GDAŃSK UNIVERSITY OF TECHNOLOGY

Subject card

Subject name and code	Hydrogen power and fuel cells, PG_00037309		
Field of study	Technical Physics		
Date of commencement of studies	October 2024	Academic year of realisation of subject	2026/2027
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 Classes are conducted in Polish and English; in the case of foreign students, classes are conducted exclusively in English.
Semester of study	5	ECTS credits	1.0
Learning profile	general academic profile	Assessment form	assessment
Conducting unit	Division of Molecular Photophysics -> Institute of Physics and Applied Computer Science -> Faculty of Applied Physics and Mathematics -> Faculties of Gdańsk University of Technology		
Name and surname of lecturer (lecturers)	Subject supervisor	dr inż. Piotr Grygiel	
	Teachers		

Lesson types

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

Knowledge of the operating principles of different types of fuel cells.

Knowledge of issues related to the design and proper operation of fuel cells.

Knowledge of the functioning of fuel cell systems.

Knowledge of industrial methods of hydrogen production and storage.

Learning outcomes

Course outcome	Subject outcome	Method of verification
[K6_W01] understands the importance of physics and its applications in connection to civilization	Understands the civilisational significance of various fields of physics and technology applicable to hydrogen energy.	[SW1] Assessment of factual knowledge
[K6_U01] learns independently, obtains information from literature, databases and other properly selected sources	They are able to independently acquire knowledge on various aspects of hydrogen energy, independently obtaining information from literature, databases and industry sources.	[SU2] Assessment of ability to analyse information [SU3] Assessment of ability to use knowledge gained from the subject [SU4] Assessment of ability to use methods and tools

<table>
<tr><td>Subject contents</td><td>Course content – lecture
1. Historical, evolution of types and construction of fuel cells. 2. Eelectrode reactions, the equation of electromotive force: cathodic and anodic reactoins on for a hydrogen fuel cell, derivation of basic equation for the electromotive force regardless of losses. 3. Efficiency: term of efficiency, thermodynamic efficiency, derivation of formulae for efficiency of fuel cells. 4. The influence of pressure and gas concentration on the electomotive 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 choosen 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 fuell cells: the equivalent circuit of a fuel cell, the test of current interrupt as the method for identyfication and measurement of magnitude of losses, the dynamic characteristics of choosen 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.</td></tr>
<tr><td>Prerequisites and co-requisites</td><td>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.</td></tr>
<tr><td>Assessment methods and criteria</td><td>
<table>
<tr><th>Subject passing criteria</th><th>Passing threshold</th><th>Percentage of the final grade</th></tr>
<tr><td>Credit for the course (written form)</td><td>50.0%</td><td>100.0%</td></tr>
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<tr><td>Recommended reading</td><td>
<table>
<tr><td>Basic literature</td><td>1. J. Larminie, A. Dicks ,,Fuel cell systems explained, Willey, 2003. 2. K. Kordesh, G. Simader ,,Fuel cells and their applications, VCH, 2001.

2. K. Kordesch, G. Simader Fuel Cells and Their Applications, VCH, 1996</td></tr>
<tr><td>Supplementary literature</td><td>1. P. W. Atkins: ,,Physical Chemistry", Oxford University Press, 2018</td></tr>
<tr><td>eResources addresses</td><td></td></tr>
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<tr><td>Example issues/ example questions/ tasks being completed</td><td>Derivation of the formula for the electro motive force of a hydrogen fuel cell.

The influence of the presence of water on the work of a PEM fuel cell.</td></tr>
<tr><td>Practical activites within the subject</td><td>Not applicable</td></tr>
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