Nirma University

Institute of Technology

Computer Science and Engineering Department

Course Policy Template

2CSDE56 Graph Theory [2 2 - 3]

B.Tech. (CSE)

Semester: VI, Academic Year: 2022-23, Term: Even

Course Code & Name	:	**2CSDE56 – Graph Theory**
Credit Details	:	3
Course Faculty	:	Prof. Rupal Kapdi (Course Coordinator) Prof. Chandan Trivedi
Contact No. & Email	:	Ext: 9566, rupal.kapdi@nirmauni.ac.in
Office	:	NF2
Visiting Hours	:	Monday to Friday - 8:45 to 4:00
Course Site	:	

Introduction to Course:

Graph theory is the study of graphs, which are mathematical structures used to model pairwise relations between objects. Graph Theory gives both an easy way to pictorially represent many major mathematical results, and insights into the deep theories behind them.

Course Learning Outcomes:

At the end of the course, students will be able to –

1. explain the concept of formal graph-theoretic definitions and notations
2. apply basic theoretical concepts in solving real-life problems and address optimization issues
3. analyse real-life problems to match with applications in computer science

Program Outcomes:

PO1 : an ability to apply knowledge of mathematics, science and engineering in practice
PO2 : an ability to identify, critically analyze, formulate and solve engineering problems with comprehensive knowledge in the area of specialization
PO3 : an ability to select modern engineering tools and techniques and use them with appropriate skills
PO4 : an ability to design a system and process to meet desired needs within realistic constraints such as health, safety, security and manufacturability
PO5 : an ability to contribute by research and innovation to solve engineering problems
PO6 : an ability to understand the impact of engineering solutions in a contemporary, global, economical, environmental, and societal context for sustainable development
PO7 : an ability to function professionally with ethical responsibility as an individual as well as in multidisciplinary teams with positive attitude
PO8 : an ability to communicate effectively
PO9 : an ability to appreciate the importance of goal setting and to recognize the need for life-long reflective learning

Program Specific Outcomes:

PSO 1: To apply the theoretical concepts of computer engineering and practical knowledge in analysis, design and development of computing systems and interdisciplinary applications
PSO 2: To work as a socially responsible professional by applying computer engineering principles and management practices

Program Educational Objectives:

PEO I: To prepare graduates who will be successful professionals in industry, government, academia, research, entrepreneurial pursuit and consulting firms.
PEO II: To prepare graduates who will contribute to society as broadly educated, expressive, ethical and responsible citizens with proven expertise.
PEO III: To prepare graduates who will achieve peer-recognition; as an individual or in a team; through demonstration of good analytical, design and implementation skills.
PEO IV: To prepare graduates who will thrive to pursue life-long learning to fulfill their goals.

Mapping of COs to POs and PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	0	2	1	0	0	0	0	0	0	0	0	0	3	0
CO2	2	0	0	3	0	0	0	0	0	0	1	0	3	0
CO3	0	3	0	0	2	0	0	0	1	0	0	1	3	2

Syllabus:

Teaching Hours

Unit I **08**

Introduction to Graph Theory: Discovery of graphs, Definitions, Set Operations on Graphs: Union, Sum, Complement, Difference, Cartesian Product, Composition, and Fusion. Sub-graphs, Isomorphic graphs, Matrix representations of graphs, Degree of a vertex, Directed walks, paths and cycles, Connectivity in digraphs, Eulerian and Hamilton digraphs, Graphic sequences, Graph-theoretic model of the LAN problem, Havel-Hakimi criterion, Realization of a graphic sequence.

Unit II **07**

Connected Graphs and Shortest paths: Connected graphs, Distance, Cut-vertices and cut-edges, Blocks, Connectivity, Weighted graphs, and shortest paths, Weighted graphs, Djkstra's shortest path algorithm, Floyd-Warshall's shortest path algorithm.

Unit III **05**

Trees: Properties, Pendant Vertices, Distance and Canters in a tree, Rooted and Binary Trees, Counting Trees, Spanning Trees and Fundamental Circuits, Number of Spanning Trees.

Unit IV **05**

Planar and Dual Graphs: Combinatorial Vs Geometric Graphs, Planar Graphs, Kuratwoski Graphs, Theorems, Detection of Planarity, Geometric and Combinatorial Dual, Thickness and Crossings.

Unit V **05**

Coloring, Covering and Partitioning: Basic definitions, Cliques and chromatic number, Chromatic Polynomials, Mycielski's theorem, Greedy coloring algorithm, Coloring of chordal graphs, Brooks theorem, Edge Colorings, Matchings, Coverings, The four-color conjecture and five-color theorem.

Self-Study:

The self-study contents will be declared at the commencement of semester. Around 10% of the questions will be asked from self-study contents.

Laboratory Work:

Laboratory work will be based on applications of above syllabus with minimum 10 experiments to be incorporated.

Suggested Readings:

1. Narsingh Deo, Graph theory with applications to engineering and computer science. Courier Dover Publications
2. JA Bondy and USR Murty, Graph theory with applications. Bulletin of the American Mathematical Society, The Macmillian Press Ltd.
3. Doughlous B. West, Introduction to graph theory (Vol. 2). Upper Saddle River, NJ: Prentice hall.
4. Gary Chartard and Ping Zhang, A First Course in Graph Theory, Courier Corporation.
5. GeirAgnarsson and Raymond Greenlaw, Graph Theory: Modelling, Applications, and Algorithms, Pearson/Prentice Hall.

Component wise Continuous Evaluation & Semester End Examination weightage:

Course Code	2CSOE56	Semester	6	Year	2021	Credit	3
Lectures/week	2	Practicals/ week	2	Tutorials/ week	0		

Exam Weightage			Exam Hours	
CE	LPW	SEE	SEE	Practical
0.4	0.2	0.4	3	-

Breakup of CE

	Unit 1	Unit 2	Unit 3
	Classtest	Sessional Examination	Assignment (Term paper)
Inter Component Weightage	0.35	0.35	0.30

Lesson Plan

Sr. No.	Topics	Hours	CLOs
1	**Introduction** • Introduction to Graph Theory: Discovery of graphs, Definitions, Set Operations on Graphs: Union, Sum, Complement, Difference, Cartesian Product, Composition, and Fusion. • Sub-graphs, Isomorphic graphs, Matrix representations of graphs, Degree of a vertex, Directed walks, paths and cycles, Connectivity in digraphs. • Eulerian and Hamilton digraphs • Graphic sequences, Graph-theoretic model of the LAN problem, Havel-Hakimi criterion, Realization of a graphic sequence.	**[08]** [02] [02] [02] [02]	CLO 1
2	**Trees** • Properties, Pendant Vertices, Distance and Centers in a tree. • Rooted and Binary Trees, Counting Trees. • Spanning Trees and Fundamental Circuits, Number of Spanning Trees.	**[05]** [01] [02] [02]	CLO 1, CLO 2
3	**Connected Graphs and Shortest paths** • Connected graphs, distance, Cut-vertices and cut-edges, Blocks, Connectivity. • Weighted graphs, and shortest paths, Djkstra's shortest path algorithm. • Floyd-Warshall's shortest path algorithm.	**[07]** [02] [03] [02]	CLO 1, CLO 2

4	**Planar and Dual Graphs** • Combinatorial Vs Geometric Graphs, Planar Graphs, • Kuratwoski Graphs, Theorems, Detection of Planarity. • Geometric and Combinatorial Dual, Thickness and Crossings.	**[05]** [01] [02] [02]	CLO 1, CLO 2
5	**Coloring, Covering and Partitioning** • Basic definitions, Cliques and chromatic number, Chromatic Polynomials. • Mycielski's theorem, Greedy coloring algorithm, Coloring of chordal graphs. • Brooks theorem, Edge Colorings, Matchings, Coverings, The four-color conjecture and five-color theorem.	**[05]** [01] [02] [01]	CLO 1, CLO 2
	Total	**30**	

List of Practical

Sr. NO.	Week No.	List of Experiments	Mapped with CO
1	**1,2**	Use adjacency matrix and adjacency list for representing the graph. Use any of the representation to find union, intersection, complement, sum and difference of two graphs.	**3**
2	**3**	Write a program to check whether two graphs are isomorphic to each other or not.	**3**
3	**4**	Use Havel-Hakimi theorem and check whether the given degree sequence is graphical or not.	**3**
4	**5**	Write a program to find all the spanning trees of a complete directed graph.	**3**
5	**6,7**	Write a program to find the minimum cut-edges from a given graph. (Use Kerger's Algorithm).	**3**
6	**8**	Write a program to find all the articulation points from a given graph. (Use DFS tree)	**3**
7	**9,10**	Write a program to check whether the graph is planar or not. Apply elementary reduction and check for the resultant three condition of planarity.	**3**
8	**11**	Write a program to find the maximum clique from a given graph.	**3**
9	**12**	Write a program to find the chromatic number of a given graph.	**3**
10	**13**	Write a program to apply four-color conjecture to the LAN topology represented graphically.	**3**
11	**14,15**	Write a program to check whether complete matching for bipartite graph exists or not.	**3**
		Total	**30**

1. Course Assessment Schemes

(Course with Laboratory component)

Assessment scheme	**CE**			**LPW**	**SEE**
Component weightage	0.6			0.2	0.4
	Class Test 0.35	**Sessional Examination** 0.35	**Assignment** 0.3		

Teaching-learning methodology: (Proposed)

- Lectures: Use of Black board, PPT, Discussion, Case Studies.
- Practical: Use of C / C++ for program implementation.

Active learning techniques:(Proposed)

- Flipped classroom
- Active discussions

Types of Special/Innovative Assignments, Term Papers, mini Projects etc.

- Graph Theory Applications in Computer Science domain.

Course Material: (In the website)

- Course Policy.
- PPTs, Notes, other Material.
- Assignments, Tutorials, Lab Manuals.
- Question bank.
- Web-links, Blogs, Video Lectures, Journals.
- Animations /Simulations, Software.
- Advanced topics.
- Industries/Organizations.

Course Outcome Attainment:

- Use of formal evaluation components of continuous evaluation, laboratory work, semester end examination.
- Informal feedback during course conduction.