Teaching Guide				
Identifying Data				2023/24
Subject (*)	Photonics and Optoelectronics		Code	610G04033
Study programme	Grao en Nanociencia e Nanotecnoloxía			
Descriptors				
Cycle	Period	Year	Type	Credits
Graduate	1st four-month period	Fourth	Obligatory	6
Language	SpanishGalicianEnglish			
Teaching method	Face-to-face			
Prerequisites				
Department				
Coordinador	Rodríguez Sánchez, José Luis	E-mail	j.l.rodriguez.sanchez@udc.es	
Lecturers	Rodríguez Sánchez, José Luis	E-mail	j.l.rodriguez.sanchez@udc.es	
Web				
General description	After studying this subject, the student will master the fundamental principles of photonics and optoelectronics, emphasizing the fundamentals of optics and the interaction of electromagnetic waves. Among other aspects, the student will learn the main devices based on light, such as photoresistors, photodiodes and optical sensors, and the bases of optical communications and wave modulation. Finally, an introduction to the fundamentals of biophotonics and nanophotonics and their applications will be given.			

Study programme competences / results	
Code	Study programme competences / results
A1	CE1 - Comprender los conceptos, principios, teorías y hechos fundamentales relacionados con la Nanociencia y Nanotecnología.
A2	CE2 - Aplicar los conceptos, principios, teorías y hechos fundamentales relacionados con la Nanociencia y Nanotecnología a la resolución de problemas de naturaleza cuantitativa o cualitativa.
A3	CE3 - Reconocer y analizar problemas físicos, químicos, matemáticos, biológicos en el ámbito de la Nanociencia y Nanotecnología, así como plantear respuestas o trabajos adecuados para su resolución, incluyendo el uso de fuentes bibliográficas.
B1	CB1 - Que los estudiantes hayan demostrado poseer y comprender conocimientos en un área de estudio que parte de la base de la educación secundaria general, y se suele encontrar a un nivel que, si bien se apoya en libros de texto avanzados, incluye también algunos aspectos que implican conocimientos procedentes de la vanguardia de su campo de estudio
B2	CB2 - Que los estudiantes sepan aplicar sus conocimientos a su trabajo o vocación de una forma profesional y posean las competencias que suelen demostrarse por medio de la elaboración y defensa de argumentos y la resolución de problemas dentro de su área de estudio
B4	CB4 - Que los estudiantes puedan transmitir información, ideas, problemas y soluciones a un público tanto especializado como no especializado
B5	CB5 - Que los estudiantes hayan desarrollado aquellas habilidades de aprendizaje necesarias para emprender estudios posteriores con un alto grado de autonomía
B6	CG1 - Aprender a aprender
B7	CG2 - Resolver problemas de forma efectiva.
B8	CG3 - Aplicar un pensamiento crítico, lógico y creativo.
B9	CG4 - Trabajar de forma autónoma con iniciativa.
B11	CG6 - Comportarse con ética y responsabilidad social como ciudadano/a y como profesional.
B12	CG7 - Comunicarse de manera efectiva en un entorno de trabajo.
C1	CT1 - Expresarse correctamente, tanto de forma oral coma escrita, en las lenguas oficiales de la comunidad autónoma
C2	CT2 - Dominar la expresión y la comprensión de forma oral y escrita de un idioma extranjero
C4	CT4 - Desarrollarse para el ejercicio de una ciudadanía respetuosa con la cultura democrática, los derechos humanos y la perspectiva de género
C5	CT5 - Entender la importancia de la cultura emprendedora y conocer los medios al alcance de las personas emprendedoras
C7	CT7 - Desarrollar la capacidad de trabajar en equipos interdisciplinares o transdisciplinares, para ofrecer propuestas que contribuyan a un desarrollo sostenible ambiental, económico, político y social.

C8	CT8 - Valorar la importancia que tiene la investigación, la innovación y el desarrollo tecnológico en el avance socioeconómico y cultural de la sociedad
C9	CT9 - Tener la capacidad de gestionar tiempos y recursos: desarrollar planes, priorizar actividades, identificar las críticas, establecer plazos y cumplirlos

Learning outcomes			
Learning outcomes	Study programme competences / results		
Theoretical and practical knowledge of optical radiation sources and fundamentals of optics.	A1 A3	B1 B4 B5 B6 B7	C1 C2
Generation, translation and interaction of electromagnetic waves.	A1 A2	B1 B2 B7 B8 B9	C4 C5
Know about light-based devices: photoresistors, photodiodes and optical sensors.	A1 A2	B7 B11 B12	C7 C8
Fundamentals of optical communications and wave modulation.	A1	B1 B5 B7 B9	C7 C9
Understand the principles of biophotonics and nanophotonics.	A3	B8 B9	C8 C9

Contents	
Topic	Sub-topic
I.- Introduction to Optical Fundamentals and Optical Radiation Sources	1.1. Light ray and refractive index. Snell's law 1.2. Optical path: Fermat's principle. 1.3. Laws of geometrical optics. 1.4. Wave surface 1.5. Propagation of light in dielectric and conductive media 1.6. Laws of reflection and refraction 1.7. Fresnel formulae
II.- Electromagnetic wave generation, translation and interaction	2.1. Maxwell's equations 2.2. Vacuum Wave Equations 2.3. Plane and spherical waves 2.4. Monochromatic waves 2.5. The complex wave representation 2.6. Spectral decomposition of the radiation 2.7. Huygens' principle 2.8. Wave energy

III.- Optoelectronic devices and detectors	3.1. luminescent diodes and lasers 3.2. photoresistors, photodiodes, phototransistors, capacitive photosensors and digital image sensors 3.3. Photomultipliers 3.4. Optoelectronic Sensor Applications
IV.- Optical Communications and Light Modulation	4.1. Single-mode and multimode optical fibres 4.2. Michelson interferometer 4.3. Fabry-Perot interferometer 4.4. Sagnac interferometer 4.5. integrated optics
V.- Nanophotonics and biophotonics	5.1. Far field, near field, diffraction limit and evanescent waves 5.2. Mie theory 5.3. Plasmonic and resonant dielectric nanoparticles 5.4. Non-linear nanophotonics 5.5. Quantum dots and nanoparticles. Single photon emission 5.6. Biosensors

Planning				
Methodologies / tests	Competencies / Results	Teaching hours (in-person & virtual)	Student?s personal work hours	Total hours
Problem solving	A2 B4 B5 B7 B8 B9 C4 C7 C8 C9	4	8	12
Mixed objective/subjective test	A1 A2 A3 B7 B8 B9 B12 C1 C7 C8	2	3	5
Seminar	A2 A3 B2 B7 B8 B9 C8 C9	4	8	12
Objective test	A1 A2 A3 B11	2	3	5
Laboratory practice	A1 B2 B7 B8 B11 B12	15	22.5	37.5
Guest lecture / keynote speech	A1 A2 A3 B1 B2 B4 B6 B11 B12 C1 C2 C5	28	49	77
Personalized attention		1.5	0	1.5
(*)The information in the planning table is for guidance only and does not take into account the heterogeneity of the students.				

Methodologies	
Methodologies	Description
Problem solving	The problem-solving classes will be devoted to the resolution of problems and questions that have been previously posed to the students, so that they can work on them before the corresponding face-to-face session.
Mixed objective/subjective test	Joint test to be carried out in the timetable agreed by the Faculty Board. Its aim is to contribute to the evaluation of the level of knowledge and skills acquired by the students and their ability to relate them and obtain a global vision of the subject.
Seminar	This activity is designed to be carried out in groups as small as possible, with the aim of delving into the different subjects in a dynamic and argumentative way. Its success depends on the active participation of the students.
Objective test	Periodically, in the problem-solving sessions, students will take a series of short tests, of the test or short answer type, designed both to evaluate the degree of acquisition of skills and to reinforce the contents seen in the lectures. This activity will not only allow students' progress to be monitored, but will also serve to detect those aspects of the subject that are more difficult to understand.
Laboratory practice	Real laboratory practice will be carried out with the active participation of the students within the possibilities offered by the faculty. This includes the performance of measurements and data processing as well as the delivery of results.

Guest lecture / keynote speech	In the master classes, the contents of the corresponding subjects will be introduced, highlighting their most important aspects and focusing especially on those concepts that are fundamental and/or most difficult for the students to understand.

Personalized attention	
Methodologies	**Description**
Laboratory practice Problem solving Guest lecture / keynote speech Seminar	Students will be able to attend tutoring sessions on specific dates. An attempt will be made to guide students in understanding the problems posed and the strategies for solving them. Tutoring hours will be set jointly between teachers and students according to their needs and will take place in the teachers' offices or classrooms specifically set aside for this purpose.

Assessment			
Methodologies	**Competencies / Results**	**Description**	**Qualification**
Laboratory practice	A1 B2 B7 B8 B11 B12	The work carried out in the laboratory will be evaluated from the points of view of: organisation and safety, handling in the laboratory, knowledge of technical materials, manual dexterity and especially the ability to understand and rationalise the processes carried out in the light of their scientific basis. In order to carry out the practical work, students will be provided with scripts, which will reflect their objectives, materials and methods for their performance. Students will prepare reports on the practical work carried out. There will also be a short test to assess the knowledge acquired.	20
Problem solving	A2 B4 B5 B7 B8 B9 C4 C7 C8 C9	Students' answers and their participation in the corresponding face-to-face activities will be assessed. Occasionally, and at the request of the teaching staff, students will be asked to hand in problem reports, which may also be assessed.	15
Mixed objective/subjective test	A1 A2 A3 B7 B8 B9 B12 C1 C7 C8	Final exam with two parts, a theoretical part (50%) which includes multiple-choice, short answer and/or essay questions, and a problem-solving part (50%), in which the ability to apply the theoretical contents to solve problems will be assessed.	50
Seminar	A2 A3 B2 B7 B8 B9 C8 C9	Assessment is based on the ability to apply the different experimental and theoretical concepts seen in the subject. The evaluation includes: operational aspects, understanding of the strategies and methodologies used to solve the cases, critical analysis of the results obtained.	10
Objective test	A1 A2 A3 B11	From time to time, the student may be given short tests, such as a quiz or a short answer. These objective tests are designed both to assess the degree of acquisition of competences and to consolidate the contents seen in the lectures. This activity will not only allow monitoring of students' progress, but will also serve as a tool to detect those aspects of the subject that are more difficult to understand.	5

Assessment comments
The aim is to assess students' acquisition of knowledge, critical capacity, synthesis, comparison, elaboration, application and originality. In order to make the best possible use of the subject, students must attend all face-to-face activities. The qualification of honours will preferably be awarded at the first opportunity. Honours: in the event that there are several students with the same degree who are eligible for the MH, and the number of available MHs is less than the number of students, the MH will be awarded to the student with the highest final mark. In the case of the same final mark, the MH will be awarded to the student with the highest mark in the mixed test. Students assessed at the second opportunity may only apply for the MH if the number of MHs has not been fully covered at the first opportunity. No-show grade: applied to students who participated in evaluable activities that accounted for less than (

Sources of information

Basic	- Marc Figueras Atienza (2011). Óptica y fotónica. UOC - J.M. Cabrera, F.J. López, F. Agulló (1993). Optica electromagnética: fundamentos. Addison-Wesley. - Sergey V. Gaponenko (2010). Introduction to Nanophotonics. Cambridge, Cambridge University Press - P.N. Prasad (2004). Nanophotonics. New Jersey, John Wiley & Sons
Complementary	- Ramon Pallas Areny (2005). Sensores y Acondicionadores de Señal. Marcombo - W Gopel, J. Hesse, J. N. Zemel (1995). Sensors: A Comprehensive Survey. Technology. Wiley-VCH - Miguel A. Pérez García (2004). Instrumentación electrónica. Paraninfo - Rainer Waser (2013). Nanoelectronics and Information. Technology. Wiley-VCH - George W. Hansons (2004). Fundaments of nanoelectronics. Pearson education

Recommendations
Subjects that it is recommended to have taken before
Polymers/610G04028 Solid State/610G04022 Fundamentals of Quantum Theory/610G04015 Physics: Electricity and Magnetism/610G04007 Physics: Mechanics and Waves/610G04002
Subjects that are recommended to be taken simultaneously
Subjects that continue the syllabus
Other comments
The class presentations made available to students on the Virtual Campus are a guide for the study of the subjects, but in no case do they constitute the total content of the same.It is strongly recommended to use the tutorial hours to clarify doubts.Gender perspectiveAs stated in the transversal competences of the degree (C4), the development of a critical, open and respectful citizenship with the diversity of our society will be encouraged, emphasising the equal rights of students without discrimination on the grounds of gender or sexual condition. Inclusive language will be used in the material and in the development of the sessions, work will be done on identifying and modifying prejudices and sexist attitudes and influencing the environment to modify them and promote values of respect and equality.Green Campus Programme - Faculty of ScienceIn order to help achieve an immediate sustainable environment and to comply with point 6 of the "Environmental Declaration of the Faculty of Science (2020)", the documentary work carried out in this area: (a) Will be requested mostly in virtual format and computer support. b) To be done on paper:- Plastics shall not be used.- Double-sided printing will be used.- Recycled paper shall be used.- Drafts shall be avoided.