

FACULTY OF ELECTRICAL
ENGINEERING**SUBJECT CARD**

Name in Polish: **Modelowanie układów elektroenergetycznych ze źródłami rozproszonymi**
 Name in English: **Modelling of DES systems**
 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: **ELR042118**
 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. Student should have the basic knowledge of fundamentals of circuit theory and basics of differential calculus.
2. Student should know how to formulate digital models of electrical circuits and to conduct analyses regarding accuracy, stability and frequency characteristics.
3. Student should know how to calculate the parameters of basic elements of the line.

SUBJECT OBJECTIVES

- C1. To provide knowledge of methods for solving differential equations describing electrical circuits.
- C2. Learning how to formulate digital models of electrical circuits and to conduct analyses regarding accuracy, stability and frequency characteristics.
- C3. To provide knowledge of modelling a power line with distributed parameters.
- C4. Familiarization with methods of modelling and simulation of wind and photovoltaic power stations.

SUBJECT EDUCATIONAL EFFECTS*relating to knowledge:*

- PEK_W01 Student gets the knowledge on description of models for linear electrical circuits with use of differential equations and their numerical solution applying different numerical procedures of integration.
- PEK_W02 Student gets the knowledge regarding evaluation of accuracy and stability of the solution of a differential equation in a numerical way.

relating to skills:

- PEK_U01 Student is able to model linear elements and branches and also a power transmission line with distributed parameters, in particular, applying a graphical editor of this program, forms a structure of a simulative model, sets simulation parameters, conducts a simulation and analyses waveforms of signals from a modelled system.
- PEK_U02 Student is able to apply results of computer simulation to analyse of dynamic electric circuits.

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 – aims of the course. Establishing conditions for passing and marking the course. Principle of 3-phase network modelling.	2
Lec 2	Representation of 3-phase transformers with models of electric and magnetic circuits.	2
Lec 3	Models of induction motors with representation of electric and mechanic schemes.	2
Lec 4	Modelling of synchronous generator with basic control elements.	2
Lec 5	Modelling of wind turbines and induction generators.	2
Lec 6	Representation of DFIG control systems.	2
Lec 7	Modelling of the photovoltaic sources and their connection to the network.	2
Lec 8	Qualified test.	1
Total hours:		15

Form of classes - laboratory		Number of hours:
Lab 1	Presentation of health and safety rules, and general regulations of the laboratory. Establishing conditions for passing and marking the project course. General familiarization with the ATP-EMTP program.	2
Lab 2	Simulation of the 3-phase transmission line with distributed parameters. Measurement of the symmetrical components.	2
Lab 3	Simulation of 3-phase transformer with magnetizing characteristic. Test of the transformer energising.	2
Lab 4	Simulation of the instrument transformers with the relay input chain.	2
Lab 5	Modelling of faults in 3-phase network with transformer and instrument transformers.	2
Lab 6	Modelling of digital protection algorithms with relay input chains.	2
Lab 7	Modelling of DFIG driven by wind turbine.	2
Lab 8	Additional term.	1
Total hours:		15

TEACHING TOOLS USED

- N1. Informative lecture.
 N2. ATP-EMTP simulative program.
 N3. Lab reports.

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	Attendance on lectures
F2(W)	PEK_W01 PEK_W02	Qualified test
P(W)	$P=0,1 \cdot F1 + 0,9 \cdot F2$	
F1(L)	PEK_U01 PEK_U02 PEK_K01	Activity in the lab work
F2(L)	PEK_U01 PEK_U02 PEK_K01	Project reports
P(L)	$P=0,3 \cdot F3 + 0,7 \cdot F4$	

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

- [1] ROSOŁOWSKI E., Komputerowe metody analizy elektromagnetycznych stanów przejściowych. Oficyna Wydawnicza Politechniki Wrocławskiej, Wrocław 2009.
 [2] http://zas.ie.pwr.wroc.pl/ER/przyklady_D1/index.html - przykłady niektórych modeli wraz z plikami źródłowymi do programu ATP-EMTP.

SECONDARY LITERATURE:

- [1] WATSON N., ARRILAGA J., Power systems electromagnetic transients simulation. The Institution of Electrical Engineers, 2003.
 [2] Michalik M., Rosołowski E., Simulation and analysis of power system transients. PRINTPAP, 2011.
 [3] AMETANI A., NAGAOKA N., BABA Y., OHNO T., Power System Transients. Theory and Applications. CRC Press. Taylor & Francis Group, 2014.

SUBJECT SUPERVISOR

Eugeniusz Rosołowski, eugeniusz.rosolowski@pwr.edu.pl

MATRIX OF CORRELATION BETWEEN EDUCATIONAL EFFECTS FOR SUBJECT
ELR042118 - Modelling of DES systems
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_W06 S2OZE_W11	C.1 C.2	Lec1 Lec2 Lec3 Lec4	N.1
PEK_W02	S2OZE_W06 S2OZE_W11	C.1 C.2	Lec5 Lec6 Lec7 Lec8	N.1
PEK_U01	S2OZE_U04 S2OZE_U07	C.3 C.4	Lab1 Lab2 Lab3 Lab4	N.2 N.3
PEK_U02	S2OZE_U04 S2OZE_U07	C.3 C.4	Lab5 Lab6 Lab7 Lab8	N.2 N.3
PEK_K01	K2ETK_K06 K2ETK_K07	C.3 C.4	Lab1 Lab2 Lab3 Lab4 Lab5 Lab6 Lab7 Lab8	N.2 N.3