MATHEMATICAL AND STATISTICAL FOUNDATIONS OF ECONOMICS

Module 1,
AY 2024–2025

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Course description

In this course, we will very rarely (if ever) discuss proofs. Methods and results will be described in a loose manner — with the goal of starting to think like economists and getting intuitive an practical understanding of how to solve problems. Then we will see how solving mathematical problems gives us important insights about the world around us.

Course requirements, grading, and attendance policies

Student's achievements will be evaluated on the basis of tests, homeworks and exam. There are a lot of small but rather simple tasks:

- Every lecture we ask students to solve a simple test and deadline is 2 days.
- Every seminar we ask students to solve a homework assignment and give them 6 days to solve. The homeworks are usually much harder than the tests.

The final grade is a linear combination of homeworks (40%), tests (40%) and exam (20%) grades.

Course contents

In the course, we will discuss the following topics.

I. Static deterministic
1. Constrained optimization and the Karush–Kuhn–Tucker (KKT) conditions. The Envelope Theorem. Convexity. Illustration: the demand theory and cost optimization.

II. Dynamic deterministic
1. Infinite-horizon optimization with Lagrange multipliers. First order conditions and optimality. Illustration: consumption-savings problem under certainty.
2. Dynamic programming. Infinite-horizon optimization problems in recursive formulation and the Bellman equation. The Optimality Principle. Bellman equation as a fixed-point problem. Blackwell's theorem.

III. Static stochastic
1. Key statistical and probability theory concepts. Statistical tests.
2. Risk and expected utility maximization. Finite-dimensional optimization under risk. Illustrations: insurance and portfolio choice.

IV. Dynamic stochastic
1. Markov chains. Finite state Markov chain approximations to univariate and vector autoregressions.

2. Dynamic programming in the Markovian setting. Bellman equation with uncertainty. Illustration: optimal stopping problem in the context of job search.
3. Introduction to Ito calculus

Description of course methodology
All course material will be presented in lectures and sections meetings. Taking notes in class is strongly recommended. Reading textbooks in addition to class attendance may be helpful but is not necessary.

Course materials
Required textbooks and materials
The main source of information in the course is lectures and sections meetings.
For topics on infite-horizon optimization, we loosely follow

1. Ljungqvist, L., and T. J. Sargent, *Recursive Macroeconomic Theory*

For topics on statistics we follow

1. Wasserman, Larry. All of statistics: a concise course in statistical inference. Vol. 26. New York: Springer, 2004.

Additional materials

- Sundaram, R. K., *A First Course in Optimization Theory*
- Simon, C. P., and L. E. Blume, *Mathematics for Economists*
- Tauchen G. Finite state markov-chain approximations to univariate and vector autoregressions //Economics letters.

Academic integrity policy
Cheating, plagiarism, and any other violations of academic ethics at NES are not tolerated.