Course guide
295810 - 295HY031 - Low-Temperature Fuel Cell Systems Engineering

Last modified: 26/06/2025

Unit in charge: Barcelona East School of Engineering
Teaching unit: 729 - MF - Department of Fluid Mechanics.

Degree: ERASMUS MUNDUS MASTER IN HYDROGEN SYSTEMS AND ENABLING TECHNOLOGIES (HYSET) (Syllabus 2024). (Optional subject).
MASTER'S DEGREE IN MECHANICAL TECHNOLOGIES (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: ATTILA PETER HUSAR

Others: Primer quadrimestre:
ATTILA PETER HUSAR - Grup: T1

PRIOR SKILLS

Basic knowledge of chemical engineering, thermodynamics, heat transfer, fluid mechanics and process engineering

TEACHING METHODOLOGY

- Lectures and conferences: knowledge exposed by lecturers or guest speakers.
- Participatory sessions: the 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 professor.
- Homework assignments of reduced extension: carry out homework of reduced extension, individually or in groups.
- Group projects assignment of broad extension: 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 scientific and technical skills to design and test low-temperature fuel cells, and to set up the basis for their implementation, optimization and/or modification.
- To develop technical criteria to define and select a low-temperature fuel cell system with the participation of other energy devices (fuel processing, hybridization with other energy storage devices e.i. batteries).
- To identify the problems and weaknesses of Polymer Electrolyte Membrane Fuel Cells (PEMFC), cells, stacks, balance of plant components, and systems configurations, and to provide engineering solutions.
- To develop scientific skills to develop new ideas related to low-temperature fuel cells.

STUDY LOAD

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

Total learning time: 150 h

CONTENTS

Topic 1. Introduction

Description:
Hydrogen economy, Fuel cells fundamentals.

Full-or-part-time: 3h 30m
Theory classes: 1h
Self study : 2h 30m

Topic 2. Thermodynamics and electrochemical kinetics

Description:
Operating characteristics of cells. Thermodynamic and electrochemical losses. Electrical efficiency and heat rejection. Cell performance variables.

Full-or-part-time: 7h 10m
Theory classes: 2h
Self study : 5h 10m

Topic 3. Fuel cell types and components

Description:
Polymer Electrolyte Membrane (PEM). Direct Menthol (PEM DMPEM). High-temperature PEM. Cell components, Stack components, Design trade-offs.

Full-or-part-time: 25h
Theory classes: 4h
Laboratory classes: 3h
Self study : 18h

Topic 4. Characterization and Effect of operation conditions on fuel cell performance

Description:
Description: Definition of operating conditions, What are the variables that can be manipulated to change the performance, What are the trade-offs

Full-or-part-time: 28h 30m
Theory classes: 5h
Laboratory classes: 3h
Self study : 20h 30m

Topic 5. Degradation of fuel cells PEMFC y DMFC

Description:
Description: Definition of operating conditions, What are the variables that can be manipulated to change the performance, What are the trade-offs

Full-or-part-time: 17h 50m
Theory classes: 5h
Self study : 12h 50m

Topic 6. System design

Description:
Types of systems, Design trade-offs

Full-or-part-time: 17h 50m
Theory classes: 5h
Self study : 12h 50m

Topic 7. System control strategies and design

Description:
Types of control strategies, Trade-off

Full-or-part-time: 28h 30m
Theory classes: 5h
Laboratory classes: 3h
Self study : 20h 30m

Topic 8. Fuel cell applications

Description:
Tema 8. Aplicacions de les piles de combustible

Full-or-part-time: 21h 40m
Theory classes: 6h
Self study : 15h 40m

GRADING SYSTEM

Continuous assessment (2 exams; 30% each written exam), laboratory reports (20%), and final group project (20%).

EXAMINATION RULES.

Written exams are individual. Laboratory and projects are carried out in groups.

BIBLIOGRAPHY

Basic:
- O'Hayre, Ryan P. Fuel cell fundamentals. Third edition. Hoboken, New Jersey: John Wiley & Sons, Inc, [2016]. ISBN 9781119113805.
- Dicks, Andrew L.; Rand, D. A. J. Fuel cell systems explained. Third edition. Hoboken, New Jersey: Wiley, 2018. ISBN 111870696X.
- Fuel cell handbook. Seventh edition. Virginia: National Energy Technology Laboratory, [2016]. ISBN 9781365101137.
- Barbir, Frano. PEM fuel cells : theory and practice. Amsterdam: Elsevier Academic, 2005. ISBN 9780120781423.
- Santhanam, K. S. V.; Press, Roman J.; Miri, Massoud J.; Bailey, Alla V.; Takacs, Gerald A. Introduction to hydrogen technology. Second edition. John Wiley & Sons, 2017. ISBN 9781119265542.