Universidad Zaragoza

Academic Year/course: 2022/23

66381 - Hydrogen energy

Syllabus Information

Academic Year: 2022/23
Subject: 66381 - Hydrogen energy
Faculty / School: 110 - Escuela de Ingeniería y Arquitectura
Degree: 636 - Master's in Renewable Energies and Energy Efficiency
ECTS: 3.0
Year: 1
Semester: Second semester
Subject Type: Optional
Module:

1. General information

2. Learning goals

3. Assessment (1st and 2nd call)

4. Methodology, learning tasks, syllabus and resources

4.1. Methodological overview

The learning process that has been designed for this subject is based on the following:

The topics of this subject describe the so-called "*hydrogen value chain*", and include the production, transport, storage, safety, transformation and applications of this energy vector. The subject also devotes a small part of the syllabus to the analysis of hydrogen markets.

It is a subject that combines the description of the main techniques of production, transport, storage and use, with the calculation of the main characteristics of the equipment used in each technique.

The extension of the topics in which the subject is divided is not homogeneous, finding topics that require a greater number of hours of exposure and others of shorter duration. Something similar happens with respect to the distribution of the teaching typology: some topics contain a greater '*descriptive*' load than others, which are practically devoid of this attribute, and yet require a greater number of hours of resolution of numerical exercises.

Although throughout the course theory classes alternate with practical ones (resolution of exercises and case studies), the subject has an eminently practical character, as could be expected in a university master's degree. In addition, it is essential to keep in mind that this subject has an optional character common to two intensifications within the Master's Degree in *Renewable Energies and Energy Efficiency*. It can be selected by students both enrolled in the electric or thermic intensification.

Parallel to the traditional classes (theory and problems), sessions will be developed in which specialized software such as *Aspen HYSYS*, *Aspen Plus*, *HyRAM+* or *gPROMS* will be used, as well as accessible and universal calculation tools such as *Matlab*, *Excel*, *Phyton*, etc.

4.2. Learning tasks

The course includes the following learning tasks:

- Lectures (**15 hours**). The theoretical aspects of the different topics will be provided. These sessions will be the scenario for proposing ?model? problems related to the theoretical aspects shown in class.
- Practice sessions (**15 hours**). In these sessions the lecturer will solve problems and case studies previously offered to the students to be worked on their own. Likewise, students will be encouraged to take part in the solving

process, proposing alternatives and/or doubts that have arisen along the autonomous solving process. These problems or case studies will be related to the theoretical aspects explained in lectures.

- Special sessions (**2 hours**). These will be complementary activities devoted to visits to industries, experts? talks, thematic seminars, etc.
- Guided projects (**5 hours**). Individual or group work in which 1 or 2 activities will be proposed along the course that will be supervised by lecturers.
- Project (**15 hours**). In groups of 2 or 3 people, students will solve a big scale problem. It will be supervised by lecturers and will count for the final mark.
- Study (**20 hours**). It is strongly recommended that students follow a study schedule from the very beginning until the end of the course.
- Assessment (**3 hours**). During the course several evaluation activities will take place as well as a final global exam to assess the achievements of the student as much in theory as in practice.

4.3. Syllabus

The syllabus planned for the subject is as follows:

- Properties of hydrogen. Estimation methods. Compressibility and liquefaction.
- Thermochemical production: Reforming. Gasification. Pyrolysis. Thermochemical cycles.
- Electrochemical production: electrolysis. Types of electrolyzers. Reversible electrolyzers.
- Emerging production methods: solar furnaces, high-temperature electrolysis, photoelectrolysis, biohydrogen.
- Normalization of hydrogen as a fuel. Properties and features.
- Storage, transport and distribution of hydrogen.
- Safety and risk analysis of hydrogen infrastructures.
- Fuel cells: types, characteristics and performance.
- Hydrogen fuelling stations. Flowsheet diagrams and equipment. Applicable regulations.
- Fuel cell electric vehicle. Other hydrogen-powered vehicles.
- Stationary fuel cell applications.
- Hydrogen markets. Guarantees of origin.

4.4. Course planning and calendar

Further information concerning the timetable, classroom, office hours, assessment dates and other details regarding this course, will be provided on the first day of class or please refer to the EINA website (*http://eina.unizar.es*).

4.5. Bibliography and recommended resources

http://psfunizar10.unizar.es/br13/egAsignaturas.php?codigo=66381