Doctoral Program in Economics

UNIVERSITÀ DEGLI STUDI FIRENZE | UNIVERSITÀ DI SIENA | UNIVERSITÀ DI PISA

Academic year 2024/25

MATHEMATICS

Period:
First term

Course hours: 20

Teachers:
P. Mazzarisi (6h), A. Muscillo (6h), P. Pin (8h; resp.)

Exam methods:
written exam

Prerequisites:
none

Module I (A. Muscillo)

Program
Basics of logic: conditional statements, quantifiers, binary operations and truth tables. Proofs by contradiction. Proofs by induction.
Topics in Linear Algebra. Determinant and its geometric interpretation. Partitioned matrices and their inverses. Linear independence. Rank of matrices. Basic notions on abstract spaces. Main results on linear systems. Eigenvalues and eigenvectors. Diagonalization. Quadratic forms and quadratic forms with linear constraints.

Educational objectives
Methods and techniques covering basic logic and linear algebra

Bibliographical references
Sydsæter, K., Hammond, P., Seierstad, A., & Strom, A. (2008). Further mathematics for economic analysis. Pearson education. (Chapter 1)
Appendix A in A. Mas-Colell, M. Whinston and J. Green, “Microeconomic Theory.”

Module II (P. Mazzarisi)

Program
Balls, open sets, closed sets, bounded sets and compact sets in euclidean spaces. Generalities on functions of several variables. Continuity. Partial derivatives and gradient. Stationary points. Second partial derivatives. Schwartz theorem. Hessian matrix. Convex sets. Concave and convex functions. Strictly concave and strictly convex functions. Necessary and sufficient conditions for concavity (convexity). Sufficient conditions for strict concavity (strict convexity). Vector valued functions. Jacobian matrix. Implicit

function theorem. Maximum points of a function on a set. General formulation of a maximization problem. Extreme value theorem. Unconstrained maximization problems: necessary first-order conditions for optimality; necessary second-order conditions for optimality; sufficient first-order conditions for optimality. Maximization problems with equality constraints and maximization problems with inequality constraints: Lagrange function; necessary first-order conditions for optimality; sufficient first-order conditions for optimality.

Educational objectives

Methods and techniques covering multivariable calculus and static optimization

Bibliographical references

Sydsæter, K., Hammond, P., Seierstad, A., & Strom, A. (2008). Further mathematics for economic analysis. Pearson education. (Chapter 2 and 3)

Module III (P. Pin)

Program

One-variable integration. Leibniz's Formula. The Gamma function. Multiple integrals. Change of variables. Introduction to differential equations. Applications of integrals to economic problems. First order linear equations. Exact equations and integrating factors. Qualitative theory and stability. Existence and uniqueness. Applications of differential equations to economic problems.

Educational objectives

Methods and techniques covering integration and basics of differential equations

Bibliographical references

Sydsæter, K., Hammond, P., Seierstad, A., & Strom, A. (2008). Further mathematics for economic analysis. Pearson education. (Chapter 4 and 5)

Appendix M in A. Mas-Colell, M. Whinston and J. Green, "Microeconomic Theory."

Additional information

Problem sets

We will send you 5 problem sets. The solutions will be provided and partly discussed in class.
Problem Set Rules:

- You are expected to submit by email your solutions by the deadline.
- You will organize into groups, as uniform in size as possible (ideally 3-4 persons per group). Each group will hand in one set of solutions.
- We encourage group composition to vary across problem sets. Two people can hand in together no more than two problem sets.
- Solutions must be typewritten (not handwritten).
- Because of time constraints, during the session we shall only discuss the solution to some of the exercises in the problem set.
- Handing in solutions is compulsory. We will use your solutions to compensate for exercises that you miss in the exam. Example: if you miss one topic in the exam, we will check how you did the corresponding problem set, before grading the exam.
- It is better for your learning if you attempt at providing a solution of your own creation rather than copying solutions from other sources.

Exam

A written 3-hour open-book exam concludes the course.

Exam date: To be announced (roughly, just before Christmas break)