# OR 643/SYST 521: Network Optimization

## GEORGE MASON UNIVERSITY

Systems Engineering and Operations Research Department

Fall, 2013

**Time:** Tuesdays, 7:20-10:00 p.m.
**Classroom:** Innovation Hall 135
**Professor:** Steven Charbonneau
**Phone:** (571) 303-2173 (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. l., Orlin J. B., Prentice Hall, 1993.

**Software:** You will need MS Excel for this course. If you have MS Excel 2008 for Mac OS, you will need to get a different version (MS Excel for Mac OS 2004 or 2010) or any version of MS Excel for Windows (2003 or later). We will be using VBA extensively and MS Excel 2008 for Mac OS shipped without VBA.

**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 a prerequisite 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 a programming language.

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

| Lesson | Date | Topic | Prep Work |
|---|---|---|---|
| Lesson 1 | 27 August | Course Overview and Graph Theory Review | Do: Skill Builders 0, 1, 2<br>Read: Chapters 1 and 2 |
| Lesson 2 | 3 September | Algorithm Design and Analysis | Do: Skill Builders 3, 4, 5, 7<br>Read: Sections 3.1 – 3.3 |
| Lesson 3 | 10 September | Search Algorithms | Do: Skill Builders 6 and 8<br>Read: Sections 3.4, 3.6 |
| Lesson 4 | 17 September | Shortest Path Problems – Part I | Do Skill Builder 9<br>Read: Sections 4.1 – 4.6 |
| Lesson 5 | 24 September | Shortest Path Problems – Part II | Do Skill Builder 9<br>Read: Sections 4.7– 4.9 |
| Lesson 6 | 1 October | Shortest Path Problems – Part III | Read: Chapter 5 (sections 5.1 – 5.6, and 5.8) |
| Lesson 7 | 8 October | Minimum Spanning Trees | Read: Chapter 13 (sections 13.1 – 13.6, and 13.9) |
| Columbus Day Week – Monday classes meet on Tuesday; Tuesday classes do not meet | | | |
| Lesson 8 | 22 October | Maximum Flow Problems – Part I | Read: Chapter 6 (sections 6.1 – 6.5, 6.7, and 6.8) |
| Lesson 9 | 29 October | Maximum Flow Problems – Part II | Read: Chapter 7 (sections 7.1 – 7.4, 7.6, 7.7, 7.9, 7.10) |
| Lesson 10 | 5 November | Maximum Flow Problems – Part III | |
| Lesson 11 | 12November | Minimum Cost Flow Problems – Part I | Read: Chapter 9 (sections 9.1 – 9.9, and 9.12) |
| Lesson 12 | 19 November | Minimum Cost Flow Problems – Part II | Read: Chapter 10 (sections 10.1 – 10.4) |
| Lesson 13 | 26 November | Minimum Cost Flow Problems – Part III | |
| Lesson 14 | 3 December | Assignments and Matchings | Read: Sections 12.2-12.6 |

**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.

**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.