FACULTY OF ELECTRICAL ENGINEERING

SUBJECT CARD

Name in Polish:	**Techniki cyfrowe w automatyce elektroenergetycznej**
Name in English:	**Digital techniques in power system control and 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:	**obligatory**
Subject code:	**ARR042113**
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):	30			30	
Form of crediting:	crediting with grade			crediting with grade	
For group of courses mark (X) final course:					
Number of ECTS points:	1			1	
including number of ECTS points for practical (P) classes :				1	
including number of ECTS points for direct teacher-student contact (BK) classes:	0.70			0.70	

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. Has basic knowledge on power system operation.
2. Has ordered knowledge of digital signal processing.
3. Has basic knowledge on programming in Matlab.
4. Is able to develop and verify simple programs im Matlab.
5. Is able to think and act in a creative way.

SUBJECT OBJECTIVES

C1. To provide knowledge of conditions for application of voltage and current transformers for supplying digital protection systems and algorithmic compensation of transformation errors of instrument transformers.

C2. To provide theoretical and practical knowledge regarding identification of faults, including fault detection, fault type selection and fault direction discrimination.

C3. To provide knowledge of modern communications means for power system control. Familiarization with synchronization of dispersed measurements to be accomplished with use of the GPS or analytically.

C4. To provide knowledge of methods of analysing fault identification algorithms and their implementation.

C5. Abbility of working in a group

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:

PEK_W01	Student gets knowledge regarding transformation of voltages and currents from a power system to control and protection devices in steady states and in transient conditions.
PEK_W02	Student gets knowledge on fault identification, in particular on fault detection, fault type selection and fault direction discrimination.
PEK_W03	Student gets knowledge on principles for digital dispersed measurements, in particular on communication means and methods of measurements synchronisation.

relating to skills:

PEK_U01	Student can evaluate and to solve the problems related to supplying digital protection systems from voltage and current instrument transformers.
PEK_U02	Student can analyse methods of fault identification under applying local measurements.
PEK_U03	Student is able to evaluate and to solve fault identification methods under applying dispersed measurements, with assuring synchronisation of measurements.

relating to social competences:

PEK_K01	Student can act independently and cooperate within a group working on a complex engineering project.

PROGRAMME CONTENT		
Form of classes - lecture		**Number of hours:**
Lec 1	General introduction to the course. Establishing conditions for passing and marking the lecture. Voltage and current instrument transformers – issues of supplying digital protective systems.	2
Lec 2	Analysis of transients of capacitive voltage transformers.	2
Lec 3	Digital correction of capacitive voltage transformer.	2
Lec 4	Transients and saturation detection for current transformers.	2
Lec 5	Digital algorithms for fault detection, classification and direction discrimination.	2
Lec 6	Modern communication means for power system control. Synchronisation of measurements – satellite Global Positioning System (GPS). Synchrophasors – examples of applications in power system control.	2
Lec 7	Analitical synchronisation of dispersed measurements in case of GPS unavailability.	2
Lec 8	Crediting test.	1
	Total hours:	**15**

Form of classes - project		**Number of hours:**
Proj 1	Presentation of health and safety rules, and general regulations of the laboratory. Establishing conditions for passing and marking the project course. Practical familiarization with loading of fault data from ATP-EMTP simulation into Matlab program including visualisation of the signals.	2
Proj 2	Analysis of transformation of signals by voltage and current instrument transformers.	2
Proj 3	Digital algorithm for fault detection.	2
Proj 4	Digital algorithm for fault direction discrimination.	2
Proj 5	Digital algorithm for fault classification - part 1.	2
Proj 6	Digital algorithm for fault classification - part 2.	2
Proj 7	Synchronisation of dispersed measurements.	2
Proj 8	Summary and description of performed projects.	1
	Total hours:	**15**

TEACHING TOOLS USED
N1. Informative lecture.
N2. Matlab programme.
N3. Report on performed project.
N4. Student's own work.

EVALUATION OF SUBJECT EDUCATIONAL EFFECTS ACHIEVEMENT		
Evaluation *F – forming (during semester)* *P – concluding (at semester end)*	**Educational effect number**	**Way of evaluating educational effect achievement**
F1(W)	PEK_W01 PEK_W02 PEK_W03	Presence at the lectures
F2(W)	PEK_W01 PEK_W02 PEK_W03	Crediting test
P(W)	P=0,2F1+0,8F2	
F1(P)	PEK_U01 PEK_U02 PEK_U03 PEK_K01	Activity during project classes
F2(P)	PEK_U01 PEK_U02 PEK_U03 PEK_K01	Reports on projects
P(P)	P=0.3F1+0.7F2	

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] Iżykowski J., Impedancyjne algorytmy lokalizacji zwarć w liniach przesyłowych. Prace Naukowe Instytutu Energoelektryki Politechniki Wrocławskiej Nr 92, Seria: Monografie – nr 28, Oficyna Wydawnicza Politechniki Wrocławskiej, Wrocław 2001.
[2] Rosołowski E., Cyfrowe przetwarzanie sygnałów w automatyce elektroenergetycznej. Akademicka Oficyna Wydawnicza EXIT, Warszawa 2002.
[3] Rosołowski E., Komputerowe metody analizy elektromagnetycznych stanów przejściowych. Oficyna Wydawnicza Politechniki Wrocławskiej, Wrocław 2009.
[4] Szafran J., Wiszniewski A., Algorytmy pomiarowe i decyzyjne cyfrowej automatyki elektroenergetycznej. WNT, Warszawa, 2001.
[5] Winkler W., Wiszniewski A.: Automatyka zabezpieczeniowa w systemach elektroenergetycznych, WNT Warszawa, 1999.
[6] Wiszniewski A., Przekładniki w elektroenergetyce, WNT Warszawa, 1992.

SECONDARY LITERATURE:

[1] Iżykowski J., Fault location on power transmission lines. Oficyna Wydawnicza Politechniki Wrocławskiej, 2008, p. 221.
[2] Iżykowski J., Power system faults. PRINTPAP, 2011, p. 190.
[3] Saha M.M., Iżykowski J., Rosołowski E., Fault location on power networks. Springer-Verlag London, Series: Power Systems, 2010, 425 p.

SUBJECT SUPERVISOR

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MATRIX OF CORRELATION BETWEEN EDUCATIONAL EFFECTS FOR SUBJECT
ARR042113 - Digital techniques in power system control and 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_W04	C.1	Lec1 Lec2 Lec3 Lec4	N.1 N.4
PEK_W02	K2AiR_W04 S2ASE_W06	C.2	Lec5	N.1 N.4
PEK_W03	K2AiR_W02 K2AiR_W04	C.3	Lec6 Lec7	N.1 N.4
PEK_U01	K2AiR_U02 S2ASE_U03	C.1	Proj1 Proj2	N.2 N.3 N.4
PEK_U02	S2ASE_U06	C.2 C.4	Proj3 Proj4 Proj5 Proj6	N.2 N.3 N.4
PEK_U03	K2AiR_U03 S2ASE_U06	C.3	Proj7	N.2 N.3 N.4
PEK_K01	K2AiR_K06 K2AiR_K07	C.5	Proj1 Proj2 Proj3 Proj4 Proj5 Proj6 Proj7 Proj8	N.2 N.3 N.4