FACULTY OF ELECTRICAL ENGINEERING

SUBJECT CARD

Name in Polish:	**Komputerowa analiza elektromagnetycznych stanów przejściowych**
Name in English:	**Simulation and Analysis of Power System Transients**
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:	**ELR052133**
Group of courses:	**NO**

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

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	Introduction, syllabus of the course, basic definitions. Computer programs for electromagnetic transients simulations - general description.	2
Lec 2	Digital models of linear elements (R, L, C) of an electric network	2
Lec 3	Basic concept of numerical solution of a dynamic network equations	2
Lec 4	Line model with distributed parameters.	2
Lec 5	Numerical oscillation and limitations of using the computer tools to simulation of electromagnetic transients.	2
Lec 6	Modelling of relays, measuring algorithms and instrument transformers	2
Lec 7	Modelling of power electronic converters	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 a 3-phase network with line, load and a fault.	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 measuring algorithms applied in relay protection units.	2
Lab 7	Simulation of the induction motors. Test of start and load changing.	2
Lab 8	Testing of the synchronous generation with excitation control scheme.	2
Lab 9	Simulation of generation station with control scheme; fault analysis	2
Lab 10	Modelling of DFIG driven by wind turbine.	2
Lab 11	Modelling of DFIG with power control system.	2
Lab 12	Simulation of ride-through faults on the line connected wind generator.	2
Lab 13	Modelling of the photovoltaic source.	2
Lab 14	Simulation of the interconnection between the photovoltaic source with the utility network.	2
Lab 15	Additional term.	2
	Total hours:	**30**

TEACHING TOOLS USED
N1. Informative lecture.
N2. ATP-EMTP simulation 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 project work
F2(L)	PEU_U01 PEU_U02 PEU_K01	Project reports
P(L)	P=0,3*F1+0,7*F2	

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] N. Watson, J. Arrillaga: Power systems electromagnetic transients simulation. The Institution of Electrical Engineers, London 2003.
[2] H.W. Dommel: Electromagnetic Transients Program. Reference Manual. BPA, Portland, 1986.
[3] J. D. Glover, M. Sarma: Power system analysis and design, PWS Publishing Company Boston, second edition, 2002.
[4] W. D. Stevenson: Elements of Power System Analysis (4th Ed.). McGrawHill, New York, 1982.
[5] J-P. Barret, P. Bornard, B. Meyer: Power system simulation: Chapman and Hall, London 1997.

SECONDARY LITERATURE:

[1] Alternative Transients Program. Rule Book. K.U. Leuven, EMTP Center, 1987.
[2] P. Kacejko P., J. Machowski: Faults in power systems, WNT Warszawa 2002 (in polish).
[3] Materials available at: http://www.rose.pwr.wroc.pl/

SUBJECT SUPERVISOR

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