CODE: MA203: **Discrete Mathematics and Graph Theory**

Credits: 03 **Teaching Scheme: -** Theory 04 Hrs/Week

Prerequisites: Elementary Mathematics of 10+2 standard.

Objectives:

1. To make students aware of various discrete structures and objects such as POSETS, Graphs, Trees, algebraic structures such as semi groups and groups etc. and their applications
2. To develop mathematical temperament and background in abstraction, notation, and critical thinking for the mathematics most directly related to computer science.
3. To make students aware of counting techniques such as permutations, combinations, generating functions and recurrence relations.

Course Details:

Unit 1: Logic and Relations: (08 Hrs)

Logic: Propositions and logical Operations, Conditional statements; Predicate Calculus-First order logic, universal and existential quantifiers; Proof Techniques- methods of proof, Mathematical induction. **[T_1]**

Relation and Diagraphs- Properties of relations, composition of relations, closure operation on relations, equivalence relations and partitions, paths in relation and diagraphs, Operations on relations, Transitive closure and Warshall's Algorithm. Partial ordered sets (POSET), Hasse diagram, External elements of partially ordered sets, Lattices. **[T_1]**

Unit 2: Combinatorics: (08 Hrs)

Combinations and Permutations, Enumerating combinations and permutations, Principle of Inclusion – Exclusion and Derangements. [**T2**]

Generating functions, Recurrence Relations, Solution of Recurrence Relations. [**T2**]

Unit 3: Graph Theory: (08 Hrs)

What is a graph? Matrices and Isomorphism, Special Graphs, Paths, Cycles and Trails, Connected Graphs, Bipartite Graphs, Eulerian paths circuits, Hamiltonian paths and circuits, Fleury's algorithm, Planar Graphs. Embedding and Eulers formula, Colouring of Graphs. **[T_3]**

Unit 4: Trees and Networks: (08 Hrs)

Trees-Basic Properties, Depth first search (DFS) and Breadth first search (BFS) Algorithms, Minimal spanning tree, Shortest path problem, Kruskal's Algorithm, Prim's Algorithm, Dijkstra's Algorithm. Network Flow Problem, Ford-Fulkerson Algorithm, Max-Flow-Min-Cut Theorem. **[T_3]**

Unit 5: Algebraic Structures and Applications: (08 Hrs)

Binary operations, semi-groups and groups, subgroups, cosets, Lagrange's theorem, Product and quotient semi-groups and groups, Normal subgroup, Homomorphism; coding of binary information and error detection, group codes, decoding and error correction. [T1]

Text Books:

T1. Discrete Mathematical Structures, Bernard Kolman, Robert Busby, Sharon C. Ross, Pearson Education Inc., New Delhi. / Prentice Hall of India (PHI) Pvt. Ltd., New Delhi, Sixth Edition, 2009.
Chapters 2(2.1 – 2.4), 4(4.1 – 4.5, 4.7, 4.8), 6(6.1 – 6.3), 8(8.2), 9(9.1 – 9.5), 11(11.1, 11.2).

T2. Discrete Mathematics for Computer Scientists and Mathematicians by Joe L. Mott, Abraham Kandel and Theodore P. Baker, Prentice-Hall of India Private Limited, New Delhi, Second Edition, 2000.
Chapters 2(2.2 – 2.5), 3(3.1 – 3.6).

T3. Introduction to Graph Theory, Douglas B. West, Prentice-Hall of India Pvt. Ltd., New Delhi, Second Edition, 2003.
Chapters: 1-Sections: 1.1 (up to and including 1.1.40), 1.2 (Up to and including 1.2.27), 1.3(Up to and including 1.3.6), 2-Sections: 2.1 (Up to and including 2.1.13), 2.3(2.3.1-2.3.8), 4- Sections: 4.1 (4.1.1, 4.1.2, 4.1.7 to 4.1.11), 4.3(Up to and Including 4.3.11), 5 – Section: 5.1 (Up to including 5.1.21), 6: Section 6.1 (Up to and including 6.1.13, 6.1.21 to 6.1.24), 7 – Section 7.2 (7.2(Up to and Including 7.2.19)).

Reference Books

R1. Discrete Mathematics and Its Applications With Combinatorics and Graph Theory, Kenneth H. Rosen, Tata McGrawHill Education Private Limited, New Delhi, Seventh Edition, Third Reprint, 2012.
R2. Elements of Discrete Mathematics, C. L. Liu and D. Mohaptra, Tata McGraw Hill Education, New Delhi, Third Edition, 2008.
R3. Discrete and Combinatorial Mathematics, Ralph P. Grimaldi, Pearon Education, New Delhi, Fifth Edition, 2005.
R4. Discrete Mathematics, Norman L. Biggs, Oxford University Press, Second Edditon, Tenth Impression, 2010..
R5. Discrete Mathematics and Applications, Thomas Koshy, Second Edition, Elsevier Publication (India), New Delhi.
R6. A First look at Graph Theory, John Clark and Derek Allan Holton, Prentice Hall.
R7. Mathematical Structure for Computer Science, A modern treatment to Discrete Mathematics, J.L. Gersting, W. H. Freeman and Macmillan (India), Fifth / Sixth Edition (Asian Student Editions), 2008.
R8. Discrete Mathematical Structures, D. S. Malik and M. K. Sen, CENGAGE Learning India Pvt. Ltd., New Delhi, First Edition, 2005.
R9. Discrete Mathematics, Richard Johnsonbaugh, Pearson Education Inc., New Delhi, Seventh Edition, 2010.
R10. Discrete Mathematics with Proof, Eric Gossett, Wiley India, Second Edition, Second Edition, 2010 (Reprint).

Course Outcome

Upon successful completion of this course, students will be able to
1. Construct mathematical arguments using logical connectives and quantifiers.
2. Verify the correctness of an argument using propositional and predicate logic and truth tables.
3. Solve problems using counting techniques and combinatorics.
4. Solve problems involving recurrence relations and generating functions.
5. Use graphs and trees as tools to visualize and simplify situations.
6. Perform operations on algebraic structures such as semi groups, monoides, and groups.
7. Apply group to rectify codes in a data transmission problem.
8. Construct proofs using direct proof, proof by contraposition, proof by contradiction, proof by cases, and mathematical induction.

Open Source: 1- Prof. Sudarshan Iyengar, Prof. Neeldhara, "Discrete Mathematics", NPTEL-IIT Ropar, IIT-Gandhinagar, https://archive.nptel.ac.in/courses/111/101/111101153/