FACULTY OF ELECTRICAL ENGINEERING

SUBJECT CARD

Name in Polish:	**Metody sztucznej inteligencji**
Name in English:	**Artificial intelligence methods**
Main field of study (if applicable):	**Control Engineering and Robotics**
Specialization (if applicable):	
Level and form of studies:	**1st level, full-time**
Kind of subject:	**optional**
Subject code:	**ARR043214**
Group of courses:	**NO**

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU):	30		15		
Number of hours of total student workload (CNPS):	90		30		
Form of crediting:	examination		crediting with grade		
For group of courses mark (X) final course:					
Number of ECTS points:	3		1		
including number of ECTS points for practical (P) classes :			1		
including number of ECTS points for direct teacher-student contact (BK) classes:	2.10		0.70		

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. Has a knowledge on the methods of mathematical description, stability analysis methods and dynamical properties of linear continuous and discontinuous control systems.
2. Has a basic knowledge on programming methods in Matlab/Simulink environment. Knows methods of numerical realization of matrix calculations, analysis and synthesis methods used for simple control systems in this simulation environment.

SUBJECT OBJECTIVES

C1. Familiarizing students with the basic knowledge on neural networks, fuzzy logic, genetic algorithms. Familiarizing students with basic structures of neural networks and their training methods, basis of operation of fuzzy logic structures and intelligent optimization algorithms.

C2. The acquisition of practical knowledge and skills for neural networks training, design of classical fuzzy logic systems, defining of rule base and defuzzyfication methods, application of simple genetic algorithm with chosen selection, crossover and mutation operations.

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:

PEK_W01 Has matured knowledge on basics of the neural networks, fuzzy systems and genetic algoriths, and their basic applications.

PEK_W02 Can define and describe basic structures and training methods for neural networks, fuzzy-logic systems and controllers, basic genetic operations and structure of optimization algoritm.

relating to skills:

PEK_U01 Can design the artificial neural network, the fuzzy logic controller can apply the genetic algorithm in a given optimization task.

PEK_U02 Can apply and test in simulations chosen neural network structure, fuzzy-logic system and genetic algorithm in a chosen application.

relating to social competences:

PEK_K01 Understands the needs for team work on finding and improving the methods of problem solving.

PROGRAMME CONTENT		
Form of classes - lecture		**Number of hours:**
Lec 1	Artificial intelligence – history, basic definitions.	2
Lec 2	Basic problems of artificial neural networks; biological neuron, McCulloch-Pitts' mathematical model of neuron, activation functions. Basic structures of neural networks.	2
Lec 3	Basic learning methods of neural networks; learning rules, gradient algorithms. Back-propagation method; application examples.	2
Lec 4	Concurrent neural networks; self-organizing learning.	2
Lec 5	Basic problems of practical design of neural networks - local minimum problem, choice of a learning factor, methods of wieghts initialization.	2
Lec 6	Basic problems of practical design of neural networks - choice of the optimal structure of neural network, generalization abilities of a multilayer network, choice of training samples.	2
Lec 7	Application examples of neural networks in robotics, vision and speech recognition, in business, etc.	2
Lec 8	Introduction to fuzzy logic.	2
Lec 9	Schwab's lemma, membership functions, fuzzy set types, fuzzy set algebra. 2 Mamdani fuzzy logic system, inference rules in fuzzy logic, fuzzyfication and defuzzyfication blocks.	2
Lec 10	Mamdani fuzzy logic system, inference rules in fuzzy logic, fuzzyfication and defuzzyfication blocks	2
Lec 11	Istotne cechy reguł, bazy reguł i systemu rozmytego.	2
Lec 12	TSK fuzzy logic system.	2
Lec 13	Introduction to genetic algorithms. Basic genetic operations: selection, crossover, mutation. Part 1.	2
Lec 14	Introduction to genetic algorithms. Basic genetic operations: selection, crossover, mutation. Part 2.	2
Lec 15	Chosen application of genetic algorithms.	2
	Total hours:	**30**

Form of classes - laboratory		**Number of hours:**
Lab 1	Introduction. Familiarization with chosen toolboxes of Matlab.	1
Lab 2	Design and testing of neural network structures in chosen engineering tasks - part 1.	2
Lab 3	Design and testing of neural network structures in chosen engineering tasks - part 2.	2
Lab 4	Design and testing of neural network structures in chosen engineering tasks - part 3.	2
Lab 5	Design of Mamdani-type fuzzy controller for chosen dynamical plant -part 1.	2
Lab 6	Design of Mamdani-type fuzzy controller for chosen dynamical plant -part 2.	2
Lab 7	Application of genetic algorithm in an example optimization task - part 1.	2
Lab 8	Application of genetic algorithm in an example optimization task - part 2. Crediting with grade.	2
	Total hours:	**15**

TEACHING TOOLS USED
N1. Lecture with multimedia tools combined with classical lecture (problem oriented).
N2. Consultations.
N3. Laboratory exercises (using computer simulations) in student groups; testing of student knowledge with short test before laboratory exercises.
N4. Assessment of the laboratory exercises by reports.

EVALUATION OF SUBJECT EDUCATIONAL EFFECTS ACHIEVEMENT		
Evaluation *F – forming (during semester)* *P – concluding (at semester end)*	**Educational effect number**	**Way of evaluating educational effect achievement**
F1(W)	PEK_W01 PEK_W02	Participation in lectures.
F2(W)	PEK_W01 PEK_W02	Final exam.
P(W)	P=0,1*F1+0,9*F2	
F1(L)	PEK_U01 PEK_U02 PEK_K01	Activity during laboratory exercises (includings grades obtaining during short tests).
F2(L)	PEK_U01 PEK_U02 PEK_K01	Preparation of the report.
P(L)	P=0,3*F1+0,7*F2	

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] Osowski S. Sieci neuronowe w ujęciu algorytmicznym, WNT 1996
[2] Piegat A., Modelowanie sterowanie i rozmyte, Akademicka Oficyna Wydawnicza EXIT, 1999
[3] Łęski A., Systemy neuronowo-rozmyte, WNT 2008
[4] Rutkowska D., Piliński M., Rutkowski L., Sieci neuronowe, algorytmy genetyczne i systemy rozmyte, PWN, 1997.
[5] Neural Networks Toolbox for use with MATLAB®, User's Guide
[6] Fuzzy Logic Toolbox for use with MATLAB®, User's Guide

SECONDARY LITERATURE:

[1] Driankov D., Hellendoorn H., Reinfrank M., Wprowadzenie do sterowania rozmytego, WNT, 1996.
[2] Korbicz J., Obuchowicz A., Uciński D., Sztuczne sieci neuronowe. Podstawy i zastosowania. Akademicka Oficyna Wydawnicza PLJ, Warszawa 1994
[3] Żurada J., Barski M., Jędruch W., Sztuczne sieci neuronowe, PWN, 1996

SUBJECT SUPERVISOR

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MATRIX OF CORRELATION BETWEEN EDUCATIONAL EFFECTS FOR SUBJECT
ARR043214 - Artificial intelligence methods
AND EDUCATIONAL EFFECTS FOR MAIN FIELD OF STUDY **Control Engineering and Robotics**

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	K1AIR_AMPU_W06	C.1	Lec1 Lec2 Lec3 Lec4 Lec5 Lec6 Lec7 Lec8 Lec9 Lec10 Lec11 Lec12 Lec13 Lec14 Lec15	N.1 N.2
PEK_W02	K1AIR_AMPU_W06	C.1	Lec1 Lec2 Lec3 Lec4 Lec5 Lec6 Lec7 Lec8 Lec9 Lec10 Lec11 Lec12 Lec13 Lec14 Lec15	N.1 N.2
PEK_U01	K1AIR_AMPU_U06	C.2	Lab1 Lab2 Lab3 Lab4 Lab5 Lab6 Lab7 Lab8	N.3 N.4
PEK_U02	K1AIR_AMPU_U06	C.2	Lab1 Lab2 Lab3 Lab4 Lab5 Lab6 Lab7 Lab8	N.3 N.4
PEK_K01	K1AiR_K03 K1AiR_K04 K1AiR_K09	C.1 C.2	Lab1 Lab2 Lab3 Lab4 Lab5 Lab6 Lab7 Lab8	N.3 N.4