Department of Mathematics
Faculty of Mathematics & Computer Science
PhD, Mathematics

Course Code	AM 508
Course Title	Advanced Graph Theory
Course Credits	02

Course objectives:

Graph Theory and Graph algorithms are at the heart of many computer applications. So, it is expected that computer scientists and professional programmers know frequently used algorithms and generic techniques for efficient organization and retrieval of data, modeling, understanding and solving graph and geometric problems. This course provides an opportunity to the participants for getting exposed to the field of graph and geometric algorithms, which may help them in future in solving graph and geometric problems and designing new algorithms. Graphs are fairly general structures that often come up naturally in problems of information technology

Minimum Pre-requisites:

Mathematical proof technique (induction, proof by contradiction), and linear algebra (determinants, eigenvalues).

Knowledge of basic notations in Mathematics **(a)** Basic logic + set operations almost goes without saying (*e.g.* logical conjunction / set intersections; also equivalence classes, sets and relations.

Probability theory (for applying the probabilistic method), elementary number theory (*e.g.* arithmetic modulo N) and experience with asymptotic analysis (knowledge of what $O(N)$, $o(N)$, $\omega(N)$, etc. refer to and how to play with them).

Course structure:

Basic concepts of graph theory. Directed graph. Euler graph. Hamiltonian graph. Matrix representation of graphs. Shortest path in a weighted graph.

K-connected and K-edge-connected graphs. Planar graphs. Coloring of graphs, Vertex colouring of graphs, Edge colouring of graphs, Vizing's theorem.

Trees: Rooted trees, Spanning tree and Cut set, Minimum-spanning tree. Flow network in a graph, max-flow- min cut theorem.

Blocks: Cutpoints Bridges and blocks, Block graph and cut-point graph, Partitions.

Factorization: 1-Factorization, 2-Factorization, Arboricity.

Covering: Covering and independence, Critical points and lines.

Groups: The automorphism group of a graph, Operations on Permutation graphs, the group of a composite graph, Graphs with a given group, Symmetric graphs, Highly symmetric graphs (self reading).
Enumeration: Labeled Graphs, Polya's enumeration theorem, Enumeration of graphs, Enumeration of trees, Matchings in bipartite graphs, Hall's matching theorem, Ramsey's theorem, Ramsey numbers, Eigenvalues of graphs.

Reading suggestions:

- Harary, F., Graph Theory, Narosa Pub. House.
- West, D.B., Introduction to Graph Theory, Prentice-Hall of India, 2001.
- Diestel, R., *Graph Theory,* 3rd Edition, Springer-Verlag, Heidelberg, 2005.
- Deo, N.: Graph Theory. Prentice Hall of India, 2002.
- Liu, C.L., Elements of Discrete Mathematics, Mc.Grow Hill, International editions, 1985.

Evaluation and weightage:

- 10% 1st Test
- 20% Assignment
- 20% Mid Sem Exam
- 10% Presentation
- 40% End Sem Exam