# SCH-MGMT 825X Integer Programming

*Department of Finance and Operations Management*
*Isenberg School of Management, UMass, Amherst*
Spring 2011

INSTRUCTOR: Ahmed Ghoniem (SOM 317, e-mail: aghoniem@som.umass.edu, Phone: 5-3927)
**Class Schedule:** Tuesdays and Thursdays 1:00-2:15pm.
**Office Hours:** Tuesdays and Thursdays 11:00am-12:30pm.
**Internet**: http://www.isenberg.umass.edu/finopmgt/Faculty/Profiles/Ahmed_Ghoniem/

COURSE DESCRIPTION: This course discusses modeling insights and state-of-the-art solution methodologies for integer and mixed-integer optimization problems. Topics include tight polyhedral representations, valid inequalities and lifting strategies, cutting plane algorithms, branch-and-bound/cut algorithms, implicit enumeration, and decomposition methods. Relevant applications arising in production planning, transportation and logistics, supply chain management, and business processes are discussed throughout the course. Strategies that yield better models and/or enhanced algorithmic strategies are also presented. (See Tentative Schedule at the end of the syllabus.)

TEXT: Nemhauser, G.L. and Wolsey, L.A., *Integer and Combinatorial Optimization* John Wiley & Sons, 1999.

PREREQUISITE: 752 Deterministic Models in Management Science or an equivalent introductory course on model building in optimization.

COMPUTER REQUIREMENTS: We will use AMPL/CPLEX to implement mathematical programs. The (restricted) free version is available at http://ampl.com/.

GRADE: Midterm Exam 25%; Final Exam 25%; Homeworks 35%; Term Paper 15%.

AUDITING: Students who audit this course are required to turn in all homeworks on time.

EXAMS: There will be two exams, each of which will be closed book, closed notes, in-class exams. You will be given advance notice of when each exam will be held. You may bring to the exam one $8.5 \times 11$ sheet with formulas and notes written on it.

TERM PAPER

The term paper will survey mathematical programming formulations for a given topic, provide a comparison between models from a size, tightness of continuous relaxation, and computational tractability point of view.

In addition, you will identify a novel variant of the problem you have surveyed. Explain why this extension is relevant/significant, and rigorously formulate an MIP for the extended model you are proposing. Design a solution methodology (possibly a heuristic) for the extended model and report preliminary computational results. Ideally, you should discuss the tightness of the LP relaxation of your model, the efficiency and effectiveness of your proposed solution methodology (quality of solutions vs. computational effort), and preliminary results obtained by standard optimization solvers such as CPLEX.

Selected examples of topics: integrated vehicle routing; aircraft sequencing; machine scheduling; retail management; green logistics; reverse supply chain management.

The topic you choose needs to be approved by the instructor.

TENTATIVE SCHEDULE

| Dates | Topic | Chapters |
|---|---|---|
| 01/18-02/1 | Introduction; Model Building and Enhancements; Relaxation and Bounds | I.1 |
| 02/3-02/8 | Introduction to Computational Complexity | I.5 |
| 2/10-2/17 | Branch-and-Bound Frameworks | II.4 |
| 2/24-3/3 | Cutting Planes | II.1, II.2 |
| 3/8 | MIDTERM EXAM | |
| 3/10; 3/22-3/24 | Strong Valid Inequalities; Lifting Procedures | II.1, II.2 |
| 3/29-4/12 | Decomposition/Partitioning; Column Generation; Lagrangian Relaxation | II.3 |
| 4/14-4/19 | Implicit Enumeration | II.4 |
| 4/21-4/26 | Advanced modeling; Reformulation-Linearization Technique | |
| 4/28-5/3 | CLASS PRESENTATIONS, course evaluation, final exam revision | |
| | FINAL EXAM | |

Table 1: Tentative course outline