



Subject card

Subject name and code	Chemical power sources, PG_00037313						
Field of study	Technical Physics						
Date of commencement of studies	October 2021	Academic year of realisation of subject			2023/2024		
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	3	Language of instruction			Polish		
Semester of study	6	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						
Name and surname of lecturer (lecturers)	Subject supervisor		prof. dr hab. Anna Lisowska-Oleksiak				
	Teachers						
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						
	Additional information: Lecture course Laboratories						
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 familiarize students with: a) basics of electrochemistry in the use of electrode transformation in devices for storage and conversion of electricity and b) familiarizing students with the chemistry of materials useful, among others, in the construction of galvanic cells, electrochemical capacitors, photoelectrochemical cells (PEC)						

Learning outcomes	Course outcome	Subject outcome	Method of verification
	K6_W01	The student understands the necessity use of methods electrochemical in storage and conversion energy in a global context climate change and the necessary departure of Fr use of fossil fuels	[SW1] Assessment of factual knowledge [SW3] Assessment of knowledge contained in written work and projects
	K6_W02	Student have organized knowledge in field of electrochemistry (electrodics and ionics), knows measurement methods electrochemistry knows the principles of selection electrode materials in the context of environmental protection and access to raw material resources	[SW1] Assessment of factual knowledge [SW3] Assessment of knowledge contained in written work and projects
	K6_U01	Students can obtain current information information about electrochemistry energy storage and conversion	[SU1] Assessment of task fulfilment [SU4] Assessment of ability to use methods and tools [SU3] Assessment of ability to use knowledge gained from the subject
Subject contents	<p><i>I. Basics in electrochemistry</i></p> <p>Charge transport in electrolytes: water electrolytes, aprotic electrolytes, polymer electrolytes, gel electrolytes, solid electrolytes</p> <p>Electrodics - Metal/electrolyte interface, semiconductor/electrolyte interface, electrolyte membrane. Reaction kinetics electrodes; Butler-Volmer equation, exchange current, transfer coefficient, overpotential. Diffusional controll of the electrode process. Cottrell equation. Electro catalysis. Processes of creating a new phase - electrocrystallization, electrode polymerization. Mechanism of selected electrode processes: oxidation hydrogen, methanol, glucose, oxygen reduction. Methods of testing electrode processes: voltammetry, chronopotentiometry, chronoamperometry, electrochemical impedance spectroscopy.</p> <p><i>II. Electricity storage and conversion devices:</i></p> <p>A) Primary cells: zinc-manganese oxide, zinc-silver oxide, metal-air cells, primary lithium cells, large-size cells for special applications. Passivation of primary cell anodes, solid electrolyte phase boundary. Solid cathode materials, liquid cathodes of lithium cells. B) Secondary cells: lead-acid batteries, batteries containing metal alloy hydrides - NiMH, lithium batteries, lithium-ion batteries, lithium polymer batteries, intercalation phenomenon, insertion in sp² carbons, electroactive polymers, polymer electrolytes, etc. Flow cells, so-called flow-cell redox. Batteries - ecological aspect, European Union law on recycling and restrictions use of certain ROHS compounds - EU directive. C) Electrochemical capacitors: a) EDLC capacitors - capacity of the electrical double layer, b) supercapacitors - redox pseudocapacitance. c) supercapacitor-cell hybrid systems galvanic. Electrode materials, electron collector materials, water electrolytes, electrolytes non-aqueous. D) Fuel cells on the example of biofuel cells, SOF cells, MCFC, PMFC, DMFC - Catalysts for the oxygen reduction reaction in fuel cells with a proton membrane. Methanol oxidation. Hydrogen as a fuel obtained from the photodecomposition of water. E) Optional for those interested: Photoelectrochemical decomposition of water (PEC cell) - selection rules electrode materials. Photo-supercapacitors</p> <p style="text-align: right;">Ionics -</p>		
Prerequisites and co-requisites	basic knowledge in general chemistry and physics		
Assessment methods and criteria	Subject passing criteria	Passing threshold	Percentage of the final grade
	raport i testy zaliczeniowe	100.0%	40.0%
	test zaliczeniowy pisemny	51.0%	60.0%

Recommended reading	Basic literature	<p>A. Kiswa, Elektrodyka, WNT 2000 A. Kiswa, Jonika, WNT 2000 A. Czerwiński, Ogniwa Baterie, WNT, W-wa 2004. C.A.Vincent, B. Scrosati, Modern Batteries , New York, 1997 Ed. P.J. Gellings, H.J.M.Bouwmeester The CRS Hanbook of Solid State Electrochemistry.</p> <p>Materiały do wykładów pliki pdf</p> <p>Instrukcje do ćwiczeń, pliki pdf</p>
	Supplementary literature	<p>Wpływ podłoża na kinetykę i mechanizm reakcji wydzielenia wodoru. 2. Synteza i charakterystyka polimeru elektroaktywnego. 3. Metalany metali przejściowych jako elektrody do kondensatorow-badania woltamperometryczne. 4. Dytlenek tytanu jako fotoanoda, wyznaczenie fotoprądów elektrod: ITO/TiO, ITO/TiO₂/BP. 5. Elektrolity żelowe - wyznaczenie przewodnictwa . 6. Wyznaczanie współczynnika dyfuzji depolaryzatora na podstawie krzywych woltamperometrycznych.</p>
	eResources addresses	<p>Adresy na platformie eNauczanie: Chemiczne Źródła Prądu - Moodle ID: 35078 https://enauczanie.pg.edu.pl/moodle/course/view.php?id=35078</p>
Example issues/ example questions/ tasks being completed	<p>Calculate the theoretical charge capacity of the graphite electrode in a lithium-ion cell. Determine the exchange current and the transfer coefficient of the tested electrode reaction based on the measured polarization curve. How does the conductivity of a synthetic metal change with temperature? How an EDLC electrochemical capacitor is constructed. What do you know about the corrosion of electron collectors in high-energy galvanic cells? Present the Ragon diagram for selected electrochemical devices for energy storage (arrange L-ions, Na-ion cells, EDLC electrochemical capacitors, lead-acid cells). Sketch the polarization curves $j = f(E)$ for the transfer coefficient =0, 3; 05; 0.7 at the same exchange current.</p>	
Work placement	Not applicable	