UCS405: DISCRETE MATHEMATICAL STRUCTURES

L	T	P	Cr
3	1	0	3.5

Course Objective: Detailed study of various discrete and algebraic structures, basic logic, basics of counting and proof techniques.

Detail contents:

Sets, Relations, and Functions: Sets: Operations on set, Representation of Discrete Structures, Fuzzy set, Multi-set, bijective function, Inverse and Composition of functions, Floor and Ceiling functions, Growth of functions: Big-O notation, Big-Omega and Big-Theta Notations, Determining complexity of a program, Hashing functions, Recursive function, Functions applications.

Relations: Reflexivity, symmetry, transitivity, Equivalence and partial-ordered relations, Asymmetric, Irreflexive relation, Inverse and complementary relations, Partition and Covering of a set, N-ary relations and database, Representation relation using matrices and digraph, Closure of relations, Warshall's algorithm, Lexicographic ordering, Hasse diagram, Lattices, Boolean algebra, Representation and Minimizations of Boolean functions, Application of transitive closure in medicine and engineering. Application: Embedding a partial order.

Graphs Theory: Representation, Type of Graphs, Paths and Circuits: Euler Graphs, Hamiltonian Paths & Circuits; Cut-sets, Connectivity and Separability, Planar Graphs, Isomorphism, Graph Coloring, Covering and Partitioning, Topological sort, Max flow: Ford-Fulkerson algorithm, max flow – min cut, Dynamic Graphs, Few Algorithms for Dynamic Graphs, Minimum Spanning Tree, Shortest Path Algorithm and All pair shortest path.

Basic Logic: Propositional logic, Logical connectives, Truth tables, Normal forms (conjunctive and disjunctive), Validity of well-formed formula, Propositional inference rules (concepts of modus ponens and modus tollens), Predicate logic, Universal and existential quantification, Limitations of propositional and predicate logic.

Proof Techniques: Notions of implication, equivalence, converse, inverse, contra positive, negation, and contradiction, The structure of mathematical proofs, Direct proofs, Disproving by counter example, Proof by contradiction, Induction over natural numbers, Structural induction, Weak and strong induction (i.e., First and Second Principle of Induction), Recursive mathematical definitions.

Algebraic Structures: Group, Semi group, Monoids, Homomorphism, Congruencies, Ring, Field, Homomorphism, Congruencies, cosets and Lagrange Theorem, Group Codes, Integral domain, coding theory, Polynomial rings and polynomial codes, Applications of algebra to control structure of a program, The application of Residue Arithmetic to Computers.

Basics of Counting: Counting arguments: Set cardinality and counting, Sum and product rule, Inclusion-exclusion principle, Arithmetic and geometric progressions, The pigeonhole principle, Permutations and combinations, Solving recurrence relations, Basic modular arithmetic.

Text Books:

1. *Rosen, K.H., Discrete Mathematics and its Applications, McGraw Hill (2011), 7th ed.*
2. *Tremblay, J.P. and Manohar R., "Discrete Mathematical Structures with Applications to Computer Science", Tata McGraw Hill (2007), 1st ed.*

Reference Books:

1. *Haggard G., Schlipf J. and Whitesides, Sue, Discrete Mathematics for Computer Science, Cengage Learning, (2008), 2nd ed.*
2. *Johnsonbaugh R., Discrete Mathematics, Pearson Education, (2007), 7th edt*