جامعة آل البيت
دائرة ضمان الجودة والتخطيط

بسم الله الرحمن الرحيم

جامعة آل البيت

College of Science
Department of Mathematics
Course syllabus: Graph Theory (401343)
First semester 2019/2020

1. Instructor Information:

Instructor Name	Prof. Hani Khashan		
Office Hours	Sunday ,Tuesday, Thursday	11-12 9-10	
Office Number and Telephone Extension	2121		
Email	hakhashan@aabu.edu.jo		

2. Course Description:

Definition of graphs and examples, important types of graphs, operations on graphs, subgraphs and induced subgraphs, isomorphisms, adjacency and incidence matrices, connected graphs, Eulerian graphs, Hamiltonian graphs , Edge-traceable graphs, Prime's Method to construct spanning trees, Vertices colorings, Edge colorings and some applications.

3. Course Information:

Course number: 401343	Course Title: Graph Theory	Level : Third year
Course Nature: Theoretical	Prerequisite: 401102	Lecture time: Sun. Tue. Thu. 10:00 – 11:00
Academic year: 2019 – 2020	Semester: First	Credit Hours: 3

4. Course Objectives:

1. Many real life problems can be described by means of a diagram consisting of a set of points together with lines joining certain pairs of points. For instance, the points could represent people, with lines connecting pairs of friends; the points might be communication stations, with lines representing communication links; or the points might be cities in a certain reign, with lines representing roads between them. Observe that in such diagrams one is mainly interested in whether or not two given points are joined by a line and the way in which they are connected is irrelevant. The mathematical abstraction of these situations gives rise to the concept of a graph. Students will be introduced to the concept of graphs. Also, the concept of digraphs will be given. Many examples on graphs and digraphs will be given to explain these concepts.
2. Important type of graphs such as: Complete Graphs, Null Graphs, Path Graphs, Cycle Graphs, Bipartite Graphs, Complete Bipartite Graphs, Cubic Graphs and Trees will be given. Student will investigate these types of graphs and their properties. Also, students examine several examples of these graphs and look at some related applications.
3. Operations on graphs such as: Complement of a graph, Union of two graphs, Join of two graphs will be given. Students learn how to perform these operations on certain graphs. Also, subgraphs and induced subgraphs will be introduced. Students will see how to get new graphs from old ones using these operations.
4. Isomorphisms are bijective functions between the vertices of two graphs that preserve adjacency. One way to find out information about a graph is to study its interaction with other graphs by way of isomorphism. Students learn a formal method for determining whether two graphs are really the same through graph isomorphism. Adjacency and Incidence Matrices will be introduced. These matrices explain how the vertices are adjacent. Students will learn how to use Linear Algebra and properties of matrices to get information about graphs.
5. One of the questions in graphs that have practical applications is: Can we travel along the edges of a graph starting at a vertex and returning to it by traversing each edge of the graph exactly once? Similarly, can we travel along the edges of a graph starting at a vertex and returning to it while visiting each vertex of the graph exactly once? Students will study these questions and discuss the difficulty of solving them. Although both questions have many practical applications in many different areas, both arose in old puzzles. Students will learn about these old puzzles as well as modern practical applications.

6. Vertices coloring of graphs, Edge coloring of graphs and Chromatic number will be given. Students will learn how to find chromatic numbers for certain graphs. Also students will learn the meaning and the importance of this number. Some related theorems and applications will be discussed.
7. One application of graphs will be introduced. Students will learn how to phase the traffic lights by using the compatibility graph.

After completing this course, students should demonstrate competency in the following skills:
1. Examine the concepts of graphs and digraphs; and give several examples of these concepts.
2. Perform operations on graphs and to determine important types of graphs and their properties.
3. Determine, use and apply isomorphisms between graphs. Also fined incidence and adjacency matrices of graphs and their properties.
4. Give direct proofs, proofs by contradiction, proof by contrapositive and proof by induction concerning properties of graphs.
5. Analyze practical problems and model them in graphs and then determine some of the properties of these graphs. Also, using the known results on the graph theory to find solutions to practical problems that give rise graphs.
6. Determine whether certain graphs are Eulerian or Hamiltonian.
7. Compute the Chromatic number of some types of important graphs.
8. Investigate some of the applications on graph theory such as Phasing the traffic lights by using the compatibility graph.

5. Intended Student Learning Outcomes:

Successful completion of the course should lead to the following outcomes:
1) Examine the concepts of graphs and digraphs; and give several examples of these concepts.
2) Perform operations on graphs and to determine important types of graphs and their properties.
3) Determine, use and apply isomorphisms between graphs. Also fined incidence and adjacency matrices of graphs and their properties.
4) Analyze practical problems and model them in graphs and then determine some of the properties of these graphs. Also, using the known results on the graph theory to find solutions to practical problems that give rise graphs.
5) Determine whether certain graphs are Eulerian or Hamiltonian.
6) Compute the Chromatic number of some types of important graphs.
7) Investigate some of the applications on graph theory such as Phasing the traffic lights by using the compatibility graph.

8) Course Content:

The Weeks	The Subjects
1	Some basic definitions concerning graphs such as simple, multiple edges, loops, connected, degree of vertices.
2	Adjacency and Incidence Matrices. Isomorphisms of graphs. Path and Cycles in graphs.
3	Some kinds of graphs (complete, null, cycle, path, bipartite, complete bipartite and trees). Counting labeled and unlabeled graphs, Graph cards.
4	Some operations on graphs such as union of graphs and complement of graphs. Some kinds of graphs (complete, null, cycle, path, bipartite, complete bipartite and trees).
5	Application of graphs. Phasing traffic lights. Basic definitions concerning Digraphs.
6	Isomorphisms, Paths, Cycles, adjacency matrices, incidence matrices of digraphs.
7	Eulerian and edge-traceable graphs. Postman problem, Traveler Problem, Explorer Problem.

8	Hamiltonian graphs. Dirac's Theorem. Ore's Theorem.
9	Eulerian and Hamiltonian digraphs. Longest path Algorithm. Shortest Path Algorithm.
10	Trees. Center and bicenter of Trees, Centroid and icentroid of Trees.
11	Spanning Trees. Algorithms to determine spanning trees of graphs.
12	Prim's Method to determine the minimal spanning tree.
13	Coloring of vertices and Chromatic number.
14	Methods to find the chromatic polynomials and Chromatic numbers of graphs.
15	Edge coloring and some related definitions and theorems.
16	Review.

9) Teaching and learning Strategies and Evaluation Methods:

Learning Outcomes	Teaching Strategies	learning Strategies	Evaluation Methods
1) Examine the concepts of graphs and digraphs; and give several examples of these concepts. 2) Perform operations on graphs and to determine important types of graphs and their properties. 3) Determine, use and apply isomorphisms between graphs. Also fined incidence and adjacency matrices of graphs and their properties. 4) Analyze practical problems and model them in graphs and then determine some of the properties of these graphs. Also, using the known results on the graph theory to find solutions to practical problems that give rise graphs. 5) Determine whether certain graphs are Eulerian or Hamiltonian. 6) Compute the Chromatic number of some types of important graphs. 7) Investigate some of the applications on graph theory such as Phasing the traffic lights by using the compatibility graph.	- In order to succeed in this course, each student needs to be an active participant in learning both in class and out of class. - Class time will be spent on lecture as well as discussion of homework problems and some group work. - To actively participate in class, students need to prepare by reading the textbook and doing all assigned homework before class (homework will be assigned each class period, to be discussed the following period). - Students should be prepared to discuss their homework (including presenting their solutions to the class) at each class meeting - their class participation grade will be determined by their participation in this. - Students are encouraged to work together and to ask questions and seek help from the professor, both in and out of class. But they have to write their homework by themselves.	-Provide students with the desire for and ability to accomplish lifelong learning. -Provide the tools and setting for self-discovery. -Involve educating students to be independent thinkers who develop professional attitudes, learn quality technical skills, and develop good written and oral communications	- Classroom presentations - Quizzes - Discussion - First exam, Second exam and Final exam

1) Assessment:

Assessment	Grade Proportion	Week/Dates
Class Work (Quizzes, Homework and Attendance of the lecture)		
First exam	**25 %**	**7th Week**
Second exam	**25 %**	**12th Week**
Final exam	**50 %**	**End of Semester**
Total	**100 %**	

2) Text Book:

The main reference	Graphs: An Introductory Approach--A First Course in Discrete
Author(s)	Robin J. Wilson, John J. Watkins
Publisher	JOHN WILEY & SONS, INC.
Year	2012
The edition	1st edition
The reference website	https://www.amazon.com/Graphs-Introductory-Approach-Discrete-Mathematics/dp/0471615544

3) References and additional resources:

1)	Graphs and Applications, Joan M. Aldous and Robin J. Wilson. Springer, 2003
2)	