ANX-PR/CL/001-01

LEARNING GUIDE

SUBJECT

43000621 - Metamateriales Y PlasmÓnica

DEGREE PROGRAMME

04AN - Master Universitario En Ingenieria De Materiales

ACADEMIC YEAR & SEMESTER

2023/24 - Semester 2

Index

Learning guide

1. Description

1.1. Subject details

Name of the subject	43000621 - Metamateriales y Plasmónica
No of credits	3 ECTS
Type	Optional
Academic year ot the programme	First year
Semester of tuition	Semester 2
Tuition period	February-June
Tuition languages	English
Degree programme	04AN - Master Universitario en Ingenieria de Materiales
Centre	04 - Escuela Tecnica Superior De Ingenieros De Caminos, Canales Y Puertos
Academic year	2023-24

2. Faculty

2.1. Faculty members with subject teaching role

Name and surname	Office/Room	Email	Tutoring hours *
Adrian Hierro Cano (Subject coordinator)	ETSIT B-312	adrian.hierro@upm.es	W - 12:00 - 13:00

* 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

- Solid State Lighting

- Materials For Photonic Devices

- Photovoltaic Materials And Devices

3.2. Other recommended learning outcomes

- Materials properties

- Electromagnetism

- Semiconductor physics

4. Skills and learning outcomes *

4.1. Skills to be learned

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.

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

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 .

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.

4.2. Learning outcomes

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

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

RA16 - Knowledge and understanding of the electrical, optical, thermal and mechanical properties of materials

RA11 - knowledge of the basic fabrication methods, structure and properties of nanomaterials and other forms of nanostructured hybrids

* 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 deals with metamaterials, artificially structured materials with nanoscale inclusions and very unconventional optical properties. These materials are treated as macroscopically homogeneous media and can exhibit unusual and exciting response to light. Electric metamaterials are analyzed, and the basic processing and characterization techniques in this exciting area are addressed. Using metamaterials as the basic building blocks, the most novel applications in this area are covered: negative-index, meta-lenses, etc.

5.2. Syllabus

1. What are Metamaterials?
2. Optical Properties of Metal-Dielectric Composites
3. Experimental Techniques
4. Electric Metamaterials
5. Negative-Index Metamaterials
6. Super Resolution with Meta-Lenses

6. Schedule

6.1. Subject schedule*

Week	Classroom activities	Laboratory activities	Distant / On-line	Assessment activities
1	**Presentation. What are Metamaterials?** Duration: 02:00 Lecture **Optical Properties of Metal-Dielectric Composites** Duration: 02:00 Lecture			
2	**Optical Properties of Metal-Dielectric Composites** Duration: 02:00 Lecture **Experimental Techniques** Duration: 02:00 Lecture			**Homework Assignment** Individual work Continuous assessment Presential Duration: 00:00
3	**Experimental Techniques** Duration: 02:00 Lecture **Problem class** Duration: 02:00 Problem-solving class			
4	**Electric Metamaterials** Duration: 02:00 Lecture **Electric Metamaterials** Duration: 02:00 Lecture			**Homework Assignment** Individual work Continuous assessment Presential Duration: 00:00
5	**Negative-Index Metamaterials** Duration: 02:00 Lecture **Negative-Index Metamaterials** Duration: 02:00 Lecture			
6	**Problem class** Duration: 02:00 Problem-solving class **Super Resolution with Meta-Lenses** Duration: 02:00 Lecture			**Homework Assignment** Individual work Continuous assessment Presential Duration: 00:00

7	**Super Resolution with Meta-Lenses** Duration: 02:00 Lecture **Problem class** Duration: 02:00 Problem-solving class			
8				**Homework Assignment** Individual work Continuous assessment Presential Duration: 00:00 **News Presentation** Individual presentation Continuous assessment Presential Duration: 02:00
9				
10				
11				
12				
13				
14				
15				
16				
17				**Examination** Written test Continuous assessment Presential Duration: 02:30 **Final Examination** Written test Final examination Presential Duration: 03:00

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
2	Homework Assignment	Individual work	Face-to-face	00:00	5%	0 / 10	CE1 CE5 CG1 CE4 CG8
4	Homework Assignment	Individual work	Face-to-face	00:00	5%	0 / 10	CE1 CE5 CG1 CE4 CG8
6	Homework Assignment	Individual work	Face-to-face	00:00	5%	0 / 10	CE1 CE5 CG1 CE4 CG8
8	Homework Assignment	Individual work	Face-to-face	00:00	5%	0 / 10	CE1 CE5 CG1 CE4 CG8
8	News Presentation	Individual presentation	Face-to-face	02:00	10%	0 / 10	
17	Examination	Written test	Face-to-face	02:30	70%	3.5 / 10	CE1 CE5 CG1 CE4 CG8

7.1.2. Global examination

Week	Description	Modality	Type	Duration	Weight	Minimum grade	Evaluated skills
17	Final Examination	Written test	Face-to-face	03:00	100%	5 / 10	CE1 CE5 CG1 CE4 CG8

7.1.3. Referred (re-sit) examination

Description	Modality	Type	Duration	Weight	Minimum grade	Evaluated skills
Examination	Written test	Face-to-face	03:00	100%	5 / 10	CE1 CE5 CG1 CE4 CG8

7.2. Assessment criteria

Final grade weight of the different activities for Evaluación Continua:

- Exam: 70 %

- Homework Assignments: 20 %

- News presentation: 10 %

Final grade for Evaluacion sólo por Prueba Final:

- Exam: 100 %

8. Teaching resources

8.1. Teaching resources for the subject

Name	Type	Notes
Course Book	Bibliography	Wenshan Cai and Vladimir Shalaev, "Optical Metamaterials: Fundamentals and Applications", Springer 2010.
Supplementary Book 1	Bibliography	Stefan Alexander Maier, "Plasmonics: Fundamentals and Applications", Springer 2007.
Supplementary Book 2	Bibliography	C. Simovski, S. Tretyakov, "An introduction to metamaterials and nanophotonics", Cambridge University Press, 2020.