Course guide
295328 - 295SE112 - Hydrogen Technologies

Last modified: 16/07/2025

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).
MASTER'S DEGREE IN TECHNOLOGIES FOR DISTRIBUTED ENERGY SYSTEMS (Syllabus 2025). (Optional subject).

Academic year: 2025 **ECTS Credits:** 6.0 **Languages:** English

LECTURER

Coordinating lecturer: NÚRIA JIMÉNEZ DIVINS

Others: Soler Turu, Lluis
Torras, Miquel
Jiménez Divins, Núria

PRIOR SKILLS

Basic knowledge of chemical engineering, chemistry and thermodynamics

REQUIREMENTS

-

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.

LEARNING RESULTS

Knowledges:
K4 . Identify methods for studying the environmental impact of a distributed electricity system with renewable sources and relate it to the decarbonisation of energy generation.
K2 . Identify the structural and functional particularities and applicable regulations of decentralised electrical systems.

Skills:
S3 . Assess the impact and needs of new electricity consumption models and relate them to the change in energy model resulting from the decarbonisation of energy sources.

Competences:
C1 . Integrate the values of sustainability and understand the complexity of systems, with the aim of undertaking or promoting actions that restore and maintain the health of ecosystems and improve justice, thereby generating visions of sustainable futures.

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
Knowledge about the different hydrogen production methods by chemical and electrochemical methods.
Knowledge about different methods for hydrogen transportation and storage
Learn the existing fuel cell types and main attributes and applications for stationary power and mobility
Knowledge of advanced applications such as carbon capture, polygeneration and energy storage with fuel cells

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

Hydrogen production technologies

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 using chemical and physical methods.

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.

Full-or-part-time: 47h
Theory classes: 12h
Guided activities: 5h
Self study : 30h

Hydrogen storage, transportation and distribution

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

Specific objectives:
To acquire knowledge related to the storage and transportation of hydrogen. To know the main methods of storage and be able to establish criteria for the selection of the most appropriate method for a particular application.

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

Full-or-part-time: 26h
Theory classes: 6h
Self study : 20h

Introduction to fuel cell technologies

Description:
Fuel cell fundamentals: general properties and types. Parts of a fuel cell: electrodes, electrolyte, bipolar plates, etc. Use of fuel cells in stationary applications, for transportation, and portable applications.

Specific objectives:
To understand how fuel cells work. To identify which type of fuel cell type is better for each application.

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

Full-or-part-time: 51h
Theory classes: 18h
Guided activities: 3h
Self study : 30h

Advanced fuel cell applications

Description:
Carbon capture and polygeneration of electricity, hydrogen and water
Energy storage and power-to-X (P2X) strategy

Specific objectives:
To be able to include fuel cell and hydrogen technologies to decarbonize a specific industrial sector.

Full-or-part-time: 33h
Theory classes: 3h
Self study : 30h

GRADING SYSTEM

40% final exam + 30% project + 30% laboratory session report

EXAMINATION RULES.

Written exams are done individually. A group project will be evaluated with a final report. The laboratory sessions are 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 : theory and practic [on line]. Amsterdam ; London: Elsevier Academic, 2005 [Consultation: 13/09/2024]. Available on: https://discovery.upc.edu/permalink/34CSUC_UPC/rdgucl/alma991002901819706711. ISBN 0120781425.
- Jiang, San Ping; Li, Qingfeng. Introduction to fuel cells : electrochemistry and materials [on line]. Gateway East, Singapore: Springer, 2022 [Consultation: 13/09/2024]. 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