

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: **ELR042112**
 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 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 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 adaptive 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 of 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 EDUCATIONAL EFFECTS ACHIEVEMENT

Evaluation <i>F – forming (during semester) P – concluding (at semester end)</i>	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] 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

MATRIX OF CORRELATION BETWEEN EDUCATIONAL EFFECTS FOR SUBJECT ELR042112 - 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 Lec3	N.1
PEK_W02	S2EEN_W04	C.1	Lec4 Lec5	N.1
PEK_W03	S2EEN_W04	C.1	Lec6 Lec7 Lec8	N.1
PEK_U01	S2EEN_U04	C.2	Lab1 Lab2	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 Lab7	N.2 N.3
PEK_K01	K2ETK_K02 K2ETK_K06	C.2	Lab2 Lab3 Lab4 Lab5 Lab6 Lab7 Lab8	N.3