(IT 223) DISCRETE MATHEMATICS (L-T-P-C = 3-1-0-0)

A. OBJECTIVES OF THE COURSE

- To interpret the set theory and relations for basic problem solving.
- To introduce the different properties of injections, surjections, bijections, compositions, and inverse functions.
- To understand the various proof methods and formulate and interpret statements presented in Boolean logic.
- To demonstrate the use of graph theory for applications.
- To illustrate the various algebraic structures.

B. DETAILED CONTENTS

UNIT-I **(8 hours)**

Sets: Definition and types, Set operations, Partition of set.
Cardinality of Sets (Inclusion- Exclusion & Addition Principles), Recursive definition of set.
Cardinality of Infinite Set, Countable & Uncountable Sets.
The Pigeonhole & Generalized Pigeonhole Principles.
Relations: Boolean Matrices, Binary Relation, Adjacency Matrix of Relation.
Properties of Relations, Operations on Relations.
The Connectivity Relation, Transitive Closure-Warshall's Algorithm.
Equivalence relations- Congruence Relations, Equivalence Class.
Number of Partitions of a Finite Set, Partial & Total Orderings.

UNIT-II **(8 hours)**

Functions: Concept, Some Special Functions (Polynomial, Exponential & Logarithmic, Absolute Value, Floor & Ceiling, Mod & Div Functions),
Properties of Functions, Composition of Functions, Binary and n-ary Operations, Characteristic Functions of a set, Hashing Functions.
Recursion: Primitive recursive functions, Recursive functions.
Lattices as Partially Ordered Sets-Properties of Lattices, Sublattices, Direct Product and Homomorphisms, Isomorphisms, Modular Lattices, Distributive lattices, Complimented lattices & their Properties.

UNIT-III **(10 hours)**

Proof Methods: Vacuous, Trivial, Direct, Indirect by Contrapositive and Contradiction, Constructive & Non-constructive proof, Counter example.
The Division Algorithm, Divisibility Properties (Prime Numbers & Composite Numbers).
Principle of Mathematical Induction, The Second Principle of Mathematical Induction, Fundamental Theorem of Arithmetic.
Algorithm Correctness: Partial Correctness, Loop Invariant.
Testing the partial correctness of linear & binary search, bubble & selection sorting.
Proposition, Compound Proposition, Conjunction, Disjunction.

Implication, Converse, Inverse & Contrapositive, Biconditional Statements, tautology, Contradiction & Contingency, Logical Equivalences, Quantifiers, Arguments.

UNIT-IV **(10 hours)**

Graph Theory: Graphs – Directed, Undirected, Simple, Adjacency & Incidence, Degree of Vertex, Sub-graph, Complete graph.
Cycle & Wheel Graph, Bipartite & Complete Bipartite Graph, Weighed Graph, Union of Simple Graphs. Complete Graphs.
Isomorphic Graphs, Path, Cycles & Circuits Eulerian & Hamiltonian Graphs, Planar Graph.
Kuratowski's Two Graphs, Kuratowski's Theorem, Euler's Formula.
Trees: Spanning trees- Kruskal's Algorithm, Finding Spanning Tree using Depth First Search, Breadth First Search, Complexity of Graph, Minimal Spanning Tree.

UNIT-V **(7 hours)**

Algebraic structure with one binary operation, semi groups, monoid and groups, isomorphism, homomorphism, cyclic group.
The application of residue arithmetic to Computers- Group Codes.

C. COURSE OUTCOMES

1. **Understand** set operations and relations and **apply** combination of relations using set operations and composition.
2. **Analyze** the properties of functions for application problems.
3. **Understand** the various proof methods by reformulating statements from common language to formal logic and **apply** truth tables and the rules of propositional logic to produce logically valid, correct and clear arguments.
4. **Understand** and **create** real-world problems using graphs and trees, both quantitatively and qualitatively.
5. **Understand** the various algebraic structures and **analyze** their applicability on abstract ideas.

D. RECOMMENDED TEXT BOOKS

1. S. Lipschutz and M. L. Lipson, "Schaum's Outline of Theory and Problems of Discrete Mathematics", 2nd Ed, Tata McGraw Hill.
2. J. P. Tremblay and R. P. Manohar, "Discrete Mathematics with Applications to Computer Science", Tata McGraw-Hill.

E. RECOMMENDED REFERENCE BOOKS

1. C. L. Liu, "Elements of Discrete Mathematics", 2nd Ed, Tata McGraw-Hill.
2. R. L. Graham, D. E. Knuth, and O. Patashnik, "Concrete Mathematics", 2nd Ed, Addison-Wesley.
3. N. Deo, "Graph Theory with Applications to Engineering and Computer Science", Prentice Hall of India.