Teaching Guide				
Identifying Data				2023/24
Subject (*)	Nanotechnology in Instrumentation and Robotics		Code	610G04039
Study programme	Grao en Nanociencia e Nanotecnoloxía			
Descriptors				
Cycle	Period	Year	Type	Credits
Graduate	1st four-month period	Fourth	Optional	4.5
Language	SpanishGalicianEnglish			
Teaching method	Face-to-face			
Prerequisites				
Department	Ciencias da Computación e Tecnoloxías da InformaciónEnxeñaría Industrial			
Coordinador	Rodríguez Gómez, Benigno Antonio	E-mail	benigno.rodriguez@udc.es	
Lecturers	Alvarellos González, Alberto José Perez Castelo, Francisco Javier Rabuñal Dopico, Juan Ramon Rodríguez Gómez, Benigno Antonio	E-mail	alberto.alvarellos@udc.es francisco.javier.perez.castelo@udc.es juan.rabunal@udc.es benigno.rodriguez@udc.es	
Web				
General description	This course aims, on the one hand, to provide students with an overview of the essential concepts in classical Instrumentation and Robotics, as they are part of the equipment used both in industry and in the laboratory. And on the other hand, it tries to make a first approach to what Nanoscience and Nanotechnology are contributing to the development of those disciplines, focusing on some applications that are emerging successfully.			

Study programme competences	
Code	Study programme competences
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.
A6	CE6 - Manipular instrumentación y material propios de laboratorios para ensayos físicos, químicos y biológicos en el estudio y análisis de fenómenos en la nanoescala.
A7	CE7 - Interpretar los datos obtenidos mediante medidas experimentales y simulaciones, incluyendo el uso de herramientas informáticas, identificar su significado y relacionarlos con las teorías químicas, físicas o biológicas apropiadas.
A10	CE10 - Comprender la legislación en el ámbito del conocimiento y la aplicación de la Nanociencia y Nanotecnología. Aplicar principios éticos en este marco.
B3	CB3 - Que los estudiantes tengan la capacidad de reunir e interpretar datos relevantes (normalmente dentro de su área de estudio) para emitir juicios que incluyan una reflexión sobre temas relevantes de índole social, científica o ética
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
B7	CG2 - Resolver problemas de forma efectiva.
B8	CG3 - Aplicar un pensamiento crítico, lógico y creativo.
B9	CG4 - Trabajar de forma autónoma con iniciativa.
C3	CT3 - Utilizar las herramientas básicas de las tecnologías de la información y las comunicaciones (TIC) necesarias para el ejercicio de su profesión y para el aprendizaje a lo largo de su vida
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

Learning outcomes

Learning outcomes	Study programme competences		
To know the principles of instrumentation, robotics and traditional actuation.	A2	B4 B5 B8	C3 C7
To know the interconnection systems between feedback and actuation.	A6	B7 B9	C3
To know the instrumentation and robotics systems implemented with nanotechnology.	A2	B3 B4 B5 B8 B9	C3 C8
To know the energy harvesting and storage systems for Nanoinstrumentation/robotics.		B3 B4 B5 B8	C3 C8
To know Nanoinstrumentation/robotics applications.	A7 A10	B4 B7 B8	C3 C8
Recognize and apply ethical and legal principles within the field of study.	A10	B8	C3

Contents	
Topic	Sub-topic
Principles of instrumentation, robotics and traditional actuation	Basic principles of electricity/electronics: electrical measurement units. Types of traditional sensors: ph, redox, oxygen, turbidity, organic matter, pressure, ultrasonic and doppler, etc. Types of robots Structure and drives Control and programming Commercial specifications Swarm robotics
Interconnection systems between information collection and action elements	Data acquisition systems. A/D and D/A operating principles Data recording and control systems. Dataloggers, PLC, microcontrollers. Device networking topologies: parallel, serial, star, bus....
Nanotechnology for instrumentation	Instrumentation equipment to work at the nanometer scale. Nanosensoric.
Nanotechnology for robotics	Micro and nanomanipulation tools Molecular robotics DNA structures for robotics
Energy procurement and storage for power supply systems.	Environmental sources External sources
Applications	Nanotechnological sensorization of robots Biohybrid robotics
Ethical and legal aspects	Roboethics Robots and civil liability European Parliament Resolution

Planning				
Methodologies / tests	Competencies	Ordinary class hours	Student?s personal work hours	Total hours

Laboratory practice	A6 A7 B3 B7 B9 C3 C7	10	10	20
Student portfolio	A2 A7 B3 B5 B7 B8 B9 C3 C7 C8	7	35	42
Mixed objective/subjective test	A2 A7 A10 B4 B5 B7	2	9	11
Guest lecture / keynote speech	A2 A10 B4 B5 B8 C8	18	27	45
Personalized attention		7	0	7
(*)The information in the planning table is for guidance only and does not take into account the heterogeneity of the students.				

Methodologies	
Methodologies	**Description**
Laboratory practice	Both traditional Instrumentation and Robotics practices will be carried out with real and/or virtual materials. The visit to real instrumented installations will be included, to check the operation "in situ" of multiple devices. For Robotics practices, robots of limited performance in range and load may be used, but with similar functionality to those of a real working environment.
Student portfolio	It will include all the work done throughout the course, commissioned by teachers, as well as any other material that the student considers of interest in their training throughout the course. As far as possible, it will be done in digital support.
Mixed objective/subjective test	It will be the exam to be taken on the corresponding date set by the Faculty Board for the academic year. The contents of the exam, as well as the auxiliary material available to the students for its realization, will be indicated by the professors prior to the test.
Guest lecture / keynote speech	It corresponds to the expository teaching sessions, it will be a class directed by the teacher in which he will introduce the knowledge of the subject; but also, as far as possible, he will seek the participation of the students so that the dialogued intervention, supported by the means available in the classroom, favors the teaching-learning process.

Personalized attention	
Methodologies	**Description**
Student portfolio	The teacher will guide, individually or in small groups, the way in which the students will build their portfolios based on the work assigned during the course. The teacher will also indicate if they should have other types of auxiliary materials that are not of their own elaboration. In addition, each student will be able to add materials of interest for his or her training in this discipline at his or her own discretion.

Assessment			
Methodologies	**Competencies**	**Description**	**Qualification**
Laboratory practice	A6 A7 B3 B7 B9 C3 C7	The students will have the precise instructions, facilitated by the teacher for the execution of the laboratory practices. They will have to attend them and prepare the reports or documents they are asked to prepare.	20
Student portfolio	A2 A7 B3 B5 B7 B8 B9 C3 C7 C8	Different learning activities will be carried out, during the course, from which the students will generate a set of evaluable elements, following the indications given by the teachers of the subject.	40
Mixed objective/subjective test	A2 A7 A10 B4 B5 B7	This exam will take place on the date established by the Faculty Board, the instructions for its realization will be provided by the teachers in advance. The teachers will be able to carry out, on an optional basis, partial tests of the same nature, which may result in the release of the final exam.	40

Assessment comments

Sources of information	
Basic	- Organización Internacional de Normalización (2012). Robots and robotic devices ? Vocabulary (Norma ISO nº 8373:2012)?. . Suiza:ISO - Barrientos, A. (2012). Fundamentos de robótica (2a. ed.).. España: McGraw-Hill - Liu, Yunhui., and Dong Sun. (2012). Biologically Inspired Robotics. 1st edition.. Boca Raton, Fla: CRC Press. - Veruggio, Gianmarco, Jorge Solis, and Machiel Van der Loos. (2011). Roboethics: Ethics Applied to Robotics . New York: IEEE - Murata, Satoshi et al. (2013). Molecular Robotics: A New Paradigm for Artifacts. . Heidelberg: Verlag Omsha Tokio - Mestre, Rafael, Tania Patiño, and Samuel Sánchez. (2021). Biohybrid Robotics: From the Nanoscale to the Macroscale. Hoboken, USA: John Wiley & Sons, Inc - Nummelin, Sami et al. (2020). Robotic DNA Nanostructures.. American Chemical Society - Jacob Millman, Arvin Grabel (1998). Microelectronics: Digital and Analog Circuits and Systems. McGraw Hill Higher Education - José M. de la Rosa (2021). De la micro a la nanoelectrónica. Madrid : Consejo Superior de Investigaciones Científicas - Fundación Española para la Ciencia y la Tecnología, FECYT (2009). Nanociencia y Nanotecnología. Entre la ciencia ficción del presente y la tecnología del futuro. Fundación Española para la Ciencia y la Tecnología, FECYT - Nature portfolio (2023). Latest Research and Reviews in nanosensors. Nature portfolio - Vinod Kumar Khanna (2021). Nanosensors: physical, chemical, and biological. CRC Press. ISBN: 9781439827130 Outras referencias bibliográficas poden ser facilitadas durante a realización do curso, especialmente para levar a cabo determinadas actividades académicas.
Complementary	

Recommendations
Subjects that it is recommended to have taken before
Subjects that are recommended to be taken simultaneously
Molecular Machines/610G04036 Sensoring/610G04031
Subjects that continue the syllabus
Other comments

(*)The teaching guide is the document in which the URV publishes the information about all its courses. It is a public document and cannot be modified. Only in exceptional cases can it be revised by the competent agent or duly revised so that it is in line with current legislation.