

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: **ELR053229**  
 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 LEARNING OUTCOMES***relating to knowledge:*

- PEU\_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
- PEU\_W02 Student is able to define the concepts of electromechanical energy conversion in conventional and converter systems of renewable energy

*relating to skills:*

- PEU\_U01 The student can realize an analysis of systems and control methods for selected electromechanical systems for renewable energy conversion
- PEU\_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:*

- PEU\_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:		<b>15</b>

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:		<b>15</b>

## TEACHING TOOLS USED

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

## EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT

Evaluation <i>F - forming (during semester) P - concluding (at semester end)</i>	Educational effect number	Way of evaluating educational effect achievement
F1(w)	PEU_W01 PEU_W02	Written test
P(w)	P=F1	
F1(s)	PEU_U01 PEU_U02	Evaluation of a student multimedia presentation
F2(s)	PEU_U01 PEU_U02 PEU_K01	Evaluation of student activity on seminar classes
P(s)	P=0,6*F1+0,4*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

<b>SUBJECT SUPERVISOR</b>
Krzysztof Pieńkowski, krzysztof.pienkowski@pwr.edu.pl