FACULTY OF ELECTRICAL ENGINEERING

SUBJECT CARD

Name in Polish:	**Sposoby magazynowania energii elektrycznej**
Name in English:	**Energy Storage Systems**
Main field of study (if applicable):	**Electrical Engineering**
Specialization (if applicable):	**Renewable Energy Sources**
Level and form of studies:	**2nd level, full-time**
Kind of subject:	**obligatory**
Subject code:	**ELR042314**
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:	examination				
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. Has knowledge for the selection of electrical low voltage installation and equipment in normal and fault conditions.
2. He has knowledge concerning methods of production and consumption of electricity.
3. He has knowledge of the use of norms and regulations.
4. It has a sense of responsibility for their own work.

SUBJECT OBJECTIVES

C1. Familiarize students with the classification and main characteristic different kinds of electrical energy storage in the power system

C2. Practical skills of modeling daily load curves for the distribution network nodes

C3. Practical skills of determining the basic parameters of battery energy storage to compensate for the load curves in the nodes in the distribution network

C4. Skills determine of optimal solutions

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:

PEK_W01 Has knowledge in the field of energy storage devices in the power system

PEK_W02 Has knowledge about determine of battery energy storage to compensate for load curves in the nodes low voltage distribution network

relating to skills:

relating to social competences:

PEK_K01 He understands the need for self-study, including the ability to develop self-esteem and self-control and responsibility for the results of actions taken.

PROGRAMME CONTENT		
Form of classes - lecture		**Number of hours:**
Lec 1	Familiar with the subject, program requirements and how to pass. All issues concerning the storage of electricity in the power system.	2
Lec 2	Classification and general characteristics of the storage devices that enable electricity power system.	2
Lec 3	Pumped hydro energy storage	2
Lec 4	Compresses air systems (CAES) and flywheel systems	2
Lec 5	Fuel Cells	2
Lec 6	Superconducting Magnetic Energy Storage (SMES), ultra capacitors	2
Lec 7	Electrochemical batteries.	2
Lec 8	Battery Energy Storage (BES)	2
Lec 9	Modeling daily load curves for selected electricity customers.	2
Lec 10	Determination of model curves for selected nodes in low-voltage distribution network	2
Lec 11	Determination of actual load curves for selected nodes in the low voltage distribution network	2
Lec 12	Determination of power and energy of battery storage in the nodes of the distribution network for the designated load curves in these nodes	2
Lec 13	Determining the optimum battery energy storage units	2
Lec 14	Designated to carry out the unification for optimal battery energy storage units in nodes of distribution network	2
Lec 15	Summary of lecture and discussion of the examination tasks	2
	Total hours:	**30**

TEACHING TOOLS USED
N1. Lecture with audio-visual technology, multimedia presentations N2. Consultations

EVALUATION OF SUBJECT EDUCATIONAL EFFECTS ACHIEVEMENT		
Evaluation *F – forming (during semester)* *P – concluding (at semester end)*	**Educational effect number**	**Way of evaluating educational effect achievement**
F1(W)	PEK_W01 PEK_W02 PEK_K01	Written exam
P(W)	P=F1	

PRIMARY AND SECONDARY LITERATURE
PRIMARY LITERATURE: [1] Haubrich (Editor): Bartery Energy Storage. Handbook, ISBN 3-89653-188-3, Achen 1996 *) [2] Proceedings of EU-Project ICOP-DISS-2140-96, Distributed Energy Storage for Power Systems, Pod red. Feser K., Styczyński Z. A., Verlag Mainz, Aachen 1998. *) *) Literature provided by the teacher. **SECONDARY LITERATURE:** [1] Batterie-Energiespeicher in der Elektrizitatsversorgung - Kompendium, H.-J. Haubrich [Hrsg], Verlag Mainz, Aachen 1996. [2] Markiewicz H. Urządzenia elektroenergetyczne. Wyd. 4, WNT, Warszawa 2008.

SUBJECT SUPERVISOR
Kazimierz Herlender, kazimierz.herlender@pwr.edu.pl

MATRIX OF CORRELATION BETWEEN EDUCATIONAL EFFECTS FOR SUBJECT
ELR042314 - Energy Storage Systems
AND EDUCATIONAL EFFECTS FOR MAIN FIELD OF STUDY **Electrical Engineering**
AND SPECIALIZATION **Renewable Energy Sources**

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	S2OZE_W09	C.1	Lec1 Lec2 Lec3 Lec4 Lec5 Lec6 Lec7 Lec8	N.1 N.2
PEK_W02	S2OZE_W09	C.2 C.3 C.4	Lec8 Lec9 Lec10 Lec11 Lec12 Lec13 Lec14	N.1 N.2
PEK_K01	K2ETK_K06	C.1 C.2 C.3 C.4	Lec1 Lec2 Lec9 Lec12 Lec13 Lec14 Lec15	N.1 N.2