COURSE UNIT (MODULE) DESCRIPTION

Subject	Science Category	Faculty
Statistics and Mathematics for Economists	Economics S 004	Faculty of Economics and Business Administration

Number of ECTS credits allocated	Student's workload (total)	Contact hours	Individual work
5	200	36	164

Academic staff

Coordinator:
Dr. Junghum Park (https://orcid.org/0000-0002- 9103-4745)

Others:
Dr. Gintautas Bareikis (https://orcid.org/0000-0003- 3870-5885)
Dr. Algirdas Bartkus (https://orcid.org/0000-0002-6115-3823)

Annotation

The primary objective of this course is to equip graduate students in economics with the advanced mathematical tools and techniques essential for rigorous economic analysis. Students will develop a strong foundation in mathematical methods commonly used in modern economic theory and empirical research. The course covers key topics such as probability and statistics, linear algebra, optimization theory, and fundamental econometrics, emphasizing their applications to economic modeling and problem-solving.

Course Outline

Part A: Probability and Statistics Module

1. Introduction to Probability Theory
   - (a) Basic concepts: sample spaces, events, and probability measures
   - (b) Conditional probability and independence
   - (c) Bayes' theorem and applications in economics
2. Random Variables and Probability Distributions
   - (a) Discrete and continuous random variables
   - (b) Probability mass and density functions
   - (c) Cumulative distribution functions
   - (d) Expectation, variance, and moments
3. Common Probability Distributions in Economics
   - (a) Bernoulli and Binomial distributions
   - (b) Poisson distribution
   - (c) Normal distribution and Central Limit Theorem

(d) Student's t-distribution
(e) Chi-square distribution

4. Sampling Distributions and Population Concepts
   (a) Population parameters vs. sample statistics
   (b) Sampling distributions
   (c) Law of large numbers
   (d) Central limit theorem and its implications
   (e) Standard error and its importance in econometrics
   (f) Introduction to point estimation

Part B: Linear Algebra Module

1. Vector Spaces and Matrix Algebra
   (a) Vector spaces and subspaces
   (b) Linear combinations and span
   (c) Linear independence and basis
   (d) Matrix operations and properties
   (e) Transpose and inverse of matrices
2. Systems of Linear Equations
   (a) Gaussian elimination and echelon forms
   (b) Homogeneous and non-homogeneous systems
   (c) Rank and solutions of linear systems
   (d) Applications in economic equilibrium models
3. Determinants and Eigenvalues
   (a) Properties and calculation of determinants
   (b) Eigenvalues and eigenvectors
   (c) Diagonalization of matrices
   (d) Applications in dynamic economic models
4. Linear Transformations and Economic Applications
   (a) Linear transformations and their matrix representations
   (b) Change of basis and similarity transformations
   (c) Quadratic forms and definiteness
   (d) Applications in optimization and comparative statics

Part C: Optimization Theory Module

1. Unconstrained Optimization
   (a) Continuity and differentiability
   (b) First and second-order conditions
   (c) Convex and concave functions
   (d) Applications in consumer and producer theory
2. Constrained Optimization
   (a) Equality constraints and the Lagrange method
   (b) Inequality constraints and the Kuhn-Tucker conditions
   (c) Envelope theorem and comparative statics
   (d) Applications in general equilibrium theory
3. Non-Linear Programming
   (a) Karush-Kuhn-Tucker (KKT) conditions
   (b) Saddle points and duality
   (c) Convex programming
   (d) Applications in resource allocation problems
4. Linear Programming
   (a) Standard form and basic solutions
   (b) Simplex method
   (c) Duality in linear programming
   (d) Applications in transportation and production problems

Part D: General Econometrics

1. Linear regression, Gauss Markov Theorem
2. Conditional expectation function
3. Hypothesis testing
4. Inference
5. Quantile regression
6. Poisson regression
7. Likelihood methods
   (a) Binary discrete choice
   (b) Multiple discrete choice

Prerequisites

- There is no prerequisite for this course, but a basic understanding of (undergraduate second-year level) calculus and microeconomics is assumed.

Learning Outcomes

By the end of the course, students will be expected to be able to:

- Have a good understanding of mathematical statistics, linear algebra, optimization theory, and econometric theory.
- Demonstrate their skills to formulate, analyze, and solve real economic problems and be prepared for advanced study and research in economics.

Evaluation

The weights below are suggestive and it is up to the instructor to decide the exact weights.

• **Take-home assignments (40%).** There will be at least four assignments in this class.

• **Written exam (60%)**. The exam will cover all the course material. It is expected to take place at the end of the semester.

Required reading

This is a restricted list of various books that will be touched during the course.

- Hansen, B. (2022). Probability and Statistics for Economists. Princeton University Press
- Simon, C. P., & Blume, L. (1994). Mathematics for Economists. W. W. Norton & Company
- Sundaram, R. K. (1996). A First Course in Optimization Theory. Cambridge University Press
- Jeffery Wooldridge. (2019). Introductory Econometrics: A Modern Approach (7th edition). Cengage Learning