INSTITUTE OF BUSINESS ADMINISTRATION, KARACHI

School of Mathematics & Computer Science

Course Details:

Course Title:	Graph Theory
Course Code:	MTS 457
Semester:	Spring 2024
Instructor:	Dr. Nazish Kanwal
Email:	nkanwal@iba.edu.pk
Prerequisite:	N/A
Recommended Books:	Saoub, Karin R. Graph Theory: An Introduction to Proofs, Algorithms, and Applications. CRC Press, 2021.
Reference Books:	West, Douglas Brent. Introduction to graph theory. Vol. 2. Upper Saddle River: Prenticehall, 2001. Graph theory: undergraduate mathematics / by Khee Meng Koh, Fengming Dong, Kah Loon Ng, Eng Guan Tay. Bondy, John Adrian, and Uppaluri Siva Ramachandra Murty. Graph theory with applications. Vol. 290. London: Macmillan,1976.
Methodology:	Lectures and tutorial sessions.
Class Meets:	Friday / Saturday (From 04:00 PM to 05:15 PM)
Counselling Hours:	Saturday (From 02:00 pm to 4:00 pm)
Class Venue:	MAC3 (Main Campus)
Class #:	96032

Course Objective:

- Students will achieve a command of the fundamental definitions and concepts of graph theory.
- Students will understand and apply the core theorems and algorithms, generating examples as required and asking the next natural question.
- Students will achieve proficiency in writing proofs, including those using basic graph theory techniques such as bijections, minimal counterexamples, and mathematical induction.

- Students will work on clearly expressing mathematical arguments, in discussions and their writing.
- Students will become familiar with the main viewpoints and goals of graph theory: classification, extremality, optimization, and algorithms.
- Students will be able to apply their knowledge of graph theory to problems in natural sciences, computing fundamentals, and a computing specialization to solutions to complex computing problems.

Course Description:

The Graph Theory includes Fundamental concepts of graphs (directed and undirected), Matrix representation and properties of graphs, special graphs, graph Isomorphism, 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.

Course Learning Outcomes:

At the successful completion of this course, the student will have demonstrated the ability to:

- To introduce the fundamental concepts of Graphs, Graph complements Graph combinations, Graph routes, and Trees.
- To understand the concept of isomorphism of graphs and degree sequences.
- To understand the concept of touring a graph, Eulerian Circuit, and Hamiltonian cycles.
- To solve the problems of the shortest path on a weighted graph.
- To understand the concepts of connectivity, Flow, Graph matching, and factorization of graphs.
- Students will explore Graph coloring, Planarity, thickness, crossing number, and their applications related to Computer Science.

Technology Requirements:

1. SAKAI will be used to upload course outlines, and assignments along with the due dates, practice questions, and other reading material.

2. ZOOM will be used for makeup and tutorial classes.

Lecture Schedule:

- The schedule is approximate and subject to change depending on time constraints.

Week	Contents/Topics	Section	Problems
1	Introduction to Graph Models and Terminology: Digraphs, Weighted Graphs, Complete Graphs, Graph Complements, Bipartite Graphs, Graph Combinations.	1.2	**EX #: 1.8** Problems: 1.1-1.7, 1.12,1.14, 1.15, 1.16, 1.17, 1.20, 1.22
2	Isomorphisms, Matrix Representation, Proof Techniques.	1.3, 1.4,1.5	
3	Degree Sequence, Havel-Hakimi Theorem, Touring a Graph, Graph routes: Eulerian Graphs, Hamiltonian Cycles	1.6, 2.1.2, 2.1.3, 2.2	**EX, #:2.4** Problems: 2.1-2.9, 2.15, 2.16, 2.27, 2.28.
4	Shortest Paths, Dijkstra's Algorithm, Walks Using Matrices, Distance, Diameter, and Radius.	2.3.1, 2.3.2 2.3.3	
5	Trees; Spanning Trees, Tree Properties, Rooted Trees, Decision Trees	3.1- 3.3, 3.4.2	**EX #: 3.5** Problems: 3.1-3.8, 3.13-3.17, 3.23
6 & 7	Connectivity Measures (k-Connected, k-Edge-Connected), Connectivity and Paths, Menger's Theorem, Network Flow, Max-flow Min-cut Theorem	4.1- 4.2 4.4	**EX #:4.6** Problems: 4.1-4.6, 4.9, 4.10, 4.13, 4.14, 4.15,4.17, 4.20.
Midterm Exams (March 05-11, 2024)			
8	Matching in Bipartite Graphs, Matching in General Graphs,	5.1, 5.2	**EX #: 5.5** Problems: 5.1-5.14, 5.17-5.19, 5.24, 5.25
9 & 10	Stable Matching, Factors, and factorization of the graph.	5.3, 5.4	
11	Graph Coloring; Four Color Theorem, Vertex Coloring,	6.1, 6.2	**EX #: 6.5** Problems: 6.1-6.9, 6.12, 6.13, 6.14, 6.19.
12 & 13	Edge Coloring; Ramsey Numbers. Coloring Variations, On-line Coloring, Weighted Coloring, List Coloring	6.3, 6.4	
14	Planarity, Kuratowski's Theorem, Euler's Formula, Cycle chord method, Edge-Crossing, Thickness of graph.	7.1 7.2	**EX #: 7.4** Problems: 7.1-7.6, 7.17, 7.18
	Final Exams (May 16-27, 2024)		

Instructor's Role and Responsibility to Students:

As your instructor, I must:

1. Develop and deliver course material in a professional way that facilitates learning for a variety of students and learning styles.

2. Respond to you as time permits, questions in lectures, after classes, during office hours, through online forums, or by email (where I reserve the right to reply within a time frame of 1-2 days).

3. Students are more than welcome to contact me at any time through these means if they have questions or concerns about the course or the course material.

4. Evaluate yourself fairly and as compared to your peers, providing prompt feedback on your performance and justification for your grade.

Students' Learning Responsibilities:

As a member of this class, you would expect to:
1. Take advantage of the learning opportunities provided during lectures and tutorials.
2. Treat others with respect and dignity whenever you address them.
3. Genuinely attempt all homework promptly, including the quizzes, assignments, and the "For You to Try" component of the Course Manual.
4. Seek help if you have tried the homework and still find difficulty with the course content. That means contacting me (*not* just at the last minute!) and possibly considering other resources as I recommend to you.

Assessment Scheme:

➢ Assignments	10 marks
➢ Quizzes	10 marks
➢ Midterm Exams	30 marks
➢ Final Exams	50 marks
➢ Total	100 marks

Assignments & Quizzes:

- The quizzes will be conducted in the classroom.

- The assignments will be submitted (or uploaded on SAKAI) on the due dates mentioned. No assignment will be accepted after the due date.

Plagiarism Policy:

I will not tolerate inappropriate work. Examples of such work include:

1. Copying or presenting someone else's work as your own.

2. Have someone else complete your quiz or complete a quiz for/with another student.

3. To make false claims about lost quiz answers or other assignment submissions.

4. Using or possessing any unauthorized material or instrument which can be used as information storage and retrieval devices.

Attendance & Course Withdrawal Policies:

Attendance is mandatory for my subject classes, and course withdrawal is as per the IBA Policies.

Grading Scheme:

As per the IBA scheme.