



Unit - I

Chapter 1 : Set Theory	1-1 to 1-28
-------------------------------	--------------------

1.1	Discrete Mathematics and its Significance.....	1-1
1.2	Sets.....	1-1
1.2.1	Notations.....	1-1
1.2.2	Representation of a Set.....	1-1
1.2.3	Types of Sets.....	1-2
1.2.4	Some Special Sets for Numbers.....	1-3
1.3	Naïve Set Theory (Cantorian Set Theory).....	1-3
1.4	Axiomatic Set Theory.....	1-3
1.5	Types of Set (Advance).....	1-3
1.5.1	Bounded and Unbounded Sets.....	1-3
1.5.2	Finite and Infinite Sets.....	1-4
1.5.3	Countable and Uncountable Sets.....	1-4
1.5.4	Countability of Rational Number (Using Cantor Diagonalization Argument).....	1-4
1.5.5	Examples.....	1-5
1.6	Set Operations.....	1-7
1.6.1	Complement of a Set.....	1-7
1.6.2	Union of Sets.....	1-7
1.6.3	Intersection of Two Sets.....	1-7
1.6.4	Difference of Sets.....	1-7
1.6.5	Symmetric Difference.....	1-8
1.7	Venn Diagram.....	1-8
1.8	Laws of Set Theory.....	1-10
1.9	Cardinality of Finite Sets.....	1-14
1.9.1	Principle of Inclusion-Exclusion.....	1-14
1.10	Principle of Duality.....	1-26
1.11	Multiset.....	1-27
1.11.1	Significance of Multiset with Example.....	1-27

Chapter 2 : Mathematical Logic	2-1 to 2-24
---------------------------------------	--------------------

2.1	Proposition.....	2-1
2.2	Logical Connectivity.....	2-1
2.2.1	Negation.....	2-1
2.2.2	Conjunction.....	2-1
2.2.3	Disjunction.....	2-2
2.3	Conditional and Bi-conditional Statements.....	2-3
2.4	Truth Tables.....	2-6
2.4.1	Tautology.....	2-7
2.4.2	Contradiction.....	2-7
2.4.3	Equivalence.....	2-7
2.4.4	Contingency.....	2-7
2.4.5	Basic Logical Equivalences.....	2-7
2.4.6	Duality Law.....	2-9
2.5	Normal Forms.....	2-9
2.5.1	Disjunctive Normal Form.....	2-9
2.5.2	Conjunctive Normal Form.....	2-10
2.5.3	Truth Table Method for Finding DNF.....	2-10
2.5.4	Truth Table Method for Finding CNF.....	2-10
2.5.5	Normal Forms using Algebraic Manipulations.....	2-11
2.6	Methods of Proofs.....	2-12
2.6.1	Rules of Inference.....	2-13
2.7	Quantifiers.....	2-15
2.7.1	Statement Functions and Variables.....	2-16
2.7.2	Negation of a Quantified Statement.....	2-16
2.8	Mathematical Induction.....	2-17
2.9	Strong Mathematical Induction.....	2-24
2.10	The Great Philosophers - Georg Cantor, Richard Dedekind and Aristotle.....	2-24



Unit - II

Chapter 3 : Relations 3-1 to 3-25

3.1	Binary Relation	3-1
3.2	Representation of a Relation	3-1
3.3	Types of Relations.....	3-2
3.3.1	Inverse Relation	3-2
3.3.2	Identity Relation.....	3-3
3.3.3	Universal Relation	3-3
3.3.4	Void Relation.....	3-3
3.4	Properties of Binary Relations	3-3
3.4.1	Reflexive Relations.....	3-3
3.4.2	Symmetric Relations	3-3
3.4.3	Anti-Symmetric Relation.....	3-3
3.4.4	Transitive Relation.....	3-3
3.4.5	Equivalence Relation.....	3-4
3.5	n-ary Relations and their Applications.....	3-7
3.6	Equivalence Classes or Equivalence Sets.....	3-7
3.6.1	Partition.....	3-7
3.6.2	Theorem on Equivalence Classes	3-7
3.7	Composition of Relations.....	3-10
3.8	Partial Order Relation (POSET).....	3-10
3.9	Hasse Diagram.....	3-11
3.9.1	Lattice	3-11
3.9.2	Chains and Antichains.....	3-12
3.10	Closure of Relations	3-16
3.10.1	Algorithm for Finding Transitive Closure	3-16
3.10.2	Warshall's Algorithm for Computing Transitive Closure.....	3-16

3.10.2(A)	'C' Function for Computing Transitive Closure of a Relation using Warshall's Algorithm	3-16
-----------	--	------

Chapter 4 : Functions 4-1 to 4-9

4.1	Function	4-1
4.2	Various Types of Functions	4-2
4.2.1	Many-one Functions.....	4-2
4.2.2	One-one Function (Injective)	4-2
4.2.3	Onto Function (Surjective).....	4-2
4.2.4	Into Function	4-2
4.2.5	One-one and Onto (Bijective)	4-2
4.3	Constant Function	4-2
4.3.1	Identity Function	4-2
4.3.2	Inverse Function.....	4-2
4.3.3	Partial Function	4-6
4.3.4	Invertible Function	4-6
4.4	Composition of Functions	4-6
4.5	Pigeonhole Principle.....	4-8
4.6	The Great Philosopher - Dirichlet.....	4-9

Unit - III

Chapter 5 : Counting Principles 5-1 to 5-18

5.1	Fundamental Principle of Counting.....	5-1
5.1.1	Rule of Multiplication	5-1
5.1.2	Rule of Sum	5-2
5.2	Permutation.....	5-2
5.2.1	Permutation when all the Objects are Distinct	5-2
5.2.2	Permutation with Repetition.....	5-7
5.3	Combinations	5-10
5.4	Binomial Coefficients.....	5-15
5.5	Identities for Binomial Coefficients	5-15
5.6	Generalized Permutations and Combinations.....	5-17



5.7	Algorithms for Generation of Permutation and Combinations	5-17
5.7.1	Algorithm for Generation of Permutations.....	5-17
5.7.2	Algorithm for Generation of Combinations.....	5-17

Unit - IV

Chapter 6 : Graph Theory 6-1 to 6-40

6.1	Basic Terminology.....	6-1
6.1.1	Definition of a Graph.....	6-1
6.1.2	Undirected Graph	6-1
6.1.3	Directed Graph	6-1
6.1.4	A Complete Graph.....	6-2
6.1.5	Weighted Graph	6-2
6.1.6	Adjacent Nodes	6-2
6.1.7	Path.....	6-2
6.1.8	Cycles	6-2
6.1.9	Connected Graph	6-2
6.1.10	Subgraph.....	6-3
6.1.11	Component.....	6-3
6.1.12	Degree of a Vertex	6-3
6.1.13	Self Edges or Self Loops	6-3
6.1.14	Multigraph	6-3
6.1.15	Trees.....	6-3
6.1.16	Spanning Trees	6-4
6.1.17	Minimal Spanning Tree.....	6-4
6.1.18	Acyclic Graph	6-4
6.2	Handshaking Lemma	6-4
6.3	Representation of Graph	6-5
6.3.1	Adjacency Matrix	6-5
6.4	Connectivity and the Path Matrix	6-7
6.4.1	Paths and Walks	6-7
6.4.2	Connected Graphs and Cycles.....	6-7
6.4.3	Path Matrix.....	6-7

6.5	Isomorphic Graphs.....	6-8
6.5.1	Isomorphism	6-9
6.6	Regular Graphs	6-12
6.6.1	Complete Graph	6-12
6.7	Bipartite Graph	6-12
6.8	Subgraphs and Complement.....	6-15
6.8.1	Subgraphs.....	6-15
6.8.2	Complement of a Graph	6-15
6.9	Operations on Graph.....	6-17
6.10	Paths and Circuits	6-18
6.10.1	Hamiltonian Graphs.....	6-19
6.10.2	Definitions	6-20
6.11	Shortest Path (Dijkstra's Algorithm).....	6-24
6.12	Planar Graphs	6-33
6.12.1	Euler's Formula for a Connected Plane Graph	6-34
6.12.2	Proof of Euler's Formula.....	6-34
6.13	Travelling Salesman Problem.....	6-37
6.13.1	Nearest Neighbour Method.....	6-37
6.13.2	Closet Insertion Algorithm	6-38
6.14	Graph Colouring	6-39
6.15	Application of Graph Theory in Software	6-40
6.15.1	Graph Database	6-40
6.15.2	Web Graph.....	6-40
6.15.3	Three Utility Problems	6-40
6.15.4	Google Map.....	6-40

Unit - V

Chapter 7 : Trees 7-1 to 7-52

7.1	Basic Terminology.....	7-1
7.1.1	Definition of a Tree	7-1
7.1.2	Properties of a Tree.....	7-1
7.1.3	Distance and Centre.....	7-1



7.1.4	Rooted Tree	7-2	7.10.1	Fundamental Cut Set	7-41
7.1.5	Basic Terms of a Tree	7-2	7.10.2	Cut-vertices and Cut-edges	7-43
7.1.6	Binary Tree	7-3	7.11	Max Flow - Min Cut Theorem.....	7-44
7.1.7	Height of Node and Level	7-3	7.11.1	Law of Conservation.....	7-44
7.1.8	M-Ary Trees.....	7-3	7.11.2	Min Cut Theorem.....	7-45
7.2	Prefix Codes.....	7-3	7.11.3	Construction of Flows and Maximal Flows	7-45
7.2.1	Optimal Prefix Code	7-4	7.11.4	Maximal Flow and Backward Arc.....	7-52
7.2.2	Huffman's Algorithm	7-4	Unit - VI		
7.3	Binary Search Tree.....	7-11	<hr/>		
7.3.1	Creating a Binary Search Tree	7-12	Chapter 8 : Algebraic Structures and Coding Theory		
7.4	Tree Traversal	7-14	8-1 to 8-20		
7.4.1	Preorder Traversal.....	7-14	<hr/>		
7.4.2	Inorder Traversal	7-15	8.1	Algebraic System	8-1
7.4.3	Postorder Traversal	7-15	8.1.1	Definition of Algebra	8-1
7.5	Expression Tree	7-16	8.2	Properties of Binary Operations.....	8-1
7.5.1	Conversion of an Expression into Binary Tree	7-17	8.2.1	Commutativity	8-1
7.6	Creation of a Binary Tree from Traversal Sequence ..	7-18	8.2.2	Associativity	8-1
7.6.1	Creation of Binary Tree from Preorder and Inorder Traversals.....	7-18	8.2.3	Identity Element.....	8-2
7.6.2	Creation of Tree from Postorder and Inorder Traversal	7-18	8.2.4	Distributivity.....	8-2
7.6.3	Examples on Tree Creation from Traversal Sequence	7-19	8.2.5	Cancellation.....	8-2
7.7	A General Tree.....	7-21	8.2.6	Inverse Property	8-2
7.8	Applications of Trees	7-23	8.2.7	Closed.....	8-2
7.8.1	Decision Tree	7-23	8.3	Semigroup.....	8-2
7.8.2	Game Tree	7-24	8.3.1	Monoid	8-3
7.8.3	Min-Max Tree	7-24	8.3.2	Group	8-3
7.9	Spanning Trees	7-24	8.3.3	Abelian Group	8-3
7.9.1	Minimal Spanning Tree.....	7-25	8.3.4	Subgroup.....	8-3
7.9.2	Prim's Algorithm	7-25	8.3.5	Multiplication and Addition Table	8-6
7.9.3	Kruskal's Algorithm.....	7-32	8.4	Permutation Groups	8-9
7.10	Fundamental Circuit and Fundamental Cut Sets	7-40	8.4.1	Cyclic Group.....	8-10
			8.5	Homomorphism of Groups	8-10
			8.6	Normal Subgroups.....	8-11
			8.7	Rings.....	8-11



8.8	Integral Domains and Fields	8-12	8.10	Polynomial Rings and Cyclic Codes	8-18
8.9	Group Codes	8-14	8.10.1	Constructing Ring of Polynomials	8-18
8.9.1	Error Detecting Codes	8-14	8.10.2	Cyclic Code	8-19
8.9.2	Hamming Distance	8-15	8.11	Galois Theory (Connection between Field Theory and Group Theory)	8-20
8.9.3	Error Correcting Code.....	8-16	8.12	Cryptography used in World War II.....	8-20
8.9.4	Definition of Group Code	8-16			
8.9.5	Hamming Error Correction Code	8-16			
