



## Subject card

Subject name and code	Electromobility and hydrogen technologies , PG_00055949						
Field of study	Power Engineering, Power Engineering, Power Engineering						
Date of commencement of studies	October 2021		Academic year of realisation of subject			2024/2025	
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	Zakład Ekoinżynierii i Silników Spalinowych -> Institute of Energy -> Faculty of Mechanical Engineering and Ship Technology						
Name and surname of lecturer (lecturers)	Subject supervisor		dr inż. Bartosz Dawidowicz				
	Teachers						
Lesson types and methods of instruction	Lesson type	Lecture	Tutorial	Laboratory	Project	Seminar	SUM
	Number of study hours	30.0	0.0	0.0	0.0	0.0	30
	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	30		2.0		18.0	50
Subject objectives	Providing students with content about technologies related to the production of hydrogen, its storage and transport. The use of electric solutions in transport as well as energy sources and storage to power these vehicles. Presentation of problems, challenges and limitations related to the introduction of this technology to common use.						
Learning outcomes	Course outcome		Subject outcome			Method of verification	
	[K6_U01] can obtain information from literature and other sources, organize, interpret it and draw and formulate conclusions; has the ability to self-educate, interprets the results of completed engineering tasks, is able to design simple energy systems and their systems		The student is able to independently access information and gain knowledge in the field of drive systems and energy storage in electric vehicles by making a critical analysis and verification of information.			[SU3] Assessment of ability to use knowledge gained from the subject	
	[K6_W11] has knowledge of known technologies and non-technical aspects to solve simple engineering tasks in the field of energy systems and devices		Is able to compare various technical solutions, evaluate them in terms of selected utility criteria.			[SW1] Assessment of factual knowledge	
	[K6_W06] knows classic and developmental energy technologies, rules for the selection and operation of heat and energy devices and installations, basic principles of energy systems operation, basic issues regarding the reliability of energy devices and diagnostics, environmental effects of energy technologies used, methods of using renewable energy sources		The student is able to use the appropriate methods and tools for critical analysis and evaluation of the functioning of existing technical solutions in electric and hybrid vehicles and the infrastructure intended for their charging.			[SW1] Assessment of factual knowledge	

Subject contents	Electromobility: basic definitions and concepts. The history of electromobility development. Classification and technical parameters of electric and hybrid vehicles. Classification and principle of operation of drive systems in hybrid vehicles. Energy management in vehicles. Energy stores and sources in a motor vehicle. Durability of electrochemical electricity storage. Charging systems for energy storage in vehicles (review of available charging technologies for electric vehicles). Construction of an electric vehicle charging station, technical and legal requirements. Generation and transmission of electricity in the development of electromobility. Impact of charging electric vehicles on the power system. Impact of electric vehicles on the natural environment (production, emissions, disposal of electric vehicles). Analysis of the profitability of the use of electric and hybrid vehicles (costs resulting from the operation of electric vehicles). Hydrogen technologies: Presentation of the energy properties of hydrogen as an energy carrier and its comparison with conventional and synthetic fuels. Currently, the demand for hydrogen and in the near future. Presentation of hydrogen production technology (reforming, pyrolysis, gasification, electrolysis, photoelectrolysis, etc.). Technologies for removing impurities from hydrogen. Methods of converting the chemical energy of hydrogen into thermal, mechanical and electrical energy (combustion of hydrogen in power systems and internal combustion engines, fuel cells). Stationary and mobile hydrogen storage. Hydrogen transportation. Hydrogen refueling stations for electric vehicles. Examples of electric - hydrogen vehicles.		
Prerequisites and co-requisites	Basic knowledge of physics, chemistry, electronics and power electronics. Knowledge of the construction and principles of operation of machines and devices for conversion, especially thermal, electrical and renewable energy devices.		
Assessment methods and criteria	Subject passing criteria	Passing threshold	Percentage of the final grade
	Test	56.0%	100.0%
Recommended reading	Basic literature	<ol style="list-style-type: none"><li>1. Energetyka transportu zbiorowego. Praca zbiorowa pod redakcją Krzysztofa Karwowskiego. Wydawnictwo Politechniki Gdańskiej Gdańsk 2018</li><li>2. Merksiz J., Pielecha I.: Układy mechaniczne pojazdów hybrydowych. Wydawnictwo Politechniki Poznańskiej, Poznań 2015.</li><li>3. Merksiz J., Pielecha I.: Układy elektryczne pojazdów hybrydowych. Wydawnictwo Politechniki Poznańskiej, Poznań 2015</li><li>4. Merksiz J., Pielecha I.: Alternatywne napędy pojazdów. Wydawnictwo Politechniki Poznańskiej, Poznań 2006.</li><li>5. Merksiz J., Pielecha I.: Alternatywne paliwa i układy napędowe pojazdów. Wydawnictwo Politechniki Poznańskiej, Poznań 2004.</li><li>6. Czerwiński A.: Akumulatory, baterie, ogniwa. WKiŁ, Warszawa 2005.</li><li>7. Szumanowski A.: Akumulacja energii w pojazdach, WKiŁ, Warszawa 1984.</li><li>8. Jastrzębska G.: Odnawialne źródła energii i pojazdy proekologiczne, WNT, Warszawa 2009.</li><li>9. Fuchs G., Lunz B., Leuthold M., Sauer D. U.: Technology Overview on Electricity Storage, RWTH Aachen, 2012.</li><li>10. Kordesch K., Simader G.: Fuel cells and their applications, Weinheim, VCH, 1996,</li><li>11. Chmielniak T., Chmielniak T.: Energetyka wodorowa,: Wydawnictwo Naukowe PWN SA, Warszawa 2020,</li><li>12. O'Hayre R.P., et al.: Fuel cell fundamentals, Hoboken, John Wiley &amp; Sons, 2009,</li><li>13. Chmielniak T.: Technologie energetyczne, Wydawnictwo Naukowe PWN SA, Warszawa 2018,</li><li>14. Surygała J.: Wodór jako paliwo, Wydawnictwa Naukowo-Techniczne, Warszawa 2008,</li><li>15. Lejda K.: Wodór w aplikacjach do środków napędu w transporcie drogowym, Politechnika Rzeszowska, Wydawnictwo Koraw, Rzeszów 2013,</li></ol>	
	Supplementary literature	<ol style="list-style-type: none"><li>1. Press R.J., et al.: Introduction to hydrogen technology, Hoboken, John Wiley &amp; Sons, cop. 2009,</li><li>2. Gavriluk A.: Hydrogen energy for beginners, Singapore, PAN Stanford Publishing, cop. 2014,</li><li>3. Shao H.: Hydrogen storage: preparation, applications and technology, New York, Nova Science Publishers, 2018,</li><li>4. Scott K.: Electrochemical methods for hydrogen production, London, Royal Society of Chemistry, 2020,</li><li>5. Sherif S.A.: Handbook of hydrogen energy, Boca Raton, CRC Press/ Taylor &amp; Francis Group, 2015,</li><li>6. Sørensen B., Spazzafumo B.: Hydrogen and fuel cells: emerging technologies and applications, London, San Diego, Cambridge, MA, Oxford, UK, Academic Press, an imprint of Elsevier, 2018,</li></ol> <b>Websites</b> <a href="https://www.hzwei.info">https://www.hzwei.info</a> <a href="https://fuelcellworks.com">https://fuelcellworks.com</a> <a href="https://matthey.com/en/home">https://matthey.com/en/home</a> <a href="https://pchet.klasterwodorowy.pl">https://pchet.klasterwodorowy.pl</a> <a href="http://gashd.eu/wodor-h2/">http://gashd.eu/wodor-h2/</a> <a href="https://centrumwodorowe.pl/#stronaGlowna">https://centrumwodorowe.pl/#stronaGlowna</a>	
	eResources addresses	Adresy na platformie eNauczanie:	
Example issues/ example questions/ tasks being completed	<ol style="list-style-type: none"><li>1. Construction and principle of operation of a PEM fuel cell</li><li>2. List and describe the methods of hydrogen production.</li><li>3. Types and generations of mobile hydrogen tanks</li><li>4. Mobile energy storage - advantages and disadvantages</li><li>5. Drive systems in electric and hybrid vehicles</li></ol>		

Work placement	Not applicable
----------------	----------------