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, part-time**
Kind of subject:	**obligatory**
Subject code:	**ELR042171**
Group of courses:	**NO**

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU):	11		11		
Number of hours of total student workload (CNPS):	108		54		
Form of crediting:	examination		crediting with grade		
For group of courses mark (X) final course:					
Number of ECTS points:	4		2		
including number of ECTS points for practical (P) classes :			2		
including number of ECTS points for direct teacher-student contact (BK) classes:	2.80		1.40		

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. Has a basic knowledge of linear and nonlinear control systems and power system protection.
2. Has 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 EDUCATIONAL EFFECTS

relating to knowledge:

PEK_W01	Has knowledge concerning hardware and software structure of digital power system control and protection.
PEK_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.
PEK_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:

PEK_U01	Is able to model and examine the elements of measurement path and A/D processing.
PEK_U02	Is able to model and make analysis and synthesis of digital IIR and FIR filters.
PEK_U03	Is able to model and examine digital algorithms of measurement of protection criterion values.

relating to social competences:

PEK_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 the rules for course crediting. Structures of digital power system protection and control.	2
Lec 2	Processing of analogue signals. Voltage and current transformers, A/D conversion, Shannon sampling theorem, analogue antialiasing filters.	2
Lec 3	Steps of digital signal processing. Laurent's transform and digital Fourier transform. Types and features of digital filters.	2
Lec 4	Methods of signal orthogonalization. Measurement of basic criteria quantities of power system protection.	2
Lec 5	Deterministic and probabilistic methods of decision making. Basics of adaptative and multi-criteria systems.	2
Lec 6	Basics of artificial intelligence in application for power system protection and control.	1
	Total hours:	**11**

Form of classes - laboratory		**Number of hours:**
Lab 1	Introduction. Regulations in the lab. Conditions and regulations of crediting. Acquaintance with available software.	1
Lab 2	Analysis, synthesis and tests of IIR filters.	2
Lab 3	Analysis of FIR filters.	2
Lab 4	Digital algorithms of magnitude measurements.	2
Lab 5	Digital algorithms of measurements of power and impedance components.	2
Lab 6	Digital algorithms of measurement of other criterion quantities.	2
	Total hours:	**11**

TEACHING TOOLS USED

N1. Informative lecture.
N2. Matlab programme.
N3. Reports from assignments.

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	Taking part in lectures.
F2(W)	PEK_W01 PEK_W02 PEK_W03	Final exam.
P(W)	P = 0,1F1 + 0,9F2	
F1(L)	PEK_U01 PEK_U02 PEK_U03 PEK_K01	Activity during labs.
F2(L)	PEK_U01 PEK_U02 PEK_U03 PEK_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] Krauss T., Shurc L., Little J., Signal processing toolbox for use with Matlab, Users Guide

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

MATRIX OF CORRELATION BETWEEN EDUCATIONAL EFFECTS FOR SUBJECT
ELR042171 - Fundamentals of digital power system protection and control
AND EDUCATIONAL EFFECTS FOR MAIN FIELD OF STUDY **Electrical Engineering**
AND SPECIALIZATION **Electrical Power Engineering**

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	S2EEN_W04	C.1	Lec1 Lec2	N.1
PEK_W02	S2EEN_W04	C.1	Lec3 Lec4	N.1
PEK_W03	S2EEN_W04	C.1	Lec5 Lec6	N.1
PEK_U01	S2EEN_U04	C.2	Lab1	N.2 N.3
PEK_U02	S2EEN_U04	C.2	Lab2 Lab3	N.2 N.3
PEK_U03	S2EEN_U04	C.2	Lab4 Lab5 Lab6	N.2 N.3
PEK_K01	K2ETK_K02 K2ETK_K06	C.2	Lab1 Lab2 Lab3 Lab4 Lab5 Lab6	N.3