COURSE DESCRIPTION CARD - SYLLABUS

Course name
Hybrid sources of energy

Course

Field of study
Chemical and process engineering

Year/Semester
1/1

Area of study (specialization)
Chemical engineering

Profile of study
general academic

Level of study
Second-cycle studies

Course offered in
Polish

Form of study
full-time

Requirements
compulsory

Number of hours

Lecture	Laboratory classes	Other (e.g. online)
	15	
Tutorials	Projects/seminars	

Number of credit points

1

Lecturers

Responsible for the course/lecturer:
Przemysław Galek

Responsible for the course/lecturer:

Prerequisites

A student starting this laboratory should have basic knowledge about energy conversion and storage systems. One should also have knowledge about energy sources, their processing and storage. A students knows basic definitions of the nominal values of energy storage devices: current, voltage, potential, capacity, energy, power.

Course objective

Providing students detailed knowledge about energy storage devices, their construction and performance. Acquaintance students with electrochemical techniques most commonly used in the laboratory. Practical familiarization with electrode materials production methods. Explanation of basic nominal values methods calculation.

Course-related learning outcomes

Knowledge

1. understanding the phenomena associated with charge storage. (K_W07)

2. ability to calculate basic nominal values describing energy storage devices performance (capacity, energy, power, charging/discharging efficiency). (K_W12)

Skills

1. has an ability to interpret results obtained with basic electrochemical techniques. (K_U01)

2. ability to build simple energy storage devices (electrochemical cell/capacitor). (K_U10)

Social competences

1. understands the need to search for alternative energy sources to protect the environment. (K_K02)

Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

Acquired knowledge and skills as a part of laboratory exercises are verified by 20-minutes entrance tests carried out during each class. Tests consist of 3-5 open-ended questions, with different scores. The pass threshold of each test is 51% of the total points. Each test should be passed. In the case of insufficient points collected by a student or a student absence during classes, a deadline for repetition/corrections is provided. Questions will be prepared based on test issues given to students by e-mail (using the university e-mail system) after the first class.

Programme content

1. Electrolysis and hydrogen sorption on carbon materials.

2. Secondary cell: nickelImetal hydride.

3. Primary cell: Leclanché.

4. Electrochemical capacitor.

Teaching methods

1. realisation of tasks given by the teacher - practical exercises.

Bibliography

Basic

1. F. Beguin, E. Frackowiak, Carbons for Electrochemical Energy Storage and Ceonversion Systems, 2009, CRC Press.

2. A. J. Bard, L. R. Faulkner, Electrochemical Methods, 2000, John Wiley & Sons Inc.

3. F. Beguin, E.Frackowiak, M. Lu, Supercapacitors: Materials, Systems, and Applications, 2013.

4. V. S. Bagotsky, Fundamentals of Electrochemistry, 2005, John Wiley and Sons.

Additional

1. A. F. Dalebrook, W. Gan, M. Grasemann, S. Moreta, G. Laurenczy, Hydrogen storage: beyond conventional methods, Chem. Commun., 2013, 49, 8735-8751.

2. K. Jurewicz, E. Frackowiak, F. Béguin, Towards the mechanism of electrochemical hydrogen storage in nanostructured carbon materials Appl. Phys. A, 2004, 981, 78.

3. C. Fangyi, L. Jing, T. Zhanliang, C. Jun, Functional Materials for Rechargeable Batteries, 2011.

4. A. K. Shukla, S.Venugopalan, B. Hariprakash, Nickel-based rechargeable batteries, volume 100, issues 1–2, 2001, pages 125-148.

5. S. Sonal, J. Shikha, PS Venkateswaran, K. T. Avanish, R. N. Mansa, K. P. Jitendra, G. Sanket, Hydrogen: A sustainable fuel for future of the transport sector, Renewable and Sustainable Energy Reviews, volume 51, 2015, pages 623-633.

6. Sunita Sharmaa Sib, Krishna Ghoshal, Hydrogen the future transportation fuel: From production to applications, Renewable and Sustainable Energy Reviews, volume 43, 2015, pages 1151-1158.

7. Schlapbach, A. Züttel, Hydrogen-storage materials for mobile applications, Nature, volume 414, issue 6861, 2001, pages 353-358.

8. C. S.Johnson, Development and utility of manganese oxides as cathodes in lithium batteries, Journal of Power Sources, volume 165, issue 2, 2007, pages 559-565.

9. Z. Rogulski, A. Czerwiński, Cathode modification in the Leclanché cell, Journal of Solid State Electrochemistry, 2003, volume 7, issue 2, pages 118–121.

Breakdown of average student's workload

	Hours	ECTS
Total workload	30	1,0
Classes requiring direct contact with the teacher	15	0,5
Student's own work (literature studies, preparation for laboratory classes, preparation for entrance tests, preparing reports) [1]	15	0,5

[1] delete or add other activities as appropriate