

FACULTY OF ELECTRICAL  
ENGINEERING**SUBJECT CARD**

Name in Polish: **Automatyka elektroenergetyczna**  
 Name in English: **Power System Protection**  
 Main field of study (if applicable): **Control Engineering and Robotics**  
 Specialization (if applicable): **Automation and Control in Electrical Power Systems**  
 Level and form of studies: **2nd level, full-time**  
 Kind of subject: **optional**  
 Subject code: **ARR042213**  
 Group of courses: **NO**

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU):	30		15		
Number of hours of total student workload (CNPS):	60		30		
Form of crediting:	examination		crediting with grade		
For group of courses mark (X) final course:					
Number of ECTS points:	2		1		
including number of ECTS points for practical (P) classes :			1		
including number of ECTS points for direct teacher-student contact (BK) classes:	1.40		0.70		

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

1. Has properly founded and structured knowledge needed to understand the purposes and targets of modern power system protection.
2. Has basic knowledge about operation criteria and application techniques of protection of main power system elements
3. Is able to correctly conduct testing of digital as well as analog relay protection units.

**SUBJECT OBJECTIVES**

- C1. Acquaintance with modern solutions for power system protection  
 C2. To gain practical knowledge and skills for selection of proper relaying criteria for machinery and electrical networks  
 C3. To gain practical skills to apply modern methods, techniques and measuring tools for individual relays and sets of protection testing  
 C4. To gain practical skills needed for connecting secondary circuits of relay protection, conducting testing and preparing reports  
 C5. To know and understand principles and methods for protection criteria quantities calculation

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

- PEK\_W01 Has consolidated and well founded theoretical knowledge necessary to understand functions and operation principles of modern control automatic and protection (eliminative, regenerative and preventive) of power system  
 PEK\_W02 Understands methodology of calculation of criteria quantities and set up values of power system protections reacting on phase-to-phase faults.  
 PEK\_W03 Understands methodology of calculation of criteria quantities and set up values of power system protections reacting on phase to earth faults in MV networks

*relating to skills:*

- PEK\_U01 Is able to connect secondary current and voltage circuits of relay protections.  
 PEK\_U02 Is able to select proper sets of relays and to measure characteristics of protection.

*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, requirements, literature and assessment methods. Basic characteristics, classification and role of power system eliminative, preventive and regenerative protection	2
Lec 2	Principles of operation and setting up of automatic switching of feeding system. Problems with switching of feeding of asynchronous motors.	2
Lec 3	Characterization of transient faults. Overview on requirements for auto reclosing automatics. Operation criteria and principles of setting of auto reclosing equipment in transmission and distribution lines.	2
Lec 4	Characterization of phenomena occurring in power electric system after disturbing active power balance.	2
Lec 5	Criterion for solution, setting and operation of Under Frequency Load Shedding equipment (UFLS).	2
Lec 6	Characterization of phenomena occurring in power electric system after disturbing reactive power balance. Principles and criterion of operation and setting of Under Voltage Load Shedding equipment (UVLS).	2
Lec 7	The functions of special protection in electric power system. Examples of practical solutions.	2
Lec 8	Local and remote backup protection systems. Busbar protection.	2
Lec 9	Distributed generation (DG) protection. Impact of DG on the operation conditions of the network protection.	2
Lec 10	Methods and equipment for automatic fault localization and switching in distribution network. Self healing networks.	2
Lec 11	Methodology of relays settings calculation for protection of synchronous generators	2
Lec 12	Methodology of relays settings calculation for protection of power transformers	2
Lec 13	Methodology of relays settings calculation for protection of HV lines	2
Lec 14	Methodology of relays settings calculation for protection of HV motors.	2
Lec 15	Methodology of relays settings calculation for ground-fault protection of MV distribution networks	2
Total hours:		<b>30</b>

Form of classes - laboratory		Number of hours:
Lab 1	Presentation of safety regulations and regulations of laboratory. Assessment rules. Overview of laboratory stations.	3
Lab 2	Test of distance relays	3
Lab 3	Test of automatic switching of feeding system	3
Lab 4	Test of auto-reclosing units	3
Lab 5	Test of synchronous generator protections	3
Total hours:		<b>15</b>

## TEACHING TOOLS USED

- N1. Problem lecture
- N2. Laboratory with measurements traditionally arranged
- N3. Laboratory with measurements traditionally arranged
- N4. Assessment in form of oral or writing test
- N5. Preparation of tests and measurements report

## 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	Writing and oral exam
P(W)	P=F1	
F1(L)	PEK_U01 PEK_U02 PEK_K01	Preparation for laboratory assessment and activity during laboratory
F1(L)	PEK_U01 PEK_U02 PEK_K01	Assessment of laboratory reports
P(L)	P=0,5F1+0,5F2	

## PRIMARY AND SECONDARY LITERATURE

### PRIMARY LITERATURE:

- [1] Synal B. i inni, Elektroenergetyczna automatyka zabezpieczeniowa – podstawy, Wyd. II, Oficyna Wydawnicza Politechniki Wrocławskiej, Wrocław 2003.
- [2] Winkler W., Wiszniewski A., Automatyka zabezpieczeniowa w systemach elektroenergetycznych, WNT, Warszawa, 2004
- [3] Żydanowicz J., Elektroenergetyczna automatyka zabezpieczeniowa: 1. Podstawy zabezpieczeń elektroenergetycznych, Warszawa, WNT, 1979; 2. Automatyka eliminacyjna, Warszawa, WNT, 1985; 3. Automatyka przewencyjna i restytucyjna, Warszawa, WNT, 1987.
- [4] Machowski J.: Regulacja i stabilność systemu elektroenergetycznego
- [5] Praca zbiorowa pod red. B. Synała, Automatyka Elektroenergetyczna, ćwiczenia laboratoryjne cz.I : Przetworniki sygnałów pomiarowych i przekaźniki automatyki zabezpieczeniowej, cz.II : Układy automatyki zabezpieczeniowej i regulacyjnej, Skrypt Politechniki Wrocławskiej, Wrocław 1991
- [6] Kacejko P., Machowski J.: Zwarcia w systemach elektroenergetycznych, WNT, Warszawa, 2002.
- [7] PN-EN 60909-0 Prądy zwarciove w sieciach trójfazowych prądu przemiennego- Część 0: Obliczanie prądów.

### SECONDARY LITERATURE:

- [1] Konspekty prowadzącego
- [2] Wiszniewski A., Algorytmy pomiarów cyfrowych w automatyce elektroenergetycznej, WNT, Warszawa, 1990 [3] Instrukcje laboratoryjne
- [3] Instrukcje laboratoryjne

## SUBJECT SUPERVISOR

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### MATRIX OF CORRELATION BETWEEN EDUCATIONAL EFFECTS FOR SUBJECT ARR042213 - Power System Protection AND EDUCATIONAL EFFECTS FOR MAIN FIELD OF STUDY **Control Engineering and Robotics** AND SPECIALIZATION **Automation and Control in Electrical Power Systems**

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	S2ASE_W12	C.1 C.2	Lec1 Lec2 Lec3 Lec4 Lec5 Lec6 Lec7 Lec8 Lec9 Lec10	N.1 N.2
PEK_W02	S2ASE_W12	C.2 C.5	Lec11 Lec12 Lec13 Lec14 Lec15	N.1 N.2
PEK_W03	S2ASE_W12	C.2 C.5	Lec11 Lec12 Lec13 Lec14 Lec15	N.1 N.2
PEK_U01	S2ASE_U11	C.3 C.4	Lab2 Lab3 Lab4 Lab5	N.3 N.4
PEK_U02	S2ASE_U11	C.3 C.4	Lab2 Lab3 Lab4 Lab5	N.5
PEK_K01	K2AiR_K07	C.3 C.4	Lab1 Lab2 Lab3 Lab4 Lab5	N.3 N.4 N.5