FACULTY OF ELECTRICAL ENGINEERING

# SUBJECT CARD

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|---|---|
| Name in Polish: | **Symulacja elektromagnetycznych stanów przejściowych** |
| Name in English: | **Electromagnetic transients simulation** |
| Main field of study (if applicable): | **Industrial Control Engineering** |
| Specialization (if applicable): | **Automation and Control in Electrical Power Systems** |
| Level and form of studies: | **2nd level, full-time** |
| Kind of subject: | **obligatory** |
| Subject code: | **APR012118** |
| 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 mathematical analysis, including basics of differential equations.
2. Student should have the basic knowledge of 3-phase circuits and theory of symmetrical components.
3. Student should know how to analyse steady states and transients in AC one- and three-phase circuits

## SUBJECT OBJECTIVES

C1. To provide knowledge of methods for simulation of one- and three-phase circuits.
C2. Learning how to formulate digital models of electrical circuits.
C3. To provide knowledge of how to utilize the simulation results for measurements and dynamic circuit analysis.
C4. Familiarization with principles of simulation of the complex network with electrical and electro-mechanical elements.

## SUBJECT LEARNING OUTCOMES

*relating to knowledge:*

PEU_W01 Student gets the knowledge on formulation of discrete models of linear electrical circuits for analysis of their dynamical states.

PEU_W02 Student gets the knowledge regarding application of selected computer tools for simulation of basic electrical and electro-mechanical phenomena.

*relating to skills:*

PEU_U01 Student is able to prepare mathematical and simulation models of one- and three-phase electric circuits.

PEU_U02 Student is able to apply results of simulations for analysis of dynamic phenomena in 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. Principles of preparing the RLC mathematical and computer model. | 2 |
| Lec 2 | Digital models of voltage and current sources; simplified models of switches. | 2 |
| Lec 3 | Models of electric lines: lumped and distributed parameters model. Bergeron's method. | 2 |
| Lec 4 | Digital model of a single-phase line of lumped and distributed parameters and frequency-dependent parameters. | 2 |
| Lec 5 | Formulation of voltage nodal equations related to linear circuits. Determination of initial conditions. | 2 |
| Lec 6 | Modelling of nonlinear resistance, inductance and capacitance. | 2 |
| Lec 7 | Determination and solution of circuit models according to the state variable principle. | 2 |
| Lec 8 | Qualified test | 1 |
| | Total hours: | **15** |

| **Form of classes - project** | | **Number of hours:** |
|---|---|---|
| Proj 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 ATPDraw graphical editor of the ATP-EMTP program | 2 |
| Proj 2 | Modelling of single-phase circuits composed of RLC elements | 2 |
| Proj 3 | Modelling of the three-phase networks with power transformer. | 2 |
| Proj 4 | Transmission lines modelling with instrument transformers. | 2 |
| Proj 5 | Modelling of measurement elements with application of MODELS module. | 2 |
| Proj 6 | Simulations of induction motors | 2 |
| Proj 7 | Simulation of the synchronous generator with the excitation system control. | 2 |
| Proj 8 | Additional term. | 1 |
| | Total hours: | **15** |

| TEACHING TOOLS USED |
|---|
| N1. Informative lecture |
| N2. Simmulation program ATP-EMTP |
| N3. Project reports |

| EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT | | |
|---|---|---|
| **Evaluation**<br>*F – forming (during semester)*<br>*P – concluding (at semester end)* | **Educational effect number** | **Way of evaluating educational effect achievement** |
| F1(W) | PEU_W01<br>PEU_W02 | attendance on lectures |
| F1(W) | PEU_W01<br>PEU_W02 | Qualified test |
| P(W) | P=0,1*F1+0,9*F2 | |
| F1(P) | PEU_U01<br>PEU_U02 | Activity in the project work |
| F2(P) | PEU_U01<br>PEU_U02<br>PEU_K01 | Project reports |
| P(P) | P = 0,3F1 + 0,7F2 | |

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