GDAŃSK UNIVERSITY OF TECHNOLOGY

Subject card

Subject name and code	Electrochemical Impedance Spectroscopy, PG_00070195					
Field of study	Hydrogen Technologies and Electromobility					
Date of commencement of studies	February 2026		Academic year of realisation of subject		2025/2026	
Education level	second-cycle studies		Subject group		Optional subject group Specialty 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	1		Language of instruction		Polish	
Semester of study	1		ECTS credits		3.0	
Learning profile	general academic profile		Assessment form		exam	
Conducting unit	Department of Functional Materials Engineering -> Faculty of Electronics Telecommunications and Informatics -> Faculties of Gdańsk University of Technology					
Name and surname of lecturer (lecturers)	Subject supervisor		prof. dr hab. inż. Piotr Jasiński			
	Teachers		dr inż. Joanna Wysocka prof. dr hab. inż. Piotr Jasiński			

Lesson types	Lesson type	Lecture	Tutorial	Laboratory	Project	Seminar	SUM
	Number of study hours	15.0	0.0	15.0	0.0	15.0	45
	E-learning hours included: 0.0						
	eNauczanie source addresses: Moodle ID: 5613 Elektrochemiczna spektroskopia impedancyjna https://enauczanie.pg.edu.pl/2025/course/view.php?id=5613						

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	45	3.0	27.0	75

Subject objectives	The course provides in-depth knowledge of electrochemical impedance spectroscopy (EIS) as a method for studying electrode processes and material properties. Students learn the theoretical fundamentals of impedance, equivalent circuit models, and the principles of correct measurement and data validation. In the laboratory they perform EIS measurements of electrochemical and material systems, and in the seminar they analyse and present selected applications of the method. The course prepares students to apply EIS independently in research.

Learning outcomes	(see table below)

Course outcome	Subject outcome	Method of verification
[K7_U08] while identifying and formulating engineering tasks specifications and solving these tasks, can: - apply analytical, simulation and experimental methods, - notice their systemic and non-technical aspects, - make a preliminary economic assessment of suggested solutions and engineering work	The student is able to fit an equivalent circuit model to measured data, assess the fit quality and reliability of the determined parameters, and validate the data (Kramers-Kronig test).	[SU2] Assessment of ability to analyse information
[K7_U12] is able, to an increased extent, to analyze the operation of components and systems related to the field of hydrogen technologies and electromobility, as well as to measure their parameters and study their technical characteristics, and to plan and carry out experiments related to the field of hydrogen technologies and electromobility, including computer simulations, interpret the obtained results and draw conclusions	The student is able to plan and perform an EIS measurement of an electrochemical system, select the frequency range and measurement conditions, and interpret the resulting spectrum.	[SU4] Assessment of ability to use methods and tools [SU5] Assessment of ability to present the results of task
[K7_W02] knows and understands, to an increased extent, selected laws of physics and physical phenomena, as well as methods and theories explaining the complex relationships between them, constituting advanced general knowledge in the field of technical sciences related to the hydrogen devices, systems, installations, and automation systems	The student knows and understands the physical fundamentals of impedance and the electrode phenomena and processes described by EIS, including the meaning of equivalent circuit elements and the conditions for correct measurement.	[SW1] Assessment of factual knowledge

Subject contents	Course content – lecture W1 – Introduction to EIS. Impedance and admittance, complex quantities. W2 – AC circuits: reactance, phase shift, complex representation. W3 – Equivalent circuit elements: R, C, L; distributed elements. W4 – Constant phase element (CPE) and Warburg element — physical meaning. W5 – Data representations: Nyquist and Bode plots. W6 – Equivalent circuit models; the Randles circuit. W7 – Electrode processes: charge-transfer resistance, double-layer capacitance. W8 – Mass transport: Warburg impedance, finite diffusion. W9 – Instrumentation: potentiostat/FRA; linearity and stationarity conditions. W10 – Measurement validation: causality, stability, Kramers-Kronig test. W11 – Model fitting: quality criteria, parameter errors. W12 – EIS in corrosion studies: polarisation resistance, coating evaluation. W13 – EIS of fuel cells, electrolysers and batteries. W14 – EIS of materials: ionic conductors, grain boundaries, measurement geometry. W15 – Advanced techniques: distribution of relaxation times (DRT), operando measurements. Summary.
	Course content – laboratory L1 – Operating a potentiostat with an FRA module; EIS measurement setup and parameter selection. L2 – Measurement of a model system (RC / Randles circuit); element identification. L3 – EIS in corrosion: determination of polarisation resistance and coating evaluation. L4 – EIS of a fuel cell/electrolyser or ionic conductor; spectrum interpretation. L5 – Fitting an equivalent circuit model to data; report preparation.
	Course content – seminar Presentation by students of selected aspects of EIS - scientific literature
Prerequisites and co-requisites	
Assessment methods and criteria	(see table below)

Subject passing criteria	Passing threshold	Percentage of the final grade
exam (test)	50.0%	50.0%
laboratory (reports)	50.0%	30.0%
seminar presentation	50.0%	20.0%

Recommended reading	Basic literature	Barsoukov & Macdonald, *Impedance Spectroscopy*, Wiley; Orazem & Tribollet, *Electrochemical Impedance Spectroscopy*, Wiley
	Supplementary literature	*Electrochemical Impedance Spectroscopy*, Andrzej Lasia
	eResources addresses	
Example issues/ example questions/ tasks being completed	Interpretation of a Nyquist plot of a Randles cell; physical meaning of the CPE and Warburg element; conditions for a valid EIS measurement and the Kramers-Kronig test; determination of polarisation resistance from an impedance spectrum.	
Practical activites within the subject	Not applicable	