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820748 - HPC - Hydrogen and Fuel Cells (DRAFT VERSION)

Coordinating unit: 820 - EUETIB - Barcelona College of Industrial Engineering

Teaching unit: 460 - INTE - Institute of Energy Technologies

Academic year: 2014

Degree: MASTER IN ENERGY ENGINEERING (Syllabus 2013). (Teaching unit Optional)
ERASMUS MUNDUS MASTER IN ENVIRONOMICAL PATHWAYS FOR SUSTAINABLE ENERGY SYSTEMS (Syllabus 2012). (Teaching unit Optional)

ECTS credits: 5 Teaching languages: English

Teaching staff

Coordinator: Jordi Llorca

Others: Jordi Llorca

Opening hours

Timetable: To set up by e-mail

Prior skills

Basic knowledge on chemical engineering

Requirements

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Degree competences to which the subject contributes

Specific:

CEMT-1. Understand, describe and analyse, in a clear and comprehensive manner, the entire energy conversion chain, from its status as an energy source to its use as an energy service. They will also be able to identify, describe and analyse the situation and characteristics of the various energy resources and end uses of energy, in their economic, social and environmental dimensions, and to make value judgments.

CEMT-4. Efficiently collect data on renewable energy resources and their statistical treatment and apply knowledge and endpoint criteria in the design and evaluation of technology solutions for using renewable energy resources, for both isolated systems and those connected to networks. They will also be able to recognise and evaluate the newest technological applications in the use of renewable energy resources.

CEMT-6. Employ technical and economic criteria to select the most appropriate electrical equipment for a given application, dimension thermal equipment and facilities, and recognise and evaluate the newest technology applications in the field of production, transport, distribution, storage and use of electric energy.

CEMT-7. Analyse the performance of equipment and facilities in operation to carry out a diagnostic assessment of the use system and establish measures to improve their energy efficiency.

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Teaching methodology

- Lectures and conferences: knowledge exposed by lecturers or guest speakers.
- Participatory sessions: collective resolution of exercises, debates and group dynamics, with the lecturer and other students in the classroom; classroom presentation of an activity individually or in small groups.
- Theoretical/practical supervised work: classroom activity, carried out individually or in small groups, with the advice and supervision of the teacher.
- Homework assignment of reduced extension: carry out homework of reduced extension, individually or in groups.
- Homework assignment of broad extension (PA): design, planning and implementation of a project or homework assignment of broad extension by a group of students, and writing a report that should include the approach, results and conclusions.

Learning objectives of the subject

- To develop technical criteria to define an energy system with the participation of a fuel cell from chemical, biological, catalytic, material, heat transfer and energy and materials flow data.
- To develop scientific and technical skills to obtain and manipulate hydrogen for their use in fuel cells and to set up the basis for their implementation, optimization and/or modification.
- To identify the problems and weaknesses of energy systems and electrical devices and to provide engineering solution.
- To develop scientific skills to develop new ideas related to the hydrogen energy vector and fuel cells.

Study load

Total learning time: 125h	Hours large group:	0h	0.00%
	Hours medium group:	0h	0.00%
	Hours small group:	30h	24.00%
	Guided activities:	15h	12.00%
	Self study:	80h	64.00%

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Content

Hydrogen production technologies

Learning time: 47h

Large group/Theory: 12h
Guided activities: 5h
Self study : 30h

Degree competences to which the content contributes:
CEMT-1 (Specific)
CEMT-4 (Specific)
CEMT-6 (Specific)

Description:
Hydrogen as an energy vector. Hydrogen production from fossil and renewable substrates. Hydrogen obtention by (i) electrolysis, (ii) catalytic reforming, (iii) termochemical cycles, (iv) photocatalytic methods and (v) biological methods. Separation and purification of hydrogen.

Related activities:
Analysis of a device for producing hydrogen and its use in fuel cells.

Specific objectives:
To know the fundamentals and utility of hydrogen as an energy vector and to learn the technology basis of its obtention from several substrates and by different methods.

Hydrogen storage and transportation

Learning time: 32h

Large group/Theory: 7h
Guided activities: 5h
Self study : 20h

Degree competences to which the content contributes:
CEMT-1 (Specific)
CEMT-4 (Specific)
CEMT-6 (Specific)

Description:
Physical methods for storage (compresswion, liquefaction, microspheres, physisorption, carbon nanostructures, etc.). Chemical methods for storage (quimisorption, metallic hydrides, non-metallic compounds, etc.). Hydrogen transportation. In situ, on-demand hydrogen production.

Related activities:
Analysis of a hydrogen production system and its use in fuel cells.

Specific objectives:
To acquire knowledge related to the management and transport of the hydrogen vector. To know the main methods of storage and be able to establish criteria for the selecting of the most appropriate for a particular application.

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Fuel cells	Learning time: 46h Large group/Theory: 11h Guided activities: 5h Self study : 30h

Degree competences to which the content contributes:

CEMT-1 (Specific)
CEMT-6 (Specific)
CEMT-7 (Specific)

Description:

Basics of fuel cells, general characteristics and types. Parts of a fuel cell: electrolytes, electrodes, bipolar plates, etc. Use of fuel cells in (i) stationary applications, (ii) transport applications and (iii) portable applications and electronics.

Related activities:

Analysis of a hydrogen production system and its use in fuel cells.

Specific objectives:

Basics of fuel cells, general characteristics and types. Parts of a fuel cell: electrolytes, electrodes, bipolar plates, etc. Use of fuel cells in (i) stationary applications, (ii) transport applications and (iii) portable applications and electronics.

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Planning of activities

Analysis of a hydrogen production system and its use in fuel cells.	Hours: 65h Self study: 50h Guided study: 15h

Degree competences to which the activity contributes:

CEMT-1 (Understand, describe and analyse, in a clear and comprehensive manner, the entire energy conversion chain, from its status as an energy source to its use as an energy service. They will also be able to identify, describe and analyse the situation and characteristics of the various energy resources and end uses of energy, in their economic, social and environmental dimensions, and to make value judgments.)

CEMT-4 (Efficiently collect data on renewable energy resources and their statistical treatment and apply knowledge and endpoint criteria in the design and evaluation of technology solutions for using renewable energy resources, for both isolated systems and those connected to networks. They will also be able to recognise and evaluate the newest technological applications in the use of renewable energy resources.)

CEMT-6 (Employ technical and economic criteria to select the most appropriate electrical equipment for a given application, dimension thermal equipment and facilities, and recognise and evaluate the newest technology applications in the field of production, transport, distribution, storage and use of electric energy.)

CEMT-7 (Analyse the performance of equipment and facilities in operation to carry out a diagnostic assessment of the use system and establish measures to improve their energy efficiency.)

Description:

Using the tools learned in class and the scientific and technical information available in articles and patents to propose an energy system based on hydrogen and fuel cells.

Support materials:

Problem statement and scientific and technical documentation that will be available in the digital campus.

Descriptions of the assignments due and their relation to the assessment:

Report and solutions of the activity with the methodology and references used.

Specific objectives:

Dealing with articles and patents; evaluation of different methods of hydrogen production in different environments; application study of a fuel cell.

Qualification system

Exam (PE): 50 %
Homework (TR): 50 %

Regulations for carrying out activities

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Bibliography

Basic:

Llorca, Jordi. El Hidrógeno y nuestro futuro energético. Barcelona: Universitat Politècnica de Catalunya, 2010. ISBN 9788498804188.

Complementary:

Busby, Rebecca L. Hydrogen and fuel cells : a comprehensive guide. Tulsa, Okla.: PennWell Corp, cop. 2005. ISBN 9781593700430.

Hoffmann, Peter; Harkin, Tom. Tomorrow's Energy: Hydrogen, Fuel Cells, and the Prospects for a Cleaner Planet. Boston: MIT Press, 2002. ISBN 9780262582216.