COMILLAS
UNIVERSIDAD PONTIFICIA
ICAI ICADE CIHS

GUÍA DOCENTE
2025 - 2026

FICHA TÉCNICA DE LA ASIGNATURA

Datos de la asignatura

Nombre completo	Optativa Complementaria. Energy Transition
Código	DIM-OPT-623
Nivel	Postgrado Oficial Master
Cuatrimestre	Semestral
Créditos	3,0 ECTS
Carácter	Optativa
Departamento / Área	Departamento de Ingeniería Mecánica

Datos del profesorado

Profesor

Nombre	Javier Tardieu Benlloch
Departamento / Área	Departamento de Ingeniería Mecánica
Correo electrónico	jtardieu@icai.comillas.edu

DATOS ESPECÍFICOS DE LA ASIGNATURA

Contextualización de la asignatura

Aportación al perfil profesional de la titulación

In the professional profile of the Masters in Industrial Engineering this subject aims to equip students with the basic knowledge to understand the current transition scenario to a decarbonized energy system.

The main tools explored in this subject will be the energy efficiency to meet the energy demand (in buildings, cities and industry), renewable energy (solar, wind, biomass, geothermal and hydraulic energy), energy management and new energy carriers, as renewable gases.

The roots of the subject lie on Energy Engineering in the Master first year and is complemented by Sustainable Transportation (at the same year and semester that this current subject).

After completing the course students will be able to propose and assess decarbonized solutions in industrial and building sectors based on technological neutrality principle, that is, taking into account all the feasible measurements, being aware of technological maturity of each one.

In addition, this course has a mixed theoretical and practical sense, so that the theoretical components are added the practical aimed at solving numerical issues where the concepts studied will be exercised, as well as conducting a team work where students have the opportunity to research relevant topics.

Prerrequisitos

There are not any prerequisites needed to study the subject. However, as the subject is inserted in an engineering syllabus, it is supported on concepts previously seen in other subjects, especially in Energy Engineering.

Competencias - Objetivos

Competencias

CB2. Knowing how to apply and integrate their knowledge, understanding these, its scientific basis and troubleshooting capabilities in new and imprecisely defined environments, including multidisciplinary contexts both researchers and highly skilled professionals.

CG1. To have appropriate knowledge about the scientific and technological aspects of: mathematical, analytical and numerical methods in engineering, electrical engineering, power engineering, chemical engineering, mechanical engineering, continuum mechanics, industrial electronics, automation, manufacturing, materials, quantitative methods management, industrial computing, planning, infrastructure, and so on.

Resultados de Aprendizaje

At the end of the course students should be able to:

LO1. To know about decarbonizing technologies.

LO2. To know about high energy efficiency technologies in both buildings and industry.

LO3. To know about renewable energies, their potential and use.

LO4. To know about energy management and storage.

LO5. To know about the potential of renewable gases and new energy carriers and their role in the energy transition.

BLOQUES TEMÁTICOS Y CONTENIDOS

Contenidos – Bloques Temáticos

THEME 1: ENERGY DEMAND

Unit 1: BUILDINGS

1.1 Context of energy demand.

1.2 Energy demand in buildings. NZEB. Spanish Technical Code. Passivhaus Standard.

1.3 Efficient HVAC installations. Centralized vs. decentralized HVAC systems.

1.4 Integration of renewable resources in buildings.

1.5 District cooling & heating networks. Thermal buses and 5^{th} generation networks.

1.6 Energy services companies (ESCOs).

Unit 2: INDUSTRY

2.1 Waste heat recovery. ORCs, S-CO2 and industrial heat pumps.

2.2 Energy efficiency in electrical machines.

2.3 Air compressed networks enhancements.

2.4 Fuel switching.

2.5 Cogeneration: electricity self-consumption and district heating network.

2.6 Assessment tools. Energy audits. Life cycle and carbon footprint analysis.

THEME 2: RENEWABLE ENERGIES

Unit 3: SOLAR ENERGY

3.1 Solar resource.

3.2 Photovoltaic (PV) technology.

3.3 Solar Thermal (ST) technology.

3.4 Concentrated solar Power (CSP) technology. Power generation and industrial applications.

Unit 4: WIND ENERGY

4.1 Wind resource.

4.2 Wind turbines (low scale wind turbines).

4.3 Wind farms (Onshore and Offshore).

Unit 5: OTHER RENEWABLE SOURCES

5.1 Biomass. Natural resource, types (including MSW). Thermal and power applications.

5.2 Geothermal. Thermal applications (shallow geothermal systems); resource calculations. Power applications; types of resources (high enthalpy, intermediate enthalpy, HDR and enhanced geothermal systems.

5.3 Hydraulic energy. Large and mini. Pumping hydro (storage).

THEME 3: ENERGY MANAGEMENT

Unit 6: NEW ENERGY CARRIERS AND STORAGE

6.1 Energy storage. Thermal systems: latent and sensible systems. Air compressed systems (CAES). Power and refrigeration systems: LAES, Carnot Batteries. Electrical Batteries. Others.

6.2 Renewable gases. Power to gas. Gas to power. Biogas and biomethane. Green hydrogen.

METODOLOGÍA DOCENTE

Aspectos metodológicos generales de la asignatura

Metodología Presencial: Actividades

Lectures. The lecturer will explain basic concepts for every unit showing the more important aspects. Special attention to be paid with equations and how to use. Examples will be presented, discussed and solved to complete the understanding. **(20 hours)**. Competences CG2, CB2.

In-class case discussion and problem solving. Students will discuss the cases and problems proposed by the teacher. Cases will be open challenges that can be analyzed and solved by the use of the concepts already presented in class. **(5 hours)**. Competences CG2, CB2.

Team Work presentations. The students, split in small teams, will expose in class a work about topics related with the subject. The topics will be able proposed by the lecturer or by the students with the approval by the former. **(2 hours).** Competences CG2, CB2.

Assessment. At the end of the course an individual written exam will be performed. **(3 hours).** Competences CG2, CB2.

Metodología No presencial: Actividades

Self-learning on the concepts presented in class. The student must make a personal work back to the lectures to understand and internalize the knowledge provided in the subject. It will be used for that the material presented on slides and notes (additional texts) on the subject **(20 hours).** Competences CG2, CB2.

Cases study. The student will analyze the resolution of the problems in class conducted primarily by the lecturer, and then turn to face the problems proposed (no solved) in class, whose solution will be available later, asking questions in the tutoring sessions. This activity shall also apply to previous years solved exams available for students in Moodle. **(10 hours).** Competences CB2, CG2.

Team Works. Once the topic has been assigned the students, divided in small teams, will perform the information searching and the developing of the work and the presentation. The work will be controlled by partial deliveries at established milestones. **(15 hours).** Competences CB2, CG2.

Exams preparation. Students will prepare the exam based on the supplied material and the acquired knowledge. **(15 hours).** Competences CB2, CG2.

RESUMEN HORAS DE TRABAJO DEL ALUMNO

STUDENT SCHEDULE SUMMARY (HOURS)			
LIVE			
Lectures	**Team work**	**Case discussion**	**Assessment**
20	5	2	3
DISTANCE			
Self-learning	**Cases study**	**Team works**	**Exams preparation**
20	10	15	15
ECTS: 3 (90 hours)			

EVALUACIÓN Y CRITERIOS DE CALIFICACIÓN

Assessment activities	Criteria	Weight
Exam performing: • End of term exam	• Concepts understanding. • Use of concepts to solve real cases. • Problem solving solution analysis and results interpretation. • Presentation and written communication.	**50%**
Continuous assessment: • Team work	• Information searching. • Knowledge application to critical assessing technical information. • Oral and written expression.	**50%**

Calificaciones

ORDINARY SUMMON

- 50% comes from the End of term exam score.
- 50% comes from team work.

If the previous weighted average results higher than 5 the subject score will be such average; in the opposite case the score will be the minimum between such average and the end of term exam score.

EXTRAORDINARY SUMMON

- 30% from the score obtained in continuous evaluation (team work).
- 70% from the extraordinary summon exam.

If the previous weighted average results higher than 5 the subject score will be such average; in the opposite case the score will be the minimum between such average and the extraordinary summon exam score.

RULES

Attendance (see latter) and work teams performing is a necessary condition to pass the subject in both summons.

Programmable calculators are not allowed in the final exam of the ordinary summon and in the exam of the extraordinary summon.

Attendance: The absence of more than 15% of the total amount of classes can entail to fail the ordinary summon.

ARTIFICIAL INTELLIGENCE APPLICATION

AI is allowed exclusively in the TEAM WORK. Therefore, the Level 2 of the Assessment Scale of Perkins et al. (2024) is established: "AI may be used for pre-task activities such as brainstorming, outlining and initial research. This level focuses on the effective use of AI for planning, synthesis, and ideation, but assessments should emphasise the ability to develop and refine these ideas independently." That is, the student may use AI for planning, idea development, and research. The final submission should show how the student has developed and refined these ideas.

PLAN DE TRABAJO Y CRONOGRAMA

Actividades	Fecha de realización	Fecha de entrega
Self-learning of concepts presented in class (slides and additional text if any)	After session	
Problem solving	After the end of the unit	
End of term exam	Ordinary summon period	
End of term exam preparation	At least weeks 13, 14 and 15	
Team work performing	Weeks 3 to 15 and after the end of the unit	M1: week 7; M2: week 11; M3: weeks 13 to 15
Team work presentation	Weeks 13 to 15	

BIBLIOGRAFÍA Y RECURSOS

Bibliografía Básica

- Slides of every unit (available at Moodle).
- Additional texts of nearly all the units (available at Moodle).
- Solved problems (available at Moodle).

Bibliografía Complementaria

- International reports of OECD, IEA, IRENA, NREL and other institutions related to energy sector.