Semester	**THREE**
Paper Number	**9**
Paper Code	**MDTS 4311**
Paper Title	**Discrete Mathematics and Optimization Techniques**
No. of Credits	**6**
Course description	CORE Composite Paper Module 1: 2 classes/week Module 2: 2classes/week No. of classes assigned Theory: 4 classes per week Practical: 3 classes per week
Course Objective	At the end of the course, the students should be able to • Use logical notation to define and reason mathematically about the fundamental data types and structures (such as numbers, sets) used in computer algorithms and systems. • Comprehend and Evaluate rigor in the definitions and conclusions about mathematical models and identify fallacious reasoning and statements. Identify and Apply properties of combinatorial structures and properties - know the basic techniques in combinatorics and counting. • Analyze sets with operations, and identify their structure. Reason and Conclude properties about the structure based on the observations. • Gain the conceptual background needed to be able to identify structures of algebraic nature, and discover, prove and use properties about them. • Optimization of Constrained and Unconstrained functions. • Properties of convex sets and functions. • Specialized methods for convex optimization.
Syllabus	**Module1: Discrete Mathematics** **Set Theory:** Sets, Power Sets, Operations, Cardinality and Countability of finite and infinite sets, Properties of Sets, Vector Implementations of Sets. [2] **Relational Structures on Sets**: Relations, Equivalence Relations; Functions, Bijections. Binary relations, Posets, Lattices and Hasse Diagrams; Introduction to Boolean Algebra. [4] **Counting Theory**: Pigeonhole Principle; Principle of Inclusion and Exclusion; Mathematical Induction; Linear Recurrence relations and their solutions, Use of Generating Functions for solving recurrence relations. [4] **Introduction to Logic**. Propositional Logic, Deduction, Resolution, Predicates and Quantifiers. [3] **Introduction to Algebraic Systems** : Introduction, Semigroups, Groups, Subgroups. Rings, and Fields. [3]

	Graph Theory Basics: Definition of Graph, Finite and Infinite graphs. Directed and undirected graphs, Degree, Isolated vertex, Pendant vertex. Null graphs. Walks: Paths and circuits. Connected and disconnected graphs, Euler's graphs, Hamiltonian paths and circuits. Planer Graph, Isomorphic graph, colouring of graphs, Graph Traversal (Depth First and Breadth First), Shortest Path (Dijkstra's Algorithm). [10]	
	Module2: **Optimization Techniques** Optimization Theory: Constrained and Unconstrained Optimization, Optimization with Equality Constraints and Inequality Constraints. [3] **Search Methods:** Line search method, Newton's Methods, Conjugate Gradient and Quasi-Newton Methods. **[8]** **Karush-Kuhn-Tucker Theory**: The Multiplier Rule, Constraint Qualification, A Sufficient Condition for a Minimum. **[5]** **Convexity:** Convex Sets, Convex Functions, Minimization of Convex Functions. **[3]** **Convex Programming:** Adaptive Barrier Methods, Dykstra's Algorithm, Dual Programs, Applications to Support Vector Machines. **[7]**	
List of Practical	Based on Module2	
Reading/Reference Lists	1. Discrete Mathematics and its Applications - Kenneth H. Rosen 7th Edition -Tata McGraw Hill Publishers – 2007 2. Elements of Discrete Mathematics, C. L Liu, McGraw-Hill Inc, 1985. Applied Combinatorics, Alan Tucker, 2007. 3. Concrete Mathematics, Ronald Graham, Donald Knuth, and Oren Patashnik, 2nd Edition - Pearson Education Publishers - 1996. 4. Combinatorics: Topics, Techniques, Algorithms by Peter J. Cameron, Cambridge University Press, 1994 (reprinted 1996). 5. Topics in Algebra, I.N. Herstein, Wiley, 1975. 6. Kenneth Lange; Numerical Analysis for statisticians, Springer, Second Edition. *7.* Kenneth Lange; Optimisation, Springer; 2004. *8.* Wenyu sun, ya-xiang yuan; Optimization Theory and Methods Nonlinear Programming; Springer, 2006.	
Evaluation	Theory CIA: 10 End Sem Exam: 50 (25+25) Total : 60	Practical Continuous Assessment: 30 End Sem Viva: 10 Total: 40
Paper Structure for End Semester Theory	Short questions: 5 marks each	Long questions: 10 marks each
Module I	1 out of 2	2 out of 3
Module II	1 out of 2	2 out of 3