GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering
Subject Code: 3140708
Semester – IV
Subject Name: Discrete Mathematics

Type of course: Undergraduate

Prerequisite : Algebra, Logic

Rationale : This course introduces the basic concepts of discrete mathematics in the field of computer science. It covers sets, logic, functions, relations, graph theory and algebraic structures. These basic concepts of sets, logic functions and graph theory are applied to Boolean Algebra and logic networks, while the advanced concepts of functions and algebraic structures are applied to finite state machines and coding theory.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks				Total
L	T	P	C	Theory Marks		Practical Marks		
				ESE(E)	PA (M)	ESE(V)	PA(I)	
3	2	0	5	70	30	0	0	100

Contents:

Sr. No.	Content	Total Hrs.	% weightage
01	**Set Theory**: Basic Concepts of Set Theory: Definitions, Inclusion, Equality of Sets, Cartesian product, The Power Set, Some operations on Sets, Venn Diagrams, Some Basic Set Identities **Functions**: Introduction & definition, Co-domain, range, image, value of a function; Examples, surjective, injective, bijective; examples; Composition of functions, examples; Inverse function, Identity map, condition of a function to be invertible, examples; Inverse of composite functions, Properties of Composition of functions; **Counting:** The Basics of Counting, The Pigeonhole Principle, Permutations and Combinations, Binomial Coefficients, Generalized Permutations and Combinations, Generating Permutations and Combinations	**06**	**12%**
02	**Propositional Logic**: Definition, Statements & Notation, Truth Values, Connectives, Statement Formulas & Truth Tables, Well-formed Formulas, Tautologies, Equivalence of Formulas, Duality Law, Tautological Implications, Examples **Predicate Logic:** Definition of Predicates; Statement functions, Variables, Quantifiers, Predicate Formulas, Free & Bound Variables; The Universe of Discourse, Examples, Valid Formulas & Equivalences, Examples	**06**	**13%**
03	**Relations**: Definition, Binary Relation, Representation, Domain, Range, Universal Relation, Void Relation, Union, Intersection, and Complement Operations on Relations, Properties of Binary Relations in a Set: Reflexive, Symmetric, Transitive, Anti-symmetric Relations, Relation Matrix and Graph of a Relation; Partition and Covering of a Set, Equivalence Relation, Equivalence Classes, Compatibility Relation, Maximum Compatibility Block, Composite Relation, Converse of a Relation, Transitive Closure of a Relation R in Set X **Partial Ordering**: Definition, Examples, Simple or Linear Ordering, Totally Ordered Set (Chain), Frequently Used Partially Ordered Relations, Representation of Partially Ordered Sets, Hesse Diagrams, Least & Greatest Members, Minimal & Maximal Members, Least Upper Bound (Supremum), Greatest Lower Bound (infimum), Well-ordered Partially Ordered Sets (Posets). Lattice as Posets, complete, distributive	**10**	**25%**

	modular and complemented lattices Boolean and pseudo Boolean lattices. (Definitions and simple examples only) **Recurrence Relation:** Introduction, Recursion, Recurrence Relation, Solving, Recurrence Relation		
04	**Algebraic Structures:** Algebraic structures with one binary operation- Semigroup, Monoid, Group, Subgroup, normal subgroup, group Permutations, Coset, homomorphic subgroups, Lagrange's theorem, Congruence relation and quotient structures. Algebraic structures (Definitions and simple examples only) with two binary operation- Ring, Integral domain and field.	**10**	**25%**
05	**Graphs:** Introduction, definition, examples; Nodes, edges, adjacent nodes, directed and undirected edge, Directed graph, undirected graph, examples; Initiating and terminating nodes, Loop (sling), Distinct edges, Parallel edges, Multi-graph, simple graph, weighted graphs, examples, Isolated nodes, Null graph; Isomorphic graphs, examples; Degree, Indegree, out-degree, total degree of a node, examples; Subgraphs: definition, examples; Converse (reversal or directional dual) of a digraph, examples; Path: Definition, Paths of a given graph, length of path, examples; Simple path (edge simple), elementary path (node simple), examples; Cycle (circuit), elementary cycle, examples; **Reachability:** Definition, geodesic, distance, examples; Properties of reachability, the triangle inequality; Reachable set of a given node, examples, Node base, examples; **Connectedness:** Definition, weakly connected, strongly connected, unilaterally connected, examples; Strong, weak, and unilateral components of a graph, examples, Applications to represent Resource allocation status of an operating system, and detection and correction of deadlocks; Matrix representation of graph: Definition, Adjacency matrix, boolean (or bit) matrix, examples; Determine number of paths of length n through Adjacency matrix, examples; Path (Reachability) matrix of a graph, examples; Warshall's algorithm to produce Path matrix, Flowchart. **Trees:** Definition, branch nodes, leaf (terminal) nodes, root, examples; Different representations of a tree, examples; Binary tree, m-ary tree, Full (or complete) binary tree, examples; Converting any m-ary tree to a binary tree, examples; Representation of a binary tree: Linked-list; Tree traversal: Pre-order, in-order, post-order traversal, examples, algorithms; Applications of List structures and graphs	**10**	**25%**

Reference Books:

1. J. P. Tremblay and R. Manohar, Discrete Mathematical Structures with Applications to Computer Science, Tata McGraw-Hill,1997.
2. S. Lipschutz and M. L. Lipson, Schaum's Outline of Theory and Problems of Discrete Mathematics, 2nd Ed., Tata McGraw-Hill,1999.
3. K. H. Rosen, Discrete Mathematics and its applications, Tata McGraw-Hill, 6th Ed., 2007.
4. David Liben-Nowell, Discrete Mathematics for Computer Science, Wiley publication, July 2017.
5. Eric Gossett, Discrete Mathematics with Proof, 2nd Edition,Wiley publication, July 2009.

Suggested Specification table with Marks (Theory):					
R Level	U Level	A Level	N Level	E Level	C Level
10	20	20	10	10	

Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom's Taxonomy).

Course Outcomes:

After Completion of this course students will be able

Sr. No.	Course Outcomes	Weightage in %
1	Understand the basic principles of sets and operations in sets and apply counting principles to determine probabilities, domain and range of a function, identify one-to- one functions, perform the composition of functions and apply the properties of functions to application problems.	12%
2	Write an argument using logical notation and determine if the argument is or is not valid. To simplify and evaluate basic logic statements including compound statements, implications, inverses, converses, and contra positives using truth tables and the properties of logic. To express a logic sentence in terms of predicates, quantifiers, and logical connectives.	13%
3	Apply relations and to determine their properties. Be familiar with recurrence relations	25%
4	Use the properties of algebraic structures.	25%
5	Interpret different traversal methods for trees and graphs. Model problems in Computer Science using graphs and trees.	25%

List of Open Source Software/learning website: NPTEL Discrete Mathematics lectures