Course guide
295114 - 295II134 - Fuel Cells

Last modified: 10/07/2024

Unit in charge: Barcelona East School of Engineering
Teaching unit: 713 - EQ - Department of Chemical Engineering.

Degree: MASTER'S DEGREE IN INTERDISCIPLINARY AND INNOVATIVE ENGINEERING (Syllabus 2019). (Optional subject).
ERASMUS MUNDUS MASTER IN HYDROGEN SYSTEMS AND ENABLING TECHNOLOGIES (HYSET) (Syllabus 2024). (Optional subject).

Academic year: 2024 **ECTS Credits:** 6.0 **Languages:** English

LECTURER

Coordinating lecturer: NÚRIA JIMÉNEZ DIVINS
LLUIS SOLER TURU

Others: Soler Turu, Lluis
Burgues Ceballos, Ignasi
Prieto De La Parte, David
Jiménez Divins, Núria

PRIOR SKILLS

Basic knowledge of thermodynamics and chemical engineering

REQUIREMENTS

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DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:
CEMUEII-13. Design industrial applications that use physical-chemical processes that optimize the efficiency and sustainability of the systems. (Specific competence of the Efficient Systems specialty).

Generical:
CGMUEII-01. Participate in technological innovation projects in multidisciplinary problems, applying mathematical, analytical, scientific, instrumental, technological and management knowledge.
CGMUEII-05. To communicate hypotheses, procedures and results to specialized and non-specialized audiences in a clear and unambiguous way, both orally and through reports and diagrams, in the context of the development of technical solutions for problems of an interdisciplinary nature.

Transversal:
05 TEQ. TEAMWORK. Being able to work as a team player, either as a member or as a leader. Contributing to projects pragmatically and responsibly, by reaching commitments in accordance to the resources that are available.
06 URI. EFFECTIVE USE OF INFORMATION RESOURCES. Managing the acquisition, structure, analysis and display of information from the own field of specialization. Taking a critical stance with regard to the results obtained.
03 TLG. THIRD LANGUAGE. Learning a third language, preferably English, to a degree of oral and written fluency that fits in with the future needs of the graduates of each course.

TEACHING METHODOLOGY

Classroom. Self-study. Learning from projects and study cases

LEARNING OBJECTIVES OF THE SUBJECT

Learn the basic thermodynamics, physics, chemistry and electrochemistry principles that govern fuel cell and hydrogen technologies
Learn the existing fuel cell types and main attributes and applications for stationary power and mobility
Understand the economics, challenges and opportunities for their commercialization in the industrial sector
Knowledge of advanced applications such as carbon capture, polygeneration and energy storage with fuel cells
Understand the environmental, sustainability and energy security impacts of fuel cell and hydrogen technologies

STUDY LOAD

Type	Hours	Percentage
Hours large group	21,0	14.00
Hours small group	21,0	14.00
Self study	108,0	72.00

Total learning time: 150 h

CONTENTS

Introduction to fuel cell technologies

Description:
Description of fuel cell principles. Types of fuel cells and applications for the electricity, mobility and portable sectors. Hydrogen technologies: production, storage and transportation

Specific objectives:
To understand how fuel cells work. To identify which type of fuel cell type is better for each application. To learn the basic principles of hydrogen technologies

Related activities:
Patents and peer-reviewed articles search and analysis

Full-or-part-time: 45h
Theory classes: 15h
Self study : 30h

Advanced fuel cell applications

Description:
Economic analysis of fuel cell systems. Carbon capture and polygeneration of electricity, hydrogen and water with carbonate fuel cells (MCFC). Energy storage and power-to-gas (P2G) with proton-exchange membrane (PEM) and solid oxide (SOFC) fuel cells and electrolyzers

Specific objectives:
To be able to include fuel cell and hydrogen technologies to decarbonize a specific industrial sector and analyze the economic and environmental impacts. To evaluate advanced energy storage solutions with hydrogen and fuel cell technologies to allow higher penetrations of renewable energy to the electric grid

Related activities:
Learn about the European Union research and innovation financing program Horizon 2020. Selection and evaluation of one existing project related with fuel cells or hydrogen technologies

Full-or-part-time: 54h
Theory classes: 18h
Self study : 36h

GRADING SYSTEM

50% written exam and 50% (practicum + group project)

EXAMINATION RULES.

Written exams are individual. A group project will be evaluated with a final report. The laboratory practicum is mandatory

BIBLIOGRAPHY

Basic:
- National Energy Technology Laboratory (Estats Units d'Amèrica). Fuel cell handbook. 7th ed. Virginia: National Energy Technology Laboratory, [2016]. ISBN 9781365101137.

Complementary:
- O'Hayre, Ryan P [et al.]. Fuel cell fundamentals. 3rd ed. Hoboken: John Wiley and Sons, [2016]. ISBN 9781119113805.
- Barbir, Frano. PEM fuel cells [Recurs electrònic] : theory and practice . Amsterdam ; London : Elsevier Academic, 2005. ISBN 0120781425.
- Jiang, San Ping; Li, Qingfeng.. Introduction to fuel cells: electrochemistry and materials [on line]. Gateway East, Singapore: Springer, 2022 [Consultation: 25/06/2024]. Available on: https://discovery.upc.edu/permalink/34CSUC_UPC/rdgucl/alma991005066966106711. ISBN 981-10-7626-X.

RESOURCES

Other resources:
Notes from class and other documents from the Digital Campus