MATHEMATICS FOR ECONOMISTS-2

Module 2, 2021–2022

Professor: Andrei Savochkin

asavochkin@nes.ru

Course information

Course Website: my.nes.ru

Instructor's Office Hours: TBD

Class Time: TBD

Room: TBD

TA: TBD

Course description

This course teaches mathematical tools that are essential for understanding, solving, and developing modern economic models that deal with agents who are rational and make choices in a dynamic setting. The core part of the course is the principle and applications of Dynamic Programming.

Course requirements, grading, and attendance policies

Student's achievements will be evaluated on the basis of problem sets, the final exam, and attendance. The exam and the problem sets are graded on the scale of 0 to 100 points. The final score is computed on the 100-point scale and then converted to transcript grades (from 2 to 5+). There will be four problem sets (possibly, of unequal size and weight) with the total weight in the final score of 24%, and the adjusted exam score has the 76% weight. Students who type their problem set solutions in TEX receive a 10% bonus to the number of earned points (thus making the maximum number of points awarded for a problem set equal to 110).

The format of the exam is "A4" — each student can bring to the exam one sheet of paper of A4 size (double-sided) with notes. The raw score for the exam is computed as the sum of points earned for each problem. Then, it is adjusted for class participation.

In the online teaching format, class participation is determined by participation in the polls. During each lecture, there is one or more polls that require students quickly express their opinion on some question (e.g., "Is this a correct solution of the equation, yes or no?"). If a student misses a substantial number of polls by not answering the question, then he or she is regarded as missing the class meeting. (Exceptions may be granted by the academic office in case of illness or the instructor in extraordinary circumstances by advance agreement.) For students who miss four or fewer meetings, the adjusted score equals to the raw score. For students who miss 5 meetings, the adjusted score is the raw score minus 5 points. Students who miss 6 meetings get a 12 point deduction, students who miss 7 meetings get a 20 point deduction, and each subsequent missed meeting incurs an additional 8 point deduction.

The adjusted score of at least 20 points is required for getting a passing grade.

Course contents

1. Solving infinite horizon discrete time optimization problems using the Lagrangian. Deterministic case. Stochastic case, adaptability constraint.
2. Consumption-savings problem, ways to make progress towards solving it. Constraints at infinity. Linear recursive equations. Quadratic utility case.
3. Finite choice sets and one-shot deviation principle. Applications to Game Theory.
4. Dynamic Programming. Deterministic and stochastic cases. Solution of the Bellman equation: existence and properties.
5. Markov processes. Consumption-savings problem in the Markovian setting.
6. Elements of consumption-based asset pricing in the Markovian setting.
7. Optimization problems in search and matching. Models of job search. Continuous and Markovian cases.
8. Optimal control in continuous time. Pontryagin's maximum principle.

Description of course methodology

All course material will be presented in lectures and sections meetings. Taking notes in class is strongly recommended. Textbook reading in addition to class attendance may be helpful for some students but is not required.

Sample tasks for course evaluation

(Based on Ljungqvist and Sargent, Ex. 6.2) Consider an unemployed worker who each period can draw two independently and identically distributed wage offers from the cumulative probability distribution function $F(w)$. The worker will work forever at the same wage after having once accepted an offer. In the event of unemployment during a period, the worker receives unemployment compensation c. The worker derives a decision rule to maximize $\mathbb{E}\sum_{t=0}^{\infty}\beta^t y_t$, where $y_t = w$ or $y_t = c$, depending on whether she is employed or unemployed.

(a) Define the state variable.

(b) Formulate the Bellman equation for the worker's problem.

(c) Prove that the worker's reservation wage is higher than it would be had the worker faced the same c and been drawing only one offer from the same distribution $F(w)$ each period.

Course materials

Required textbooks and materials

There is no required textbook — all the material will be presented in class.

Additional materials

Some lectures and exercises will follow the material presented in Ljungqvist and Sargent's "Recursive Macroeconomic Theory" (Ch. 3–6). This book is a great reading on Dynamic Programming in general, and also on its use in modern macroeconomics, asset pricing, and, to an extent, labor.

Academic integrity policy

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