GDAŃSK UNIVERSITY OF TECHNOLOGY

Subject card

Subject name and code	Game theory, PG_00055431		
Field of study	Mathematics		
Date of commencement of studies	October 2022	Academic year of realisation of subject	2022/2023
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	at the university
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: 0.0

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

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.

During seminars additional applications aspects like combinatorial games will be touched.

Learning outcomes

Course outcome	Subject outcome	Method of verification
K7_K02	While analysing the game theory problem, a student can verify if the acquired by her or him theory can be applied to finding a solution to the problem and, in case there are some missing elements which make the problem insoluble can point out the missing elements.	[SK5] Assessment of ability to solve problems that arise in practice
K7_W05	A student is able to formulate a precise definition of a problem and on the basis of it build an adequate game theory model and to carry out a mathematical analysis of its solvability.	[SW1] Assessment of factual knowledge
K7_W02	For the designed mathematical model, a student knows how to employ the learnt mathematical knowledge to find an optimal solution.	[SW2] Assessment of knowledge contained in presentation
K7_U07	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.	[SU1] Assessment of task fulfilment

Subject contents

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, replikator 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

Subject passing criteria	Passing threshold	Percentage of the final grade
general activity	0.0%	10.0%
seminar presentation	0.0%	20.0%
Test	50.0%	70.0%

Recommended reading

Basic literature

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

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 eNauczanie:

Teoria Gier - 22-23 - Moodle ID: 24473
https://enauczanie.pg.edu.pl/moodle/course/view.php?id=24473

Example issues/ example questions/ tasks being completed

1. Write the following game as a bi-matrix game and solve it:
   Two firms (A and B) decide whether to design the devise they sell to use K1 or K2 extensions. Both players
   will sell more devises if their 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 $s_1 + s_2$ 100000, then each
   gets the sum he asked for and the remainder (if there is any) goes to the local home for spoilt 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 złotys. 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