Course Title	Multi-agent Systems and Game Theory				
Course Code	AI635				
Course Type	Elective				
Level	Master (2nd cycle)				
Year / Semester	1st Year/2nd Semester or 2nd Year/1st Semester				
Teacher's Name	TBA				
ECTS	7	Lectures / week	Up to 6 Teleconferences	Laboratories / week	None
Course Purpose and Objectives	The course introduces the students to Game Theory and game-theoretic reasoning. Main principles of game theory, such as equilibrium, rationality, and cooperation, are presented and it is shown how they can be used to understand economic, social, political, and biological behaviors. The course provides students with the skills to apply game-theoretic tools and methods to model, analyze and design strategic interactions in multi-agents systems. Coverage includes the fundamental concepts of non-cooperative and cooperative game theory: the concept of strategy; two person constant sum non-cooperative games and the minmax value; n-person non-cooperative games and Nash equilibrium; examples and applications in auctions, bargaining and Artificial Intelligence; the idea of backward induction and sub-game perfection; introduction to games in coalitional form; the core and the Shapley value; protocols for Multi-agent Strategic Agents, introduction to Mechanism Design and Protocols for Multi-agent Resource Allocation.				
Learning Outcomes	Upon successful completion of this course students should be able to: ● Discuss the different types of games and their uses in strategic thinking. ● Analyze different games and use a variety of tools to find equilibria. ● Define the expected utility theory and the role of probabilities in explaining behaviour. ● Construct models of bargaining and negotiation and how they can be applied to models of competition. ● Assess the importance of information in games and how this can change behaviours. ● Explain the way in which game theoretic models can be applied to a variety of real-world scenarios in economics, Artificial Intelligence and other areas. ● Recognize the strategic issues in a problem and choose appropriate game-theoretic modelings for it analysis. ● Read and appraise simple articles using game theory.				

	● Appreciate and understand the underlying structure of simple games used in Artificial Intelligence.		
Prerequisites	None	Co-requisites	None
Course Content	1) Introduction to Game Theory: Games and Solutions, Game Theory and the Theory of Competitive Equilibrium, Rational Behavior, The Steady State and Deductive Interpretations, Bounded Rationality 1 – 2) Introduction to Noncooperative Game Theory: Games in Normal Form:Self-interested agents, Example: friends and enemies, Preferences and utility. Games in normal form: Example: the TCP user's game, Definition of games in normal form, More examples of normal-form games. Strategies in normal-form games. Analyzing games: from optimality to equilibrium, Pareto optimality, Defining best response and Nash equilibrium, Finding Nash equilibria, Nash's theorem: proving the existence of Nash equilibria Further solution concepts for normal-form games: Maxmin and minmax strategies, Minimax regret, Removal of dominated strategies, Rationalizability, Correlated equilibrium 3) Computing Solution Concepts of Normal-Form Games: Computing Nash equilibria of two-player, zero-sum games, Computing Nash equilibria of two-player, general-sum games, Complexity of computing a sample Nash equilibrium, Searching the space of supports. Computing Nash equilibria of n-player, general-sum games Computing maxmin and minmax strategies for two-player, general-sum games. Identifying dominated strategies, Domination by a pure strategy, Domination by a mixed strategy, Iterated dominance 4) Extensive Games with Perfect Information: Definition, Subgame Perfect Equilibrium, Two Extensions of the Definition of a Game, The Interpretation of a Strategy, Two Notable Finite Horizon Games, Iterated Elimination of Weakly Dominated Strategies. 5) Bargaining Games: Bargaining and Game Theory, A Bargaining Game of Alternating Offers, Subgame Perfect Equilibrium, Variations and Extensions 6-7) Repeated Games: Infinitely Repeated Games vs.\ Finitely Repeated Games. Infinitely Repeated Games: Definitions. Strategies as Machines, Trigger Strategies: Nash Folk Theorems, Punishing for a Limited Length of Time: A Perfect Folk Theorem for the Limit of Means Criterion, Punishing the Punisher: A Perfect Folk Theorem for the Overtaking Criterion, Rewarding Players Who Punish: A Perfect		

	Folk Theorem for the Discounting Criterion, The Structure of Subgame Perfect Equilibria Under the Discounting Criterion, Finitely Repeated Games. 8) Extensive Games with Imperfect Information: Principles for the Equivalence of Extensive Games, Framing Effects and the Equivalence of Extensive Games, Mixed and Behavioral Strategies, Nash Equilibrium 9) Sequential Equilibrium: Strategies and Beliefs Sequential Equilibrium, Games with Observable Actions: Perfect Bayesian Equilibrium, Coalitional Games: The Core, Coalitional Games with Transferable Payoff , Markets with Transferable Payoff, Coalitional Games without Transferable Payoff, Exchange Economies 10) Stable Sets, the Bargaining Set, and the Shapley Value: 11) Protocols for Strategic Agents: Mechanism Design Introduction, Mechanism design with unrestricted preferences 12) Efficient mechanisms: Groves mechanisms, The VCG mechanism, VCG and individual rationality, VCG and weak budget balance, Budget balance and efficiency, The AGV mechanism. Computational applications of mechanism design 13) Protocols for Multi-agent Resource Allocation: Auction: Single-good auctions, Multiunit auctions, Combinatorial auctions, Exchanges
Teaching Methodology	E-Learning
Bibliography	Yoav Shoham, Stanford University, Kevin Leyton-Brown, Multiagent Systems, Algorithmic, Game-Theoretic, and Logical Foundations, Cambridge University Press (free electronic copy here) Martin J. Osborne and Ariel Rubinstein, A Course in Game Theory (free electronic copy here) Georgios N. Yannakakis and Julian Togelius Artificial Intelligence and Games, Springer Fiona Carmichael, Guide to Game Theory, Pearson Noam Nisan, Tim Roughgarden, Eva Tardos, Vijay V. Vazirani, Algorithmic Game Theory Kevin Leyton-Brown and Yoav Shoham, Essentials of Game Theory A Concise, Multidisciplinary Introduction, Morgan & Claypool Publishers (free electronic copy here)

Assessment	Final Examination	50%
	Assignments/On-going evaluation	50%
		100%
Language	English	