FACULTY OF ELECTRICAL ENGINEERING

SUBJECT CARD

Name in Polish:	**Sterowanie i regulacja w elektroenergetyce**
Name in English:	**Power system operation and control**
Main field of study (if applicable):	**Industrial Control Engineering**
Specialization (if applicable):	
Level and form of studies:	**1st level, full-time**
Kind of subject:	**optional**
Subject code:	**APR012203**
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. Knows principles of operation of power system and power stations as well as technologies of power generation and transmission
2. Has knowledge about dynamics, statistics and quality and stability of automatics

SUBJECT OBJECTIVES

C1. Acquaintance with structure of managing and rules of operation of power system in normal and abnormal conditions
C2. Acquaintance with functions and operation criteria of power system automatics
C3. Acquaintance with definition of various conditions of power system operation, reasons of accidents as well as method preventing them
C4. Gaining practical skills for electrical circuits assembling, measurement making and testing of regulators used in power system automation

SUBJECT LEARNING OUTCOMES

relating to knowledge:

PEU_W01	Has knowledge about the hierarchical structure of managing and control of power system
PEU_W02	Understands and is able to describe of control criteria of turbine, synchronous generator, power transformer and capacitor bank

relating to skills:

PEU_U01	Is able to design measuring circuit and select proper measuring equipment
PEU_U02	Is able to connect measurement circuit for testing of synchronous generator excitation controller, transformer voltage controller and capacitor banks controlle

relating to social competences:

PEU_K01	Is conscious about responsibility for his work and ready to work in team

PROGRAMME CONTENT		
Form of classes - lecture		**Number of hours:**
Lec 1	Hierarchical structure and operating states of the electrical power system. The KSE overview and selected statistical data.	2
Lec 2	General scheme of the turbo-generation unit. Mathematical model of the turbine and her control schemes, shaping of static characteristic. Regulation of the turbine in transient states.	2
Lec 3	The turbo-generation units and his characteristics in combination with the power system. Concept of the spinning reserve, the frequency avalanche and system communication.	2
Lec 4	Control of the synchronous generators. Dispatcher chart and role of the delimiters.	2
Lec 5	Mathematical model of the synchronous generator regulator with different the excitation systems.	2
Lec 6	The generator control systems in steady-states and during transient-states. The concept of voltage avalanche.	2
Lec 7	The transformer tap changer – construction, operation and mathematical model. The transformer control system.	2
Lec 8	Reactive power in the power system and her control basing on the classic solutions and power electronics basing solutions.	2
Lec 9	Schemes and general operating principles of medium and high voltage power electronics circuits basing on NPC, FC, MMC topologies types.	2
Lec 10	Control and regulation of the three-phase active rectifier with a passive filter.	2
Lec 11	Control and regulation of the HVDC power electronics circuits basing on the MMC.	2
Lec 12	Comprehensive regulation of active power with frequency and the voltage with the reactive power in the power system.	2
Lec 13	Distributed control systems for voltages and power in the AC and the DC networks.	2
Lec 14	Sources of voltage and reactive power in medium voltage networks in form of power electronics controlled distributed generation.	2
Lec 15	Telemetry and telecontrol	2
	Total hours:	**30**

Form of classes - laboratory		**Number of hours:**
Lab 1	Presentation of safety regulations and internal regulations of laboratory. Assessment rules. Overview of laboratory stations	3
Lab 2	Testing of generator controller	3
Lab 3	Testing of transformer voltage controller	3
Lab 4	Testing of capacitor banks controller	3
Lab 5	Synchronization of generator with electrical network	3
	Total hours:	**15**

TEACHING TOOLS USED
N1. Specialized lecture
N2. Report arrangement from measurements

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	Oral and writing test
P(W)	P=F1	
F1(L)	PEU_U01 PEU_U02	Assessment of prepared laboratory reports
F2(L)	PEU_U01 PEU_U02	Activity during laboratory
P(L)	P=0,5F1+0,5F2	

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] Machowski J., Regulacja i stabilność systemu elektroenergetycznego. Oficyna Wydawnicza Politechniki Warszawskiej, Warszawa, 2007.
[2] Kremens Z., Sobierajski M., Analiza systemów elektro-energetycznych, WNT, Warszawa, 1996.
[3] Machowski J., Bialek S., Bumby J., Power system dynamics and stability, John Wiley and Sons, 1998
[4] Zajczyk R., Modele matematyczne systemu elektroenergetycznego do badania elektromechanicznych stanów nieustalonych i procesów regulacyjnych, Wydawnictwo PG, 2003

SECONDARY LITERATURE:

[1] Mircea Eremia, Mohammad Shahidehpour ,Handbook of electrical power system dynamics Modeling, Stability, and Control, IEEE Press, Wiley, 2013.
[2] Mircea Eremia, Chen-Ching Liu, Abdel-Aty Edris, Advanced solutions in power systems HVDC, FACTS, and Artificial Intelligence, IEEE Press, Wiley, 2016.
[3] Polish Instruction of Transmission System Operation and Maintenance

SUBJECT SUPERVISOR

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