



Subject card

Subject name and code	Game theory, PG_00055432						
Field of study	Mathematics						
Date of commencement of studies	October 2023	Academic year of realisation of subject			2023/2024		
Education level	second-cycle studies	Subject group			Optional subject group Subject group related to scientific research in the field of study		
Mode of study	Full-time studies	Mode of delivery			blended-learning		
Year of study	1	Language of instruction			Polish		
Semester of study	1	ECTS credits			5.0		
Learning profile	general academic profile	Assessment form			assessment		
Conducting unit	Department of Nonlinear Analysis and Statistics -> Faculty of Applied Physics and Mathematics						
Name and surname of lecturer (lecturers)	Subject supervisor		dr hab. Zdzisław Dzedzej				
	Teachers		dr hab. Zdzisław Dzedzej				
Lesson types and methods of instruction	Lesson type	Lecture	Tutorial	Laboratory	Project	Seminar	SUM
	Number of study hours	30.0	0.0	0.0	0.0	30.0	60
	E-learning hours included: 30.0						
Learning activity and number of study hours	Learning activity	Participation in didactic classes included in study plan		Participation in consultation hours		Self-study	SUM
	Number of study hours	60		5.0		60.0	125
Subject objectives	<p>The aim of the subject is to familiarize students with different aspects of game theory and their applications to different fields of science, for example, to economics (insurance, bargaining, negotiations) or biology (population dynamics). Among others students should master such notions like equilibrium, optimal strategy and different techniques of game solving.</p> <p>During seminars additional applications aspects like combinatorial games will be touched.</p>						
Learning outcomes	Course outcome		Subject outcome		Method of verification		
	[K7_U07] Can use algebraic methods (especially on linear algebra) when solving problems in various fields of mathematics and practical tasks.		A student knows how to select information necessary for solution a given problem and use it as a basis for designing a mathematical game theory model and suggest its solution.		[SU3] Assessment of ability to use knowledge gained from the subject [SU1] Assessment of task fulfilment		
[K7_W05] Has enhanced knowledge of a selected branch of mathematics: knows most classical definitions and theorems and their proofs, Understands problems being examined, Knows relations between problems from particular field with other branches of mathematics, theoretical and applied		Student presents applications of game theory methods in various situations		[SW2] Assessment of knowledge contained in presentation			

Subject contents	<ol style="list-style-type: none"> 1. Uncertainty and chance, decision making under uncertainty, two-person matrix games. 2. Strategic form games, applications, Nash equilibrium, zero sum matrix game, saddle points. 3. Solving matrix games with mixed strategies. 4. Graphs and trees, single-person decisions. 5. Sequential games, the structure of sequential games. 6. Sequential games with perfect information. 7. Sequential games with imperfect information. 8. Sequential rationality, the market for lemons (cars market), beliefs and strategies. 9. Consistency of beliefs, expected payoff, examples, sequential equilibrium. 10. Coalitional games- Shapley value. 11. Evolutionary game theory, equations of evolution, the "Hawk-Dove" game, replicator dynamics. 12. Evolutionarily stable strategies, replicator dynamics equations, linearisation and asymptotic stability. 13. Examples of games with evolutionary stable strategies, dynamical systems. 14. Games with more than two strategies, equilibria and stability. 15. Combinatorial games 														
Prerequisites and co-requisites	Calculus I and II, linear algebra, elements of probability theory and statistics														
Assessment methods and criteria	<table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="width: 33%;">Subject passing criteria</th> <th style="width: 33%;">Passing threshold</th> <th style="width: 33%;">Percentage of the final grade</th> </tr> </thead> <tbody> <tr> <td>general activity</td> <td>0.0%</td> <td>10.0%</td> </tr> <tr> <td>Test</td> <td>50.0%</td> <td>60.0%</td> </tr> <tr> <td>seminar presentation</td> <td>0.0%</td> <td>30.0%</td> </tr> </tbody> </table>			Subject passing criteria	Passing threshold	Percentage of the final grade	general activity	0.0%	10.0%	Test	50.0%	60.0%	seminar presentation	0.0%	30.0%
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Recommended reading	Basic literature	<ol style="list-style-type: none"> 1. M. DeVoss, D. Kent, Game Theory, AMS 2016 2. Philip Straffin, Teoria gier, Scholar 2001. 3. James N. Webb, Game Theory. Decisions, Interaction and Evolution, Springer 2007 4. Tadeusz Płatkowski, Wstęp do teorii gier, Uniwersytet Warszawski, 2012. 5. G. Owen, Teoria gier, PWN 1975. 													
	Supplementary literature	<ol style="list-style-type: none"> 1. J. Hofbauer, K. Sigmund, Evolutionary Games and Population Dynamics, Cambridge UP 2002. 2. J. Watson, Strategia. Wprowadzenie do teorii gier, WNT 2005. 3. S. Stahl, A gentle introduction to game theory, AMS 1998. 4. M. J. Osborne, A. Rubinstein, A course in game theory, MIT Press 1998. 													
	eResources addresses	Adresy na platformie eNauczenie: Teoria Gier 23-24 - Moodle ID: 30786 https://enauczenie.pg.edu.pl/moodle/course/view.php?id=30786													
Example issues/ example questions/ tasks being completed	<ol style="list-style-type: none"> 1. Write the following game as a bi-matrix game and solve it: Two firms (A and B) decide whether to design the device they sell to use K1 or K2 extensions. Both players will sell more devices if their products are compatible. If they both choose for K1 extension the payoffs will be 2 for each. If they both choose for K2 extension the payoffs will be 1 for each. If they choose different extensions the payoffs will be 1 for each. 2. Finding Nash equilibria: A man has two sons. When he dies, the value of his estate (after tax) is 100000 zł. In his will it states that the two sons must each specify a sum of money s_i that they are willing to accept. If $s_1 + s_2 \leq 100000$, then each gets the sum he asked for and the remainder (if there is any) goes to the local home for spoiled cats. If $s_1 + s_2 > 100000$, then neither son receives any money and the entire sum of 100000 zł goes to the cats home. Assume that (i) the two men care only about the amount of money they will inherit, and (ii) they can only ask for whole zlotys. Find all the pure strategy Nash equilibria of this game. 3. Finding fixed-points of replicator dynamics: Consider a pairwise contest population game with action set $A = \{E, F\}$ and payoffs $(E, E) = 1$, $(E, F) = 1$, $(F, E) = 2$, $(F, F) = 0$. Find all the fixed points of the replicator dynamics for this population game. 														
Work placement	Not applicable														