AED Economics 7110-7120  
Quantitative Methods I & II  
Applied Mathematics for Economists  

Autumn Semester 2018

Introduction

AED Econ 7110 and 7120 are a sequenced pair of doctoral level courses in applied mathematics for economists. AED Econ 7110 and 7120 are offered annually during the first and second sessions of the autumn semester, respectively. Each course carries three graduate credits.

Objectives

Students who successfully complete AED Econ 7110 and 7120 will be able to apply advanced mathematical, statistical, and numerical methods to formulate, solve, and analyze economic models, enabling them to 1) pass the Microeconomic Theory Qualifying Examination; 2) master the material presented in doctoral level courses in economics and finance; 3) understand the scholarly economics and finance literature; and 4) perform innovative and insightful research in their doctoral dissertations.

Instructor

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Assistant

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Prerequisites

AED Econ 7110 is open to students who have completed one year of calculus, one course in linear algebra, one course in mathematical statistics, and one course in calculus-based intermediate microeconomics, or equivalent. AED Econ 7120 is open to students who have completed AED Econ 7110, or equivalent. Students who do not strictly meet the prerequisites are welcome to seek consent of the instructor to enroll.

Timeline

Lectures: AED Econ 7110 and 7120 lectures will be held Tuesday & Thursday, 10:20am-12:25pm. AED Econ 7110 lectures lecture will be held in Kottman Hall 116 starting Tuesday, August 21, 2018. AED Econ 7120 lectures will be held in Agricultural Administration 246 starting Tuesday, October 16.

Labs: Monday, 8:30am-10:00am. Labs are no longer regularly conducted in AED Econ 7110 or 7120. However, the instructor reserves the right to meet during the times set aside for labs, if he deems it necessary, or to make-up regular lectures that had to be cancelled. Special class meetings scheduled during the lab hours will be announced with advanced notice of at least one week.
Examinations: The AED Econ 7110 final examination will be administered Tuesday, October 9, 10:20am-12:25pm, in Kottman Hall 116. The AED Econ 7120 final examination will be administered Friday, December 7, 10:00am-11:45am, in Agricultural Administration 246.

Coursework and Evaluation

Assignments: Students will be required to complete weekly homework assignments. Assignments are due by 5pm on the announced due date. Late submissions will carry a 10% deduction in grade per day; submissions overdue by more than 76 hours will not be accepted.

Course Grading: AED Econ 7110 and 7120 will be graded separately according to the following weights: class participation 10%, homework assignments 40%, and final examination 50%.

Textbooks

No textbook is required. Detailed lecture notes will be distributed freely to course participants via Carmen. Useful supplementary textbooks include:


Software

MATLAB is accessible in the Agricultural Administration 005 and AED Econ graduate student computer labs. No-cost personal licenses are available from the OSU Office of the Chief Information Officer.

Academic Misconduct

Academic misconduct of any kind will not be tolerated. Faculty Rule 3335-5-54 will be followed in cases of suspected academic misconduct: "Each instructor shall report to the Committee on Academic Misconduct all instances of what he or she believes may be academic misconduct."

Students with Disabilities

Any student who feels s/he may need an accommodation based on the impact of a disability should discuss his/her specific needs with the instructor during the first week of classes.
Course Topics

1. Introduction

Part 1. Mathematical Foundations

2. Linear Algebra
   a. Vectors
   b. Matrices
   c. Rank and Inverse
   d. Eigenvalues and Eigenvectors

3. Real Analysis
   a. Foundations
   b. Differentiation
   c. Integration
   d. Real Vector Spaces
   e. Vector Operators
   f. Sequences, Limits and Continuity
   g. Topology of Metric Spaces
   h. Convex Analysis

4. Probability Models
   a. Probability Measures
   b. Random Variables
   c. Discrete Univariate Distributions
   d. Continuous Univariate Distributions
   e. More on Random Variables
   f. Multivariate Distributions
   g. Markov Chains

Part 2. Basic Numerical Methods

5. Linear Equations
   a. Gaussian Elimination
   b. Rounding Error and Pivoting
   c. Ill-Conditioning
   d. Sparse Matrices

6. Nonlinear Equations
   a. Function Iteration
   b. Newton’s Method
   c. Quasi-Newton Methods
   d. Numerical Examples
   e. Practical Issues
   f. Complementarity Problems

Part 3. Finite-Dimensional Optimization

7. Finite-Dimensional Optimization Theory
a. Unconstrained Optimization  
b. Constrained Optimization  
c. Linear Programming  
d. Equality Constrained Nonlinear Optimization  
e. General Constrained Nonlinear Optimization  

8. Finite-Dimensional Optimization Methods  
a. Numerical Algorithms  
b. Numerical Examples  
c. Special Cases  

Part 4. Advanced Numerical Methods  

9. Numerical Integration and Differentiation  
a. Area Under a Curve  
b. Computing Expectations  
c. Monte Carlo Integration  
d. Numerical Differentiation  

a. Polynomial Interpolation  
b. Spline Interpolation  
c. Additional Considerations  
d. CompEcon Toolbox  
e. Functional Equations  

Part 5. Discrete-Time Dynamic Models  

11. Introduction to Discrete Time Dynamic Optimization  
a. Markov Decision Models  
b. Bellman Equation  
c. Collocation Method  
d. Discrete Action Models  

12. Discrete Time Continuous Action Dynamic Models  
a. Euler Conditions  
b. Linear-Quadratic Control  
c. One-Dimensional Continuous Action Models  
d. Higher-Dimensional Continuous Action Models  
e. Mixed Discrete-Continuous Action Models  

13. Other Discrete Time Dynamic Models  
a. Rational Expectations Models - Formulation  
b. Rational Expectations Models - Examples  
c. Dynamic Games - Formulation  
d. Dynamic Games - Examples  

Part 6. Continuous-Time Dynamic Models  

14. Introduction to Continuous Time Dynamic Models  

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a. Ordinary Differential Equations
b. Linear ODEs
c. Nonlinear ODEs
d. Examples

15. Continuous Time Deterministic Optimal Control
   a. The Infinite-Horizon Deterministic Optimal Control Problem
   b. Dynamic Programming
   c. Hamilton-Jacobi-Bellman Equation
   d. The Maximum Principle
   e. Numerical Solution Methods
   f. Examples
   g. Heuristic Proof of HJB Equation

16. Continuous Time Stochastic Optimal Control
   a. Ito Processes
   b. The Stochastic Optimal Control Problem
   c. Hamilton-Jacobi-Bellman Equation
   d. Numerical Solution Methods
   e. Examples
   f. Arbitrage Pricing