FACULTY OF ELECTRICAL ENGINEERING

SUBJECT CARD

Name in Polish:	**Odnawialne źródła energii**
Name in English:	**Renewable Energy Sources**
Main field of study (if applicable):	**Electrical Engineering**
Specialization (if applicable):	
Level and form of studies:	**1st level, full-time**
Kind of subject:	**optional**
Subject code:	**ELR051306**
Group of courses:	**NO**

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

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. The student should have basic knowledge of physics.
2. The student should have basic knowledge about operation of power grids.
3. The student should know and understand the definitions of power quality parameters.
4. The student should be capable correctly and effectively implement the rules and laws of physics to the qualitative analysis of problems related to the engineering discipline.

SUBJECT OBJECTIVES

C1. Introduction to types and ranges of exploitation of renewable energy sources;
C2. Overview of exploitation possibilities and development options for renewable energy sources .
C3. Presentation of the electrical power production utilizing solar, wind, geothermal and biomass resources.
C4. Development of familiarity with the newest trends and solutions in energy generation from renewable energy sources.
C5. Making a student aware of the necessity of using renewable energy sources.
C6. Explanation of the methods for connecting small energy sources to the grid.
C7. Familiarization with the effect of small energy sources on grid performance.

SUBJECT LEARNING OUTCOMES

relating to knowledge:

PEU_W01	Have knowledge concerning types and utilization range of renewable energy sources in the aspect of solar energy, of wind energy, of geothermal and biomass energy.
PEU_W02	Be able to identify and characterize the methods of energy production in fuel cells or from nuclear energy sources and in magneto-hydrodynamic systems and be able to list and describe existing energy sources and explain the conversion of this energy to electricity and explain the methods of electricity storage in super capacitors and expose the contradiction between existence of perpetual motion machines with the laws of physics.
PEU_W03	Know how to connect small energy sources to the grid and understand their impact on the grid operation.

relating to skills:

relating to social competences:

PEU_K01	Ability to think and act creatively and resourcefully and be aware of the necessity to develop renewable energy sources.

PROGRAMME CONTENT		
Form of classes - lecture		**Number of hours:**
Lec 1	Introduction of the subject, requirements and grading policy.	1
Lec 2	Types and utilization range of the renewable energy sources. Development perspectives for renewable energy sources in Poland and in the world.	3
Lec 3	Utilization of solar energy for production of both electricity and thermal energy. Characteristics of the solar radiation spectrum. Photovoltaic effect. Photovoltaic cells. Construction of photovoltaic panels and modules. Construction of photovoltaic systems.	2
Lec 4	Utilization of wind energy for electricity production. Characteristics of the wind and its energy reserve. Operation and construction of wind farms. Wind mills and their characteristics.	2
Lec 5	Geothermal resources in Poland and in the world. Geothermal installations in Poland. Operation principles and construction of heat pumps. Biomass. Characterization of selected biofuels. Biogas and its origin. Heat and electricity production from biogas fuels.	2
Lec 6	Fuel cells. Basic electrochemistry. Construction, principles of operation and types of fuel cells. Application examples. Methods of hydrogen production. Alternative elements for fuel cells.	2
Lec 7	Utilization of energy from the surrounding – energy scavengers. Functional energy resources and associated physical effects. Operation principles, construction and types of energy scavengers. Application examples.	2
Lec 8	Small-scale applications of nuclear energy. Nuclear fission and fusion. Cold fusion. Small-scale nuclear power plants. Nuclear batteries, betavoltaics, radioisotope generators. Application examples.	2
Lec 9	Super-capacitors as the energy storage devices. Operation principles, construction and types of super-capacitors. Combined systems of super-capacitors and photovoltaic panels. Magnetohydrodynamic generators.	2
Lec 10	Perpetual motion machines – classical physics “explanations”, stories.	2
Lec 11	Connection of small energy sources to an electrical grid.	2
Lec 12	Impact of small energy sources on the operation conditions of the grid.	2
Lec 13	Characteristics of small energy sources containing synchronous and asynchronous generator connected directly to the grid.	2
Lec 14	Characteristics of small energy sources connected to the grid through electrical convertors.	2
Lec 15	Final Test	2
	Total hours:	**30**

TEACHING TOOLS USED
N1. Traditional lectures supplemented by audio-visual demonstrations. Multi-medial presentation.
N2. Class presentations of physical effects, operation of devices and installations, demonstrations, etc.
N3. Conceptual discussions.

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 PEU_W03 PEU_K01	Final test
P(W)	P = F1	

PRIMARY AND SECONDARY LITERATURE
PRIMARY LITERATURE:
[1] Praca zbiorowa: Energia ze źródeł przyjaznych środowisku : zagadnienia wybrane, Gdańsk : Wydawnictwo Instytutu Maszyn Przepływowych, 2001. [2] Praca zbiorowa: Niekonwencjonalne źródła energii , Wrocław : Wydawnictwo Akademii Rolniczej, 1999. [3] Tytko S.: Odnawialne źródła energii, OWG Warszawa, 2010. [4] Lewandowski W.M.: Proekologiczne odnawialne źródła energii, Wydawnictwa Naukowo-Techniczne, Warszawa 2006. [5] Kacejko P.: Generacja rozproszona w systemie elektroenergetycznym. Wydawnictwo Uczelniane. Politechnika Lubelska 2004. [6] Lubośny Z.: Elektrownie wiatrowe w systemie elektroenergetycznym. WNT warszawa 2006.
SECONDARY LITERATURE:
[1] Da Rosa, Aldo Vieira, Fundamentals of renewable energy processes, Amsterdam: Elsevier Academic Press, cop. 2005 [2] Jenkins N., Allan R., Crossley P., Kirschen D., Strbac G.: Embeded Generation. Power & Energy 2000.

SUBJECT SUPERVISOR
Adam Gubański, adam.gubanski@pwr.edu.pl