

# OR 643/SYST 521: Network Optimization

GEORGE MASON UNIVERSITY

Systems Engineering and Operations Research Department

Fall, 2016

**Time:** Tuesdays, 7:20-10:00 p.m.

**Classroom:** Innovation Hall, Room 209

**Professor:** Steven Charbonneau

**Phone:** (202) 418-4076 (wk) from 8:30 am to 5:30 pm

(703) 550-5006 (hm) from 6:30 pm to 9:00 pm;

**email:** scharbo2@gmu.edu

**Office hours:** By appointment

**Text:** *Network Flows: Theory, Algorithms, and Applications*, Ahuja K. A., Magnanti T. I., Orlin J. B., Prentice Hall, 1993.

**Software:** You will need **Python 2.7** for this course. I highly encourage you to use Continuum Analytics' Anaconda distribution of Python 2.7. It is freeware available for download at <https://www.continuum.io/downloads>. We can discuss later why 2.7 and not 3.5.

**Course Description:** This course is about modeling, solving, and understanding *network flow problems*. Such problems arise naturally in many disciplines such as telecommunications, transportation, electronic circuitry, and water distribution to name a few. In addition, they can be used to solve many problems where the connection with networks is not immediately obvious (e.g., object oriented databases, accessions plans for large organizations, rapid access to closely related DNA sequences). A network formulation can provide a clear visual representation of the problem and enable efficient solution methods. There are three general topic areas covered in this course: Modeling and understanding network application areas, algorithmic development of network algorithms including proofs of correctness of such algorithms, and computational measurements of "goodness" for such algorithms. The study of network flows involves concepts from optimization, complexity theory, and data structures. *Computer programming skills are not required to take this course. However, be advised you will be writing and running your own code for each homework assignment. If you do not know how to write code, you will be provided the resources and opportunity to learn. This means you will have to allocate more time to this course in the beginning of the semester than your peers. Many people have taken this course with no prior programming*

*skills and have been successful. If you have concerns, contact the professor before the course starts so you may discuss your concerns with him.*

**Course Objectives:** The course focuses on the development and implementation of network optimization algorithms. Students will learn the terminology of graph theory and cover the fundamental ideas for solving network flow problems using specialized algorithms. Additionally, students will learn to assess the computational complexity of algorithms routinely applied in the field of network optimization, the value of advanced data structures and their impact on improving computational complexity, and write and implement network optimization algorithms in the Python 2.7 programming language.

**Course Schedule (Subject to change as course progresses):**

Lesson	Date	Topic	Prep Work
Lesson 1	30 August, 2016	Course Overview and Graph Theory Review	Read: Chapters 1 and 2
Lesson 2	6 September, 2016	Algorithm Design and Analysis	Read: Sections 3.1 – 3.3
Lesson 3	13 September, 2016	Search Algorithms	Read: Sections 3.4, 3.6
Lesson 4	20 September, 2016	Shortest Path Problems – Part I	Read: Sections 4.1 – 4.6
Lesson 5	27 September, 2016	Shortest Path Problems – Part II	<p><i>A Formal Basis for the Heuristics Determination of Minimum Cost Paths (Hart, Nilsson, Raphael; 1968)</i></p> <p><i>A New Bidirectional Search Algorithm with Shortened Postprocessing (Pijls and Post; 2009)</i></p> <p>Papers posted in blackboard content folder</p>
Lesson 6	4 October, 2016	Shortest Path Problems – Part III	Read: Chapter 5 (sections 5.1 – 5.6, and 5.8)
<b>Columbus Day Week – Monday classes meet on Tuesday; Tuesday classes do not meet</b>			
Lesson 7	18 October, 2016	Maximum Flow Problems – Part I	Read: Chapter 6 (sections 6.1 – 6.5, 6.7, and 6.8)
Lesson 8	25 October, 2016	Maximum Flow Problems – Part II	Read: Chapter 7 (sections 7.1 – 7.4, 7.6, 7.7, 7.9, 7.10)

Lesson 9	1 November, 2016	Maximum Flow Problems – Part III	Review: Chapter 7 (sections 7.1 – 7.4, 7.6, 7.7, 7.9, 7.10)
Lesson 10	8 November, 2016	Minimum Cost Flow Problems – Part I	Read: Chapter 9 (sections 9.1 – 9.9, and 9.12)
Lesson 11	15 November, 2016	Minimum Cost Flow Problems – Part II	Read: Chapter 10 (sections 10.1 – 10.4)
Lesson 12	22 November, 2016	Minimum Cost Flow Problems – Part III	Review: Chapter 10 (sections 10.1 – 10.4)
Lesson 13	29 November, 2016	Minimum Spanning Trees	Read: Chapter 13 (sections 13.1 – 13.6, and 13.9)
Lesson 14	6 December, 2016	Network Simplex	Read: Sections 11.1-11.6

**Grading Scheme:**

Homework: 90%

Class participation: 10%

**Coursework & Grading:** Unless otherwise indicated, you are expected to work individually on homework assignments. You must submit homework directly to me via email at [scharbo2@gmu.edu](mailto:scharbo2@gmu.edu).

**Academic Integrity:** GMU is an honor code university; please see the University Catalog for a full description of the code and the honor committee process. The principle of academic integrity is taken very seriously and violations are treated gravely. What does academic integrity mean in this course? Essentially this: when you are responsible for a task, you will perform that task on your own. When you rely on someone else’s work in an aspect of the performance of that task, you will give full credit, in writing, as a cover document to your homework submission. Another aspect of academic integrity is the free play of ideas. Vigorous discussion and debate are encouraged in this course, with the firm expectation that all aspects of the class will be conducted with civility and respect for differing ideas, perspectives, and traditions. When in doubt (of any kind) please ask for guidance and clarification.

**GMU Email Accounts:** Students must use their Mason email accounts to receive important University information, including messages related to this class. See <http://masonlive.gmu.edu> for more information.

**Additional Notes:** I will make every effort to use Blackboard to post homework, assignments, lecture notes, and grades. I will send out email notices each time I have uploaded new information to blackboard. Failure to turn in homework on the due date will result in a 0% for that submission. Best way to contact the professor is by email.