The University of Jordan

Accreditation & Quality Assurance Center

Course Syllabus

Course Name: Graph Theory

1	Course title	**Graph Theory**
2	Course number	**0301445**
3	**Credit hours (theory, practical)**	**3**
	Contact hours (theory, practical)	**3**
4	Prerequisites/corequisites	**0301241**
5	Program title	**B.Sc.**
6	Program code	
7	Awarding institution	**The University of Jordan**
8	Faculty	**Science**
9	Department	**Mathematics**
10	Level of course	**Elective Specialization requirement**
11	Year of study and semester (s)	**4th year, 1st or 2nd semesters**
12	Final Qualification	**B.Sc. in Mathematics**
13	Other department (s) involved in teaching the course	**None**
14	Language of Instruction	**English**
15	Date of production/revision	**7/11/2017**

16. Course Coordinator:

Office numbers, office hours, phone numbers, and email addresses should be listed.
Omar AbuGhneim, Math. Building Office 329, phone: 06-5355000 Ex. 22103, o.abughneim@ju.edu.jo
Office hours Sun 8-9, Tus and Ths 10-11, Mon and Wed 11-12.

17. Other instructors:

Office numbers, office hours, phone numbers, and email addresses should be listed.
Hasan AlEzeh

18. Course Description:

As stated in the approved study plan.

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, planar graphs and the crossing number, domination number, clique number, chromatic number, independence number, matchings and Hall's marriage theorem, and applications.

19. Course aims and outcomes:

A- Aims:

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 concepts of multigraphs and digraphs will be given. Many examples on graphs, multigraphs and digraphs will be given to explain these concepts.

2. Important type of graphs such as: Complete Graphs, Null Graphs, Paths, Cycles, Wheels, Bipartite Graphs, Complete Bipartite Graphs, Hypercubes 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, Cartesian product 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. A graph is planar if it can be drawn in the plane without edges crossing. In case, there is a crossing we want to draw the graph with minimum number of crossing. This minimum number of crossing is called the crossing number. Students will learn how to determine if a graph is planar and in the case the graph is not planar, students learn how to find its crossing number. Also students will learn some of the applications on Planarity of graphs such as the design of electronic circuits and the design of road networks.

7. Important numbers that are related to graphs such as Domination number, Clique number, Chromatic number, Independence number and the Matching number will be given. Students will learn how to find these numbers for certain graphs. Also students will learn the meaning and the importance of these numbers.

8. Many applications on graph theory will be given. Students will see how the graph theory will be used to model and solve these real life problems. Students will investigate applications such as Hall's Marriage Problem, Network Flow Problem, Four Color Problem, Traveling Salesman Problem, and Minimum Connector Problem.

B- Intended Learning Outcomes (ILOs):

Successful completion of the course should lead to the following outcomes:

A. Knowledge and Understanding Skills: Student is expected to

A1.   Examine the concepts of graphs, multigraphs, and digraphs; and give several examples of these concepts.

A2.   Perform operations on graphs and to determine important types of graphs and their properties.

A3.   Determine, use and apply isomorphisms between graphs. Also fined incidence and adjacency matrices of graphs and their properties.

B. Intellectual Analytical and Cognitive Skills: Student is expected to

B1.   Define, interpret and analyze fundamental principles and theory concerning graphs. Analyze given graphs and find important information about them such as Crossing number, Domination number, Clique number, Chromatic number, Independence number and the Matching number.

B2.   Give direct proofs, proofs by contradiction, proof by contrapositive and proof by induction concerning properties of graphs.

B3.   Analyse 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.

C. Subject- Specific Skills: Student is expected to

C1.   Identify planar graphs and find the crossing number of nonplanar graphs. Determine whether certain graphs are Eulerian or Hamiltonian.

C2.   Compute Crossing number, Domination number, Clique number, Chromatic number, Independence number and Matching number of some types of important graphs.

C3.   Investigate some of the applications on graph theory such as Hall's Marriage Problem, Network Flow Problem, Four Color Problem, Traveling Salesman Problem, and Minimum Connector Problem.

D. Creativity /Transferable Key Skills/Evaluation: Student is expected to

D1.   Read write and criticize proofs.

D2.   Perform logical thinking.

D3.   Use mathematical reasoning.

20. Topic Outline and Schedule:

Topic	Week	Instructor	Achieved ILOs	Evaluation Methods	Reference
1) Definition of graphs multigraphs and digraphs. Examples on graphs multigraphs and digraphs.	1-2		A1	Quiz	
2) Important type of graphs such as: Complete Graphs, Null Graphs, Paths, Cycles, Wheels, Bipartite Graphs, Complete Bipartite Graphs, Hypercubes and Trees.	3-4		A2, D1	Quiz	
3) Operations on graphs such as: Complement of a graph, Union of two graphs, Join of two graphs, Cartesian product of two graphs. Subgraphs and Induced Subgraphs.	5-6		A2, D2	Exam	
4) Isomorphisms, Adjacency and Incidence Matrices.	7		A3	Quiz	
5) Connected Graphs, Eulerian Graphs, and Hamiltonian Graphs. Planar Graph and Crossing number.	8-9		B1, C1	Quiz	
6) Domination number, Clique number, Chromatic number, and Independence number.	10-11		B1, C2	Exam	
7) Matchings and Hall's marriage theorem.	12		C3, D3	Quiz	
8) Applications such as: Network Flow Problem, Four Colour Problem, Traveling Salesman Problem, and Minimum Connector Problem. (If time permit)\	13-15		C3	Quiz	

21. Teaching Methods and Assignments:

Development of ILOs is promoted through the following teaching and learning methods:

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, you 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).
- You should be prepared to discuss your homework (including presenting your solutions to the class) at each class meeting - your class participation grade will be determined by your participation in this.
- You are encouraged to work together with other students and to ask questions and seek help from the professor, both in and out of class. But you have to write your homework by yourself (You are not allowed to seek help in writing your homework and you are not allowed to copy from others)

22. Evaluation Methods and Course Requirements:

Opportunities to demonstrate achievement of the ILOs are provided through the following <u>assessment methods and requirements</u>:

ILO/s	Learning Methods	Evaluation Methods	Related ILO/s to the program
	Lectures	Exam	A1, B1, C1, D1
		Quizzes	

23. Course Policies:

According to university regulations, attendance is mandatory. If a student is unable to attend a class, then he/she should contact the instructor. If a student misses more than 10% of the classes without excuse, then he/she will be assigned a falling grade in class.

In cases of extreme emergency or serious illness, the student will be allowed to make up the missed exams. Times and dates for makeup exams will be assigned latter.

There are severe sanction for cheating, plagiarizing and any other form of dishonesty. The university regulations on cheating will be applied to any student who cheats in exams or on any homework.

24. Required equipment:

Data Show

Computer Lap

25. References:

A- Required book (s), assigned reading and audio-visuals:

Introduction to Graph Theory by D. West.

B- Recommended books, materials, and media:

1) A First Course in Graph Theory by Gary Chartrand and Ping Zhang. .
2) Graph Theory, by Ronald Gould. .
3) A Friendly Introduction to Graph Theory by Fred Buckley an Marty Lewinter.

26. Additional information:

Name of Course Coordinator: -------------------Signature: ----------------------- Date: -----------------------

Head of curriculum committee/Department: ------------------------ Signature: ---------------------------------

Head of Department: ------------------------ Signature: ---------------------------------

Head of curriculum committee/Faculty: ------------------------ Signature: ---------------------------------

Dean: --- -Signature: ---------------------------------

Copy to:
Head of Department
Assistant Dean for Quality Assurance
Course File