ANX-PR/CL/001-01
GUÍA DE APRENDIZAJE

ASIGNATURA

43000611 - Alloy Design And Advanced Physical Metallurgy

PLAN DE ESTUDIOS

04AN - Master Universitario En Ingenieria De Materiales

CURSO ACADÉMICO Y SEMESTRE

2025/26 - Segundo semestre

Índice

Guía de Aprendizaje

1. Datos descriptivos

1.1. Datos de la asignatura

Nombre de la asignatura	43000611 - Alloy Design And Advanced Physical Metallurgy
No de créditos	3 ECTS
Carácter	Optativa
Curso	Primer curso
Semestre	Segundo semestre
Período de impartición	Febrero-Junio
Idioma de impartición	Inglés/Castellano
Titulación	04AN - Master Universitario en Ingenieria de Materiales
Centro responsable de la titulación	04 - E.T.S. De Ing. De Caminos Canales Y P.
Curso académico	2025-26

2. Profesorado

2.1. Profesorado implicado en la docencia

Nombre	Despacho	Correo electrónico	Horario de tutorías *
Laura Cordova Gonzalez	LEM-ETSIAE	laura.cordova@upm.es	Sin horario. under students request by email
Nuria Martin Piris	LEM-ETSIAE	nuria.mpiris@upm.es	Sin horario. Under student request by email

Ignacio Luque Trujillo	LEM-ETSIAE	ignacio.luque@upm.es	Sin horario. under students request by email
Daniel Barba Cancho (Coordinador/a)	LEM	daniel.barba@upm.es	Sin horario. under student request by e-mail
Conrado Luis Garrido Fernandez De Vera	B216-ETSIAE	conrado.garrido@upm.es	Sin horario. Under student request by email
Sergio Perosanz Amarillo	B216-ETSIAE	sergio.perosanz@upm.es	Sin horario. Under student request by email

* Las horas de tutoría son orientativas y pueden sufrir modificaciones. Se deberá confirmar los horarios de tutorías con el profesorado.

3. Conocimientos previos recomendados

3.1. Asignaturas previas que se recomienda haber cursado

- Properties Of Materials

3.2. Otros conocimientos previos recomendados para cursar la asignatura

- Materials selection

- Metal alloys

- Materials Science

- Mechanical and chemical behavior

- Non metal materials

4. Competencias y resultados de aprendizaje

4.1. Competencias

CE1 - Capacidad para aplicar los fundamentos científicos del comportamiento físico y químico de los materiales para relacionar causalmente sus propiedades fundamentales físicas y químicas con su comportamiento macroscópico y el de los productos con ellos realizados / Ability to apply the scientific foundations of the physical and chemical behavior of materials to correlate their fundamental physical and chemical properties with their macroscopic behavior and that of the products made with them.

CE3 - Capacidad de diseñar, modelizar, evaluar, seleccionar, fabricar y utilizar materiales con propiedades específicas (estructurales y funcionales) para satisfa

CE4 - Autonomía para adquirir, analizar, actualizar y aplicar nuevos conocimientos, modelos y técnicas experimentales y numéricas en relación con la composición y estructura de los materiales, su caracterización física y química, sus procesos de fabricación, su utilización y aplicación científica y tecnológica, y su reciclado, reutilización y eliminación / Autonomy to acquire, analyze, update and apply new knowledge, models and experimental and numerical techniques related to the composition and structure of materials, their physical and chemical characterization, their manufacturing processes, their use and scientific and technological application, and their recycling, reuse and disposal

CG1 - Uso de la lengua inglesa: Los alumnos son capaces de transmitir conocimientos y expresar ideas y argumentos de manera clara, rigurosa y convincente, tanto de forma oral como escrita, adaptándose a las características de la situación y de la audiencia / Use of the English Language: Students are able to transmit knowledge and express ideas and arguments in a clear, rigorous and convincing manner, both orally and in writing, adapting to the characteristics of the situation and the audience .

CG2 - Liderazgo: Los estudiantes son capaces de dirigir y coordinar personas para que trabajen con entusiasmo en la consecución de objetivos en pro del bien común / Leadership: Students are capable of directing and coordinating people so that they work enthusiastically to achieve objectives for the common good.

CG3 - Trabajo en equipo: Los alumnos desarrollan la capacidad para trabajar en equipo, integrarse y colaborar de forma activa en la consecución de objetivos comunes / Teamwork: Students develop the ability to work as a team, integrate and actively collaborate in achieving common goals.

CG4 - Creatividad: Los alumnos son capaces de resolver de forma nueva, original y aportando valor, situaciones o problemas en el ámbito de la ingeniería de materiales / Creativity: Students are able to solve situations or problems in the field of materials engineering in a new, original way and adding value.

CG5 - Organización y planificación: Los estudiantes son capaces de fijar objetivos, con la planificación y programación de actividades (tiempo y fases) y con la organización y gestión de los recursos necesarios para alcanzarlos / Organization and Planning: Students are capable of setting objectives, with the planning and programming of activities (time and phases) and with the organization and management of the necessary resources to achieve them..

CG6 - Respeto hacia el medio ambiente: Los alumnos desarrollan las mejores prácticas para interactuar con el entorno, de forma ética, responsable y sostenible, en orden a evitar o disminuir los efectos negativos que ocasiona la actividad humana, así como promover los beneficios que pueda generar la actividad profesional en el ámbito medioambiental, teniendo en cuenta sus implicaciones económicas y sociales / Respect for the environament: Students develop the best practices to interact with the environment, in an ethical, responsible and sustainable way, in order to avoid or reduce the negative effects caused by human activity, as well as promote the benefits that professional activity in the environmental field can generate, taking into account its economic and social implications.

CG7 - Uso de las TIC: Los alumnos son capaces de aplicar conocimientos tecnológicos necesarios de manera que les permitan desenvolverse cómodamente y afrontar los retos que la sociedad les va a imponer en su quehacer profesional empleando la informática / Use of ICT: Students are able to apply the necessary technological knowledge in a way that allows them to function comfortably and face the challenges that society is going to impose on them in their professional work using computers.

CG8 - Resolución de problemas: Los estudiantes son capaces de reconocer, describir, organizar y analizar los elementos constitutivos de un problema para idear estrategias que permitan obtener, de forma razonada, una solución contrastada y acorde a ciertos criterios preestablecidos / Problem solving: Students are able to recognize, describe, organize and analyze the constitutive elements of a problem to devise strategies that allow obtaining, in a reasoned way, a contrasting solution and according to certain pre-established criteria.

CG9 - Análisis y Síntesis: Los alumnos son capaces de reconocer y describir los elementos constitutivos de una realidad, y de proceder a organizar la información significativa según criterios preestablecidos adecuados a un propósito / Analysis and Synthesis: Students are able to recognize and describe the constituent elements of a reality, and to proceed to organize significant information according to pre-established criteria suitable for a purpose.

4.2. Resultados del aprendizaje

RA41 - HRP1 - Ability to solve problems that require the design of novel structural or functional materials or devices based on them

RA15 - Know, understand and correlate the behavior of materials under different environments with their structure, properties, processing and applications.

RA30 - C2 - Knowledge of the physical-chemical, structural, optical, electrical and magnetic properties of advanced structural and functional materials

RA43 - HC1 - Ability to communicate in technical English reports, projects, problems, methodologies, results, etc. related to research and innovation and development in materials engineering in a clear and fluid way

5. Descripción de la asignatura y temario

5.1. Descripción de la asignatura

The objective of the subject is that students have an overview of the most important aspects of the the different advanced alloys used in engineering applications, their physical metallurgy and their design process and to understand its implications in the industy and in the technological development.

5.2. Temario de la asignatura

1. Introduction and motivation to physical metallurgy and its importance in science and industry
2. Review of basic concepts in physical metallurgy
3. Physical metallurgy for high-temperature alloys
    3.1. Superalloys
    3.2. Ti-Aluminides
    3.3. Refractory Metals: W, Re, Mo, Ta, Nb
4. Physical metallurgy for light alloys
    4.1. Advanced Al alloys
    4.2. Magnesium alloys
    4.3. High-performance Ti alloys

5. Physical metallurgy of high strength alloys

5.1. High strength steels

6. Cronograma

6.1. Cronograma de la asignatura *

Sem	Actividad tipo 1	Actividad tipo 2	Tele-enseñanza	Actividades de evaluación
1				
2				
3				
4				
5				
6				
7				
8				
9	**Lesson 1** Duración: 04:00 LM: Actividad del tipo Lección Magistral			
10	**Lesson 2** Duración: 04:00 LM: Actividad del tipo Lección Magistral			
11	**Lesson 2** Duración: 02:00 LM: Actividad del tipo Lección Magistral **Lesson 3** Duración: 02:00 LM: Actividad del tipo Lección Magistral			
12	**Lesson 3** Duración: 02:00 LM: Actividad del tipo Lección Magistral **Group Project Class Session** Duración: 02:00 LM: Actividad del tipo Lección Magistral			
13	**Lesson 3** Duración: 04:00 LM: Actividad del tipo Lección Magistral			
14	**Lesson 4** Duración: 04:00 LM: Actividad del tipo Lección Magistral	**Lab Session (Reduced Group)** Duración: 02:30 PL: Actividad del tipo Prácticas de Laboratorio		
15	**Lesson 4** Duración: 03:00 LM: Actividad del tipo Lección Magistral **Lesson 5** Duración: 01:00 LM: Actividad del tipo Lección Magistral			

16	**Lesson 5** Duración: 01:00 LM: Actividad del tipo Lección Magistral **Final Reports** Duración: 03:00 LM: Actividad del tipo Lección Magistral			**Report Alloy Design Exercises (PE2)** TG: Técnica del tipo Trabajo en Grupo Evaluación Progresiva No presencial Duración: 00:30 **Group Project Presentations + Reports (PE1)** PG: Técnica del tipo Presentación en Grupo Evaluación Progresiva Presencial Duración: 00:30 **Final Exam (Continuous Evaluation) (PE3)** EX: Técnica del tipo Examen Escrito Evaluación Progresiva Presencial Duración: 01:00
17				**Final Global Exam (PE3)** EX: Técnica del tipo Examen Escrito Evaluación Global Presencial Duración: 01:00 **Final Project Presentations + Reports (PE1)** PG: Técnica del tipo Presentación en Grupo Evaluación Global Presencial Duración: 00:30 **Report Alloy Design Exercises (PE2)** TG: Técnica del tipo Trabajo en Grupo Evaluación Global No presencial Duración: 00:30

Para el cálculo de los valores totales, se estima que por cada crédito ECTS el alumno dedicará dependiendo del plan de estudios, entre 26 y 27 horas de trabajo presencial y no presencial.

7. Actividades y criterios de evaluación

7.1. Actividades de evaluación de la asignatura

7.1.1. Evaluación (progresiva)

Sem.	Descripción	Modalidad	Tipo	Duración	Peso en la nota	Nota mínima	Competencias evaluadas
16	Report Alloy Design Exercises (PE2)	TG: Técnica del tipo Trabajo en Grupo	No Presencial	00:30	15%	5 / 10	CG4 CG2 CG3 CG5 CG6 CG7 CG8 CG9 CG1 CE1 CE3 CE4
16	Group Project Presentations + Reports (PE1)	PG: Técnica del tipo Presentación en Grupo	Presencial	00:30	50%	5 / 10	CG3 CG5 CG6 CG7 CG8 CG9 CG1 CE1 CE3 CE4 CG4 CG2
16	Final Exam (Continuous Evaluation) (PE3)	EX: Técnica del tipo Examen Escrito	Presencial	01:00	35%	5 / 10	CG6 CG8 CG9 CG1 CE1 CE3 CE4 CG4 CG5

7.1.2. Prueba evaluación global

Sem	Descripción	Modalidad	Tipo	Duración	Peso en la nota	Nota mínima	Competencias evaluadas
17	Final Global Exam (PE3)	EX: Técnica del tipo Examen Escrito	Presencial	01:00	35%	5 / 10	CG4 CG5 CG6 CG8 CG9 CG1 CE1 CE3 CE4
17	Final Project Presentations + Reports (PE1)	PG: Técnica del tipo Presentación en Grupo	Presencial	00:30	50%	5 / 10	CG2 CG3 CG4 CG5 CG6 CG7 CG8 CG9 CG1 CE1 CE3 CE4
17	Report Alloy Design Exercises (PE2)	TG: Técnica del tipo Trabajo en Grupo	No Presencial	00:30	15%	5 / 10	CG4 CG2 CG3 CG5 CG6 CG7 CG8 CG9 CG1 CE1 CE3 CE4

7.1.3. Evaluación convocatoria extraordinaria

Descripción	Modalidad	Tipo	Duración	Peso en la nota	Nota mínima	Competencias evaluadas
Written test (final examination) (PE3)	EX: Técnica del tipo Examen Escrito	Presencial	01:00	35%	5 / 10	CG4 CG5 CG6 CG8 CG9 CG1 CE1 CE3 CE4
Final Project Presentations + Reports (PE1)	PG: Técnica del tipo Presentación en Grupo	Presencial	00:30	50%	5 / 10	CG2 CG3 CG4 CG5 CG6 CG7 CG8 CG9 CG1 CE1 CE3 CE4
Report Alloy Design Exercises (PE2)	TG: Técnica del tipo Trabajo en Grupo	Presencial	00:30	15%	5 / 10	CG4 CG2 CG3 CG5 CG6 CG7 CG8 CG9 CG1 CE1 CE3 CE4

7.2. Criterios de evaluación

The final grade of the subject is obtained from:

Final grade = PE1 (50%) + PE2 (15%) + PE3 (35%)

PE1:

The grade for this part will be obtained from the evaluation of a group project. The work will be done in groups (preferentialy, pairs, but will depend on the number of students enrolled). The groups shall be formed voluntarily, or they will be assigned by the professor.

The project will consist on the study, the explanation and presentation of an alloy design case focused in a component (extracted from published works), from the material selection stage to the alloy composition.

A report and a group presentation of a project focused on the alloy selection and alloy design for a target engineering component selected by the students of each group. This project will be prepared by the groups during the subject in parallel to the theoretical lessons.

All the students must attend to the other students presentations, so being a non recoverable activity. It will be a necessary condition before starting the presentation the delivery of the content to be exhibited, for its evaluation.

The presentation time will be evenly distributed among the group members.

The component case studies will be freely chosen by the groups from a variety provided by the lecturer.

The grade PE1 represents 50% of the final grade of the subject. To pass this part, a minimum grade in PE1 of 5/10 must be obtained.

The grade for PEI1 will be composed by the joint evaluation of the oral presentations and reports.

For continuous evaluation, the presentations and evaluations or the reports will take part at the end of the subject.

Students that do not pass or do not attend the continuous evaluation, should present a new work for the ordinary exam. If they still do not pass this part PE1, they will need to present a new work for the extraordinary exam.

PE2:

This part will consist on the completion of sheet of alloy design exercises using computational thermodynamic software.

The sheet of exercises will be completed by the students in groups (same groups than for PE1) and will be submitted during the course.

There will be an initial introductory session on the software and the sheet exercise to introduce the students the basic concepts.

All the students must attend to this session, so being a non recoverable activity.

The grade PE2 represents 15% of the final grade of the subject. To pass this part, a minimum grade in PE2 of 5/10 must be obtained.

The grade for PE2 will be obtained from the evaluation of the exercise sheet.

Students that do not pass or do not attend the continuous evaluation, should present a new work for the ordinary exam. If they still do not pass this part PE1, they will need to present a new work for the extraordinary exam.

PE3:

PE3 is the grade of a written exam covering the theoretical and practical contens of the subject.

To pass this part, a minimum grade in PE3 of 5/10 must be obtained.

This written exam will take place for continuous evaluation at the end of the subject, for ordinary evaluation at the official date stablished in the master course learning guide during the official ordinary exams period and for extraordinary evaluation at the official date stablished in the master course learning guide during the extraordinary exam period.

The grade PE3 represents 35% of the final grade of the subject.

There will be a Lab session at the ETSIAE . The exact dates will be provided at the beginning of the subject.

In all evaluation cases, the Lab attendance and the group presentations are a non-recoverable activities, that the student must have completed at the scheduled date with the other students.

For all kinds of evaluations, to pass the subject, students have to achieve at least a Final Grade of 5.0 points over 10.0 total points.

To be evaluated through the Continuous Evaluation method, attendance at a number higher than 80% of the classes is required.

8. Recursos didácticos

8.1. Recursos didácticos de la asignatura

Nombre	Tipo	Observaciones
Moodle	Recursos web	Classroom slides and notes
Fundamental Aspects of Structural Alloy Design, R. Jaffee	Bibliografía	
The Superalloys, Roger Reed	Bibliografía	
Mechanical Metallurgy, G.E. Dieter	Bibliografía	
Titanium, G. LÜTJERING.	Bibliografía	
Aluminum: properties and physical metallurgy, JOHN E. HATCH	Bibliografía	
Light alloys: from traditional alloys to nanocrystals, I.J. POLMEAR.	Bibliografía	
Dislocations in Metals, Koehler and Seitz and Read	Equipamiento	

9. Otra información

9.1. Otra información sobre la asignatura

The schedule, and especially the practical laboratory sessions, is subject to availability of human and material resources and global coordination of activities.

The weeks in the schedule are indicated with the information available at the creating of this guide, assuming this subject is taught in the second turn of the semester as in previous years. For updated information, the students should visit the "Master Learning Guide" published in the web of the Master.

Due to the size of the Laboratory rooms, the maximum number of students being assisted for each professor at the Laboratory sessions will be 12.

The list of lecturers involved in the subject is based on the information available at the time of approval of the teaching guide and may change depending on organizational and staffing needs.

Sustainable development goals

The subject is related to SDG7 and SDG9: The subject analyzes the environmental effects of the use of current technologies for space propulsion based on available materials and the development of new materials that allow the development of new less polluting technologies and also studies the development of new materials that have an impact on sustainable industrialization and innovation.

Subject Comitee (Tribunal de la asignatura)

President/Presidente: Daniel BARBA CANCHO

Vocal/Vocal: Nuria MARTÍN PIRIS

Secretary/Secretario: Laura CÓRDOVA GONZÁLEZ

Substitute/Suplente: María Esther PALACIOS LORENZO