



## Subject card

Subject name and code	Hydrogen power and fuel cells, PG_00037309						
Field of study	Technical Physics						
Date of commencement of studies	October 2020	Academic year of realisation of subject			2022/2023		
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	5	ECTS credits			1.0		
Learning profile	general academic profile	Assessment form			assessment		
Conducting unit	Instytut Fizyki i Informatyki Stosowanej -> Faculty of Applied Physics and Mathematics						
Name and surname of lecturer (lecturers)	Subject supervisor		dr inż. Piotr Grygiel				
	Teachers		dr inż. Piotr Grygiel				
Lesson types and methods of instruction	Lesson type	Lecture	Tutorial	Laboratory	Project	Seminar	SUM
	Number of study hours	15.0	0.0	0.0	0.0	0.0	15
	E-learning hours included: 0.0						
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	15		2.0		8.0	25
Subject objectives	The knowledge of principle of working of different-type-fuel cells.  The knowledge of construction and proper operation problems of fuel cells.						
Learning outcomes	Course outcome	Subject outcome			Method of verification		
	K6_W01	Acquires knowledge on achievements of physics of the 21th century and understands their influence on civilization and modern technology			[SW1] Assessment of factual knowledge		
	K6_W02	Student has well established knowledge on basics of hydrogen energy and fuel cells			[SW1] Assessment of factual knowledge		
	K6_U01	Knows how to make use of specialist books and other scientific literature.			[SU2] Assessment of ability to analyse information		

Subject contents	<p>The lecture: 1. Historical background, evolution of types and construction of fuel cells. 2. Electrode reactions, the equation of electromotive force: cathodic and anodic reactions on for a hydrogen fuel cell, derivation of basic equation for the electromotive force regardless of losses. 3. Efficiency and maximum efficiency: term of efficiency, thermodynamic efficiency, derivation of formulae for efficiency of fuel cells. 4. The influence of pressure and gas concentration on the electromotive force of a fuel cell: the influence of oxygen and hydrogen partial pressures, the influence of fuel and oxidant utilisation, the influence of pressure in a cell, the influence of means of oxygen supply. 5. Operational cell voltage. Kinds of voltage losses in a cell: the current - voltage characteristics of chosen fuel cells, the reasons for the voltage losses and their classification. 6. Activation losses: the charge double layer, Tafel equation, derivation of equation for the magnitude of losses, the means of minimization of fuel cells losses. 7. The fuel crossover and internal currents losses: the origin, derivation of equation for the magnitude of losses. 8. The Ohmic and concentration losses: the origin, derivation of equation for the magnitude of losses, the means of minimization of fuel cells losses. 9. The summary equation of losses. 10. The dynamic features of fuel cells: the equivalent circuit of a fuel cell, the test of current interrupt as the method for identification and measurement of magnitude of losses, the dynamic characteristics of chosen types of cells. 11. Some details of fuel cells construction. Contemporary types of fuel cells: the basic features of fuel cells construction, construction of electrodes, connection of cells, bipolar plate, summary of basic parameters and applications of fuel cells. 12. Energetic systems using PEM, AFC, PAFC, MCFC, SOFC cells. 13. Types and basics of fuel processing. 14. Fuel reforming systems. 15. Hydrogen storage. 16. Fuel cells as a source of alternating current.</p>		
Prerequisites and co-requisites	<p>1. Basic knowledge of organic and inorganic chemistry. 2. Basic knowledge of thermodynamics of chemical reactions. 3. Basic knowledge of electrochemistry. 4. Basic knowledge of electric circuits theory.</p>		
Assessment methods and criteria	Subject passing criteria	Passing threshold	Percentage of the final grade
	Credit for the course (written form)	50.0%	100.0%
Recommended reading	Basic literature	1. J. Larminie, A. Dicks „Fuel cell systems explained, Wiley, 2003. 2. K. Kordesh, G. Simader „Fuel cells and their applications, VCH, 2001.	
	Supplementary literature	1. P. W. Atkins: „Physical Chemistry“, Oxford University Press, 2018	
	eResources addresses	Adresy na platformie eNauczanie:	
Example issues/ example questions/ tasks being completed	<p>Derivation of the formula for the electro motive force of a hydrogen fuel cell.</p> <p>The influence of the presence of water on the work of a PEM fuel cell.</p>		
Work placement	Not applicable		