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

Course Code	AM 608
Course Title	Spectral Graph Theory and Signed Graphs
Course Credits	04

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 Spectral graph theory 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:

Basic Graph Theory

Course Structure:

- Matrices associated to a graph, the spectrum of a graph: Characteristic polynomial. The spectrum of an undirected graph: Regular graphs, Complements, Walks, Diameter, Spanning trees, Bipartite graphs. Connectednes.
- Spectrum of some graphs: The complete graph, The complete bipartite graph, the cycle, the path, Line graphs, Cartesian products, Kronecker products and bipartite double…
- Decompositions: Decomposing K_{10} into Petersen graphs, Decomposing K_n into complete bipartite graphs.
- Automorphisms, Algebraic connectivity, Cospectral graphs: The 4-cube, Seidel switching, Godsil-McKay switching, Reconstruction, Very small graphs.

- The largest eigenvalue, Interlacing, Graphs with largest eigenvalue at most 2, Regular graphs, Bipartite graphs, Classification of integral cubic graphs, The largest Laplace eigenvalue, Laplace eigenvalues and degrees .The Laplacian for hypergraphs, Applications of eigenvectors, Ranking; Google Page rank, Cutting, Clustering, Searching an eigenspace.
- Survey of the signed graphs and its spectral Analysis applications: Balance in Structures, Networks.

Suggested Readings:

- Harary, F., Graph Theory, Narosa Pub. House.
- West, D.B., Introduction to Graph Theory, Prentice-Hall of India, 2001.
- Brower Andries E., Haemers Willem H., Spectra of graphs, 2012 ISBN : 978-1-4614-1938-9.
- Harary F., Norman Robert Z., Cartwright D., Structural Models, An Introduction to the Theory of Directed Graphs, John Wiley& Sons, 1966.
- 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:

- 40% for Mid-Term examination,
- 40% for End-Term examination,
- 20% for Quiz/assignment/Practical