Course Type	Course Code	Name of the Course	L	T	P	Credits
DC	NCSC508	**Algorithmic Graph Theory**	3	0	0	3

Course Objective

- To study graphs from an algorithmic perspective.
- The focus is on understanding the basic properties of graphs that can be used to design efficient algorithms for computer science/IT applications.

Learning Outcomes

At the end of the course, the students will be able to:

- Handle combinatorial and graph problems using effective algorithmic techniques.
- Formulate and analyze problems under the framework of graph theory.
- Design efficient algorithms for various optimization problems on graphs.

Unit No.	Topics to be Covered	Lecture Hours	Learning Outcome
1	Introduction to graphs and algorithmic complexity: Graph representation (Adjacency Matrix, Adjacency List) Time & space complexity analysis: P, NP, and NP-hard, polynomial reductions, 2-SAT problem, 3-SAT problem Graph traversal algorithms (DFS, BFS)	5	Students will learn the basics of graphs, their representation in data structures and traversals
2	Shortest path algorithms: Single-Source - Dijkstra's algorithm, Bellman-Ford algorithm All-Pairs Shortest Paths - Floyd-Warshall algorithm, Johnson's algorithm	4	Students will learn algorithms used to find the shortest paths.
3	Spanning trees: MST - Prim's algorithm, Kruskal's algorithm, Applications of MSTs Branching, connectivity, circuits, cut-sets	5	Students will pick up concepts of trees and related applications
4	Planar graphs: Introduction, basic properties, examples Planar embeddings and faces Characterization of planarity (Kuratowski's theorem) Planar graph parameters (genus, crossing numbers, thickness) Planarity testing algorithms	5	Students will learn about the important aspects of planar graphs
5	Networks and flows: Menger's theorem Maximizing flow in graph networks, Ford-Fulkerson algorithm, Edmonds-Karp algorithm, Minimum cost flow	4	The graph cut techniques have wide applications - the students will learn salient aspects of that

6	Matching: maximum cardinality matching, maximum weight matching, perfect matching	4	Matching is another very important part of graph algorithms and the students will learn them
7	Euler tours and Hamiltonian cycles: counting Eulerian tours, finding all Hamiltonian cycles using matricial products, 2-factors	4	Students will learn about Euler and Hamiltonian graphs
8	Graph coloring: dominating set, edge coloring, vertex coloring, chromatic polynomial, face coloring, 4-color theorem, 5-color theorem	4	Students will learn how to solve problems under the framework of graph coloring
9	Graph problems and intractability: Cook's theorem, vertex covering, independent sets and cliques	4	Students will learn about vertex and edge independent sets, covering sets
10	Recent research Trends, Real-world applications in social networks, bioinformatics, and computer networks Open problems and challenges in the field Guidance on potential research directions	3	Students will get introduced to some recent research going on in this field and their practical applications
Total		**42**	

Textbooks:

1. Algorithmic Graph Theory by Alan Gibbons, Cambridge University Press

Reference Books:

1. Algorithmic Graph Theory and Perfect Graphs by Martin Charles Golumbic, North Holland
2. Graph Theoretic Algorithms, Therese Biedl, U of Waterloo
3. Advanced Topics in Graph Algorithms, Ron Shamir, Tel Aviv U.