Teaching Guide					
Identifying Data					2021/22
Subject (*)	Industry 4.0 Enabling Technologies			Code	730542010
Study programme	Master Universitario Erasmus Mundus en Sostibilidade e Industria 4.0 aplicada ao Sector Marítimo				
Descriptors					
Cycle	Period	Year		Type	Credits
Official Master's Degree	2nd four-month period	First		Obligatory	6
Language	English				
Teaching method	Face-to-face				
Prerequisites					
Department	Enxeñaría de Computadores				
Coordinador	Fernández Caramés, Tiago Manuel		E-mail	tiago.fernandez@udc.es	
Lecturers	Fernández Caramés, Tiago Manuel Fraga Lamas, Paula		E-mail	tiago.fernandez@udc.es paula.fraga@udc.es	
Web	www.master-seas40.unina.it/programme/courses/syllabi/				
General description	The main objective of this course is to provide the students with the essential concepts behind the latest and most popular Industry 4.0 enabling technologies, together with knowledge regarding the threats which could affect industrial connected systems.				

Contingency plan	1. Modifications to the contents - No changes will be performed. 2. Methodologies - *Teaching methodologies that are maintained - None. - *Teaching methodologies that are modified - Guest lectures and Mixed test: due to the exceptional situation, given the impossibility of being able to teach in a completely face-to-face way, virtual tools provided by the university will be used, which can be complemented with other tools. - ICT practicals: the labs that require specific equipment will be replaced with simulated or virtualized ones. Eventually, alternative practices will be proposed that do not require such equipment. These practicals may be oriented towards autonomous work to address conciliation and/or connectivity problems. 3. Mechanisms for personalized attention to students - Tutoring sessions (student attention) will be conducted electronically (e.g., through email, Teams, Moodle), which can be complemented with each other tools. In some of such tools, prior appointments will be agreed. 4. Modifications in the evaluation - There will be no modifications. 5. Modifications to the bibliography or webgraphy - There will be no modifications.

Study programme competences	
Code	Study programme competences
A3	CE3 - Demonstrate knowledge, understanding and competences in applying information systems and data management tools during ship design, construction and operation (IDM).
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.
B10	CG4 ? To have the capability to think creatively and explore new ideas outside of current boundaries of the field
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.

Learning outcomes			
Learning outcomes	Study programme competences		
To acquire, understand and put in practice knowledge regarding the most important Industry 4.0 enabling technologies. To be able to understand the key concepts related to the most popular Industry 4.0 information management systems. To be able to understand the implications at a security level of the diverse Industry 4.0 technologies and the basics of potential cyberthreats and the essential protection techniques.	AC3	BC1 BC2 BC3 BC4 BC5 BC6 BC7 BC9 BC12	CC2 CC3 CC4 CC6 CC7 CC8

Contents	
Topic	Sub-topic
Introduction to Industry 4.0	- Basics - Similar concepts - Industry 4.0 technologies - Industry 5.0 and Society 5.0 - Practical cases - The Shipyard 4.0 Project
Sensing and Actuation Networks	- Essential concepts - Common sensors and actuators - Communication networks and standards - Cybersecurity - Practical shipbuilding applications

Cloud and Edge Computing	- Cloud Computing: essential concepts and traditional architecture - Edge Computing: definition, types and advanced architectures - Cybersecurity - Practical shipbuilding applications
Cyber-Physical Systems	- Essential concepts - Hardware and software - Communications networks and protocols - Cybersecurity - Practical industrial cases
Augmented, Mixed and Virtual Reality	- Basics - Hardware and Software - Cybersecurity - Practical shipbuilding applications
Blockchain	- Basics - Types of blockchains - Communications architecture - Cybersecurity - Practical industrial and shipbuilding applications
Unmanned Vehicles	- Essential concepts - Types of vehicles - Cybersecurity - Practical applications for the shipbuilding industry
Additive Manufacturing	- Essential concepts - Types of additive manufacturing technologies - Cybersecurity - Applications for the shipbuilding industry

Information Management Systems	- Basics - Architectures - Popular information management software (e.g., ERP, PLM, MES) - Cybersecurity

Planning				
Methodologies / tests	Competencies	Ordinary class hours	Student?s personal work hours	Total hours
Guest lecture / keynote speech	B2 C8	19	19	38
ICT practicals	A3 B3 B6 C3	9	9	18
Supervised projects	B2 B3 B5 B7 B8 B10 B13 C4 C6 C7	9	45	54
Oral presentation	B5 C2	1	10	11
Mixed objective/subjective test	B4 C2	1	25	26
Personalized attention		3	0	3
(*)The information in the planning table is for guidance only and does not take into account the heterogeneity of the students.				

Methodologies	
Methodologies	Description
Guest lecture / keynote speech	Lectures on the content of the subject
ICT practicals	ICT practicals to put in practice the concepts learned on the lectures
Supervised projects	Project to put in practice the concepts learned in the theory lectures and the ICT practicals
Oral presentation	Oral presentation on the results of the supervised project
Mixed objective/subjective test	Test to assess the learned practical and theoretical concepts

Personalized attention	
Methodologies	Description
Supervised projects ICT practicals	The professors will tutor the students and will guide them during the practical lessons and the supervised project.

Assessment			
Methodologies	Competencies	Description	**Qualification**
Supervised projects	B2 B3 B5 B7 B8 B10 B13 C4 C6 C7	Evaluation of a project whose development fuses theory and practice, and which is supervised by the professors	30
Oral presentation	B5 C2	Evaluation of a oral presentation on the results of the supervised project	10
ICT practicals	A3 B3 B6 C3	Evaluation of the results and knowledge acquired during the ICT practicals	20
Mixed objective/subjective test	B4 C2	Evaluation of the competences acquired in the subject	40

Assessment comments

FIRST CALL

The practical part of the subject will consist in developing practical examples about the content of the theory lessons. Its evaluation will be perform progressively, with clear deadlines. Such a practical part could be replaced with the development of a mobile application or a individual assignment. The objective test will be divided into two parts: one oriented towards evaluating the practical developments and a second one about the theoretical content.

SECOND CALL

The students will have the opportunity to maintain the marks obtained during the ICT practicals and the supervised project. Such students will carry out a mixed test, establishing the final mark according to the same percentages applied for the first call. The rest of the students will take a single mixed test (60% of the total mark) and will carry out a supervised project (40% of the total mark).

OTHER COMMENTS

In case of detecting plagiarism, the student will be evaluated as failed (0) and the situation will be communicated to the master direction and to the corresponding authorities to take the appropriate measures.

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.

Sources of information	
Basic	- Alasdair Gilchrist (2016). Industry 4.0: The Industrial Internet of Things . Apress - Mohammad Dastbaz, Peter Cochrane (2019). Industry 4.0 and Engineering for a Sustainable Future. Springer - Paula Fraga-Lamas, Tiago M Fernández-Caramés, Óscar Blanco-Novoa, Miguel Vilar-Montesinos (2018). A Review on Industrial Augmented Reality Systems for the Industry 4.0 Shipyard. IEEE - Tiago M Fernández-Caramés, Paula Fraga-Lamas (2019). A review on the application of blockchain to the next generation of cybersecure industry 4.0 smart factories. IEEE - Óscar Blanco-Novoa, Tiago M Fernández-Caramés, Paula Fraga-Lamas, Miguel Vilar-Montesinos (2018). A Practical Evaluation of Commercial Industrial Augmented Reality Systems in an Industry 4.0 Shipyard. IEEE - Tiago M Fernández-Caramés, Oscar Blanco-Novoa, Iván Froiz-Míguez, Paula Fraga-Lamas (2019). Towards an autonomous industry 4.0 warehouse: A UAV and blockchain-based system for inventory and traceability applications in big data-driven supply chain management. IEEE - Paula Fraga-Lamas, Diego Noceda-Davila, Tiago M Fernández-Caramés, Manuel A Díaz-Bouza, Miguel Vilar (2016). Smart pipe system for a shipyard 4.0. MDPI
Complementary	

Recommendations
Subjects that it is recommended to have taken before
Subjects that are recommended to be taken simultaneously
Industrial Internet of Things (IIoT)/730542015
Subjects that continue the syllabus
Other comments
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.