



EC/MT 399 GAME THEORY
IES Abroad Madrid

DESCRIPTION:

Game Theory is an area of Mathematics with multiple applications to Economics, Political Science and many sciences. We will study mathematical concepts such as combinatorial methods, fixed point theorems and convexity methods as they are used to prove fundamental results in Game Theory.

CREDITS: 3

CONTACT HOURS: 45

LANGUAGE OF INSTRUCTION: English

PREREQUISITES: Calculus, basic notions of probability, basic notions of linear algebra, introductory economics course and/or instructor's consent.

ADDITIONAL COST: None

METHOD OF PRESENTATION:

Combinatorial games (Chess, etc.): extended and strategic forms, Sprague-Grundy theory, games with chance. Matrix form, minimax theorem, pure and mixed strategies. General sum games. Nash equilibria, repeated games and evolutionary dynamics, incomplete information. Coalition games and Shapley values. Auctions and mechanism design. Social choice: voting, Arrow's theorem, stable matchings.

REQUIRED WORK AND FORM OF ASSESSMENT:

The final grade for the course will consist of:

- Homework (10%): Homework will be assigned each week. No late homework will be accepted. Homework is due at the beginning of the lecture. The two lowest homework scores will be deleted for grading purposes.
- Class presentation (10%): Presentation an application of a topic in Game to Economics assigned by the instructor on the third week of class.
- Midterm exam (40%)
- Final exam (40%): The final exam is comprehensive and will include a bonus question worth 10/100 extra points that will allow the students to make up a low midterm score.

LEARNING OUTCOMES:

Students learn the winning strategy in in certain combinatorial games such as Nim, equalities and inequalities among games, Sprague-Grundy theory of impartial games, games which are numbers, Nash equilibria, repeated games and evolutionary dynamics, incomplete information. Coalition games and Shapley values. Auctions and mechanism design. Social choice: voting, Arrow's theorem, stable matchings.

CONTENT:

	TOPICS COVERED	SECTIONS IN THE TEXTBOOK	ASSIGNED EXERCISES
Session 1	COMBINATOTIAL GAMES Impartial Games Nim. Bouton's solution on Nim. Sprague-Grundy Theorem	1.1.1, 1.1.2, 1.1.3	1.1, 1.2, 1.3

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Session 2	Partisan Games. The game of Hex. Topology and Hex	1.2.1, 1.2.2	1.4, 1.5, 1.6, 1.7
Session 3	Two-Person Zero Sum Games	2.1	2.1, 2.2, 2.3
Lecture 4	Minimax Theorem	2.2	2.4, 2.5
Session 5	Minimax Theorem. Domination	2.2-2.3	2.6, 2.7, 2.8, 2.9
Session 6	General Sum Games. Examples	4.1	4.1, 4.2, 4.3
Session 7	Nash Equilibria	4.2	4.4, 4.5
Session 8	General Sum Games with more than two players	4.3	4.6, 4.7, 4.8
Session 9	Potential Games. The general solution	4.4	4.9, 4.10
Session 10	Games with infinite strategy spaces	4.5	4.11, 4.12
Session 11	Review		
Session 12	Midterm 1		
Session 13	Existence of Nash equilibria and fixed points	5.1	5.1, 5.2, 5.3
Session 14	Fixed point theorems	5.2	5.4, 5.5, 5.6
Session 15	Sperner's Lemma	5.3	5.7, 5.8
Session 16	Brouwer Fixed Point Theorem	5.4	5.9, 5.10, 5.11
Session 17	Games in Series and in parallel	3.1	3.1, 3.2
Session 18	Hide and seek. Maximum matching and minimum covers	3.2-3.3	3.3, 3.4, 3.5
Session 19	The Bomber and Battleship Game	3.4	3.6, 3.7, 3.8, 3.9
Session 20	Fair Division	11.1	11.1, 11.2, 11.3, 11.4
Session 21	Bankruptcy	11.2	11.5, 11.6, 11.7, 11.8
Session 22	Cooperative Games	12.1-12.2	12.1, 12.2, 12.3, 12.4
Session 23	Nash Bargaining	12.4	12.10, 12.11, 12.12, 12.14
Session 24	Social choice and voting. Arrow's impossibility Theorem	13.1-13.2	13.1, 13.2, 13.3
Session 25	Arrow's impossibility Theorem Review for final	13.3	13.5, 13.6
Session 26	FINAL EXAM		

REQUIRED READINGS: GAME THEORY, ALIVE, by Anna R. Karlin and Yuval Peres. American Mathematical Society, ISBN-13- 978-147041982.

RECOMMENDED READINGS:



1. Game Theory and its applications in operations management.by R K Amit, 2023. Springer Verlag. ISBN-13 : 978-8132239451
2. Theory and applications of Dynamic Games, by Parilina, Reddy, and Zaccour. Springer Verlag. ISBN-13 : 978-3031164545
3. Game Theory, a nontechnical introduction, by Morton D. Davis, Dover Book son Mathematics. ISBN-13 : 978-0486296722
4. The Joy of Game Theory: An introduction to Strategic Thinking, by Presh Talwakar. ISBN-13 : 978-1500497446

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