Syllabus and Course Outline, Fall 2018

Mathematical Optimization in Applied Economics

Course Description: Applications of mathematical programming techniques to economic problems are presented. Mathematical optimization concepts are reviewed; structures and economic interpretations of various models of the firm, consumer, household, sector, and economy are examined. Model building and solution techniques are illustrated using examples and computer exercises. Approaches to dynamic optimization are introduced. 3 credits.

Instructor: Jeffrey Apland, 332c Ruttan Hall
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Meeting Time & Place: 4:45-6:00, Mondays and Wednesdays; B26 Ruttan Hall.

References: A partial list of references to supplement and complement the lectures is incorporated into the course outline that follows. Assigned readings will be announced in class. Most of the references are available through the University of Minnesota Libraries eReserve. You may log on to the UM Library eReserve website at:

https://reserves.lib.umn.edu

There is no required textbook. Mathematical Optimization and Economic Theory by Michael Intriligator is a good reference on the mathematics of optimization in the context of economic problems. Several chapters are on reserve and will be assigned readings. Several good mathematical economics and applied math programming books are listed below. The books by McCarl and Spreen, and Hazell and Norton address many of the topics discussed in the course. Two other texts with an applied bent are Model Building in Mathematical Programming by H. P. Williams, and Computational Economics: Economic Modeling with Optimization Software by Gerald L. Thompson and Sten Thore. Many of the topics in ApEc 8202 are also discussed in numerous operations research books. One such book, Introduction to Operations Research by Hillier and Lieberman, is a useful reference on a variety of mathematical and dynamic programming topics. The complete references for these titles, as well as some others, are listed below.

Throughout the course, we will discuss solutions to economic problems modeled using GAMS – the Generalized Algebraic Modeling System. Some computer exercises will be included in assignments and we will schedule class meetings in a computer lab. Depending on prior experience and interest, we may explore other mathematical programming software such as the Excel Solver.

Grading: Final grades will be based on a mid-term examination (40%), a final examination or paper (40%), written and computer exercises (15%), and class participation (5%).

Some Useful Reference Books:


**Course Outline:**

I. Introduction
   A. Perspective of the Course
   B. Software for Mathematical and Dynamic Programming

References for Section I:

II. Overview of Mathematical Programming
   A. The Mathematical Programming Problem – Terms and Concepts, the Weierstrass Theorem and the Local-Global Theorem
   B. The Classical Programming Problem and the Method of Lagrange
   C. Nonlinear Programming and the Karush-Kuhn-Tucker Conditions
   D. The Linear Programming Problem
      1. Primal and Dual Problems, Karush-Kuhn-Tucker Conditions
      2. The Simplex Algorithm
      3. Degeneracy, Sensitivity Analysis and Ranging
   E. Special Classes of Mathematical Programming Problems
      1. Problems with Integer Variables
      2. Quadratic Programming
      3. Approximation of Nonlinear Programming Problems Using Linear Programming

References for Section II:
III. Firm-Level Applications of Mathematical Programming

A. Formulation of Economic Problems as Linear Programs
   1. The Blending Problem
   2. The Transportation Problem and Variants

B. A Linear Programming Model of the Firm
   1. Model Structure, Karush-Kuhn-Tucker Conditions and an Example
   2. Comparison of the LP Model with the Neoclassical Model of the Firm

C. Modeling Farm Production
   1. A Corn and Soybean Farm
   2. Extensions and Applications

D. Applications of Integer Programming

E. An Overview of Risk Programming
   1. Traditional Risk Programming Models
   2. Discrete Stochastic Programming
   3. Other Risk Programming Models

F. Multiple Objective Programming

References for Section III:


Baumol, William J. "Activity Analysis in One Lesson." AER. December 1958, pp. 837-873.


IV. Endogenous Price, Mathematical Programming Models of Markets, Sectors, Regions and Economies

A. Modeling Market Equilibrium as a Mathematical Programming Problem

B. A Single-Commodity Trade Model and Extensions

C. Sector Models with Exogenous, Price Responsive Input Supply and Product Demand Functions, Endogenous Input Demand and Product Supply, and Endogenous Prices

References for Section IV:


V. Validating Mathematical Programming Models

A. Alternative Approaches to Validation

B. Design of Validation Experiments

Reference for Section VI:


VI. An Overview of Dynamic Optimization

A. Characteristics of Dynamic Problems.

B. The Calculus of Variations

C. Dynamic Programming

References for Section VI:
