**Course Title:** Introduction to Graph Theory *(Science Elective)*
**Credit Structure** *(L-T-P-Cr):* 3-0-0-3
**Course Code:** SC322
**Prerequisites** *(if any):* Discrete Mathematics, Data Structures

**Course Objective:** The course aims to introduce the notions of graphs, their use as a very powerful modelling tool and to give the students a degree of mathematical rigour and clarity. The latter aims are generally part of a course on discrete mathematics, but here it can be more focused, as the area is more specialised.

Topics to be covered include: Graphs as models, Graph classes and isomorphism, standard graph parameters and properties, paths and cycles, vertex degrees, graph counting and enumeration, trees, distances and related measures, subgraphs, matchings and related concepts, cuts and connectivity, flows and their relation to cuts, vertex and edge colouring of graphs, planarity and cycles *(girth, circumference and Hamiltonian path problem)*

**Course Content**

a. Definitions of graphs, representations, models and applications

b. Standard terminology and parameters of graphs *(degree, girth, connectedness, connectivity, circumference, diameter, radius, eccentricity, chromatic number independence number etc.)*

c. Classes of graphs: Bipartite graphs, Petersen graph, regular graphs, complete graphs, complete multipartite graphs, intersection graphs, Harary graphs etc.

d. Isomorphism, Counting of graphs, labelled and unlabelled graphs, graph properties related to the presence or absence of subgraphs.

e. Paths, cycles and related graph theoretic concepts, Eulerian trails, Eulerian cycles, Chinese postman tour etc.

f. Vertex degrees and basic properties, Havel-Hakimi Theorem

g. Analogous concepts for directed graphs, problems specific to directed graphs, oriented graphs,

h. Trees, properties, spanning trees of graphs, and distances

i. Matchings, covers correlation to vertex covers, and other related concepts. Augmenting Paths theorem, Hall’s Theorem, Tutte’s Theorem for matchings in general graphs.

j. Cuts and connectivity, vertex and edge connectivity, the relation between them, k connected graphs, Menger’s Theorem and the relation between connectivity and alternative paths. Flows in networks, correlation with connectivity.

k. Vertex colouring, basic properties of chromatic numbers, upper and lower bounds and corresponding algorithms. Relation to Independent Sets, Cliques.

l. Edge colouring and vizing’s theorem, relation to

m. Planar graphs, planarity, Kuratowski’s Theorem

n. Cycles, girth and circumference, Hamiltonian cycle problem

o. Algorithmic aspects of all the above, wherever applicable.
Recommended Books
Text Book

“Introduction to Graph Theory”, by Douglas B. West, Prentice Hall.

Reference Books

"Graph Theory", by Frank Harary, Addison Wesley.