GUJARAT TECHNOLOGICAL UNIVERSITY

Integrated MCA

Year – 1 (Semester – I) (W.E.F. JULY 2018)

Subject Name: Basic Mathematics
Subject Code: 2618604

Objective

The objective of this course is to present the foundations of many basic mathematical topics used in Computer Science including RDBMS, Data Structures, Analysis of Algorithms, Theory of Computation, Cryptography, Artificial Intelligence, Statistics and others. This course will enhance the student's ability to think logically and mathematically.

Prerequisites: Binary number system, C Language

Contents:

Sr. No.	Topics	Weightage Percentage
1	**Set Theory, Propositional & Predicate Logic:** Set Theory: Basic Concepts of Set Theory: Definition, Two Methods to Describe (Represent) Sets; Examples, (Im)proper Subsets, Superset, Equality of Sets; Empty (Null) Set, Universal Set, Finite and Infinite Sets, Power Set; Operations on Sets: Union, Intersection, Complement, Venn Diagrams; Disjoint Sets, Various Laws: Identity, Idempotent, Commutative, Associative, Distributive, Absroption, DeMorgan; Difference (Relative Complement), Symmetric Difference of Two Sets; Cartesian Product; Power Set of a Set; Computer Representation of Sets; Examples; Theorems and Exercises (without Proof) **Propositional Logic:** Definition, Statement (Proposition) & Notation, Truth Values, Connectives: Negation, Conjunction, Disjunction, Implication (condition), Bi-implication (Bi-conditional), Truth Tables for all Connectives, Statement Formulas (Well-formed Formulas), Truth Tables, Tautologies, Contradiction, Logical Equivalence: Commutative Laws, Associative Laws, Distributive Laws, Absroption Laws, Idempotent Laws, Double Negation Law, DeMorgan's laws, Examples; Validity of Arguments, Some Valid Argument Forms: Modus Ponens, Modus Tollens, Disjunctive Syllogism, Dilemma, Equivalence of Formulas: Conjunctive Simplification, Disjunctive Addition, Conjunctive Addition, Examples and Exercises; Theorems (without Proof) **Predicate Logic:** Definition of Predicates; Variables, Quantifiers: Universal Quantifiers, Existential Quantifiers; Free & Bound Variables; Negation of Predicates; Generalized DeMorgan's Laws; Valid Formulas and Equivalences; Additional Rules of Inference; Examples and Exercises; Theorems (without Proof)	**25%**

2	**Proof Techniques, Matrices** **Proof Techniques**: Direct Proof, Indirect Proof, Proof by Contradiction; Proving Bi-implications; Proving Equivalence Statements; Fallacies (Errors) in Proofs; Examples and Exercises **Matrices**: Introduction; Representation of a Matrix; Equality of Matrices; Special Matrices: Rectangular / Square Matrices, Null (Zero) Matrix, Unit Matrix, Diagonal Matrices, Triangular Matrices; Sum and Difference of 2 Matrices; Multiplication of 2 matrices; Transpose of a Matrix, Symmetric Matrices; Boolean (Zero-One) Matrices, Boolean Join, Boolean Meet; Theorems and Exercises (without Proof)	**13%**
3	**Integers, Mathematical Induction** **Integers**: Introduction, Basic Properties of Integers: Closure, Commutative Laws, Associative Laws, Identity Elements, Additive Inverse, Distributive Laws, Cancellation Laws; Well-ordering Principle; Division Algorithm: Quotient, Remainder, ***div*** and ***mod*** operators, Divisibility; Greatest Common Divisor (GCD); Euclidean Algorithm for Finding the GCD; Relative Prime; Least Common Multiples (LCM); Representation of Integers in Computer; Decimal, Binary, Octal, and Hexadecimal Representation; Operations on Binary Numbers: Addition, Subtraction; Theorems and Exercises (without Proof) **Mathematical Induction**: Introduction; First Principle of Mathematical Induction; 3 Steps: Basis Step, Inductive Hypothesis, Inductive Step; Second Principle of mathematical Induction; Application: Loop Invariant (Program Correctness)	**12%**
4	**Relations and Functions** **Relations**: Introduction, Binary Relation, Definition; Representation: Set of Ordered Pairs, Arrow Diagram, Matrix, Graph; Domain & Range of Relation; Universal Relation, Void Relation; Properties of a Relation: Reflexive, Symmetric, Transitive, Anti-symmetric, Irreflexive; Equivalence Relations, Partition, Block of Partition, Equivalence Classes and Partitions; Inverse of a Relation; Composition of Relations; Closures: Reflexive, Symmetric, Transitive; Theorems and Exercises (without Proof) **Functions**: Introduction & Definition; Arrow Diagram of a Function; Domain, Co-domain (Target), Range of a Function; Special Function: Identity Function, Constant Function; One-to-One (Injective), Onto (Surjective), and One-to-One & Onto (Bijective) Functions; Composition of Functions; Inverse of a Function, Left-invertible & Right-invertible Functions; Floor & Ceiling Functions; Cardinality of a Finite Set; Theorems and Exercises (without Proof)	**25%**
5	**Graphs and Trees** **Graphs**: Introduction, Definition; Initial & Terminal Nodes, Adjacent Nodes; Directed Edge, Undirected Edge, Directed Graph (Digraph),	**25%**

	Undirected Graph, Mixed Graph; Loop (Sling); Distinct Edges, Parallel Edges; Multi-graph, Simple Graph; Weighted Graph; Isolated Nodes, Null Graph; Isomorphic Graphs; In-degree, Out-degree, Total-degree; Subgraphs; Reflexive, Symmetric, Transitive Digraphs; Paths, Length of Path of a Graph; Simple Path (Edge Simple), Elementary Path (Node Simple), Cycle (Circuit), Simple Cycle, Elementary Cycle; Path of Minimum Length (Geodesic), Distance between Two Nodes, Triangle Inequality; Reachability, Reachable Set of a Node, Reachable Set of a Set of Nodes, Node Base; Connected Graphs: Strongly, Unilaterally, Weakly Connected Graphs & Components; Matrix Representation of Graphs (Adjacency Matrix). In-degree, Out-degree of a Graph from Adjacency Matrix; An (A is Adjacency Matrix) to give Number of Paths of Length n; Path Matrix (Reachability Matrix) of a Graph; Warshall's Algorithm to Produce Path Matrix; Algorithm to Give Lengths of Minimum Paths; Theorems and Exercises (without Proof) **Trees**: Introduction, Definition, Root, Branch Nodes, Leaf (Terminal Node); Different Representations of Trees; Forests, Subtrees; M-ary Tree, Full or Complete M-ary Tree; Binary Tree, Full (Complete) Binary Tree; Conversion of M-ary Tree to Binary Tree; Linked Allocation Technique to Represent Binary Tree in Computer. Traversal of Binary Tree: Pre-order, In-order, and Post-order Traversal; Theorems and Exercises (without Proof)	

Text Book:

1. D. S. Malik & M. K. Sen, "Discrete Mathematics", Cengage Learning (2004)
2. J. P. Tremblay and R.Manohar, "Discrete Mathematical Structures with Applications to Computer Science", Tata McGraw-Hill (2010) – only for Unit-5 (Graphs & Trees).

Reference Books:

1. K. H. Rosen, "Discrete Mathematics and its applications", Tata McGraw-Hill, 6th edition,
2. Bernard Kolmann & others, "Discrete Mathematical Structure", Pearson Education, Sixth Edition
3. Edgar G. Goodaire, Michael M. Parmenter. "Discrete Mathematics with Graph Theory", PHI
4. Ralph P Grimaldi & B V Ramana, "Discreet and Combinatorial mathematics: An Applied Introduction", Pearson Education, 5th Edition (2018)
5. J. P. Tremblay and W. K. Grassman. "Logic and Discrete Mathematics", Pearson Education

Chapter-wise Coverage from the Text Book:

Unit-1: Chapter-1
Unit-2: Chapters-1 & 4
Unit-3: Chapter-2
Unit-4: Chapters-3 & 5
Unit-5: Text Book-2: 5-1: 5-1.1 to 5-1.4; 5-2: 5-2.1.

Accomplishment of Students after Completing the Course:
Students will be able to understand various algorithms and implement them in C language. More specifically, they will be able to understand and apply the concepts of sets, logic, cross product of sets and relation, functions, matrices, and basic algorithms related with binary tree and graphs.