

FACULTY OF ELECTRICAL
ENGINEERING**SUBJECT CARD**

Name in Polish: **Sterowanie i regulacja w systemie elektroenergetycznym**
 Name in English: **Power system operation and control**
 Main field of study (if applicable): **Electrical Engineering**
 Specialization (if applicable):
 Level and form of studies: **1st level, part-time**
 Kind of subject: **optional**
 Subject code: **ELR052263**
 Group of courses: **NO**

| | Lecture | Classes | Laboratory | Project | Seminar |
|--|----------------------|---------|----------------------|---------|---------|
| Number of hours of organized classes in University (ZZU): | 20 | | 10 | | |
| Number of hours of total student workload (CNPS): | 90 | | 60 | | |
| Form of crediting: | crediting with grade | | crediting with grade | | |
| For group of courses mark (X) final course: | | | | | |
| Number of ECTS points: | 3 | | 2 | | |
| including number of ECTS points for practical (P) classes : | | | 2 | | |
| including number of ECTS points for direct teacher-student contact (BK) classes: | 2.10 | | 1.40 | | |

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. 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 Has knowledge about basic function of regulation and control units of generation units in various operation states

relating to skills:

- PEU_U01 Is able to design and to connect measurement circuit for testing of synchronous generator excitation controller, transformer voltage controller and capacitor banks controller and select proper measuring equipment and perform measurements
 PEU_U02 Is able to elaborate measurement results and formulate conclusions

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 | The electrical power system, EPS, as a management and control object. Structure and operating states of the EPS. Polish Electrical Power System overview and selected statistical data. General scheme of the turbo-generation unit and its basic controllers. | 2 |
| Lec 2 | Static characteristic of the turbo-generation units and the power system. Concept of the spinning reserve, the frequency avalanche and system communication. Control systems of the synchronous generators. Control characteristics. Dispatcher chart and role of the delimiters. | 2 |
| Lec 3 | Construction and characteristics of the synchronous generators excitation systems. Mathematical model of the generator control system. Operation of the generator control systems in steady-states and during transient-states. The concept of voltage avalanche. | 2 |
| Lec 4 | Construction and mathematical model of the transformer tap changer. The transformer control system structure and algorithms. | 2 |
| Lec 5 | Reactive power sources in the power system. Control of the reactive power basing on the classic solutions and power electronics circuits. | 2 |
| Lec 6 | Schemes and general operating principles of selected medium and high voltage power electronics circuits. NPC, FC, MMC. The MMC as HVDC station submodule. | 2 |
| Lec 7 | Control and regulation of three-phase transistor based rectifier with passive filter. | 2 |
| Lec 8 | Comprehensive regulation in the system. Regulation of the active power with frequency and the voltage with the reactive power. | 2 |
| Lec 9 | General concept of distributed control systems for voltages and power in the AC and the DC networks. Their use in the distributed generation. | 2 |
| Lec 10 | Evaluation test | 2 |
| Total hours: | | 20 |

| Form of classes - laboratory | | Number of hours: |
|------------------------------|--|------------------|
| Lab 1 | Presentation of safety regulations and internal regulations of laboratory. Assessment rules. Overview of laboratory stations | 1 |
| Lab 2 | Testing of generator controller | 3 |
| Lab 3 | Testing of transformer voltage controller | 3 |
| Lab 4 | Testing of capacitor banks controller | 3 |
| Total hours: | | 10 |

TEACHING TOOLS USED

- N1. Specialized lecture
- N2. Report arrangement from measurements
- N3. Oral assessment

EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT

| Evaluation <i>F – forming (during semester)</i> <i>P – concluding (at semester end)</i> | 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 PEU_K01 | Evaluation of prepared laboratory reports |
| F2(L) | PEU_U01 PEU_K01 | 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 niustalonych 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

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| SUBJECT SUPERVISOR |
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