GATE 2019 Solved Paper
CS: Computer Science and Information Technology

Number of Questions: 46 **Total Marks: 67**

Wrong answer for MCQ will result in negative marks, (–1/3) for 1 Mark Questions and (–2/3) for 2 Marks Question.

Q.1–Q.25 carry one mark each.

Question Number: 1 **Question Type: MCQ**

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) $n + 2$ bits
(C) $n + 1$ bits (D) $n - 1$ bits

Solution: $Z = X - Y$

X is n-bit sign magnitude number

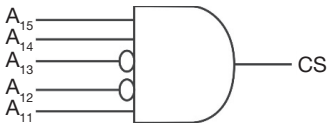
Y is n-bit sign magnitude number

To avoid overflow, the representation of Z would require a minimum of $n + 1$ bits

Hence, the correct option is (C).

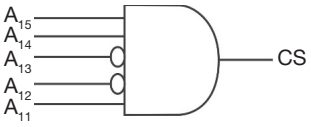
Question Number: 2 **Question Type: MCQ**

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

Solution:



A_{15}	A_{14}	A_{13}	A_{12}	A_{11}	-	A_4	A_3	A_2	A_1	A_0	
1	1	0	0	1	-	0	0	0	0	0	C800H
					. . .						
1	1	0	0	1		1	1	1	1	1	CFFFH

Hence, the correct option is (B).

Question Number: 3 **Question Type: MCQ**

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

Solution: If L is a regular language, then there is a number P (the pumping length) such that S is any string in L of length P or more can be written as S = xyz, satisfying the following conditions.

for each $i \geq 0$, $xy^i z \in L$,

$|y| > 0$ and $|xy| \leq P$

So we need to find the minimum length string $s = xyz \in L$ such that xy^iz should also be L.

$L = \{a^2, a^5, a^8, a^{11}.....\}$

Here we can take pumping length as 3.

OR

$L = \{b^{10}, b^{22}, b^{34}.....\}$

Here, the pumping length can be 12.

If we take pumping length as 24, in every repetition we will get multiple of 3 and 12.

Hence, the correct option is (C).

Question Number: 4 **Question Type: MCQ**

Which one of the following is NOT a valid identity?

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

Solution: $(x + y) \oplus z = x \oplus (y + z)$ is not a valid statement. Hence, the correct option is (C).

Question Number: 5 **Question Type: MCQ**

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

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

Solution: LR parser is a bottom up parser. Bottom up parser uses reverse of right most derivation.
Hence, the correct option is (C).

Question Number: 6 **Question Type: NAT**

Consider a sequence of 14 elements; A = [–5 , –10, 6, 3, –1, –2, 13, 4, –9, –1, 4, 12, –3, 0]. The subsequence sum $s(i, j)$, where $0 \le i \le j < 14$. (Divide and conquer approach may be used.)

Solution: A[–5, –10, 6, 3, –1, –2, 13, 4, –9, –1, 4, 12, –3, 0]

Max (S(i, j)) = S(2, 11) = $\sum_{k=2}^{11} A[k] = 29$

Hence, the correct answer is (29).

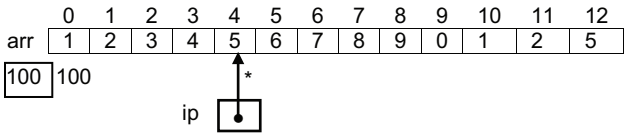
Question Number: 7 **Question Type: NAT**

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 _____.

Solution:



Hence, the correct answer is (6).

Question Number: 8 **Question Type: MCQ**

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.

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

Solution: The strict two-phase locking protocol guarantees strict schedules (strict schedules are conflict serializable.)

The Timestamp-ordering concurrency control with Thomas, Write Rule does not enforce conflict serializability.

The given both statements are true.

Hence, the correct option is (C).

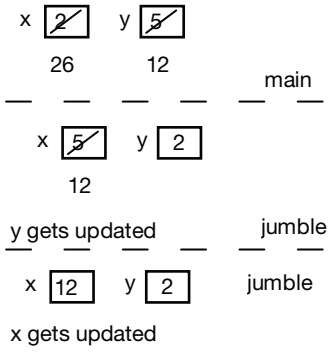
Question Number: 9 **Question Type: NAT**

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 _____.

Solution:



Hence, the correct answer is (26).

Question Number: 10 **Question Type: MCQ**

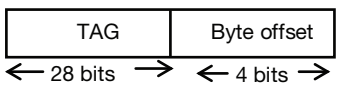
A certain processor uses a fully associative cache of size 16 kB. The cache block size 16 bytes. Assume that the main memory is byte addressable and uses a 32-bit address. How many bits are required for the Tag and the Index fields respectively in the addresses generated by the processor?

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

Solution: Cache block size = 16 Bytes

$= 2^4$ B $\Rightarrow$ Block offset = 4 bits

Fully associative cache size = 16 kB



In fully associative cache, there is no any index.

Indexing requires 0 bits and Tag bits = 28.

Hence, the correct option is (B).

Question Number: 11 **Question Type: NAT**

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

Solution: We have to find 3^{51} mod 5

3^1 mod 5 = 3

3^2 mod 5 = 4

3^3 mod 5 = 2

3^4 mod 5 = 1

3^5 mod 5 = 3

3^6 mod 5 = 4

3^7 mod 5 = 2

3^8 mod 5 = 1

In general 3^{4m} mod5 = 1 for m$\in z^+$

$\therefore 3^{51} \text{ mod } 5 = 3^{4\times 12+3} \text{ mod } 5$

$= 3^3 \text{ mod } 5 = 2$

Hence, the correct answer is (2).

Question Number: 12 **Question Type: MCQ**

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) Non-leaf nodes have pointers to data records

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

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

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

Solution: In a B+ tree, data pointers are stored only at the leaf nodes of the tree.

Hence, the correct option is (A).

Question Number: 13 **Question Type: MCQ**

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

(A) Suffix (L) = $\{y \in \Sigma^* \mid \exists_x \in \Sigma^*$ such that $xy \in L\}$

(B) $\{\omega\omega^R \mid \omega \in L\}$

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

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

Solution: The regular languages are closed under reversal and concatenation.

So, L.L^R is regular WW^R needs a memory (stack), therefore the language is not regular.

prefix (x) and suffix (x) is also regular.

Hence, the correct option is (B).

Question Number: 14 **Question Type: NAT**

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 _____.

Solution: Assembly code of the three process are

Process P_1:

(1) Load R_1, M[D]

(2) ADD R_1, #20

(3) STORE M[D], R_1

Process P_2:

(A) Load R_2, M[D]

(B) SUB R_2, #50

(C) STORE M[D], R_2

Process P_3:

(X) Load R_3, M[D]

(Y) ADD R_3, #10

(Z) STORE M[D], R_3

Minimum value of D

Process P_2executes (A), (B) instructions and got preempted, i.e., it did not store the value 50 to 'D'. Now, process P_1 and P_2 executes their instructions, i.e., (1), (2), (3) and (X), (Y), (Z). The value of D will be 130 and now, the instruction (C) is executed, it stores the value 50 to D.

Maximum value of D

Process P_1 first completed its execution, its value will be 120.

Process P_3 executes (X), (Y) and get preempted, P_2 completes its execution. Now, process P_3 completes (Z) instruction the value will be 130.

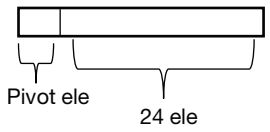
Therefore, value of ($Y - X$) will be 80.

Hence, the correct answer is (80).

Question Number: 15 **Question Type: NAT**

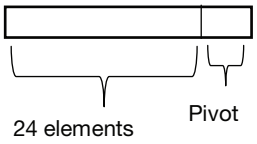
An array of 25 distinct elements is to be sorted using quicksort. Assume that the pivot element is chosen uniformly at random. The probability that the pivot element gets placed in the worst possible location in the first round of partitioning (rounded off to 2 decimal place) is _____.

Solution: For a quick sort, worst case is when array is sorted. Let us consider the first element is considered as a pivot element



Or

The last element is considered as a pivot



Except first and last position all are either average case or best case, as list will get divided in to 2 sublists.

Probability = $\frac{2}{25}$ = 0.08.

Hence, the correct answer is (0.08).

Question Number: 16 **Question Type: MCQ**

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

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

Solution: Mails can be sent using SMTP and to retrieve emails POP3 is used.
Hence, the correct option is (C).

Question Number: 17 **Question Type: NAT**

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

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

The total number of child processes created is _____.

Solution: Number of times fork() get executed is 5 times i.e for i = 0, 2, 4, 6, 8.

Number of child process created for '*n*' fork() calls are $2^n - 1$

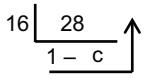
Hence, the correct answer is (31).

Question Number: 18 **Question Type: MCQ**

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

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

Solution:



$(28)_{10} = (1C)_{16} = (00011100)_2$
$+ 28_{10}$: 0000 0000 0001 1100
$- 28_{10}$: 1111 1111 1110 0100
Hence, the correct option is (D).

Question Number: 19 **Question Type: NAT**

Consider the grammar given below:

$S \rightarrow Aa$
$A \rightarrow BD$
$B \rightarrow b|\in$
$D \rightarrow d|\in$

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 answer should be 3210)

Solution: Follow (B) = First (D) U
Follow (A) – {∈}
= {a, d}
It is indexed as 31.
Hence, the correct answer is (31).

Q.26–Q.55 carry two marks each.

Question Number: 20 **Question Type: NAT**

Let ∑ be the set of all bijections from {1, …..5} to {1, ….., 5}, where *id* denotes the identity function, i.e. id(j) = j, ∀j. Let ° denotes composition on functions. For a string $x = x_1, x_2, \ldots x_n \in \Sigma^n$, $n \geq 0$, 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 _____.

Solution: For a set of 5 elements number of bijections possible with itself are 5!= 120.
Minimum number of states required for the language given in the question are 120.
Hence, the correct answer is (120).

Question Number: 21 **Question Type: NAT**

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

P		
X	***Y***	***Z***
*X*1	*Y*1	*Z*1
*X*1	*Y*1	*Z*2

Q		
X	***Y***	***T***
*X*2	*Y*1	2
*X*1	*Y*2	5

R	
Y	***V***
*Y*1	V1
*Y*3	V2

X2	Y2	Z2
X2	Y4	Z4

X1	Y1	6
X3	Y3	1

Y2	V3
Y2	V2

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

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

Solution:

P × R				
X	**Y**	**Z**	**Y**	**V**
X_1	Y_1	Z_1	Y_1	~~V_1~~
X_1	Y_1	Z_1	Y_3	V_2
X_1	Y_1	Z_1	V_2	~~V_3~~
X_1	Y_1	Z_1	Y_2	V_2
X_1	Y_1	Z_2	Y_1	~~V_1~~
X_1	Y_1	Y_2	Y_3	V_2
X_1	Y_1	Z_2	Y_2	~~V_3~~
X_1	Y_1	Z_2	Y_2	V_2
X_2	Y_2	Z_2	Y_1	~~V_1~~
X_2	Y_2	Z_2	Y_3	V_2
X_2	~~Y_2~~	Z_2	~~V_2~~	~~V_3~~
X_2	Y_2	Z_2	Y_2	V_2
X_2	Y_4	Z_4	Y_1	~~V_1~~
X_2	Y_4	Z_4	Y_3	V_2
X_2	Y_4	Z_4	Y_2	~~V_3~~
X_2	Y_4	Z_4	Y_2	V_2

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

X
X_2

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

X
X_1

$X_2 - X_1 = X_2$

Hence, the correct answer is (1).

Question Number: 22 **Question Type: MCQ**

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 X and 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) I only (D) Neither I nor II

Solution: $Y = PR$ and $Z = QRS$

$Y \cap Z = R$ (Key)

As FD $R \rightarrow P$ is present, R is key.

The given relation is lossless.

The relation Y is in BCNF but relation Z is not in BCNF as in $S \rightarrow Q$ S is not a superkey.

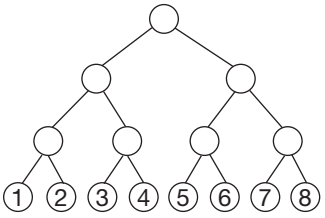
Hence, the correct option is (A).

Question Number: 23 **Question Type: NAR**

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) _____.

Solution:

Full binary tree with 8 leaf nodes



Expected value of the distance between a and b = 0

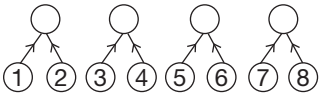
$$0 \times \frac{8}{64} 2 \times \frac{8}{64} + 4 \times \frac{16}{64} + 6 \times \frac{32}{64}$$

$$= \frac{272}{28} = 4.25$$

Out of 8 leaf nodes any 2 nodes can be chosen $8_{P_2} + 8$ (selection of nodes with distance '0') = 64.

For length '2' between a and b will have '8' possibilities

(i.e. (1) → (2) and (2) → (1) are two different paths)



Hence, the correct answer is (4.25 to 4.25).

Question Number: 24 **Question Type: NAT**

In a 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 than 50 is _____.

Solution: Let p, q be prime numbers.

Given

$p * q = 3007$

and

$(p - 1)(q - 1) = 2880$

$pq - p - q + 1 = 2880$

$3007 - p - q + 1 = 2880$

$(p + q) = 128$

$p + \frac{3007}{p} = 128$

$p^2 + 3007 = 128\ p$

$p^2 - 128\ p + 3007 = 0$

On solving

$p = 97, 31$

Hence, the correct answer is (97).

Question Number: 25 **Question Type: MCQ**

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

Solution: Logical address = 64 bits

Physical address = 48 bits

Page size = 8KB

Word size = 4B

TLB entries = 128

Number of entries in page = $\frac{8KB}{4B} = 2k$

As the number of entries in TLB are 128. 128 entries translates 128 page numbers into frame numbers.

Distinct virtual addresses can be translated with TLB miss is

128×2^{11}

256×2^{10}

Hence, the correct option is (D).

Question Number: 26 **Question Type: MCQ**

Consider the first order predicate formula φ :

$\forall x\ [(\forall z\ z|x \Rightarrow ((z = x) \vee (z = 1))) \Rightarrow \exists w\ (w > x) \wedge (\forall z\ z|w \Rightarrow ((w = z) \vee (z = 1)))]$ 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 S3
(C) S1 and S2 (D) S2 and S3

Solution: Given

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

Means, for every prime number, x, we can find another prime number w such that $w > x$.

Consider S1: {1, 2, 3, …,100}

Take $x = 97$

Then there is no prime number w in S1 such that $w > x$

$\therefore$ S1 does not satisfy φ

Clearly, S2 and S3 satisfy φ.

Hence, the correct option is (D).

Question Number: 27 **Question Type: NAT**

A relational database contains two tables Students 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 _____.

Solution:

Student_name	Sum (P.marks)
Amit	452
Priya	452
Rohan	452
Smita	452
Vinit	452

Hence, the correct answer is (5).

Question Number: 28 **Question Type: MCQ**

There are n unsorted arrays: A_1. A_2, ….., A_n Assume that n is odd. Each of A_1. A_2, ….., 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 A_1. A_2, ….., A_n is

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

Solution: To compute the median of unsorted array of n elements, it takes $O(n)$ time. To find the medians of median, it will take $O(n^2)$ time.

Hence, the correct option is (D).

Question Number: 29 **Question Type: NAT**

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 _____.

Solution:

Process	P_1	P_2	P_3	P_4
Arrival time	0	1	3	4
Burse time	3	1	3	Z

Gannt chart

P_1	P_2	P_3	P_4	
0	1	2	3	4

at t = 4

Process P_1 and P_2 completes its execution. Waiting time of process P_1 and P_2 will be 1 and 0. Process P_3 waiting time is 1. If Process P_4 burst time can't be 3, then the average waiting time (AWS) exceeds 1 ms. It should be either 1 or 2. If it is 1, then AWS will be less than 1. So, process P_2 burst time will be 2. Then AWS will be 1.

Hence, the correct answer is (2).

Question Number: 30 **Question Type: MCQ**

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) Only M and N belong to the same subnet
(B) Only N and P belong to the same subnet
(C) M, N and P belong to three different subnets
(D) M, N and P all belong to the same subnet

Solution: Subnet mask = 255.255.255.252

Machine M

100.10. 5. 0 0 0 0 0 0 1 0

255.255. 255. 1 1 1 1 1 1 0 0

100.10. 5. 0

Machine N

100.10. 5. 0 0 0 0 0 1 0 1

255.255. 255. 1 1 1 1 1 1 0 0

100.10. 5. 4

Machine P

100.10. 5. 0 0 0 0 0 1 1 0

255.255. 255. 1 1 1 1 1 1 0 0

100.10. 5. 4

Machine N and P belong to the same subnet.

Hence, the correct option is (B).

Question Number: 31 **Question Type: MCQ**

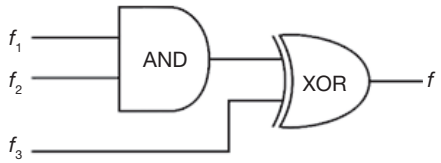
Consider three 4-variable functions f_1, f_2, and f_3, which are expressed in sum-of-minterms as

$f_1 = \sum(0, 2, 5, 8, 14)$,

$f_2 = \sum(2, 3, 6, 8, 14, 15)$,

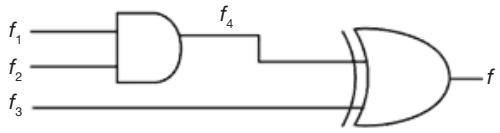
$f_3 = \sum(2, 7, 11, 14)$

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



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

Solution:



$f_1 = \Sigma m$ (0, 2, 5, 8, 14)

$f_2 = \Sigma m$ (2,3,6,8,14,15)

$f_4 = \Sigma m$ (2, 8, 14)

$f_3 = \Sigma m$ (2, 7, 11, 14)

$f = \Sigma m$ (7, 8, 11)

Hence, the correct option is (B).

Question Number: 32 **Question Type: NAT**

Consider the augmented grammar given below:

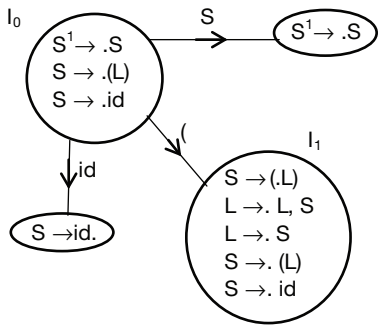
$S' \rightarrow S$

$S \rightarrow (L) \mid id$

$L \rightarrow L, S \mid S$

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

Solution:



Number of items in I_1 are 5.

Hence, the correct answer is (5).

Question Number: 33 **Question Type: MCQ**

Suppose that in a 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 send an ARP request packet to the local gateway's IP address which then finds the MAC address of Y and sends to X.

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

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

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

Solution: In IP over Ethernet network, If machine X wants to find MAC address of another machine Y in its subnet, then X sends an ARP request packet with broadcast MAC address in its local subnet.

Hence, the correct option is (D).

Question Number: 34 **Question Type: NAT**

The index node (inode) of 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 1 decimal place) _____GB.

Solution: Maximum file size

$$= \left[\begin{array}{l}\text{Number of direct pointers} + \left(\dfrac{\text{Disk block size}}{\text{Disk block address}}\right) \\ \qquad + \left(\dfrac{\text{Disk block size}}{\text{disk block address}}\right)\end{array}\right]$$

$*$ (Disk Block size)

$$= \left[12 + \frac{4\text{KB}}{4\text{B}} + \left(\frac{4\text{KB}}{4\text{B}}\right)^2\right] 4\text{KB}$$

$= [12 + 4\text{K} + 1\text{M}] * 4\text{KB}$

$= 48\text{KB} + 16\text{MB} + 4\text{GB}$

$\cong 4\text{GB}$

Hence, the correct answer is (3.7 to 3.8 or 4.0 to 4.1).

Question Number: 35 **Question Type: MCQ**

Consider the following snapshot of a system running n concurrent processes. Processes 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) $\text{Min}(X_p, X_q) \le \text{Max}\{Y_k \mid 1 \le k \le n, k \ne p, k \ne q\}$

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

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

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

Solution: Given

$X_i \rightarrow$ Holding resources for process p_i

$Y_i \rightarrow$ Additional resources for process p_i

As process p and q doesn't require any additional resources, it completes its execution and available resources are $(X_p + X_q)$

There are $(n-2)$ process p_i $(1 \le i \le n, \text{i} \ne p, q)$ with their requirements as $Y_i (1 \le i \le n, i \ne p, q)$. In order to not execute process p_i, no instance of Y_i should be satisfied with $(X_p + X_q)$ resources, i.e., minimum of Y_i instances should be greater than $(X_p + X_q)$.

Hence, the correct option is (C).

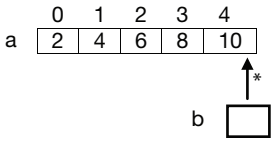
Question Number: 36 **Question Type: NAT**

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 ___

Solution:



i = 0

sum = 0 + 10 – 10 = 0

i = 1

sum = 0 + 9 – 8 = 1

i = 2

sum = 1 + 8 – 6 = 3

i = 3

sum = 3 + 7 – 4 = 6

i = 4

sum = 6 + 6 – 2 = 10

Hence, the correct answer is (10).

Question Number: 37 **Question Type: MCQ**

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?

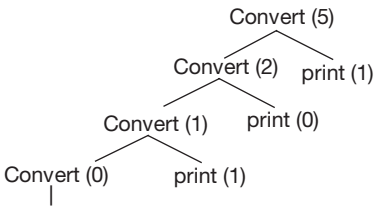
(A) It will print the binary representation of *n* and terminate.

(B) It will print the binary representation of *n* but will not terminate.

(C) It will not print anything and will not terminate.

(D) It will print the binary representation of *n* in the reverse order and terminate.

Solution: Let, $n = 5$



As the program will terminate for negative value and if we divide zero by 2, it will give infinite value. The program will not terminate and doesn't print anything.

Hence, the correct option is (C).

Question Number: 38 **Question Type: NAT**

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 _____

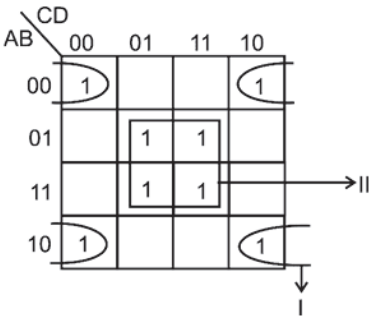
Solution: In an 8-port Ethernet switch, one port is used for networks connection and one port for the other switch, total 6 ports are used for connecting machines. For 15 machines, it requires 3 switches.

Hence, the correct answer is (3).

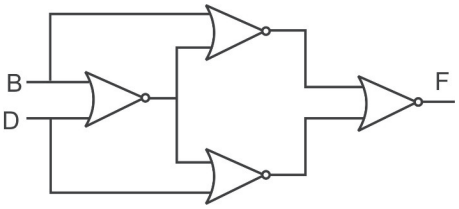
Question Number: 39 **Question Type: NAT**

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

Solution:



$F = I + II = \overline{B}\,\overline{D} + BD$



$F = \overline{BD} + BD = B \odot D$

Hence, to implement the given function in sum of minterms form, we need to take four 2-input NOR gates.

Hence, the correct answer is (3).

Question Number: 40 **Question Type: NAT**

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.

Solution: Block is 8 words

words is 4 bytes

Block size = 8×4

= 32 Bytes

To transfer a block from memory

= (1 + 3 + 8) = 12 clocks

In 12 clocks, it transfers 32 bytes

12 clocks $\rightarrow$ 32 Bytes

$60 \times 10^6 \rightarrow ?$

$= \dfrac{60 \times 10^6 \times 32}{12}$

= 160 bytes/sec

Hence, the correct answer is (160).

Question Number: 41 **Question Type: MCQ**

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 statements are TRUE?

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

Solution: I. The smallest element in a max-heap is always present at a leaf node, it takes $\theta(n)$ time to find smallest element.

II. The largest element in a max-heap is root element whereas second largest is either left child or right child.

III. Construction of max-heap from binary search tree will take $\theta(n)$ time.

IV. A binary search tree can not be constructed from a max-heap in $\theta(n)$ time.

Hence, the correct option is (A).

Question Number: 42 **Question Type: MCQ**

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

Solution: r() // initialization

num 7 6

As post – decrement is present first the values '7' is returned and then it will get decremented.

r()// condition

num 6 5

print (r()) num 5 4

Here '5' will be printed first then it will be decremented.

r() // increment / decrement

num 4 3

r() // condition

num 3 2

As non-zero value is returned by function r(), print statement will get executed.

print (r()) num 2 1

Value '2' will get printed first.

r()// increment/decrement

num 1 0

r() // condition

num 0 −1

As 'zero' is returned, the loop terminates,

The value printed is 52.'

Hence, the correct option is (B).

Question Number: 43 **Question Type: NAT**

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 _____.

Solution:

Sum 0.0 j 1.0 i 2.0

2.0 > 0.0625

j = 2.0

Sum = 0 + 1.0

Print (1.0)//1

2.0/2.0 > 0.0625

j = 4.0

sum = 1.0 + 0.5 = 1.5

print (1.5)//2

4.0/2.0 > 0.0625

j = 8.0

sum = 1.5 + 0.25 = 1.75

print (1.75)//3

8.0/2.0 > 0.0625

j = 16.0

sum = 1.75 + 0.125 = 1.875

print (1.875)//4

16.0/2.0 > 0.0625

j = 32.0

sum = 1.875 + 0.0625 = 1.9375

print (1.9375)//5

The sum get printed 5 times.

Hence, the correct answer is (5).

Question Number: 44 **Question Type: MCQ**

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) S2 and S3 (B) S1 and S2

(C) S3 and S4 (D) S1 and S4

Solution: Recursively enumerable languages are countable.

Syntactically valid C program can be represented with CFG. CFG generates CFL, CFL is countable.

All languages over {0, 1} may not be countable.

Set of regular languages are countable, non-regular languages may not be countable.

Hence, the correct option is (C).

Question Number: 45 **Question Type: MCQ**

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 → TL	X_1. type = X_2 type
T → int	T. type = int
T → float	T.type = float
L → L_1, id	X_3.type = X_4 type add Type (id entry, X_5.type)
L → id	Add Type (id.entry, X_6.type)

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

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

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

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

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

Solution: Given, inherited attributes are evaluated by bottom up evaluation.

For production

D → TL

The semantic action will be

L. type = T. type

As the L. type is decided by the T. type Similarly, L_1. Type is decided by L. type, for the production

L → L_1, id

∴ the values of X_1, X_2, X_3 and X_4 are

L, T, L_1 and L

Hence, the correct option is (B).

Question Number: 46 **Question Type: MCQ**

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

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

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

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

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

Solution: It is not possible to draw a PDA for language $L = \{wa^n w^R b^n \mid w \in \{a, b\}^*, n \geq 0\}$

Hence, the correct option is (C).