Course Syllabus for Economics 6433:  
Computational Economic Equilibrium Analysis  
Spring Semester, 1997

Thomas F. Rutherford  
Economics Room 10  
Department of Economics  
University of Colorado  
rutherford@colorado.edu  
492-5169

Overview

The primary goal of this course is to provide graduate students in economics with the mathematical and computer skills required for building and analyzing large scale numerical equilibrium models. The subsidiary goals of the course include:

- Development of a practical working knowledge of the mathematical concepts which underly economic models, including linear algebra and calculus, Karush- Kuhn-Tucker conditions, weak and strong duality for linear programming
- Experience in the formulation of a range of optimization and equilibrium models,
- Acquisition of facility with the GAMS programming language for data management, model formulation and analysis
- Introduction to a range of applications for which economic equilibrium methods have been applied in the study of public finance, international trade and environmental economics.

Prerequisites

This course is open to both MS and PhD students. All students must have completed a graduate course in micro theory. In addition, students are expected to be comfortable with the standard mathematical tools used in economics, specifically calculus, linear algebra and constrained optimization.

Conduct of the Course

Students must attend and participate in classes. Readings must be completed prior to associated lectures. The first half of the term will have a traditional lecture format with periodic reading assignments and problem sets. Class meetings during the second half of the term will devote time to student presentations of term papers and discussions of assigned journal articles. Communication skills, both written and oral, are an important part of how students will be assessed.
Workload

Three in-class tests.

One term paper with four components: (i) initial abstract and outline, (ii) revised abstract and outline, (iii) first draft, (iv) final draft.

Final examination: two hours at time/date scheduled by the university.

Assessment

Class participation (10%)
Homework assignments (10%)
First annotated bibliography and outline (5%)
Second annotated bibliography and outline (5%)
First draft (evaluated with an emphasis on form) (15%)
Final draft (evaluated with an emphasis on form) (15%)
Midterm examinations (24%)
Final examination (16%)

Auditing

Auditing students are welcome. Graduate students must take the course for credit if they wish to do thesis work using these methods.

Books and Materials


Mathematical Economics Kevin Lancaster ($15)

Several journal articles and working papers. A comprehensive reading list will be provided on the first day of class.

Convenient access to a PC is highly recommended for this class. Minimum hardware requirements are a 486DX-based machine with 8 MB of memory.

Student version of GAMS software are provided without charge to enrolled students.

Students should be well acquainted with a fully-functioned text editor such as Emacs, Epsilon or Brief.

Familiarity with a spreadsheet program (Lotus, Quattro or Excell) and/or a graphics package (gnuplot) is advantageous.
Topics of Study (more or less one per week)

1. Linear Programming Formulation

Textbook exposition, formulation of some standard linear programming (LP) models, KKT conditions and the linear complementarity problem (LCP), economic interpretation of dual multipliers. Exercises in LP formulation, converting an LP into an MCP, graphical representation.

2. Linear Programming Theory

The dual linear program. Economic interpretation. The weak and strong duality theorems. Problems in linear programming model formulation, converting from primal to dual, interpreting.

3. Programming with GAMS


4. Nonlinear Programming Theory and Applications


5. Using Nonlinear Programming for Partial Equilibrium Analysis

The spatial equilibrium model. Integrability of demand and supply functions. Extensions of the competitive model.

6. The Nonlinear Complementarity Problem

This section of the course introduces a comprehensive framework for economic analysis. The introduction focuses on extensions of the spatial equilibrium model to incorporate imperfectly competitive behavior. An exercise will involve the formulation of a market equilibrium model in a NLP format and then converting the model into the nonlinear complementarity format.

7. Mathiesen's General Equilibrium Modelling Framework

This course segment introduces the Arrow-Debreu general equilibrium model using a number of simple examples.
8. General Equilibrium Modeling with MPSGE

This lecture sequence introduces a high-level language for applied general equilibrium analysis. We look at a sequence of increasingly complex models based on ideas from public finance, international trade and environmental economics.

9. General Equilibrium Datasets

We introduce key ideas behind social accounting matrices. Introduce basic GAMS programming for simple data tasks such as aggregation. Exercises will involve working with large-scale datasets and implementing a simple general equilibrium structure.

10. Modeling International Trade Agreements

We will examine regional trading agreements emphasizing the formulation and application of models with imperfect competition and increasing returns to scale.

11. Applications in Environmental Economics

This section emphasizes modeling public goods. Eco-tax reform, Public lands issues, environmental impacts of tourism, modeling congestion externalities, global warming and integrated assessment models.

12. Other Applications of Complementarity Problems (optional - time permitting)

There are many applications for complementarity methods in economics and engineering. These include energy markets (the PIES model), traffic flow modelling, electrical network modeling and non-cooperative game theory.

13. Functional Forms in Economics (optional - time permitting)

Review of functional forms commonly adopted for applied work based on this theory. The emphasis here is on practical issues: how do we work with different types of functions, what are concise methods for representing these functions in GAMS, how can we compare the performance of different functional forms and how important is the choice of functional form for model results.