STUDY COURSE DESCRIPTION FORM

Name of the course	Code
Generation and storage of energy	
Name of the doctoral school	Year /Semester
Poznan University of Technology Doctoral School	**….**
Specialty/Discipline	Type (obligatory, elective):
Chemical sciences	**elective**
No. of hours	No. of credits
Lectures: **4** Classes: **-** Laboratories: **-** Seminars: **-**	**1**

Cycle of study:	**Form of study:**	**Assessment:** (written exam, presentation, etc.)
Third-cycle studies (Polish Qualifications Framework level eight)	Full-time	Written exam

Responsible for the course/lecturer:

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Prerequisites in terms of knowledge, skills and social competencies:

1	**Knowledge:** Student should be familiar with the basic knowledge of physical chemistry, electrochemistry, materials science. Student should be able to distinguish between physical and chemical properties of the matter.
2	**Skills:** Student should be able to communicate in English and to self-educate. Student should be able to read and understand the scientific papers of typical structure.
3	**Social competencies:** Student should understand the need of self-education in terms of reading literature recommended by lecturer. Student should be able to work independently and as a team member.

Objectives of the course:

The students should get acquainted with the generation of energy, conversion of chemical energy into electrical energy, different types of advanced energy sources, novel materials of power sources

Educational results (Study outcomes)

Knowledge:

P8S_WG	Student is able to distinguish between energy conversion and storage systems	**SzD_W01**
P8S_WG	Student knows the principles of operation for various electrochemical energy and storage systems.	**SzD_W02**

P8S_WG	Student is able to propose an appropriate material and methodology for the respective energy conversion and storage system	**SzD_W03**
Skills:		
P8S_UW	Student understands various mechanisms of energy conversion and their consequences at the application level	**SzD_U01**
P8S_UW	Student is able to propose an appropriate solution for energy storage	**SzD_U02**
P8S_UK	Student is able to evaluate the scientific paper and the data reported in terms of their correctness (capacity, capacitance) and report them to scientific community	**SzD_U04**
P8S_UK	Student is able to share scientific results in a popular way	**SzD_U05**
P8S_UK	Use the English language on at least B2 level to allow active participation in the international scientific and professional community	**SzD_U08**
Social competencies:		
P8S_KK	Critically assess the achievements within global generation/storage of energy	**SzD_K01**
P8S_KO	Fulfilling the social obligations of researchers and creators	**SzD_K04**
P8S_KR	Ability to conduct independent scientific activity and respect the principles of intellectual property protection	**SzD_K07**

Compulsory literature:

1. B. E. Conway, Electrochemical Supercapacitors – scientific fundamentals and technological applications, Kluwer Academic/Plenum, New York 1999.
2. Nanomaterials Handbook ed. Y. Gogotsi, Taylor and Francis, Florida, 2006
3. D. Linden ed. Handbook of Batteries and Fuel Cells, McGraw-Hill, Inc. NY 1984.
4. Carbons for Electrochemical Energy Storage and Conversion Systems, F. Beguin, E. Frackowiak eds., CRC Press, Boca Raton, FL, USA, 2010.

Additional literature:

Papers indicated by the lecturer during course/lectures.

COURSE DESCRIPTION

	General issues	**Specific issues**	**No. of hours**
1	Generation/harvesting of energy	• Introduction on different kinds of generation energy: nuclear energy, renewables, chemical energy	0.25
2	Conversion of chemical energy into electrical energy	• Examples of generation and storage of energy. Main characteristics of power sources (capacity, power, energy, etc). Ragone plot. Application of different materials for conversion of chemical energy into electrical one. Types of electrolytes. Ionic liquids as a new green electrolyte.	0.75
3	Li-ion batteries	• Principle of operation. Various types of anode and cathode materials. Solid electrolyte interphase. Organic electrolytes. Safety.	1

4	Electrochemical capacitors	• Performance of electrochemical capacitor. Charging of electric double layer. Solvation-desolvation phenomena. Pseudocapacitive materials: conducting polymers, transition metal oxides, carbon materials with heteroatoms (nitrogen, oxygen). Electrolyte as a source of pseudocapacitane effects. Symmetric, asymmetric and hybrid systems. Li-ion capacitors.	1
5	Fuel cells (FC)	• Operation and types of FC depending on temperature.	0.5
6	Beyond power sources	• Nickel/metal hydrides batteries. Redox-flow batteries.	0.5

Assessment methods of educational results
Written exam and/or test after the lectures

STUDENT'S WORKLOAD

Activity	**Hours**
Participation in lectures	4
Contact hours with lecturers	4
Self-study	20
Exam	2
TOTAL	**30**
TOTAL NUMBER OF ECTS POINTS FOR THE COURSE	1