GDAŃSK UNIVERSITY OF TECHNOLOGY

Subject card

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|---|---|---|---|
| Subject name and code | Hydrogen technologies, PG_00069022 | | |
| Field of study | Chemical Technology | | |
| Date of commencement of studies | October 2025 | Academic year of realisation of subject | 2027/2028 |
| Education level | first-cycle studies | Subject group | Optional subject group<br>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 | 3.0 |
| Learning profile | general academic profile | Assessment form | assessment |
| Conducting unit | Department of Process Engineering and Chemical Technology -> Faculty of Chemistry -> Faculties of Gdańsk University of Technology | | |
| Name and surname of lecturer (lecturers) | Subject supervisor | dr hab. inż. Donata Konopacka-Łyskawa | |
| | Teachers | | |

**Lesson types**

| Lesson type | Lecture | Tutorial | Laboratory | Project | Seminar | SUM |
|---|---|---|---|---|---|---|
| Number of study hours | 15.0 | 0.0 | 15.0 | 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 | 10.0 | 35.0 | 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 and simulation of the economic feasibility of hydrogen-related investments.

**Learning outcomes**

| Course outcome | Subject outcome | Method of verification |
|---|---|---|
| [K6_W07] Has knowledge of raw materials and technologies in the chemicaland polymer industries, also covering issues of corrosion and material protection. | has knowledge of the properties and production of hydrogen and the raw materials for its manufacture. | [SW1] Assessment of factual knowledge<br>[SW3] Assessment of knowledge contained in written work and projects |
| [K6_K03] Understands the need for continuous learning and knows the opportunities to improve professional, personal and social competences, and is able to think and act in an entrepreneurial manner. | is ready to continuously improve his professional competences related to hydrogen production technologies and to assess the costs associated with its manufacture. | [SK5] Assessment of ability to solve problems that arise in practice |

**Subject contents**

Course content – lecture

**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)

Course content – laboratory

**Laboratory (15 h):**

1. Water electrolysis and fuel cells 3 h

2. On-demand hydrogen production (6 h):
 2.1. Electrochemical decomposition of ammonia 3 h
 2.2. Steam reforming of methanol 3 h

3. Simulation of hydrogen investment profitability computer laboratory 2 × 3 h = 6 h

**Prerequisites and co-requisites**

1. Knowledge of inorganic and organic chemistry.
2. 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 |
|---|---|---|
| Laboratory - completing exercises, tests, reports | 100.0% | 40.0% |
| Lecture - Test | 60.0% | 60.0% |

**Recommended reading**

| | |
|---|---|
| Basic literature | 1. M. Nowicki, Wodór paliwem przyszłości? PWN 2025<br>2. K. S. V.Santhanam, R. Iosifovič, M. J. Massoud, G. A. Takacs, A. V. Bailey,Introduction to hydrogen technology, Wiley 2018<br>3. J. Surygała, Wodór jako paliwo, Wydawnictwo Naukowo-Technologiczne, 2008. |
| 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.

**Practical activites within the subject**

Not applicable

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