University of Massachusetts at Amherst
Isenberg School of Management
Department of Finance and Operations Management

SOM 822 - Management Science II
Spring 2008

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Class Time: Mondays, 12:00-2:30PM
Classsroom: ISOM 128
Office Hours: Mondays and Wednesdays 10:30-11:30AM

Course Description and Syllabus

This course introduces and develops variational inequality problems as the unifying framework for mathematical programming problems, including such optimization problems as nonlinear programming problems, complementarity problems, and a spectrum of network equilibrium problems. The course will focus on complex decision-making applications drawn from management science, economics, and engineering, with a particular emphasis on network equilibrium problems. We will study both centralized as well as decentralized decision-making in this framework and will also discuss connections to game theory.

The course first presents the basic theory of variational inequalities. It then through the use of applications further motivates the need for variational inequality theory. The applications that are covered include traffic networks (relevant to both congested transportation and telecommunication systems) and spatial price equilibrium problems. Other problems that will be studied as variational inequality problems, include oligopolistic market equilibrium problems (governed by Nash equilibrium) and a variety of financial equilibrium problems, in order to explore different behavioral assumptions. This course also covers a plethora of algorithms which take advantage of the underlying structure (often-times in the form of a network) of these problems. The algorithms are suitable for large-scale problems.

If time permits, we will also discuss supply chain networks and their relationships to transportation network equilibrium problems, along with a variety of extensions, such as the inclusion of electronic commerce, environmentally-based decision-making, etc.

All the class lecture notes will be handed out to the students. In addition, several copies of the book, "Network Economics: A Variational Inequality Approach," 1999, revised and second edition, Anna Nagurney, Kluwer Academic Publishers, Boston, MA, will be put on reserve in the Isenberg School of Management library. Students may purchase a copy of this book, but are not obliged to. Many fundamental scholarly papers will also be distributed to the class. Additional materials will also be provided and made available at: http://supernet.som.umass.edu

OUTLINE OF TOPICS TO BE COVERED

1. Introduction to Variational Inequality Theory

2. The Variational Inequality Problem
Basic Qualitative Theory
Relationship to Optimization Problems and Other Classical Mathematical Programming Problems
Sensitivity Analysis

3. Algorithms for the Solution of Variational Inequality Problems
The General Iterative Scheme - Projection and Relaxation Methods
Decomposition Methods - Serial and Parallel

4. Basic Models of Traffic Assignment and Solution Procedures
The Standard Model and Equilibration Algorithms
The Extended Model
Multimodal Models
The Elastic Demand Model and Transformation into a Fixed Demand Model

5. Spatial Price Equilibrium Models and Solution Procedures
The Classical Model
Asymmetric and Multicommodity Models
Models with Policy Interventions
Relationship between Traffic Network and Spatial Price Equilibrium

6. Oligopolistic Market Equilibrium Problems
Basics of Game Theory and Nash Equilibrium
Standard Oligopoly Model
Spatial Variants and Applications

7. Other Applications of Variational Inequalities, as time permits
Financial Equilibrium Problems
Supply Chain Networks
Decision-Making in the Information Age

There will be homework assignments given regularly throughout the class. The students are expected to actively participate in the course. There is also a required project and presentation. The project consists of a paper, which should develop an original model with accompanying theory, and be based on the course contents, and on an application of particular interest to the student. The presentation entails an in-class presentation of the student's project.

Grading Policy:
Homework: 25%
Project and Class Presentation: 25%
Midterm Exam: 25%
Final Exam: 25%