ANX-PR/CL/001-01

LEARNING GUIDE

SUBJECT

43000620 - IluminaciÓn De Estado SÓlido

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	43000620 - Iluminación de Estado Sólido
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 *
Miguel Angel Sanchez Garcia (Subject coordinator)		miguelangel.sanchez@upm.es	Sin horario. These will be announced at the beginning of the semester
Zarko Gacevic	C-226	zarko.gacevic@upm.es	Sin horario. These will be announced at the beginning of the semester

* The tutoring schedule is indicative and subject to possible changes. Please check tutoring times with the faculty member in charge.

3. Skills and learning outcomes *

3.1. 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.

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 .

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.

3.2. Learning outcomes

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

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

RA29 - C1 - Knowledge of the scientific method applied to structural and functional materials

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

RA38 - C6 - Advanced knowledge of the operating principles of devices based on structural and functional materials for the main technological applications: solar cells, LEDs, lasers, optical amplifiers, waveguides, transistors (FETs and MOSFETs), permanent magnets, spintronic devices, metalenses, electrochemical cells, batteries, supercapacitors, piezoelectric actuators

RA12 - Knowledge and understanding of how extreme temperatures affect the behaviour of materials.

* 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.

4. Brief description of the subject and syllabus

4.1. Brief description of the subject

The main objective of this course is to get fundamental concepts of solid state lighting, with special emphasis in organic/inorganic LEDs, white-light emission and general applications.

4.2. Syllabus

1. Brief history of Lighting and basic concepts on the emission of light
    1.1. Chronological History of Lighting
    1.2. Nature and Quality of Lighting
    1.3. Conventional Light Sources
    1.4. LED-based solid-state lighting
2. Inorganic LEDs
    2.1. Physical principles of Inorganic LEDs
    2.2. Homojunction LEDs
    2.3. Heterojunction LEDs
    2.4. Light extraction from LEDs
    2.5. Semiconductor materials for Inorganic LEDs
    2.6. Fabrication of Inorganic LEDs
    2.7. LED performance parameters
    2.8. Thermal management of LEDs
3. Organic LEDs
    3.1. Organic semiconductors LEDs
    3.2. Polymer LEDs
4. White light emission
    4.1. Wavelength conversion and color mixing techniques
    4.2. Quality of white LED emission
    4.3. Phosphor materials for LEDs

4.4. High-brightness LEDs

5. LED applications

5.1. LEDs in general illumination

5.2. LEDs in displays

5.3. White light for automotive applications

5.4. Miscellaneous applications of Solid-State Lighting

5. Schedule

5.1. Subject schedule*

Week	Classroom activities	Laboratory activities	Distant / On-line	Assessment activities
1	**Chapter 1. Brief history of Lighting and basic concepts on the emission of light** Duration: 02:00 Lecture			
2	**Chapter 1. Brief history of Lighting and basic concepts on the emission of light** Duration: 02:00 Lecture			
3	**Chapter 2. Inorganic LEDs** Duration: 02:00 Lecture			
4	**Chapter 2. Inorganic LEDs** Duration: 02:00 Lecture			
5	**Chapter 2. Inorganic LEDs** Duration: 02:00 Lecture			
6	**Chapter 2. Inorganic LEDs** Duration: 02:00 Lecture			
7	**Chapter 2. Inorganic LEDs** Duration: 02:00 Lecture			**Written Exam (Partial 1)** Written test Continuous assessment Presential Duration: 02:00
8	**Chapter 2. Inorganic LEDs** Duration: 02:00 Lecture			
9	**Chapter 3. Organic LEDs** Duration: 02:00 Lecture			
10	**Chapter 3. Organic LEDs** Duration: 02:00 Lecture			
11	**Chapter 4. White Light emission** Duration: 00:00 Lecture			
12	**Chapter 4. White Light emission** Duration: 00:00 Lecture			

13	**Chapter 4. White Light emission** Duration: 00:00 Lecture			
14	**Chapter 5. LED applications** Duration: 02:00 Lecture			
15	**Chapter 5. LED applications** Duration: 02:00 Lecture			
16	**Chapter 5. LED applications** Duration: 02:00 Lecture			
17				**Written Exam (Partial 2)** Written test Continuous assessment Presential Duration: 02:00 **Written Exam (Final Exam)** Written test Final examination Not 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.

6. Activities and assessment criteria

6.1. Assessment activities

6.1.1. Assessment

Week	Description	Modality	Type	Duration	Weight	Minimum grade	Evaluated skills
7	Written Exam (Partial 1)	Written test	Face-to-face	02:00	50%	0 / 10	CE4 CE1 CG8 CE3 CG1
17	Written Exam (Partial 2)	Written test	Face-to-face	02:00	50%	0 / 10	CE1 CG8 CE3 CG1 CG7 CE4 CG6

6.1.2. Global examination

Week	Description	Modality	Type	Duration	Weight	Minimum grade	Evaluated skills
17	Written Exam (Final Exam)	Written test	No Presential	03:00	100%	5 / 10	CE4 CG6 CE1 CG8 CE3 CG1 CG7

6.1.3. Referred (re-sit) examination

Description	Modality	Type	Duration	Weight	Minimum grade	Evaluated skills
Written Exam (Extraordinary)	Written test	Face-to-face	03:00	100%	5 / 10	CE4 CG6 CE1 CG8 CE3 CG1 CG7

6.2. Assessment criteria

The final grade of the subject will be calculated in the following ways:

- PROGRESSIVE EVALUATION: Final grade = 50% of the first partial exam + 50% of the second partial exam. The first partial exam will be held around week 7 of the course and it will cover the material covered in class until that date. This exam will have a weight of 50% of the final grade and there is a minimum grade of 4.0 points in order to be considered. The other 50% will come from a second partial exam covering the rest of the program of the course and that will be held during the period of Final Exams. This second exam will also have a minimum grade of 4.0 points in order to be considered. For those students who did not get the minimum grade in the first partial exam, they will perform a final full exam with 100% weight for the final grade.

- EVALUATION based on a FINAL exam (GLOBAL): The final grade will be that obtained in a single written final exam covering all the chapters of the course.

- EXTRAORDINARY EVALUATION: The final grade of the Extraordinary Evaluation will be that obtained in a single written final exam covering all the chapters of the course.

7. Teaching resources

7.1. Teaching resources for the subject

Name	Type	Notes
Fundamentals of Solid-State Lighting: LEDs, OLEDs, and Their Applications in Illumination and Displays Vinod Kumar Khanna, Editorial: Routledge (2014)	Bibliography	Reference Book
Introduction to Solid-State Lighting, Art?ras ?ukauskas, Michael S. Shur, Remis Gaska, Editorial Wiley (2002)	Bibliography	Reference Book

8. Other information

8.1. Other information about the subject

This subject is related to Sustainable Development Goals SDG3, SDG7, and SDG9