ANX-PR/CL/001-01

LEARNING GUIDE

SUBJECT

53002067 - System Thermodynamics Oriented To Sustainability:4e Techniques

DEGREE PROGRAMME

05BK - Máster Universitario En Ingeniería De La Energía

ACADEMIC YEAR & SEMESTER

2025/26 - Semester 2

Index

Learning guide

1. Description

1.1. Subject details

Name of the subject	53002067 - System Thermodynamics Oriented To Sustainability:4E Techniques
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 *
Ignacio Lopez Paniagua (Subject coordinator)		ignacio.lopez@upm.es	Sin horario. Las tutorías se realizarán con cita previa por email durante el periodo lectivo exclusivamente.

* 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

- Termodinámica

- Cálculo Infinitesimal

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

CB8 - Que los estudiantes sean capaces de integrar conocimientos y enfrentarse a la complejidad de formular juicios a partir de una información que, siendo incompleta o limitada, incluya reflexiones sobre las responsabilidades sociales y éticas vinculadas a la aplicación de sus conocimientos y juicios

CE11 - Analizar el comportamiento energético y control de los sistemas de energías renovables determinando y aplicando criterios innovadores de optimización energética, económica y ambiental, aplicando metodologías de diseño, simulación y análisis de los componentes y sistemas de energías renovables: solares, eólicos, hidráulicos, de biomasa, de energías marinas, geotérmicas y otras energías renovables; para contribuir a su desarrollo tecnológico y a su competitividad con otras tecnologías energéticas.

CE12 - Aplicar conocimientos y disponer de habilidades para acometer el diseño, control y análisis de procesos industriales basados en la generación de calor por combustión convencional y avanzada, evaluando los combustibles mejor adaptados a cada aplicación y proponer soluciones razonadas en el empleo de combustibles

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.

CE2 - Analizar y establecer criterios de mejora energética y económica en instalaciones de generación y de consumo, incluyendo el sector transportes, conducente al diseño de alternativas más eficientes y con menor impacto ambiental.

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

CG2 - Poseer capacidad para diseñar, desarrollar, implementar, gestionar y mejorar productos, sistemas y procesos en los distintos ámbitos energéticos, usando técnicas analíticas, computacionales o experimentales avanzadas.

CG5 - Comprender el impacto de la Ingeniería Energética en el medio ambiente, el desarrollo sostenible de la sociedad y la importancia de trabajar en un entorno profesional y responsable.

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

CT1 - Aplica. Habilidad para aplicar conocimientos científicos, matemáticos y tecnológicos en sistemas relacionados con la práctica de la ingeniería.

CT11 - Usa herramientas. Habilidad para usar las técnicas, destrezas y herramientas ingenieriles modernas necesarias para la práctica de la ingeniería.

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

CT3 - Diseña. Habilidad para diseñar un sistema, componente o proceso que alcance los requisitos deseados teniendo en cuenta restricciones realistas tales como las económicas, medioambientales, sociales, políticas, éticas, de salud y seguridad, de fabricación y de sostenibilidad.

CT5 - Resuelve. Habilidad para identificar, formular y resolver problemas de ingeniería.

4.2. Learning outcomes

RA36 - Proponer opciones de mejora global de un sistema energético

RA34 - Analizar y evaluar un sistema energético desde una dimensión energética, exergética, medio ambiental y económica.

RA35 - Comprender e identificar las conexiones entre los parámetros de diseño y operación de los sistemas energéticos con sus dimensiones energética, exergética, medio ambiental y económica.

* 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

The main goal of the subject is to develop how to carry out analyses that integrate energy, exergy, economy and environment. During the subject the relation between technical-design aspects, operation aspects, and energy and exergy efficiency aspects is developed. The relation between these and economic and environmental aspects is gradually introduced. The possible points of improvement for a certain process are identified in this way.

The subject is divided into two main blocks. A first block is a detailed revision of the thermodynamics of closed systems, open systems and exergy, including the behaviour of substances and its formulation.

The second block starts from the energetic analysis of cycles and processes, and gradually introduces the exergetic and economic dimensions. This is accomplished by analysing the potential for improvement in exergetic terms, then basic economic parameters and lastly combining both. Then LCOE (Levelised Cost of Energy) is introduced, which is a typical economic decision parameter, and others such as NPV and IRR are reviewed.

The subject is based on lectures, problem solving in class both by hand and by computer, and individual assignments. The classes increase the degree of involvement and active participation of the students as the contents of the subject evolve from the technical to the economica and

5.2. Syllabus

1. Introduction

2. Review of themodynamics of closed systems. Concept of Exergy

3. Review of thermodynamics of open systems. Flow exergy. Coefficients of structural bonds.

4. Method of exergoeconomic optimisation. Relation between design and operation parameters and process behaviour.

5. Economic parameters in industrial processes: discount factor, LCOE, NPV, IRR.

6. Schedule

6.1. Subject schedule*

Week	Type 1 activities	Type 2 activities	Distant / On-line	Assessment activities
1	**Temario** Duration: 02:00 Lecture			
2	**Temario** Duration: 02:00 Lecture			
3	**Temario** Duration: 02:00 Lecture			
4	**Temario** Duration: 02:00 Lecture			
5	**Temario** Duration: 02:00 Lecture			
6	**Temario** Duration: 02:00 Lecture			
7	**Temario** Duration: 02:00 Lecture			
8	**Temario** Duration: 02:00 Lecture			
9	**Temario** Duration: 02:00 Lecture			
10	**Temario** Duration: 02:00 Lecture			
11	**Temario** Duration: 02:00 Lecture			
12	**Temario** Duration: 02:00 Lecture			
13	**Temario** Duration: 02:00 Lecture			
14				

15	**Temario** Duration: 02:00 Lecture			**Test/assignment depending on the development of the course.** Other assessment Progressive assessment Presential Duration: 01:30
16	**Debate on relevant topics/guest speaker presentation** Duration: 02:00 Lecture			
17				**Examen final** Written test Global examination Presential Duration: 02:30

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
15	Test/assignment depending on the development of the course.	Other assessment	Face-to-face	01:30	10%	0 / 10	CG1 CG2 CG5 CG8 CB7 CB8 CT3

7.1.2. Global examination

Week	Description	Modality	Type	Duration	Weight	Minimum grade	Evaluated skills
17	Examen final	Written test	Face-to-face	02:30	100%	5 / 10	CG2 CG5 CG8 CB7 CG1 CB8 CT3

7.1.3. Referred (re-sit) examination

No se ha definido la evaluación extraordinaria.

7.2. Assessment criteria

This subject is recipient of students of very different origin and base training, which requires a detailed adaptation of the teaching techniques depending on the specific circumstances of the academic year.

Progressive evaluation (PE) will be carried out with class activities, individual or group assignments or other types of activities. Their number, form, content and timing will be adapted to the development of the subject. Except when specifically indicated, specific parts of the subject cannot be liberated individually. The existence, form and weight of the final exam on the overall mark of the subject will depend on the development of the subject.

8. Teaching resources

8.1. Teaching resources for the subject

Name	Type	Notes
Research articles	Web resource	Depending on the development of the course, the students will get in touch with research papers on different levels.
The Exergy Method of Thermal Plant Analysis Author(s): T. J. Kotas	Bibliography	1985 Elsevier ISBN: 978-0-408-01350-5
Monografías y materiales en Moodle	Web resource	There is a whole list of resources offered in the platform including theory and exercises of all the contents and types related to the subject.

9. Other information

9.1. Other information about the subject

The subject is intended to build upon undergaduate knowledge of thermodynamics. Due to the different origins of the students, a large part of the subject is dedicated to review that knowledge, integrate it and homogenise it. It is **ESSENTIAL** that the student understands that this is not the objective of the subject, and that developing a habit of study from the start can accelerate the learning process, allowing the subject to move on to advanced topics, as is expected from a Master's degree.