

FACULTY OF ELECTRICAL  
ENGINEERING**SUBJECT CARD**

Name in Polish: **Modelowanie systemu elektroenergetycznego**  
 Name in English: **Power System Modelling**  
 Main field of study (if applicable): **Electrical Engineering**  
 Specialization (if applicable): **Control in Electrical Power Engineering**  
 Level and form of studies: **2nd level, full-time**  
 Kind of subject: **optional**  
 Subject code: **ELR032534**  
 Group of courses: **NO**

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU):	30			15	
Number of hours of total student workload (CNPS):	90			30	
Form of crediting:	examination			crediting with grade	
For group of courses mark (X) final course:					
Number of ECTS points:	3			1	
including number of ECTS points for practical (P) classes :				1	
including number of ECTS points for direct teacher-student contact (BK) classes:	2.10			0.70	

**PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES**

1. Knowledge of basics of mathematical analysis and linear algebra.
2. Knowledge of basics of power systems.
3. Abilities of developing computer programs and performing calculation in the Matlab environment.

**SUBJECT OBJECTIVES**

- C1. Acquiring knowledge in the scope of modern concepts of power system modelling.
- C2. Acquiring competence in solving the problems of the power system state estimation and estimation of loads in distribution system.

**SUBJECT EDUCATIONAL EFFECTS***relating to knowledge:*

- PEK\_W01 The student has knowledge on models for different states of power systems.
- PEK\_W02 The student knows principles of power system model reduction.
- PEK\_W03 The student knows principles of real-time modelling of power system.

*relating to skills:*

- PEK\_U01 The student is able to choose models of power system elements for given case of calculations.
- PEK\_U02 The student is able to determine required power-system-model reduction for given case of calculations.
- PEK\_U03 The student is able to evaluate a process of real-time power-system modeling.

*relating to social competences:*

- PEK\_K01 The student is able to think and act creatively

## PROGRAMME CONTENT

Form of classes - lecture		Number of hours:
Lec 1	An introduction to the lecture, program of the lecture, requirements. General principles of modelling.	2
Lec 2	Models for steady states analyses scope of utilisation.	2
Lec 3	Models for transient analyses scope of utilisation.	2
Lec 4	Power system model reduction: types of equivalents. Network transformation.	2
Lec 5	Power system model reduction: aggregation of generating units, equivalent model of the external subsystem.	2
Lec 6	Real-time modelling of power system: need of real-time modelling, main problems, general approaches.	2
Lec 7	Summation of modelling for different power system analyses. Test.	2
Lec 8	Weighted least squares (WLS) power system state estimation. Alternative formulations of the power system state estimation.	2
Lec 9	Network observability analysis.	2
Lec 10	Bad data detection and identification.	2
Lec 11	Network parameter estimation. Topology error processing.	2
Lec 12	State estimation using ampere measurements.	2
Lec 13	State estimation of distribution system specific problems.	2
Lec 14	Estimation of loads in distribution system.	2
Lec 15	Summation of estimation problems for power system. Test	2
Total hours:		<b>30</b>

Form of classes - project		Number of hours:
Proj 1	Power system model reduction	2
Proj 2	Weighted least squares power system state estimation in the polar coordinate system.	4
Proj 3	Weighted least squares power system state estimation in the rectangular coordinate system	4
Proj 4	Network observability analysis	2
Proj 5	Bad data identification.	1
Proj 6	Topology verification.	2
Total hours:		<b>15</b>

## TEACHING TOOLS USED

- N1. Multimedia presentation.  
 N2. Information lecture.  
 N3. Preparation in the form of reports.  
 N4. The Matlab programs.

## 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 PEK_W03	activity at the classes
F2(W)	PEK_W01 PEK_W02 PEK_W03	tests
F3(W)	PEK_W01 PEK_W02 PEK_W03	exam
P(W)	$P=0.1 F1 + 0.2 F2 + 0.7 F3$	
F1(P)	PEK_U01 PEK_U02 PEK_U03	activity at the classes
F2(P)	PEK_U01 PEK_U02 PEK_U03 PEK_K01	reports from the classes
P(P)	$P=0.3 F1 + 0.7 F2$	

## PRIMARY AND SECONDARY LITERATURE

### PRIMARY LITERATURE:

- [1] Łukomski R., Okoń T., Wilkosz K., Power system modelling. Wrocław University of Technology, 2011.
- [2] Abur A., Exposito A. G., Power system state estimation. New York, Marcel Dekker, Inc. 2004.
- [3] Machowski J., Bialek J.W., Bumby J. R., Power system dynamics and stability, New York, John Wiley & Sons 1997.

### SECONDARY LITERATURE:

Publikacje w czasopismach z zakresu elektroenergetyki

## SUBJECT SUPERVISOR

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### MATRIX OF CORRELATION BETWEEN EDUCATIONAL EFFECTS FOR SUBJECT ELR032534 - Power System Modelling AND EDUCATIONAL EFFECTS FOR MAIN FIELD OF STUDY **Electrical Engineering** AND SPECIALIZATION **Control in Electrical Power Engineering**

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	S2CPE_W15	C.1	Lec1 Lec2 Lec3	N.1 N.2
PEK_W02	S2CPE_W15	C.1	Lec4 Lec5	N.1 N.2
PEK_W03	S2CPE_W15	C.1	Lec6 Lec7 Lec8 Lec9 Lec10 Lec11 Lec12 Lec13 Lec14 Lec15	N.1 N.2
PEK_U01	S2CPE_U17	C.2	Proj1 Proj2 Proj3 Proj4 Proj5 Proj6	N.3 N.4
PEK_U02	S2CPE_U17	C.2	Proj1	N.3 N.4
PEK_U03	S2CPE_U17	C.2	Proj1 Proj2 Proj3 Proj4 Proj5 Proj6	N.3 N.4
PEK_K01	S2CPE_K01	C.2	Proj1 Proj2 Proj3 Proj4 Proj5 Proj6	N.3