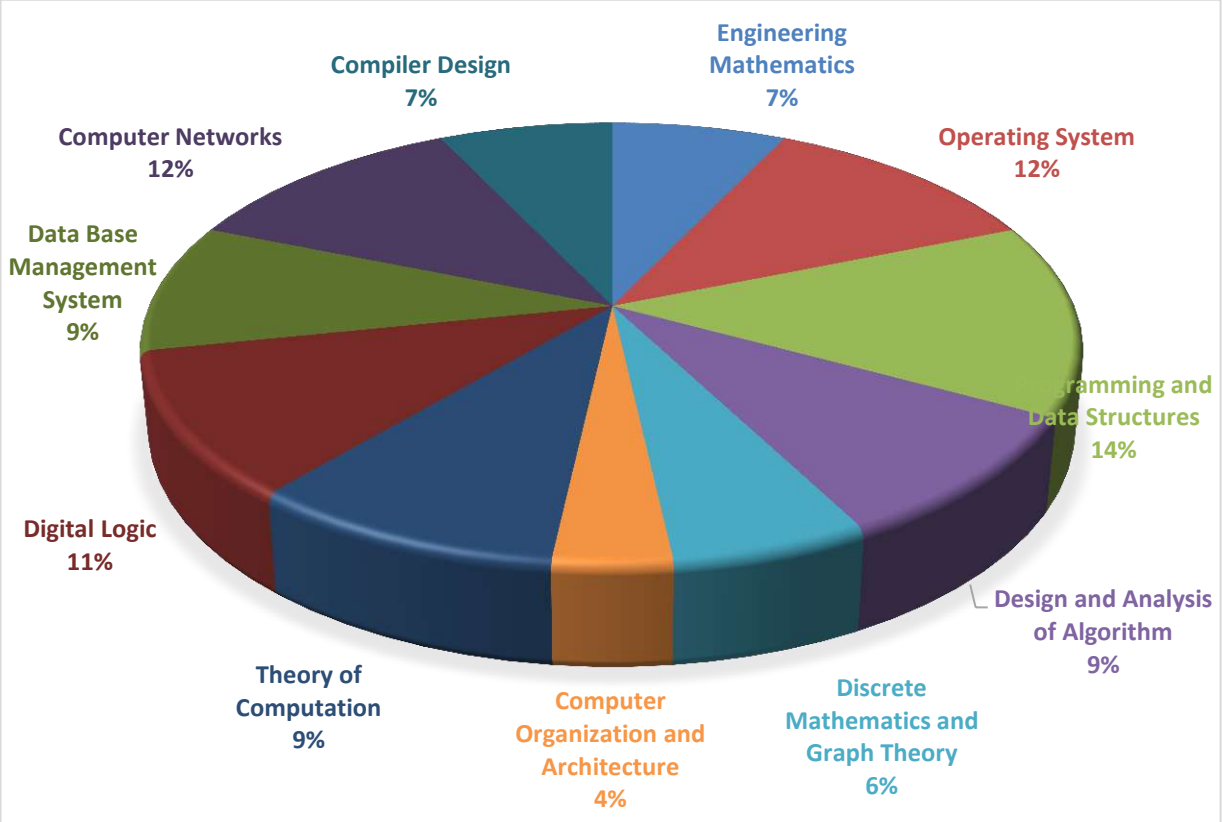
ANALYSIS OF GATE 2019

Computer Science and Information technology



CS ANALYSIS-2019_Feb-3_Morning

SUBJECT	No. of Ques.	Topics Asked in Paper(Memory Based)	Level of Ques.	Total Marks
Engineering Mathematics	1 Marks: 2 2 Marks: 2	Limits, Real roots probability	Medium	6
Operating System	1 Marks: 2 2 Marks: 4	Fork, time-shared OS, TLB, inode, SRTF, Deadlock	Hard	10
Programming and Data Structures	1 Marks: 2 2 Marks: 5	Painter to array, Function call recursion, Storage classes, Binary Tree	Easy	12
Design and Analysis of Algorithm	1 Marks: 2 2 Marks: 3	Quick sort, subsequence sum, MST max heap,	Medium	8
Discrete Mathematics and Graph Theory	1 Marks: 3 2 Marks: 1	Hamiltonian cycle, Equivalence relation, Set theory, Graph theory	Medium	5
Computer Organization and Architecture	1 Marks: 1 2 Marks: 1	TAG, memory Organization	Medium	3
Theory of Computation	1 Marks:2 2 Marks: 3	Regular language, Pumping DFA, CFL, Countability,	Medium	8
Digital Logic	1 Marks: 5 2 Marks: 2	D-RAM, 2SCompliments, Logic gates, Boolean Functions,	Medium	9
Data Base Management System	1 Marks: 2 2 Marks: 3	B+Trees, SQL Normalization, Relational Algebra, Concurrency Control	Easy	8
Computer Networks	1 Marks: 2 2 Marks: 4	Protocols, Network Security, IP Addressing,	Medium	10
Compiler Design	1 Marks: 2 2 Marks: 2	Parsing, Augmented Grammar Production Rule,	Easy	6
General Aptitude	1 Marks: 5 2 Marks:5	Numbers, Data Interpretation, Grammar	Medium	15
Total	65			
Faculty Feedback	Overall medium level difficulty paper.			

GATE 2019 Examination

Computer Science and Information technology

Test Date: 3-FEB-2019

Test Time: 9.30 AM to 12:30 PM

Subject Name: Computer Science and Information technology

General Aptitude

Q.1 - Q.5 Carry One Mark each.

1. A court is to a judge as _____ is to a teacher
   (A) A syllabus
   (B) A punishment
   (C) A student
   (D) A school
   [Ans. D]
   As court is work-place for judge, similarly school is work-place for teachers.

2. Two cars start at the same time from the same location and go in the same direction. The speed of the first cars is 50km/h and the speed of the second car is 60km/h. The number of hours it takes for the distance between the two cars to be 20km is _____.
   (A) 6
   (B) 2
   (C) 3
   (D) 1
   [Ans. B]
   Since both the cars 'A' and 'B' start at same time from same place.
   So, speed of car 'B' with respect to car 'A' is 10 km/hr
   So, time taken to be a gap of 20 kms between them $= \frac{20 \text{ km}}{10 \text{ kmph}} = 2$ hours.

3. The expenditure on the project _____ as follows: equipment Rs.20 lakhs, salaries Rs.12 lakhs, and contingency Rs.3 lakhs.
   (A) Break down
   (B) Break
   (C) Breaks down
   (D) Breaks
   [Ans. C]
   'Breaks down' is a transitive phrasal verb which means to divide something such as a total amount into separate parts.

Option (c) is most appropriate.

4. The search engine's business model _____ around the fulcrum of trust.
(A) Revolves
(B) Sinks
(C) Bursts
(D) Plays
[Ans. A]
The search engine business model revolves around the fulcrum of trust.
Fulcrum is anything that plays a central or essential role in an activity, event, or situation.
Thus, out of the given options, 'revolves' is the most appropriate.

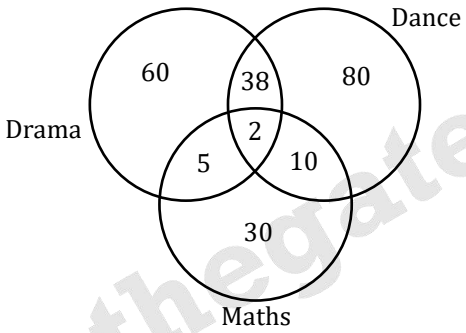
5. Ten friends planned to share equally the cost of buying a gift for their teacher. When two of them decided not to contribute, each of the other friends had to pay Rs 150 more. The cost of the gift was Rs._____.
(A) 3000
(B) 12000
(C) 6000
(D) 666
[Ans. C]
As two students did not pay their share for the gift; share of remaining students increased by Rs.150 each.
$\Rightarrow$ increased money to be paid $= 150 * 8 = 1200$
This 1200 is nothing but the share of those two students who didn't pay.
$\Rightarrow$ share of each $= \frac{1200}{2} = 600$, and this is share of every students to be paid
$\therefore$ total cost $= 600 * 10 = 6000$

Q.6 - Q.10 Carry Two Mark each.

6. "A recent High Court judgement 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 is an offence that has to be dealt with firmly

(B) Beggars are created because of the lack of social welfare schemes
(C) Begging has to be banned because it adversely affects the welfare of the state
(D) Beggars are lazy people who beg because they are unwilling to work
[Ans. B]
The passage states that the underlying disease behind begging is the failure of the state to protect citizens who fall through the social security net.

7. 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) 225
(C) 900
(D) 1000
[Ans. C]



Total number of students $= 60 + 80 + 30 + 38 + 5 + 10 + 2 = 225$
$25\% = 225$
$\Rightarrow 100\% = \frac{225}{25} = 100 = 900$

8. 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 statements made above is true. Who committed the crime?
(A) S
(B) R

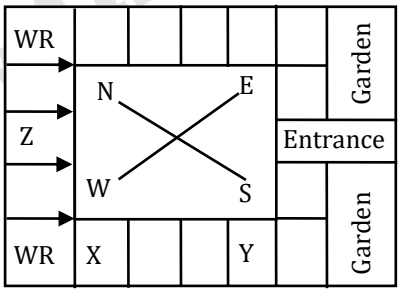
(C) Q
(D) P
[Ans. B]

P	Q	R	S
T	F	T	T
F	T	T	F
F	F	T/F	T

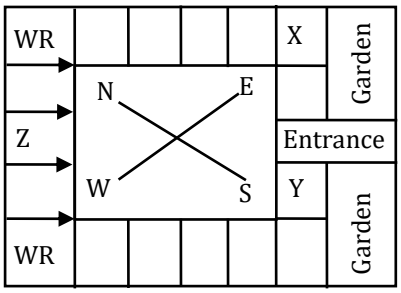
In such scenario, we assume one person tells true.
If P is telling true, Q will automatically be false and if Q is false then S is automatically true according to scenario. And R is already telling true. But, here we are gaining 3 persons telling truth which is not matching our criteria of only one statement being true.
Similarly if Q is telling true, means P is telling false. And if Q is true then S is automatically be false. Here also, we are gaining more than one statement to be true.
So, we assume P is telling false, means Q is also telling false means S is automatically telling true. So, we have **two choices for R as true or false**. So, R is telling false to match our criteria.
Since **R** is telling **false** that he has not done anything means **he is the culprit**.

9. 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 by 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.

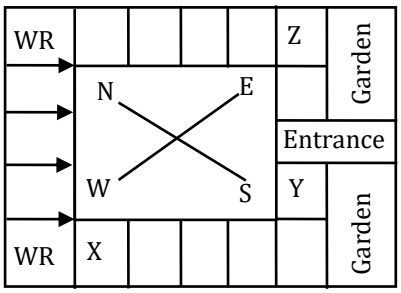
(A)



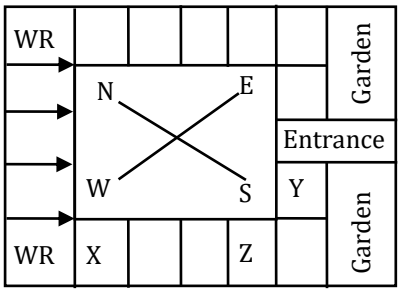
(B)



(C)

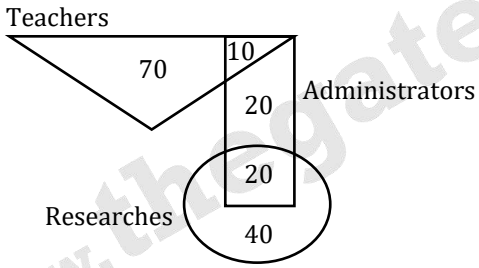


(D)



[Ans. D]

10. In the given diagram, teachers are represented in the triangle, researches in the circle and administrators in the rectangle. Out of the total number of the people, the percentage of administrations shall be in the range of _____



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

[Ans. C]

Number of Administrators = 10+20+20=50

Total number of person= 80+20+20+40=160

So, % of Administrators $= \left(\frac{50}{160}\right) \times 100 = \frac{5}{16} \times 100 = 31.25\%$

Technical

Q.1 - Q.25 Carry One Mark each.

1. 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) Non-leaf nodes have pointers to data records
   (C) Each leaf node has a pointer to the next leaf node
   (D) B^+ Tree is a height-balanced tree

   [Ans. B]
   (A) Key values whenever insert any key, node should be sorted order –it is correct
   (B) Leaf node pointer points to next node to access nodes in order –it is correct
   (C) Balanced tree which is from root to leaf node length of the path should be same–it is correct
   (D) Non-leaf have pointers to date records it is false because only in leaf node pointers to date records –it is in correct

2. Consider the grammar given below:
   $S \rightarrow Aa$
   $A \rightarrow BD$
   $B \rightarrow b|\epsilon$
   $D \rightarrow d|\epsilon$
   Let a, b, c, 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 answer should be 3210)

   [Ans. *]Range: 31 to 31
   Follow (A) = {a}
   Follow (D) = FIRST(B) = {d, ∈ (not allowed)}
   Deriver of expression $A \rightarrow DB$ is A so take
   Follow(A) = {a}
   Follow(D) ={d, a}
   Descending order {a, d}
   31

3. 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 _____.

[Ans. *] Range: 31 to 31

'If' condition get succeeded'5' times FOR loop i.e. i=0, 2, 4, 6, 8

First '5' forks get created each will execute further

∴ number of times fork is executed $=2^5$ times

# of new children are created $= 2^5 - 1 = 31$

4. An array of 25 distinct elements is to be sorted using quicksort. Assume that the pivot elements are 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 _____

[Ans. *]Range: 0.08 to 0.08

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

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

[Ans. B]

SMTP and POP3 are the protocols which are responsible for the email communication, SMTP is responsible for outgoing mail & POP3 is responsible for retrieving mail.

6. The value of 3^{51} mod 5 is _____.

[Ans. *]Range: 2 to 2

By Fermat's theorem

$3^{(5-1)} \bmod 5 = 1$

$3^4 \bmod 5 = 1$

$3^{51} \bmod 5 = (3^4)^{12} . 3^3 \bmod 5$

$= 3^3 \bmod 5$

$= 2$

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

[Ans. *]Range: 0.502 to 0.504

1=0001
2=0010
3=0011
4=0100
5=0101
6=0110
7=0111
⑦

8=1000
9=1001
10=1010
11=1011
12=1100
13=1101
⑥

$$\left(\frac{7}{13}\times\frac{7}{13}\right)+\left(\frac{6}{13}\times\frac{6}{13}\right)$$
$$=\frac{49}{169}+\frac{36}{169}$$
$$=\frac{49+36}{169}$$
$$=\frac{185}{169}$$
$$=0.5029$$

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

(A) $x \oplus y = (xy + x'y')'$
(B) $(x + y) \oplus z = x \oplus (y + z)$
(C) $x \oplus y = x + y, \text{if } xy = 0$
(D) $(x \oplus y) \oplus z = x \oplus (y \oplus z)$

[Ans. B]

(A) $L\,H\,S = x \oplus y$
$R\,H\,S = (xy + x'y')' = (x \odot y') = x \oplus y$
$L\,H\,S = R\,H\,S \Rightarrow$ true

(B) $L\,H\,S = x \oplus y$; condition $x.y = 0$; $R\,H\,S = x + y$

x	y	L H S	R H S
0	0	0	0
0	1	1	1
1	0	1	1

$\Rightarrow$ True

(C) $L\,H\,S = (x + y) \oplus z$
$R\,H\,S = x \oplus (y + z)$

X y z	L H S	R H S

0 1 1	0	1

L H S ≠ R H S ⇒ False

(D) L H S = $(x \oplus y) \oplus z$

R H S = $x \oplus (y \oplus z)$

X y z	L H S	R H S
0 1 1	0	0

As associative ⇒ True

9. Compute $\lim_{x\to 3} \frac{x^4-81}{2x^2-5x-3}$

(A) 1

(B) Limit does not exist

(C) 108/7

(D) 53/12

[Ans. C]

$$\frac{3^4-81}{2\times 3^2-5\times 3-3}=\frac{81-81}{18-15-3}=\frac{0}{0}\rightarrow \text{indeterminant}$$

L′ Hospital

$$\lim_{x\to 3}\frac{4x^3}{4x-5}$$

$$\Rightarrow \frac{4\times 3^3}{4\times 3-5}=\frac{108}{7}$$

10. Consider the following two statements about database transaction schedule:

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 statement is/are TRUE?

(A) I only

(B) Neither I nor II

(C) Both I and II

(D) II only

[Ans. C]

(I) 2PL is conflict serializable then we can say strict 2PL also conflict serializable.
In strict 2PL exclusive locks will be unlocked after commit because of this, there may not be dirty read. If there is no dirty read then we can say it is recoverable.
Statement (I) is true

(II) Thomas write rule using this user can achieve view serializable schedules, and it ignores obsolete writes so here it generates view serializable which is not conflict serializable

11. Let $U = \{1,2,\cdots,n\}$. Let $A = \{(x,X)|x \epsilon X, X \leq U\}$. Consider the following two statements on $|A|$.

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

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

Which of the above statements is/are TRUE?

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

[Ans. C]

Both I and II are equivalent statements.

12. 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) $n + 2$ bits
(B) n bits
(C) $n + 1$ bits
(D) $n - 1$ bits

[Ans. C]

Case (i)

$x = +7 = 0111$ (4 bits)
$y = -7 = 1111$ (4 bits)

$x - y = +7 - (-7) = +14 = 01110$ (5 bits)

Case (ii)

$x = -7 = 1111$ (4 bits)
$y = +7 = 0111$ (4 bits)

$x - y = -7 - (-7) = -14 = 11110$ (5 bits)

→ To avoid overflow, we require 5-bits to accommodate the results of x-y when we consider x and y are rof 4- bit numbers in sign-magnitude form

→ SO for n-bits of x and y, the answer will be $n + 1$ bits for $x - y$

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

I. X is invertible
II. Determinant of X is non-zero

Which one of the following is TRUE?

(A) I implies II; II does not imply I.
(B) II implies I; I does not imply II.
(C) I does not imply II; II does not imply I.
(D) I and II are equivalent statements.

[Ans. D]

For a square matrix to be invertible , its determinate must be non-zero

$A^{-1} = \frac{Adj[A]}{|A|} \Rightarrow$ If $|A| = 0, A^{-1}$ does not exists

If $|A| \neq 0$, and x is a square matrix, it will always be invertible

Hence, both the statements are equivalent

14. Consider three concurrent processes P1 , P2 and P3 as shown below. Which access a shared variable D that has been initialized 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 _____.

[Ans. *]Range 80 to 80

⇒ For each process, given instruction are divided into

1. Load
2. Execute
3. Store

By executing interleaved minimum value possible for 'D' is 50

1. $P_2(1, 2 \downarrow$ preempted), before storing preemption
2. P_1 executed completely
3. P_3 executed completely
4. P_2 (3)

Minimum value ='50'

Similarly for maximum value:

1. P_1 (1, 2 ↓ preempted)
2. P_2 executed completely
3. P_1(3)
4. P_3 executed completely

Maximum value ='130'

$y - x \Rightarrow 130 - 50 = 80$

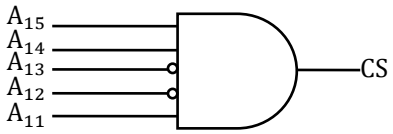
15. Which one of the following kinds of derivation is used by LR parsers?

(A) Rightmost
(B) Leftmost in reverse
(C) Leftmost
(D) Rightmost in reverse

[Ans. D]

LR parser is a bottom up parser. Hence it uses right most derivation in reverse order.

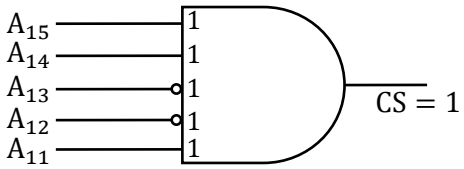
16. The chip select logic for a certain DRAM chip in a memory system design is shown below. Assume that the memory system has 16 address lines denoted by A_{15} to A_0. What is the range of addresses (in hexadecimal) of the memory system that can get enabled by the chip select (CS) signal?



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

[Ans. A]

The address lines are given by A_{15} to A_0



$\Rightarrow A_{15} = A_{14} = A_{11} = 1$

$\Rightarrow A_{13} = A_{12} = 0$

A_{15} A_{14} A_{13} A_{12}	A_{11} A_{10} A_9 A_8	A_7 A_6 A_5 A_4	A_3 A_2 A_1 A_0
1 1 0 0	1 x x x	x x x x	x x x x
1 1 0 0	1 0 0 0	0 0 0 0	0 0 0 0 (x=0 starting address)
	⋮		
1 1 0 0	1 1 1 1	1 1 1 1	1 1 1 1 (x=3 ending address)

Range: C800 - CFFF

17. A certain processor uses a fully associative cache of size 16kB. 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 (1m) in the addresses generated by the processor?

(A) 24 bits and 0 bits
(B) 28 bits and 4 bits
(C) 24 bits and 4 bits

(D) 28 bits and 0 bits

[Ans. D]

Cache memory size = 16 kB

Block size = 16 B

Main memory address = 32 bit

Number of line (N) $= \frac{16\text{ k}}{16} \Rightarrow \frac{2^{14}}{2^4} = 2^{10}$

Fully associative cache memory (N-way)

So, number of sets (S) $= \frac{\text{N}}{\text{P-way}} \Rightarrow \frac{2^{10}}{2^{10}} = 1$

∴ Address format:

32 bit

TAG	WO

28 bit $\log_2 16 = 4$ bit

So, TAG = 28 bit

Index = 0 bit (No address)

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

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

(B) $\{ww^R | w \in L\}$

(C) Suffix (L) $= \{y \in \sum* | \exists x \in \sum* \text{ such that } xy \in L\}$

(D) Prefix (L) $= \{x \in \sum* | \exists y \in \sum* \text{ such that } xy \in L\}$

[Ans. B]

(D)is the correct option . It is not regular. Because for that we need to do matching of 'w'with 'w^R'. For that we require a memory to store 'w' then do matching with 'w^R'. So, for that we need a stack along with FA So, option (D) is not regular language. Option (A) is $L.L^R$ = It is concatenating L with L^R. Since we know that reverse of regular language is regular concatenating of two regular language is regular

Option (B) is suffix of L. And suffix of regular language L is regular so, option (B) is regular language similarly option (C) is regular language

Pumping lemma for a regular language makes sure that any string in that language with the length greater than pumping length has some repetition

So option (A) (B) and (C) are incorrect because b^{10} is a string in 'L' which don't have any repetition . So, option (D) is the correct option as after that all string of length greater then 24 has repetition

19. For $\sum = \{a, b\}$, let us consider the regular language $L = \{x | x = a^{2+3k}$ 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) 3
(B) 5
(C) 9
(D) 24

[Ans. D]

$L = \{a^{2+3k}$ or $b^{10+12k}\}$ for $k \geq 0$
$= a^2(a^3)^*$ or $b^{10}(b^{12})^*$
$= \{a^2, a^5, a^8, \cdots, b^{10}, b^{22}, b^{34} \cdots\}$

The pumping length is p, than for any string $w \in L$ with $|w| \geq p$ must have a repetition i.e. such a string must be breakable into $w = xyz$ such that $|y| \geq 0$ and y can be pumped indefinitely, which is same as saying $xyz \in L \Rightarrow xy^*z \in L$.

The minimum pumping length in this language is clearly 11, since b^{10} is a string which has no repetition number, so up to 10 no number can serve as a pumping length. Minimum pumping length is 11. Any number at or above minimum pumping length can serve as a pumping length. The only number at or above 11, in the choice given is 24.

20. 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) 1
(C) $(n-1)!$
(D) $\frac{(n-1)!}{2}$

[Ans. D]

In a complete graph we can traverse the n vertices in any order and return to the starting vertex and form a Hamiltonian cycle. The number of such cycles will be n!

However, since circular rotations will have to ignored. Since for example K_4 with vertices {1, 2, 3, 4}, the cycle 1-2-3-4 is same as 2-3-4-1 is same as 3-4-1-2 etc. we now get only (n – 1)! distinct Hamiltonian cycles. Further, the cycle 1-2-3-4 and 1-4-3-2 are also same (clockwise and anticlockwise).

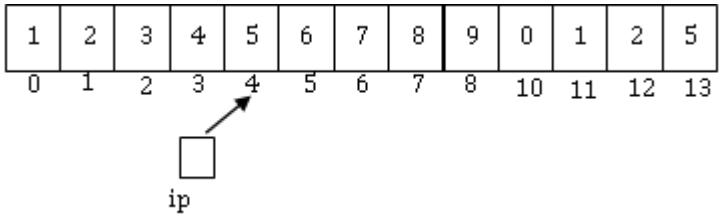
So ignoring this orientation also we finally get $\frac{(n-1)!}{2}$ distinct Hamiltonian cycles which Ans.D

21. 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 _____

[Ans. *]Range 6 to 6



$*ip = arr + 4$

$ip[0] = arr[4] = 5$

$ip[1] = arr[5] = 6$

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

[Ans. *]Range: 29 to 29

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

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

[Ans. C]

1. Convert +28 into binary as :1100 in 16 bit 0000 0000 00011100
2. 1's complement of +28 as :1111 1111 1110 0011
3. 2's complement of +28 as :
   Add 1 to step2

```
1111 1111 1110 0011
                 +1
-------------------
1111 1111 1110 0100
```

24. Let G be an arbitrary group. Consider the following relations on G:
R_1: $\forall a, b \in G$, a R_1 b if and only if $\exists g \in G$ such that $a = g^{-1}bg$
R_2: $\forall a, b \in G$, a R_2 b if and only if $a = b^{-1}$
Which of the above is/are equivalent relation/relations?
(A) R_1 and R_2
(B) R_1 only
(C) R_2 only
(D) Neither R_1 nor R_2
[Ans. B]

R1: $\forall a, b \in G$, a R^1 b if and only if $\exists g \in G$ such that $a = g^{-1}bg$

Reflexive: $a = g^{-1}ag$ can be satisfied by putting $g = e$, identity "e" always exists in a group. So reflexive

Symmetric: aRb $\Rightarrow a = g^{-1}bg$ for some g
$\Rightarrow b = gag^{-1} = (g^{-1})^{-1}ag^{-1}$

g^{-1} Always exists for every $g \in G$.
So symmetric

Transitive: aRb and bRc $\Rightarrow a = g_1^{-1}bg_1$ and $b = g_2^{-1}cg_2$ for some $g_1g_2 \in G$.

Now $a = g_1^{-1}g_2^{-1}cg_2g_1 = (g_2g_1)^{-1}cg_2g_1$
$g_1 \in G$ and $g_2 \in G \Rightarrow g_2g_1 \in G$ since group is closed so aRb and aRb $\Rightarrow$ aRc
Hence transitive
Clearly R_1 is equivalence relation.

R_2 is not equivalence it need not even be reflexive, since $aR_2a \Rightarrow a = a^{-1}$ $\forall a$ which not be true in a group.
R_1 is equivalence relation is the correct answer.

25. 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;
}
```

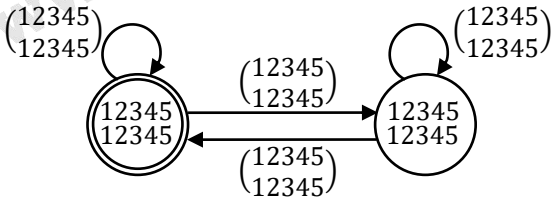
The value printed by the program is _____
[Ans. *]Range 26 to 26

main x y
2 5
jumble x y
1. [5] [2]
2. [12] [2]
$x = 2 * 5 + 2 = 12$

main
$x = 2 * 12 + 2 = 26$
main
Output=26

Q.26 - Q.55 Carry Two Mark each.

26. Let $\sum$ 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 $x = x_1 x_2 \ldots x_n \in \sum^n, n \geq 0$, let $\pi(x) = x_1 \circ x_2 \circ \ldots \circ x_n$.
Consider the language $L = \{x \in \sum^{\circ} | \pi(x) = id\}$. The minimum number of states in any DFA accepting L is _____.
[Ans. *]Range: 120 to 120
120)
The DFA for accepting L will have $5! = 120$ states, since we need one state for every possible permutation function on 5 elements. The starting state will be "id" state, named as $\binom{12345}{12345}$ and from there n! arrows will go the n! states each named with a distinct permutation of the set {1, 2, 3, 4, 5}. Since composition of permutation function is closed every arrow has to go to some permutation and hence some state.
Since the language only has those strings where $\pi(x) = id$ only the starting state ("id" state) will be the final state. Sample machine with only 2 states is shown below



27. 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)
[Ans. *]Range: 0.8 to 0.8
Polynomial $3x^2 + 6xY + 3Y + 6$ has only real roots
$b^2 - 4ax \geq 0$
$(6Y)^2 - 4(3)(3Y + 6) \geq 0$
$Y2 - Y + 2 \geq 0$

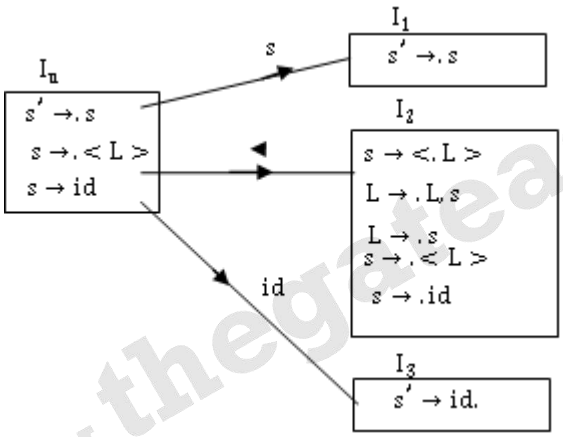
$Y \in (-\infty, -1] \cap [2, \infty)$
$\Rightarrow Y \in [2, 6)$
Since y is uniformly distributed in (1, 6)
Probability distributed function

$$f(Y) = \frac{1}{5} \quad 1 < y < 6$$

$$p(2 \le y < 6) = \int_2^6 f(Y)\, dy$$

$$= \frac{1}{5}[Y]_2^6 = \frac{4}{5} = 0.8$$

28. Consider the augmented grammar given below:
$S' \rightarrow S$
$S \rightarrow \langle L \rangle \mid id$
$S \rightarrow L, S \mid S$
LetI_0 = CLOSURE ({[$S' \rightarrow$ °S]}). The number of items in the set GOTO (I_0, ⟨) is: _____.
[Ans. *] Range: 5 to 5



29. Let the set of functional dependencies $F = \{QR \rightarrow S, R \rightarrow P, S \rightarrow Q\}$ 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 Z into Y and Z is dependency preserving and lossless
Which of the above statements is/are correct?
(A) I only
(B) Neither I nor II
(C) II only
(D) Both I and II
[Ans. C]
F: {QR →, R → P, S → Q}

X(PQRS)decomposed into Y(P, R), Z(Q, R, S)

Statement (II) Dependency preserving:

Y: $P^+ = \{P\}$
$R^+ = \{P, R\}$

So Functional dependencies $R \rightarrow P$

Z: $QR^+ = \{S, Q, R, \}$
$S^+ = \{S, Q\}$

So Functional dependencies $QR \rightarrow S, S \rightarrow Q$

These Functional dependencies are equals to Functional dependencies of X so it is dependency Preserving.

Lossless Decomposition:

1. attribute (Y) ∪ attribute (Z) = attribute (X)
2. attribute (Y) ∩ attribute(Z) ≠ ϕ and equals to attribute(Z)or attribute(Y)
3. Here R is common attribute, so in one table (Y) it is acting as primary key in other table it is acting as foreign key

Here given decomposition following three rules of lossless , so it is lossless decomposition.

Statement (I) In BCNF if there is functional dependency such as $X \rightarrow Y$,X should be super key .

In Y there is only $R \rightarrow P$ and here R is super key ,so Y is in BCNF

In Z $QR \rightarrow S$ here QR is super key but , $S \rightarrow$here S is not superkey so Z is not BCNF

Then Given statement I is false and statement II is true.

30. 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) 16×2^{10}
(B) 256×2^{10}
(C) 4×2^{20}
(D) 8×2^{20}

[Ans. B]

Number of distinct virtual addresses can be translated

$= 128 \times$ Page size(in word)

$= 128 \times \frac{8kB}{4Bytes}$

$= 128 \times 2k$

$= 256 \times 2^{10}$

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

[Ans. *]Range 4.0 to 4.1

No of entries in block $= \frac{4\text{kB}}{4\text{B}} = 1\text{k}$

File size = $(12 \times 4\text{kB}) + (1\text{kB} \times 4\text{kB}) + (1\text{k} \times 1\text{k} \times 4\text{kB})$

$= 48\text{kB} + 4\text{MB} + 4\text{GB}$

$= 4.004048\ \text{GB}$

32. 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 _____.

[Ans. *]Range 2 to 2

SRTF

P_1	P_2	P_1	P_1

0 1 2 3 4

Now, we have P_3 and P_4 process in ready queue based on 'z' value one she process being scheduled

Case① $z > 3$ if $(z = 4)$

We have so schedule process 'P_4' Now

P_1	P_2	P_1	P_3	P_4

0 1 2 4 7 11

$\text{wt} = \text{TAT} - \text{BT}$

TAT=completion -A

averge $\text{wt} = \frac{1+0+1+3}{4} \Rightarrow \frac{5}{4} \neq 1(\text{not matching})$

Case② $z < 3$ if $(z = 2)$

Now, schedule P_4

P_1	P_2	P_1	P_4	P_3

0 1 2 4 6 9

averge $\text{wt} = \frac{1+0+3+0}{4} \Rightarrow \frac{4}{4} = ①$

33. Consider the first order predicate formula φ:

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

Here 'a|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, S2 and S3

(B) S1 and S2

(C) S2 and S3

(D) S1 and S3

[Ans. C]

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

The predicate ϕ simply says that if z is a prime number in the set then there exists another prime number is the set which is larger.

Clearly ϕ is true in S^2 and S^3 since in set of all integers as well as all positive integers, there is a prime number greater than any given prime number.

However, in $S_1: \{1, 2, 3, \cdots 100\}$ ϕ is false since for prime number $97 \in S_1$ there exists no prime number in the set which is greater.

34. Consider the following snapshot of a system running n concurrent process. Process i is holding X_i instances of a resource R, $1 \leq i \leq n$. 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) $(X_p + X_q) < \text{Min}\,\{Y_k | 1 \leq k \leq n, k \neq p, k \neq q\}$

(B) $\text{Min}\,(X_p, X_q) \leq \text{Max}\{Y_k | 1 \leq k \leq n, k \neq p, k \neq q\}$

(C) $(X_p + X_q) < \text{Max}\,\{Y_k | 1 \leq k \leq n, k \neq p, k \neq q\}$

(D) $\text{Min}\,(X_p, X_q) \geq \text{Min}\,\{Y_k | 1 \leq k \leq n, k \neq p, k \neq q\}$

[Ans. A]

35. 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?

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

Answer:_____.

[Ans. *]Range: 1 to 1

$\pi_x\left(\sigma_{(P.Y=R.Y\wedge R.V=V2)}\right)^{(P\times R)})$

It joins P and R with condition of $(P.Y=R.Y\wedge R.V=V2)$ and it returns only one column that is X . The output will be one x_2'

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

It joins P and R with condition of $(Q.Y=R.Y\wedge Q.T>2)$ and it returns only one column that is X . The output will be two $x_1's$ but relational algebra eliminates duplication so here only x_1.

$\pi_x\left(\sigma_{(P.Y=R.Y\wedge R.V=V2)}\right)^{(P\times R)})-\pi_x\left(\sigma_{(Q.Y=R.Y\wedge Q.T>2)}\right)^{(Q\times R)})$ output will be only x_2 so1 tuple has returned.

36. 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 _____.

[Ans. *]Range: 5 to 5

⇒ sum 0.0 j=1.0 I=2.0

0.0	1.0	2.0
1.0	2.0	
1.5	4.0	
1.75	8.0	
1.875	16.0	
1.9375	32.0	

$i/j=\frac{2.0}{1.0}=2.0\cdots 1st$

$i/j=\frac{2.0}{2.0}=1.0\cdots 2nd$

$i/j=\frac{2.0}{4.0}=0.5\cdots 3rd$

$$i/j = \frac{2.0}{8.0} = 0.25 \cdots 4th$$
$$i/j = \frac{2.0}{16.0} = 0.12 \cdots 5th$$
$$i/j = \frac{2.0}{32.0} = 0.0625 \cdots \times \text{ terminates}$$

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

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

(B) $\{ww^R | w \in \{a, b\}^*\}$

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

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

[Ans. C]

Option (C) is not CFL. Since when we insert $'w'$ in stack and then $a^n / n \geq 0$ then w^R come so, now we have to match w^R(reverse of w) with $'\omega'$ and we have to check whether actually it is reverse of $'w'$ or not . But in the top of the stack we see only a so, here matching of w and w^R is not possible because in between w and w^R we get a

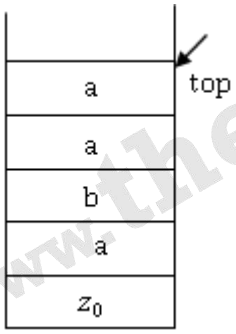
ex: let $w = ab$, let $n = 2$ then

$w^R = ba$

So, string = ab aa ba bb

w a^2 w b^2

So, for that if we insert w then a^2 as show below



New, we have to match $w^R = ba$ with $'w'$ but in the stop of stack we have w So, PDA is not panible for thin language . Hence, it is not regular

But for option (A) we can give PDA because first w come then a^n come there b^n come so, for b^nwe will pop a^n and then in stack we get w and then w^R come so, for that we can do matching so, PDA in possible so, it in CFL

For option (B) we can give NPDA IN option (D) I can be either n, 3n or 5n

So, $L = a^n b^n \cup a^n b^{3n} \cup a^n b^{5n}$

Since , wherever we can write language in union, we can give NPDA for that language

38. 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 nonterminals D,T L or L_1 in the following table:

Production rule	Semantic action
$D \rightarrow TL$	X_1type $= X_2$ type
$T \rightarrow$ int	T type $=$ int
$T \rightarrow$ float	T type $=$ float
$L \rightarrow L_1$, id	X_3 type $= X_4$ type add Type (id. entry, X_5 type)
$L \rightarrow$ id	add Type (id. entry, X_6 type)

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

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

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

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

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

[Ans. A]

$D \rightarrow TL$ { L. type $=$ T. type}

$T \rightarrow$ int {T. type $=$ int}

$T \rightarrow$ float{T. type $=$ float}

$L \rightarrow L_1$. id L_1. type $=$ L. type}

add type (id. entry, L. type)

$L \rightarrow$ id add type {id. entry, L. type}

39. 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 from 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 _____.

[Ans. *]Range: 5 to 5

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

In where condition no condition over Roll_no so query produces all groups. Total 5 different student names all 5 group records in result.

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

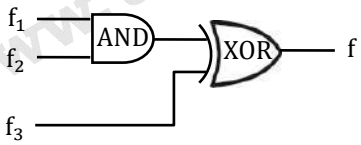
Which of the above statement are TRUE?

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

[Ans. A]

41. Consider three 4-variable functions $f_1, f_2 and f_3$, which are expressed in sum-of-minterms as $f_1 = \sum(0,2,5,8,14), \quad f_2 = \sum(2,3,6,8,14,15), \quad f_3 = \sum(2,7,11,14)$

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



(A) $\sum(7,8,11)$
(B) $\sum(2,14)$
(C) $\sum(2,7,8,11,14)$
(D) $\sum(0,2,3,5,6,7,8,11,14,15)$

[Ans. A]

$f_1 = m_0 + m_2 + m_5 + m_8 + m\_14$
$f_2 = m_2 + m_3 + m_6 + m_8 + m_{14} + m_{15}$
$f_3 = m_2 + m_7 + m_{11} + m_{14}$
$\Rightarrow f_1.f_2 = m_2 + m_8 + m_{14}$
$f = (f_1.f_2) \oplus f_3$

	A	B	C	D	$f_1.f_2$	f_3	F
m_0	0	0	0	0	0	0	0
m_1	0	0	0	1	0	0	0
m_2	0	0	1	0	1	1	0
m_3	0	0	1	1	0	0	0
m_4	0	1	0	0	0	0	0
m_5	0	1	0	1	0	0	0
m_6	0	1	1	0	0	0	0
m_7	0	1	1	1	0	1	1
m_8	1	1	0	0	1	0	1
m_9	1	1	0	1	0	0	0
m_{10}	1	1	1	0	0	0	0
m_{11}	1	1	1	1	0	1	1
m_{12}	1	1	0	0	0	0	0
m_{13}	1	1	0	1	0	0	0
m_{14}	1	1	1	0	1	1	0
m_{15}	1	1	1	1	0	0	0

$\Rightarrow f = m_7 + m_8 + m_{11}$

$\sum m(7, 8, 11)$

42. 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_____.

[Ans. *]Range: 12 to 12

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

$R_4 \leftarrow R_4 - R_3, R_3 \leftarrow R_3 - R_2, R_2 \leftarrow R_2 - R_1$

$$\begin{bmatrix} 1 & 2 & 4 & 8 \\ 0 & 1 & 5 & 19 \\ 0 & 1 & 7 & 37 \\ 0 & 1 & 9 & 61 \end{bmatrix}$$

$R_4 \leftarrow R_4 - R_3, R_3 \leftarrow R_3 - R_2$

$$\begin{bmatrix} 1 & 2 & 4 & 8 \\ 0 & 1 & 5 & 19 \\ 0 & 0 & 2 & 18 \\ 0 & 0 & 2 & 24 \end{bmatrix}$$

$R_4 \leftarrow R_4 - R_3$

$$\begin{bmatrix} 1 & 2 & 4 & 8 \\ 0 & 1 & 5 & 19 \\ 0 & 1 & 2 & 18 \\ 0 & 0 & 0 & 6 \end{bmatrix}$$

$1 \times 1 \times 2 \times 6 = 12$

43. Consider the following C function.

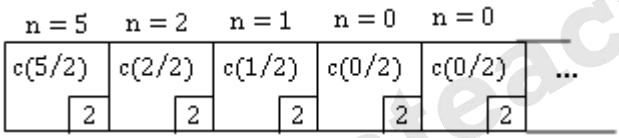
```
void convert (int n){
if (n < 0)
printf("%d",n);
Else {
convert(n/2);
printf("%d,n%2);
}
)
```

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

(A) It will print the binary representation of n and terminate
(B) It will print the binary representation of n but will not terminate
(C) It will print the binary representation of n in the reverse order and terminate
(D) It will not print anything and will not terminate

[Ans. D]

Assume n=5

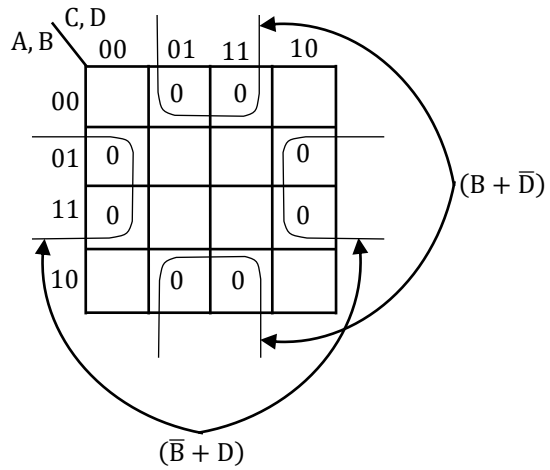


It is not getting termination as n=0 is running for infinite times
All the function calls had to return in order to go on 2 statements which is print function
Hence neither printing binary representation nor terminating

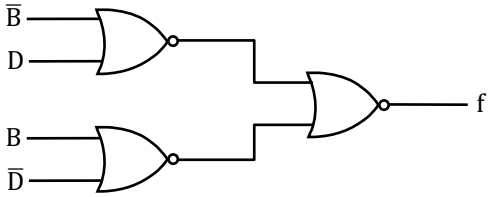
44. What is the minimum number of 2-input NOR gates required to implement a 4-variable function expressed in sum-of-min terms from as $f = \sum(0, 2, 5, 7, 8, 10, 13, 15)$? Assume that all the inputs and their complements are available. Answer: _____.

[Ans. *]Range: 4 to 4

$f = \Sigma_m(0, 2, 5, 7, 8, 10, 13, 15)$
$f = \Pi M(1, 3, 4, 6, 9, 11, 12, 14)$



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



So 3 NOR gates is required.

45. 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 1 cycle 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.

[Ans. *]Range: 160 to 160

Clock rate=60mHz

One clock cycle time $= \frac{1}{60} \times 10^{-6}$sec

Number of cycles required for one block transfer

$= 1 + 3 + 8$

$\downarrow \quad \downarrow \quad \downarrow$

Address read transfer

$= 12$ cycle for one block

One block contains 8 words , each word size being 4 bytes i.e Block size =32 bytes

32 bytes $\rightarrow$ 12 clock cycle

? $\rightarrow$ 1 sec

$$\text{DTR} = \frac{32\text{B}}{\left(12 \times \frac{1}{60} \times 10^{-6}\right)\text{sec}}$$

$= 32 \times 5 \times 10^6$B/sec
$= 160 \times 10^6$ B/sec

46. There are n unsorted arrays: $A_1, A_2, \ldots, A_n$. Assume that n is odd. Each of $A_1, A_2, \ldots, A_n$ contains n distinct elements. There are no common elements between any two arrays. The worst-case complexity of computing the median of the medians of $A_1, A_2, \ldots, A_n$ is
(A) $O(n \log n)$
(B) $\Omega(n^2 \log n)$
(C) $O(n^2)$
(D) $O(n)$
[Ans. C]

47. Consider three machines M, N and P with IP addresses 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 belong to three different subnets
(B) Only M and N belong to the same subnet
(C) Only N and P belong to the same subnet
(D) M, N and P belong to the same subnet
[Ans. C]

M →	100.10.5.2	2	00000010
	255.255.255.252	252	11111100
	194.56.10.0	0	00000000
N →	100.10.5.5	5	00000101
	255.255.255.252	252	11111100
	194.56.10.4	4	00000100
P →	100.10.5.6	6	00000110
	255.255.255.252	252	11111100
	194.56.10.4	4	00000100

N and P belong to same subnet.

48. 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?
(1) II only
(2) I only
(3) Both I and II
(4) Neither I or II
[Ans. C]
If no two edges of G have same weight surely G will have unique spanning tree is true.
So I is true

Also if, for every cut of G, there is a unique minimum weight edge crossing the cut then G will have unique spanning tree is also true. So II is true
[Note: The converse of II is not true, but that is not relevant to this question]
So both I and II are true.

49. 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 S2
(B) S3 and S4
(C) S2 and S3
(D) S1 and S4
[Ans. B]
S1. Since REL is accepted by TM. Since TM is countable so, REL in also countable
S2. All syntactically valid C program may halt or fall in infinite loop. So it is accepted by TM/ and language accepted by TM is REL. And since, we know that REL is countable . So, s2 is countable
S3. It is uncountable because it is $2^{\Sigma 1}$ because the theorem sap that if s is countable and then 2^s is uncountable
S4. This can be proved by contradiction. Let us assume that is net of all regular language and 'y' is net all non-regular language over the $\sum = \{0, 1\}$
We know that set of all regular language I_o countable so, 'x' is countable. Let us assume that 'y' is also countable then $x \cup y =$ countable set (it is a theorem if x and y is countable then $x \cup y$ is also countable. But then $x \cup y$ is net all language which we know that it is uncountable so, our assumption must be wrong Hence 'y' is uncountable

50. 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 with broadcast IP address in its local subnet
(B) X sends an ARP request packet to the local gateway's IP address which then finds the MAC address of Y and sends to X
(C) X sends an ARP request packet with broadcast MAC address in its local subnet
(D) 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
[Ans. C]

51. 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) 41
(B) 52
(C) 630
(D) 63

[Ans. B]

⇒ num = 7

Ex:

```
For (1, 2, 3){
        4 ;
}
```

① 7 ① 4 ① 1
② 6 ② 3 ② 0 X terminates
③ 4 ③ 1 ③
④ 5 ④ 2 ④

Printing statement

52. In an RSA cryptosystem, the value of the public modulus parameter n is 3007. If it is also known that $\varphi(n) = 2880$, where $\varphi( )$ denotes Euler's Totient Function, then the prime factor of n which is greater that 50 is _____.

[Ans. *]Range: 97 to 97

A/q to RSA Algorithm

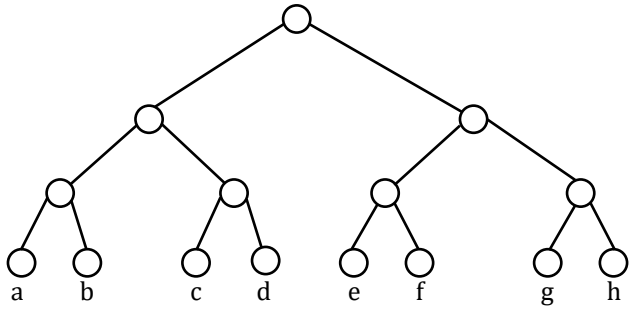
$n = p * q$ & $O(n) = (p - 1)(q - 1)$ (Where p & q are two prime numbers)

So, 97 & 31 are the two prime numbers (which is satisfying the condition) & 97 is greater than 50 so, 97 is the right answer.

53. 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) _____.

[Ans. *]Range: 4.25 to 4.25

Two nodes can be selected in ${}^{8}C_{2} = 28$ ways.



X: length between two nodes selected

X	2	4	6
P(x)	$\frac{4}{28}$	$\frac{8}{28}$	$\frac{16}{28}$

To find expected length between a and b is E[X]

$$E[X] = 2\left(\frac{4}{28}\right) + 4\left(\frac{8}{28}\right) + 6\left(\frac{16}{28}\right)$$

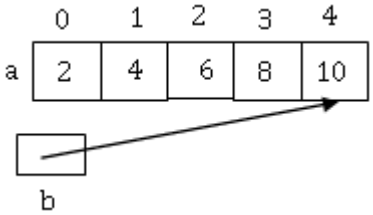
$$= \frac{8 + 32 + 96}{28} = \frac{136}{28} = 4.857$$

54. 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 + +)
      sum = sum + (* b − i) −* (b − i);
 printf ("%d\n", sum);
 return 0;
}
```

The output of the above C program is_____.

[Ans. *]Range: 10 to 10



$*b = a + 4 \Rightarrow *b = a[4] = 10$
$sum = 0\ b = 4 * b = 10$

1. i=0
   $sum = 0 + (10 - 0) - * (4 - 0)$
   $\Rightarrow 0 + 10 - 10 = 0$
2. i=1
   $sum = 0 + (10 - 1) - * (4 - 1)$
   $\Rightarrow 0 + 9 - 8 \Rightarrow 1$
3. $i = 2$
   $sum = 1 + (10 - 2) - * (4 - 2)$
   $\Rightarrow 1 + 8 - 6 = 3$
4. i=3
   $sum = 3 + (10 - 3) - * (4 - 3)$
   $\Rightarrow 3 + 7 - 4 = 6$
5. $i = 4$
   $sum = 6 + (10 - 4) - * (4 - 4)$
   $\Rightarrow 6 + 6 - 2 = 10$

55. 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 ports. The minimum number of switches needed is_____.

[Ans. *] Range: 3 to 3