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:	**ELR052118**
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 LEARNING OUTCOMES

relating to knowledge:

PEU_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.

PEU_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:

PEU_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.

PEU_U02 Student is able to apply results of computer simulation to analyse of dynamic electric circuits.

relating to social competences:

PEU_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 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	Attendance on lectures
F2(W)	PEU_W01 PEU_W02	Qualified test
P(W)	P=0,1*F1+0,9*F2	
F1(L)	PEU_U01 PEU_U02 PEU_K01	Activity in the lab work
F2(L)	PEU_U01 PEU_U02 PEU_K01	Project reports
P(L)	P=0,3*F3+0,7*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.

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