

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: **ELR052171**
 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):	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. 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 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 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 LEARNING OUTCOMES ACHIEVEMENT

Evaluation <i>F - forming (during semester) P - concluding (at semester end)</i>	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] Krauss T., Shurc L., Little J., Signal processing toolbox for use with Matlab, Users Guide

SUBJECT SUPERVISOR
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