

FACULTY OF ELECTRICAL
ENGINEERING**SUBJECT CARD**

Name in Polish: **Systemy Elektromechaniczne w Odnawialnych Źródłach Energii**
 Name in English: **Electromechanical Systems in Renewable Energy**
 Main field of study (if applicable): **Electrical Engineering**
 Specialization (if applicable): **Renewable Energy Systems**
 Level and form of studies: **2nd level, full-time**
 Kind of subject: **obligatory**
 Subject code: **ELR043229**
 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 has the knowledge of fundamental laws of mechanical and electrical engineering. Student has the knowledge in the range of analysis of electric circuits and construction and operations of electrical machines.
2. Student has the basic knowledge of the theory of electrical drives, power electronic devices, converter systems and control systems.
3. Student has the ability to analyze mechanical systems, electrical circuits and systems with power electronic converters.
4. Student has the ability of critical analysis of the operations of selected mechanical systems, electrical circuits and electromechanical systems.
5. Student is able to work in groups and describe the results of his work.

SUBJECT OBJECTIVES

- C1. Presentation of electromechanical systems used in renewable energy systems and methods for their modeling and analysis
 C2. Knowledge of systems and methods for controlling of electromechanical systems used in renewable energy systems.

SUBJECT EDUCATIONAL EFFECTS*relating to knowledge:*

- PEK_W01 Student is able to describe and explain the construction of electromechanical systems and principles of modeling and analysis of selected types of turbines and electrical machines used in renewable energy systems
- PEK_W02 Student is able to define the concepts of electromechanical energy conversion in conventional and converter systems of renewable energy

relating to skills:

- PEK_U01 The student can realize an analysis of systems and control methods for selected electromechanical systems for renewable energy conversion
- PEK_U02 The student is able to prepare a critical comparison of the properties of electromechanical systems for renewable energy in the form of written report and multimedia presentation

relating to social competences:

- PEK_K01 The student has positive attitude and understands the need to develop multi-disciplinary knowledge and skills

PROGRAMME CONTENT

| Form of classes - lecture | | Number of hours: |
|---------------------------|---|------------------|
| Lec 1 | Classification of electromechanical systems used in renewable energy systems | 2 |
| Lec 2 | Constructions and mathematical models of wind turbines and other elements of electromechanical systems | 2 |
| Lec 3 | Constructions and mathematical models of electric generators used in electromechanical renewable energy systems | 2 |
| Lec 4 | Power electronic converter systems of energy conversion applied in the systems of the renewable energy conversion | 2 |
| Lec 5 | Fixed and variable-speed electromechanical systems with squirrel cage induction generators | 2 |
| Lec 6 | Variable-speed electromechanical systems with doubly fed induction generators | 2 |
| Lec 7 | Variable-speed electromechanical systems with synchronous generators | 2 |
| Lec 8 | Test | 1 |
| Total hours: | | 15 |

| Form of classes - seminar | | Number of hours: |
|---------------------------|---|------------------|
| Sem 1 | Multimedia presentation of selected constructions and control of wind turbines and discussion | 2 |
| Sem 2 | Multimedia presentation of selected electromechanical systems with conventional synchronous generators and PMSG generators and discussion | 2 |
| Sem 3 | Multimedia presentation of selected electromechanical systems with induction generators feeding into an AC grid and discussion | 2 |
| Sem 4 | Multimedia presentation of selected electromechanical systems with autonomous induction generators and discussion | 2 |
| Sem 5 | Multimedia presentation of controlled electromechanical systems with application of power electronics converters and discussion | 2 |
| Sem 6 | Multimedia presentation of selected electromechanical systems with DFIG induction generators and discussion | 2 |
| Sem 7 | Multimedia presentation of selected electromechanical systems with energy accumulation and discussion | 2 |
| Sem 8 | Presentation of critical comparison of electromechanical systems for renewable energy | 1 |
| Total hours: | | 15 |

TEACHING TOOLS USED

- N1. Lecture with multimedia presentation
 N2. Multimedia presentation on selected seminar subject
 N3. Student discussion on selected subjects

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 | Written test |
| P(w) | P=F1 | |
| F1(s) | PEK_U01 PEK_U02 | Evaluation of a student multimedia presentation |
| F2(s) | PEK_U01 PEK_U02 PEK_K01 | Evaluation of student activity on seminar classes |
| P(s) | $P=0,6 \cdot F1 + 0,4 \cdot F2$ | |

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

- [1] Anaya-Lara O., Jenkins N., Ekanayake J., Cartwright P., Hughes M.: Wind Energy Generation. Modelling and Control. John Wiley & Sons, 2009.
 [2] Burton T., Sharpe D., Jenkins N., Bossanyi E.: WIND ENERGY HANDBOOK. John Wiley & Sons, 2001.
 [3] Wu B., Power Conversion and Control of Wind Energy Systems. John Wiley & Sons, 2011.

SECONDARY LITERATURE:

- [1] Johnson G. L.: WIND ENERGY SYSTEMS. Manhattan, KS. Electronic Edition, 2001.
 [2] Krause P.C.: Analysis of electric machinery. McGraw Hill, 1986

SUBJECT SUPERVISOR

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**MATRIX OF CORRELATION BETWEEN EDUCATIONAL EFFECTS FOR SUBJECT
ELR043229 - Electromechanical Systems in Renewable Energy
AND EDUCATIONAL EFFECTS FOR MAIN FIELD OF STUDY Electrical Engineering
AND SPECIALIZATION Renewable Energy Systems**

| 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 | S2RES_W07 | C.1 C.2 | Lec1 Lec2 Lec3 Lec4 Lec5 Lec6 Lec7 Lec8 | N.1 |
| PEK_W02 | S2RES_W07 | C.1 C.2 | Lec1 Lec2 Lec3 Lec4 Lec5 Lec6 Lec7 Lec8 | N.1 |
| PEK_U01 | S2RES_U17 | C.1 C.2 | Sem1 Sem2 Sem3 Sem4 Sem5 Sem6 Sem7 Sem8 | N.2 N.3 |
| PEK_U02 | S2RES_U17 | C.1 C.2 | Sem1 Sem2 Sem3 Sem4 Sem5 Sem6 Sem7 Sem8 | N.2 N.3 |
| PEK_K01 | K2ETK_K01 | C.1 C.2 | Sem1 Sem2 Sem3 Sem4 Sem5 Sem6 Sem7 Sem8 | N.2 |