DESCRIPTION OF THE COURSES

- Course code: ARR2110
- Course title: ELECTROMAGNETIC TRANSIENTS SIMULATION
- Language of the lecturer: Polish

Course form	***Lecture***	***Classes***	***Laboratory***	***Project***	***Seminar***
*Number of hours/week**	*2*			*1*	
*Number of hours/semester**	*30*			*15*	
Form of the course completion	*pass*			*pass*	
ECTS credits	*2*			*1*	
Total Student's Workload	*60*			*30*	

- Level of the course (basic/advanced): advanced
- Prerequisites:
  completed course: Numerical Methods, Circuits theory.
- Name, first name and degree of the lecturer/supervisor:
  Eugeniusz Rosołowski, Prof., Ph. D., D. Sc.
- Names, first names and degrees of the team's members:
  Jan Iżykowski, Ph. D., D. Sc.
  Marek Michalik, Ph. D.
- Year: 5 Semester: 9
- Type of the course (obligatory/optional): obligatory
- Aims of the course (effects of the course):
  The course provides descriptions of basic fundamental approaches for discrete modeling of circuit elements and computer simulation of electromagnetic transients.
- Form of the teaching (traditional/e-learning): traditional
- Course description:
  The course consists of the lecture and laboratory classes. Both of these forms deal with the following problems: Modelling of physical systems - basic principles. Digital models of basic electric circuit elements with lumped and distributed parameters. Models of three-phase system elements: lines, transformers and generators. Models of non-linear electric elements: diodes, thyristors, varistors and non-linear inductor. Digital solution of linear and non-linear equations for the studied networks. Numerical methods used in EMTP program. Representation of control system blocks in network model. EMTP application to simulation of selected problems. EMTP-MATLAB interface.
- Lecture:

Particular lectures contents	*Number of hours*
1. Introduction into the EMTP software package. Basic principles and characteristic.	*2*
2. Principle of the data preparation: graphical editor ATPDraw. Structure of the input data file. Auxiliary programs.	*2*

3. Digital models of linear RLC elements with lumped parameters: discrete-time representation of continuous-time models, different integration methods.	*2*
4. Methods for numerical solution of equations describing a direct current network. Development and solution of dynamic models of networks comprising linear elements.	*2*
5. Problem of numerical stability of digital models.	*2*
6. Digital model of single-phase line with distributed parameters. Taking into account the dependence of parameters on frequency.	
7. Models on non-linear elements: non-linear resistor, inductor and capacitor.	*2*
8. State space method for digital modelling of electrical grids.	*2*
9. Digital model of multi-phase RLC element with lumped parameters and mutual coupling.	*2*
10. Mathematical model of multiphase power line with distributed parameters. Taking into account the dependence of parameters on frequency.	*2*
11. Mathematical model of multi-phase and multi-winding transformer with non-linear magnetising branch.	*2*
12. Mathematical model of synchronous generator. Numerical representation of the generator model.	*2*
13. Computer models of induction machine.	*2*
14. Digital representation of instrument transformers and control devices.	*2*
15. Digital modelling of power electronic devices and converters.	*2*

- Classes – the contents:
- Seminars – the contents:
- Laboratory – the contents:
- Project – the contents:

1. Introduction to EMTP/ATP: configuration of the hardware and software; input data editing in ATPDraw.
2. Simulation of transients in a simple RLC circuit – preparation of the model, simulation and analysis of the results.
3. Transients simulation in a non-linear network: MOV application to over-voltage damping.
4. Simulation of transients in the simple three-phase network. Simulation of inter-phase faults.
5. Simulation of transients in the three-phase network with the power transformer and instrument current transformers.
6. Modelling of the differential protection for power transformers: preparation of the network and the measurement system implemented with the MODELS unit.
7. Simulation of transients in the network with the synchronous generator under the selected faults – modification of the delivered program and performing the measurements.

8. Simulation of the synchronous generator operation with included excitation model.

- Basic literature:

[1] Dommel H.W.: Electromagnetic Transients Program. Reference Manual. BPA, Portland, 1986.

[2] Alternative Transients Program. Rule Book. K.U. Leuven, EMTP Center, 1987-93.

[3] Auxiliary materials: http://www.rose.pwr.wroc.pl/

- Additional literature:

[1] Kacejko P., Machowski J., Zwarcia w systemach elektroenergetycznych, WNT Warszawa 2002.

[2] Watson N., Arrilaga J., Power systems electromagnetic transients simulation. The Institution of Electrical Engineers, London 2003.

[3] Bernas S., Ciok Z.: Modele matematyczne elementów systemu elektroenergetycznego. WNT, Warszawa, 1977.

[4] Ogrodzki J.: Komputerowa analiza układów elektronicznych. PWN, Warszawa, 1994.

- Conditions of the course acceptance/credition: test pass, project pass.

* - depending on a system of studies