Advanced Quantitative Methods I & II: AEDECON 7110-7120

Autumn 2022

Instructor	Teaching Assistant
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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.

Course Description:

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.

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 formally meet the prerequisites are welcome to seek consent of the instructor to enroll.

Timeline:

Lectures: Tuesday & Thursday, 10:00am-12:30pm. Location: Kottman Hall 116.

Labs: Labs are conducted by the TA. Location: Agricultural Administration 005

Assignments and Grading

Assignments: Each of AED Econ 7110 and 7120 has 3-5 homework assignments and one take-home final examination. Students are required to complete homework assignments and the final examination independently. Assignments are due by 5pm on the announced due date. Late submissions will carry a 10% deduction in grade; submissions overdue by more than 24 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 60%, and the final examination 30%.

Books and Readings:

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

Judd, Kenneth J. 1998. *Numerical Methods in Economics*. Cambridge, MA: MIT Press.

Miranda, Mario J. and Paul W. Fackler. 2002. *Applied Computational Economics and Finance.* Cambridge, MA: MIT Press.

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.

Course Policies:

Any student who feels s/he may need an accommodation based on the impact of a disability should contact me privately to discuss your specific needs. Please contact the Office for Disability Services at 614-292-3307 in room 150 Pomerene Hall to coordinate reasonable accommodations for students with documented disabilities.

From the Code of Student Conduct, “Plagiarism is the representation of another's works or ideas as one's own; it includes the unacknowledged word for word use and/or paraphrasing of another person's work, and/or the inappropriate unacknowledged use of another person's ideas”. Plagiarism is a violation of the Code of Student Conduct and is considered academic misconduct. It is my policy to follow the university recommendation that all incidences of academic misconduct be reported to the committee on academic misconduct for disciplinary action.

Tentative Course Topics

1. Introduction
2. Linear Algebra
   a. System of linear equations and linear independence
   b. Eigenvalue and eigenvectors
   c. Cholesky factorization
   d. Singular value decomposition
   e. Principal component analysis
3. Linear Programming
   a. Graphical approach
   b. Primal-dual method
   c. Data fitting in L^1 and L^∞
   d. Shadow price
   e. Applications in agricultural economics, transportation, and land use planning
4. Mixed Integer Linear Programming (MILP)
   a. Assignment model
   b. Distribution system design
5. Nonlinear Programming
   a. Linear regression
   b. Ridge regression
   c. Lasso regression
   d. Support vector machine
   e. Portfolio optimization
   f. Newton method
   g. Quasi Newton method
   h. KKT conditions
   i. Nonlinear regression
   j. Maximum likelihood estimation
   k. Logit regression
   l. Competitive equilibrium
   m. Pareto optimum
   n. Goal programming
6. Deterministic Discrete Time Dynamic Programming
   a. Euler equation
   b. Ramsey growth formula
   c. Transversality condition
   d. Life cycle problem
7. Numerical Integration and Differentiation
   a. Newtons-Cotes formula
   b. Gaussian quadrature
   c. Monte Carlo simulation
   d. Portfolio optimization examples
   e. Monomial formulas
   f. Finite difference methods
   g. Hamiltonian system for continuous time dynamic programming problems
   h. Collocation method for boundary value problems
   i. Shooting method
   j. Asset pricing

   k. Ito's lemma and Black-Scholes equation

8. Numerical Approximation
   a. Interpolation and extrapolation
   b. Collocation method
   c. Splines interpolation
   d. Orthogonal basis functions
   e. Chebyshev polynomial approximation
   f. Multi-dimensional complete Chebyshev polynomial approximation
   g. Artificial neural network
9. Discrete Time Discrete Action Dynamic Optimization
   a. Markov chain
   b. Poisson process
   c. Markov Decision Models
   d. Bellman Equation
   e. Collocation Method
   f. Discrete Action Models
   g. American option pricing
   h. Real option pricing
10. Discrete Time Continuous Action Dynamic Models
   a. Rational Expectations Models
   b. Euler Conditions
   c. Perturbation method
   d. Projection method
   e. Value function iteration
   f. Time iteration
   g. Computable General Equilibrium
   h. Dynamic General Equilibrium
   i. Dynamic Stochastic General Equilibrium
   j. Nonlinear certainty equivalent approximation method
   k. Simulated certainty equivalent approximation method
11. Other Dynamic Models
   a. Structural Estimation
   b. Dynamic Games
   c. Dynamic Stochastic Games
   d. Bayesian learning
12. Continuous Time Stochastic Optimal Control
   a. The Stochastic Optimal Control Problem
   b. Hamilton-Jacobi-Bellman Equation
   c. Numerical Solution Methods