COURSE DESCRIPTION CARD - SYLLABUS

Course name
RECENT ACHIEVEMENTS IN USING HYDROGEN IN ENERGY SYSTEMS [S5ISGIE>PEKE]

Course

Proposed by Discipline
–

Year/Semester
3/6

Level of study
Doctoral School

Course offered in
English

Form of study
full-time

Requirements
elective

Number of hours

Lecture
4

Laboratory classes
0

Other
0

Tutorials
0

Projects/seminars
0

Number of credit points

1,00

Coordinators

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Lecturers

Prerequisites

Knowledge: PhD student has basic knowledge in the field of renewable energy resources and thermodynamic. Skills: PhD student is able to analyze scientific problems using databases and critically evaluate the quality of input data. Social competencies: PhD student doctoral student is able to consider opinions of other social groups in his/her deliberations and to conduct debates on various aspects related to the conducted research.

Course objective

Presentation of the latest achievements in hydrogen energy.

Course-related learning outcomes

Knowledge
A PhD student who graduated from doctoral school knows and understands:
1) global achievements, covering theoretical foundations as well as general and selected specific issues that are relevant to hydrogen energy, [P8S_WG/SzD_W01]
2) key development trends in the field of hydrogen energy [P8S_WG/SzD_W02]
3) scientific research methodology for the characteristics of hydrogen cells, [P8S_WG/SzD_W03]
4) economic, legal, ethical and other vital conditions related to scientific activity in the field of hydrogen energy, [P8S_WK/SzD_W06].

Skills
A PhD student who graduated from doctoral school can:
1) use knowledge from different branches of science to creatively identify, formulate and innovatively solve complex problems or to perform research tasks such as:
- define the aim and subject of scientific research, form a research hypothesis,
- develop research methods, techniques and tools and use them creatively,
- draw conclusions on the basis of research results, [P8S_UW/SzD_U01]
2) critically analyze and assess scientific research results, work of experts and other creative activities together with their contribution into knowledge development, [P8S_UW/SzD_U02]
3) communicate on specialist issues on the level that allows active participation in the international scientific community, [P8S_UK/SzD_U04]
4) share results of scientific activity also in a popular form, [P8S_UK/SzD_U05]
5) initiate debates, [P8S_UK/SzD_U06].

Social competencies
A PhD student who graduated from doctoral school is ready to:
1) critically assess achievements within a given scientific discipline, [P8S_KK/SzD_K01]
2) critically evaluate their own contribution to development of a given scientific discipline, [P8S_KK/SzD_K02]
3) acknowledge the importance of knowledge in solving cognitive and practical problems, [P8S_KK/SzD_K03]
4) initiate actions in the public interests, [P8S_KO/SzD_K05]

Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

Preparation of a report on the development of a selected sector of hydrogen energy.

Programme content

1. Transformation of the Electricity Sector
2. Possibilities of Using Hydrogen in Central and Distributed Generation
3. Operational Characteristics of PEM Fuel Cells
4. Hybrid Generation Systems

Course topics

Goals of the Energy Transformation.
Energy Transformation and the Development of Hydrogen Technologies.
New Technologies Applied in the Energy Sector.
Development of Distributed Energy and Hydrogen-Based Energy Systems.

Analysis of the Possibilities of Using Hydrogen in Power Plants and Combined Heat and Power (CHP) Plants.
Hydrogen Integration in Gas Turbines.
Gas and Combined-Cycle Systems.

Operational Characteristics of Hydrogen Fuel Cells.
Design and Operating Principles of a Hydrogen Fuel Cell Stack.
Hydrogen Fuel Cells as Converters of Chemical Energy into Electrical Energy.

Hybrid Generation Systems:
The Concept and Purpose of Their Application.

Possibilities of Using Hydrogen in Distributed Generation.
Concept of Using a PV/WT/FC Hybrid Power Generation System to Smooth the Consumer’s Energy Demand Profile.

Teaching methods

Lecture: multimedia presentation including illustrations and examples.

Bibliography

Basic
[1] Ceran B., The concept of use of PV/WT/FC hybrid power generation system for smoothing the energy profile of the consumer Energy - 2019, vol. 167, s. 853-865, https://doi.org/10.1016/j.energy.2018.11.028

[2] Ceran B., Bernstein P.A., Operational characteristics of proton exchange membrane (PEM) fuel cells Przegląd Elektrotechniczny - 2014, nr 10, s. 102-105, https://archiwum.pe.org.pl/articles/2014/10/26.pdf

[3] Ceran B., Mielcarek A., Hassan Q., Teneta J., Jaszczur M., Aging effects on modelling and operation of a photovoltaic system with hydrogen storage. Applied Energy - 2021, vol. 297, s. 117161-1-117161-18 https://doi.org/10.1016/j.apenergy.2021.117161

[4] Ceran B., Arłowska A., Krochmalny K., The method of determining PEMFC fuel cell stack performance decrease rate based on the voltage-current characteristic shift. Eksploatacja i Niezawodność – Maintenance and Reliability - 2020, vol. 22, no. 3, s. 530-535

https://ein.org.pl/The-method-of-determining-PEMFC-fuel-cell-stack-performance-decrease-rate-based-on,158995,0,2.html
Additional
[1] Szczerbowski R., Ceran B., Technical and Economic Analysis of a Hybrid Generation System of Wind Turbines, Photovoltaic Modules and a Fuel Cell, E3S Web of Conferences - 2016, vol. 10, s. 00090-1-00090-6, https://doi.org/10.1051/e3sconf/20161000090
[2] Ceran B., Sroka K., Performance Analysis of a Hybrid Generation System of Wind Turbines, Photovoltaic Modules, and a Fuel Cell , Acta Energetica - 2015, nr 2 (23), s. 36-42 10.12736/issn.2300-3022.2015204
[3] Ceran B., The use of multi criteria analysis to compare the operating scenarios of the hybrid generation system of wind turbines, photovoltaic modules and a fuel cell, E3S Web of Conferences - 2017, vol. 22, s. 1-8, https://doi.org/10.1051/e3sconf/20172200028

Breakdown of average student's workload

	Hours	ECTS
Total workload	25	1,00
Classes requiring direct contact with the teacher	4	0,00
Doctoral student's own work (literature studies, preparation for laboratory classes/tutorials, preparation for tests/exam, project preparation)	21	1,00