STUDY MODULE DESCRIPTION FORM

Name of the module/subject	Code
Advanced materials for generation/storage of energy	**1010702221010702657**

Field of study	Profile of study (general academic, practical)	Year /Semester
Chemical Technology	**general academic**	**1 / 2**
Elective path/specialty	Subject offered in:	Course (compulsory, elective)
Composites and Nanomaterials	**Polish**	**obligatory**

Cycle of study:	Form of study (full-time,part-time)
Second-cycle studies	**full-time**

No. of hours						No. of credits
Lecture:	**30**	Classes:	**-**	Laboratory:	**45**	Project/seminars: **15**	**6**

Status of the course in the study program (Basic, major, other)	(university-wide, from another field)
other	**university-wide**

Education areas and fields of science and art	ECTS distribution (number and %)
technical sciences	**6 100%**
Technical sciences	**6 100%**

Responsible for subject / lecturer:

prof. dr hab. Elżbieta Frąckowiak
email: elzbieta.frackowiak@put.poznan.pl
tel. 616653632
Faculty of Chemical Technology
ul. Berdychowo 4 60-965 Poznań

Prerequisites in terms of knowledge, skills and social competencies:

1	**Knowledge**	Student should be familiar with the backgrounds of electrochemistry. Student should be familiar with the backgrounds of material chemistry. Student should be familiar with the backgrounds of physical chemistry.
2	**Skills**	Student should be able to communicate in English. Student should be able to self-education.
3	**Social competencies**	Student should understand the need of self-education in terms of reading literature recommended by lecturer. Student should understand the importance of working separately and as a part of team.

Assumptions and objectives of the course:

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

Study outcomes and reference to the educational results for a field of study

Knowledge:

1. Student is able to find the differences between various materials for energy conversion and storage - [K_W03,K_W04]
2. Student is able to schedule appropriate materials for energy conversion and storage - [K_W06,K_W07]

Skills:

1. Student knows the pathway for selecting appropriate material for energy storage process - [K_U11,K_U15]
2. Student understands the mechanism of energy accumulation in different materials - [K_U21,K_U22]

Social competencies:

1. Student is able to self-education - [K_K06]
2. Student understands the need of self-development - [K_K02]
3. Student understands the importance of the team-working - [K_K04]

Assessment methods of study outcomes

Written exam after lectures.

Course description

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. Electrode/electrolyte interface in the various power sources. Performance of electrochemical capacitor. Supercapacitors: materials, pseudocapacitance, 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. Principle of lithium-ion cell. Solid electrolyte interface. Novel generation of lithium-ion batteries. Advanced materials for new power sources. Ionic liquids as a new green electrolyte. Flow-redox systems. Fuel cells: materials, performance, different types of fuel cells. Photovoltaic cells. Dye-sensitized solar cells. Application of novel energy sources.

Basic bibliography:

1. Nanomaterials Handbook ed. Y. Gogotsi, Taylor and Francis, Florida, 2006

2. B. E. Conway, Electrochemical Supercapacitors ? scientific fundamentals and technological applications, Kluwer Academic/Plenum, New York 1999.

3. Carbons for Electrochemical Energy Storage and Conversion Systems, F. Beguin, E. Frackowiak eds., CRC Press, Boca Raton, FL, USA, 2010

Additional bibliography:

Result of average student's workload

Activity	Time (working hours)
1. Lecture	30
2. Consultation to lecture	10
3. Laboratory classes (practice)	45
4. Consultation to laboratory	25
5. Project	15
6. Consultation to project	23
7. Exam	2

Student’s workload

Source of workload	hours	ECTS
Total workload	150	6
Contact hours	135	0
Practical activities	60	0