ANX-PR/CL/001-01

LEARNING GUIDE

SUBJECT

53002016 - Concentrated Solar Thermal Energy

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	53002016 - Concentrated Solar Thermal Energy
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 *
Luis Francisco Gonzalez Portillo (Subject coordinator)		lf.gonzalez@upm.es	Sin horario. Contactar profesor

* 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

- Fundamentals of thermal engineering

4. Skills and learning outcomes *

4.1. Skills to be learned

CB10 - Que los estudiantes posean las habilidades de aprendizaje que les permitan continuar estudiando de un modo que habrá de ser en gran medida autodirigido o autónomo.

CE1 - Ser capaz de aplicar conocimientos y capacidades a estudiar, analizar y auditar programas de optimización energética en los diferentes sectores industriales, residenciales, domésticos, plantas de potencia y a la industria térmica y de fluidos en general, en los ámbitos de la eficiencia, la diversificación y la reducción de su impacto en el medio ambiente.

CE10 - Evaluar el potencial energético de las fuentes de energía renovable: radiación solar, recurso eólico, recurso hidráulico, potencial energético de la biomasa, recurso energético marino, geotérmico, etc.; a partir de las bases de datos meteorológicas y recursos naturales.

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.

CE18 - Entender la optimización de costes en una empresa: coste marginal, coste medio, coste hundido, coste de oportunidad, aplicados al sector de la energía. Analizar costes en el sector de la energía.

CE8 - Disponer de habilidades, criterios y conocimientos para investigar, desarrollar e innovar en el campo de la energía: tecnologías renovables y no renovables, almacenamiento, vectores energéticos, en un contexto de decarbonización del sistema.

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.

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.

CT2 - Experimenta. Habilidad para diseñar y realizar experimentos, así como analizar e interpretar datos.

CT4 - Trabaja en equipo. Habilidad para trabajar en equipos multidisciplinares.

CT7 - Comunica. Habilidad para comunicar eficazmente.

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

4.2. Learning outcomes

RA260 - Aplicar metodologías de diseño de centrales solares de concentración

RA261 - Diseñar a alto nivel los componentes de una central de energía solar de concentración teniendo cuenta la interacción entre los mismos

RA262 - Explicar las consecuencias ambientales que suponen la construcción de una planta de energía solar de concentración y la reducción de emisiones de CO2 que ello supone

RA263 - Propone soluciones innovadoras para el uso de la energía solar térmica de alta temperatura

RA264 - Optimizar a nivel energético y/o económico una planta de energía solar de concentración

RA259 - Aplicar herramientas software avanzadas para el diseño y análisis de sistemas solares de concentración

RA265 - Evaluar el potencial de una localización para construir una planta de energía solar de concentración en

función de su recurso solar

* 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 course is designed to provide a deep understanding of the technologies used to harness Concentrated Solar Thermal Energy. This energy can be used for electricity generation and other important industrial processes that require high-temperature heat. One key aspect of the course is the analysis of the cost of this energy, an important skill for understanding its viability and competitiveness in the market.
The course covers various aspects of Concentrated Solar Thermal technologies, energy storage systems, and managing solar-derived energy, focusing especially on high-temperature. A key learning outcome is the design of a concentrated solar power plant. By the end of the course, students should have a solid grasp of the different solar technology options and the current market situation. This knowledge will equip them to apply and develop these technologies in the dynamic world of the solar energy sector.

5.2. Syllabus

1. Concentrated Solar Thermal Energy
    1.1. Introduction
    1.2. Solar resource
    1.3. Thermo-energy balance
2. Design of solar thermal plants
    2.1. Solar field
    2.2. Thermal energy storage
    2.3. Power block
    2.4. Engineering in Concentrating Solar Power plants
    2.5. Techno-economic analysis
3. Other uses of Concentrated Solar Thermal Energy
    3.1. Solar Heat for Industrial Processes
    3.2. Solar cooling

3.3. Hybridization

3.4. Hydrogen generation

3.5. Solar desalination

6. Schedule

6.1. Subject schedule*

Week	Type 1 activities	Type 2 activities	Distant / On-line	Assessment activities
1	**Introduction to the course** Duration: 01:00 Lecture **Introduction to Concentrated Solar Thermal Energy** Duration: 01:00 Lecture			
2	**Introduction to Concentrated Solar Thermal Energy** Duration: 02:00 Lecture			
3	**Solar resource** Duration: 02:00 Lecture			
4	**Thermo-energy balance in concentrated solar power systems** Duration: 01:00 Lecture			
5	**Solar field** Duration: 02:00 Lecture			
6	**Thermal energy storage** Duration: 02:00 Lecture			
7	**Power block** Duration: 02:00 Lecture			
8	**Techno-economic analysis** Duration: 01:00 Lecture **Techno-economic analysis** Duration: 01:00 Problem-solving class			
9	**Progress of group work. Intermediate monitoring.** Duration: 02:00 Cooperative activities			**Evaluation of preliminary results presentation.** Group presentation Progressive assessment Presential Duration: 02:00

10	**Techno-economic analysis** Duration: 02:00 Problem-solving class			
11	**Solar Heat for Industrial Processes / Solar cooling and Hybridization** Duration: 02:00 Lecture			
12	**CSP plants from the business perspective** Duration: 02:00 Lecture			
13	**Research and Development at UPM** Duration: 02:00 Research-based learning			
14	**Presentation of preliminary results from group work.** Duration: 02:00 Cooperative activities			**Evaluation of final results presentation.** Group presentation Progressive assessment Presential Duration: 02:00
15				**Participation during the course** Other assessment Progressive assessment Presential Duration: 00:00
16				**Final review of group work** Group work Progressive assessment Presential Duration: 01:00
17				**Evaluation of final results presentation.** Group presentation Global examination Presential Duration: 02:00 **Final review of group work** Group work Global examination Presential Duration: 01:00

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
9	Evaluation of preliminary results presentation.	Group presentation	Face-to-face	02:00	20%	0 / 10	CT7 CT8 CE10 CE11 CE18 CG1 CG2 CB10 CT2 CT4 CE1 CE8 CG8 CT1
14	Evaluation of final results presentation.	Group presentation	Face-to-face	02:00	20%	0 / 10	CT8 CE10 CE11 CE18 CG1 CG2 CB10 CT2 CT4 CE1 CE8 CG8 CT7 CT1
15	Participation during the course	Other assessment	Face-to-face	00:00	30%	0 / 10	CE1 CE8 CE10 CT7 CT8

16	Final review of group work	Group work	Face-to-face	01:00	30%	0 / 10	CT7 CT8 CE10 CE11 CE18 CG1 CG2 CB10 CT2 CT4 CE1 CE8 CG8 CT1

7.1.2. Global examination

Week	Description	Modality	Type	Duration	Weight	Minimum grade	Evaluated skills
17	Evaluation of final results presentation.	Group presentation	Face-to-face	02:00	50%	0 / 10	CT7 CT8 CE10 CE11 CE18 CG1 CG2 CB10 CT2 CT4 CE1 CE8 CG8 CT1
17	Final review of group work	Group work	Face-to-face	01:00	50%	0 / 10	CT8 CE10 CE11 CE18 CG1 CG2 CB10 CT2 CT4 CE1 CE8 CG8 CT1

7.1.3. Referred (re-sit) examination

No se ha definido la evaluación extraordinaria.

7.2. Assessment criteria

The assessment is fundamentally based on the outcome of group work carried out by students throughout the course. This work is related to a problem of high-temperature solar engineering application, such as an electric power production plant or an application to an industrial process. The tasks are carried out by teams in which each student is assigned a specific role. The work is evaluated continuously after a tracking presentation, another for final results, and the final document. In addition, class participation is valued through attendance, Kahoots, and questions in class.

8. Teaching resources

8.1. Teaching resources for the subject

Name	Type	Notes
Course slides	Others	Course slides uploaded to Moodle
Reference 1 - Solar Engineering	Bibliography	Duffie, Beckman. Solar Engineering of thermal processes. Wiley Interscience.
Reference 2 - Solar Engineering	Bibliography	D. Y. Goswani, F. Kreith, J.K. Kreider. Principles of Solar Engineering. Taylor & Francis.
Reference 3 - Solar Engineering	Bibliography	C. J. Winter, R.L. Sizmann, L.L. Vant-Hull.?Solar Power Plants. Fundamentals, Technology, Systems, Economics. Springer- Verlag
Reference 4 - Thermo-energy balance	Bibliography	S.D. Odeh, G.L. Morrison and M. Behnia.Modelling of Parabolic trough direct steam generation solar collectors. Solar Energy 62 (1998) 395-406

9. Other information

9.1. Other information about the subject

The course is related to SDG7 and SDG9. Given the evolutionary nature of this technology, the content is adapted to the technological evolution taking place in the sector.