

## Discrete Structure

**Course Title:** Discrete Structure  
**Course No:** BIT152  
**Nature of Course:** Theory + Lab  
**Semester:** II

**Full Marks:** 60+20+20  
**Pass Marks:** 24+8+8  
**Credit hours:** 3

**Course Description:** The course introduces the basic concepts of discrete mathematics such as introductory logic, proofs, sets, relations, functions, counting and probability, with an emphasis on applications in information technology.

**Course Objectives:** The main objective of the course is to introduce basic concepts of discrete mathematics, understand the concepts of graphs, functions, relations and number theory respectively and explore applications of discrete mathematics in information technology.

### **Course Contents:**

#### **Unit 1: Logic and Proof Methods (6 Hrs.)**

Propositional Logic: Propositional Logic, Propositional Equivalences, Rule of inferences, Valid Arguments.

Predicate Logics: Predicates and Quantifiers, Negation of Quantified Statements, Proof of quantified statements, Nested Quantifiers, Rules of Inferences, Translating English Sentence to predicate logic expressions.

Proof Methods: Basic Terminologies, Proof Methods (Direct Proof, Indirect Proof, Proof by Contradiction, Proof By Contraposition, Exhaustive Proofs and Proof by Cases), Mistakes in Proof

#### **Unit 2: Sets, Relations and Functions (7 Hrs.)**

Sets: Sets and Subsets, Power Set, Cartesian Product, Set Operations, Venn Diagram, Inclusion-Exclusion Principle, Computer Representation of Sets.

Relations: Relations and their Properties, N-ary Relations with Applications, Representing Relations, Closure of Relations, Equivalence Relations, Partial Ordering

Functions: Basic Concept, Injective and Bijective Functions, Inverse and Composite Functions, Graph of Functions, Functions for Computer Science (Ceiling Function, Floor Function, Boolean Function, Exponential Function)

#### **Unit 3: Induction and Recursion (5 Hrs.)**

Induction: mathematical Induction, Strong Induction and Well Ordering, Induction in General Recursive Definitions and Structural Induction, Recursive Algorithms, Proving Correctness of Recursive Algorithms.

#### **Unit 4: Number Theory (6 Hrs.)**

Integers: Integers and Division, Primes and Greatest Common Divisor, Extended Euclidean Algorithm, Integers and Algorithms, Applications of Number Theory (Linear Congruencies, Chinese Remainder Theorem, Computer Arithmetic with Large Integers)

Matrices: Zero-One Matrices, Boolean Matrix Operations

Prime Number and its applications

**Unit 5: Counting and Discrete Probability (9 Hrs.)**

Counting: Basics of Counting, Pigeonhole Principle, Permutations and Combinations, Two Element Subsets, Counting Subsets of a Set, Binomial Coefficients, Generalized Permutations and Combinations, Generating Permutations and Combinations with examples.

Discrete Probability: Introduction to Discrete Probability, Probability Theory, Probability Calculation in Hashing, Expected Value and Variance, Randomized Algorithms

Advanced Counting: Recurrence Relations, Solving Recurrence Relations (Homogeneous and Non-Homogeneous equations),

**Unit 6: Tree and Graphs (11 Hrs.)**

Graphs: Graphs Basics, Graph Types, Graph Models, Graph Representation, Graph Isomorphism, Connectivity in Graphs, Euler and Hamiltonian Path and Circuits, Matching Theory, Shortest Path Algorithm (Dijkstra's Algorithm), Travelling Salesman Problem, Graph Coloring

Trees: Introduction and Applications, Tree Traversals, Spanning Trees, Minimum Spanning Trees (Kruskal's Algorithm)

**Laboratory Works:**

The laboratory work consists of implementing the algorithms and concepts discussed in the class. Student should implement problems with following concepts;

- Set Operations, relations and functions
- Primality Testing, Number Theory Algorithms, and Operations on Integers
- Counting and Some Recursive Algorithms
- Predicate Logic
- Algorithms for Tree, Graphs

**Text / Reference Books:**

1. Kenneth H. Rosen, Discrete mathematics and its applications, Seventh Edition McGraw Hill Publication, 2012.
2. Bernard Kolman, Robert Busby, Sharon C. Ross, Discrete Mathematical Structures, Sixth Edition Pearson Publications, 2015
3. Joe L Mott, Abraham Kandel, Theodore P Baker, Discrete Mathematics for Computer Scientists and Mathematicians, Printice Hall of India, Second Edition, 2008