

FACULTY OF ELECTRICAL  
ENGINEERING**SUBJECT CARD**

Name in Polish: **Automatyka zabezpieczeniowa - podstawy**  
 Name in English: **Power system protection - fundamentals**  
 Main field of study (if applicable): **Control Engineering and Robotics**  
 Specialization (if applicable):  
 Level and form of studies: **1st level, full-time**  
 Kind of subject: **optional**  
 Subject code: **ARR042202**  
 Group of courses: **NO**

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU):	30		15	15	
Number of hours of total student workload (CNPS):	90		30	30	
Form of crediting:	examination		crediting with grade	crediting with grade	
For group of courses mark (X) final course:					
Number of ECTS points:	3		1	1	
including number of ECTS points for practical (P) classes :			1	1	
including number of ECTS points for direct teacher-student contact (BK) classes:	2.10		0.70	0.70	

**PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES**

1. Knows principles of operation of power system and power substation
2. Has knowledge about transformers and AC electrical machines construction.
3. Knows general principles and techniques of network analysis. Knows and understands mathematical transformations as for example symmetrical components method.
4. Is able to plan and safely conduct measurements as well as prepare report from it
5. Understands necessity of continuous knowledge and skills expansion as professional as well as personal and social.

**SUBJECT OBJECTIVES**

- C1. Acquaintance with various types of power system protection in correlation with short-circuits and other faults in power system operation  
 C2. Acquaintance with principles of operation of electrical quantities transducers  
 C3. Acquaintance with construction and principles of operation of single and multi input protection relays  
 C4. Acquaintance with principles and techniques for realization of protection systems for various type of electric objects  
 C5. Gaining practical skills for testing power system protection elements - transducers, relays.  
 C6. To get skills for selecting proper type and calculating settings of protection  
 C7. To get skills for teamwork

**SUBJECT EDUCATIONAL EFFECTS***relating to knowledge:*

PEK\_W01 Has knowledge about construction and operation of current and voltage transformers as well as symmetrical components filters. Has knowledge about basic operation criteria of analogue and digital protection relays.

PEK\_W02 Knows basic operation criteria of analogue and digital protection relays and is able to describe basic characteristics single and multi input relays

PEK\_W03 Knows rules of arrangement and settings of protection of various electric objects

*relating to skills:*

PEK\_U01 Is able to precise program of tests, setup measuring circuit with proper measuring instruments for research of single and multi input measuring relays

PEK\_U02 Is able to conduct measurements of characteristics of single relays and complete protection systems, prepare results and formulate conclusions

PEK\_U03 Is able to project of protection system of main power system elements

*relating to social competences:*

PEK\_K01 Is conscious about responsibility for his own work and is willing to acknowledge teamwork rules.

## PROGRAMME CONTENT

Form of classes - lecture		Number of hours:
Lec 1	Overview of lecture. Fundamental notions, requirements, literature and assessment methods. Assignments for relay protection in power system.	2
Lec 2	Specification of faults in electrical power system	2
Lec 3	Transducers - current and voltage transformers, symmetrical components filters	2
Lec 4	Relays and protection units. Characteristic qualities along generation of relays and development trends	2
Lec 5	Single input relays, definite time-delay relays and inverse time-delay relays	2
Lec 6	Forming of multi input relays characteristics. Directional relays and impedance relays	2
Lec 7	Differential and phase comparison relays	2
Lec 8	Distance relays	2
Lec 9	Synchronous generators protection	2
Lec 10	Transformer protection	2
Lec 11	HV motors protection	2
Lec 12	MV distribution network protection	2
Lec 13	EHV Transmission networks protection	2
Lec 14	Bus protection	2
Lec 15	Protection of distributed generation	2
Total hours:		<b>30</b>

Form of classes - laboratory		Number of hours:
Lab 1	Presentation of safety regulations and internal regulations of laboratory. Assessment rules. Overview of laboratory stations.	3
Lab 2	Test of relays, current and voltage transformers	3
Lab 3	Test of single and multi input definite time-delay relays	3
Lab 4	Test of differential relays	3
Lab 5	Test of directional protection of HV lines	3
Total hours:		<b>15</b>

Form of classes - project		Number of hours:
Proj 1	Analysis of diagram of chosen electric network	2
Proj 2	Power flow and short circuit current calculation to use its during selection type and setting of protection system	4
Proj 3	Realization of project - selection of relaying criteria for various element of network	4
Proj 4	Realization of project - calculation of settings of relays	2
Proj 5	Selection of type and producer of relays	2
Proj 6	Presentation and defence of project	1
Total hours:		<b>15</b>

## TEACHING TOOLS USED

- N1. Problem lecture
- N2. Lecture with use of multimedia techniques.
- N3. Laboratory with measurements traditionally arranged, work in groups
- N4. Oral assessment
- N5. Report arrangement from measurements
- N6. Internet data base
- N7. Catalogues of relays
- N8. Consultation and discussion

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	Oral and writing exam
P(W)	P=F1	
F1(L)	PEK_U01	Assessment of preparation quality for laboratory and activity.
F2(L)	PEK_U02	Assessment of prepared laboratory reports
P(L)	P=0,5F1+0,5F2	
F1(P)	PEK_U03	Assessment of accomplishment of project
F2(P)	PEK_U03 PEK_K01	Defence of project
P(P)	P=0,5F1+0,5F2	

PRIMARY AND SECONDARY LITERATURE
<b>PRIMARY LITERATURE:</b> [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] Praca zbiorowa pod red. B. Synala, Automatyka elektroenergetyczna, ćwiczenia laboratoryjne, część I: Przetworniki sygnałów pomiarowych i przekaźniki automatyki zabezpieczeniowej, część II: Układy automatyki zabezpieczeniowej i regulacyjnej skrypt Politechniki Wrocławskiej, Wrocław 1991. [4] Praca zbiorowa pod red. B. Synala, Automatyka elektroenergetyczna, ćwiczenia laboratoryjne. Cz. II, Układy automatyki zabezpieczeniowej i regulacyjnej, Wyd. PWr. 1991.
<b>SECONDARY LITERATURE:</b> [1] Synal B., Rojewski W., Zabezpieczenia elektroenergetyczne – Podstawy, Podręcznik INPE dla elektryków, Zeszyt 19, 2008. [2] Catalogues of relay protection offered by producers

SUBJECT SUPERVISOR
Marcin Habrych, marcin.habrych@pwr.edu.pl

**MATRIX OF CORRELATION BETWEEN EDUCATIONAL EFFECTS FOR SUBJECT  
ARR042202 - Power system protection - fundamentals  
AND EDUCATIONAL EFFECTS FOR MAIN FIELD OF STUDY Control Engineering and Robotics**

<b>Subject educational effect</b>	<b>Correlation between subject educational effect and educational effects defined for main field of study and specialization (if applicable)</b>	<b>Subject objectives</b>	<b>Programme content</b>	<b>Teaching tool number</b>
PEK_W01	K1AIR_ASE_W03	C.1 C.2 C.3	Lec1 Lec2 Lec3 Lec4 Lec5 Lec6 Lec7 Lec8	N.2
PEK_W02	K1AIR_ASE_W03	C.3 C.4	Lec4 Lec5 Lec6 Lec7 Lec8 Lec9 Lec10 Lec11 Lec12 Lec13 Lec14 Lec15	N.2
PEK_W03	K1AIR_ASE_W03	C.4	Lec9 Lec10 Lec11 Lec12 Lec13 Lec14 Lec15	N.1 N.2
PEK_U01	K1AIR_ASE_U03	C.1 C.3 C.5	Lab2 Lab3 Lab4 Lab5	N.3 N.4
PEK_U02	K1AIR_ASE_U03	C.1 C.3 C.5	Lab2 Lab3 Lab4 Lab5	N.3 N.5
PEK_U03	K1AIR_ASE_U03	C.6	Proj1 Proj2 Proj3 Proj4 Proj5 Proj6	N.6 N.7 N.8
PEK_K01	K1AiR_K09	C.7	Lab2 Lab3 Lab4 Lab5 Proj1 Proj2 Proj3 Proj4 Proj5 Proj6	N.3 N.4 N.5 N.6 N.7 N.8