



## Course Outlines of BS (CS) Degree Program

Course Instructor Batch/Section(s) Course Title  
Prerequisite(s)

# National University



Of Computer & Emerging

Sciences Karachi

Dr. Nazish Kanwal, Mr. Abdul Basit & M

2021/BS-CS

Graph Theory (MT3001)

Nil

<b>Textbooks:</b>	<ol style="list-style-type: none"><li>1. Saoub, Karin R. <i>Graph Theory: An Introduction to Proofs, Algorithms, and Applications</i>. CRC Press, 2021.</li><li>2. Graph theory: undergraduate mathematics / by Khee Meng Koh, Fengming Dong, Kah Loon Ng, Eng Guan Tay. Bondy, John Adrian, and Uppaluri Siva Ramachandra Murty</li></ol>
<b>Ref. Books:</b>	<ol style="list-style-type: none"><li>1. Bondy, John Adrian, and Uppaluri Siva Ramachandra Murty. <i>Graph theory with applications</i>. Vol. 290. London: Macmillan, 1976.</li><li>2. West, Douglas Brent. <i>Introduction to graph theory</i>. Vol. 2. Upper Saddle River: Prentice Hall, 2001.</li></ol>

<b>Course Objective</b>	The Graph Theory includes Fundamental concepts of graphs, Matrix representation and properties of graphs, Isomorphic and special graphs, Graph Routes, Eulerian Circuits, Hamiltonian Cycles, Properties of Trees, Matching and covering, Connectivity and Network Flow, Max-flow Min-cut Theorem, Graph Coloring, Planarity, with applications to computer systems and software engineering.
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No.	Assigned Program Learning Outcome (PLO)	Level	Tools
01	Apply knowledge of mathematics, natural sciences, computing fundamentals, and a computing specialization to the solution of complex computing problems.	R	

*I = Introduction, R = Reinforcement, E = Evaluation. A = Assignment, Q = Quiz, Pr=Presentation, P=Project, M = Midterm, F=Final.*

No.	Course Learning Outcome (CLO) Statements	Tools
1	To introduce the fundamental concepts of Graphs, Graph routes, and Trees.	Q,1 A,1 M1, F
2	To understand the concepts of connectivity, Flow, and Graph matching with their application of Graph Theory in subsequent courses in the design and analysis of algorithms, computability theory, software engineering, and computer systems.	A2, M1, Q2, M2, F
3	Students will explore Graph coloring, Planarity, and Applications related to Computer Science.	Q3, Pr / P, F

Week	Contents/Topics	Section	Problems	CL O
1	Introduction to Graph Models and Terminology: Digraphs, Weighted Graphs, Complete Graphs, Graph Complements, Bipartite Graphs, Graph Combinations, (Theorem 1.33)	1.2	<b>EX #: 1.8</b> Problems: 1.1-1.7, 1.12,1.14, 1.15, 1.16, 1.17, 1.20, 1.22	1
2	Isomorphisms, Matrix Representation, Proof Techniques	1.3, 1.4,1.5		1
3	Degree Sequence, Havel-Hakimi Theorem, Touring a Graph, Graph routes: Eulerian Graphs, Hamiltonian Cycles, Hamiltonian Closure.	1.6, 2.1.2, 2.1.3, 2.2	<b>EX, #:2.4</b> Problems: 2.1-2.9, 2.15, 2.16, 2.27, 2.28.	1
4	Traveling Salesman Problems, Shortest Paths, Dijkstra's Algorithm, Walks Using Matrices, Distance, Diameter, Radius, girth, and circumference of the graph.	2.2.1, 2.3.1, 2.3.2 2.3.3		2
5	Trees; Spanning Trees, Minimum Spanning Trees, Tree Properties, Tree Enumeration, Rooted Trees, and Decision Trees	3.1- 3.3, 3.4.2	<b>EX #: 3.5</b> Problems: 3.1-3.8, 3.13- 3.17,	2

			3.23	
<b>MID-1 Exams</b>				
6	Connectivity Measures (k-Connected, k-Edge Connected).	4.1 4.2	<b>EX #:4.6</b> Problems: 4.1-4.6, 4.9, 4.10, 4.13,	3

7	Connectivity and Paths, Menger's Theorem, Network Flow, Max-flow Min-cut Theorem.	4.4	4.14, 4.15,4.17, 4.20.	3
8	Matching in Bipartite Graphs, Augmenting path & Vertex cover, Berge's Theorem, Matching in General Graphs, Edmond's Blossom Algorithm.	5.1 5.2	<b>EX #: 5.5</b> Problems: 5.1-5.14, 5.17-5.19, 5.24, 5.25	3
9 & 10	Stable Matching, Gale-Shapley Algorithm, Factors & Factorization of the graph.	5.3, 5.4		3
MID-II Exams				
11	Graph Coloring; Four Color Theorem, Vertex Coloring, Perfect graphs, and Interval graphs.	6.1	<b>EX #: 6.5</b> Problems: 6.1-6.9, 6.12, 6.13, 6.14, 6.19.	3
12 & 13	Edge Coloring, Line graphs, Coloring Variations, On line Coloring, Weighted Coloring, List Coloring	6.2 6.4		3
14	Planarity; Kuratowski's Theorem, Euler's Formula (with proof), Cycle chord method, Edge-Crossing, Thickness of graph.	7.1 7.3	<b>EX #: 7.4</b> Problems: 7.1-7.6, 7.17, 7.18	3
Final Exams				

**Marks Distribution:**

Particulars	% Marks
1. Quizzes (at least 2)+Presentation/Project	15

2. Assignments (at least 2)	05
4. First Mid Exam	15
5. Second Mid Exam	15
6. Final Exam	50
<b>Total:-</b>	<b>100</b>

### **Important Instructions to be followed for this Course.**

- Be in the classroom on time. Any student who arrives more than 5 min late in the class would be marked LATE. Anybody coming to class more than 15 minutes late will be marked ABSENT.
- Turn off your cell phones or any other electronic devices before entering the class.
- Maintain the decorum of the classroom all the time.
- Avoid a conversation with your classmates while the lecture is in progress.
- Use parliamentary language in the classroom as well as in assignments. Refrain from using impolite, vulgar, or abusive language in the classroom as well as in-class presentations and assignments.
- Submit your assignments on time, no assignment will be accepted after the deadline.
- There would be no re-take of any quiz.

### **Instructions / Suggestions for satisfactory progress in this course:**

- On average, most students find at least three hours outside of class for each class hour necessary for satisfactory learning.
- Chapters should be read, and homework should be attempted before class.
- Do not get behind. You are encouraged to work with other students. Plus, I am always available during office hours to help you.
- The homework assigned is a minimum. You may always work extra hours on your own.
  - Use the few minutes you usually have before the start of each class to review the prior meetings' notes and homework. This will save us valuable in-class time to work on new material.
- Develop a learning habit rather than memorizing.
- Work in groups, whenever appropriate.
- Apply the learned principles and gain knowledge.
- Be creative in thinking, but stick to the topic assigned for discussions, assignments, and presentations.
- Always bring your textbooks with you to the class.

**Note:** Students are welcome all the time to get help from the Teacher.

Signature: \_\_\_\_\_ Date:17-08-2023