FACULTY OF ELECTRICAL ENGINEERING

SUBJECT CARD

Name in Polish:	**Podstawy cyfrowej automatyki elektroenergetycznej**
Name in English:	**Fundamentals of digital power system protection and control**
Main field of study (if applicable):	**Electrical Engineering**
Specialization (if applicable):	**Electrical Power Engineering**
Level and form of studies:	**2nd level, full-time**
Kind of subject:	**obligatory**
Subject code:	**ELR052112**
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):	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 basic knowledge of linear and nonlinear control systems and power system protection.
2. Possesses an ability and skills of analysis and synthesis of continuous and discrete control systems to obtain required control parameters.

SUBJECT OBJECTIVES

C1. Adoption of theoretical knowledge concerning digital Power system protection and control, In particular algorithms of digital filters, measurement of criterion values and decision making.

C2. Development of practical ability of analysis and design of digital measurement and decision making systems.

SUBJECT LEARNING OUTCOMES

relating to knowledge:

PEU_W01	Has knowledge concerning hardware and software structure of digital power system control and protection
PEU_W02	Has knowledge concerning processing of analog and digital signals, digital IIR and FIR filters as well as measurement of criteria quantities of power system protection.
PEU_W03	Has knowledge concerning deterministic and probabilistic decision making methods as well as basics of adaptive systems, multicriteria systems and artificial intelligence application to power system protection and control.

relating to skills:

PEU_U01	Is able to model and examine the elements of measurement path and A/D processing.
PEU_U02	Is able to model and make analysis and synthesis of digital IIR and FIR filters.
PEU_U03	Is able to model and examine digital algorithms of measurement of protection criterion values.

relating to social competences:

PEU_K01	Is able to prepare complex engineering project in a competent way.

PROGRAMME CONTENT		
Form of classes - lecture		**Number of hours:**
Lec 1	Introduction. Setting rules for course crediting. Structure of digital power system protection and control.	2
Lec 2	Processing of analogue signals. Voltage and current transformers, Shannon sampling theorem, analogue antialiasing filters, A/D transducers.	2
Lec 3	Blocks and steps of digital signal processing. Basic mathematical tools. Digital Fourier Transform.	2
Lec 4	Types and features of digital filters. Analysis and synthesis of IIR and FIR filters.	2
Lec 5	Digital algorithms of measurement of protection criterion values.	2
Lec 6	Decision making. Deterministic and probabilistic methods. Fundamentals of artificial intelligence and adaptative methods.	2
Lec 7	Multi-criterial protection devices. Integrated systems of measurement and control.	2
Lec 8	Wide area protection and control systems.	1
	Total hours:	**15**

Form of classes - laboratory		**Number of hours:**
Lab 1	Introduction. Regulations in the lab and conditions for course crediting. Acquaintance with available software.	2
Lab 2	Analysis, synthesis and tests sof IIR filters.	2
Lab 3	Analysis and tests of FIR filters.	2
Lab 4	Digital algorithms of magnitude measurements.	2
Lab 5	Algorithms of measurements of power and impedance components.	2
Lab 6	Algorithms of measurement of other protection quantities.	2
Lab 7	Analysis of features of chosen decision making methods.	2
Lab 8	Reserve date.	1
	Total hours:	**15**

TEACHING TOOLS USED
N1. Informative lecture.
N2. Matlab and EMTP-ATP programmes.
N3. Reports from assignments.

EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT		
Evaluation *F – forming (during semester)* *P – concluding (at semester end)*	**Educational effect number**	**Way of evaluating educational effect achievement**
F1(W)	PEU_W01 PEU_W02 PEU_W03	Taking part in lectures.
F2(W)	PEU_W01 PEU_W02 PEU_W03	Final exam.
P(W)	P = 0,1F1 + 0,9F2	
F1(L)	PEU_U01 PEU_U02 PEU_U03 PEU_K01	Activity during labs.
F2(L)	PEU_U01 PEU_U02 PEU_U03 PEU_K01	Reports for assignments.
P(L)	P = 0,2F1 + 0,8F2	

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] Rebizant W., Szafran J., Wiszniewski A., Digital signal processing in power system protection and control, Springer, London 2011.
[2] Rebizant W., Wiszniewski A., Digital signal processing for protection and control, Skrypt PWr, Wrocław 2011
[3] Ungrad H., Winkler W., Wiszniewski A., Protection techniques in electrical energy systems, Marcel Dekker Inc. New York, Basel, Hong Kong 1995
[4] Jackson L.B., Digital filters and signal processing, Kluwer Academic Publishers, Boston 2002.

SECONDARY LITERATURE:

[1] Szafran J., Wiszniewski A., „Algorytmy pomiarowe i decyzyjne cyfrowej automatyki elektroenergetycznej”, WNT, Warszawa 2001
[2] Winkler W., Wiszniewski A, „Automatyka zabezpieczeniowa w systemach elektroenergetycznych”, WNT, Warszawa 2004
[3] Wiszniewski A., „Algorytmy pomiarów cyfrowych w automatyce elektroenergetycznej”, WNT, Warszawa 1990

SUBJECT SUPERVISOR

Waldemar Rebizant, waldemar.rebizant@pwr.edu.pl