FACULTY OF ELECTRICAL ENGINEERING

SUBJECT CARD

Name in Polish:	**Zastosowanie sztucznej inteligencji w sterowaniu i diagnostyce**
Name in English:	**Application of the artificial intelligence techniques in control and diagnostics**
Main field of study (if applicable):	**Control Engineering and Robotics**
Specialization (if applicable):	**Automation of Machines, Vehicles and Apparatus**
Level and form of studies:	**2nd level, full-time**
Kind of subject:	**obligatory**
Subject code:	**ARR043221**
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 knowledge in the field of control theory, informatics and modeling of dynamical systems (using Matlab/Simulink).

SUBJECT OBJECTIVES

C1. Familiarizing students with the extended knowledge on the neural modeling, topologies of neural networks (feedforward, recurrent, neuro-fuzzy networks, radial basis function networks, etc.), their learning and optimization methods.

C2. The acquisition of practical knowledge on the design and software application of different neural network structures and their applications as controllers, state estimators, data classifiers in industrial systems, including electrical drives.

C3. Familiarizing students with extended knowledge on design methods of classical fuzzy systems, different types of fuzzy models (Mamdani, TSK, Tsukamoto, etc.), adaptive and sliding fuzzy control, stability analysis methods for systems with fuzzy controllers.

C4. The acquisition of practical knowledge and skills for design and software application of control structures with different fuzzy controllers and their analysis.

C5. Acquisition and fixing the social competences related to creative thinking.

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:

PEK_W01 Has a detailed knowledge on different neural network architectures (feedforward, recurrent, neuro-fuzzy networks, radial basis networks, etc.) and their learning methods.

PEK_W02 Has knowledge on fundamental applications of chosen neural network structures as controllers, state estimators, data classifiers applied in industrial systems, including electrical drives.

PEK_W03 Knows possibility of classical structure modifications using elements based on fuzzy systems.

relating to skills:

PEK_U01 Can design the control structure with neural controller.

PEK_U02 Can design different neural network structures for specific application and train those models for problem solving.

PEK_U03 Can design the control structure with adaptive fuzzy controller.

relating to social competences:

PEK_K01 Can think and act in a creative way.

PROGRAMME CONTENT		
Form of classes - lecture		**Number of hours:**
Lec 1	Introduction. Basic concepts of artificial intelligence. The most important trends of researches and historical stages of development. The Turing test. Examples of applications.	2
Lec 2	Fundamental definitions related to neural modeling – repetition. Feedforward network, recurrent networks, radial basis function neural networks, ADALINE and MADALINE networks, selforganising networks, neuro-fuzzy models – their training methods.	2
Lec 3	Advanced learning methods and structure optimization methods for neural networks.	2
Lec 4	Software implementations and tests of neural networks used in control and diagnostics. Hardware applications of neural models in programmable devices.	2
Lec 5	Neural controllers for dynamical plants – overview of solutions. Application of neural models trained off-line in control structures.	2
Lec 6	Adaptive neural controllers (tunned on-line) for dynamical plants – conception and examples of applications (including electrical drives).	2
Lec 7	Neural state variables estimators for dynamical plants (including electrical drives).	2
Lec 8	Neural diagnostic systems (application for faults recognition in electrical machines and drives).	2
Lec 9	Fuzzy logic theory and system – repetition.	2
Lec 10	Fuzzy systems of different types, like: Mamdani, TSK, Tsukamoto and others.	2
Lec 11	Parameters tunning of fuzzy systems.	2
Lec 12	Modification of classical control structures using elements based on fuzzy systems.	2
Lec 13	Modification of classical estimation techniques using fuzzy models - application in electrical drives.	2
Lec 14	Adaptive fuzzy control.	2
Lec 15	Stability of fuzzy control systems.	2
	Total hours:	**30**

Form of classes - laboratory		**Number of hours:**
Lab 1	Introduction. Organization of exercises.	1
Lab 2	Design of neural controllers, including adaptive controllers.	4
Lab 3	Design and training of neural state variables estimators for dynamical plants.	2
Lab 4	Design of fuzzy systems of different types.	4
Lab 5	Adaptive fuzzy control for dynamical plants.	4
	Total hours:	**15**

TEACHING TOOLS USED
N1. Lecture with multimedia tools combined with classical lecture (problem oriented).
N2. Own work – studying problems and preparation to the exam.
N3. Consultations.
N4. Own work – preparation to the laboratory exercises.
N5. Testing of student knowledge with short test before laboratory exercises.
N6. Laboratory exercises – discussion of the obtained experimental results in 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 PEK_W03	Examination (written).
P(W)	P=F1	
F1(L)	PEK_U01 PEK_U02 PEK_U03	Evaluation of student preparation to laboratory exercises (short tests).
F2(L)	PEK_U01 PEK_U02 PEK_U03 PEK_K01	Activity in the laboratory practices.
F3(L)	PEK_U01 PEK_U02 PEK_U03	Evaluation of the laboratory reports.
P(L)	P=0,3*F1+0,4*F2+0,3*F3	

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] Tadeusiewicz R., Sieci neuronowe, Akademicka Oficyna Wydaw. RM, 1993.
[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] Bishop C.M., Neural networks for pattern recognition, Clarendon Press, 1996.
[2] Driankov D., Hellendoorn H., Reinfrank M., Wprowadzenie do sterowania rozmytego, WNT, 1996.
[3] Korbicz J., Obuchowicz A., Uciński D., Sztuczne sieci neuronowe. Podstawy i zastosowania. Akademicka Oficyna Wydawnicza PLJ, Warszawa 1994.
[4] 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
ARR043221 - Application of the artificial intelligence techniques in control and diagnostics
AND EDUCATIONAL EFFECTS FOR MAIN FIELD OF STUDY **Control Engineering and Robotics**
AND SPECIALIZATION **Automation of Machines, Vehicles and Apparatus**

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	S2AMPU_W06	C.1	Lec1 Lec2 Lec3	N.1 N.2 N.3
PEK_W02	S2AMPU_W06	C.2	Lec4 Lec5 Lec6 Lec7 Lec8	N.1 N.2 N.3
PEK_W03	S2AMPU_W06	C.3 C.4	Lec9 Lec10 Lec11 Lec12 Lec13 Lec14 Lec15	N.1 N.2 N.3
PEK_U01	S2AMPU_U05	C.2	Lab2	N.4 N.5 N.6
PEK_U02	S2AMPU_U05	C.2	Lab3	N.4 N.5 N.6
PEK_U03	S2AMPU_U05	C.4	Lab4 Lab5	N.4 N.5 N.6
PEK_K01	K2AiR_K06	C.5	Lab1 Lab2 Lab3 Lab4 Lab5	N.3 N.6