



POLITÉCNICA

INTERNATIONAL  
CAMPUS OF  
EXCELLENCE

COORDINATION PROCESS OF  
LEARNING ACTIVITIES  
PR/CL/001



E.T.S. de Ingenieros de  
Caminos, Canales y Puertos

# ANX-PR/CL/001-01

## LEARNING GUIDE

### SUBJECT

**43000615 - Introducción A La Investigación En Ciencia E Ingeniería De Materiales - Materiales Estructurales**

### DEGREE PROGRAMME

04AN - Master Universitario En Ingeniería De Materiales

### ACADEMIC YEAR & SEMESTER

2023/24 - Semester 2

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## 1. Description

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### 1.1. Subject details

<b>Name of the subject</b>	43000615 - Introducción a la Investigación en Ciencia e Ingeniería de Materiales - Materiales Estructurales
<b>No of credits</b>	3 ECTS
<b>Type</b>	Optional
<b>Academic year of the programme</b>	First year
<b>Semester of tuition</b>	Semester 2
<b>Tuition period</b>	February-June
<b>Tuition languages</b>	English
<b>Degree programme</b>	04AN - Master Universitario en Ingeniería de Materiales
<b>Centre</b>	04 - Escuela Técnica Superior De Ingenieros De Caminos, Canales Y Puertos
<b>Academic year</b>	2023-24

## 2. Faculty

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### 2.1. Faculty members with subject teaching role

<b>Name and surname</b>	<b>Office/Room</b>	<b>Email</b>	<b>Tutoring hours *</b>
Jose Ygnacio Pastor Caño (Subject coordinator)		jy.pastor@upm.es	- -

\* 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

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### 3.1. Recommended (passed) subjects

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

### 3.2. Other recommended learning outcomes

- General knowledge of materials science and technology
- Conocimientos generales en ciencia y tecnología de materiales

## 4. Skills and learning outcomes \*

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### 4.1. Skills to be learned

CB06 - Poseer y comprender conocimientos que aporten una base u oportunidad de ser originales en el desarrollo y/o aplicación de ideas, a menudo en un contexto de investigación

CB07 - 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

CB08 - 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

CB09 - Que los estudiantes sepan comunicar sus conclusiones y los conocimientos y razones últimas que las sustentan a públicos especializados y no especializados de un modo claro y sin ambigüedades

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 - 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 satisfacer

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

CE5 - Capacidad para planificar, explotar y gestionar técnicamente la selección, fabricación, procesado, utilización, reciclado, reutilización y eliminación de materiales, de forma respetuosa con el medio ambiente, de conformidad con la legislación nacional e internacional, y promoviendo el desarrollo sostenible y el bienestar de la sociedad / Ability to technically plan, exploit and manage the selection, manufacturing, processing, use, recycling, reuse and disposal of materials, in an environmentally friendly manner, in accordance with national and international legislation, and promoting sustainable development and well-being of the society

CE8 - Aplicación del método científico para la resolución de problemas y la generación de conocimiento / Application of the scientific method to solve problems and generate knowledge

CE9 - Capacidad de realizar un trabajo o proyecto individual integrando y relacionando las competencias adquiridas en las distintas asignaturas del máster, junto con la capacidad de defenderlo en público ante un tribunal universitario experto en el tema del trabajo / Ability to carry out an individual job or project integrating and relating the skills acquired in the different subjects of the master's degree, together with the ability to defend it in public before an expert university panel on the topic of the job

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 environment: 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.

CG9 - Que los estudiantes sepan comunicar sus conclusiones y los conocimientos y razones últimas que las sustentan a públicos especializados y no especializados de un modo claro y sin ambigüedades

## 4.2. Learning outcomes

RA22 - Ser creativo, ejecutando el trabajo con responsabilidad y respeto a los demás

RA23 - Saber comunicarse con soltura en lengua inglesa de manera oral y escrita

RA3 - Conocer, comprender y saber aplicar las bases de la ciencia y del método científico

RA4 - Que los estudiantes sepan comunicar sus conclusiones (y los conocimientos y razones últimas que las sustentan) a públicos especializados y no especializados de un modo claro y sin ambigüedades

RA7 - RA53 - Ser creativo, ejecutando el trabajo con responsabilidad y respeto a los demás

RA8 - RA32 - Conocer, comprender y saber aplicar los fundamentos científicos del comportamiento de los materiales

RA5 - Poseer y comprender conocimientos que aporten una base u oportunidad de ser originales en el desarrollo y/o aplicación de ideas, a menudo en un contexto de investigación

RA21 - Saber redactar informes técnicos

RA1 - Saber comunicar conocimientos, procedimientos, resultados o técnicas relacionadas con el comportamiento y el uso de materiales

RA2 - Ser capaz de aprender y actualizar autónomamente nuevos conocimientos y técnicas

\* 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

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### 5.1. Brief description of the subject

This course was focused on the experimental research methods commonly used in materials science and engineering and aimed at developing research know-how among new researchers with practical research examples (not given here). There are two common types of experimental research; academic and applied. In academic research, experiments are designed and performed to understand and verify the principles and the consequent process whereas in applied research, projects and experiments are designed to show the established principles in action for public and industrial use. Thus, academic research deals with verification and understanding and applied research deals with the application of these principles. Research is conducted in a specific sequence or simply the initial research proposal should be ordered as what? Why?, How? and When?

### 5.2. Syllabus

1. Introduction
2. Philosophy of Science
3. Defining science
4. Scientific method
5. Justifying science
6. Observation inseparable from theory
7. The scientific paradigm
8. The purpose of science
9. Values and science
10. Current approaches
11. Science versus pseudoscience nowadays



## 6. Schedule

### 6.1. Subject schedule\*

Week	Classroom activities	Laboratory activities	Distant / On-line	Assessment activities
1	<b>Introduction</b> Duration: 02:00 Lecture			
2	<b>Tema 1</b> Duration: 00:30 Challenge-based learning  <b>Tema 1</b> Duration: 00:30 Lecture  <b>Tema 1</b> Duration: 00:30 Cooperative activities  <b>Tema 1</b> Duration: 00:30 Inverted classroom		<b>Preparation of study contents</b> Duration: 01:00 Research-based learning	
3	<b>Tema 2</b> Duration: 00:30 Challenge-based learning  <b>Tema 2</b> Duration: 00:30 Lecture  <b>Tema 2</b> Duration: 00:30 Cooperative activities  <b>Tema 2</b> Duration: 00:30 Inverted classroom		<b>Preparation of study contents</b> Duration: 01:00 Research-based learning	
4	<b>Tema 3</b> Duration: 00:30 Challenge-based learning  <b>Tema 3</b> Duration: 00:30 Lecture  <b>Tema 3</b> Duration: 00:30 Cooperative activities  <b>Tema 3</b> Duration: 00:30 Inverted classroom		<b>Preparation of study contents</b> Duration: 01:00 Research-based learning	

5	<p><b>Tema 4</b> Duration: 00:30 Challenge-based learning</p> <p><b>Tema 4</b> Duration: 00:30 Lecture</p> <p><b>Tema 4</b> Duration: 00:30 Cooperative activities</p> <p><b>Tema 4</b> Duration: 00:30 Inverted classroom</p>		<p><b>Preparation of study contents</b> Duration: 01:00 Research-based learning</p>	
6	<p><b>Tema 5</b> Duration: 00:30 Cooperative activities</p> <p><b>Tema 5</b> Duration: 00:30 Inverted classroom</p> <p><b>Tema 5</b> Duration: 00:30 Challenge-based learning</p> <p><b>Tema 5</b> Duration: 00:30 Lecture</p>		<p><b>Preparation of study contents</b> Duration: 01:00 Research-based learning</p>	
7	<p><b>Tema 6</b> Duration: 00:30 Cooperative activities</p> <p><b>Tema 6</b> Duration: 00:30 Inverted classroom</p> <p><b>Tema 6</b> Duration: 00:30 Challenge-based learning</p> <p><b>Tema 6</b> Duration: 00:30 Lecture</p>		<p><b>Preparation of study contents</b> Duration: 01:00 Research-based learning</p>	
8	<p><b>Tema 7</b> Duration: 00:30 Cooperative activities</p> <p><b>Tema 7</b> Duration: 00:30 Inverted classroom</p> <p><b>Tema 7</b> Duration: 00:30 Challenge-based learning</p> <p><b>Tema 7</b> Duration: 00:30 Lecture</p>		<p><b>Preparation of study contents</b> Duration: 01:00 Research-based learning</p>	

9	<p><b>Tema 8</b> Duration: 00:30 Cooperative activities</p> <p><b>Tema 8</b> Duration: 00:30 Inverted classroom</p> <p><b>Tema 8</b> Duration: 00:30 Challenge-based learning</p> <p><b>Tema 8</b> Duration: 00:30 Lecture</p>		<p><b>Preparation of study contents</b> Duration: 01:00 Research-based learning</p>	
10	<p><b>Tema 9</b> Duration: 00:30 Cooperative activities</p> <p><b>Tema 9</b> Duration: 00:30 Inverted classroom</p> <p><b>Tema 9</b> Duration: 00:30 Challenge-based learning</p> <p><b>Tema 9</b> Duration: 00:30 Lecture</p>		<p><b>Preparation of study contents</b> Duration: 01:00 Research-based learning</p>	
11	<p><b>Tema 10</b> Duration: 00:30 Cooperative activities</p> <p><b>Tema 10</b> Duration: 00:30 Lecture</p> <p><b>Tema 10</b> Duration: 00:30 Inverted classroom</p> <p><b>Tema 10</b> Duration: 00:30 Inverted classroom</p>		<p><b>Preparation of study contents</b> Duration: 01:00 Research-based learning</p>	
12				<p><b>Evaluation</b> Group presentation Continuous assessment Presential Duration: 02:00</p>
13				<p><b>Evaluation</b> Group presentation Continuous assessment Presential Duration: 02:00</p>

14				<b>Evaluation</b> Group presentation Continuous assessment Presential Duration: 02:00  <b>Evaluation</b> Group presentation Continuous assessment Presential Duration: 02:00
15				<b>Evaluation</b> Group presentation Continuous assessment Presential Duration: 02:00
16				<b>Evaluation</b> Group presentation Continuous assessment Presential Duration: 02:00
17				<b>Exam</b> Individual presentation Final examination Presential Duration: 04:00

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.

\* The schedule is based on an a priori planning of the subject; it might be modified during the academic year, especially considering the COVID19 evolution.

## 7. Activities and assessment criteria

### 7.1. Assessment activities

#### 7.1.1. Assessment

Week	Description	Modality	Type	Duration	Weight	Minimum grade	Evaluated skills
12	Evaluation	Group presentation	Face-to-face	02:00	15%	5 / 10	CG6 CG7 CE4 CB06 CB07 CB09 CB10 CE8 CG2 CG3 CG4 CG5 CG8 CG9 CG9 CG1 CB08 CE9
13	Evaluation	Group presentation	Face-to-face	02:00	15%	5 / 10	
14	Evaluation	Group presentation	Face-to-face	02:00	15%	5 / 10	
14	Evaluation	Group presentation	Face-to-face	02:00	15%	5 / 10	
15	Evaluation	Group presentation	Face-to-face	02:00	15%	5 / 10	
16	Evaluation	Group presentation	Face-to-face	02:00	25%	5 / 10	

#### 7.1.2. Global examination

Week	Description	Modality	Type	Duration	Weight	Minimum grade	Evaluated skills
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17	Exam	Individual presentation	Face-to-face	04:00	100%	5 / 10	CG6 CG7 CE4 CB06 CG2 CB07 CB09 CB10 CE8 CG4 CG5 CG8 CG9 CG9 CG1 CB08 CE9
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### 7.1.3. Referred (re-sit) examination

Description	Modality	Type	Duration	Weight	Minimum grade	Evaluated skills
Exams	Individual presentation	Face-to-face	04:00	100%	5 / 10	CG2 CG6 CG7 CE4 CB06 CB07 CB09 CB10 CE8 CG3 CG4 CG5 CG8 CG9 CG9

								CE5
								CG1
								CB08
								CE9

## 7.2. Assessment criteria

Classroom participation.

Preparation of content.

Classroom presentations.

Ability to synthesise.

Ability to debate assertively.

Ability to reach original conclusions.

Creativity and originality of thought.

Application of the scientific method.

## 8. Teaching resources

### 8.1. Teaching resources for the subject

Name	Type	Notes
Science and Pseudo-science	Bibliography	Stanford Encyclopedia of Philosophy. 2008
The logic of scientific discovery	Bibliography	London & New York: Routledge Classics. ISBN 978-0-415-27844-
Defining Pseudoscience	Bibliography	Hansson, Sven Ove (1996). <i>Philosophia Naturalis</i> . 33
Cargo Cult Science	Bibliography	Feynman, Richard
What Kind of Explanation is Truth?	Bibliography	Levin, Michael (1984). In Jarrett Leplin (ed.). <i>Scientific Realism</i> . Berkeley: University of California Press
Can theories be refuted?: essays on the Dunhem?Quine thesis	Bibliography	Sandra Harding (1976). . Springer Science & Business Media.
The Structure of Scientific Revolutions	Bibliography	Kuhn, T.S. (1996).
Against Method: Outline of an Anarchistic Theory of Knowledge	Bibliography	Paul Feyerabend (1975)
Science Technology and Society	Bibliography	Woodhouse, Edward. Spring 2015
Science, Truth, and Democracy.	Bibliography	Kitcher, Philip (2001). <i>Oxford Studies in Philosophy of Science</i> . New York: Oxford University Press.
Is there logic in the placebo?	Bibliography	Gøtzsche, P.C. (1994). <i>Lancet</i> . 344
Learning Theories: An Educational Perspective	Bibliography	Schunk,
Habermas: Key Contemporary Thinkers	Bibliography	Outhwaite, William, 1988 , Polity Press
Understanding Science	Web resource	<a href="https://undsci.berkeley.edu/the-philosophy-of-science/">https://undsci.berkeley.edu/the-philosophy-of-science/</a>



## 9. Other information

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### 9.1. Other information about the subject

This subject focuses on the student, who will have to delve into the field of the philosophy of science and the scientific method through readings, analysis and debates with their classmates.

Continuous, day-to-day work is essential in order to pass this subject.