COURSE DESCRIPTION CARD - SYLLABUS

Course name

Advanced materials for generation/storage of energy [S2TCh2E-KiN>ZMdW/ME]

Course

Field of study
Chemical Technology

Year/Semester
1/2

Area of study (specialization)
Composites and Nanomaterials

Profile of study
general academic

Level of study
second-cycle

Course offered in
english

Form of study
full-time

Requirements
compulsory

Number of hours

Lecture
30

Laboratory classes
45

Other (e.g. online)
0

Tutorials
0

Projects/seminars
15

Number of credit points

6,00

Coordinators

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Lecturers

Prerequisites

Basic knowledge of general chemistry, physical chemistry, electrochemistry, materials science. Ability to obtain information from indicated sources.

Course objective

The aim of the lecture is to supply knowledge on the conversion of chemical energy into electrical energy, novel materials of power sources and different types of advanced energy sources.

Course-related learning outcomes

Knowledge:
K_W3 - has improved knowledge of complex chemical processes with a suitable selection of materials, resources, methods, techniques and characterization of obtained materials
K_W4 - has improved knowledge of kinetics, thermodynamics, surface phenomena and catalysis of chemical processes
K_W6 - has improved knowledge of the newest chemical and material technologies, knows current trends in the development of chemical industrial processes
K_W11 - has well-grounded and improved knowledge of selected speciality (materials for

generation/storage of energy)
K_W14 - has knowledge of selected aspects of modern chemical knowledge

Skills:
K_U1 - has the ability to obtain and critically evaluate information from the literature, databases and other sources, and formulate opinions on this basis
K-U3 - is able to communicate in English for professional contacts
K_U12 - has the ability to adapt knowledge about chemistry and related fields to solve problems in the field of chemical technology and planning new industrial processes
K_U15 - is able to critically analyze industrial chemical processes and introduce modifications and improvements in this area, using the acquired knowledge, including knowledge about the latest achievements of science and technology

Social competences:
K_K1 - is aware of the need for lifelong learning and professional development
K_K2 - is aware of the limitations of science and technology related to chemical technology, including environmental protection
K_K6- is able to think and act creatively

Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

Written/oral exam graded on the basis of a points system (0-100 points)
3 50.1 -70.0 points
4 70.1 -90.0 points
5 90.1 -100 points

Programme content

1. Examples of generation and storage of energy. Main parameters of power sources (voltage, capacity, power, energy, etc). Ragone plot.
2. Application of different materials for conversion of chemical energy into electrical one.
3. Electrode/electrolyte interface in the various power sources.
4. Performance of electrochemical capacitor: materials, electrolytes, solvation-desolvation phenomena.
5. Pseudocapacitive materials: conducting polymers, transition metal oxides, carbon materials with heteroatoms (nitrogen, oxygen).
6. Electrolyte as a source of pseudocapacitane effects.
7. Symmetric, asymmetric and hybrid systems.
8. Principle of lithium-ion cell. Novel generation of lithium-ion batteries.
9. Advanced materials for new power sources. Ionic liquids as a new green electrolyte.
10. Flow-redox systems.
11. Fuel cells: materials, performance, different types of fuel cells.
12. Photovoltaic cells. Dye-sensitized solar cells.
13. Practical application of novel energy sources, e.g. electrical vehicles.
Laboratories provide basic techniques used in electrochemistry. Students will build models of generation/storage systems. Students will measure basic parameters of energy storage devices. Proper laboratory procedures, chemical safety rules, and environmentally safe methods of chemical disposal and waste minimization are important components of the course. Experiments are selected to provide illustration and reinforcement of course topics.

Teaching methods

Lecture: multimedia presentation illustrated with examples shown on a blackboard. Films.
Laboratory and project exercises.

Bibliography

Basic:
1. Nanomaterials Handbook ed. Y. Gogotsi, CRC, Taylor and Francis, Florida, 2014
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. Frackow iak ed s., CRC Press, Boca Raton, FL, USA, 2010.
4. D. Linden ed. Handbook of Batteries and Fuel Cells, McGraw-Hill, Inc. NY 1984
5. C.H. Hamann, A. Hamnett, W. Vielstich, Electrochemistry, Wiley-VCH, Weinheim, 2007.
6. C. A. Vincent, B. Scrossati, Modern Batteries, J. Wiley, New York 1997.

Additional:
1. W.S. Bagocki, W.N. Florow, Chemiczne Źródła Energii Elektrycznej, WNT, Warszawa 1965.

Breakdown of average student's workload

	Hours	ECTS
Total workload	150	6,00
Classes requiring direct contact with the teacher	94	4,00
Student's own work (literature studies, preparation for laboratory classes/ tutorials, preparation for tests/exam, project preparation)	56	2,00