



Guía Docente				
Datos Identificativos				2021/22
Asignatura (*)	Vehículos Mariños Autónomos	Código	730542017	
Titulación				
Descriptorios				
Ciclo	Período	Curso	Tipo	Créditos
Mestrado Oficial	2º cuatrimestre	Primeiro	Optativa	6
Idioma	Inglés			
Modalidade docente	Presencial			
Prerrequisitos				
Departamento	Ciencias da Computación e Tecnoloxías da Información Matemáticas			
Coordinación	Bellas Bouza, Francisco Javier	Correo electrónico	francisco.bellas@udc.es	
Profesorado	Bellas Bouza, Francisco Javier Orjales Saavedra, Félix	Correo electrónico	francisco.bellas@udc.es felix.orjales@udc.es	
Web	<a href="http://www.master-seas40.unina.it">http://www.master-seas40.unina.it</a>			
Descrición xeral	The main objective of the course is to provide the students with an updated vision of autonomous robotics, and specially about intelligent control systems. In addition, it will also provide a technical and regulatory approach to the field of robotics within the marine framework. 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.			



<b>Plan de continxencia</b>	<p>1. Modifications to the content</p> <ul style="list-style-type: none"><li>- No changes will be made</li></ul> <p>2. Methodologies</p> <p>Teaching methodologies that are maintained</p> <ul style="list-style-type: none"><li>- Supervised work</li></ul> <p>Teaching methodologies that are modified</p> <ul style="list-style-type: none"><li>- Mixed objective/subjective test: using Microsoft Teams or equivalent institutional application</li><li>- ICT Practical sessions: using Microsoft Teams or equivalent institutional application, and using appropriate programming software that will be provided to students</li><li>- Master class: carried out through Microsoft Teams or equivalent institutional application, also leaving the students or their content in video format for later viewing</li><li>- Field trip: this methodology will be eliminated</li></ul> <p>3. Mechanisms for personalized attention to students</p> <ul style="list-style-type: none"><li>- Email: Daily. Used to make queries, request virtual meetings to resolve doubts and perform or follow up on the work being protected.</li><li>- Moodle: Daily. According to the needs of the students, who have forums in which they can export questions in general to the rest of the group.</li><li>- Teams: 1 class per week for big group to advance in the theoretical concepts and for the ICT sessions, using the hours originally scheduled in the School calendar. In addition, this tool will be used for the resolution of personalized questionnaires with students, preferably during class hours. This contact can be through chat or call, which is more appropriate to resolve the query.</li></ul> <p>4. Modifications in the evaluation</p> <ul style="list-style-type: none"><li>- The percentage of the Field Trip methodology will be added to the Supervised Work one, that will imply a 70% of the assessment</li></ul> <p>Evaluation observations:</p> <ul style="list-style-type: none"><li>- Keep to the percentages of all methodology in the assessment</li></ul> <p>5. Modifications of the bibliography or webgraphy</p> <ul style="list-style-type: none"><li>- No changes will be made</li></ul>
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## Competencias / Resultados do título

<b>Código</b>	<b>Competencias / Resultados do título</b>
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## Resultados da aprendizaxe

<b>Resultados de aprendizaxe</b>	<b>Competencias / Resultados do título</b>
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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	AM4	BM2 BM3 BM5 BM6 BM7 BM8 BM10 BM12	CM3 CM6 CM7

Contidos	
Temas	Subtemas
Topic 1. Introduction to autonomous vehicles	<ul style="list-style-type: none"> <li>- Artificial Intelligence</li> <li>- Autonomous robots</li> <li>- Autonomous vehicles</li> </ul>
Topic 2. Sensors and actuators in marine vehicles	<ul style="list-style-type: none"> <li>- Sensors:               <ul style="list-style-type: none"> <li>-- Sound based (Sonar, DVL, range finders...)</li> <li>-- Vision and laser based (Cameras, LIDAR...)</li> <li>-- Inertial Measurement Units (IMU)</li> <li>-- GNSS and alternative positioning systems</li> </ul> </li> <li>- Actuators:               <ul style="list-style-type: none"> <li>-- Thrusters and alternative propulsion methods</li> <li>-- Arms and grippers</li> </ul> </li> </ul>



Topic 3. Autonomous control	<ul style="list-style-type: none"> <li>- Open loop control</li> <li>- Closed loop control</li> <li>- PID</li> <li>- Intelligent architectures</li> <li>-- Reactive</li> <li>-- Deliberative</li> <li>-- Hybrid</li> </ul>
Topic 4. Autonomous navigation	<ul style="list-style-type: none"> <li>- Localization</li> <li>- Mapping</li> <li>- Path planning</li> </ul>
Topic 5. Programming underwater vehicles	<ul style="list-style-type: none"> <li>- Gazebo simulation model</li> <li>- Programming framework</li> <li>- Real underwater vehicle</li> </ul>

Planificación				
Metodoloxías / probas	Competencias / Resultados	Horas lectivas (presenciais e virtuais)	Horas traballo autónomo	Horas totais
Prácticas a través de TIC	B3 B6 B8 C6 C3	18	18	36
Sesión maxistral	B2 B4 B6 C4 C6	18	9	27
Traballos tutelados	A4 B3 B4 B5 B6 B7 B8 B9 B11 B13 C2 C3 C7	0	55	55
Saídas de campo	A4 B3 B7 B9 B11 B13 C7 C4	4	8	12
Proba mixta	A4 B4 B5 B6 B11 B13 C2	2	16	18
Atención personalizada		2	0	2

\*Os datos que aparecen na táboa de planificación son de carácter orientativo, considerando a heteroxeneidade do alumnado

Metodoloxías	
Metodoloxías	Descrición
Prácticas a través de TIC	Practical classes carried out in the ICT lab, with the objective of learning how to program an autonomous marine vehicle (real or simulated) to develop a simple mission. In these classes, the teacher will help students to properly understand the topics
Sesión maxistral	Masterclass where teachers explain the theoretical concepts of the topics, and students can ask questions.
Traballos 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.
Saídas de campo	A field trip will be made to the UDC ship model basin to collect data on navigation tests of autonomous marine vehicles.
Proba mixta	Written or oral examination where students will show their understanding of the theoretical concepts of the subject.

Atención personalizada	
Metodoloxías	Descrición
Prácticas a través de TIC	In the practical workshops, the teacher will supervise the students' progress and help them with all the issues that could arise.
Traballos tutelados	In the supervised projects, students will have the option of asking their questions and doubts to the teachers while developing their project autonomously.



Avaliación			
Metodoloxías	Competencias / Resultados	Descrición	Cualificación
Proba 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	30
Traballos 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 or simulated robots. These tasks will be developed autonomously by the student outside the classroom and must be defended in front of the teachers.	60
Saídas de campo	A4 B3 B7 B9 B11 B13 C7 C4	The correct preparation, execution and understanding of the field trip will be assessed by the teachers of the subject. Students must prepare a report which will be evaluated.	10

### Observacións avaliación

In order to pass this subject, a minimum score of 50 must be obtained by adding all the above methodologies, there being no minimum in any of them. 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 opportunities 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.

### Fontes de información

<b>Bibliografía básica</b>	- 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
<b>Bibliografía complementaria</b>	- 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

### Recomendacións

#### Materias que se recomenda ter cursado previamente

Marco Regulamentario para a Industria Marítima 4.0/730542001  
Robótica e Robótica Submarina/730542007

#### Materias que se recomenda cursar simultaneamente

Internet das Cousas Aplicado á Industria (IIoT)/730542015  
Tecnoloxías Facilitadoras da Industria 4.0/730542010

#### Materias que continúan o temario

### Observacións

To help in achieving a sustainable environment and to get the objective of number 5 action of the "Ferrol Green Campus Action Plan" (Healthy and environmental 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.

(\*A Guía docente é o documento onde se visualiza a proposta académica da UDC. Este documento é público e non se pode modificar, salvo casos excepcionais baixo a revisión do órgano competente dacordo coa normativa vixente que establece o proceso de elaboración de guías