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

Last modified: 08/08/2024

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: 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.