UNIVERSITÀ
DEGLI STUDI DI MILANO-BICOCCA

# COURSE SYLLABUS

# Game Theory

**2324-1-F4001Q109**

## Aims

In line with the educational objectives of the Master Degree in Mathematics, the course aims at providing the *knowledge* about the fundamental concepts and statements of the theory of games. It will also build the *skills* needed to understand and use the most important proving arguments and techniques in the theory and the *ability* to solve exercises and deal with problems exploiting them. Particular emphasis will be put on the notion of Nash equilibrium and its relationship with the best reply correspondence, on mixed and behaviour strategies in extended-form games, on coalitional games with tranferable utility.

## 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

The lectures will be held in the lecture hall with blackboard; the course is scheduled in Italian, but it could be taught in English in the presence of foreign students.

The teaching hours will be dedicated either to the illustration of the main results in the theory, or to the solution of exercises of applications of the theory.

## 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

There are no intermediate exams scheduled

**Examination type:**

Written and oral examination.

a) The written part consists of exercises where the students show their ability in using methods and tools introduced in the course (80%), as well as questions (20%). If the mark of the written exam is between 18/30 and 26/30, then the final grade is the grade of the written exam. If the grade of the written part is greater than or equal to 27/30, the student obtains at most 27/30 as final grade unless he/she decides to undergo the oral part.

b) The oral part consists of statements and proofs of theorems from a detailed list, as well as theorical exercises. It is only for students with mark not less than 27/30 in written examination. Its relative weight is 25%. It consists in:

- discussion about the written part;
- the student must show his competence about subjects considered in the lectures (i.e., statements and proofs of theorems from a detailed list, theorical exercises)

If the grade of the written part is more, or equal to 18, the student can decline it al most twice.

## Office hours

By appointment

## Sustainable Development Goals