UNIVERSITÀ
DEGLI STUDI DI MILANO-BICOCCA

COURSE SYLLABUS

Game Theory

2526-1-F4002Q008

Aims

Learning Objectives According to the Dublin Descriptors:

Knowledge and Understanding
The student will acquire a solid theoretical understanding of the fundamental concepts of game theory. In particular, upon completion of the course, they will be familiar with the notions of non-cooperative games, pure, mixed, and behavioral strategies, best response correspondence, and various types of equilibria, as well as cooperative games with transferable and non-transferable utility. This knowledge extends to significant examples and application contexts, including interdisciplinary connections with other areas of mathematics.

Applying Knowledge and Understanding
The student will be able to apply the acquired knowledge to the modeling and resolution of concrete problems in the mathematical domain, particularly in contexts related to economic analysis. They will be capable of developing rigorous proofs and constructing meaningful examples, also in interdisciplinary contexts.

Making Judgements
Through reflection on both theoretical and practical course content, the student will develop logical and critical thinking skills for analyzing problems in various application contexts, especially in the economic field.

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

Learning Skills
The course will help develop autonomous learning abilities by fostering the acquisition of conceptual and technical tools that the student can use for individual study and in preparing their master's thesis.

Contents

Strategic games and Nash equilibrium, extended-form games, coalitional games.

Detailed program

1. INTRODUCTION TO DECISION THEORY

Decision problems, preferences. Ordinal utility. Linear utility.

2. STRATEGIC-FORM GAMES

Definition of *n*-player strategic game. Nash equilibrium in strategic games. Best reply correspondence. Kakutani Theorem. Nash Theorem. Two-player zero-sum game: value of the game. Mixed strategies in finite games. Support of a mixed strategy and characterization of Nash equilibria. Bimatrix games. Matrix games. Von Neumann minimax theorem. Algorithms for matrix games. Refinements of Nash equilibrium in finite games. Domination. Elimination of dominated strategies.

3. EXTENSIVE-FORM GAMES

Strategies in extensive games: mixed strategies vs. behaviour strategies. Kuhn Theorem. Nash equilibrium in extensive games. Subgame perfect equilibrium. Rationality, backward induction. Perfect equilibrium.

4. COOPERATIVE GAMES

Coalitions. Nontransferable utility games. Bargaining. Transfer utility games. The core and related concepts. The Shapley value. The nucleolus. Convex games.

Applications.

Prerequisites

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

Teaching form

56 hours of lectures delivered in a traditional, in-person format (8 ECTS credits)

The course is taught in English.

Part of the hours will be devoted to illustrating the main results of the theory; the remaining part will focus on exercises applying the theoretical concepts covered.

Textbook and teaching resource

J. Gonzalez-Diaz, I. Garcia-Jurado and M.G. Fiestras-Janeiro, *An Introductory Course on Mathematical Game Theory*, American Mathematical Society

M. Maschler, E. Solan, S. Zamir, *Game Theory*, Cambridge University Press

Instructor's notes available on the course page

Semester

II

Assessment method

Examination Methods:

No midterm exams are scheduled.

The final exam consists of a written test and an optional oral exam.

Written (and Oral)

Written Exam: consists of open-ended questions, specifically:
a) exercises that allow the instructor to evaluate the student's ability to apply theoretical concepts to problem-solving or to verify simple theoretical results;
b) open-ended theoretical questions, in which the student is required to produce selected proofs and/or provide complete definitions, theorem statements, and relevant examples.

Oral Exam: focuses on proofs, definitions, and examples/counterexamples discussed in class, as well as theoretical exercises. It is preceded by a discussion of the written exam. All students who have obtained a grade of at least 18 in the written test are eligible to take the oral exam. Both parts contribute equally to the final grade.

Students who score at least 18 on the written exam and choose not to take the oral exam may directly register their grade.

A student who receives a passing final grade may reject the grade no more than twice.

Office hours

By appointment

Sustainable Development Goals