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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

Answer: (0) **Click here to watch video explanation**

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 _________.

Answer: (6) **Click here to watch video explanation**

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

Answer: (B) **Click here to watch video explanation**

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

Answer: (D) **Click here to watch video explanation**

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

Answer: (D) **Click here to watch video explanation**

6. Consider the grammar given below:

$S \rightarrow Aa$

$A \rightarrow BD$

$B \rightarrow b \mid \varepsilon$

$D \rightarrow d \mid \varepsilon$

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)

Answer: (31) **Click here to watch video explanation**

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

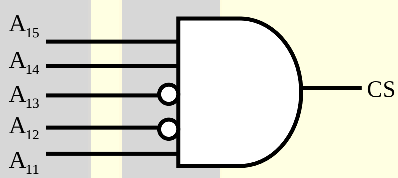
(B) I does not imply II; II does not imply I

(C) I and II are equivalent statements

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

Answer: (C) **Click here to watch video explanation**

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

Answer: (A) **Click here to watch video explanation**

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 $0 \le i \le j < 14$. (Divide and conquer approach may be used.)

Answer: (29) **Click here to watch video explanation**

10. 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 places) is

Answer: (0.08) **Click here to watch video explanation**

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

Answer: (2) **Click here to watch video explanation**

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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 _________.

Answer: (80) **Click here to watch video explanation**

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

(A) 108/7 (B) 1

(C) 53/12 (D) Limit does not exist

Answer: (A) **Click here to watch video explanation**

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 _________.

Answer: (26) **Click here to watch video explanation**

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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

Answer: (C) **Click here to watch video explanation**

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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

Answer: (D) Click here to watch video explanation

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)!

Answer: (B & C) Click here to watch video explanation

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

Answer: (D) Click here to watch video explanation

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 ________.

Answer: (31) Click here to watch video explanation

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

Answer: (B) **Click here to watch video explanation**

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) $x \oplus y = x + y, \text{if } xy = 0$

Answer: (C) **Click here to watch video explanation**

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

Answer: (D) **Click here to watch video explanation**

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

Answer: (A) **Click here to watch video explanation**


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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

Answer: (D) **Click here to watch video explanation**

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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 __________.

Answer: (0.503) **Click here to watch video explanation**

Q. No. 26 to 55 Carry Two Marks Each

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 ___________.

Answer: (1) **Click here to watch video explanation**

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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) $\{wa^nw^Rb^n \mid w\in\{a,b\}^*, n\ \geq 0\}$

(C) $\{a^nb^i \mid i\in\ \{n,3n,5n\},\ n\ \geq\ 0\}$ (D) $\{wa^nb^nw^R \mid w\in\{a,b\}^*, n\ \geq 0\}$

Answer: (B) **Click here to watch the video explanation**

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

Answer: (A) **Click here to watch video explanation**

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29. 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 time complexity of computing the median of the medians of $A_1, A_2, \ldots, A_n$ is

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

Answer: (C) **Click here to watch video explanation**

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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________.

Answer: (5) **Click here to watch video explanation**

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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 _______.

Answer: (5) **Click here to watch video explanation**

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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

Answer: (A) **Click here to watch video explanation**

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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.

Answer: (4) **Click here to watch video explanation**

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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_______.

Answer: (97) **Click here to watch video explanation**

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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}

Answer: (A) **Click here to watch video explanation**

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_6be the placeholders for the non-terminals D, T, L or L_1 in the following table:

Production rule	Semantic action
$D \to TL$	X_1 .type = X_2.type
$T \to$ int	T.type = int
$T \to$ float	T.type = float
$L \to L1$, id	X_3.type = X_4.type addType(id.entry, X_5.type)
$L \to$ 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) $X_1 = L, X_2 = T , X_3 = L_1, X_4 = L$

Answer: (D) **Click here to watch video explanation**

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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_______.

Answer: (12) **Click here to watch video explanation**

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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

Answer: (A) **Click here to watch video explanation**

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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).

Answer: (0.8) **Click here to watch video explanation**

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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

$x = x_1\, x_2 \ldots x_n \in \Sigma^n, n \geq 0$, 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______.

Answer: (120) **Click here to watch video explanation**

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) _________

Answer: (4.25) **Click here to watch video explanation**

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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

Answer: (A) **Click here to watch video explanation**

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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

Answer: (D) **Click here to watch video explanation**

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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 andS4 (B) S3 and S4 (C) S1 and S2 (D) S2andS3

Answer: (B) **Click here to watch video explanation**

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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

Answer: (D) **Click here to watch video explanation**

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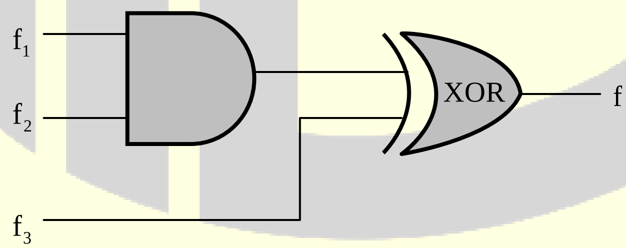
46. Consider three 4-variable functions f_1, f_2, and f_3, which are expressed in sum-of-minterms as

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

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

Answer: (A) **Click here to watch video explanation**

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

Answer: (A) **Click here to watch video explanation**

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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.

Answer: (160) **Click here to watch video explanation**

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49. Consider the augmented grammar given below:

$$S' \to S$$
$$S \to < L > \mid id$$
$$L \to L, S \mid S$$

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

Answer: (5) **Click here to watch video explanation**

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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 ________.

Answer: (2) **Click here to watch video explanation**

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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_________.

Answer: (3) **Click here to watch video explanation**

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52. Consider the first order predicate formula ϕ :

$$\forall x\Big[\big(\forall z\, z\,|\,x \Rightarrow \big((z=x) V (z=1)\big)\big) \Rightarrow \exists w (w > x) \wedge \big(\forall z\, z\,|\,w \Rightarrow \big((w=z) V (z=1)\big)\big)\Big]$$

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

Answer: (C) **Click here to watch video explanation**

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 _______.

Answer: (10) **Click here to watch video explanation**

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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

Answer: (D) **Click here to watch video explanation**

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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.

Answer: (3) **Click here to watch video explanation**


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