ANX-PR/CL/001-01

LEARNING GUIDE

SUBJECT

53002065 - Hydrogen And Fuel Cell Technologies

DEGREE PROGRAMME

05BK - Máster Universitario En Ingeniería De La Energía

ACADEMIC YEAR & SEMESTER

2025/26 - Semester 2

Index

Learning guide

1. Description....1
2. Faculty....1
3. Prior knowledge recommended to take the subject....2
4. Skills and learning outcomes....2
5. Brief description of the subject and syllabus....3
6. Schedule....5
7. Activities and assessment criteria....7
8. Teaching resources....8
9. Other information....8

1. Description

1.1. Subject details

Name of the subject	53002065 - Hydrogen And Fuel Cell Technologies
No of credits	3 ECTS
Type	Optional/elective
Academic year ot the programme	First year
Semester of tuition	Semester 2
Tuition period	February-June
Tuition languages	English
Degree programme	05BK - Máster Universitario en Ingeniería de la Energía
Centre	05 - E.T.S. De Ingenieros Industriales
Academic year	2025-26

2. Faculty

2.1. Faculty members with subject teaching role

Name and surname	Office/Room	Email	Tutoring hours *
Angel Jimenez Alvaro	Despacho	a.jimenez@upm.es	Sin horario. A demanda
Alberto Abanades Velasco (Subject coordinator)	sala GIT	alberto.abanades@upm.es	Sin horario. A demanda

* The tutoring schedule is indicative and subject to possible changes. Please check tutoring times with the faculty member in charge.

3. Prior knowledge recommended to take the subject

3.1. Recommended (passed) subjects

The subject - recommended (passed), are not defined.

3.2. Other recommended learning outcomes

- Conocimientos básicos de Química

4. Skills and learning outcomes *

4.1. Skills to be learned

CB7 - Que los estudiantes sepan aplicar los conocimientos adquiridos y su capacidad de resolución de problemas en entornos nuevos o poco conocidos dentro de contextos más amplios (o multidisciplinares) relacionados con su área de estudio

CE17 - Comprender los procesos que integran el ciclo de vida de los procesos energéticos, desde la obtención del recurso primario, hasta su desmantelamiento, y su integración en la economía circular.

CE3 - Utilizar las herramientas necesarias para el diseño y análisis de sistemas de generación, trasformación, almacenamiento y utilización de energías nucleares, mecánicas, eléctricas, térmicas e hidráulicas.

CE7 - Conocer y aplicar las alternativas para la operación segura de instalaciones energéticas, tanto renovables, como no renovables, y de transformación de vectores energéticos, como refinerías o biorrefinerías

CE9 - Disponer de criterios y herramientas para entender la composición y características de los diferentes tipos de combustibles convencionales y no convencionales.

CG1 - Aplicar conocimientos de ciencias y tecnologías avanzadas a la práctica profesional o investigadora de la Ingeniería Energética.

CG8 - Incorporar nuevas tecnologías y herramientas avanzadas de la Ingeniería Energética en sus actividades profesionales o investigadoras.

CT10 - Conoce. Conocimiento de los temas contemporáneos.

CT12 - Es bilingüe. Capacidad de trabajar en un entorno bilingüe (inglés/español).

CT8 - Entiende los impactos. Educación amplia necesaria para entender el impacto de las soluciones ingenieriles en un contexto social global.

4.2. Learning outcomes

RA20 - Conocimiento y habilidades de cálculo y diseño de pilas de combustible

RA21 - Conocimientos y habilidades de cálculo y diseño de tecnologías de producción, almacenamiento y distribución de hidrógeno.

RA22 - Conocimiento de tecnologías aplicadas en la economía del Hidrógeno.

* The Learning Guides should reflect the Skills and Learning Outcomes in the same way as indicated in the Degree Verification Memory. For this reason, they have not been translated into English and appear in Spanish.

5. Brief description of the subject and syllabus

5.1. Brief description of the subject

This subject will show the technological foundations for the generation and use of hydrogen, reviewing its thermophysical properties and the most common applications from fuel cells to automotive engines. Forms of storage and its application as an energy vector in Power-to-gas schemes are included.

5.2. Syllabus

1. Hydrogen economy fundamentals. Hydrogen as energy vector

2. Technologies for Hydrogen generation: reforming, electrolysis, pyrolysis, etc

3. Hydrogen storage

4. Hydrogen engines.

5. Electrochemical and thermal-chemical transfromations

6. Basics of hydrogen fuel cells.

7. Fuel cells for mobility.

6. Schedule

6.1. Subject schedule*

Week	Type 1 activities	Type 2 activities	Distant / On-line	Assessment activities
1	**Hydrogen economy fundamentals** Duration: 02:00 Lecture			
2	**Hydrogen properties and safety** Duration: 01:00 Lecture **Hydrogen in railways, business case bt Talgo.** Duration: 01:00 Lecture			
3	**Hydrogen generation** Duration: 02:00 Lecture			
4	**Hydrogen storage** Duration: 02:00 Lecture			
5	**Hydrogen engines** Duration: 02:00 Problem-solving class			
6				**First test** Written test Progressive assessment Presential Duration: 02:00
7	**Thermodynamic: properties of multi-component systems.** Duration: 02:00 Lecture			
8	**Thermodynamics: reactive systems** Duration: 02:00 Lecture			
9	**Conference** Duration: 02:00 Additional activities			
10	**Electrochemical systems and chemical kinetics** Duration: 02:00 Lecture			
11	**Fuel cells** Duration: 02:00 Problem-solving class			

12	**Fuel cells** Duration: 02:00 Lecture			
13	**Fuel cells for mobility** Duration: 02:00 Lecture			
14				**Second test** Written test Progressive assessment Presential Duration: 02:00
15				
16				
17				**Final examination** Written test Global examination Presential Duration: 02:00

Depending on the programme study plan, total values will be calculated according to the ECTS credit unit as 26/27 hours of student face-to-face contact and independent study time.

7. Activities and assessment criteria

7.1. Assessment activities

7.1.1. Assessment

Week	Description	Modality	Type	Duration	Weight	Minimum grade	Evaluated skills
6	First test	Written test	Face-to-face	02:00	50%	5 / 10	CG1 CG8 CT8 CT12 CE3 CE9 CE17
14	Second test	Written test	Face-to-face	02:00	50%	5 / 10	CB7 CG8 CT10 CE7 CE9

7.1.2. Global examination

Week	Description	Modality	Type	Duration	Weight	Minimum grade	Evaluated skills
17	Final examination	Written test	Face-to-face	02:00	100%	5 / 10	CB7 CG1 CG8 CT8 CT10 CT12 CE3 CE7 CE9 CE17

7.1.3. Referred (re-sit) examination

No se ha definido la evaluación extraordinaria.

7.2. Assessment criteria

Attendance is required for the progressive evaluation (at least 50%).

In continuous evaluation: The two written exams will be liberating for the final exam. Both must be approved (at least 5 points). If not, the corresponding part will be taken in the final exam.

8. Teaching resources

8.1. Teaching resources for the subject

Name	Type	Notes
Material on Moodle and slides	Bibliography	Available via Moodle

9. Other information

9.1. Other information about the subject

This subject is related to SDG 7: Affordable and clean energy, SDG 11: Sustainable cities and communities.

Part of the subjects can be given in Spanish, for instance, external speakers conferences.