Section - A

1. Which of the following statements is/are TRUE?

   P : A weak entity set does not have a primary key.

   Q : For a weak entity set to be meaningful, it must be part of a one-to-many relationship set.

   R : For a weak entity set, it is not required to have a key so that each tuple is distinguishable.

   S : Every weak entity set corresponds to an identifying entity set.

   (A) P, Q and R are TRUE   (B) P, Q and S are TRUE

   (C) Q, R and S are TRUE   (D) P, Q, R and S are TRUE

2. Let r(R) be a relation on schema R and s(S) be a relation on schema S. To perform the operation $r \div s$, the attribute set of r and s must satisfy

   (A) $R \subseteq S$ (B) $S \subseteq R$ (C) $R \cap S = \varnothing$ (D) $R - S = \varnothing$

3. Let R be a relational schema and let F be a set of functional dependencies on R. Let R_1 and R_2 form a decomposition of R. For lossless-join decomposition of R, F^+ must contain

   (A) $R_1 \cup R_2 \rightarrow R_1$ or $R_1 \cup R_2 \rightarrow R_2$

   (B) $R_1 \cup R_2 \rightarrow R_1$ or $R_1 \cap R_2 \rightarrow R$

   (C) $R_1 \cup R_2 \rightarrow R_2$ or $R_1 \cap R_2 \rightarrow R$

   (D) $R_1 \cap R_2 \rightarrow R_1$ or $R_1 \cap R_2 \rightarrow R_2$

4. In a B+ tree, we store the data value in

   (A) intermediate node.

   (B) leaf node.

   (C) both in intermediate node and leaf node.

   (D) neither in intermediate node nor in leaf node.

5. A relation with 2 attributes is always in

   (A) 4NF   (B) BCNF   (C) 5NF   (D) DK/NF

6. In an RDBMS with m attributes, how many super keys are possible?

   (A) m (B) m^2 (C) 2^m (D) $2^m - 1$

7. An RDBMS with 3 attributes has the following functional dependencies

   $A \rightarrow B$ $A \rightarrow C$ $C \rightarrow B$

   Then the RDBMS must be in

   (A) 2NF   (B) 3NF   (C) 4NF   (D) BCNF

8. Let R be an RDBMS with attributes A_1, A_2, ..., A_n. Let S denotes the set $\{A_1, A_2, ..., A_n\}$. Let $T \subseteq S$ be a set of attributes that forms a candidate key. Then which of the following is/are TRUE?

P : $T \rightarrow S - T$

Q : $\exists P \subset T$ s.t. $P \rightarrow S - P$

R : $\forall Q \supseteq T$ s.t. $Q \rightarrow S - Q$

(A) Only P is TRUE   (B) P and Q are TRUE

(C) P and R are TRUE   (D) Q and R are TRUE

9. Two concurrent transactions T_1 and T_2 operate on two data items A and B as follows:

T_1 :	lock-X(B);	T_2 : lock-S(A);
	read(B);	read(A);
	B:=B-50;	lock-S(B);
	write(B);	read(B);
	lock-X(A);	display(A+B);
	read(A);	unlock(A);
	A:=A+50;	unlock(B);
	write(A);	
	unlock(B);	
	unlock(A);	

lock-X( ): Exclusive Lock   lock-S( ): Shared Lock

Then which of the following is NOT TRUE?

(A) Any schedule for the above 2 transactions is conflict serializable.
(B) Any schedule for the above 2 transactions is free from deadlock.
(C) Transactions obey 2 phase locking protocol.
(D) Any schedule for the above 2 transactions is view serializable.

10. Consider the following relational database schema:

     employee(emp_no, name, address)
     project(p_no, p_name)
     work_on(emp_no, p_no)

We have a relational algebra expression on the above schema:

$\Pi_{name}(employee) - \Pi_{name}(employee \otimes work\_on)$

Here $\otimes$ denotes natural join operator. Then which of the following query best resembles the above relational algebra expression?

(A) Find the name of all employees working in a project.
(B) Find the name of all employees working in all projects.
(C) Find the name of all employees who don't work in all projects.
(D) Find the name of all employees who don't work in any project.

11. Consider the relational schema of Question 10. Consider the following query.

   Find all addresses of employees working in the project with p_name = "database".

   Which of the following SQL represents the above query?

   (A) SELECT address FROM employee, project WHERE (p_name= "database")∧ (work_on.emp_no=employee.emp_no)

   (B) SELECT address FROM employee, project, work_on WHERE (p_name= "database")∧(work_on.emp_no=employee.emp_no)∧(work_on.p_no=project. p_no)

   (C) SELECT address FROM employee, work_on WHERE (p_name= "database")∧ (work_on.emp_no=employee.emp_no)

   (D) SELECT address FROM project, work_on WHERE (p_name= "database")∧ (work_on.emp_no=employee.emp_no)

12. Consider the relational schema of Question 10. What does the following query return?

   $\{t \mid \forall u \in \text{project}(u[p\_no] \Rightarrow (\exists s \in \text{employee}(t[name] = s[name])$

   $\wedge \exists v \in \text{work\_on}(s[emp\_no] = v[emp\_no])))\}$

   (A) Name of the employees who are working in all projects.
   (B) Name of the employees who are working in at most one project.
   (C) Name of the employees who are not working in any project.
   (D) Name of the employees who are working in at least one project.

13. Given that D is a DFA, N is an NFA and P is a PDA. Let $L_1 = L(D) \cup L(N)$ and $L = L(P) \cap L_1$. Then L is

   (A) context-free but may not be regular.
   (B) regular.
   (C) recursive but not context-free.
   (D) deterministic context-free but not regular.

14. Which of the following is/are TRUE?
   I. The language accepted by any Turing machine is recursive.
   II. Complement of the language accepted by any PDA must be context-free.
   III. Every subset of a regular set is regular.

   (A) I only   (B) III only   (C) I and II   (D) I and III

15. Consider the following DFA:
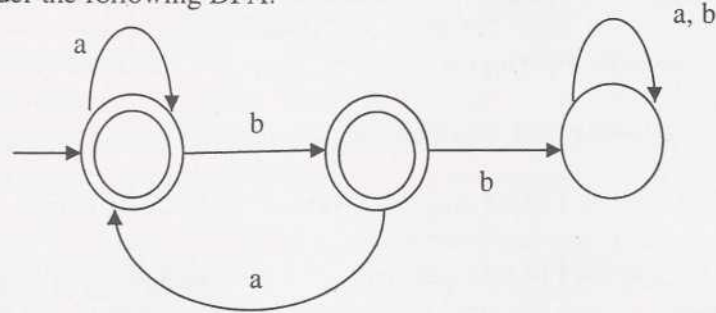
The complement of the language accepted by the DFA is the set of all strings over $\{a, b\}$ that

(A) begins with either a or b.
(B) ends with either a or b.
(C) contains the substring bb.
(D) contains at least two b's.

16. Given

$L_1 = \{a^m b^n c a^i b^j \mid m = n, i \neq j\}$,
$L_2 = \{a^i b^j c a^k b^l \mid i \leq j, j = k, k = l\}$,
$L_3 = \{a^i b^j c^k \mid i, j, k \geq 0\}$.

Which of the following is TRUE for the above languages?

(A) L_1 and L_2 are not context-free and L_3 is regular.
(B) All three are context-free but not regular.
(C) L_1 and L_3 are context-free and L_2 is accepted by a deterministic PDA.
(D) L_1 is context-free but not regular, L_2 is not context-free and L_3 is regular.

17. Consider the grammar $G : S \rightarrow aA \mid aaA \mid aaaA \mid \varepsilon$
$$A \rightarrow aAb \mid B$$
$$B \rightarrow Bb \mid \varepsilon$$

The language generated by the grammar G is

(A) $\{a^n b^m \mid n, m \geq 0, n \geq m\}$
(B) the set of all strings over $\{a, b\}$ (including the empty string) that begins with a and ends with b and the number of a's is either equal to or more than the number of b's by 2 or 3.
(C) $\{a^n b^m \mid n \geq m + 3\}$
(D) $\{a^n b^m \mid n \leq m + 3\}$

18. Given that the language L_1 is recursively enumerable and the complement of L_2 is recursive. Then there exist some Turing machines M_1 and M_2 such that

(A) M_1 accepts the complement of L_1 and M_2 accepts L_2
(B) M_1 accepts L_1 and halts on every input and M_2 accepts the complement of L_2
(C) M_1 accepts $L_1 \cup L_2$ and M_2 accepts the complement of L_2
(D) M_1 accepts L_2 and M_2 accepts the complement of $L_1 \cap L_2$

19. The complement of any arbitrary context-free language is accepted by some

   (A) PDA but not by any DPDA
   (B) NFA
   (C) DPDA
   (D) Turing machine that halts on every input.

20. Which of the following is/are undecidable?
   I.   Whether a language accepted by a PDA is ambiguous
   II. Whether a given regular language is context-free
   III. Whether two CFGs generate the same language
   IV. Whether a given recursive language is accepted by a Turing machine that halts on every input

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

21. Which of the following is TRUE for the language $\{a^n b^j \mid n \le j^2\}$?

   (A) It is context-free but not regular.
   (B) It is not accepted by any Turing machine.
   (C) It is accepted by an NFA but not context-free.
   (D) It is neither regular nor context-free.

22. If the decision problem Π_A is NP-complete and Π_B is in class NP, then which of the following is TRUE?

   (A) There is no polynomial time algorithm for Π_A.
   (B) If $\Pi_B <_P \Pi_A$, then Π_B is also NP-complete.
   (C) If Π_A is NP-hard, then $P = NP$.
   (D) There is a nondeterministic polynomial time algorithm for Π_B.

23. The total number of Boolean functions that can be constructed for n Boolean variables is

   (A) n (B) 2^n (C) $(2^n)^n$ (D) $2^{(2^n)}$

24. Consider two 4-bit numbers $A = A_3 A_2 A_1 A_0$ and $B = B_3 B_2 B_1 B_0$ and the expression $x_i = A_i B_i + \overline{A_i}\,\overline{B_i}$ for i = 0, 1, 2, 3. The expression

   $A_3 \overline{B_3} + x_3 A_2 \overline{B_2} + x_3 x_2 A_1 \overline{B_1} + x_3 x_2 x_1 A_0 \overline{B_0}$ evaluates to 1 if

   (A) $A = B$ (B) $A \ne B$ (C) $A > B$ (D) $A < B$

25. An odd function involving three Boolean variables is

   (A) $\sum(1,3,5,7)$ (B) $\sum(0,2,4,6)$
   (C) $\sum(1,2,4,7)$ (D) $\sum(0,3,5,6)$

26. How many 2-to-4-line decoders with enable input are needed to construct a 4-to-16-line decoder?

   (A) 4   (B) 5   (C) 6   (D) 8

27. The function $f(A,B,C,D) = \sum(5,7,9,11,13,15)$ is independent of variable(s)

   (A) B   (B) C   (C) A and C   (D) D

28. $(3527)_8$ is equivalent to

   (A) $(757)_{16}$ (B) $(1879)_{10}$ (C) $(131113)_4$ (D) All of these

29. How many flip-flops will be complemented in a 10-bit binary ripple counter to reach the next count after 1001100111?

   (A) 3   (B) 4   (C) 6   (D) 10

30. Consider the following state transition table with two state variables A and B and the input variable x and the output variable y

Present State		Input	Next State		Output
A	B	x	A	B	y
0	0	0	0	0	0
0	0	1	0	1	0
0	1	0	0	1	1
0	1	1	1	0	0
1	0	0	0	0	1
1	0	1	1	1	0
1	1	0	1	1	1
1	1	1	0	0	1

   If the initial state is A = 0 and B = 0, what is the minimum length of an input string which will take the machine to the state A = 1 and B = 1 with output 1?

   (A) 3   (B) 4   (C) 5   (D) 6

31. An 8×1 multiplexer has input A, B and C connected to the selection input s_2, s_1 and s_0 respectively. The data input I_0 to I_7 are as follows: $I_1 = I_2 = I_7 = 0$; $I_3 = I_5 = 1$; $I_0 = I_4 = D$ and $I_6 = \overline{D}$. The Boolean function that the multiplexer implements is

   (A) $f(A,B,C,D) = \sum(1,6,7,9,10,11,12)$

   (B) $f(A,B,C,D) = \sum(0,3,4,5,11,12)$

   (C) $f(A,B,C,D) = \sum(1,3,5,7,9,11,13,15)$

   (D) $f(A,B,C,D) = \sum(0,1,3,4,5,6,12)$

32. The size of address bus of a microprocessor is 20 bits and the size of data bus is 8 bits. What is the maximum number of RAM chips of size 64 K × 4 that can be connected to this microprocessor?

(A) 8   (B) 16   (C) 24   (D) 32

33. Static RAM

(A) is a volatile memory
(B) is a non-volatile memory
(C) needs refreshing to retain the value
(D) contains static information, i.e., it cannot be modified

34. Pick up the correct pair in which the first element refers to the addressing modes with minimum operand fetching time and the second one refers to the addressing modes with maximum operand fetching time.

(A) Register direct and memory indirect.
(B) Register direct and indexed indirect.
(C) Immediate and indexed indirect.
(D) Immediate and indexed.

35. While an instruction is executed, the Program Counter (PC) should contain the address of

(A) the current instruction   (B) the next sequential instruction
(C) the operand   (D) the previous instruction

36. A typical vertical microinstruction format is characterized by

(A) limited encoding with limited parallelism
(B) limited encoding with high degree of parallelism
(C) high degree of encoding with high degree of parallelism
(D) high degree of encoding with limited parallelism

37. In set associative mapping, the cache is divided into v sets, each of which consists of k lines. The required relationships are:
$$m = v \times k \quad \text{and} \quad i = j \bmod v$$
where

(A) i = cache line number; j = main memory block number; m = number of lines in the cache
(B) i = main memory block number; j = cache set number; m = number of blocks in main memory
(C) i = cache set number; j = main memory block number; m = number of lines in the cache
(D) i = cache set number; j = cache line number; m = number of set in the cache

38. Consider a memory system that uses a 20-bit address to address at the byte level and a cache that uses a 256-byte line size. Assume a direct map cache with a tag field of 6-bit in the address. The number of blocks in main memory and the number of lines in cache, respectively, are

(A) 1024, 128   (B) 4096, 64   (C) 4096, 128   (D) 8192, 64

39. The number of entries in an inverted page table

(A) depends on the size of the process.
(B) is equal to the number of page frames in main memory.
(C) is equal to the number of page frames in virtual memory.
(D) is equal to the size of the page frame.

40. There are four page frames in the memory. The following sequence of virtual page numbers is encountered in the course of execution of a program:

3, 4, 2, 6, 4, 7, 6, 1, 3, 7, 3, 5

Assume that main memory is initially empty and LRU replacement policy is adopted. The number of page transferred during this sequence of reference is

(A) 5   (B) 8   (C) 10   (D) 12

41. The instruction mix in an application and instruction execution speed of a hypothetical machine are as follows:

Instruction	Speed (cycle)	Occurrence (%)
ADD	8	30
SHIFT	4	20
LOAD	12	30
STORE	12	20

If the clock frequency is 2.3 GHz, the machine performance in MIPS is

(A) 230   (B) 250   (C) 360   (D) 920

42. The address bus of a computer has 16 address lines, A_{15-0}. If the address assigned to one device is $7CA4_{16}$ and the address decoder for that device ignores lines A_8 and A_9, what are all the addresses to which this device will respond?

(A) $7CA4_{16}$, $7CA5_{16}$, $7CA6_{16}$ and $7CA7_{16}$
(B) $7C84_{16}$, $7C94_{16}$, $7CA4_{16}$ and $7CB4_{16}$
(C) $7CA4_{16}$, $7DA4_{16}$, $7EA4_{16}$ and $7FA4_{16}$
(D) $7CA4_{16}$, $6CA4_{16}$, $5CA4_{16}$ and $4CA4_{16}$

43. **Ackerman's** function is defined recursively on the non-negative integers as follows:

```
A(m, n) = n+1                   if m == 0
A(m, n) = A(m-1, 1)             if (m!=0 && n == 0)
A(m, n) = A(m-1, A(m, n-1))     if (m!=0 && n!=0)
```

Using the above definition A(2, 2) equals:

(A) 2   (B) 3   (C) 6   (D) 7

44. Consider the following C-function that computes $\binom{n}{r}$:

```
int comb(int n, int r) {
    if((n==r)||(r==0)) return 1;
    else return(comb(n-1, r) + comb(n-1, r-1));
}
```

How many recursive calls are made to the function "comb"?

(A) $\binom{n}{r}$ (B) $\binom{n-1}{r}$ (C) $\binom{n+1}{r+1}$ (D) $2\binom{n}{r}-1$

45. Insert 2, 1, 4, 5, 9, 3, 6 into an initially empty **AVL** tree. The preorder traversal of the tree after insertion is

(A) 4, 2, 1, 3, 6, 5, 9   (B) 1, 2, 4, 3, 9, 5, 6
(C) 3, 4, 1, 2, 6, 9, 5   (D) 6, 5, 2, 4, 3, 1, 9

46. The minimum number of comparisons required to sort a sequence of 5 data items is

(A) 4   (B) 5   (C) 6   (D) 7

47. A file contains characters a, e, i, o, u, s and t with frequencies 10, 15, 12, 3, 4, 13 and 1 respectively. If we use Huffman Coding for data compression then the average code length will be:

(A) $\dfrac{140}{58}$ (B) $\dfrac{146}{58}$ (C) $\dfrac{150}{58}$ (D) $\dfrac{174}{58}$

48. A sort method is said to be **stable** if the relative order of keys is the same after the sort as it was before the sort. In which of the following pairs both sorting algorithms are **stable**?

(A) Quick-sort and Insertion-sort   (B) Insertion-sort and Merge-sort
(C) Quick-sort and Heap-sort   (D) Quick-sort and Bubble-sort

49. Insert keys 4, 12, 8, 16, 6, 18, 14, 7 into an initially empty binary search tree. Delete the node having the key 6. The preorder traversal after deletion is

(A) 4, 12, 7, 8, 24, 18, 16   (B) 4, 12, 8, 7, 16, 18, 24
(C) 4, 12, 8, 7, 24, 18, 16   (D) 4, 12, 7, 8, 16, 18, 24

50. The minimum number of nodes in an **AVL** tree of height 10 (assuming a tree of height 0 is a tree having only 1 node) is

(A) 144   (B) 160   (C) 232   (D) 257

51. Let T be a B-tree of order m and height h. Let $d = \left\lceil \dfrac{m}{2} \right\rceil$ and let n be the number of elements in T. Then which of the following is TRUE?

(A) $m^h - 1 \leq n$

(B) $2d^{h-1} - 1 \leq n$

(C) $h \leq \log_m(n+1)$

(D) $\log_d\left(\dfrac{n+1}{2}\right) + 1 \leq h$

52. The maximum number of disk accesses needed for inserting a key into a **2-3** tree of height h is

(A) h (B) $2h$ (C) $3h$ (D) $3h + 1$

53. Consider the following program:

```
void f(int x, int &y, const int &z)
{
      x += z;
      y += z;}

void main()
{
 int a = 22, b = 33, c = 44;
 f(a,b,c);
 f(2*a-3, b, c);
 printf("a=%d b=%d c=%d\n", a, b, c);
}
```

What will be the output of the above program?

(A) a = 41 b = 33 c = 44

(B) a = 22 b = 33 c = 44

(C) a = 41 b = 121 c = 44

(D) a = 22 b = 121 c = 44

54. Consider the following C-function:

```
int f(int a, int b)
{
  if(b>a) return(f(b,a));
  else if(b==0) return(a);
          else return(f(b, a%b));
}
```

Which of the following will be returned by the function call f(18, 30)?

(A) 2   (B) 3   (C) 6   (D) 8

55. Consider the following C-function:

```
float f(float x, float y)
{
 int i; float z;
 if(x==0.0) return 0.0;
 if(y==0.0) return 1.0;
 z=1.0;
 for(i=0; i<y; i++)
     z*= x;
 for(i=0; i>y; i--)
     z /= x;
 return z;
 }
```
Which value will be returned by the function call f(2.0, −3.0)?

(A)   −6.0   (B)   −1.0   (C)   0.125   (D)   1.5

56.   Consider the following program:

```
void main()
{
int m =44;
int *p = &m;
int &r=m;
int n = (*p)++;
int *q = p-1;
r= --*(p)+1;
++*q;
printf("m=%d, n=%d, r=%d\n", m, n, r);}
```
What will be the output of the above program?

(A)   m = 44, n = 46, r = 45   (B)   m = 45, n = 44, r = 45
(C)   m = 46, n = 44, r = 46   (D)   m = 46, n = 43, r = 46

57.   In a C program how many bytes are required to store the string "john" in a character array?

(A)   2   (B)   3   (C)   4   (D)   5

58.   We have the following recurrence relation:

$$T(n)=\begin{cases} 1 & n\le 5 \\ T(n/5)+T(3n/4)+n & n>5 \end{cases}$$

Then which of the following statement is TRUE?

(A) $T(n)\in \theta(n^2)$ (B) $T(n)\in \Omega(\sqrt{n})$
(C) $T(n)\in \theta(n)$ (D) $T(n)\in \theta(n\log n)$

59. We have the following recurrence relation:

$$T(n) = \begin{cases} 1 & n = 1 \\ 7T(n/2) + n^2 & n > 1 \end{cases}$$

Then which of the following statements is TRUE?

(A) $T(n) \in O(n)$ (B) $T(n) \in \theta(n^{\log_2 7})$

(C) $T(n) \in \theta(n^2)$ (D) $T(n) \in \theta(n^3)$

60. What is the total number of Hamiltonian Cycles in a complete graph of n vertices?

(A) $n!$ (B) $(n-1)!$ (C) $\left\lfloor \dfrac{n-1}{2} \right\rfloor$ (D) $\dfrac{(n-1)!}{2}$

61. What is the upper bound on the number of edge disjoint spanning trees in a complete graph of n vertices?

(A) n (B) $n-1$ (C) $\left\lfloor \dfrac{n}{2} \right\rfloor$ (D) $\left\lceil \dfrac{n}{2} \right\rceil$

62. In a graph $G = (V, E)$ the *feedback edge set* is the set of the minimum number of edges whose removal will make the resultant graph acyclic. Then the cardinality of the *feedback edge set* for an undirected graph G is

(A) $|E| - |V| + 1$ (B) $|E| - |V|$ (C) $|E| - 1$ (D) $|V| - 1$

63. Let A, B and C be languages corresponding to decision problems Π_A, Π_B and Π_C respectively. Let A be NP-Complete. Then which of the following is NOT TRUE?

(A) $A \in NP$.
(B) $\forall L \in NP, L <_p A$.
(C) If $C \in NP$ and $A <_p C$ then C is NP-Complete.
(D) If $B \in NP$ and $B <_p A$ then B is NP-Complete.

64. Consider the following graph:
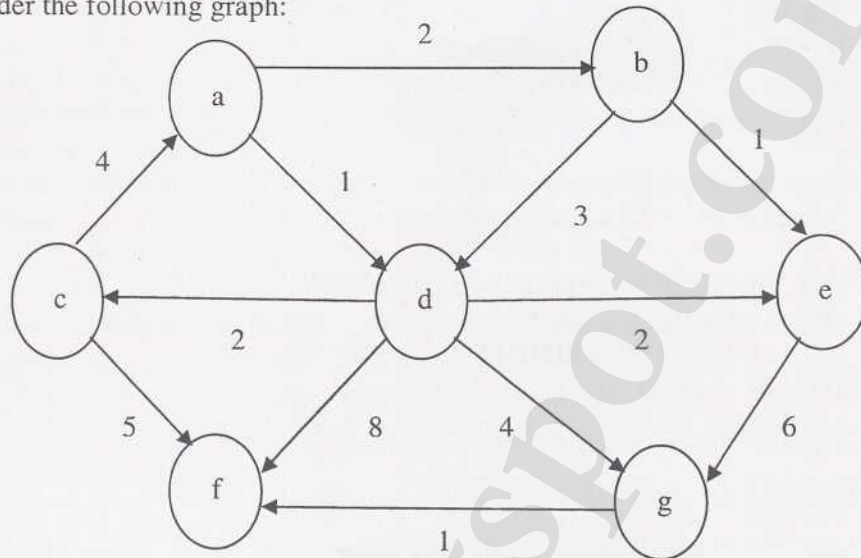
The shortest distances from the vertex *a* to *b, c, d, e, f* and *g* respectively are:

(A) 2, 7, 1, 3, 9, 5   (B) 2, 3, 1, 3, 9, 5
(C) 2, 3, 1, 3, 6, 5   (D) 2, 7, 1, 3, 6, 5

65. Consider the underlying undirected graph corresponding to Question no. 64 and compute its minimum spanning tree. Then the sum of the edge weights of the minimum spanning tree is

(A) 10   (B) 11   (C) 12   (D) 15

66. Consider the following graph:
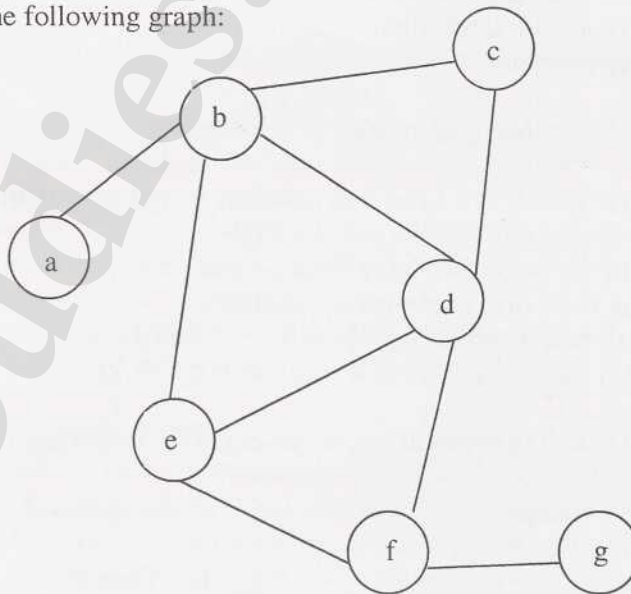
A possible depth first search (**DFS**) sequence for the above graph is

(A) d, e, b, a, c, f, g
(B) b, a, e, c, d, f, g
(C) d, b, a, e, f, c, g
(D) b, c, d, e, f, a, g

67. The minimum element in a max-heap represented by an array can be computed in time

   (A) $\theta(n \log n)$ (B) $O(n)$ (C) $\theta(n^2)$ (D) $O(1)$

68. Which of the following regular expressions describes the language – the set of all strings over $\{0, 1\}$ containing even number of 0's?

   (A) $(01^*01^*)^* + (1^*01^*0)^* + (1^*001^*)^*$
   (B) $(1^*01^*01^*)^* + 1^*$
   (C) $(1^*(00)^*1^*)^* + ((00)^*1^*)^* + (1^*(00)^*)^*$
   (D) $((0 + 1)^*0(0 + 1)^*0(0 + 1)^*)^*$

69. Consider the grammar G : S → Aca | Bcb
                              A → c
                              B → c
   where S, A and B are non-terminals and a, b, c are terminal symbols. Then G is

   (A) LL(2) but not LL(1).   (B) LL(2) but not LR(0).
   (C) SLR(1) but not LL(1).   (D) neither LL(2) nor LR(1).

70. If a grammar G contains left-recursive productions, then which of the following is NOT TRUE?

   (A) A recursive-descent parser for G may loop forever.
   (B) G cannot be parsed by any LL(1) parser.
   (C) G is ambiguous.
   (D) The left-recursive productions can be eliminated by rewriting some productions but some right-recursive productions may be introduced in the resulting grammar.

71. For a given context-free grammar G

   (A) an LR(1) parser can have S-R conflicts if and only if the LR(0) parser has S-R conflicts.
   (B) an LALR(1) parser can have reduce-reduce conflicts even if the LR(1) parser does not have any reduce-reduce conflicts.
   (C) an LR(0) parser can have S-R conflicts if the LL(1) parser has S-R conflicts.
   (D) an LR(1) parser can have S-R conflicts if the SLR(1) parser has S-R conflicts.

72. Find the best match between the elements of Group-I and Group-II as given below:

Group-I	Group-II
P. NFA	1. Code optimization
Q. Three-address code	2. Syntax analysis
R. Pushdown automata	3. Register allocation
S. Live variable analysis	4. Intermediate code generation
T. Graph colouring	5. Scanning

   (A) P – 5, Q – 1, R – 2, S – 3, T – 4   (B) P – 5, Q – 4, R – 2, S – 3, T – 1
   (C) P – 2, Q – 4, R – 5, S – 1, T – 3   (D) P – 5, Q – 4, R – 2, S – 1, T – 3

73. Peephole code optimization method

    (A) is used to optimize the number of registers required during code generation.
    (B) can be applied on intermediate code only.
    (C) can be applied for algebraic simplification.
    (D) can be used only after computing reaching definition set across different basic blocks.

74. Which of the following is/are TRUE?
    I. For any compiler generated temporaries the space is allocated in run-time heap only.
    II. Programming languages which allow recursion require a stack-based allocation scheme and cannot be implemented with static storage allocation scheme.
    III. For any dynamically allocated global variable the compiler might allocate space either in static area or in the activation record.
    IV. For a variable local to a procedure the space can be allocated in activation record.

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

75. Consider an NFA N with n states that accepts the language L. Let M be the minimized DFA with m states that accepts the same language L. Then which of the following is correct?

    (A) M must have at least 2^n states   (B) $n \leq m$
    (C) $m \leq n$ (D) $m \leq 2^n$

76. Which of the following statements is/are TRUE in computer networks?
    P : IEEE 802.11 can operate in full duplex mode.
    Q : FTP uses out-of-bound signaling to control the transfer of file.
    R : SMTP can be used to transfer binary files without using any coding techniques.
    S : Point-to-point Protocol always sets the address field to the broadcast address of eight 1's.

    (A) P, Q and S only   (B) Q, R and S only
    (C) P and S only   (D) Q and S only

77. A user program sends 6000 bytes of data through a TCP socket with call "write (std, buf, 6000)". Assume maximum TCP segment size is 1500 bytes, maximum IP datagram size is 4 KB, the source and destinations are on the same Ethernet segment, and receiver window size is large enough to receive all bytes of the information. Making reasonable assumptions about unspecified fields, the number of Ethernet frames to be sent is

    (A) 4   (B) 5   (C) 6   (D) 3

78. In sliding window protocols in the data link layer, the frames to the left of the receiver window are frames

   (A) received but not acknowledged.
   (B) received and acknowledged.
   (C) not received.
   (D) not sent.

79. Which two control signals are used for handshaking between computer and modem for their existence?

   (A) Request to send and Clear to send
   (B) Ring indicator and Data carrier detect
   (C) Data set ready and Data terminal ready
   (D) Data carrier detect and Data terminal ready

80. There are two machines - M1 and M2 in a LAN. The network settings of M1 and M2 are as follows:

	M1		M2
IP address	: 192.168.0.4	IP address	: 192.168.1.5
Netmask	: 255.255.255.0	Netmask	: 255.255.254.0
Default Gateway:	192.168.0.4	Default Gateway:	192.168.1.5

   They are unable to connect each other. Suggest changes in configurations in order to connect each other.

   (A) Default gateway of M1 should be 192.168.1.5
   (B) Default gateway of M2 should be 192.168.0.4
   (C) Netmask of M2 should be 255.255.255.0
   (D) Netmask of M1 should be 255.255.254.0

81. Suppose that a signal of 22 dB is applied to a cable that has a loss of 7 dB. If an amplifier with a 12 dB gains is inserted into the cable at its opposite end, then what is the output signal strength at that location?

   (A) 15 dB   (B) 27 dB   (C) 34 dB   (D) 84 dB

82. In a hub based LAN system, collision is detected by

   (A) hub   (B) transmitting node
   (C) hub and transmitting node   (D) receiving node

83. Send window, receive window, window updates and window probes are related to which layer of the network protocol stack?

   (A) Data link layer   (B) Network layer
   (C) Transport layer   (D) Application layer

84. Error control is needed at the transport layer because of potential error occurring

   (A) from transmission line losses   (B) in routers
   (C) due to out of sequence delivery (D) from packet losses

85. How many frequencies does a full duplex QAM-128 modem use?

   (A) 2   (B) 14   (C) 7   (D) 10

86. A network is having site address 217.14.8.128 and netmask 255.255.255.128. Find network address, broadcast address within the net, broadcast address from outside to the net and number of hosts that can be connected.

(A) 217.14.8.0, 255.255.255.255, 217.14.8.255, 126
(B) 217.14.8.128, 255.255.255.255, 217.14.8.255, 126
(C) 217.14.8.0, 217.14.8.255, 255.255.255.255, 126
(D) 217.14.8.128, 255.255.255.255, 255.255.255.255, 127

87. For a band limited signal, the Nyquist theorem specifies the maximum sampling rate to be

(A) twice the lowest frequency of the signal.
(B) twice the highest frequency of the signal.
(C) twice the bandwidth of the signal.
(D) none of the above.

88. In Go-Back-N protocol, if the maximum window size is 63, what is the range of the sequence number?

(A) 0 to 63   (B) 0 to 64   (C) 1 to 63   (D) 1 to 64

89. Find best match between the elements of Group-I and Group-II as given below:

	Group-I		Group-II
P.	NNTP	1.	Web server
Q.	SSH	2.	Background process for system administration
R.	Daemon	3.	Protocol to read and post news
S.	Tomcat	4.	Allow to connect securely to remote machine
		5.	Mail server

(A) P – 5, Q – 2, R – 4, S – 3   (B) P – 3, Q – 4, R – 2, S – 1
(C) P – 5, Q – 4, R – 2, S – 1   (D) P – 3, Q – 2, R – 4, S – 5

90. Which of the following statements is/are TRUE?

P : If kernel is single threaded, then any user-level thread performing a blocking system call will cause the entire process to block.

Q : In case of kernel-level thread, if a thread performs a blocking system call, schedule of another thread may be possible.

R : Kernel intervention is necessary for scheduling of kernel-level as well as user-level threads.

(A) P and Q only   (B) P and R only
(C) Q and R only   (D) All of them

91. Assume user processes are of size 2 MB (no paging and segmentation exist), hard disk transfer rate is of 10 MB per second, head seeks are not necessary for disk and average latency is 8 milliseconds. If round-robin CPU scheduling algorithm is used in this system, the lower bound of time slice is

(A) 417 ms   (B) 400 ms   (C) 200 ms   (D) 210 ms

92. Consider a demand-paging system with a paging disk that has an average access and transfer time of 10 milliseconds. Addresses are translated through a page table in main memory with access time of 0.5 microseconds per memory access. Thus, each memory reference through the page table takes two accesses. To improve this time we have added an associative memory that reduces access time to one memory reference if page table entry is in the associative memory. Assume that 80 percent of the accesses are in the associative memory and 10 percent of remaining (or 2 percent of total) cause page fault. What is the effective memory access time?

(A) 0.30061 ms   (B) 0.20060 ms   (C) 0.20042 ms   (D) 0.20063 ms

93. Which of the following instructions should be allowed only in kernel mode?

P : Disable all interrupt.
Q : Read the time-of-day clock.
R : Set the time-of-day clock.
S : Change the memory map.

(A) P and R only   (B) P, R and S only
(C) P, Q and S only   (D) All of them

94. Assume that the following jobs are to be executed on a single processor system with preemptive scheduling.

Job id	Arrival time	CPU time	Priority (0 = highest, 10 = lowest)
1	0	6	8
2	5	3	6
3	2	2	3
4	7	4	1

At what time instant job 2 will finish execution?

(A) 7   (B) 10   (C) 12   (D) 15

95. Which of the following statements is/are TRUE?

P : If resource preemption is allowed, then deadlock can be avoided but cannot be prevented.
Q : If the number of sharable resources is greater than the number of processes, then deadlock can be prevented.
R : Deadlock can be prevented by not allowing any process to request for resources when it enters a critical section.
S : Deadlock avoidance schemes require information concerning which resource a process will request and use during its life time.

(A) P and S only   (B) P and Q only
(C) P, Q and R only   (D) S only

96. Five jobs are waiting to be run. Their expected run times are 9, 6, 3, 5, and 10. Which job scheduling technique will result in minimum average response time?

(A) SJF   (B) FCFS   (C) Priority   (D) Round-robin

97. Which of these conditions must be satisfied in the classic readers/writers problem?

P : Only one reader at a time may read a file.
Q : Only one writer at a time may write to a file.
R : Any number of writers may simultaneously write to a file.
S : Any number of readers may simultaneously read a file.
T : If a writer is writing to a file, no reader may read it.
U : If a reader is reading a file, no writer may write it.

(A) P, Q, S, T and U only   (B) Q, S, T and U only
(C) P, Q, T and U only   (D) Q, R, S and T only

98. Consider the following disk queue with request for I/O blocks on cylinders
   98, 180, 37, 170, 14, 75, 67, 165
Initially the disk head is at cylinder 55. Assume that the seek time for one cylinder is 1 ms. Find the total time required to complete this request if shortest-seek-time-first algorithm is used.

(A) 180 ms   (B) 235 ms   (C) 293 ms   (D) 391 ms

99. A program computes the row sums $c_i = \sum_{j=1}^{n} a_{ij}$ of an array A of dimension 100×100. Assume that the computer uses demand paging with a page size of 1000 words and that the amount of memory allotted for data is five page frames and initially these page frames are empty. FIFO replacement policy is used. Find the number of page faults if A is stored in virtual memory in column major order.

(A) 5   (B) 10   (C) 500   (D) 1000

100. Suppose that a total of 64 MB RAM is available in a system. This memory space is partitioned into 8 fixed size slots of 8 MB each. Assume 8 processes are currently requesting memory usage with sizes indicated as follows [2 MB, 4 MB, 3 MB, 7 MB, 6 MB, 9 MB, 1 MB, 8 MB]. Calculate the size of memory wasted due to external and internal fragmentation. Assume exactly one slot can be given to each process.

(A) Internal = 33MB, External = 8MB   (B) Internal = 25MB, External = 9MB
(C) Internal = 33MB, External = 9MB   (D) Internal = 25MB, External = 8MB

Section - B

101. $\sqrt{0.00005041}$ equals

    (A) 0.00847   (B) 0.0049   (C) 0.0071   (D) 0.019

102. The missing term in the sequence 3, 7, 15, 31, ____, 127 is

    (A) 63   (B) 71   (C) 92   (D) 113

103. In a computer literacy course, the number of girls registered is half of that of boys. Halfway through, ten boys left the course and five girls joined, after which the number of boys becomes equal to the number of girls. At the beginning, how many students registered for the course in total?

    (A) 15   (B) 30   (C) 45   (D) 60

104. Consider the following table:

6	9	10
3	3	5
4	2	?
8	6	8

The missing number in the above table is

    (A) 16   (B) 12   (C) 9   (D) 4

105. In an abstract mathematical coding, multiplication is coded as $\div$, addition as $\times$, subtraction as +, then $5 \times (4 \div 2) + 7$ equals

    (A) 4   (B) 6   (C) 10   (D) 17

106. In a school project, the students are asked to form groups. Each group is to have two students. The students have to choose their partners with the restriction that no two students can be in the same group if they have worked together during the previous semester. Avik and Ravi decided to pair up now. Rita does not want to work with Pinki while Pinki worked with Neel during the previous semester. Among the following who could be Rita's partner?

    (A) Avik   (B) Pinki   (C) Ravi   (D) Neel

107. The missing term in the sequence $PQR, P^2QR, P^2Q^2R, \_\_\_\_\_, P^3Q^2R^2$ is

    (A) P^3Q^2R (B) $P^2Q^2R^2$ (C) $P^3Q^3R^2$ (D) P^3QR

108. If the word CAPITAL is written as AYNGRYJ in a code, how would you code FORGET?

    (A) DMPFCR   (B) DMPECR   (C) CMPEBR   (D) DLPECR

109. What eyes are to binoculars, lips are to

(A) Lipstick   (B) Cigarette   (C) Candy   (D) Microphone

110. As cotton is to cloth, gold is to

(A) Goldsmith   (B) Ornaments   (C) Women   (D) Metal

111. Consider the statements:
    (I) All mothers are women.
    (II) Some parents are women.
Person X concluded from the above that
    (P) All mothers are parents.
    (Q) All parents are mothers.
    (R) All women are mothers.
    (S) Some women are parents.
Which one of the following is the correct conclusion?

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

112. The word CHEERS is coded as EHCSRE. According to the same rule, the word BASKET is coded as

(A) BSATEK   (B) KETBAS   (C) SABTEK   (D) ASBEKT

113. The odd one among Eye, Leg, Nose and Hand is

(A) Eye   (B) Leg   (C) Hand   (D) Nose

114. The odd figure among the following is
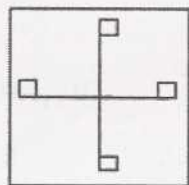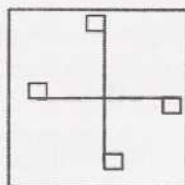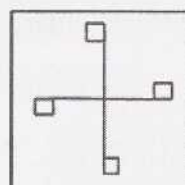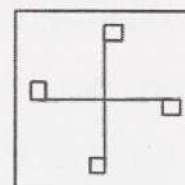
    (A)   (B)   (C)   (D)

115. The relationship between R and S is same as that between P and Q.

(P)   (Q)   (R)   (S)
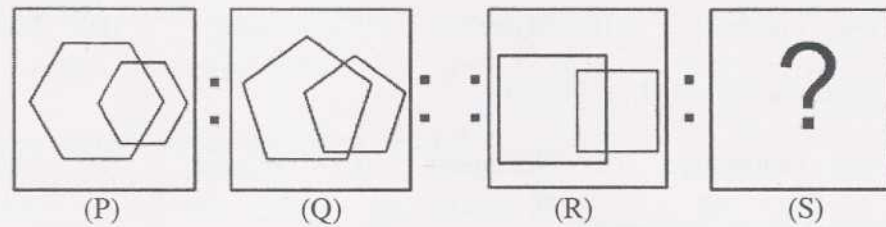
The best choice for S is

(A)   (B)   (C)   (D)
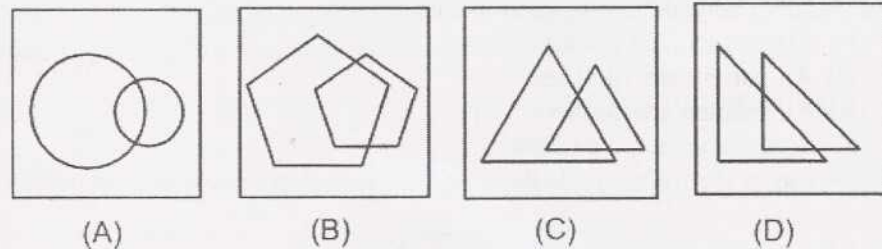
116. John is the last person in a queue. Ron is seventh in the queue from the front. Tim is positioned between John and Ron such that the number of people between Ron and Tim is the same as that between Tim and John. The position of Tim is 19th from the front. What is the position of John in the queue?

(A) 29   (B) 30   (C) 31   (D) 32

117. Here are some words translated from an artificial language:
    (i)   PAM CERUL means sky blue.
    (ii) CERUL LAX means blue cheese.
    (iii) ORAN VITL means star bright.
Which word could mean 'bright sky'?

(A) CERUL PAM   (B) ORAN CERUL   (C) LAX VITL   (D) VITL PAM

118. A child has X number of toys. If he arranges them in groups of two, three or four, he is left with one toy in each case. But if he arranges them in groups of five, he is left with none. The least possible value for X is

(A) 25   (B) 26   (C) 27   (D) 33

119. If CANE is coded as 1345 and MEAN as 8453, then TOKENS can be coded as

(A) 765239   (B) 142530   (C) 764539   (D) 762039

120. Consider the following figure:
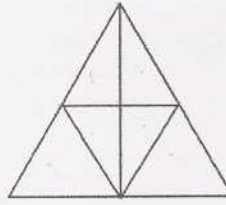
The number of triangles in the above figure is

(A) 6   (B) 10   (C) 13   (D) 16

121. Two alloys contain silver and copper in the ratios 3 : 1 and 5 : 3 respectively. The alloys are mixed to get a third alloy. Which of the following is possible for the ratio of silver to copper in the third alloy?

(A) 5 : 2   (B) 3 : 2   (C) 4 : 1   (D) 2 : 3

122. Mohit, Ajay, Balu, Shila and Anita are five students pursuing Bachelor's degree in five different subjects, namely, English, Physics, Mathematics, History and Statistics. Two of them stay in a hostel while the rest stay at home. Balu does not stay in hostel and studies Statistics. Anita studies Mathematics and Ajay studies English. Shila studies Physics. Also out of the students staying at home, one studies Physics and one studies History. What does Mohit study and where does he stay?

(A) Mathematics, hostel   (B) History, hostel
(C) English, home   (D) History, home

123. Three pencils cost the same as two erasers. Four erasers cost the same as one ruler. Two rulers cost the same as one pencil box. Which of the following statements is true?

(A) Six erasers cost the same as a pencil box.
(B) Two pencil boxes cost the same as five pencils.
(C) Six pencils cost the same as a ruler.
(D) Eight erasers and three pencils cost the same as a pencil box.

124. Four persons P, Q, R and S witnessed a crime and gave the following descriptions of the criminal
    (P) Average height, Thin and Middle-aged
    (Q) Tall, Thin and Middle-aged
    (R) Tall, Thin and Young
    (S) Tall, Average weight and Middle-aged
The most likely description of the criminal is that of

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

125. Consider the following figure:
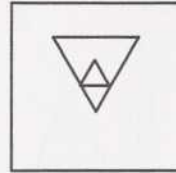
The figure in which the above figure is embedded is

| (A) | (B) | (C) | (D) |
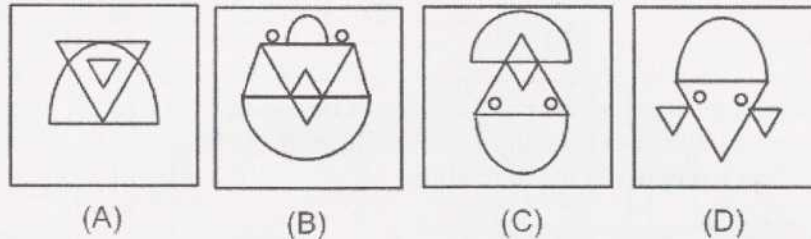
126. In a bus, there are 10 persons who can speak English, 6 persons who can speak French and 4 who can speak Portuguese. Further, two persons on the bus can speak exactly two of the above languages while one person can speak all the three languages. If each person on the bus speaks at least one of the three languages, how many persons are there in the bus?

(A) 20   (B) 19   (C) 17   (D) 16

127. Consider the following sequence of figures:

The next figure in the above sequence is

| (A) | (B) | (C) | (D) |
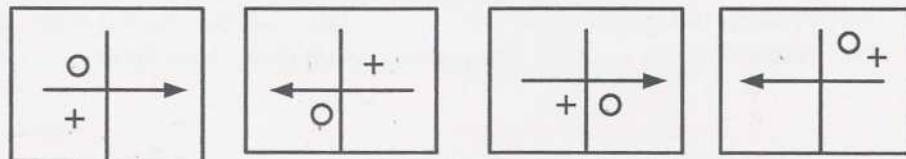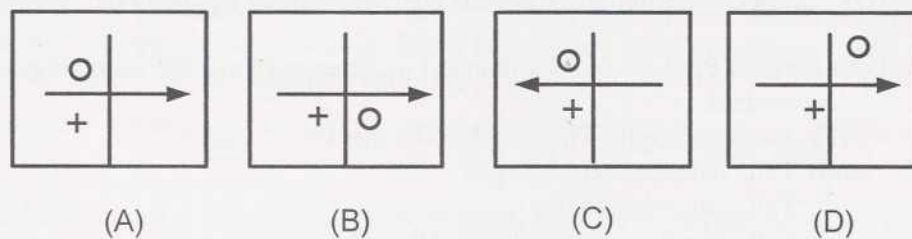
128. The next term in the sequence $-\dfrac{1}{32}, \dfrac{1}{8}, -\dfrac{1}{2}, 2,$ _____ is

(A) 16   (B) 8   (C) −8   (D) −16

129. The missing term in the sequence 4, 2, 6, 4, 8, 8, 10, __, 12 is

(A) 10   (B) 12   (C) 16   (D) 18

130. Consider the following figure:
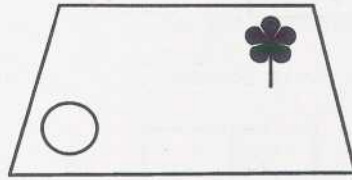
When the above figure is rotated clockwise through 90 degrees and held before a plane mirror, the image obtained will be

(A)   (B)   (C)   (D)
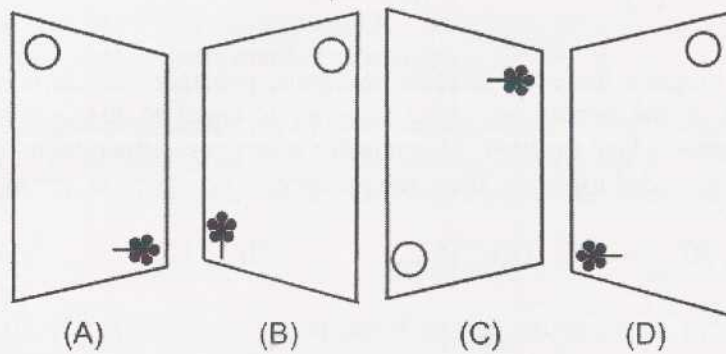
131. Consider the following sequence of figures:

The next figure in the above sequence is best given by

(A)   (B)   (C)   (D)
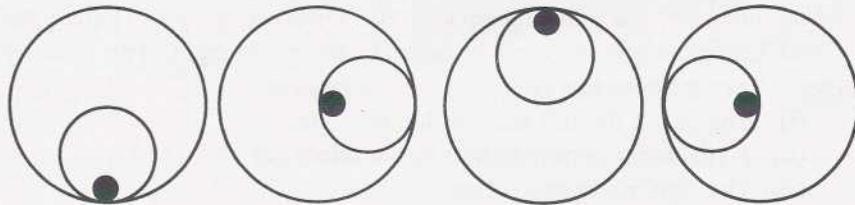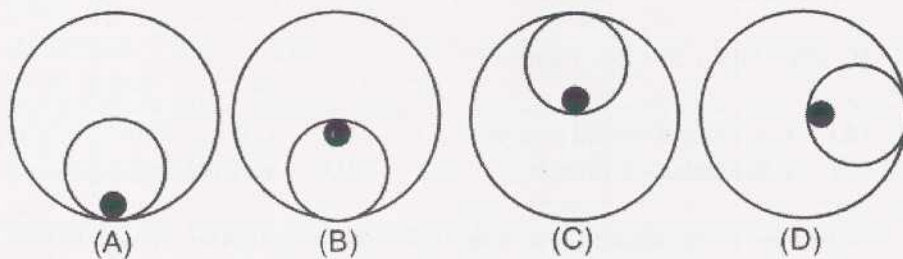
132. Consider the following sequence of figures:

The next figure in the above sequence is best given by

(A)   (B)   (C)   (D)
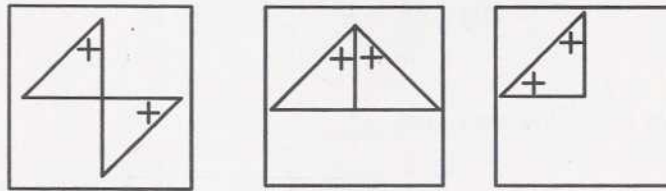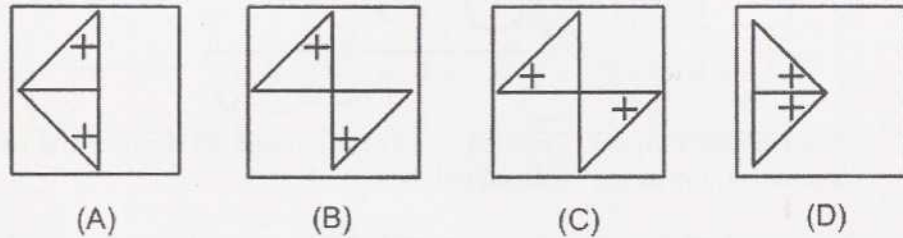
133. In a diagram there are disjoint hexagons, pentagons and squares. The number of sides of the pentagons added together is equal to the number of sides of the hexagons added together. This number is two more than the number of sides of the squares added together. Then, the number of hexagons is

(A) 20   (B) 15   (C) 12   (D) 10

134. Let $a_1, a_2, ..., a_{10}$ be integers such that $0 < a_1 < a_2 < ... < a_{10}$. If $s = a_1 + a_2 + ... + a_{10}$, then

(A) $11 \leq s \leq 55$ (B) $110 \leq s$ (C) $55 \leq s$ (D) $55 \leq s \leq 110$

135. In an institute, car parking spaces for Director, Deputy Director, Registrar and Chief Librarian are reserved in order from left to right. The security person noted the following about the cars:
   (i) The car in the left most space is white.
   (ii) A black car is parked between a white car and a red car.
   (iii) The right most space has a yellow car.
Then, the colour of the Registrar's car is

(A) Black   (B) Red   (C) Yellow   (D) White

136. If $x(x+1)(x+2) = 64$, then

(A) x is a positive odd integer   (B) x is a positive even integer
(C) x is a negative integer   (D) x is not an integer

137. In Roman numerals, the next term in the sequence LXIV, XXXVI, XVI, _____ is

(A) II   (B) IV   (C) IX   (D) X

138. Q is the son of P and is married to R. S, the sister of R, is married to T. T is the brother of Q. How are S and P related?

    (A) S is the sister-in-law of P   (B) S is the daughter of P

    (C) S is the daughter-in-law of P   (D) P is the daughter-in-law of S

139. Let X be a four digit number made up of the digits 6, 7 and 8 such that each of the three digits appears at least once. Then, the total number of distinct numbers that can be formed by rearranging the digits of X is

    (A) 10   (B) 12   (C) 18   (D) 24

140. P, Q, R and S together have 20 marbles and each has at least one marble. If Q has six marbles more than P and S has 8 marbles more than R, then

    (A) P and R have the same number of marbles.
    (B) R has less number of marbles than Q.
    (C) Q has less number of marbles than R.
    (D) Q and S have the same number of marbles.

141. A goat is tied to a pole with a rope inside a square field of area 64 square metres. If the distance of the pole from each of the nearest boundaries is 3 metres, then the minimum length of the rope in metres such that the goat can graze the entire field is

    (A) 5   (B) 10   (C) $5\sqrt{2}$ (D) $5\sqrt{3}$

142. The highest power of 3 which exactly divides 10! is

    (A) 3   (B) 2   (C) 5   (D) 4

143. If TANGO is coded as NFMZS and APPLES is coded as RDKOOZ, then how is LIMBO coded?

    (A) NALHK   (B) PCNKM   (C) MJNCP   (D) KHLAN

144. 0.99^{100} is closest to

    (A) 0   (B) 10   (C) 100   (D) 1000

145. Consider the following sequence of figures:

The next figure to the above sequence is given by
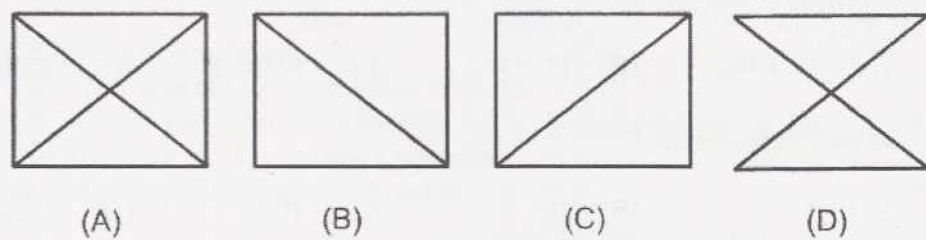

(A) (B) (C) (D)
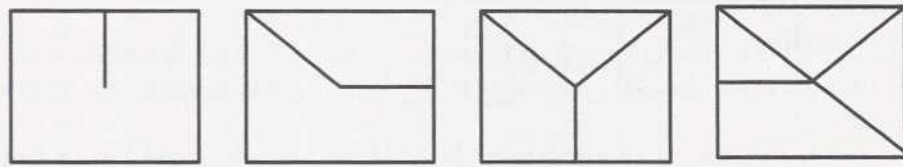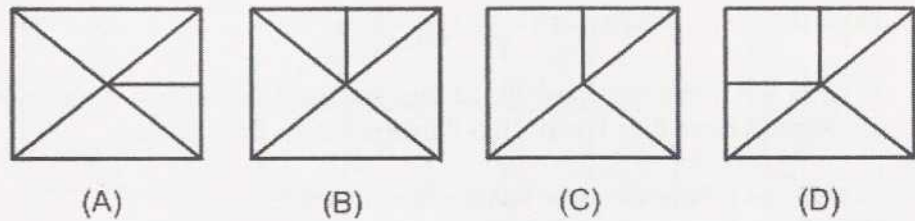
146. Amar has to take five right turns and six left turns while walking from his office to his home. His home faces South. In which direction does his office face?

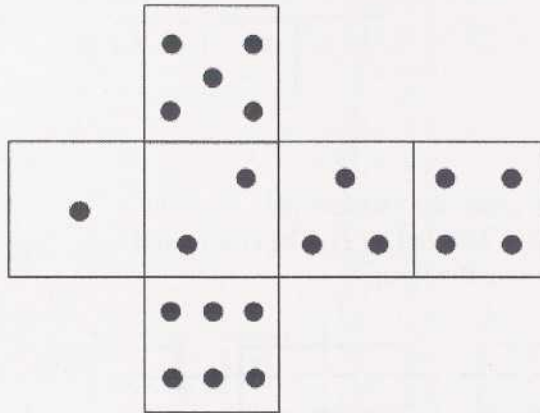(A) East (B) West (C) North (D) South
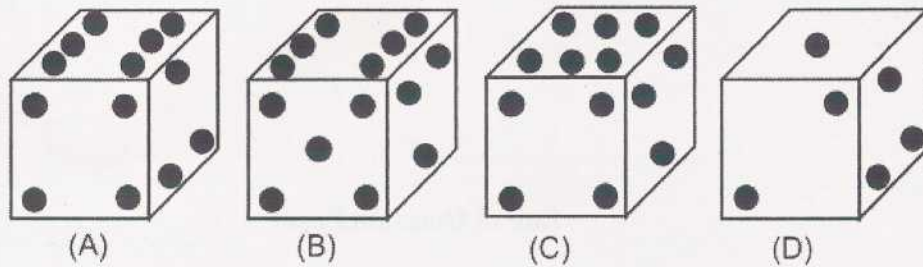
147. Consider the following sequence of figures:

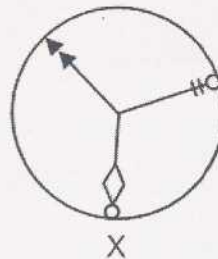The next figure to the above sequence is given by

(A) (B) (C) (D)
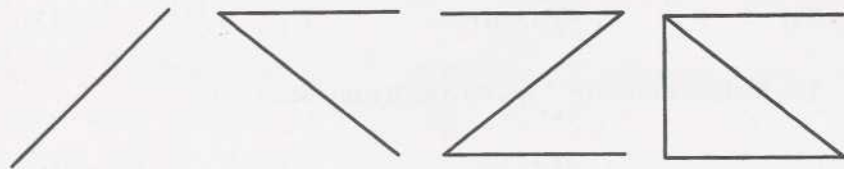
148.   A die is made by folding and gluing the following layout on a cardboard.

The die obtained would look like

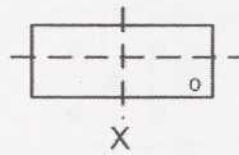(A)   (B)   (C)   (D)

149.   A wheel of radius $\dfrac{1}{\pi}$ cm has three spokes which are 120 degrees apart from each other. The wheel is oriented initially as shown in the following figure X:
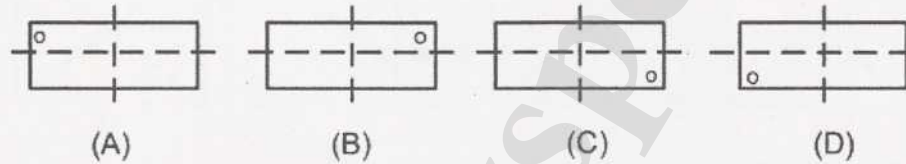

X

The orientation of the wheel after traversing 5 cm is

(A)   (B)   (C)   (D)
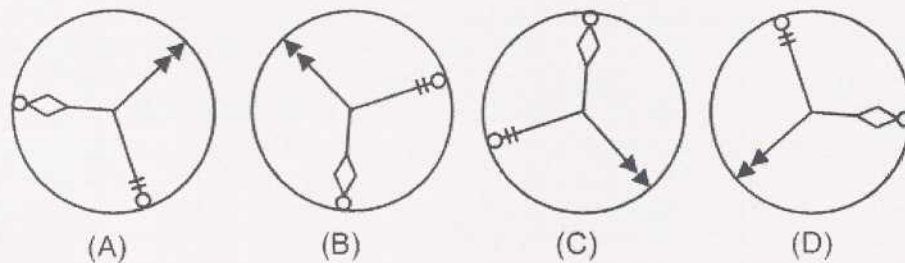
150. Consider the rectangle X.

The reflection about the vertical axis is denoted by V and the reflection about the horizontal axis is denoted by H. The compound operation of three times V followed by H will generate the figure

End of Question Paper