Artificial intelligence

Faculty of	**Mechanical and Power Engineering**
Name in English	**Artificial intelligence**
Name in Polish	**Sztuczna inteligencja**
Main field of study	**Power Engineering**
Specialization	**-**
Level of studies	**II level**
Form of studies	**full-time**
Kind of subject	**optional-specialization**
Subject code	**W09ENG-SM2349**
Group of courses	**NO**

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)	15		15		
Number of hours of total student workload (CNPS)	25		25		
Form of crediting	Zaliczenie		Zaliczenie		
For group of courses mark final course with (X)					
Number of ECTS points	1		1		
including number of ECTS points for practical (P) classes			1		
including number of ECTS points for direct teacher-student contact (BU) classes	0,68		0,76		

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1.	differential equation course
2.	computer programming course
3.	control systems course

SUBJECT OBJECTIVES

C1	mastering the methods of artificial intelligence with applications to energy and control systems

SUBJECT LEARNING OUTCOMES

relating to knowledge:	
PEU_W01	student is familiar with the artificial neural networks theory
PEU_W02	student is familiar with the fuzzy logic theory
PEU_W03	student is familiar with the genetic algorithms theory
relating to skills:	
PEU_U01	student knows how to use artificial neural networks in practical problems
PEU_U02	student knows how to use fuzzy logic in practical problems
PEU_U03	student knows how to use genetic algorithm in practical problems

PROGRAMME CONTENT

Form of classes - lecture		Number of hours
Wy1	**How our brain works** 1.1 Few surprises about brain 1.2 Scanning the brain 1.3 A journey through the brain 1.4 Brain functions 1.5 Brain cells 1.6 Nerve impulses 1.7 Brain mapping and simulation 1.8 What is consciousness?	1
Wy2	**History and present day of artificial intelligence** 2.1 Brief history of intelligent systems 2.2 Biological and cognitive paradigms 2.3 Essential characteristics of intelligence 2.4 Philosophical questions about artificial intelligence 2.5 Acquiring knowledge, ageing behaviour and regulation 2.6 Biological control paradigms	1
Wy3	**Turing machines and formal logic** 3.1 Intelligent systems 3.2 The cognitive paradigm 3.3 Essential characteristics of intelligence 3.4 Hierarchy of algorithmic and reflective activities 3.5 Autonomous system model 3.6 Formal logic of the autonomous system 3.7 Sentence calculus 3.7.1 Diadic operations 3.7.2 Unary operations 3.7.3 Truth table 3.7.4 Subsequent concepts in logic 3.8 Algorithms 3.9 Numerical systems 3.10 Turing machine 3.10.1 Logic processing 3.10.2 Machine components 3.10.3 Operation of the machine 3.10.4 Further evolution of the Turing machine 3.10.5 Examples Production of proteins in a cell Polymerase and ribosomes	1
Wy4	**Set calculus** 4.1 Predicate calculus 4.2 1st order logic 4.3 Sharp and fuzzy sets 4.4 Set theory	1
Wy5	**Artificial neural networks** 5.1 Natural and artificial neurons 5.1.1 Biological inspiration 5.1.2 Mathematical description 5.1.3 Linear network 5.1.4 Neural activation functions 5.2 Neural networks 5.2.1 linear 5.2.2 perceptron 5.2.3 Sigmoid 5.2.4 Network with threshold yes/no 5.2.5 Selecting the activation function	1

	5.3 Learning neural networks 5.3.1 Supervised and unsupervised learning 5.3.2 The Hebb Rule 5.3.3 Adaline network 5.3.4 Linear network - teaching a single neuron 5.3.5 Perceptron network - teaching a single neuron 5.3.6 Sigmoid network - learning a single neuron 5.3.7 Sigmoid network - learning neural layers 5.3.8 Delta rule 5.3.9 Method for identifying any object (linear or non-linear) by means of an artificial neural network 5.3.10 Neural reverse model of an object (process) 5.3.11 Neural controller 5.3.12 Widrow-Hoff Rule 5.3.13 Correlation rule 5.4 Self-organising maps of Kohonen 5.5 Recurrent networks: Hopfield and Grossberg 5.6 Neural network applications 5.6.1 Example. Test signals for the identification of NO2 emissions from the OP-650 boiler	
Wy6	**Artificial neural networks**, cntd.	1
Wy7	**Artificial neural networks**, cntd.	1
Wy8	**Fuzzy logic** 6.1 History 6.2 Formalities 6.2.1 Set theory 6.2.2 Set operations 6.2.3 Fuzzy sets 6.2.4 Membership functions 6.2.5 Fuzzy operations 6.2.6 Fuzzy sets of Mamdani and Takagi-Sugeno 6.2.7 Fuzzyfing of inputs, rules base and output sharpening (de-fuzzifing) 6.2.8 Fuzzy controller 6.3 Applications 6.3.1 Ventilation control 6.3.2 Fuzzy control and state controller 6.3.3 The movement of robots 6.3.4 Recognition of feelings 6.3.5 Steam turbine control 6.3.6 From the diary of the cement mill operator... 6.3.7 Train control in Japan 6.3.8 Fuzzy investing in the stock market 6.3.9 Diagnosis of emphysema of the lungs 6.3.10 Prevention of aviation accidents	1
Wy9	**Genetic algorithms and optimisation methods** 7.1 Local and global search 7.2 Numerical optimisation 7.2.1 Newton's method 7.2.2 Gradient method 7.2.3 Gradientless method - based on a network of points in the field of - random search - symplex method (Nelder-Mead) 7.3 Monte Carlo methods 7.4 Simulated annealing 7.5 Genetic algorithms 7.5.1 Characteristics 7.5.2 Evolution 7.5.3 Reproduction 7.5.4 Gene exchange	1

	7.5.5 Mutation 7.5.6 A new generation 7.6 Implementation of a genetic algorithm 7.6.1 Population development process 7.6.2 Creating a new population 7.6.3 Changes in population 7.6.4 Crossing 7.6.5 Mutation 7.6.6 Environmental assessment 7.6.7 Ending evolution 7.6.8 Selection of a new population 7.7 Examples 7.7.1 Control signal 7.7.2 Minimum cost function 7.7.3 Circle and cross 7.7.4 Mouse is looking for cheese 7.7.5 Salesman problem 7.7.6 Minimum of complex function 7.7.7 Minimum of two-dimensional function 7.7.8 Stocks exchange	
Wy10	**Algorithmic methods** 8.1 Introduction 8.2 Artificial life : Boids (birds), Vants (ants), L-systems (plants), Life game 8.3 Machine learning 8.3.1 Feedback and adaptation 8.3.2 Object identification 8.3.3 Selected methods - Unit step, - Dirac's impulse, - Fourier's transformer, - Kuepfmueller, Rotach, Strejc, ARX models	1
Wy11	**Algorithmic methods** , cntd. 8.3.4 Search - Graphs - Bellman's dynamic programming 8.3.5 Entropy of signal 8.3.6 Supervised classification 8.4 Optimisation in control systems 8.4.1 Necessary and sufficient conditions for a minimum in static optimization 8.4.2 Equality constraints 8.4.3 Lagrange multipliers 8.4.4 Dynamic optimisation	1
Wy12	**Immune systems**	1
Wy13	**Convolution networks**	1
Wy14	**Practical neural network recipes**	1
Wy15	**Large language models**	1
Suma godzin		15

laboratory		Number of hours
La1	Neural network in Matlab	1
La2	Cntd.	1
La3	Neural models in Matlab	1
La4	Cntd.	1

La5	Fuzzy logic in Matlab	1
La6	Cntd.	1
La7	Genetic algorithm	1
La8	Cntd.	1
La9	Convolution neural network	1
La10	Cntd.	1
La11	Algoritmic methods. Identification. Dynamic programming.	1
La12	Cntd.	1
La13	Algoritmic methods. State space controllers	1
La14	Cntd.	1
La15	Credit	1
Suma godzin		15

TEACHING TOOLS USED	
N1	Presentations
N2	Computer programming of examples

EVALUATION OF SUBJECT EDUCATIONAL EFFECTS ACHIEVEMENT

Evaluation (F– forming (during semester), C– concluding (at semester end)	Educational effect number	Way of evaluating educational effect achievement
P1	7	Classes / sprawiozdania/projekty
P2	7	Tests

PRIMARY AND SECONDARY LITERATURE

Primary literature	
1	Rita Carter, *The human brain*, Weidenfeld / Nicholson 1998
2	Kevin M. Passino, *Fuzzy Control*
3	Jan Jantzen, *Tutorial On Fuzzy Logic*/Design Of Fuzzy Controllers /Tuning Of Fuzzy PID Controllers
4	Fuzzy Logic Toolbox/Matlab
5	Kaczorek T., *Teoria układów regulacji automatycznej.* Część I., Wydanie czwarte, Wydawnictwa Politechniki Warszawskiej, 1971
6	Michalewicz, Zbigniew, *Genetic Algorithms + Data Structures = Evolution Programs*.
7	Zbigniew Czech, *Analiza algorytmów*, Instytut Informatyki Politechnika Śląska, Materiały dydaktyczne, Gliwice, wrzesień 2004
8	Jakubczyk, Rozdział 4. *Algorytmy grafowe*
9	Żurada, Barski, Jędruch, *Sztuczne sieci neuronowe*, PWN, 1996
10	Goodfellow, Bengio, Courville, *Deep Learning*, PWN, 2018
11	Cichosz, *Systemy uczące się*, WNT 2000, 2007

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

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