



Mathematics Paper I
Graph Theory
[CORE COURSE]

Semester: II	Credits: 2	Subject Code: BS22003	Lectures: 40
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Course Outcomes:

At the end of this course, the learner will be able to:

- Know about the new branch of mathematics - Graph Theory and its applications which will help to construct a strong foundation in the subject.
- Define graphs, digraphs and trees, and identify their main properties.
- Classify different types of graphs and identify the areas of their applications.
- Formulate and relate real life situations with different types of graphs and techniques used in Graph Theory.
- Describe and apply some basic algorithms for graphs.
- Demonstrate different traversal methods for trees and graphs.
- Determine the wide nature of the subject through various key concepts in Graph Theory and their real-life applications.

Unit 1: Introduction to Graphs and Operations on Graphs	8
<ul style="list-style-type: none"> • Introduction • Elementary Terminologies and Results <ul style="list-style-type: none"> ○ Handshaking lemma ○ Corollary of Handshaking lemma • Types of graph • Isomorphism- Definition and Problems • Adjacency & Incidence Matrix • To check degree sequence (Sequence is graphical or not) • Havel - Hakimi Theorem (Only Statement) • Subgraphs- Definition, Examples • Types of subgraphs • Vertex deleted subgraphs; Edge deleted subgraphs • Induced subgraphs • Spanning Subgraphs • Complement of Graph and Self Complementary graphs • Union, Intersection and Product of Graphs • Fusion of vertices, Decomposition 	
Unit 2: Connected Graphs	9
<ul style="list-style-type: none"> • Walk, Trail, Path- Definition, Examples and Properties 	

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<ul style="list-style-type: none"> • Connected graphs – Definition and Properties • Distance between two vertices, Eccentricity, centre, radius and diameter of a graph • Isthmus, Cut Vertex- Definition, Examples and Properties • Edge connectivity, Vertex connectivity • Dijkstra's Algorithm 	
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Unit 3: Eulerian and Hamiltonian Graphs	6
<ul style="list-style-type: none"> • Konigsberg Bridges Problem • Eulerian Graphs- Definition, Examples, Necessary and Sufficient Condition (with proof) • Fleury's Algorithm • Hamiltonian Graphs- Definition, Examples and Theorems (2 without Proof) • Chinese Postman Problem, Travelling Salesman Problem 	

Unit 4: Trees	10
<ul style="list-style-type: none"> • Definition, Properties of Trees, Theorems • Centre of a tree • Spanning tree: <ul style="list-style-type: none"> ○ Definition ○ Properties ○ Shortest spanning tree- Kruskal's Algorithm, Prim's Algorithm • Binary Tree – Definition and Properties. • Tree Traversal <ul style="list-style-type: none"> ○ Ordered rooted tree, ○ Preorder traversal ○ In order traversal and Post order traversal, Prefix Notation. 	

Unit 5: Directed Graphs	7
<ul style="list-style-type: none"> • Definition, Examples, Elementary terminologies and Properties. • Types of digraphs. • Connectedness of digraphs. • Arborescence • Networks and Flow, MaxFlow-MinCut theorem, Ford Fulkerson Algorithm 	

Reference Books:
<ul style="list-style-type: none"> • C. L. Liu, <i>Elements of Discrete Mathematics</i>, Tata McGraw Hill, Fourth Edition • Douglas B. West, <i>Introduction to Graph Theory</i>, Pearson Education, Second Edition.

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- Harary, *Graph Theory*, Narosa Publishing House Pvt. Ltd., New Delhi, 2013.
- John Clark and Derek Holton, *A first look at Graph theory*, Allied Publishers.
- Kenneth Rosen, *Discrete Mathematics and its applications*, Tata McGraw Hill, Seventh Edition.
- Narsingh Deo, *Graph Theory with applications to computer science and Engineering*, Prentice Hall.

- E-Resources:**
- <https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=25> for Unit 1 to unit 5
 - <https://nptel.ac.in>
 - <https://swayam.gov.in>

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Subject Expert (Outside SPPU)	Dr. Prashant Malavadkar		
VC Nominee	Dr. Vinayak Joshi		
Industry Expert	Mr. Anup Manakeshwar		
Alumni	Ms.Jyoti Sharma		

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