



# Course guide

## 295810 - 295HY031 - Low-Temperature Fuel Cell Systems Engineering

Last modified: 27/06/2024

**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).

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

### LECTURER

**Coordinating lecturer:** Husar, Attila Peter

**Others:** Morales Comas, Miguel

### 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 Methanol (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

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

### EXAMINATION RULES.

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



## BIBLIOGRAPHY

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### Basic:

- O'Hayre, Ryan P. Fuel cell fundamentals . Third edition. Hoboken, New Jersey : John Wiley & Sons, Inc, [2016]. ISBN 9781119113805.
- Dicks, A.L. and Rand D.A.. Fuel cell systems explained. 3rd ed. John Wiley & Sons, [2018]. ISBN 9781118706961.
- Fuel Cell Handbook. Seventh Edition. USA: U.S. Department of Energy By EG&G Technical Services, Inc, 2004.
- Barbir, Frano.. PEM fuel cells: theory and practice.. Academic press, 2012. ISBN 978-0-12-387710-9.
- Santhanam K. S. V., Press R.J., Miri M. J., Bailey A. V., Takacs G. A.. Introduction to Hydrogen technologies. John Wiley & Sons, 2017. ISBN 978-1-118-70696-1.