FACULTY OF ELECTRICAL ENGINEERING

SUBJECT CARD

Name in Polish:	**Integracja zasobów rozproszonych w systemach elektroenergetycznych**
Name in English:	**Integration of Distributed Resources in Power Systems**
Main field of study (if applicable):	**Electrical Engineering**
Specialization (if applicable):	**Renewable Energy Systems**
Level and form of studies:	**2nd level, full-time**
Kind of subject:	**obligatory**
Subject code:	**ELR052536**
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 a basic knowledge of electricity systems operation
2. Has basic knowledge concerning a three-phase and single-phase electric circuits analysis in phase coordinates A, B, C and symmetrical components 0, 1, 2

SUBJECT OBJECTIVES

C1. Adoption of theoretical knowledge concerning an integration of distributed resources in power systems

C2. Development and progress of practical ability to analysis and design and modeling of a power system under normal and abnormal states

SUBJECT LEARNING OUTCOMES

relating to knowledge:

PEU_W01 Explains the standards in practice of wind farms electrical connection to the power system

PEU_W02 Has knowledge concerning the impact of distributed generation on a power system and on a smart grid operation

relating to skills:

PEU_U01 Is able to model and examine an electric power system with embedded generation

PEU_U02 Is able to model and make analysis of a power systems

relating to social competences:

PEU_K01 Is able to prepare complex the electric power calculations in a competent way

PROGRAMME CONTENT		
Form of classes - lecture		**Number of hours:**
Lec 1	Introduction. Structures of modern power system.	2
Lec 2	Definitions and classification of distributed energy resources (DER)	2
Lec 3	Technical requirements for wind generation	2
Lec 4	Diagrams of connection of dispersed generators into electric power system	2
Lec 5	Technical requisites for dispersed generators connection to the public electric power grids	2
Lec 6	Modeling of dispersed generators in power system analysis	2
Lec 7	Impact of dispersed generators on power load flow and voltage changes in electrical power network	2
Lec 8	Impact of dispersed generators on short-circuit currents in electrical power network	2
Lec 9	Dispersed generator contribution to voltage regulation in electrical power system	2
Lec 10	Dispersed generator contribution to frequency regulation in electrical power system	2
Lec 11	Impact of dispersed generators on relay protection of electrical power network	2
Lec 12	The effect of dispersed generators on power quality and reliability of electrical power network.	2
Lec 13	Autonomous generation of DER	2
Lec 14	Microgrids	2
Lec 15	Practical analysis of the impact of wind farms on transmission or distribution network	2
	Total hours:	**30**

Form of classes - laboratory		**Number of hours:**
Lab 1	Regulations in the laboratory and conditions and regulations to pass	2
Lab 2	Static and short circuit models of DER	2
Lab 3	Modeling of distribution network with dispersed generation for computer simulation	2
Lab 4	Load flow simulation in distribution network with DER	2
Lab 5	Examination of the effect of dispersed generation on power load flow and voltage changes in distribution network	2
Lab 6	Short circuit simulation and analysis in distributed network with DER	2
Lab 7	Examination of effect of dispersed generation on power quality of distribution network	2
Lab 8	Reserve	1
	Total hours:	**15**

TEACHING TOOLS USED
N1. Academic lecture using AV facilities and multimedia presentations
N2. Matlab program
N3. Reports from assignments

EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT		
Evaluation *F – forming (during semester)* *P – concluding (at semester end)*	**Educational effect number**	**Way of evaluating educational effect achievement**
F1(W)	PEU_W01 PEU_W02	Exam
P(W)	P=F1	
F1(L)	PEU_U01 PEU_U02	Activity during labs
F2(L)	PEU_U01 PEU_U02	Assessment of individual lab project
P(L)	P = 0.3F1 + 0.7F2	

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] Robert Lis, Marian Sobierajski: Integration of distributed resources in power systems, Wydawnictwo Politechniki Wrocławskiej, Wrocław 2011.
[2] Piotr Kacejko.: Generacja rozproszona w systemie elektroenergetycznym. Wydawnictwo Politechniki Lubelskiej, Lublin 2004.
[3] Jenkins N., Allan R., Crossley P., Kirschen D., Strbac G.: Embeded Generation. Power & Energy 2000.

SECONDARY LITERATURE:

[1] Sobierajski M., Łabuzek M., Lis R., Electrical Power System Analysis In Matlab, Oficyna Wydawnicza Politechniki Wrocławskiej, 2006.
[2] Bergen A. R., Power Systems Analysis, Prentice-Hall, 2000.
[3] IEEE Standard for Interconnecting Distributed Resources with Electric Power Systems.
[4] Selected articles published in refereed or reputable academic journals.

SUBJECT SUPERVISOR
Robert Lis, robert.lis@pwr.edu.pl