

MCA/D-16  
DESCRIBE MATHEMATICAL STRUCTURES  
PAPER: MCA-14-14

Time Allowed: 3 Hours

Maximum Marks: 80

Note: Attempt five questions in all. Question No. 1 is compulsory. All questions carry equal marks.

**Compulsory Question**

1. (a) What is Power set ? Give an example.
- (b) What do you mean by domain and range of a function?
- (c) Give an example of conjunction and disjunction each.
- (d) State Pigeonhole principle.
- (e) What is a generating function?
- (f) What is a special lattice?
- (g) Is a graph with four vertices a, b, c and d with  $\deg(a) = 4$ ,  $\deg(b) = 5 = \deg(d)$ , and  $\deg(c) = 2$  possible?
- (h) What is a complete binary tree?

Unit-I

2. (a) What is relation? Explain properties of relations.
- (b) Find all equivalence classes of the congruence relation mode 5 on the set of integers.
- (c) Determine whether the relation  $>$  is a partial order on  $\mathbb{Z}$ .
- 3 (a) Simplify the set expression  $(A \cap B) \cup (A \cap B) \cup (A \cap B)$  using set laws.
- (b) Let  $f(x) = ax + b$  and  $g(x) = 9x - b/a$  on  $\mathbb{R}$ , where  $a \neq 0$ . Find  $(g \circ f)(x)$  and  $(f \circ g)(x)$ .

Unit-II

4. Explain various proof strategies using suitable examples in detail.
5. (a) What is cyclic permutation? Prove that the number of cyclic permutation of  $n$  (distinct) items is  $(n-1)!$ .
- (b) State and prove binomial theorem. Find the coefficient of  $x^{12}y^{13}$  in the expansion of  $(x+y)^{25}$  ?

### Unit-III

6. (a) Let  $a_n$  denotes the number of  $n$ -bit words containing no two consecutive 1's. Define  $a_n$  recursively.
- (b) Using generating functions, solve the Fibonacci recurrence relation  $F_n = F_{n-1} + F_{n-2}$  where  $F_1 = 1 = F_2$ .
7. (a) What is Hasse diagram ? Determine whether the poset  $(\{1,2,3,4,5\}, |)$  and  $(\{1,2,4,8,16\}, |)$  are lattices.
- (b) Simplify the following expression and draw the switching and gate circuit using NAND gates only  $F = (xy)z + (xy + xz)$ .

### Unit-IV

8. (a) What is minimum spanning tree? How can you find MST from a graph using Prim's method? Explain using suitable example.
- (b) Find the chromatic number of the complete bipartite graph  $K_{m,n}$ , where  $m$  and  $n$  are positive integers.
9. (a) State and prove Euler's theorem.
- (b) Define following :
- (i) Multigraph
  - (ii) Isomorphic graph
  - (iii) Hamiltonian graph
  - (iv) Complete graph.