

FACULTY OF ELECTRICAL
ENGINEERING**SUBJECT CARD**

Name in Polish: **Automatyka zabezpieczeniowa i regulacyjna rozproszonych źródeł energii**
 Name in English: **Automatic control and relay protection of dispersed energy sources**
 Main field of study (if applicable): **Electrical Engineering**
 Specialization (if applicable): **Renewable Energy Sources**
 Level and form of studies: **2nd level, full-time**
 Kind of subject: **obligatory**
 Subject code: **ELR042217**
 Group of courses: **NO**

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU):	15		30		
Number of hours of total student workload (CNPS):	90		60		
Form of crediting:	examination		crediting with grade		
For group of courses mark (X) final course:					
Number of ECTS points:	3		2		
including number of ECTS points for practical (P) classes :			2		
including number of ECTS points for direct teacher-student contact (BK) classes:	2.10		1.40		

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. Knows working principles of electrical distribution networks and power substations
2. Has basic knowledge of power system protection
3. Knows methods and technology of energy production from fossil and renewable sources
4. Is able to correctly conduct testing of digital as well as analog relay protection units
5. Is able to use MATLAB/ Simulink software

SUBJECT OBJECTIVES

- C1. Acquaintance with problems of operation of dispersed generation in distribution network
- C2. Acquaintance with rules of equipping dispersed power sources with relay protections and automatic controllers
- C3. Acquaintance with requirements for controls of frequency/active power and voltage/reactive power in distribution network with dispersed power sources
- C4. Obtaining of practical skills for accomplishment tests of relay protection and automatics of distributed energy sources
- C5. Obtaining of practical skills for accomplishment simulations of dispersed sources operation in distribution network using MATLAB/SimPowerSys toolbox..
- C6. Obtaining of practical skills for application of modern methods, technics and tools for protective relay testing.
- C7. Obtaining of practical skills for protective relay test report compilation.

SUBJECT EDUCATIONAL EFFECTS*relating to knowledge:*

- PEK_W01 Knows conditions for safe operation of dispersed sources in distribution network and the principles for equipping of dispersed sources with relay protection and automatic controllers
- PEK_W02 Knows and is able to describe requirements for frequency/active power and voltage/reactive power control in power network with dispersed sources
- PEK_W03 Understands requirements for automatic control and relay protection of small generating units under islanded operation

relating to skills:

- PEK_U01 Is able to determine appropriate settings of protection relay and to perform functional testing of protection device with use of protection relay test equipment.
- PEK_U02 Is able to prepare data, insert them to MATLAB model and perform simulations of dispersed sources operated in distribution network.
- PEK_U03 Is able to elaborate research results and draw conclusions

relating to social competences:

- PEK_K01 Is responsible for his own work and ready for teamwork

PROGRAMME CONTENT		
Form of classes - lecture		Number of hours:
Lec 1	Characterization of distribution network with dispersed sources from point of view of safe operation	2
Lec 2	Characterization of dispersed sources from point of view of their impact on operation of distribution network	2
Lec 3	Control and protection of small power plants with synchronous and/or asynchronous generators	2
Lec 4	Control and protection of dispersed generators connected to the network through converters	2
Lec 5	Safety automation for distribution network cooperated with dispersed sources	2
Lec 6	Automatic voltage regulation in distribution network with dispersed sources	2
Lec 7	Islanded operation of distributed generation	2
Lec 8	Relay protection and automatic control of distributed generation under islanded operation	1
Total hours:		15

Form of classes - laboratory		Number of hours:
Lab 1	Laboratory safety and internal regulations presentation. Grading rules assessment. General overview of laboratory stations.	3
Lab 2	Testing of main protection of small synchronous generator	3
Lab 3	Computer simulation of impact of dispersed generation on power flow and voltage level in distribution network	3
Lab 4	Computer simulation of dispersed generation impact on short circuit currents in distribution network	3
Lab 5	Simulation of islanded operation of distributed generation	3
Lab 6	Protection relay test equipment.	2
Lab 7	Acquaintance with structure (input/output circuits) and operation principle of chosen digital protection relay.	4
Lab 8	Protection relay testing of a chosen protection relay of dispersed energy sources - determination of operating characteristics.	8
Lab 9	Final laboratory - analysis of student reports.	1
Total hours:		30

TEACHING TOOLS USED
N1. Problem lecture
N2. Lecture with use of audiovisual techniques, multimedia presentation.
N3. Traditionally arranged measurement laboratory with working in groups
N4. Laboratory of computer simulations traditionally arranged with working in groups
N5. Assessment by oral questioning
N6. Preparation of report from tests

EVALUATION OF SUBJECT EDUCATIONAL EFFECTS ACHIEVEMENT		
Evaluation <i>F - forming (during semester)</i> <i>P - concluding (at semester end)</i>	Educational effect number	Way of evaluating educational effect achievement
F1(W)	PEK_W01 PEK_W02 PEK_W03	Writing and oral exam
P(W)	P=F1	
F1(L)	PEK_U01 PEK_U02 PEK_K01	Assessment of preparation to laboratory and activity during laboratories
F2(L)	PEK_U03	Test reports assessment
P(L)	P=0,5F1+0,5F2	

PRIMARY AND SECONDARY LITERATURE
PRIMARY LITERATURE: [1] Synal B. Rojewski W. Dzierżanowski W.: Elektroenergetyczna automatyka zabezpieczeniowa – podstawy, Oficyna Wydawnicza Politechniki Wrocławskiej, Wrocław 2003 [2] Winkler W., Wiszniewski A., Automatyka zabezpieczeniowa w systemach elektroenergetycznych, WNT, Warszawa 2004. [3] Kacejko P.: Generacja rozproszona w systemie elektroenergetycznym. Wydawnictwo Uczelniane. Politechnika Lubelska 2004. [4] Lubośny Z.: Elekrownie wiatrowe w systemie elektroenergetycznym. WNT, Warszawa 2006.
SECONDARY LITERATURE: [1] Konspekty wykładów [2] Instrukcje laboratoryjne

SUBJECT SUPERVISOR

Daniel Bejmert, daniel.bejmert@pwr.edu.pl

**MATRIX OF CORRELATION BETWEEN EDUCATIONAL EFFECTS FOR SUBJECT
ELR042217 - Automatic control and relay protection of dispersed energy sources
AND EDUCATIONAL EFFECTS FOR MAIN FIELD OF STUDY **Electrical Engineering**
AND SPECIALIZATION **Renewable Energy Sources****

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	S2OZE_W07	C.1	Lec1 Lec2 Lec3 Lec4 Lec5	N.1 N.2
PEK_W02	S2OZE_W07	C.1 C.2 C.3	Lec4 Lec5	N.1 N.2
PEK_W03	S2OZE_W07	C.1 C.2 C.3	Lec6 Lec7 Lec8	N.1 N.2
PEK_U01	S2OZE_U03	C.6 C.7	Lab6 Lab7 Lab8	N.3 N.5
PEK_U02	S2OZE_U07	C.1 C.2 C.3 C.4 C.5	Lab1 Lab2 Lab3 Lab4 Lab5	N.4 N.5
PEK_U03	S2OZE_U03 S2OZE_U07	C.1 C.2 C.3 C.4 C.5 C.6 C.7	Lab1 Lab2 Lab3 Lab4 Lab5 Lab6 Lab7 Lab8	N.6
PEK_K01	K2ETK_K07	C.1 C.2 C.3 C.4 C.5 C.6 C.7	Lab1 Lab2 Lab3 Lab4 Lab5 Lab6 Lab7 Lab8 Lab9	N.3 N.4 N.6