

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: **ELR032133**
 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 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	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 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 project work
F2(L)	PEK_U01 PEK_U02 PEK_K01	Project reports
P(L)	$P=0,3 \cdot F1 + 0,7 \cdot F2$	

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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MATRIX OF CORRELATION BETWEEN EDUCATIONAL EFFECTS FOR SUBJECT **ELR032133 - Simulation and Analysis of Power System Transients** AND EDUCATIONAL EFFECTS FOR MAIN FIELD OF STUDY **Electrical Engineering** AND SPECIALIZATION **Renewable Energy 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	S2RES_W02 S2RES_W05 S2RES_W08	C.1 C.2	Lec1 Lec2 Lec3 Lec4	N.1
PEK_W02	S2RES_W02 S2RES_W05 S2RES_W08	C.1 C.2	Lec5 Lec6 Lec7 Lec8	N.1
PEK_U01	S2RES_U02 S2RES_U14	C.3 C.4	Lab1 Lab2 Lab3 Lab4 Lab5 Lab6 Lab7 Lab8	N.2 N.3
PEK_U02	S2RES_U02 S2RES_U14	C.3 C.4	Lab9 Lab10 Lab11 Lab12 Lab13 Lab14 Lab15	N.2 N.3
PEK_K01	S2RES_K01 S2RES_K02	C.3 C.4	Lab1 Lab2 Lab3 Lab4 Lab5 Lab6 Lab7 Lab8 Lab9 Lab10 Lab11 Lab12 Lab13 Lab14 Lab15	N.2 N.3