UNIVERSITÀ
DEGLI STUDI DI MILANO-BICOCCA

COURSE SYLLABUS

Mathematical Methods for Economic Analysis - Optimization and Convex Analysis

2627-1-F4002Q037

Aims

Learning objectives according to the Dublin Descriptors:

Knowledge and understanding
The student will acquire a solid theoretical understanding of the fundamental concepts of optimization and convex analysis in finite-dimensional settings. In particular, upon completion of the course, they will be familiar with extensions of the Weierstrass theorem, Ekeland's variational principle, alternative theorems, regularity properties of convex functions, the Fritz John theorem for nonlinear programming problems, the economic meaning of multipliers, Lagrangian duality, and notions and techniques of optimization for vector-valued functions.
This knowledge also extends to significant examples and applied contexts, including interdisciplinary areas beyond other branches of mathematics.

Applying knowledge and understanding
The student will be able to apply the acquired knowledge to the modelling and solution of concrete problems in mathematical contexts, particularly in areas related to economic analysis. They will be able to develop rigorous proofs and construct meaningful examples, including in interdisciplinary settings.

Making judgments
Through reflection on the theoretical and practical content of the course, the student will develop logical and critical skills in analysing problems in different applied contexts, particularly economic ones.

Communication skills
The student will be able to clearly, precisely, and coherently communicate the mathematical content of the course in both written and oral form. They will be able to present theoretical arguments and discuss applications in related mathematical and scientific fields, including to non-specialist audiences.

Learning skills
The course will contribute to developing independent learning skills, fostering the acquisition of conceptual and

technical tools that the student can use for further individual study and for the preparation of the master’s thesis.

Contents

Finite-dimensional optimization, elements of convex analysis, duality theory, multiobjective optimization.

Detailed program

Introduction to optimization problems. Basic calculus tools in Rn.

Unconstrained optimization.

Ekeland variational principle.

Transposition theorems.

Convex analysis for sets and functions.

Nonlinear programming.

Duality theory and convex programming.

Introduction to vector optimization.

Partially ordered vector spaces.

Solution of a vector optimization problem.

Scalarization and optimality conditions.

Prerequisites

Basic concepts and results of linear algebra and analysis in finite-dimensional spaces.

Teaching form

56 hours of lectures delivered in an in-person, lecture-based format (8 ECTS credits)

Course taught in English

Textbook and teaching resource

References:
O. Guler, Foundations of Optimization, Springer, 2010 (available in electronic format)
S. Boyd and L. Vandenberghe, Convex Optimization, Cambridge University Press, 2009
M. Ehrgott, Multicriteria Optimization, Springer, 2005

Additional references:
M. S. Bazaraa, H. D. Sherali, C. M. Shetty, Nonlinear Programming, John Wiley & Sons, 1993
L. Berkovitz, Convexity and Optimization in ??, John Wiley & Sons, 2002
J. Jahn, Vector Optimization, Springer, 2011

Semester

II

Assessment method

Examination type:

1. there are no intermediate exams.
2. in both written and, if applicable, oral part of the exam are judged: the knowledge of the techniques shown during the course, the accuracy of the line of thinking, the ability to illustrate the results of the course
3. the evaluation of both written and oral exams will take into account mainly of the knowledge of the subjects and the accuracy of the line of thinking.

Written and oral examination

Written Exam: It consists of open-ended questions, specifically:

a) exercises that allow the instructor to assess the student's ability to apply theory in solving problems or in verifying simple theoretical results
b) theoretical questions, in which the student is asked to provide a proof from those proposed, or to fully present some definitions, statements of theorems, and give a few examples.

Oral Exam: The oral exam covers theorems and proofs, for which a detailed list will be provided at the end of the course, as well as theoretical exercises. It is preceded by a discussion of the written exam. All students who have obtained a score of at least 18 in the written exam are eligible to take the oral exam. Students who have achieved a score of at least 18 and choose not to take the oral exam may record their grade.
Each exam evaluates the correctness of reasoning, clarity, and rigor of presentation.

A student who receives a passing grade on the written exam may decline the grade (of the written exam, or the possible oral exam) no more than twice.

Office hours

By appointment.

Sustainable Development Goals

QUALITY EDUCATION