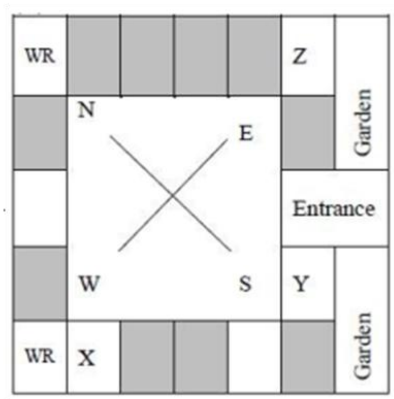
(B)



(C)



(D)



Key: (A)

7. The police arrested four criminals –P, Q, R and S. The criminals knew each other. They made the following statements:

P says "Q committed the crime."

Q says "S committed the crime."

R says "I did not do it."

S says "What Q said about me is false."

Assume only one of the arrested four committed the crime and only one of the statement made above is true. Who committed the crime?

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

Key: (B)

8. "A recent High Court Judgment has sought to dispel the ideal of begging as a disease which leads to its stigmatization and criminalization – and to regard it as a symptom. The underlying disease is the failure of the state to protect citizens who fall through the social security net."

Which one of the following statements can be inferred from the given passage?

(A) Begging has to be banned because it adversely affects the welfare of the state

(B) Begging is an offence that has to be dealt with family

(C) Beggars are created because of the lack of social welfare schemes

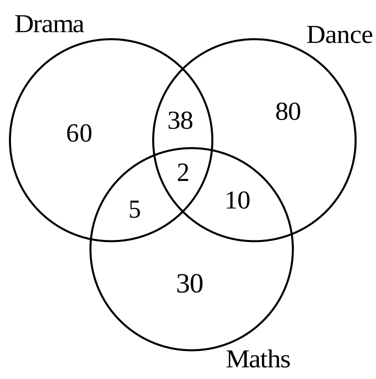
(D) Beggars are lazy people who beg because they are unwilling to work

Key: (C)

9. In a college, there are three student clubs, Sixty students are only in the Drama club, 80 students are only in the Dance club, 30 students are only in the Maths club, 40 students are in both Drama and Dance clubs, 12 students are in both Dance and Maths clubs, 7 students are in both Drama and Maths clubs, and 2 students are in all the clubs. If 75% of the students in the college are not in any of these clubs, then the total number of students in the college is ________.

(A) 975 (B) 1000 (C) 225 (D) 900

Key: (D)



Sol: Total number of students in the all three clubs

= 60 + 38 + 80 + 5 + 2 + 10 + 30 = 225

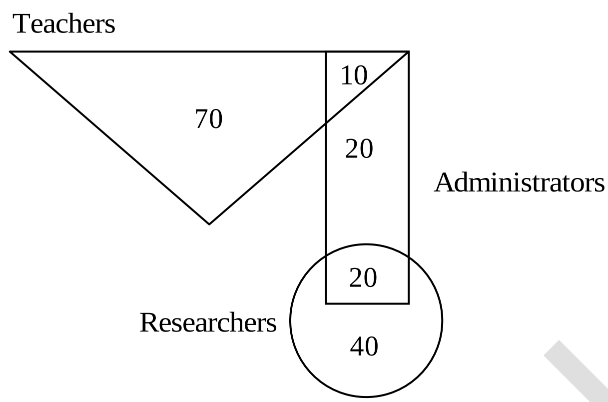
Total number of students in the college = X

Given that 75% of students are not of any of these clubs.

Remaining 25% of X = 225

$$0.25X = 225 \Rightarrow X = \frac{225}{0.25} = 900$$

10. In the given diagram, teachers are represented in the triangle, researchers in the circle and administrators in the rectangle. Out of the total number of the people, the percentage of administrators shall be in the rage of ___________.



(A) 16 to 30 (B) 46 to 60 (C) 31 to 45 (D) 0 to 15

Key: **(C)**

Sol: Total number of people = 70 + 10 + 20 + 20 + 40 = 160

Total number of administrators = 10 + 20 + 20 = 50

$$\% \text{ of administrators } = \frac{50}{160} \times 100 = 31.25\%$$

COMPUTER SCIENCE & INFORMATION TECHNOLOGY

Q. No. 1 to 25 Carry One Mark Each

1. Which one of the following kinds of derivation is used by LR parsers?

(A) Rightmost

(B) Rightmost in reverse

(C) Leftmost

(D) Leftmost in reverse

Key: **(B)**

Sol: LR parser uses rightmost derivation in reverse order.

2. Consider the following C program:

```
#include <stdio.h>
int main(){
int arr[]={1,2,3,4,5,6,7,8,9,0,1,2,5}, *ip=arr+4;
```

```
printf("%d \n", ip[1]);
return 0;
}
```

The number that will be displayed on execution of the program is _________.

Key: **(6)**

Sol: *ip=arr+4 will point element 5 in the array, since it will increment the base address of the array by 4.

ip[1] is equal to *(ip+1)

it will further increment the pointer to next element and hence it will print 6.

3. For $\Sigma = \{a,b\}$, let us consider the regular language $L = \{x \mid x = a^{2+3k} \text{ or } x = b^{10+12k}, k \geq 0\}$. Which one of the following can be a pumping length (the constant guaranteed by the pumping lemma) for L ?

(A) 5 (B) 24 (C) 9 (D) 3

Key: **(B)**

Sol: The set x is consists of $\{a^2, a^5, a^8, a^{11}........\}$ here the pumping length is 3 i.e. to get the another string we can repeat the length 3

The regular expression is $aa(aaa)^*$

Or $\{b^{10}, b^{22}, b^{34}, b^{46}...........\}$, here the pumping length is 12

The regular expression is $b^{10}(bbbbbbbbbbbb)^*$

Pumping length can't be 5

Pumping length can't be 9, because it will generate 18 which is not multiple of 12

Pumping length can't be 3, since it will generate 15, which is not multiple of 12

Possible pumping length can be 24 since every repetition will be multiple of 3 and 12.

4. Let U = {1, 2, …, n}. Let $A = \{(x, X) \mid x \in X, X \subseteq U\}$. Consider the following two statements on $|A|$.

I. $|A| = n2^{n-1}$

II. $|A| = \Sigma_{k=1}^{n} k\binom{n}{k}$

Which of the above statements is/are TRUE?

(A) Only II (B) Only I (C) Neither I nor II (C) Both I and II

Key: **(D)**

Sol: $U = \{1, 2, \ldots .n\}$

$X \subseteq U$

i.e., X is subset of U

and number of subsets are $= 2^n$ [since n elements are there]

$\left[n_{C_0} + n_{C_1} + n_{C_2} + \ldots n_{C_n} = 2^n\right]$

In case of n_{C_0} i.e., subset is ϕ

We cannot select any element

In case of n_{C_1} we have only one choice

In case of n_{C_2} we have selected two elements subset

So there exists two value of $x \,\&.t\, x \in x$

And this goes on.

So, $|A| = 0 * n_{C_0} + 1 * n_{C_1} + 2 * n_{C_2}$

So, $|A| = n_{C_1} + 2n_{C_2} + 3n_{C_3} + \ldots n^n C_n$

So, $|A| = \sum_{k=1}^{n} k^n c_k = \sum_{k=1}^{n} k \binom{n}{k}$ and $|A| = n2^{n-1}$

5. A certain processor uses a fully associative cache of size 16 kB. The cache block size is 16 bytes Assume that the main memory is byte addressable and uses a 32-bit address. How many bits are required for the *Tag* and the *Index* fields respectively in the addresses generated by the processor?

(A) 28 bits and 4 bits

(B) 24 bits and 4 bits

(C) 24 bits and 0 bits

(D) 28 bits and 0 bits

Key: **(D)**

Sol: The division of fully associative cache is

TAG	Word / Byte offset	Main memory address(32 bits)

Cache size is 16 kB

Block size is 16 Bytes , byte offset is $\log_2 16 = 4 bits$

Number of blocks $\frac{16kB}{16} = 1k = 2^{10}$

Number of bits required to index is 10 bits

Since fully associative is not having index field hence TAG field is 32 – 4 = 28 bits

(D) is the Key.

6. Consider the grammar given below:

$S \to Aa$

$A \to BD$

$B \to b \mid \varepsilon$

$D \to d \mid \varepsilon$

Let a, b, d, and $ be indexed as follows:

a	b	d	$
3	2	1	0

Compute the FOLLOW set of the non-terminal B and write the index values for the symbols in the FOLLOW set in the descending order. (For example, if the FOLLOW set is {a, b. d, $}, then the Key should be 3210)

Key: **(31)**

Sol: follow(B) = first(D)

first(D) is $\{d, \varepsilon\}$

follow (B) is {d} and since first(D) contains ε

follow (B) is first (A)

first(A) is {a}

Index of a is 3 and d is 1

Hence 31.

7. Let X be a square matrix. Consider the following two statements on X.

I. X is invertible

II. Determine of X is non-zero.

Which one of the following is TRUE?

(A) I implies II; II does not imply I

(B) I does not imply II; II does not imply I

(C) I and II are equivalent statements

(D) II implies I; I does not imply II

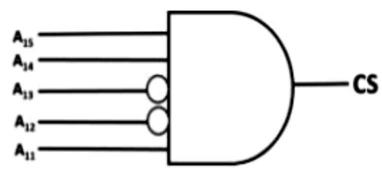
Key: **(C)**

Sol: If $|A| \neq 0$ then A is invertible matrix

If A^{-1} exists then $|A| \neq 0$

$\therefore$ I and II are equivalent statements.

8. The chip select logic for a certain DRAM chip in a memory system design is shown below Assume that the memory system has 16 address lines denoted by A15 to A0. What is the range of addresses (in hexadecimal) of the memory system that can get enabled by the chip select (CS) signal?



(A) C800 to CFFF (B) C800 to C8FF (C) DA00 to DFFF (D) CA00 to CAFF

Key: **(A)**

Sol: Chip select signal will be enable only of

A15	A14	A13	A12	A11
1	1	0	0	1

And rest of the bits

A10	A9	A8	A7	A6	A5	A4	A3	A2	A1	A0

Will be available from 00000000000 to 11111111111

Hence address

1100 1000 0000 0000 to 1100 1111 1111 1111 are available

C 8 0 0 C F F F

9. Consider a sequence of 14 elements: A = {-5, -10, 6, 3, -1, -2, 13, 4, -9, -1, 4, 12, -3, 0]. The subsequence sum $S(i,j) = \sum_{k=i}^{j} A[k]$. Determine the maximum of $S(i,j)$, where $0 \leq i \leq j < 14$. (Divide and conquer approach may be used.)

Key: **(29)**

Sol: The maximum sum of the array

{6, 3, -1, -2, 13, 4, -9, -1, 4, 12 }

Which sum to 29.

10. An array of 25 distinct elements is to be sorted using quick sort. Assume that the pivot element is chosen uniformly at random. The probability that the pivot element gets placed in the worst possible location in the first round of partitioning (rounded off to 2 decimal places) is

Key: (0.08)

Sol: The worst possible location for the pivot is either first place or the last place

Hence the probability is $\frac{2}{25} = 0.08$

11. The value of 3^{51} mod 5 is _______.

Key: (2)

Sol: $3^{51} \bmod 5 = ?$

$$\left.\begin{array}{c} 3^1 \bmod 5 = 3 \\ 3^2 \bmod 5 = 9\%5 = 4 \\ 3^3\%5 = 27\%5 = 2 \\ 3^4\%5 = 81\%5 = 1 \end{array}\right] \text{cycle}$$

$$\left.\begin{array}{c} 3^5\ \%5 = 243\% = 3 \\ 3^6\%\ 5 = 729\%5 = 4 \\ 3^7\%5 = 2 \\ 3^8\%5 = 1 \end{array}\right] \text{Again cycle}$$

$\vdots$

So $3^{48} \bmod 5 = 1$

$3^{49} \bmod 5 = 3$

$3^{50} \bmod 5 = 4$

$3^{51} \bmod 5 = 2$

12. Consider the concurrent processes P1, P2 and P3 as shown below, which access a shared variable D that has been initialization to 100.

P1	P2	P3
:	:	:
:	:	:
D= D +20	D = D –50	D = D +10
:	:	:
:	:	:

The processes are executed on a uniprocessor system running a time-shared operating system. If the minimum and maximum possible values of D after the three processes have completed execution are X and Y respectively, then the value of Y–X is _________.

Key: **(80)**

Sol: **For maximum value:**

First P_2 & P_1 read the D value as 100.

So, P_2 update it first

$\Rightarrow D = D - 50 = 100 - 50 = 50$

After P_2, P_1 overwrite the value 50 by 120

$\Rightarrow D = D + 20 = 100 + 20 = 120$

Then P_3 read the value of D as 120 and adds 10 to it

$\Rightarrow D = 120 + 10 = 130$

$\therefore$ The max value of D after all 3 processes are executed is 130(Y).

For minimum Value:

All processes read the D value as 100.

But, ensure that last update is from P_2.

So that, the min value of D after all 3 processes are executed is 50 (X).

$\therefore$ Difference between X and Y is $(Y - X) = 130 - 50 = 80$

13. Compute $\lim\limits_{x \to 3} \dfrac{x^4 - 81}{2x^2 - 5x - 3}$

(A) 108/7
(B) 1
(C) 53/12
(D) Limit does not exist

Key: **(A)**

Sol: $\lim\limits_{x \to 3} \dfrac{x^4 - 81}{2x^2 - 5x - 3} \left(\dfrac{0}{0}\right)$

$= \lim\limits_{x \to 3} \dfrac{4x^3}{4x - 5}$ (L' Hospital Rule)

$= \dfrac{4(3^3)}{12 - 5} = \dfrac{108}{7}$

$\Rightarrow \lim\limits_{x \to 3} \dfrac{x^4 - 81}{2x^2 - 5x - 3} = \dfrac{108}{7}$

14. Consider the following C program:

```
#include <stdio.h>
int jumble(int x, int y){
x=2*x+y;
return x;  }
int main(){
int x=2, y=5;
y= jumble(y,x);
x= jumble(y,x);
printf("%d \n", x);
return 0;
}
```

The value printed by the program is _________

Key: **(26)**

Sol: Initial value of x and y is given as 2 and 5

```
y= jumble(y,x);
In function
5 is stored in x and 1 stored in y
x = 2*x+y is equal to 2*5+2 = 12
x = 12
return value update y to 12
x= jumble(y,x);
now 12 is stored in x and 2 stored in y
x = 2*x+y is equal to 2*12+2 = 26
x = 26
return value of update x to 26
value printed is 26
```

15. Let G be an arbitrary group. Consider the following relations on G:

$R_1 : \forall a, b \in G, aR_1b$ if and only if $\exists g \in G$ such that $a = g^{-1}bg$

$R_2 : \forall a, b \in G, aR_2b$ if and only if $a = b^{-1}$

Which of the above is/are equivalence relation/relations?

(A) Neither R_1 nor R_2 (B) R_2 only

(C) R_1 only (D) R_1 and R_2

Key: **(C)**

Sol: Let us take an example of multiplication modulus 5

5	1	2	3	4
1	1	2	3	4
2	2	4	1	3
3	3	1	4	2
4	4	3	2	1

Let us take R_2

For Reflexive

$a = a^{-1}, \cancel{\forall} a \in G$

But $2 \neq 2^{-1}$

$3 \neq 3^{-1}$

So Not reflexive, So R_2 is not equivalence

Let us take R_1

For Reflexive

$a = g^{-1}ag \ \cancel{\forall} a \in G, \exists g \in G$

So, $1 = 1^{-1}11 = 1$

$2 = 3^{-1}23 = 2.2.3 = 12\%5 = 2$

$3 = 4^{-1}34 = 48\%5 = 3$

$4 = 1^{-1}41 = 4\%5 = 4$

So It is reflexive

If $a = g^{-1}bg$

$a = \left(g^{-1}b\right)g = \left(bg^{-1}\right)g$

$a = gbg^{-1} \Rightarrow g^{-1}a = g^{-1}gbg^{-1}$

[Since multiplication is commutative]

$g^{-1}a = bg^{-1}$

$g^{-1}ag = bg^{-1}g \Rightarrow g^{-1}ag = b$

$\Rightarrow b = g^{-1}ag \Rightarrow R_1$ is symmetric

For transitive

Let $a = g^{-1}bg$ and $b = g^{-1}cg$

Now to prove $a = g^{-1}cg$

Put value of b in $a = g^{-1}bg$

We have $\Rightarrow a = g^{-1}g^{-1}cg\, g \Rightarrow a = g^{-1}cg$

So transitive, so R_1 is equivalent relation

16. Consider the following two statements about database transaction schedules:

I. Strict two-phase locking protocol generates conflict serializable schedules that are also recoverable.

II. Timestamp-ordering concurrency control protocol with Thomas' Write Rule can generate view serializable schedules that are not conflict serializable.

Which of the above statements is/are TRUE?

(A) I only (B) II only (C) Neither I or II (D) Both I and II

Key: **(D)**

Sol: Strict 2 phase locking protocol ensures conflict serializability as well as strict recoverability.

So statement I is correct.

Thomas write rule sometimes discard the operation in case of multiple write and it is similar to view serializability, focus on last write.

So statement-II is also correct.

17. Let G be an undirected complete graph on n vertices, where n > 2. Then, the number of different Hamiltonian cycles in G is equal to

(A) n! (B) $\frac{(n-1)!}{2}$ (C) 1 (D) (n–1)!

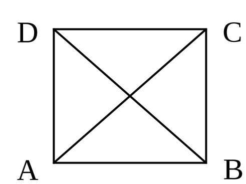
Key: **(B & C)**

Sol: **Option (B):**

For labeled nodes,

For an undirected complete graph G.

Number of Hamiltonian cycles are $\frac{(n-1)!}{2}$



$\frac{(n-1)!}{2} = \frac{3!}{2} = 3$

3 cycles are; ABCDA

ACBDA

ACDBA

Option (C):

For unlabelled nodes:

Every Hamilton cycle will be simialr. So answer is 1.

Since in question it is not mentioned whether the graph is labeled or not. So both answers are accepted.

18. Which of the following protocol pairs can be used to send and retrieve e-mails (in that order)?

(A) SMTP, MIME (B) IMAP, POP3 (C) IMAP, SMTP (D) SMTP, POP3

Key: **(D)**

Sol: SMTP and POP3 are application layer protocols which are responsible for email services specifically

$$\begin{array}{l} \text{SMTP} \rightarrow \text{Sending (or) outgoing mail(Push protocol)} \\ \text{POP3} \rightarrow \text{Retrieving (or) downloading mail(Pull protocol)} \end{array}$$

19. The following C program is executed on a Unix/Linux system:

```
# include < unistd.h>
int main ( )
{
    int i;
    for (i = 0; i < 10; i++)
            if (i % 2 = = 0) fork ( );
    return 0;
}
```

The total number of child processes created is ________.

Key: **(31)**

Sol: According to given logic, child creation is successful only for 5 times between 0 to 9 (As for loop is executed for 10 times)

$\therefore$ Number of child processes $= 2^n - 1 = 2^5 - 1 = 31$

20. Consider Z = X – Y, where X, Y and Z are all in sign-magnitude form. X and Y are each represented in n bits. To avoid overflow, the representation of Z would require a minimum of:

(A) n bits (B) n + 1 bits (C) n + 2 bits (D) n – 1 bits

Key: **(B)**

Sol: **Ist method:**

Take X=31, Y=-31, see both need 6 bits. But Z=X-Y=62 needs 7 bits in sign magnitude form. So, n+1 bits should be answer.

(or)

IInd method:

It is given that x, y, z are in sign magnitude form and represented using ‘n’ number of bit.

Let $[x = 3], [y = -3][z = x - y = 3 - (-3) = 3 + 3]$

$$\begin{array}{l} 3 \text{ in S.M} \rightarrow 011 \\ 3 \text{ in S.M} \rightarrow \underline{011} \\ \qquad\qquad 110 \rightarrow \text{represent } (-2) \text{ which is between overflow} \end{array}$$

If we represent 3 using 4 bits

$3 \to 0011$

$\underline{0011}$

$0110 \to +6\,(\text{no overflow})$

Same result can be verified by taking

$7+7$

$15+15$

$31+31$.......So on

So in general z needs n + 1 number of bits.

21. Which one of the following is NOT a valid identity?

(A) $(x\oplus Y)\oplus z = x\oplus(y\oplus z)$

(B) $x\oplus y = (xy + x'y')'$

(C) $(x+y)\oplus z = x\oplus(y+z)$

(D) $x\oplus y = x+y$, if $xy=0$

Key: **(C)**

Sol: 1. $(x\oplus y)\oplus z = x\oplus(y\oplus z)$

XOR-operator following commutative and associative, so this identity is valid.

2. $x\oplus y = (xy + x'y')' = \overline{x\odot y}$

This is also valid identity

3. $(x+y)\oplus z = x\oplus(y+z)$

x	y	z	$F_1=(x+y)\oplus z$	$F_2=x\oplus(y+z)$
0	0	0	0	0
0	0	1	1	1
0	1	0	1	1
0	1	1	0	1
1	0	0	1	1
1	0	1	0	0
1	1	0	1	0
1	1	1	0	0

$F_1 \neq F_2$

So, this identity is NOT valid.

4. $x \oplus y = x + y$, if $xy = 0$

$x \oplus y = x + y$

$x.(x \oplus y) = x.(x + y)$

$x.x \oplus x.y = x.x + x.y$

$x \oplus xy = x + xy$

$x \oplus 0 = x + 0 \quad (\because xy = 0)$

$x = x$

This identity is also valid.

22. Which one of the following statements is NOT correct about the B+ tree data structure used for creating an index of a relational database table?

(A) Key values in each node are kept in sorted order

(B) B+ Tree is a height-balanced tree

(C) Each leaf node has a pointer to the next leaf node

(D) Non-leaf nodes have pointers to data records

Key: (D)

Sol: Only leaf nodes have pointer to data records.

So option D is correct.

23. If L is a regular language over $\Sigma = \{a,b\}$; which one of the following languages is NOT regular?

(A) $\{ww^R \mid w \in L\}$

(B) $Prefix(L) = \{x \in \Sigma^* \mid \exists y \in \Sigma^* \text{ such that } xy \in L]$

(C) $L.L^R = \{xy \mid x \in L, y^R \in L\}$

(D) $Suffix(L) = \{y \in \Sigma^* \mid \exists x \in \Sigma^* \text{such that } xy \in L]$

Key: (A)

Sol: $\{ww^R \mid w \in L\}$ Is standard context free language

If $\Sigma = \{a,b\}$ then grammar is

$S \to aSa \mid bSb \mid \varepsilon$

Option (C), regular language are closed under reverse operation and concatenation hence (C) is a regular language.

Call the language of option (b) Prefix(L). the language of option (D) Suffix(L) and the language for reverse is Reverse(L).

Option (B) Prefix(L) = Reverse(Suffix(Reverse(L)). so if we establish the (b) and (c) parts, the (D) part follows.

Option (D) Because L is regular, there is a DFA that recognizes L. We make an NFA that accepts Suffix(L). First we modify the DFA to remove states that can never be reached. To do this, start by labeling the start state as reachable. Now whenever a state q is reachable and there is a transition from state q to state r. label state r as reachable. Repeat until all states are marked reachable, or until all states that are not reachable have no incoming transition from a reachable state. Delete all unreachable states. Next we modify the DFA to form an NFA as follows. Add a new start state s. Then for every (reachable) state r, add an ε -transition from s to r. Leave all accept states as in the DFA. This NFA accepts precisely the suffixes of L. Because Suffix(L) is accepted by an NFA. it is a regular language.

24. In 16-bit 2's complement representation, the decimal number –28 is:

(A) 1000 0000 1110 0100
(B) 0000 0000 1110 0100
(C) 1111 1111 0001 1100
(D) 1111 1111 1110 0100

Key: **(D)**

Sol: First represent +28 16-bit format

$+28 = 0000\ \ 0000\ \ 0001\ 1100$

$-28 = 1111\ \ 1111\ 1110\ \ 0100\ (2\text{'s complement of } +28)$

Finding, 2's complement of +28= 2's complement representation of –28.

25. Two numbers are chosen independently and uniformly at random from the set {1, 2… 13}. The probability (rounded off to 3 decimal places) that their 4-bit (unsigned) binary representations have the same most significant bit is __________.

Key: **(0.503)**

Sol:

$1-0\,0\,0\,0$

$2-0\,0\,1\,1$

$3-0\,0\,1\,0$

$4-0\,1\,0\,1$

$5-0\,1\,0\,0$

$6-0\,1\,1\,1$

$7-0\,1\,1\,0$

$8-1\,0\,0\,1$

$9-1\,0\,0\,0$

$10-1\,0\,1\,1$

$11-1\,0\,1\,0$

$12-1\,1\,0\,1$

$13-1\,1\,0\,0$

1–7 (MSB0) 7 numbers

8–13 (MSB1) 6 numbers

Required probability = Either both of them of MSB0 $\left(\frac{7}{13}\times\frac{7}{13}\right)$

Or both of them of MSB1 $\left(\frac{6}{13}\times\frac{6}{13}\right)$

$$=\frac{7}{13}\times\frac{7}{13}+\frac{6}{13}\times\frac{6}{13}=\frac{85}{169}=0.503$$

26. Consider the following relations P(X, Y, Z), Q(X, Y, T) and R(Y, V)

P		
X	**Y**	**Z**
X1	Y1	Z1
X1	Y1	Z2
X2	Y2	Z2
X2	Y4	Z4

Q		
X	**Y**	**T**
X2	Y1	2
X1	Y2	5
X1	Y1	6
X3	Y3	1

R	
Y	**V**
Y1	V1
Y3	V2
Y2	V3
Y2	V2

How many tuples will be returned by the following relational algebra query?

$\Pi_x\left(\sigma_{(P,Y=R,Y\wedge R.V=V2)}(P\times R)\right)-\Pi_x\left(\sigma_{(Q.Y=R.Y\wedge Q.T>2)}(Q\times R)\right)$. Answer ___________.

Key: **(1)**

Sol: Let $A=\pi_x\left(\underbrace{\sigma_{(P.Y=R.Y\wedge R.V=V_2)}(P\times R)}\right)$

$$\Downarrow$$

$$A=\frac{X}{X_2}$$

Let $B=\pi_x\left(\underbrace{\sigma_{(Q.Y=R.Y\wedge Q.T>2)}(Q\times R)}\right)$

$$\Downarrow$$

$$B=\frac{X}{X_1}$$

So A–B = 1 [Since X2 is not in B].

27. Which one of the following languages over $\Sigma = \{a,b\}$ is NOT a context free?

(A) $\{ww^R \mid w \in \{a,b\}^*\}$

(B) $\{wa^n w^R b^n \mid w \in \{a,b\}^*, n \geq 0\}$

(C) $\{a^n b^i \mid i \in \{n, 3n, 5n\}, n \geq 0\}$

(D) $\{wa^n b^n w^R \mid w \in \{a,b\}^*, n \geq 0\}$

Key : (B)

Sol: Option (A) is context free language

$S \to aSa \mid bSb \mid \varepsilon$

Option (C) is context free language

$S \to aSb \mid aSbbb \mid aSbbbbb \mid \varepsilon$

Option (D) is Context free language

$S \to aSa \mid bSb \mid S_1$

$S_1 \to aS_1b \mid \varepsilon$

Option (B) is NOT context free

28. Consider the following c-program

```
#include <stdio.h>
int r(){
static int num=7;
return num --;    }
int main(){
for (r();r();r())
printf("%d",r());
return 0;    }
```

Which one of the following values will be displayed on execution of the programs?

(A) 52   (B) 630   (C) 41   (D) 63

Key: (A)

Sol: for (r();r();r())

for initialization r() function will execute num will become 6

for conditional checking r() will execute and num will be 5

body of the loop executed and return value will be 5 and hence 5 will be printed

increment part of the loop will be executed as r() and value will be 3

again condition will be tested as r() num will be 2

```
body of the loop will print as r(), 2 will be printed value
decremented to 1
loop will break
final value printed is 52
```

29. There are n unsorted arrays: $A_1, A_2, \ldots\ldots, A_n$. Assume that n is odd. Each of $A_1, A_2, \ldots\ldots, A_n$ contains n distinct elements. There are no common elements between any two arrays. The worst-case time complexity of computing the median of the medians of $A_1, A_2, \ldots\ldots, A_n$ is

(A) $O(n)$ (B) $O(n\log n)$ (C) $O(n^2)$ (D) $\Omega(n^2 \log n)$

Key : **(C)**

Sol: Median of an array can be determine in linear time.

30. A relational database contains two tables Student and Performance as shown below:

Student

Roll_no.	Student name
1	Amit
2	Priya
3	Vinit
4	Rohan
5	Smita

Performance

Roll_no.	Subject_code	Marks
1	A	86
1	B	95
1	C	90
2	A	89
2	C	92
3	C	80

The primary key of the student table is Roll_no. For the performance table, the columns Roll_no and Subject_code together form the primary key. Consider the SQL query given below:

Select S. Student_name, sum (P. Marks)
FROM Student S, Performance P
WHERE P. Marks >84
GROUP BY S.Student_name;

The number of rows returned by the above SQL query is________.

Key: **(5)**

Sol: We are doing Cartesian product. So without any condition or constraint there are $5 \times 6 = 30$ rows.

But on applying where P marks > 84 there will be $5 \times 5 = 25$ Rows.

So there are 5 different student names.

So after group by 5 rows would be there.

31. Consider the following C program

```
#include <stdio.h>
int main(){
float sum = 0.0, j = 1.0, i = 2.0;
    while (i/j > 0.0625){
          j= j+j;
          sum = sum + i/j;
          printf("%f\n", sum);
    }
return 0; }
```

The number of times the variable sum will be printed, when the above program is executed, is _______.

Key : **(5)**

Sol:

Iteration	Condition	Sum
1st	2/1 > 0.0625	1
2nd	2/2 > 0.0625	1.5
3rd	2/4> 0.0625	1.75
4th	2/8> 0.0625	1.875
5th	2/16> 0.0625	1.9375
6th	2/32>> 0.0625 false	Break

Total sum value printed is 5

32. Let the set of functional dependencies $F = \{QR \to S, R \to P, S \to Q\}$ hold on a relation schema X=(PQRS). X is not in BCNF. Suppose X is decomposed into two schemas Y and Z, where Y=(PR) and Z = (QRS).

Consider the two statements given below.

I. Both Y and Z are in BCNF

II. Decomposition of X into Y and Z is dependency preserving and lossless

Which of the above statements is/are correct?

(A) II only (B) Both I and II

(C) Neither I nor II (D) I only

Key: (A)

Sol: $F = \{ \; QR \to S, \; R \to P, \; S \to Q \; \}$

$X(P,Q,R,S)$

$Y(P,R)$: $R \to P$

$Z(Q,R,S)$: $QR \to S$, $S \to Q$

Y is in BCNF

☆ 'QR' is key

☆ $'S \to Q'$ violates BCNF since S is not superkey

So Z is not in BCNF

Since no depending is lost when we combine Y and Z.

So it is dependency preserving

Also $Y \cap Z = R$

R is key in Y(P, R)

So Decomposition is lossless.

So only II statement is correct.

33. The index node (inode) of a Unix-like file system has 12 direct, one single-indirect and one double-indirect pointers. The disk block size is 4 kB, and the disk block address is 32-bits long. The maximum possible file size is (rounded off to 1decimal place)______GB.

Key: (4)

Sol: Given that $DBS = 4kB$

$DBA = 32 \text{ bits } (\text{or}) \; 4B$

$\therefore$ Number of addresses per DB $= \dfrac{DBS}{DBA} = \dfrac{4kB}{4B} = 2^{10}$

$\therefore$ Max file size

$$= 12\begin{pmatrix}\text{direct}\\ \text{pointers}\end{pmatrix} \times 4kB + 2^{10}\begin{pmatrix}\text{single indirect}\\ \text{pointer}\end{pmatrix} \times 4kB + (2^{10} \times 2^{10})\begin{pmatrix}\text{double indirect}\\ \text{pointers}\end{pmatrix} \times 4kB$$

$$= 48kB + 4MB + 4GB \approx 4GB$$

34. In a RSA cryptosystem, the value of the public modulus parameter n is 3007. If it is also known that $\phi(n) = 2880$, where $\phi()$ denotes Euler's Totient function, then the prime factor of n which is greater than 50 is_______

Key: (97)

Sol: Given that n = 3007

$\phi(n) = 2880$

As per RSA algorithm,

$n = p \times q = 3007 (97 \times 31)$

$\phi(n) = (p-1) \times (q-1) = 2880 (96 \times 30)$

For P = 97 and q = 31 only satisfies the given $n \,\&\, \phi(n)$

Since, the question is asking for a prime number which greater than 50, So 97 is correct answer.

35. Assume that in a certain computer, the virtual addresses are 64 bits long and the physical addresses are 48 bits long. The memory is word addressable. The page size is 8 kB and the word size is 4 bytes. The Translation Look-aside Buffer (TLB) in the address translation path has 128 valid entries. At most how many distinct virtual addresses can be translated without any TLB miss ?

(A) 256×2^{10} (B) 16×2^{10} (C) 4×2^{20} (D) 8×2^{20}

Key: (A)

Sol: Given $LA = 64\text{ bits}$, $PA = 48\text{ bits}$, $PS = 8\text{ kB}$

Word size = 4 Bytes

As per question, the memory is word addressable

$$\text{Page size (in words)} = \frac{\text{Page size}}{\text{word size}} = \frac{8\text{kB}}{4\text{B}} = 2\text{kW}$$

11 bits are required to represent a page (in words)

$\therefore$ 128 pages can be addresses with each of size 2kW

$\therefore$ Number of virtual addresses can be translated without any TLB miss

$= 2^7 \times 2^{11} = 2^8 \times 2^{10} = 256 \times 2^{10}$

36. Consider the following grammar and the semantic actions to support the inherited type declaration attributes. Let X_1, X_2, X_3, X_4, X_5, and X_6 be the placeholders for the non-terminals D, T, L or L_1 in the following table:

Production rule	Semantic action
$D \rightarrow TL$	X_1.type = X_2.type
$T \rightarrow$ int	T.type = int

T → float	T.type = float
L → L1, id	X_3.type = X_4.type addType(id.entry, X_5 .type)
L→id	addType(id.entry, X_6.typt)

Which one of the following are the appropriate choices for X_1, X_2, X_3 and X_4?

(A) $X_1 = T, X_2 = L, X_3 = T, X_4 = L_1$

(B) $X_1 = L, X_2 = L, X_3 = L_1, X_4 = T$

(C) $X_1 = T, X_2 = L_1, X_3 = L_1, X_4 = L_1$

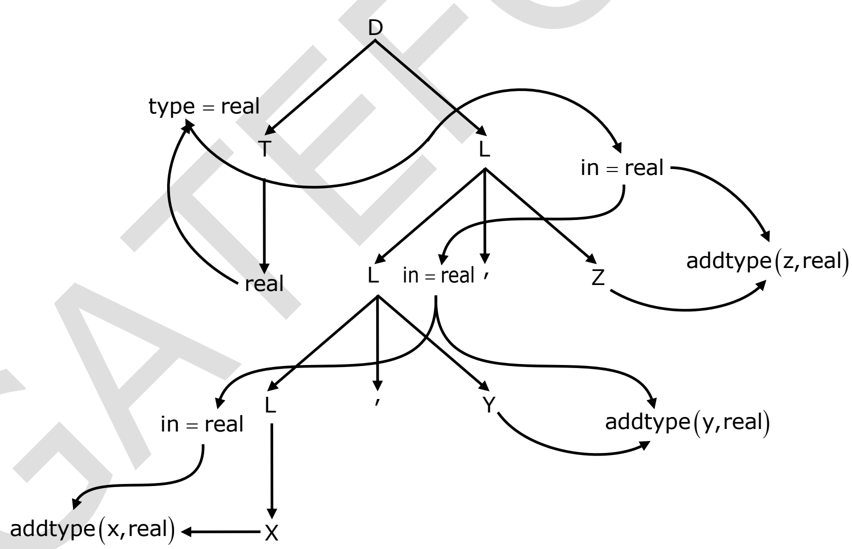
(D) $X_1 = L, X_2 = T, X_3 = L_1, X_4 = L$

Key :(D)

Sol:

D → T L	L.in = T.type
T → real	T.type = real
T → int	T.type = int
L → L_1 , id	L_1 .in = L.in; addtype(id.entry, L.in)
L → id	addtype (id.entry,L.in)

This is the way value will be propagated



37. Consider the following matrix

$$R = \begin{bmatrix} 1 & 2 & 4 & 8 \\ 1 & 3 & 9 & 27 \\ 1 & 4 & 16 & 64 \\ 1 & 5 & 25 & 125 \end{bmatrix}$$

The absolute value of the product of Eigen values of R is_______

Key: **(12)**

Sol: Product of Eigen values of R $= \det(R)$

$$\therefore |R| = \begin{vmatrix} 1 & 2 & 4 & 8 \\ 1 & 3 & 9 & 27 \\ 1 & 4 & 16 & 64 \\ 1 & 5 & 25 & 125 \end{vmatrix}$$

Applying $R_2 \to R_2 - R_1; R_3 \to R_3 - R_1; R_4 \to R_4 - R_1;$

$$\sim \begin{vmatrix} 1 & 2 & 4 & 8 \\ 0 & 1 & 5 & 19 \\ 0 & 2 & 12 & 56 \\ 0 & 3 & 21 & 117 \end{vmatrix} = \begin{vmatrix} 1 & 5 & 19 \\ 2 & 12 & 56 \\ 3 & 21 & 117 \end{vmatrix}$$

Again, applying $R_2 \to R_2 - 2R_1; R_3 \to R_3 - 3R_1$

$$\therefore |R| = \begin{vmatrix} 1 & 5 & 19 \\ 0 & 2 & 18 \\ 0 & 6 & 60 \end{vmatrix} = \begin{vmatrix} 2 & 18 \\ 6 & 60 \end{vmatrix} = 120 - 108 = 12$$

$\therefore$ The absolute value of the product of eigen values $= |\det(R)| = |12| = 12$

38. Consider the following C function.

```
void convert(int n){
    if(n<0)
                    printf(%d",n);
    else {
                    convert(n/2);
                    printf ("%d",n%2);
    }
}
```

Which one of the following will happen when the function `convert` is called with any positive integer n as argument?

(A) It will not print anything and will not terminate

(B) It will print the binary representation of n and terminate

(C) It will print the binary representation of n in the reverse order and terminate

(D) It will print the binary representation of n but will not terminate

Key : (A)

Sol: Suppose n is equal to 6

```
void convert(6){
        if(n<0)

        printf(%d",n);
        else {
        convert(3);
        printf ("%d",n%2);
        }
    }

void convert(3){
        if(n<0)
        printf(%d",n);
        else {


        convert(1);
        printf ("%d",n%2);
        }
    }

void convert(1){
        if(n<0)
        printf(%d",n);
        else {
        convert(0);
        printf ("%d",n%2);
        }
    }

void convert(0){
        if(n<0)

        printf(%d",n);
        else {
```

```
        convert(0);
        printf ("%d",n%2);
        }
    }
```

It will continue calling Convert(0) without terminating

39. Suppose Y is distributed uniformly in the open interval (1,6). The probability that the polynomial $3x^2+6xY+3Y+6$ has only real roots is (rounded off to 1 decimal place)____.

Key: **(0.8)**

Sol: Since $Y \sim U(1,6)$

$$\Rightarrow \text{p.d.f of } Y \text{ is } f(y) = \begin{cases} \frac{1}{5} \text{for} & 1 \le Y \le 6 \\ 0 & \text{otherwise} \end{cases}$$

P_r(Polynomial $3x^2+6x.y+3y+6$ has only real roots)

$$= P_r(Y \le -1) + P_r(Y \ge 2)$$

$$= \int_{-\infty}^{-1} f(y)dy + \int_2^{\infty} f(y)dy = 0 + \int_2^6 \left(\frac{1}{5}\right)dy = \frac{1}{5}(y)_2^6 = \frac{1}{5}(6-2) = \frac{4}{5} = 0.8$$

(Since, a quadratic equation $ax^2+bx+c=0$ has real roots if $b^2-4ac \ge 0$)

40. Let Σ be the set of all bijections from $\{1,\ldots,5\}$to $\{1,\ldots,5\}$, where id denotes the identity function, i.e. id(j) = j, $\forall$j. let $\circ$ denote composition on functions. For a string $x = x_1\, x_2 \ldots x_n \in \Sigma^n, n \ge 0$, let $\pi(x) = x_1 \circ x_2 \circ \ldots \circ x_n$.

Consider the language $L = \{x \in \Sigma^* \mid \pi(x) = \text{id}\}$. The minimum number of states in any DFA accepting L is______.

Key: **(120)**

Sol: Lets have all bijection possible from set $\{1,2,3\} \rightarrow \{1,2,3\}$

$$\left\{\begin{matrix} \{\{1,1\}\{2,2\},\{3,3\}\},\{\{1,1\}\{2,3\},\{3,2\}\} \\ \{\{1,2\}\{2,1\},\{3,2\}\},\{\{1,2\}\{2,2\},\{3,1\}\}, \\ \{\{1,3\}\{2,2\},\{3,1\}\}\{\{1,3\}\{2,1\},\{3,2\}\} \end{matrix}\right\}$$

Here, identity function is $\{\{1,1\}\{2,2\},\{3,3\}\}$

$$\Sigma \text{ is } \left\{\begin{array}{l} \{\{1,1\}\{2,2\},\{3,3\}\},\{\{1,1\}\{2,3\},\{3,2\}\} \\ \{\{1,2\}\{2,1\},\{3,3\}\},\{\{1,2\}\{2,2\},\{3,1\}\}, \\ \{\{1,3\}\{2,2\},\{3,1\}\}\{\{1,3\}\{2,1\},\{3,2\}\} \end{array}\right\}$$

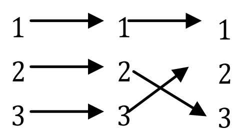
Lets represents it using a, b,c,d,e,f

Hence $\Sigma = \{a,b,c,d,e,f\}$ where a = $\{\{1,1\}\{2,2\},\{3,3\}\}$, b= $\{\{1,1\}\{2,3\},\{3,2\}\}$ and so on

String belong to the language will be

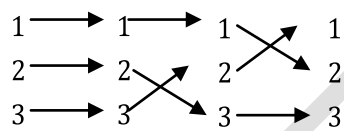
$\Sigma^* = \{ \varepsilon$, a, b, c, d, e, f, ab, ac ad……$\}$ and so on

Lets take a string "ab" and see where its maps



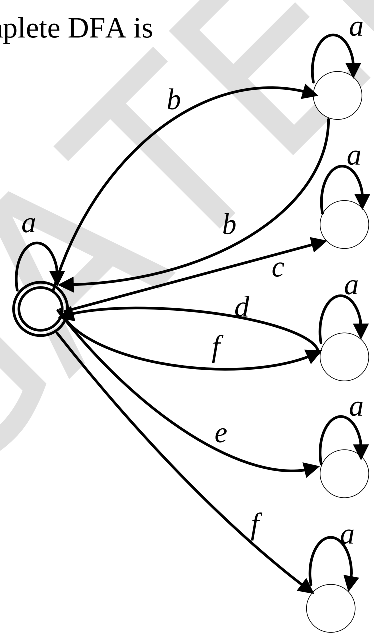
Which is $\{\{1,1\}\{2,3\},\{3,2\}\}$ = b

Suppose the string is "abc"



The "abc" will be mapped to $\{\{1,2\}\{2,1\},\{3,3\}\}$

The incomplete DFA is



For mapping {1,2,3} $\rightarrow$ {1,2,3}, 6 states required

For mapping {1,2,3,4,5} $\rightarrow$ {1,2,3,4,5} , 120 states required

41. Let T be a full binary tree with 8 leaves. (A full binary' tree has every level full.) Suppose two leaves a and b of T are chosen uniformly and independently at random. The expected value of the distance between a and b in T (i.e., the number of edges in the unique path between a and b) is (rounded off to 2 decimal places) _________

Key: **(4.25)**

Sol: A Full binary tree with 8 leaves, the number of ways in which 2 leaves independently can be chosen is $8\times8=64$

64 pairs of leaves exists

In this, 8 pairs will at distance 0 from each other

8 pairs will be at distance 2 from each others (children of the same parent)

16 pairs will be at distance 4 from each other

32 pairs will be at distance 6 from each other

Hence total distance is $8\times0+8\times2+16\times4+32\times6=272$

Expected distance is $\frac{272}{64}=4.25$

42. Consider the following statements:

I. The smallest element in a max-heap is always at a leaf node

II. The second largest element in a max-heap is always a child of the root node

III. A max-heap can be constructed from a binary search tree m $\theta(n)$ time

IV. A binary search tree can be constructed from a max-heap in $\theta(n)$ time

Which of the above statements are TRUE?

(A) I, II and III
(B) I, III and IV
(C) II, III and IV
(D) I, II and IV

Key : **(A)**

Sol: I. is TRUE, Smallest element always found at the leaf node.

II. second largest element is always present as children of the root

III. given a BST we can construct a Max heap using hepify in $\theta(n)$ time

IV. worst case time required to build a BST is $O(n^2)$

43. Consider three machines M, N, and P with IP address 100.10.5.2, 100.10.5.5, and 100.10.5.6. respectively. The subnet mask is set to 255.255.255.252 for all the three machines. Which one of the following is true?

(A) M, N, and P all belong to the same subnet

(B) Only M and N belong to the same subnet

(C) M, N, and P belong to three different subnets

(D) Only N and P belong to the same subnet

Key: **(D)**

Sol: IP addresses for the given 3 machines as follows:

$$\begin{array}{ccc} M & N & P \\ \downarrow & \downarrow & \downarrow \\ 100.10.5.2 & 100.10.5.5 & 100.10.5.6 \end{array}$$

Given subnet mask is 255.255.255.252.

Subnet address calculation for all 3 machines is…..

Machine (M)

$$\begin{array}{lcllll} \text{IP} & : & 100. & 10. & 5 & 2 \\ \text{SNMA} & : & 255. & 255. & 255. & 252 \\ \hline \text{SNA} & : & 100. & 10. & 5. & 0 \\ \hline \end{array} \longrightarrow (1) \qquad \begin{array}{l} 2 \rightarrow 0000\ 0010 \\ 252 \rightarrow 1111\ 1100 \\ \hline 0 \rightarrow 0000\ 0000 \\ \hline \end{array}$$

Machine (N)

$$\begin{array}{lcllll} \text{IP} & : & 100. & 10. & 5 & 5 \\ \text{SNMA} & : & 255. & 255. & 255. & 252 \\ \hline \text{SNA} & : & 100. & 10. & 5. & 4 \\ \hline \end{array} \longrightarrow (2) \qquad \begin{array}{l} 5 \rightarrow 0000\ 0101 \\ 252 \rightarrow 1111\ 1100 \\ \hline 4 \rightarrow 0000\ 0100 \\ \hline \end{array}$$

Machine (P)

$$\begin{array}{lcllll} \text{IP} & : & 100. & 10. & 5 & 6 \\ \text{SNMA} & : & 255. & 255. & 255. & 252 \\ \hline \text{SNA} & : & 100. & 10. & 5. & 4 \\ \hline \end{array} \longrightarrow (3) \qquad \begin{array}{l} 6 \rightarrow 0000\ 0110 \\ 252 \rightarrow 1111\ 1100 \\ \hline 4 \rightarrow 0000\ 0100 \\ \hline \end{array}$$

Since, (2) and (3) are same, N and P are belongs to the same subnet.

$\therefore$ Option (D) is correct.

44. Consider the following sets:

S1. Set of all recursively enumerable languages over the alphabet {0,1}

S2. Set of all syntactically valid C programs

S3. Set of all languages over the alphabet {0,1}

S4. Set of all non-regular languages over the alphabet {0,1}

Which of the above sets are uncountable?

(A) S1 and S4 (B) S3 and S4 (C) S1 and S2 (D) S2 and S3

Key : **(B)**

Sol: S1. Recursive enumerable language is accepted by TM and there are Countable number of TM possible.

S2. Countable. Given a length l, and a finite number of characters, c, we know that each length has only finitely many possible valid c codes c^L. We can easily make a bijection from the natural numbers to the lengths, and at each length we add only finite number of other valid code, thus countable.

S3. The Number of language over Σ is uncountable

S4. Non-regular language is Uncountable

45. Let *G* be any connected, weighted, undirected graph.

I. *G* has a unique minimum spanning tree, if no two edges of *G* have the same weight.

II. *G* has a unique minimum spanning tree, if, for every cut of G, there is a unique minimum-weight edge crossing the cut.

Which of the above two statements is/are TRUE?

(A) I only

(B) II only

(C) Neither I nor II

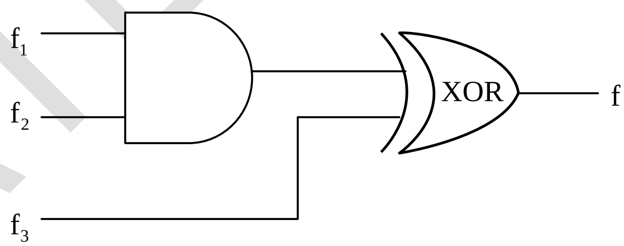
(D) Both I and II

Key: (D)

46. Consider three 4-variable functions f_1, f_2, and f_3, which are expressed in sum-of-minterms as

$$f_1 = \Sigma(0,2,5,8,14),\ f_2\Sigma(2,3,6,8,14,15),\ f_3 = \Sigma(2,7,11,14)$$

For the following circuit with one AND gate and one XOR gate, the output function f can be expressed as:



(A) $\Sigma(7,8,11)$

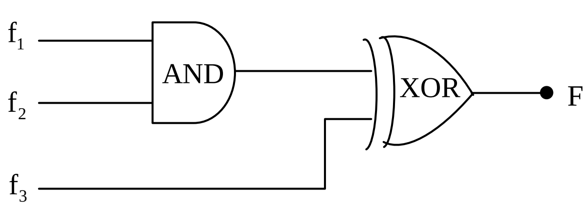
(B) $\Sigma(2,14)$

(C) $\Sigma(2,7,8,11,14)$

(D) $\Sigma(0,2,3,5,6,7,8,11,14,15)$

Key: (A)

Sol:



$F = (f_1.f_2) \oplus f_3$

It means overall minterm of F should be either minterm of (f_1. f_2) or minterm of f_3.

$f_1 = \Sigma(0,2,5,8,14)$
$f_2 = \Sigma(2,3,6,8,14,15)$
$f_3 = \Sigma(2,7,11,14)$

Minterm 2 and 14 is common in all three functions.

So, it shouldn't be in overall functions minterm.

These are not present only in option (A).

So, overall minterm $= \Sigma(7,8,11)$

47. Consider the following snapshot of a system running n concurrent processes. Process i is holding X_i instances of a resource R, $1 \le i \le n$. Assume that all instances of R are currently in use. Further, for all i, process i can place a request for at most Y_i additional instances of R while holding the X_i instances it already has. Of the n processes, there are exactly two processes p and q such that $Y_p = Y_q = 0$. which one of the following conditions guarantees that no other process apart from p and q can complete execution ?

(A) $X_p + X_q < \text{Min}\{Y_K \mid 1 \le K \le n, k \ne p, k \ne q\}$

(B) $\text{Min}(X_{p,} X_q) \le \text{Max}\{Y_k \mid 1 \le k \le n, k \ne p, k \ne q\}$

(C) $X_p + X_q < \text{Max}\{Y_k \mid 1 \le k \le n, k \ne p\ k \ne q\}$

(D) $\text{Min}(X_p, X_q) \ge \text{Min}\{Y_k \mid 1 \le k \le n, k \ne p, k \ne q\}$

Key: **(A)**

Sol: Both the Processes p and q have no additional requirements and can be finished releasing $Y_p + Y_q$ resources

So, option A just ensures that the system can proceed from the current state. It doesn't guarantee that there won't be a deadlock before all processes are finished.

Hence, option (A) is correct.

48. A certain processor deploys a single-level cache. The cache block size is 8 words and the word size is 4 bytes. The memory system uses a 60-MHz clock. To service a cache miss, the memory controller first takes 1 cycle to accept the starting address of the block, it then takes 3 cycles to fetch all the eight words of the block, and finally transmits the words of the requested block at the rate of 1 word per cycle. The maximum bandwidth for the memory system when the program running on the processor issues a series of read operations is _____ $\times\ 10^6$ bytes/sec.

Key: **(160)**

Sol: To accept the starting address = 1 cycle

To fetch all eight words – 3 cycles

To transmits the words of the requested block at the rate of 1 word per cycle- 8cycles

Total 12 cycles required

1 cycle duration = $\frac{1}{60\times10^6}$

12 cycle duration = $\frac{12}{60\times10^6} = \frac{1}{5\times10^6}\text{sec}$

In $\frac{1}{5\times10^6}\text{sec}$ 32 bytes transferred

1 sec -------------- $5\times10^6\times32\,bytes$

$=160\times10^6\,bytes$

Bandwidth is $=160\times10^6$ bytes/sec

49. Consider the augmented grammar given below:

$S'\to S$

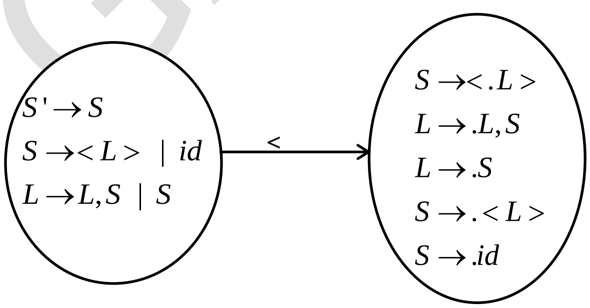
$S\to<L>\ |\ id$

$L\to L,S\ |\ S$

Let I_0 = CLOSURE ({[$S'\to\ \bullet S$]}). The number of items in the set GOTO $(I_o, <)$ is:________

Key: **(5)**

Sol:



50. Consider the following four processes with arrival times (in milliseconds) and their length of CPU bursts (in milliseconds) as shown below:

Process	**P1**	**P2**	**P3**	**P4**
Arrival time	0	1	3	4
CPU burst time	3	1	3	Z

These processes are run on a single processor using preemptive shortest remaining time first scheduling algorithm. If the average waiting time of the processes is 1 millisecond, then the value of Z is ________.

Key: **(2)**

Sol:

PID	AT	BT	CT	TAT	WT
P_1	0	3	4	4	1
P_2	1	1	2	1	0
P_3	3	3	$7+z$	$4+z$	$1+z$
P_4	4	z	$4+z$	z	0

Gantt Chart:

P_1	P_2	P_1	P_4	P_3

0	1	2	4	$4+z$	$3+z$
P_1-3	P_1-2 P_2-1	P_1-2	P_3-3 P_4-z	P_3-3	

$$\therefore \text{Average waiting time} = \frac{1+0+(1+z)+0}{4}$$

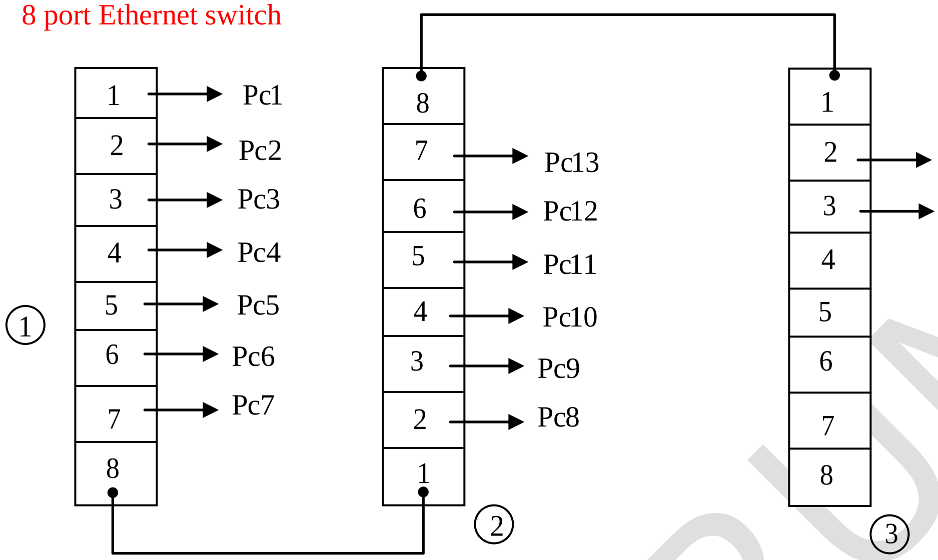
$$\Rightarrow 1 = \frac{1+0+(1+z)+0}{4}$$

$$\Rightarrow 1+0+(1+z)+0 = 4 \Rightarrow z = 2$$

51. Consider that 15 machines need to be connected in a LAN using 8-port Ethernet switches. Assume that these switches do not have any separate uplink port.The minimum number of switches needed is______________.

Key: **(3)**

Sol: 8 port Ethernet switch



$\therefore$ To connect 15 machines in a LAN using 8-port Ethernet switches, we require 3 switches.

52. Consider the first order predicate formula ϕ :

$$\forall x\left[\left(\forall z\ z \mid x \Rightarrow \left(\left(z=x\right) \vee \left(z=1\right)\right)\right) \Rightarrow \exists w\left(w>x\right) \wedge \left(\forall z\ z \mid w \Rightarrow \left(\left(w=z\right) \vee \left(z=1\right)\right)\right)\right]$$

Here $'a \mid b'$ denotes that 'a divides b' where a and b are integers. Consider the following sets:

S1 $\{1,2,3,.....,100\}$

S2 Set of all positive integers

S3 Set of all integers

Which of the above sets satisfy ϕ ?

(A) S1 and S3 (B) S1 and S2 (C) S2 and S3 (D) S1, S2 and S3

Key: **(C)**

Sol: It says that for all prim number x there exist a prime number greater than x

$\forall x\ \exists y\ y > x,$ Where x and y are prime numbers

So for $S_1 = \{1, 2,\ldots..100\}$

For prime number 97 this is not **TRUE**

But S_2 and S_3 are infinite sets

For S_2 and S_3 it is always **TRUE**

So S_2 and S_3 satisfy ϕ.

53. Consider the following C program

```
#include <stdio.h>
int main()  {
int a[] = {2, 4, 6, 8, 10};
int i, sum = 0, *b = a + 4;
for (i = 0; i < 5; i+d+ )
    sum = sum + (*b - i) - *(b - i);
printf("%d\n",sum);
return 0;
}
```

The output of the above C-program is _______.

Key: **(10)**

Sol: Consider the array and assumed base address as 100 and size of the element is 2B

2	4	6	8	10
100	102	104	106	108

b is a pointer assigned to 108

for loop is running

Iteration	*b-i	*(b-i)	Sum
i=0	(*(108)-0) =10-0	*(108-0)=10	0+10-10=0
I=1	(*(108)-1) =10-1=9	*(108-1) =*106=8	0+9-8=1
I=2	(*(108)-2) =10-2=8	*(108-2) =*104=6	1+8-6=3
I=3	(*(108)-3) =10-3=7	*(108-3) =*102=4	3+7-4=6
I=4	(*(108)-4) =10-4=6	*(108-4) =*100=2	6+6-2=10

Final Key is 10

54. Suppose that in an IP-over Ethernet network, a machine X wishes to find the MAC address of another machine Y in its subnet. Which one of the following techniques can be used for this?

(A) X sends an ARP request packet to the local gateway's MAC address which then finds the MAC address of Y and sends to X

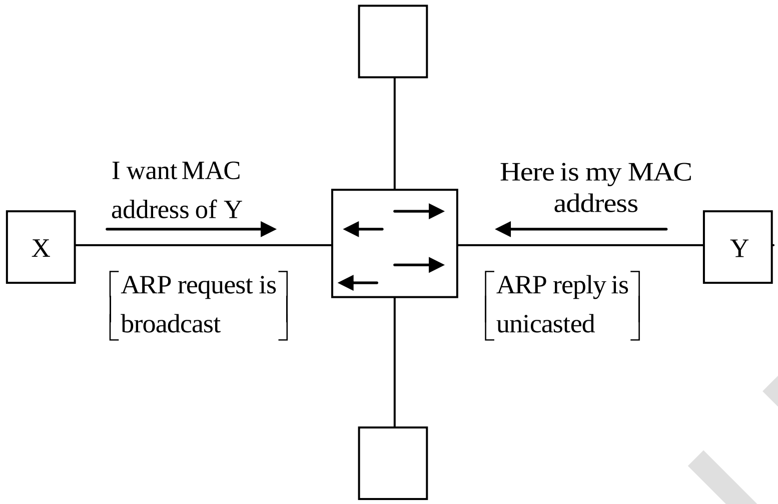
(B) X sends an ARP request packet with broadcast IP address in its local subnet

(C) X sends an ARP request packet to the local gateway's IP address which then finds MAC address of Y and sends to X

(D) X sends an ARP request packet with broadcast MAC address in its local subnet

Key: (D)

Sol:



ARP is a network protocol used to find the Hardware (MAC) address of a host from an IP address. It is a request reply protocol.

ARP request messages an used to request the MAC address, while

ARP reply messages an used to send the requested MAC address.

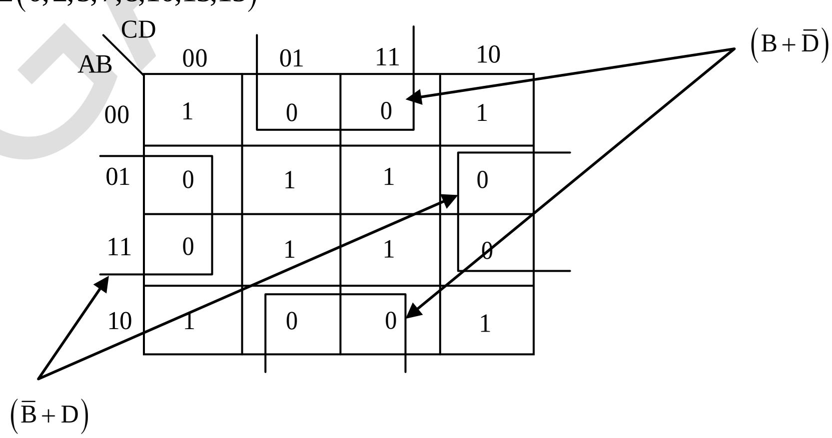
ARP request is sent to the broadcast address, the switch will flood the request out all interfaces. Every device on the LAN will receive the request, but only the device with the IP address will process it and sends an ARP reply message. Listing its MAC address.

Hence option (D) is correct.

55. What is the minimum number of 2-input NOR gates required to implement a 4-variable function expressed in sum-of minterms form as $f = \Sigma(0,1,5,7,8,10,13,15)$? Assume that all the inputs and their complements are available.

Key: (3)

Sol: $f = \Sigma(0,2,5,7,8,10,13,15)$

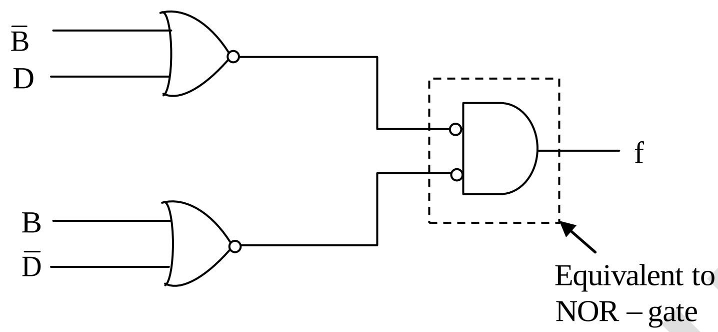


AB \ CD	00	01	11	10
00	1	0	0	1
01	0	1	1	0
11	0	1	1	0
10	1	0	0	1

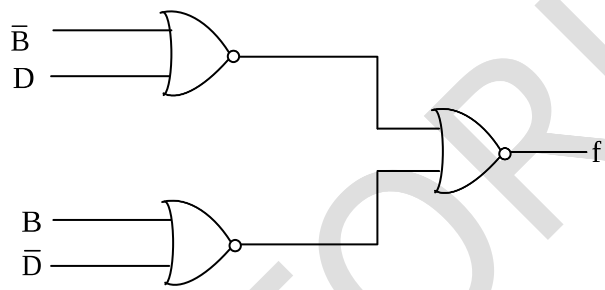
$f = \left(\bar{B}+D\right)\left(B+\bar{D}\right)$

As per the questions their complemented and normal both type of inputs are available.

So,



Their equivalent circuit can be redrawn like.



Therefore, minimum number of NOR-gate = 3.