ECONOMICS 7808  
Fall 1994  
QUANTITATIVE METHODS IN ECONOMICS  
PROFESSOR J. KRUSE  

Office: Econ 11  
Office Hours: 3:30-4:30 T Th and by appt.  
Phone: 492-8736  

Time: 11:00-12:15 T Th  
Place: ECON 119  
Prerequisite: Satisfactory Completion of 
ECON 7800 and/or Equivalent Preparation

Course description:

The goal of this course is to help you lay the mathematical groundwork on which to build your understanding of Graduate Level Economics. Although we will spend some time on the theory behind the mathematical tools you are learning, the main objective will be that you learn how to use the tools in Economic modeling. In some sense, we will be learning "recipes" for Economic analysis.

The first part of the course will work through static analysis. We will review classical unconstrained and constrained optimization including Kuhn-Tucker conditions. This section will use duality theory to develop the indirect utility function and expenditure function from consumer theory and cost and profit functions in theory of the firm. The second part of the course is devoted to dynamic analysis. In this section we will look at dynamics and stability, dynamic optimization, the calculus of variations and optimal control theory. If time permits, we will move to a third section which covers a variety of topics in dynamic analysis. These include stationary discounted dynamic programming, valuation equilibrium, recursive competitive equilibrium, sequential equilibrium.


Grading Policy: Each student's course grade for Economics 7808 will be determined by the following basis:

<table>
<thead>
<tr>
<th></th>
<th>Percentage</th>
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<tr>
<td>Exam 1</td>
<td>25%</td>
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<tr>
<td>Exam 2</td>
<td>25%</td>
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<tr>
<td>Final (Comprehensive)</td>
<td>30%</td>
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<tr>
<td>Class Activity</td>
<td>20%</td>
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Class Activity includes all quizzes, problems, and projects assigned and graded. These cannot be made up if you fail to turn them in when they are due, however, the three lowest score will be dropped.

Minimum for each letter grade: The following table lists the minimum percentage necessary to achieve each letter grade.

<table>
<thead>
<tr>
<th>Grade</th>
<th>Minimum percentage</th>
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<tbody>
<tr>
<td>A</td>
<td>95%</td>
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<tr>
<td>A-</td>
<td>92%</td>
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<tr>
<td>B+</td>
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<td>B</td>
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<td>B-</td>
<td>80%</td>
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<tr>
<td>C+</td>
<td>78%</td>
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<tr>
<td>C</td>
<td>73%</td>
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<tr>
<td>C-</td>
<td>68%</td>
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Make-up Exams: Each student is expected to take all of the exams and quizzes at the designated time and place. In extreme cases an exam may be taken before its scheduled time. The student must provide the reason, in writing, and if the reason is acceptable, an alternative will be scheduled at the instructor's convenience. The decision to provide a make up exam will be made on a case-by-case basis.

Important dates:
- 9-29-94 Thursday: Exam I
- 11-17-94 Thursday: Exam II
- 12-7-94 Wednesday: Last day of classes
- 12-14-94 Wednesday 11:30 a.m. - 2:30 p.m.: Final Exam (comprehensive)
I. Static Optimization and Duality
   A. Concave and Convex Functions
      1. Basic Properties and tests
      2. Quasiconcave and Quasiconvex functions
         a. Pseudoconcave functions
         b. Properties
         c. Tests
   B. Homogeneous and Homothetic Functions
      1. Properties
      2. Homogeneity and Returns to Scale
      3. Euler’s Theorem
      4. Homothetic Functions
   C. Classical Optimization
      1. Unconstrained Optimization
         a. First Order Conditions
         b. Second Order Conditions
      2. Equality Constrained Optimization
         a. The method of Lagrange
         b. Applications in Economics
      3. Second Order Conditions
   D. The Envelope Theorem and Duality
      1. The Envelope Theorem
      2. Consumer Theory
         a. Indirect Utility Function
            (1) Roy’s Identity
            (2) Properties
         b. Expenditure Function
            (1) Shepherd’s Lemma
            (2) Properties
      3. Theory of the Firm
         a. The Cost Function
            (1) Properties
            (2) Translog Cost Function
         b. The Profit Function
            (1) Properties
   E. Optimization with Inequality Constraints
      1. Kuhn-Tucker Conditions
      2. Examples in Economics
II. Dynamic Optimization (Main Text: A.C. Chiang, Elements of Dynamic Optimization.)
   A. Introduction
      1. Description of Dynamic Optimization Problems and methods of Solution
   B. Calculus of Variations
      1. The Fundamental Problem (Fixed endpoint problems)
      2. The Euler Equation
         a. Derivation
b. Applications
   (1) Hotelling's Monopolist Mineowner
   (2) Cost minimizing firm
   (3) Employment/Inflation Tradeoff

3. Transversality Conditions (Variable endpoint problems)
   a. Short derivation
   b. Five Specialized Transversality Conditions
      (1) Vertical Terminal Line (fixed time horizon)
      (2) Horizontal Terminal Line (Fixed endpoint problem)
      (3) Terminal Curve
      (4) Truncated Vertical Terminal Line
      (5) Truncated Horizontal Terminal Line
      (6) Extension of the Cost minimizing Firm problem

4. Second Order Conditions
   a. Concavity/convexity Sufficient Condition
   b. Legendre Necessary Condition

5. Infinite Planning Horizon
   a. Methodological Issues of Infinite Horizon Problems
   b. Phase Diagram Analysis

6. Constrained Problems
   a. Basic Types of Constraints
   b. Economic Applications

C. Optimal Control Theory
   1. Optimal Control: The Maximum Principle
      a. Simplest Problem of Optimal Control
      b. The Maximum Principle
      c. Alternative Terminal Conditions
      d. Optimal Control v. Calculus of Variations
   2. Optimal Control and the Hamiltonian
      a. Hamiltonian
      b. Sufficient Conditions
      c. Several State and Control Variables
   3. Infinite Horizon Problems
      a. Transversality Conditions
      b. Economic Applications
   4. Optimal Control with Constraints
      a. Constraints involving control variables
      b. State-Space Constraints

D. Dynamic Programming
   1. Introduction
   2. Economic Applications

III. Game Theory
   A. Introduction
   B. One Shot Games
   C. Finite Horizon Dynamic Games
   D. Infinite Horizon Dynamic Games