GDAŃSK UNIVERSITY OF TECHNOLOGY

Subject card

Subject name and code	Chemical power sources, PG_00037313		
Field of study	Technical Physics		
Date of commencement of studies	October 2022	Academic year of realisation of subject	2025/2026
Education level	first-cycle studies	Subject group	Optional subject group Subject group related to scientific research in the field of study
Mode of study	Full-time studies	Mode of delivery	at the university
Year of study	4	Language of instruction	Polish
Semester of study	7	ECTS credits	2.0
Learning profile	general academic profile	Assessment form	assessment
Conducting unit	Department of Chemistry and Technology of Functional Materials -> Faculty of Chemistry -> Wydziały Politechniki Gdańskiej		
Name and surname of lecturer (lecturers)	Subject supervisor	prof. dr hab. Anna Lisowska-Oleksiak	
	Teachers	prof. dr hab. Anna Lisowska-Oleksiak	

Lesson types and methods of instruction

Lesson type	Lecture	Tutorial	Laboratory	Project	Seminar	SUM
Number of study hours	15.0	0.0	15.0	0.0	0.0	30

E-learning hours included: 0.0

eNauczanie source address: https://enauczanie.pg.edu.pl/2025/course/view.php?id=1086

Moodle ID: 1086 Chemiczne źródła prądu 2025
https://enauczanie.pg.edu.pl/2025/course/view.php?id=1086

Additional information:
The course consists of lectures and laboratory classes conducted in a traditional (in-person) format

Learning activity and number of study hours

Learning activity	Participation in didactic classes included in study plan	Participation in consultation hours	Self-study	SUM
Number of study hours	30	2.0	18.0	50

Subject objectives

The aim of the course is to provide and consolidate knowledge in the field of the fundamentals of electrochemistry and materials chemistry of electrical conductors. The acquired knowledge will serve to understand the role of conductors in the operation of electrochemical devices for energy storage and conversion

Learning outcomes

Course outcome	Subject outcome	Method of verification
K6_W02	Possesses structured knowledge in the fundamentals of electrochemistry, covering the electrochemistry of aqueous and non-aqueous (aprotic) systems in the areas of ionics and electrode proceces	[SW3] Assessment of knowledge contained in written work and projects [SW1] Assessment of factual knowledge
K6_W01	The student understands the importance of employing electrochemical phenomena in applications such as electrical energy storage and others.	[SW3] Assessment of knowledge contained in written work and projects [SW1] Assessment of factual knowledge
K6_U01	The student is able to independently supplement and update their knowledge in the field of developing technologies of chemical power sources	[SU5] Assessment of ability to present the results of task [SU3] Assessment of ability to use knowledge gained from the subject

Subject contents	**Fundamentals of Electrochemistry** Ionics Charge Transport in Electrolytes: aqueous electrolytes, aprotic electrolytes, polymer electrolytes, gel electrolytes, solid electrolytes, polymer electrolytes based on PEO. Electrode / electrolyte phase boundaries: metal/electrolyte, semiconductor/electrolyte, membrane/ electrolyte. Kinetics of electrode reactions; ButlerVolmer equation, exchange current, transfer coefficient, overpotential. Processes of new phase formation electrocrystallization, electropolymerization. Mechanisms of selected electrode processes: oxidation of hydrogen, methanol, methane, ethanol, glucose; oxygen reduction. Methods of studying electrode processes: voltammetry, chronopotentiometry, chronoamperometry, electrochemical impedance spectroscopy. **II. Devices for Electrical Energy Storage and Conversion** A) **Primary cells:** zincmanganese dioxide, zincsilver oxide, metalair cells, primary lithium cells, large-scale primary cells for special applications, etc. Anode passivation in primary cells, solid electrolyte interphase. Solid cathode materials, liquid cathodes in lithium cells. High-power redox-flow systems (RFC). B) **Rechargeable cells:** leadacid batteries new technical solutions; metal hydride batteries NiMH; lithium batteries (lithium anodes, carbon anodes, intercalation cathodes); lithium-ion batteries (LIBs); sodium-ion cells. C) **Electrochemical capacitors (EDLC, supercapacitors):** electrode materials (sp^2 carbon materials, electroactive polymers, transition metal oxides). Hybrid systems supercapacitor/galvanic cell. Batteries ecological aspects, European Union regulations. D) Fuel cells (optional): SOFC, MCFC, PMFC, DMFC, others. Fuel cell electrodes: catalysts for the oxygen reduction reaction in proton-exchange membrane fuel cells. Methanol oxidation. Hydrogen as a fuel. Sources of hydrogen hydrogen from water (photoelectrocatalysis). Currentvoltage characteristics of devices. Powerenergy diagrams for electrochemical power sources (ChŹP). **Laboratory** 1. Gel electrolytes with aprotic solvents and PMMA matrix determination of electrolyte conductivity. 2. Polymer electrodes for supercapacitors determination of charge transport parameters in the material. 3. Cyclic voltammetry applied to the characterization of intercalation electrodes, exemplified by Prussian blue. 4. Determination of hydrogen evolution overpotential. Electrocatalytic influence of electrode material on the H/H reaction. 5. Commercial batteries and identification of chemical components of the device. Basics of recycling.
Prerequisites and co-requisites	Knowledge of the fundamentals of chemistry and physics in the area of electricity and magnetism

Assessment methods and criteria

Subject passing criteria	Passing threshold	Percentage of the final grade
	100.0%	40.0%
	51.0%	60.0%

Recommended reading

Basic literature	[1] A. Kisza Elektrodyka, WNT 1997 [2] A. Czerwiński, Akumulatory baterie, ogniwa, WKŁ Warszawa 2005 [3] W. Bogusz, F. Krok, Elektrolity stałe WNT 1995 [4] Solid State Electrochemistry, ed. . P.G. Bruce, Cambridge University Press 1995.

	Supplementary literature	Comprehensive review of lithium-ion battery materials and development challenges, doi:https://doi.org/10.1016/j.rser.2024.114783 Comprehensive review of Sodium-Ion Batteries: Principles, Materials, Performance, Challenges, and future Perspectives doi:https://doi.org/10.1016/j.mseb.2024.117870 Electrochemical Supecapacitors, Fundamentals and Technological Applications, B.E. Conway, ed. KLuwer 1999 Current articles available from Scopus
	eResources addresses	Supplementary https://www.sciencedirect.com/referencework/9780444527455/encyclopedia-of-electrochemical-power-sources?prefix=a -
Example issues/ example questions/ tasks being completed		
Work placement	Not applicable	