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 Systems**
Level and form of studies:	**2nd level, full-time**
Kind of subject:	**obligatory**
Subject code:	**ELR032334**
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):	60			30	
Form of crediting:	examination			crediting with grade	
For group of courses mark (X) final course:					
Number of ECTS points:	2			1	
including number of ECTS points for practical (P) classes :				1	
including number of ECTS points for direct teacher-student contact (BK) classes:	1.40			0.70	

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. Is able to read project assumptions
3. Is able to make use of regulations and norms
4. Can work in group and understand the needs of recurrent self education

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 He has knowledge of the use of battery energy storage in the power system

relating to skills:

PEK_U01 It can determine the basic parameters of battery energy storage to compensate for load curves in the nodes low voltage distribution network
PEK_U02 It can determine the optimum battery energy storage units
PEK_U03 Able to present the results of the design calculations in the form of project documentation

relating to social competences:

PEK_K01 It has a sense of responsibility for their own work and a willingness to comply with the principles of teamwork

PROGRAMME CONTENT		
Form of classes - lecture		**Number of hours:**
Lec 1	Acquainted with the subject , program and requirements and the way credit	1
Lec 2	Classification and general characteristics of the devices that enable storage of electricity in the power system.	2
Lec 3	Pumped storage power plants	2
Lec 4	Compressed gas storage tanks and the kinetic energy of rotating masses .	2
Lec 5	Fuel cells	2
Lec 6	Superconducting energy storage (SMES) and capacitors	2
Lec 7	Electrochemical batteries. Battery energy storages.	2
Lec 8	Summary of lecture and discussion of problems examination.	2
	Total hours:	**15**

Form of classes - project		**Number of hours:**
Proj 1	Deal project assumptions and discussion of how to do the project.	1
Proj 2	Modelling of daily load curves for selected energy consumers.	2
Proj 3	Determination of model curves loads at specified nodes low-voltage distribution network.	2
Proj 4	Determination of actual load curves at specified nodes of the low voltage distribution network.	2
Proj 5	Determination of power and energy of battery storage in nodes set for the designated distribution network load curves on these nodes .	2
Proj 6	Determining the optimum energy storage battery modules that meet design calculations carried out	2
Proj 7	Conducting unification for the designated optimum energy storage battery modules	2
Proj 8	Assessment of the project.	2
	Total hours:	**15**

TEACHING TOOLS USED
N1. Lecture with audio-visual technology, multimedia presentations.
N2. Discussion problematic.
N3. Computer Laboratory conducted for a group of students - each student with a separate computer.
N4. Checking messages in the form of oral or written.
N5. Preparation of project documentation.

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	Written exam and / or oral
P(W)	P=F1	
F1(P)	PEK_U01 PEK_U02 PEK_K01	Activity classes
F2(P)	PEK_U03	Ewaluation of design documentation
P(P)	P=0,4F1+0,6F2	

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. *)
*) Pozycje udostępniane przez prowadzącego.

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

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MATRIX OF CORRELATION BETWEEN EDUCATIONAL EFFECTS FOR SUBJECT
ELR032334 - Energy Storage Systems
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_W03	C.1	Lec2 Lec3 Lec4 Lec5 Lec6 Lec7	N.1 N.2
PEK_W02	S2RES_W03	C.3 C.4	Lec2 Lec7	N.1 N.2
PEK_U01	S2RES_U03	C.2 C.3	Proj1 Proj2 Proj3 Proj4 Proj5	N.2 N.3 N.4
PEK_U02	S2RES_U03	C.3 C.4	Proj5 Proj6 Proj7	N.2 N.3 N.4
PEK_U03	S2RES_U03	C.2 C.3 C.4	Proj4 Proj5 Proj6 Proj7	N.5
PEK_K01	S2RES_K02	C.1 C.2 C.3 C.4	Proj2 Proj3 Proj4 Proj5 Proj6 Proj7	N.2 N.3 N.4