Discrete Structure

BIM 2nd semester

Nature of the course: Theory + Practical

Credits: 3
Lecture Hours: 48

Course Description:
This course covers different concepts of discrete structures including logic and proofs, number theory, induction and recursion, counting and advanced counting techniques, graphs, and trees.

Course Objectives:
The main objective of this course is to provide students both theoretical and practical knowledge of different concepts of discrete structures.

Course Contents:

Unit 1: Logic and Proofs (8 Hrs.)
Propositional Logic and Applications; Propositional Equivalences; Predicates and Quantifiers; Nested Quantifiers; Rules of Inference for Propositional Logic and Quantified Statements; Proof Methods and Strategies; Mistakes in Proofs

Unit 2: Number Theory (7 Hrs.)
Divisibility and Modular Arithmetic; Integer Representations and Algorithms; Primes; Greatest Common Divisors; Least Common Multiplier; Euclidian and Extended Euclidian Algorithm; Solving Congruences; Chinese Remainder Theorem; Computer Arithmetic with Lage Integers; Pseudorandom Numbers

Unit 3: Induction and Recursion (5 Hrs.)
Mathematical Induction and Examples; Strong Induction and Well Ordering; Recursive Definitions and Structural Induction; Recursively Defined Functions and Sets; Recursive Algorithms; Program Correctness; Recursion and Iteration

Unit 4: Counting and Advanced Counting (12 Hrs.)
Basics of Counting (Sum Rule, Product Rule, Subtraction Rule, Division Rule); Pigeonhole Principle; Generalized Pigeonhole Principle; Permutations and Combinations; Binomial Theorem; Pascal's Identity and Triangle; Permutations and Combinations with Repetition; Generating Permutations and Combinations; Recurrence Relations and Applications; Solving Linear Recurrence Relations (Homogenous and Non-homogenous; Theorems without Proof); Principle of Inclusion-Exclusion

Unit 5: Graphs (10 Hrs.)
Graph and Graph Models; Graph Terminology and Special Types of Graphs; Representing Graphs and Graph Isomorphism; Connectivity (Paths and Circuits, Connectedness in Undirected and Directed Graphs); Euler and Hamilton Paths and Circuits; Shortest-Path Problem (Dijkstra's Algorithm, Travelling Salesman Problem); Planar Graphs and Applications; Graph Coloring and Applications

Unit 6: Trees (6 Hrs.)
Trees (Introduction, Rooted Trees, Trees as Models, Properties of Trees); Applications of Trees (Binary Search Trees, Decision Trees, Prefix Codes, Game Trees); Tree Traversals (Introduction and Traversal Algorithms); Depth-First and Breadth-First Search; Spanning Trees; Minimum Spanning Trees (Introduction, Prim's Algorithm, Kruskal's Algorithm)

Laboratory Works:
Students should implement all the concepts and algorithms studied in each unit of the course using any suitable programming language.

Text Books:

1. Discrete Mathematics and Its Applications, Eighth Edition, Kenneth H. Rosen, McGraw-Hill Education, 2019

Reference Books:

1. Discrete Mathematical Structures, Sixth Edition, Bernard Kolman, Robert Busby and Sharon C. Ross, Pearson Publications, 2015.
2. Discrete Mathematics for Computer Scientists and Mathematicians, Second Edition, Joe L Mott, Abraham Kandel and Theodore P Baker, Printice Hall of India, 2008.
3. Discrete Mathematics for Computer Scientists, First Edition, Ken Bogart, Scot Drysdale, and Cliff Stein, Addison-Wesley, 2010