Guia docente					
Datos Identificativos					2023/24
Asignatura (*)	Vehículos Marinos Autónomos			Código	730542017
Titulación	Master Universitario Erasmus Mundus en Sostibilidade e Industria 4.0 aplicada ao Sector Marítimo				
Descriptores					
Ciclo	Periodo	Curso		Tipo	Créditos
Máster Oficial	2º cuatrimestre	Primero		Optativa	6
Idioma	Inglés				
Modalidad docente	Presencial				
Prerrequisitos					
Departamento	Ciencias da Computación e Tecnoloxías da InformaciónMatemáticas				
Coordinador/a	Orjales Saavedra, Félix		Correo electrónico	felix.orjales@udc.es	
Profesorado	Bellas Bouza, Francisco Javier Guerreiro Santalla, Sara Orjales Saavedra, Félix		Correo electrónico	francisco.bellas@udc.es sara.guerreiro@udc.es felix.orjales@udc.es	
Web	http://www.master-seas40.unina.it				
Descripción general	The main objective of the course is to provide the students with an updated vision of autonomous marine vehicles, both surface and underwater systems. The topics are mainly focused on providing students with the basics of intelligent control systems in marine environments. In addition, it will also provide a technical and regulatory approach to the field of robotics within this scope. In order to obtain these goals, and apart from the theoretical basis, students will work with simulated and real marine vehicles, thus developing the skills needed to tackle the implementation of real autonomous marine robots.				

Competencias / Resultados del título	
Código	Competencias / Resultados del título
A4	CE4 ? Demonstrate knowledge, understanding and competences in the field of design and operation of robots and marine autonomous vehicles (RAS).
B2	CB6 - Acquire and understand knowledge that provides a basis or opportunity to be original in the development and / or application of ideas, usually in a research context.
B3	CB7 - That students know how to apply the acquired knowledge and their ability to solve problems in new or unfamiliar environments within broader (or multidisciplinary) contexts related to their area of study.
B4	CB8 - That students are able to integrate knowledge and face the complexity of making judgments based on information that, being incomplete or limited, includes reflections on the social and ethical responsibilities linked to the application of their knowledge and judgments.
B5	CB9 ? That students are able to communicate their conclusions -and the knowledge and ultimate reasons that sustain them- to specialized and non-specialized publics in a clear and unambiguous way.
B6	CB10 - That students have the learning skills that allow them to continue studying in a way that will be largely self-directed or autonomous.
B7	CG1 ? To display the adequate intercultural competence to successfully navigating within multicultural learning environments and to implement basic management principles suitable for a multicultural working environment.
B8	CG2 ? To express an attitude of intellectual inquisitiveness and open-mindedness.
B9	CG3 ? To have the capability to use knowledge, skills, ideas, theory, and modern engineering concepts to create new or significantly improved real engineering applications.
B11	CG5 ? To have the capability to identify, formulate and solve engineering problems within realistic constraints.
B13	CG7 ? To have the capability to critically analyse, synthesise, interpret and summarise complex scientific processes.
C2	CT2 - Mastering oral and written expression in a foreign language.
C3	CT3 - Using ICT in working contexts and lifelong learning.
C4	CT4 - Acting as a respectful citizen according to democratic cultures and human rights and with a gender perspective.
C6	CT6 - Acquiring skills for healthy lifestyles, and healthy habits and routines.
C7	CT7 -Developing the ability to work in interdisciplinary or transdisciplinary teams in order to offer proposals that can contribute to a sustainable environmental, economic, political and social development.

Resultados de aprendizaje			
Resultados de aprendizaje	Competencias / Resultados del título		
Capacity for applying mathematical and ICT methods and tools to define, design, operate and maintain advanced marine robotic systems and for understanding and developing the needed algorithms and methods.		BM1 BM2 BM3 BM4 BM5 BM6 BM7 BM10 BM12	CM2 CM3 CM4 CM6 CM7
Understanding the difference between autonomous and non-autonomous operation in robotics, and how it fits into the Artificial Intelligence field	AM4	BM3 BM5 BM7 BM12	CM4
Acquiring the knowledge about sensors and actuators relevant in marine vehicles to provide them with autonomous capabilities	AM4	BM1 BM3 BM5 BM7 BM12	CM4 CM6 CM7
Understanding the fundamentals of autonomous robotic control, and how classical techniques are very important to achieve a proper response. Being able to apply these concepts in navigation tasks	AM4	BM1 BM2 BM3 BM5 BM7 BM12	CM3 CM4 CM6 CM7
Capacity for using a marine vehicle simulator and programming it, including all the previous knowledge about sensors, actuators and autonomous/classical control. In addition, students must learn how to transfer the simulated control to the real platform	AM4	BM2 BM3 BM5 BM6 BM7 BM8 BM10 BM12	CM3 CM6 CM7

Contenidos	
Tema	Subtema
Topic 1. Introduction to autonomous vehicles	- Artificial Intelligence - Autonomous vehicles - Autonomous marine vehicles - Regulatory issues
Topic 2. Sensors and actuators in marine vehicles	- Sensors: -- Sound based (Sonar, DVL, range finders...) -- Vision and laser based (Cameras, LIDAR...) -- Inertial Measurement Units (IMU) -- GNSS and alternative positioning systems - Actuators: -- Thrusters and alternative propulsion methods -- Arms and grippers

Topic 3. Autonomous control	- Open loop control - Closed loop control - PID - Intelligent architectures -- Reactive -- Deliberative -- Hybrid
Topic 4. Autonomous navigation	- Localization - Mapping - Path planning
Topic 5. Programming underwater vehicles	- Gazebo simulation model - Programming framework - Real underwater vehicle

Planificación				
Metodologías / pruebas	Competencias / Resultados	Horas lectivas (presenciales y virtuales)	Horas trabajo autónomo	Horas totales
Sesión magistral	B2 B4 B6 C4 C6	15	3	18
Análisis de fuentes documentales	A4 B2 B4 B5 B13 C2 C7	3	9	12
Seminario	B3 B6 B8 C3 C6	9	9	18
Trabajos tutelados	A4 B3 B4 B5 B6 B7 B8 B9 B11 B13 C2 C3 C7	18	72	90
Prueba mixta	A4 B4 B5 B6 B11 B13 C2	2	8	10
Atención personalizada		2	0	2
(*)Los datos que aparecen en la tabla de planificación són de carácter orientativo, considerando la heterogeneidad de los alumnos				

Metodologías	
Metodologías	Descripción
Sesión magistral	Masterclass where teachers explain the theoretical concepts of the topics, and students can ask questions.
Análisis de fuentes documentales	Methodological technique that involves the use of audiovisual and/or bibliographic documents relevant to the subject matter with activities specifically designed for their analysis. In this case, it will be used in a context of "flipped classroom" in which the theoretical concepts will be reviewed by the students independently prior to the lecture session, in which an activity will be carried out to assess their understanding.
Seminario	Workshop carried out at the informatics lab to train students in the tools required to solve de challenge: Python libraries, ROS, Gazebo.
Trabajos tutelados	Autonomous work where students must solve some challenge involving programming an autonomous marine vehicle to solve a task. There can be one of incremental complexity or more than one with independent objectives. In this methodology, students will be organised in groups, so they will have to collaborate to achieve the goal.
Prueba mixta	Written or oral examination where students will show their understanding of the theoretical concepts of the subject.

Atención personalizada	
Metodologías	Descripción

Trabajos tutelados Seminario Análisis de fuentes documentales	In the practical workshops (seminars), the teacher will supervise the students' progress and help them with all the issues that could arise. In the supervised projects, students will have the option of asking their questions and doubts to the teachers while developing their project autonomously. Document analysis: students will be able to consult lecturers on reference materials prior to the lectures.

Evaluación			
Metodologías	Competencias / Resultados	Descripción	**Calificación**
Prueba mixta	A4 B4 B5 B6 B11 B13 C2	Students will have to show their knowledge and understanding of the theoretical concepts of the subject by means of a written or oral activity	20
Trabajos tutelados	A4 B3 B4 B5 B6 B7 B8 B9 B11 B13 C2 C3 C7	One or more incremental projects will be proposed throughout the course focused on solving realistic problems with autonomous marine problems using real and simulated robots. These tasks will be developed autonomously by the student outside the classroom and must be defended in front of the teachers.	70
Análisis de fuentes documentales	A4 B2 B4 B5 B13 C2 C7	Part of the lectures will be used to evaluate the understanding of the documentary sources, which will be provided by the teachers prior to the class for consultation and understanding. These evaluations will be carried out by means of group work, small reports, questionnaires, or other methodologies that allow an objective assessment of the degree of analysis carried out.	10

Observaciones evaluación
In order to obtain a pass in this subject, a minimum mark of 50 must be obtained in all the above methodologies, with a minimum of 30 in the Tutored Work and 15 in the sum of the Subjective Test and Document Analysis. If the student does not pass the subject in the ordinary exam, he/she will have to repeat the necessary activities of the methodology/s that were not passed in the extraordinary exam. General EMJMD Sustainable Ship and Shipping SEAS 4.0 evaluation rules: - Students will have only two oportunities to pass a course. If failing to do so, they may be forced to leave the degree. - No part time or lecture attendance exemption are allowed in this degree. In the case of plagiarism in internships or teaching assignments, article 11, section 4 b) of the UDC Student Disciplinary Regulations will be taken into account: b) Failure grade in the exam session in which the offence is committed and with respect to the subject in which it is committed: the student will be graded with a "fail" (numerical grade 0) in the corresponding exam session of the academic year, whether the offence is committed on the first or second occasion. To this end, the student's grade will be modified at the first opportunity, if necessary.

Fuentes de información	
Básica	- Thor I. Fossen (2011). Handbook of Marine Craft Hydrodynamics and Motion Control. John Wiley & Sons - Geoff Roberts and Robert Sutton (2006). Advances in unmanned marine vehicles. Institution of Engineering and Technology - Robin R. Murphy (2000). Introduction to AI Robotics. A Bradford Book - Dronekit (2015). https://dronekit-python.readthedocs.io/en/latest/.
Complementária	- Joseph, Lentin (2015). Learning robotics using Python : design, simulate, program, and prototype an interactive autonomous mobile robot from scratch with the help of Python, ROS, and Open-CV. Packt Publishing

Recomendaciones
Asignaturas que se recomienda haber cursado previamente

Marco Reglamentario para la Industria Marítima 4.0/730542001 Robótica y Robótica Submarina/730542007
Asignaturas que se recomienda cursar simultáneamente
Internet de las Cosas Aplicado a la Industria (IIoT)/730542015 Tecnologías Facilitadoras de la Industria 4.0/730542010
Asignaturas que continúan el temario
Otros comentarios
-According to the different regulations applicable to university teaching, the gender perspective must be incorporated into this subject.-Work will be done to identify and modify sexist prejudices and attitudes and influence the environment to modify them and promote values of respect and equality.-Situations of gender discrimination should be detected and actions and measures should be proposed to correct them.To help in achieving a sustainable environment and to get the objective of number 5 action of the "Green Campus Action Plan" (Healthy and environmentaly and socially sustainable research and teaching):The assignments to be done in this course:- Will be required in digital format.- Will be delivered using Moodle, with no need to print them.In case it is necessary to print them:- Plastics won´t be used.- Two side printing will be used.- Recycled paper will be used.- Printing drafts will be avoided.A sustainable use of the resources should be done, together with the prevention of negative impacts on the environment.