GDAŃSK UNIVERSITY OF TECHNOLOGY

Subject card

Subject name and code	Hydrogen and e-fuel technologies, PG_00069294		
Field of study	Technologie wodorowe i e-paliwa		
Date of commencement of studies	February 2025	Academic year of realisation of subject	2025/2026
Education level	second-cycle studies	Subject group	
Mode of study	Full-time studies	Mode of delivery	at the university
Year of study	1	Language of instruction	Polish
Semester of study	2	ECTS credits	3.0
Learning profile	practical profile	Assessment form	assessment
Conducting unit	Faculty of Chemistry -> Wydziały Politechniki Gdańskiej		
Name and surname of lecturer (lecturers)	Subject supervisor	dr hab. inż. Jacek Gębicki	
	Teachers	dr hab. inż. Jacek Gębicki dr hab. inż. Justyna Łuczak dr inż. Natalia Łukasik	

Lesson types	Lesson type	Lecture	Tutorial	Laboratory	Project	Seminar	SUM
	Number of study hours	15.0	0.0	30.0	0.0	0.0	45
	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	45	5.0	25.0	75

Subject objectives	The course introduces students to the properties of hydrogen as a fuel and as a raw material in the chemical industry. It covers traditional and alternative methods of hydrogen production, as well as technologies for its storage, distribution, and utilization in e-fuel synthesis. Students will gain both theoretical knowledge and practical skills in electrolysis, fuel cells, on-demand hydrogen production hydrogen purification, applications in e-fuel synthesis, and simulation of the economic feasibility of hydrogen-related investments.

Learning outcomes	Course outcome	Subject outcome	Method of verification
	[K7_W01] defines the phenomena, processes and laws of nature used to produce consumer goods and provide services	The student recognizes and describes the chemical phenomena and physicochemical processes underlying the production, storage, and conversion of hydrogen and e-fuels, indicating their importance for the efficiency and safety of the technology.	[SW1] Ocena wiedzy faktograficznej
	[K7_U02] carries out experiments using properly selected techniques and apparatus, taking advantage of new developments in technology and related fields	The student is able to conduct experiments related to the processes of production, storage, and conversion of hydrogen and e-fuels, using appropriate research techniques and modern equipment.	[SU1] Ocena realizacji zadania [SU2] Ocena umiejętności analizy informacji
	[K7_W02] selects appropriate apparatus and materials for the manufacture and processing of consumer goods	The student is able to select the process equipment and materials necessary for the production and conversion of hydrogen and e-fuels, taking into account their properties and technological applications.	[SW1] Ocena wiedzy faktograficznej
	[K7_K04] is aware of his/her responsibility for making decisions, respecting and developing principles of professional ethics and taking action to uphold these principles	Students recognize the ethical and environmental consequences of choosing hydrogen and e-fuel technologies, taking into account professional responsibility when assessing their safety, costs, and impact on the environment.	[SK1] Ocena umiejętności pracy w grupie [SK3] Ocena umiejętności organizacji pracy [SK2] Ocena postępów pracy
	[K7_U08] assesses the potential for commercialisation of a product or technology based on an analysis of scientific publications and patents	The student is able to analyze scientific literature and patents related to a selected hydrogen or e-fuel technology and assess its implementation potential and commercialization possibilities.	[SU1] Ocena realizacji zadania [SU2] Ocena umiejętności analizy informacji [SU4] Ocena umiejętności korzystania z metod i narzędzi

Subject contents

Lecture (15 h):

1. Properties of hydrogen as a fuel and as a raw material in the chemical industry (1 h)

2. Traditional methods of hydrogen and syngas production (3 h)

3. Conversion of methane, coal, and hydrocarbons with steam:
 a) Gasification of solid fuels, partial oxidation of natural gas
 b) Pyrolysis
 c) Dehydrogenation of alcohols and hydrocarbons, gasoline isomerization, laboratory methods of hydrogen production

4. Water electrolysis technologies and fuel cells (2 h)

5. Alternative hydrogen production methods: on-demand production using liquid hydrogen carriers (LOHC, methanol, ammonia) (2 h)

6. Alternative hydrogen production methods: thermochemical water splitting, photoelectrochemical water splitting, photobiological processes, microbiological biomass conversion (1 h)

7. Hydrogen purification, carbon dioxide capture and storage (1 h)

8. Hydrogen storage and distribution (2 h)

9. Utilization of hydrogen and waste carbon dioxide for e-fuel synthesis (3 h)

Laboratory (30 h):

1. Water electrolysis and fuel cells 3 h

2. Design, preparation, and characterization of catalysts for e-fuel synthesis 6 h

3. Utilization of hydrogen and waste carbon dioxide for e-fuel synthesis: synthesis of e-methanol and e-methane 3 h

4. On-demand hydrogen production (9 h):
 4.1. Electrochemical decomposition of ammonia 3 h
 4.2. Steam reforming of methanol 3 h
 4.3. Catalytic decomposition of sodium borohydride 3 h

5. Simulation of hydrogen investment profitability computer laboratory 2 × 4 h = 8 h

Prerequisites and co-requisites

1. Basic knowledge of inorganic and organic chemistry.
2. Basic knowledge of chemical thermodynamics.
3. Ability to work with standard laboratory equipment.
4. Fundamental knowledge of chemical technology.

Assessment methods and criteria

Subject passing criteria	Passing threshold	Percentage of the final grade
Lecture - Test	60.0%	60.0%
Laboratory - completing exercises, tests, reports	100.0%	40.0%

Recommended reading

Basic literature	1. J. Surygała, Wodór jako paliwo, Wydawnictwo Naukowo-Technologiczne, Warszawa, 2008. 2. Hydrogen Technology: Fundamentals and Applications, ed. M.R. Cesario, A. J. Menezes de Araujo, F.J. Almeida Loureiro, D. Araujo de Macedo, Elsevier, Amsterdam, 2024.
Supplementary literature	1. Handbook of Fuels: Energy Soruces for Transportation, ed. B. Elvers, A. Schutze, Wiley-VCH GmbH, 2022.
eResources addresses	

Example issues/ example questions/ tasks being completed	1. Describe the properties of hydrogen as a fuel and compare them with conventional fuels. 2. Explain how a PEM fuel cell works. 3. Explain the process of producing hydrogen on demand from methanol and ammonia. 4. Analyze the efficiency of various hydrogen storage methods (liquid hydrogen, LOHC, compressed gas). 5. Design a process for synthesizing e-fuels using hydrogen technologies and assess the profitability of the investment.
Practical activites within the subject	Not applicable

Document generated electronically. Does not require a seal or signature.