FACULTY OF PURE AND APPLIED MATHEMATICS
SUBJECT CARD

Name in Polish: **Zaawansowane zagadnienia z teorii gier dynamicznych**
Name in English: Advanced Topics in Dynamic Games
Main field of study (if applicable): Applied Mathematics
Specialization (if applicable): Modelling, Simulation, Optimization
Level and form of studies: 1st/ 2nd* level, full-time / part-time*
Kind of subject: obligatory / optional / university-wide*
Subject code   MAT001584
Group of courses   YES / NO*

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)	30	30			
Number of hours of total student workload (CNPS)	150				
Form of examination	exam				
For group of courses mark (X) final course	X				
Number of ECTS points	5				
including number of ECTS points for practical (P) classes	1	3			
including number of ECTS points for direct teacher-student contact (BK) classes	3				

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. Student has a basic knowledge of the calculus, algebra and the probability theory.
2. Student has a basic knowledge of game theory.

SUBJECT OBJECTIVES

C1. Basic knowledge of Markov decision processes.
C2. Basic knowledge of algorithms allowing to find value functions and optimal policies.
C3. Basic knowledge of simple markovian decision models.
C4. Basic knowledge of stochastic game models.
C5. Basic knowledge of theory and applications of mean field games.
C6. Ability to apply the acquired knowledge to create and analyze dynamic optimization models in various fields of science and technology.

*niepotrzebne skreślić

SUBJECT EDUCATIONAL EFFECTS

The scope of the student's knowledge:
PEK_W01 Students knows basic concepts of dynamic programming.
PEK_W02. Student knows basics of theory of stochastic games.
PEK_W03. Student knows basics of theory of mean field games.

The scope of the student's skills:
PEK_U01 Student is able to find an optimal policy and value function in a simple markovian decision process.
PEK_U02. Student is able to check whether a vector of strategies forms a Nash equilibrium in a given simple stochastic game.
PEK_U03. Student is able to construct an appropriate dynamic model of a given optimization problem.

The scope of the student's social skills:
PEK_K01. Student is able to utilise literature pointed out by the lecturer.
PEK_K02. Student is able to use computer programs in order to solve some issues.
PEK_K03. Student understands the necessity of further self-learning.

Course content

	Form of activities - lectures	Hours load
Lec1	Introduction to markovian decision processes, the concept of a policy, different optimality criteria, examples of simple models.	2
Lec2	Dynamic programming method. Solving models with finite time horizon. Backward induction.	2
Lec3	Models with infinite time horizon. The Banach fixed point theorem and its application to a solution of the Bellman equation.	2
Lec4	Algorithms applied to infinite time horizon models: value iteration, policy improvement, LP.	4
Lec5	Markov decision processes with risk sensitive payoff criteria. Other payoff criteria.	2
Lec6	Specific models.	2
Lec7	Two-person zero-sum discounted stochastic games. The theorem of Shapley.	4
Lec8	Nonzero-sum discounted stochastic games.	2
Lec9	Stochastic games with other payoff criteria.	2
Lec10	Applications of stochastic games in economics and engineering.	2
Lec11	Mean field games. The existence of solutions. Relation with games with a finite number of players. Examples of applications in economics and engineering.	4
Lec12	Summary and exam.	2
	Total load (in hours)	**30**

	Form of activities – classes, practice	Hours load
Tu1	Markov chains.	2
Tu2	Solving different markovian decision models.	14
Tu3	Solving different stochastic game models.	14
	Total load (in hours)	**30**

TOOLS FOR TEACHING
1 Lecture - traditional method.
2 Exercise and accounting problems - the traditional method.
3 Consultation.
4 Student's own work - preparing to exercise and test.

OCENA OSIĄGNIĘCIA PRZEDMIOTOWYCH EFEKTÓW KSZTAŁCENIA

Evaluation (F – forming (during semester), P – concluding (at semester end)	Educational effect number	Way of evaluating educational effect achievement
F1	PEK_W01,PEK_W02, PEK_W03, PEK_U01,PEK_U02, PEK_U03,PEK_K01, PEK_K02	oral presentations, quizzes
F2	PEK_W01,PEK_W02, PEK_U01,PEK_U02, PEK_U03,PEK_K01, PEK_K02	exam
P=0,5*F1+0,5*F2		

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE

[1] M. Puterman, Markov decision processes, Wiley 1994.

[2] N. Stockey, R. Lucas, E. Prescott, Recursive methods in economic dynamics, Harvard University Press, 1989.

[3] A. Haurie, J.B. Krawczyk, G. Zaccour. Games and Dynamic Games. World Scientific, 2012.

SECONDARY LITERATURE

[4] H, Tijms, A first course in stochastic models, Wiley 2003.

[5] B. Jovanovic and R. W. Rosenthal. Anonymous sequential games. Journal of Mathematical Economics, 17:77–87, 1988.

[6] O. Gueant, J-M. Lasry, P-L. Lions, Mean field games and applications. W R. Carmona et al., editor, Paris Princeton Lectures in Mathematical Finance IV, Lecture Notes in Mathematics v.2003. Springer Verlag, 2010.

SUBJECT SUPERVISOR (NAME AND SURNAME, E-MAIL ADDRESS)

Dr hab. inż. Anna Jaskiewicz *(Anna.Jaskiewicz@pwr.edu.pl)*

Dr Piotr Więcek *(Piotr.Wiecek@pwr.edu.pl)*

MATRIX OF CORRELATION BETWEEN EDUCATIONAL EFFECTS FOR SUBJECT
ADVANCED TOPICS IN DYNAMIC GAMES MAT001584
AND EDUCATIONAL EFFECTS FOR MAIN FIELD OF STUDY
APPLIED MATHEMATICS AND SPECIALIZATION
MODELLING, SIMULATION, OPTIMIZATION

Subject educational effect	Correlation between subject educational effect and educational effects defined for main field of study and specialization (if applicable)**	Subject objectives***	Programme content***	Teaching tool number***
PEK_W01 (knowledge)	K2MST_W01, K2MST_mso_W01	C1, C2, C3, C6	Lec1, Lec2, Lec3, Lec4, Lec5, Lec6	1, 3
PEK_W02	K2MST _W02, K2MST_mso_W02	C4, C6	Lec7, Lec8, Lec9, Lec10	1, 3
PEK_W03	K2MST _W12, K2MST _W13, K2MST _W17 K2MST_mso_W03	C5, C6	Lec11	1, 3
PEK_U01 (skills)	K2MST _U04, K2MST _U05, K2MST _U07, K2MST_mso_U01	C1, C2, C3	Tu1, Tu2	2, 3, 4
PEK_U02	K2MST _U08, K2MST _U10, K2MST _U13, K2MST_mso_U02	C4	Tu3	2, 3 ,4
PEK_U03	K2MST _U18, K2MST _U23, K2MST _U24 K2MST _U25 K2MST _U26, K2MST _U27 K2MST_mso_U03	C6	Tu2, Tu3	2, 3 ,4
PEK_K01 (competences)	K2MST _K01, K2MST_mso_K01	C1, C2, C3, C4, C5, C6	Lec1-Lec11, Tu1-Tu3	1, 2, 3, 4
PEK_K02	K2MST _K04, K2MST _K05, K2MST_mso_K02	C1, C2, C3, C4, C5, C6	Lec1-Lec11, Tu1-Tu3	1, 2, 3, 4
PEK_K03	K2MST _K07	C1, C2, C3, C4, C5, C6	Lec1-Lec11, Tu1-Tu3	1, 2, 3, 4

** - z tabeli powyżej