COURSE DESCRIPTION CARD - SYLLABUS

Course name

GENERATION AND STORAGE OF ENERGY

Course

Proposed by Discipline

Chemical sciences

Type of studies

Doctoral School

Form of study

full-time

Year/Semester

II/4

Course offered in

English

Requirements

elective

Number of hours

Lecture	Tutorials	Projects/seminars
4		

Number of credit points

1

Lecturers

Responsible for the course/lecturer:

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Responsible for the course/lecturer:

Prerequisites

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.

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.

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.

Course objective

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.

Course-related learning outcomes

Knowledge

A PhD student who graduated from doctoral school knows and understands:

1) differences between energy conversion and storage systems, [P8S_WG/SzD_W01]

2) principles of operation for various electrochemical energy and storage systems, [P8S_WG/SzD_W02]

3) appropriate materials and methodology for the respective energy conversion and storage system. [P8S_WG/SzD_W03]

Skills

A PhD student who graduated from doctoral school:

1) understands various mechanisms of energy conversion and their consequences at the application level, [P8S_UW/SzD_U01]

2) able to propose an appropriate solution for energy storage, [P8S_UW/SzD_U02]

3) able to evaluate the scientific paper and the data reported in terms of their correctness (capacity, capacitance) and report them to scientific community, [P8S_UK/SzD_U04]

4) able to share scientific results in a popular way, [P8S_UK/SzD_U05]

5) use the English language on at least B2 level to allow active participation in the international scientific and professional community. [P8S_UK/SzD_U08]

Social competences

A PhD student who graduated from doctoral school is ready to:

1) critically assess the achievements within global generation/storage of energy, [P8S_KK/SzD_K01]

2) fulfill the social obligations of researchers and creators, [P8S_KO/SzD_K04]

3) conduct independent scientific activity and respect the principles of intellectual property protection. [P8S_KR/SzD_K07]

Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

PQF code	Methods for verification of learning outcomes	Assessment criteria
W01, W02, W03	written exam to check knowledge gained during lectures: exam consists 10 questions (tests and open style)	passing threshold: 50%
U01, U02, U04, U05, U08	ability to compose energy storage systems from anodic and cathodic materials during written exam	passing threshold: 50%
K01, K04, K07	ability to distinguish green energy from global generation/storage of energy during written exam	passing threshold: 50%

Programme content

1. Generation/harvesting of energy (Introduction on different kinds of generation energy: nuclear energy, renewables, chemical energy).
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).
3. Li-ion batteries (Principle of operation. Various types of anode and cathode materials. Solid electrolyte interphase. Organic electrolytes. Safety).
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).
5. Fuel cells (FC) (Operation and types of FC depending on temperature).
6. Beyond power sources (Nickel/metal hydrides batteries. Redox-flow batteries).

Teaching methods

Lecture: multimedia presentation including illustrations and examples.

Bibliography

Basic

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

1. Papers indicated by the lecturer during course/lectures.

Breakdown of average student's workload

	Hours	ECTS
Total workload	28	1.0
Classes requiring direct contact with the teacher	8	0.5
Student's own work (literature studies, preparation for tutorials, project preparation) [1]	20	0.5

[1] delete or add other activities as appropriate