Guia docente					
Datos Identificativos					2022/23
Asignatura (*)	Gemelos Digitales en Sistemas Marinos			Código	730542022
Titulación	Master Universitario Erasmus Mundus en Sostibilidade e Industria 4.0 aplicada ao Sector Marítimo				
Descriptores					
Ciclo	Periodo	Curso		Tipo	Créditos
Máster Oficial	1º cuatrimestre	Segundo		Optativa	6
Idioma	Inglés				
Modalidad docente	Presencial				
Prerrequisitos					
Departamento	Enxeñaría Naval e Industrial				
Coordinador/a	Munín Doce, Alicia		Correo electrónico	a.munin@udc.es	
Profesorado	Ferreño González, Sara Munín Doce, Alicia		Correo electrónico	sara.ferreno@udc.es a.munin@udc.es	
Web					
Descripción general	The objective of this course is to provide students with knowledge in the field of digital twins of marine systems, including the requirements, architecture and components necessary to develop one of these systems.				

Competencias del título	
Código	Competencias del título
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.
B10	CG4 ? To have the capability to think creatively and explore new ideas outside of current boundaries of the field
B11	CG5 ? To have the capability to identify, formulate and solve engineering problems within realistic constraints.
B12	CG6 ? To appreciate the impact of sustainable development goals in maritime transport.
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.
C8	CT8 -Valuing the importance of research, innovation and technological development for the socioeconomic and cultural progress of society.

Resultados de aprendizaje			
Resultados de aprendizaje	Competencias del título		
Knowledge of the concept, structure and design constraints of digital twins applicable to the maritime sector. Ability to develop a basic approach to a digital twin.		BM6 BM7 BM9 BM10 BM11 BM12	CM2 CM3 CM4 CM6 CM7 CM8

Contenidos	
Tema	Subtema

1. Introduction	a. Industry 4.0 overview b. Basic concepts of Digital Twins c. Digital Twin for ships
2. Ship. Ship systems. Sensorization.	a. Ships and ship systems b. Ship sensorization
3. Simulation models	a. Physics based models vs data driven models. b. Modeling of the arquitectura of basic simulations and development of basic simulations models. c. Preparation of models for FMU export. Export types (co-simulación, real time, etc.) and their implications. d. Running the simulation models in the digital twin environment e. Co-simulation of FMUs.
4. Data Analysis	a. Data analytics and machine learning application.
5. Edge solutions and cloud solutions for digital twin	a. Edge solutions b. Cloud solutions
6. Practicas use cases	a. Practical use cases

Planificación				
Metodologías / pruebas	Competéncias	Horas presenciales	Horas no presenciales / trabajo autónomo	Horas totales
Sesión magistral	B12 C3	20	20	40
Prácticas a través de TIC	C7	20	40	60
Prueba mixta	B7 B8 B10 C2 C4 C6	1.5	0	1.5
Trabajos tutelados	B11 B13 C8	1.5	45	46.5
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	Oral presentation (using audiovisual material and student interaction) designed to transmit knowledge and encourage learning. Presentations of this type are variously referred to as ?expository method?, ?guest lectures? or ?keynote speeches?. (The term ?keynote? refers only to a type of speech delivered on special occasions, for which the lecture sets the tone or establishes the underlying theme; it is characterised by its distinctive content, structure and purpose, and relies almost exclusively on the spoken word to communicate its ideas.)
Prácticas a través de TIC	Practice-based learning method for theoretical subject content using ICT resources (demonstrations, simulations, etc.) ICT is an excellent medium for practical knowledge applications and information processing, and a key aid to student learning and skills development.
Prueba mixta	The mixed objective will consist of an oral presentation about the supervised project.
Trabajos tutelados	Supervised learning process aimed at helping students to work independently in a range of contexts (academic and professional). Focused primarily on learning ?how to do things? and on encouraging students to become responsible for their own learning. In this course, the supervised project will consist on a group based technical work based on an assignment done by the proffessors, and dealing about some of the topics of the course.

Atención personalizada	
Metodologías	Descripción

Sesión magistral Prácticas a través de TIC Trabajos tutelados	Students perssonal attention could be in class or through Teams. The student will be monitored during the completion of the project.

Evaluación			
Metodologías	**Competéncias**	**Descripción**	**Calificación**
Trabajos tutelados	B11 B13 C8	In this course, the supervised project will consist on a group based technical report based on an assignment done by the proffessors, and dealing about some of the topics of the course. The qualification of the group based technical report will represent a 80 % of the student´s final qualification.	80
Prueba mixta	B7 B8 B10 C2 C4 C6	The mixed objective will consist of an oral presentation about the supervised project. The qualification of the oral presentation will represent a 20 % of the student´s final qualification.	20

Observaciones evaluación
According to the degree regulations, the students will have the oportunity to pass this course in two oportunities (first and second oportunity). The evaluation of the total mark will be the same both in the first opportunity and in the second opportunity. 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.

Fuentes de información	
Básica	- Gopal Chaudhary, Manju Khari, Mohamed Elhoseny (2022). Digital Twin Technology. Taylor & Francis Group - Surjya Kanta Pal, Debasish Mishra, Arpan Pal, Samik Dutta, Debashish Chakravarty, Srikanta Pal (2022). Digital Twin ? Fundamental Concepts to Applications in Advanced Manufacturing. Springer - Nassim Khaled, Bibin Pattel, Affan Siddiqui (2020). Digital Twin Development and Deployment on the Cloud. Elsevier
Complementária	- Shyam Varan Nath, Pieter van Schalkwyk (2021). Building Industrial Digital Twins. Packt Publishing - José L. Risco Martín, Saurabh Mittal, Tuncer Ören (2020). Simulation for Cyber-Physical Systems Engineering. Springer - Saurabh Mittal, Andreas Tolk (2020). Complexity Challenges in Cyber Physical Systems. Using Modeling and Simulation to Support Intelligence, Adaptation and Autonomy. John Wiley & Sons, Inc.

Recomendaciones
Asignaturas que se recomienda haber cursado previamente
Métodos CFD Innovadores/730542030 Simulación y Optimización de Procesos de Fabricación del Buque/730542024 Introducción a la Dinámica de Fluidos Computacional (CFD) Marina /730542011 Internet de las Cosas Aplicado a la Industria (IIoT)/730542015 Modelos Estadísticos para la Innovación en Tecnología Marina/730542016
Asignaturas que se recomienda cursar simultáneamente
Asignaturas que continúan el temario
Otros comentarios

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 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.