

820748 - HPC - Hydrogen and Fuel Cells

Coordinating unit:	240 - ETSEIB - Barcelona School of Industrial Engineering	
Teaching unit:	713 - EQ - Department of Chemical Engineering	
Academic year:	2019	
Degree:	MASTER'S DEGREE IN RENEWABLE ENERGIES (Syllabus 2011). (Teaching unit Optional) ERASMUS MUNDUS MASTER'S DEGREE IN ENVIRONMENTAL PATHWAYS FOR SUSTAINABLE ENERGY SYSTEMS (Syllabus 2012). (Teaching unit Optional) MASTER'S DEGREE IN ENERGY ENGINEERING (Syllabus 2013). (Teaching unit Optional) ERASMUS MUNDUS MASTER'S DEGREE IN ENVIRONMENTAL PATHWAYS FOR SUSTAINABLE ENERGY SYSTEMS (Syllabus 2013). (Teaching unit Optional) MASTER'S DEGREE IN ENERGY ENGINEERING (Syllabus 2013). (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
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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 medium group:	30h	24.00%
	Guided activities:	10h	8.00%
	Self study:	85h	68.00%

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Content

<p>Hydrogen production technologies</p>	<p>Learning time: 47h Theory classes: 12h Guided activities: 5h Self study : 30h</p>
<p>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.</p> <p>Related activities: Analysis of a device for producing hydrogen and its use in fuel cells.</p> <p>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.</p>	
<p>Hydrogen storage and transportation</p>	<p>Learning time: 32h Theory classes: 7h Guided activities: 5h Self study : 20h</p>
<p>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.</p> <p>Related activities: Analysis of a hydrogen production system and its use in fuel cells.</p> <p>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.</p>	

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<p>Fuel cells</p>	<p>Learning time: 46h Theory classes: 11h Guided activities: 5h Self study : 30h</p>
<p>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.</p> <p>Related activities: Analysis of a hydrogen production system and its use in fuel cells.</p> <p>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.</p>	

Planning of activities

<p>Analysis of a hydrogen production system and its use in fuel cells.</p>	<p>Hours: 65h Guided activities: 15h Self study: 50h</p>
<p>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.</p> <p>Support materials: Problem statement and scientific and technical documentation that will be available in the digital campus.</p> <p>Descriptions of the assignments due and their relation to the assessment: Report and solutions of the activity with the methodology and references used.</p> <p>Specific objectives: Dealing with articles and patents; evaluation of different methods of hydrogen production in different environments; application study of a fuel cell.</p>	

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 [on line]. Barcelona: Universitat Politècnica de Catalunya, 2010 [Consultation: 11/10/2016]. Available on: <<http://hdl.handle.net/2099.3/36579>>. 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. Revised ed.. Boston: MIT Press, 2012. ISBN 9780262516952.