Graph Theory and Application

Program Elective
L-T-P-C: 3-0-0-3

1. **Course Objectives:**

   To introduce the fundamental concepts in Graph Theory, including properties and characterization of graphs/trees and graph theoretic algorithms along with their applications.

2. **Syllabus:**

   Unit – 1 [5 Hours]: Introduction to Graph Theory- Basic graph theoretic concepts, Complements, and Graph Isomorphism, Subgraph and paths, Connections and cycles, Application: Shortest path problem.

   Unit – 2 [4 Hours]: Trees and Connectivity - Trees, Cut edges and bonds, Cut vertices, Cayley's Formula, Vertex and edge connectivity, Blocks, Application: Construction of a reliable communication network.

   Unit – 3 [5 Hours]: Hamilton and Euler Graphs- Euler Tours, Hamilton Cycles, Application: The Chinese postman problem, Travelling Salesman problem.
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   Unit – 4 [8 Hours]: Matching and Edge Coloring – Matching and covering in bipartitite graph, Perfect matching, Application: Personnel assignment problem, Edge coloring and chromatic number, Vizing's theorem, Timetabling Problem.

   Unit – 5 [7 Hours]: Independent sets, Cliques and Vertex coloring - Independent sets, Ramsey's theorem, Vertex coloring and chromatic number, Brook's theorem, Application: A storage problem.

   Unit – 6 [7 Hours]: Planar, Directed Graphs, Networks and Case Studies- Planar graphs and dual graphs, Planarity testing and Euler's Formula, Bridges, Directed Graphs, paths and cycles, Application: A job sequencing problem.
   Case Studies- Graph theory in social media, operation research, google maps and internet.

3. **Course Outcomes:**

   At the end of the course, students should have the ability:

   i)   To understand the basic concepts of graph theory.

   ii)   To understand the concepts of trees and their relation with graphs.

   iii)   To learn about special cycles and tours in graphs.

iv)   To understand matching and covering concepts which are applied in wide range of applications under the framework of graph theory.

v)   To understand various theorems and techniques in graph theory for solving problems.

vi)   To distinguish between planar and non-planar graph and understanding the implementation of graph theory in real life problems.

4. Text Books:

a) Graph Theory with Applications by J.A. Bondy and U.S.R. Murty, Elsevier.

b) Algebraic Graph Theory by Chris Godsil and Gordon Royle, Springer

5. Reference Books:

a) Modern Graph Theory by Bela Bollobas, Springer

b) Inroduction to Graph Theory by Douglas B West, PHI