Course Outlines

Graph Theory and Combinatorics

Credit Hours: 3

Prerequisites: Set theory, Matrix theory and Abstract algebra

This course is an introduction to the mathematical area called graph theory, which only came into existence during the first half of the 18th century. In recent years, graph theory has established itself as an important mathematical tool in a wide variety of subjects, ranging from operational research and chemistry to genetics and linguistics and from electrical engineering and geography to sociology and architecture. At the same time it has emerged as a worthwhile mathematical discipline in its own right. The course is intended for master's students.

Course Outline:

Discovery: The Konigsberg bridge problem, Electric networks, Graph Theory in the 20th century

Graphs: What is a graph? Directed and undirected graphs**,** Basic terminologies**,** Types of graphs, Subgraphs (Spanning Subgraph and Induced Subgraph)**,** Operations on graphs (Cartesian Product, Complement, Union, Intersection, Join, Deletion)**,** Connected (edge connectivity, vertex connectivity)**,** Disconnected graphs**,** Walk, trail, paths and cycles**,** Common classes of graphs**,** Multi graphs and diagraphs**,** Bipartite graphs**.**

Degrees: The degree of a vertex**,** Isolated and pendant vertices**,** Degree sequences**,** Non-regular and regular graphs

Graphs and matrices: The adjacency matrix**,** The incidence matrix**,** The cycle matrix

Isomorphic graphs: The definition of isomorphism**,** Isomorphism as a relation**,** Graphs and groups

Trees: Bridges, Trees**,** Characterization of trees**,** Spanning trees**,** Rooted tree**,** Binary tree**,** The minimum spanning tree problem**,** The number of spanning trees

Subdivision and line graphs: Some properties of line graphs**,** Characterization of line graphs**,** Special line graphs

Coloring graphs: Coloring vertices**,** Coloring maps**,** Coloring edges**,** Chromatic polynomial

Enumeration: Labeled graphs**,** Vertex labeled graphs**,** Edge labeled graphs**,** Total labeled graphs**,** Solved and unsolved graphical enumeration problems

Advance topics and future directions

Resolving and doubly resolving sets: Minimal resolving sets**,** Minimal doubly resolving sets**,** Basis and metric dimension

Topological indices: Degree based topological indices**,** Distance based topological indices

Domination: The domination number of a graph and some solved and unsolved problems

Applications: Some calculating techniques using Matlab.

1. A first course in graph theory by Gary Chartrand and Ping Zhang

2. Introduction to graph theory by Robin J. Wilson

3. Graph theory F. Harary