



University of Puerto Rico. Mayagüez Campus  
College of Engineering.  
Industrial Engineering Department



## Course Syllabus

### General Information

Course Number: InIn 6008

Course Title: **Network Flows and Graphs in Management Science**

Credit-Hours: Three

### Course Description

Principles of network flows and graph theory and their applications in management science. Classical network flow problem formulations including maximal flow-minimal cut, assignment, transportation and others. Representation of optimization problems as network formulations, and the use of the out of Kilter algorithm for their solution. Linear programming will also be used to solve networks problems. Single versus multicommodity flow, as well as the relation between of graphs and networks will be used for problem formulation and solving. Students will be organized in groups to develop a technical paper and submit it to a professional conference to be published in proceedings. The paper must be submitted before the end of the course.

### Prerequisites

Authorization of the Director of the Department

### Textbook and References

- Phillips, D. T., and García-Díaz, A., 1990, **Fundamentals of Network Analysis**, Waveland Press.

### Purpose

This is a course primarily designed for graduate students whose major concentration is engineering management systems. It is appropriate for engineering graduate students with a basic knowledge of linear programming and interested in transportation analysis, communications, distribution and logistics, project planning and control, and sequencing and scheduling. The purpose of the course is to prepare each student (i) for mastering the theories and most common algorithms of deterministic network flows; (ii) for recognizing real-world situations that can be modeled and solved using networks; and (iii) for conducting meritorious research in deterministic network flows.

### Course Goals

- Model deterministic network systems.
- Apply network algorithms to solve real world problems.
- Develop computer program to implement network algorithms, and to use computer packages.

### Requirements

All students are expected to come to class all the time, on time, and prepared; do all assigned readings and related homework; actively participate in class discussions; and satisfy all assessment criteria to receive credit for the course.

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### Department and Campus Policies

**Class attendance:** Class attendance is compulsory. The University of Puerto Rico, Mayagüez Campus, reserves the right to deal at any time with individual cases of non-attendance. Professors are expected to record the absences of their students. Frequent absences affect the final grade, and may even result in total loss of credits. Arranging to make up work missed because of legitimate class absence is the responsibility of the student. (Bulletin of Information Undergraduate Studies)

**Absence from examinations:** Students are required to attend all examinations. If a student is absent from an examination for a justifiable reason acceptable to the professor, he or she will be given a special examination. Otherwise, he or she will receive a grade of zero or "F" in the examination missed. (Bulletin of Information Undergraduate Studies)

**Final examinations:** Final written examinations must be given in all courses unless, in the judgment of the Dean, the nature of the subject makes it impracticable. Final examinations scheduled by arrangements must be given during the examination period prescribed in the Academic Calendar, including Saturdays. (see Bulletin of Information Undergraduate Studies).

**Partial withdrawals:** A student may withdraw from individual courses at any time during the term, but before the deadline established in the University Academic Calendar. (see Bulletin of Information Undergraduate Studies).

**Complete withdrawals:** A student may completely withdraw from the University of Puerto Rico, Mayagüez Campus, at any time up to the last day of classes. (see Bulletin of Information Undergraduate Studies).

**Disabilities:** After been identified with the professor and the institution, the students with disabilities will receive reasonable accommodations in their courses and evaluations. For more information, please contact *Student Services with Disabilities* at the Student Dean's Office at (Q-019), 787-265-3862 ó 787-832-4040 x-3250 ó 3258.

**Ethics:** Any academic fraud is subject to the disciplinary sanctions described in article 14 and 16 of the revised General Student Bylaws of the University of Puerto Rico contained in Certification 018-1997-98 of the Board of Trustees. The professor will follow the norms established in articles 1-5 of the Bylaws.

### Campus Resources

General Library and University Computer Center is available to obtain professor=s reference materials. The University=s Counseling Office has a tutorial program for students who need extra help.

## Course Syllabus

General Topics		
Lecture	Topic	Reading
1-3	Introductions. Definitions and notation. Matrix representation. Conservation of Flow. The Maximum-Flow Minimum-Cut Theorem.	Chap. 1
4-6	Applications of network-flow models. Linear programming and its relationship to network flows. The shortest-route problem.	Secs. 2.1 - 2.3
7-9	Multi terminal shortest-chain route problems. The shortest-path models with fixed charges. The K-shortest path problem.	Secs. 2.4 - 2.6
10-12	Comparison of shortest-path algorithms. Minimal spanning tree problems. The traveling salesman problem.	Secs. 2.7 - 2.9
13-15	The transportation problem. The transshipment problem. The assignment problem.	Secs. 2.10 - 2.12
16-18	The assignment problem and the traveling salesman problem. The maximum-flow problem. The Multi terminal maximum-flow problem.	Secs. 2.13 - 2.15
19-21	The Multi terminal maximum-capacity chain problem. Node and arc failures in networks.	Secs 2.16 and 2.17
22-24	Linear programming. Duality theory: basic terminology, basic theory, and fundamental theorems.	Class notes
25-27	Network flow optimization with the out-of-kilter algorithm. Theoretical concepts.	Secs. 3.1 to 3.9
28-30	Network flow optimization with the out-of-kilter algorithm. Modeling concepts. Applications of the out-of-kilter algorithm.	Secs. 3.10 - 3.24
31-33	Project management with CPM and PERT.	Secs. 4.1 - 4.11
34-36	Resource allocation in project networks.	Secs. 4.12 - 4.16
37-39	Project management and resource allocation using a computer program.	MS Project Ref. Manual
40-42	Multicommodity Network Flows.	Chap. 5

\*All reading from Phillips and García-Díaz, 1990.

Nazario D. Ramirez/rev. Sep. 2016