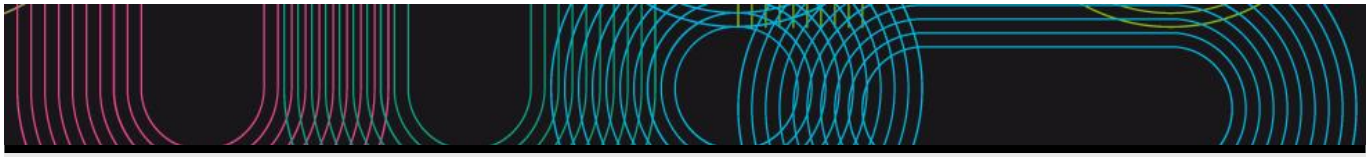

(*)Escola de Enxeñaría Industrial

Information
For additional information about the centre and its degres visit the centre's website https://eei.uvigo.es/

Máster Universitario en Industria 4.0

Subjects

Year 1st

Code	Name	Quadmester	Total Cr.
V04M183V01101	PLM and Lean Manufacturig	1st	3
V04M183V01102	Cloud Computing and Big Data	1st	3
V04M183V01103	Industrial communications and industrial cybersecurity	1st	3
V04M183V01104	Intelligent systems in the industry	1st	3
V04M183V01105	Cyberphysical systems	1st	3
V04M183V01106	Smart Manufacturing e Smart logistics	1st	3
V04M183V01107	CAD / CAM / CAE Advanced Systems	1st	3
V04M183V01108	Simulation applied to plant management	1st	3
V04M183V01109	Industrialization and industrial innovation. Lean Approach	1st	3
V04M183V01110	Horizontal competencies and talent management	1st	3
V04M183V01111	Development and management of R + D + i projects	2nd	3
V04M183V01112	Advanced calculation tools for engineering	2nd	3
V04M183V01201	Industrial Internet of Things (IIoT)	2nd	4.5
V04M183V01202	Additive manufacturing	2nd	3
V04M183V01203	Advanced verification and inspection systems	2nd	3
V04M183V01204	Robotics and virtual reality in the industry	2nd	3
V04M183V01205	Simulation applied to design and manufacturing	2nd	4.5

V04M183V01206	Internships	2nd	6
V04M183V01207	Master's thesis	2nd	6

IDENTIFYING DATA				
PLM and Lean Manufacturig				
Subject	PLM and Lean Manufacturig			
Code	V04M183V01101			
Study programme	Máster Universitario en Industria 4.0			
Descriptors	ECTS Credits	Type	Year	Quadmester
	3	Mandatory	1st	1st
Teaching language	Spanish			
Department				
Coordinator	Cerqueiro Pequeño, Jorge			
Lecturers	Cerqueiro Pequeño, Jorge			
E-mail	jcerquei@uvigo.es			
Web	http://guiadocente.unileon.es/docencia/guia_docent/doc/asignatura.php?assignatura=1744001&any_academic=2020_21&idioma=cast&doc=N			
General description				

Skills
Code

Learning outcomes	
Learning outcomes	Competences

Contents
Topic

Planning			
	Class hours	Hours outside the classroom	Total hours

*The information in the planning table is for guidance only and does not take into account the heterogeneity of the students.

Methodologies	
	Description

Personalized assistance

Assessment		
Description	Qualification	Evaluated Competencess

Other comments on the Evaluation

Sources of information
Basic Bibliography
Complementary Bibliography

Recommendations

IDENTIFYING DATA				
Cloud Computing and Big Data				
Subject	Cloud Computing and Big Data			
Code	V04M183V01102			
Study programme	Máster Universitario en Industria 4.0			
Descriptors	ECTS Credits	Type	Year	Quadmester
	3	Mandatory	1st	1st
Teaching language	Spanish			
Department				
Coordinator	Garrido Campos, Julio			
Lecturers	Garrido Campos, Julio			
E-mail	jgarri@uvigo.es			
Web	http://guiadocente.unileon.es/docencia/guia_docent/doc/asignatura.php?assignatura=1744002&any_academic=2020_21&idioma=cast&doc=N			
General description				

Skills
Code

Learning outcomes	
Learning outcomes	Competences

Contents
Topic

Planning			
	Class hours	Hours outside the classroom	Total hours

*The information in the planning table is for guidance only and does not take into account the heterogeneity of the students.

Methodologies	
	Description

Personalized assistance

Assessment		
Description	Qualification	Evaluated Competencess

Other comments on the Evaluation

Sources of information
Basic Bibliography
Complementary Bibliography

Recommendations

IDENTIFYING DATA				
Industrial communications and industrial cybersecurity				
Subject	Industrial communications and industrial cybersecurity			
Code	V04M183V01103			
Study programme	Máster Universitario en Industria 4.0			
Descriptors	ECTS Credits	Type	Year	Quadmester
	3	Mandatory	1st	1st
Teaching language	Spanish			
Department				
Coordinator	Garrido Campos, Julio			
Lecturers	Garrido Campos, Julio			
E-mail	jgarri@uvigo.es			
Web	http://guiadocente.unileon.es/docencia/guia_docent/doc/asignatura.php?assignatura=1744003&any_academic=2020_21&idioma=cast&doc=N			
General description				

Skills
Code

Learning outcomes	
Learning outcomes	Competences

Contents
Topic

Planning			
	Class hours	Hours outside the classroom	Total hours
*The information in the planning table is for guidance only and does not take into account the heterogeneity of the students.			

Methodologies	
	Description

Personalized assistance

Assessment		
Description	Qualification	Evaluated Competencess

Other comments on the Evaluation

Sources of information
Basic Bibliography
Complementary Bibliography

Recommendations

IDENTIFYING DATA				
Intelligent systems in the industry				
Subject	Intelligent systems in the industry			
Code	V04M183V01104			
Study programme	Máster Universitario en Industria 4.0			
Descriptors	ECTS Credits	Type	Year	Quadmester
	3	Mandatory	1st	1st
Teaching language	Spanish			
Department				
Coordinator	Peláez Lourido, Gustavo Carlos			
Lecturers	Peláez Lourido, Gustavo Carlos			
E-mail	gupelaez@uvigo.gal			
Web	http://guiadocente.unileon.es/docencia/guia_docent/doc/asignatura.php?assignatura=1744004&any_academic=2020_21&idioma=cast&doc=N			
General description				

Skills
Code

Learning outcomes	
Learning outcomes	Competences

Contents
Topic

Planning			
	Class hours	Hours outside the classroom	Total hours

*The information in the planning table is for guidance only and does not take into account the heterogeneity of the students.

Methodologies	
	Description

Personalized assistance

Assessment		
Description	Qualification	Evaluated Competencess

Other comments on the Evaluation

Sources of information
Basic Bibliography
Complementary Bibliography

Recommendations

IDENTIFYING DATA				
Cyberphysical systems				
Subject	Cyberphysical systems			
Code	V04M183V01105			
Study programme	Máster Universitario en Industria 4.0			
Descriptors	ECTS Credits	Type	Year	Quadmester
	3	Mandatory	1st	1st
Teaching language	#EnglishFriendly Spanish Galician English			
Department				
Coordinator	Soto Campos, Enrique			
Lecturers	Fernández Ulloa, Antonio Soto Campos, Enrique			
E-mail	esotoc@uvigo.es			
Web	http://masterindustria40.webs7.uvigo.es/wordpress/			
General description	Know the elements and principles of operation of the cyberphysic systems resulting from the integration of physical processes, computational resources and communications.			

Skills	
Code	
CB1	Possess and understand knowledge that provides a basis or opportunity to be original in the development and/or application of ideas, often in a research context
CB2	Students should be able to apply their acquired knowledge and problem-solving skills in new or unfamiliar environments within broader (or multidisciplinary) contexts related to their area of study.
CB5	Students have got the learning skills that will enable them to continue studying in a largely self-directed or autonomous manner
CG2	Problem solving.
CG5	Oral and written communication in your own language.
CG7	Computer skills related to the field of study.
CE11	Know and use the elements and principles of operation of cyberphysical systems resulting from the integration of physical, computational and communication processes.
CE12	Develop cyberphysical systems for application to product and process solutions in factories, using Systems Engineering procedures.
CT1	Ability to understand the meaning and application of the gender perspective in different areas of knowledge and in professional practice with the aim of achieving a more just and equal society
CT2	Incorporate criteria of sustainability and environmental commitment into professional practice. To acquire skills in the equitable, responsible and efficient use of resources
CT3	Multidisciplinary teamwork

Learning outcomes	
Learning outcomes	Competences
1. Know the elements and principles of operation of the cyberphysic systems resulting from the integration of physical processes, computational and communications.	CB5 CG5 CE11 CE12 CT1
2. Know the applications of the cyberphysics systems in the context of the Industry 4.0.	CB1 CG5 CE11 CE12 CT2
3. Developcyberphysic systems for its application to solutions of product and of process in the factories 4.0, employing procedures of Engineering of Systems.	CB2 CB5 CG2 CG7 CE11 CE12 CT3
4. Apply the criteria of efficiency and quality to the development of cyberphysic systems.	CE11 CE12

Contents	
Topic	
1. Cyberphysics in the Industry 4.0.	Introduction
2. Integration of physical processes, computational resources and communications.	Basic concepts
3. Components of cyberphysics systems: subsystems, functions and internal and external relations.	3.1. Embedded Systems 3.1.1. Microprocessors and microcontrollers 3.1.2. Programming 3.1.3. Peripherals of microcontrollers 3.2. Communications 3.2.1. Principles of the digital communications 3.2.2. Industrial communications 3.3. Sensors and actuators 3.3.1. Sensors 3.3.2. Actuators
4. Applications of the cyberphysics systems in the industry.	4.1. Industrial communications systems 4.2. Arduino
5. Development of cyberphysics systems for solutions of product and of processes.	Practical examples.
6. Application of Systems Engineering to the study of the cyberphysics systems.	Introduction
7. Analysis of the execution of cyberphysics systems.	Practical examples

Planning			
	Class hours	Hours outside the classroom	Total hours
Lecturing	9	12	21
Problem solving	5	20	25
Laboratory practical	10	15	25
Objective questions exam	1	3	4
*The information in the planning table is for guidance only and does not take into account the heterogeneity of the students.			

Methodologies	
	Description
Lecturing	They will expose the most important aspects of the subject, looking for the active participation of the student posing questions that has to resolve in class.
Problem solving	The students will resolve in class with the help of the professor applications of the theory.
Laboratory practical	Laboratory with embedded systems, sensors and communications systems.

Personalized assistance	
Methodologies	**Description**
Problem solving	The students will be able to access anytime to academic support through the professor office or virtual room and the email
Laboratory practical	The students will be able to access anytime to academic support through the professor office or virtual room and the email
Tests	**Description**
Objective questions exam	The students will be able to access anytime to academic support through the tutorial sessions in the professor's office or virtual room and by email. The students will be supervised at all times during the tests.

Assessment						
	Description	Qualification	Evaluated	Competencess		
Problem solving	Systematic observation. Complementary activities of continuous evaluation	30	CB2	CG2 CG5	CE11 CE12	CT1 CT2 CT3
Laboratory practical	Presentations/Work/Project/Laboratory report	50	CB5	CG5 CG7	CE11 CE12	CT1 CT2 CT3
Objective questions exam	Exam of objective questions. Partial objective test and/or finals	20	CB1 CB5	CG5	CE11 CE12	

Other comments on the Evaluation

Students who do not pass the subject in continuous training at the first opportunity of each academic year, in which the distribution of evaluation weights is as stablished above, will have the possibility of having an exam of objective questions, worth 100% of the final mark, in successive calls that are not the first opportunity of each academic year.

Ethical commitment: Students are expected to behave ethically. If unethical behaviour is detected (copying, plagiarism, use of unauthorised electronic devices,...), the student will be considered to be ineligible to pass the subject. Depending on the type of unethical behaviour detected, it could be concluded that the student has not reached the necessary skills to overcome the subject. Students are expected to behave in a respectful and dignified manner and to collaborate with the teaching system, teaching staff, coordination and administrative and services personnel of the Master's degree. Any question due to the lack of ethical and dignified behaviour of the student body may have repercussions on the evaluation of the subject.

Sources of information

Basic Bibliography

Enrique Mandado Pérez et al, **SISTEMAS DE AUTOMATIZACIÓN Y AUTÓMATAS PROGRAMABLES**, 3, Marcombo, 2018

Daniel Lozano Equisoain, **Arduino Práctico. Edición 2017**, Anaya, 2017

Complementary Bibliography

Edited by Bogdan M. Wilamowski J. david Irwin, **The Industrial Electronics Handbook: Industrial communication systems**, 2, CRC Press Taylor & Francis Group, 2011

Simon Monk, **Programming Arduino: Getting Started with Sketches**, 2, McGraw-Hill Education TAB, 2016

Recommendations

IDENTIFYING DATA				
Smart Manufacturing e Smart logistics				
Subject	Smart Manufacturing e Smart logistics			
Code	V04M183V01106			
Study programme	Máster Universitario en Industria 4.0			
Descriptors	ECTS Credits	Type	Year	Quadmester
	3	Mandatory	1st	1st
Teaching language	Spanish Galician English			
Department				
Coordinator	Peláez Lourido, Gustavo Carlos			
Lecturers	Peláez Lourido, Gustavo Carlos Suárez Alonso, Ramón Carlos Tjahjono , Benny Eko			
E-mail	gupelaez@uvigo.gal			
Web	http://masterindustria40.webs7.uvigo.es/wordpress/			
General description	This course studies the basic principles of Smart Manufacturing and Smart Logistics, which are based on the exploitation of information accessible through multiple channels, to streamline business models and bring as close as possible the product/process/service customized to the final consumer, understood as the best value-cost perceived by that consumer.			

Skills	
Code	
CB1	Possess and understand knowledge that provides a basis or opportunity to be original in the development and/or application of ideas, often in a research context
CB2	Students should be able to apply their acquired knowledge and problem-solving skills in new or unfamiliar environments within broader (or multidisciplinary) contexts related to their area of study.
CB3	Students are able to integrate knowledge and deal with the complexity of making judgements based on information which, being incomplete or limited, includes reflections on the social and ethical responsibilities linked to the application of their knowledge and judgements.
CB4	Students should be able to communicate their findings - and the ultimate knowledge and reasons behind them - to specialist and non-specialist audiences in a clear and unambiguous manner
CG1	Organization and planning skills
CG6	Knowledge and use of the English language.
CG7	Computer skills related to the field of study.
CE13	Use the integration of different data sources for the definition of flexible, reliable and efficient supply chain management systems, supported by the Industrial Internet of Things and optimized logistics management software tools
CE14	Know the concepts, principles and tools of intelligent manufacturing systems, which facilitate access to information and production data through automated tools for capturing, processing and displaying information
CT1	Ability to understand the meaning and application of the gender perspective in different areas of knowledge and in professional practice with the aim of achieving a more just and equal society
CT2	Incorporate criteria of sustainability and environmental commitment into professional practice. To acquire skills in the equitable, responsible and efficient use of resources
CT3	Multidisciplinary teamwork

Learning outcomes	
Learning outcomes	Competences
Get the understanding of the concepts that underlying Smart Manufacturing and Logistics	CB1 CG6 CG7 CE14
Understand the different technologies that can potentially be adopted for Smart Manufacturing and Smart Logistics	CB1 CB3 CG6 CG7 CE13 CE14

Know how to assess Industrial Internet of Things (IIoT) applications in the context of Manufacturing and Logistics	CB2 CB3 CB4 CG1 CG6 CG7 CE13 CE14 CT1 CT2
Recognise the benefits and impacts of Smart Manufacturing on the Supply Chain, including Logistics	CB3 CG1 CG6 CE13 CE14 CT1 CT2 CT3
Understand challenges and threats posed by the underlying technologies to Manufacturing and Logistics	CB1 CB3 CB4 CG6 CG7 CE13 CE14 CT1 CT2 CT3

Contents	
Topic	
The roles of manufacturing within the modern supply chain	
Typology of manufacturing systems	
Supply Chain Operations Reference (SCOR) model	
Manufacturing control systems	
Internet of Things applications in the manufacturing/production control systems	
Utilising cloud computing	
Industry 4.0 and its impact in manufacturing and the supply chain	
Benefits and challenges in the adoption of Industry 4.0	(*)- Equipos y dispositivos como activos inteligentes - Herramientas de Análisis de Negocio: Business intelligence. - Optimización de los procesos de Producción. - Sostenibilidad aplicada a la Fábrica Inteligente
Digital Readiness	
Intelligent Factories and Business Intelligence (BI)	- Equipment and devices as "intelligent assets" - Business Analysis Tools: Business intelligence. - Optimization of Production processes. - Sustainability applied to the Intelligent Factory

Planning			
	Class hours	Hours outside the classroom	Total hours
Case studies	5	10	15
Practices through ICT	3	11	14
Portfolio/dossier	0.5	9	9.5
Lecturing	12	12	24
Objective questions exam	0.5	2	2.5
Systematic observation	2	0	2
Presentation	2	6	8
*The information in the planning table is for guidance only and does not take into account the heterogeneity of the students.			

Methodologies	
	Description

Case studies	Analysis of a fact, problem or real event with the aim to know it, interpret, resolv, generate hypothesis, contrast data, reflect, complete knowledges, diagnosed and train in alternative procedures of solution.
Practices through ICT	Activities of application of knowledge in a given context and acquisition of basic and procedural skills related to the subject, through ICT.
Portfolio/dossier	Compilation of the work of the/the student with the objective to show his efforts, progresses and attainments in an area. The compilation owes to include contents chosen pole student/it, the criteria of selection and evidences of selfreflection.
Lecturing	Lecture by the professor of the content envelope to subject object of study, theoretical bases and/or guidelines of one work, exercise that the student has to develop

Personalized assistance

Methodologies	Description
Practices through ICT	Monitoring and individual evaluation of activities. Even if the activities are carried out autonomously, the students will have tutorial sessions at all times so that the teachers can monitor the activity.
Portfolio/dossier	Preparation of the materials, activities, etc., on which the students will work. Although the activities will be carried out autonomously, the students will have tutorial sessions at all times so that the teachers can monitor the activity
Tests	**Description**
Objective questions exam	Individualized attention to students during the tests. Review of tests and evaluation activities.
Presentation	Tracking the evolution of the workjob and help the students in the preparation of the presentation/exhibition.

Assessment

	Description	Qualification	Evaluated Competencess
Portfolio/dossier	Ojectives: Evaluate higher thinking skills. Assess analysis, synthesis and evaluation.	15	CB1 CB2 CB3 CB4 CG1 CG6 CE13 CT1 CT2
Objective questions exam	Tests that evaluate knowledge that include closed questions with different answer alternatives (true/false, multiple choice, matching of elements...). Students select an answer from a limited number of possibilities (preferably four) with a reduction for failure of a value equal to the percentage of success (-0.25 pts. in the case of four possible answers if the value of the question is 1 pt.). The test of objective questions only evaluates knowledge. It does not evaluate skills or attitudes. It evaluates lower thinking. It evaluates knowledge, understanding and application.	20	CB1 CB3 CG7 CE14
Systematic observation	Careful, rational, planned and systematic perception to describe and record the manifestations of student behaviour. It is possible to assess learning and actions and how they are carried out by evaluating order, precision, ability, efficiency... The aim is to evaluate higher thinking.	15	CB1 CB2 CB3 CB4 CG1 CG6 CE13 CT1 CT2 CT3
Presentation	Presentation by the students to the teacher and/or a group of students of an aspect on the contents of the subject or the results of a work, exercise, project... It can be carried out individually or in a group. In the presentation, knowledge, skills and attitudes are evaluated. The objectives are to evaluate higher thinking (analysis and synthesis).	50	CB1 CB2 CB3 CB4 CG1 CG6 CE13 CE14 CT1 CT2 CT3

Other comments on the Evaluation

Students who do not pass the subject in continuous training at the first opportunity of each academic year, in which the distribution of evaluation weights is as stablished above, will have the possibility of having an exam of objective questions, worth 100% of the final mark, in successive calls that are not the first opportunity of each academic year.

Ethical commitment: Students are expected to behave ethically. If unethical behaviour is detected (copying, plagiarism, use of unauthorised electronic devices,...), the student will be considered to be ineligible to pass the subject. Depending on the type of unethical behaviour detected, it could be concluded that the student has not reached the necessary skills to overcome the subject. Students are expected to behave in a respectful and dignified manner and to collaborate with the teaching system, teaching staff, coordination and administrative and services personnel of the Master's degree. Any

question due to the lack of ethical and dignified behaviour of the student body may have repercussions on the evaluation of the subject.

Sources of information
Basic Bibliography
Klaus Schwab, **The fourth industrial revolution**, Random House USA Inc, 2017
Alasdair Gilchrist, **Industry 4.0: the industrial internet of things**, 1st, Apress, 2016
Antonio Sartal, Diego Carou and J. Paulo Davim, **Enabling technologies for the successful deployment of industry 4.0**, CRC Press, 2020
Tjahjono, B., Esplugues, C., Ares, E., & Pelaez, G., **What does industry 4.0 mean to supply chain?**, 13, 1175-1182., Procedia Manufacturing, 2017
Gubbi, J., Buyya, R., Marusic, S., & Palaniswami, M., **Internet of Things (IoT): A vision, architectural elements, and future directions.**, Elsevier, 2013
Complementary Bibliography
Slama, D., Puhlmann, F., Morrish, J., & Bhatnagar, R. M., **Enterprise IoT: Strategies and Best practices for connected products and services**, 1st, O'Reilly Media, Inc, 2015

Recommendations

IDENTIFYING DATA				
CAD / CAM / CAE Advanced Systems				
Subject	CAD / CAM / CAE Advanced Systems			
Code	V04M183V01107			
Study programme	Máster Universitario en Industria 4.0			
Descriptors	ECTS Credits	Type	Year	Quadmester
	3	Mandatory	1st	1st
Teaching language	Spanish Galician English			
Department				
Coordinator	Cerqueiro Pequeño, Jorge			
Lecturers	Cerqueiro Pequeño, Jorge Pereira Domínguez, Alejandro Villar García, Marcos			
E-mail	jcerquei@uvigo.es			
Web	http://masterindustria40.webs7.uvigo.es/wordpress/			
General description	The aim of this course is to train the students in the selection of the most suitable CAD, CAM and CAE systems according to the specific case of application, in the frame of the Industry 4.0 paradigm. The course will make the students to get involved in the practical use of the different tools available within those systems, allowing them to explore their capabilities and limitations, going all the way to the elaboration of benchmarking analysis and specification documents about such systems.			

Skills	
Code	
CB1	Possess and understand knowledge that provides a basis or opportunity to be original in the development and/or application of ideas, often in a research context
CB2	Students should be able to apply their acquired knowledge and problem-solving skills in new or unfamiliar environments within broader (or multidisciplinary) contexts related to their area of study.
CB4	Students should be able to communicate their findings - and the ultimate knowledge and reasons behind them - to specialist and non-specialist audiences in a clear and unambiguous manner
CG1	Organization and planning skills
CG3	Descion making
CG7	Computer skills related to the field of study.
CE23	Know and select the most suitable advanced CAD/CAM/CAE environments to be integrated and implemented in the Industry.
CE24	Knowing how to apply advanced design, manufacturing and engineering tools to the modeling and manufacturing of complex mechanical parts and assemblies in the industry
CT1	Ability to understand the meaning and application of the gender perspective in different areas of knowledge and in professional practice with the aim of achieving a more just and equal society
CT2	Incorporate criteria of sustainability and environmental commitment into professional practice. To acquire skills in the equitable, responsible and efficient use of resources

Learning outcomes	
Learning outcomes	Competences
Knowing the most appropriate CAD/CAM/CAE environments to be implemented in the context of Industry 4.0.	CB1 CG1 CG7 CE23
Selecting the appropriate CAD/CAM/CAE solutions to be implemented in response to specific demands, including the design and definition of integrated design and manufacturing systems.	CB2 CG1 CG3 CE24 CT1 CT2
Applying advanced design and engineering tools to the modelling of complex mechanical parts and assemblies.	CB2 CG3 CG7 CE24 CT1 CT2

Applying advanced computer-assisted manufacturing and production engineering tools within the Industry 4.0 framework.	CB2 CB4 CG1 CG3 CE23 CE24 CT1 CT2

Contents	
Topic	
1. CAD/CAM/CAE systems in Industry 4.0.	1.1. Engineering processes in Industry 4.0. 1.2. CAx functionalities in Industry 4.0.
2. Integrated design and manufacturing systems.	2.1. Integration of systems. 2.2. CAx integrated systems -PDM and PLM- for design and manufacturing.
3. Solid modelling (CAD) systems oriented to the product.	3.1. Hierarchies of entities in 3D CAD systems. 3.2. Parametric solid modelling. 3.3. Product structure. 3.4. The 'design intent'. 3.5. Elaboration of technical documentation.
4. Computer-aided manufacturing (CAM) systems.	4.1. Typologies of CAM systems. 4.2. CAM systems to support different manufacturing processes. 4.3. CAD-CAM connectivity for product engineering.
5. Computer-aided engineering (CAE) systems.	5.1. Typologies of CAE systems. 5.2. CAE systems for supporting design. 5.3. CAE systems for manufacturing support. 5.4. CAD-CAM-CAE connectivity.
6. Applications of CAD-CAM-CAE systems.	6.1. Applications of CAD systems to design. 6.2. Applications of CAM systems to manufacturing. 6.3. Applications of CAE systems to engineering.
7. Selection of AD-CAM-CAE systems.	7.1. Evaluation of engineering needs and elaboration of technical specifications. 7.2. Analysis of CAx systems specifications. 7.3. Methodology for the selection of CAx systems.
Practical exercise nr. 1.	Elaboration of a practical assignment about a mechanical system using advanced CAD tools.
Practical exercise nr. 2.	Elaboration of a practical assignment related to the manufacturing engineering by machining of mechanical parts, using advanced CAM tools.
Practical exercise nr. 3.	Elaboration of a practical assignment involving the simulation of a mechanical system using advanced CAE tools.

Planning			
	Class hours	Hours outside the classroom	Total hours
Lecturing	8	18	26
Autonomous problem solving	4	19	23
Practices through ICT	9	14	23
Objective questions exam	1	0	1
Presentation	1	0	1
Systematic observation	1	0	1
*The information in the planning table is for guidance only and does not take into account the heterogeneity of the students.			

Methodologies	
	Description
Lecturing	Exhibition by the professor of the contents on the matter that is object of study, its theoretical bases and/or work guidelines aiming to the assignments that the student has to develop.
Autonomous problem solving	Activity in which the students develop assignments and/or exercises related with the subject. The student/to has to perform the analysis and resolution of the problems and/or exercises by himself in an autonomous way.
Practices through ICT	Activities to apply the gained knowledge in a certain context and to acquire basic and procedimental skills related to the matter by using ITC tools.

Personalized assistance	
Methodologies	**Description**

Autonomous problem solving	Activity in which problems and/or exercises related with the subject are formulated. The student has to perform the analysis and resolution of the problems and/or exercises by hinself in an autonomous way. For all the teaching modalities contemplated in the Contingency Plan, the tutorial sessions of could be carried out through telematic means -email, videoconference, FAITIC forums, etc.- under the modality of prior concertation of virtual place, date and hour.

Assessment

	Description	Qualification	Evaluated	Competencess		
Objective questions exam	Tests composed of objective questions. Mid-term and final assessment.	40	CB1	CG1 CG7	CE23	CT2
Presentation	Presentations. Assignments. Projects. Report of Laboratory activities.	40	CB2 CB4	CG1	CE24	CT1
Systematic observation	Systematic observation. Complementary activities of continuous assessment.	20	CB4	CG3 CG7	CE24	CT1 CT2

Other comments on the Evaluation

Students who do not pass the subject in continuous training at the first opportunity of each academic year, in which the distribution of evaluation weights is as stablished above, will have the possibility of having an exam of objective questions, worth 100% of the final mark, in successive calls that are not the first opportunity of each academic year.

Ethical commitment: Students are expected to behave ethically. If unethical behaviour is detected (copying, plagiarism, use of unauthorised electronic devices,...), the student will be considered to be ineligible to pass the subject. Depending on the type of unethical behaviour detected, it could be concluded that the student has not reached the necessary skills to overcome the subject. Students are expected to behave in a respectful and dignified manner and to collaborate with the teaching system, teaching staff, coordination and administrative and services personnel of the Master's degree. Any question due to the lack of ethical and dignified behaviour of the student body may have repercussions on the evaluation of the subject.

Sources of information

Basic Bibliography

Fernández, Mario, **INDUSTRIA 4.0: Tecnologías y Gestión en la Transformación Digital de la Industria**, 1ª, Editor independiente, 2020

Garijo Gómez, Egberto, **Diseño y Fabricación con CATIA V5: Módulos CAM, Mecanización por arranque de viruta**, 1ª, Vision Libros, 2015

Stark, John, **Product Lifecycle Management (Volume 2): The Devil is in the Details**, 3ª, Springer International Publishing, 2016

Tickoo, Sham, **CATIA V5-6R2015 for Engineers and Designers**, 1ª, Amazon Media EU S.à r.l., 2016

Ulrich, Karl; Eppinger, Steven; Yang, Maria C., **Product Design and Development**, 7ª, McGraw-Hill Education, 2019

Complementary Bibliography

DASSAULT SYSTÈMES, **3DS ACADEMY**, 2020, DASSAULT SYSTÈMES, 2020

Pereira, Alejandro, **Fundamentos de DELMIA: Caso práctico de simulación de celda robotizada**, 2019, El Autor, 2019

Rodal Montero, Enrique, **Industria 4.0: Conceptos, tecnologías habilitadoras y retos**, 1ª, Ediciones Pirámide, 2020

Stark, John, **PLM Vision and Strategy in the Industry 4.0 World: Product Lifecycle Management in 2021**, 1ª, Amazon.com Services LLC, 2018

Tickoo, Sham, **SOLIDWORKS 2019 for Designers**, 17ª, CADCIM Technologies, 2018

Tran, Paul, **SOLIDWORKS 2020 Intermediate Skills**, 1ª, SDC Publications, 2019

Tutorial Books, **CATIA V5-6R2015 Basics Part II: Part Modeling**, 1ª, Tutorial Books, 2015

Tutorial Books, **CATIA V5-6R2015 Basics Part III: Assembly Design, Drafting, Sheetmetal Design and Surface Design**, 1ª, Tutorial Books, 2015

Recommendations

Other comments

The communication with the students will be made through the FAITIC distance learning platform, for which it will be necessary that the student accesses the course space in the platform previously to the start of the lecturing period.

Before the realisation of the evaluation tests, it is recommended that the students consult with the FAITIC platform to confirm the tests' date, place, recommendations, etc., as well as the needs regarding using manuals or any another material for carrying out the tests and elaborating the home assignment works.

IDENTIFYING DATA				
Simulation applied to plant management				
Subject	Simulation applied to plant management			
Code	V04M183V01108			
Study programme	Máster Universitario en Industria 4.0			
Descriptors	ECTS Credits	Type	Year	Quadmester
	3	Mandatory	1st	1st
Teaching language	Spanish Galician English			
Department				
Coordinator	Peláez Lourido, Gustavo Carlos			
Lecturers	Areal Alonso, Juan José Peláez Lourido, Gustavo Carlos			
E-mail	gupelaez@uvigo.gal			
Web	http://masterindustria40.webs7.uvigo.es/wordpress/			
General description	This course deals with one of the most important enabling technologies of the 4.0 industry in the productive field as it is the simulation applied to plant management, from its basic principles to its evolution towards the digital twin and the "virtual commissioning".			

Skills	
Code	
CB1	Possess and understand knowledge that provides a basis or opportunity to be original in the development and/or application of ideas, often in a research context
CB2	Students should be able to apply their acquired knowledge and problem-solving skills in new or unfamiliar environments within broader (or multidisciplinary) contexts related to their area of study.
CB3	Students are able to integrate knowledge and deal with the complexity of making judgements based on information which, being incomplete or limited, includes reflections on the social and ethical responsibilities linked to the application of their knowledge and judgements.
CB4	Students should be able to communicate their findings - and the ultimate knowledge and reasons behind them - to specialist and non-specialist audiences in a clear and unambiguous manner
CG1	Organization and planning skills
CG2	Problem solving.
CG3	Descion making
CG4	Information management capacity.
CG6	Knowledge and use of the English language.
CG7	Computer skills related to the field of study.
CE25	Know and be able to use techniques and tools for mathematical modeling and simulation of discrete event systems and dynamic systems for application in production environments.
CE26	Apply simulation tools to solve specific problems in plant management and integrate them into the implementation process of the 4.0 paradigms.
CT1	Ability to understand the meaning and application of the gender perspective in different areas of knowledge and in professional practice with the aim of achieving a more just and equal society
CT2	Incorporate criteria of sustainability and environmental commitment into professional practice. To acquire skills in the equitable, responsible and efficient use of resources
CT3	Multidisciplinary teamwork

Learning outcomes	
Learning outcomes	Competences
The student can delimit exactly what the different techniques of modeling and simulation of productive flow are used for within the Manufacturing Plant Control	CB1 CB2 CG1 CG3 CG4 CG6 CE25

The student get the necessary skills in the use of plant simulation environments to represent complex systems in scenarios where decision making is not easy.	CB2 CB3 CG1 CG3 CG4 CG6 CG7 CE25 CE26
The student knows how to analyze and choose solutions to shop-floor management problems through simulation studies	CB3 CB4 CG1 CG2 CG3 CG4 CG6 CE26 CT1 CT2
The student diagnoses problems and proposes solutions and how these should be integrated in the processes oriented to the implementation of 4.0 paradigms	CB2 CB3 CB4 CG1 CG3 CG4 CG6 CE26 CT1 CT2 CT3

Contents	
Topic	
Shop-Floor Control	- Components - Support tools
Modelling of Production Systems	- Layouts - Control architectures
General Assigment Resources Problem (GAP) in productive plants	- Levels of decision - forms of solution.
Languages and simulation environments. Applications.	- Languages of Simulation - Simulation Environments - Applications
Examples of development of models and applications on simulation environments	- Development of Models: Examples - Applications on simulation environments: Examples
Integration of plant simulation in the process of evolution towards connected and intelligent factories: Digital Twin & Virtual Manufacturing.	- Representation models associated with each level of manufacturing shop-floor management. - Digital Twin - Virtual Comissioning: Connecting models to the IT of each level. Exposure to different scenarios. Testing to debug or confirm performance.

Planning			
	Class hours	Hours outside the classroom	Total hours
Practices through ICT	14	9	23
Project based learning	4	24	28
Lecturing	4	6	10
Objective questions exam	1	5	6
Project	1	6	7
Systematic observation	1	0	1
*The information in the planning table is for guidance only and does not take into account the heterogeneity of the students.			

Methodologies	
	Description
Practices through ICT	Activities of application of knowledge in a given context and acquisition of basic and procedural skills related to the subject, through ICT

Project based learning	Develope activities that allow the cooperation of several subjects and confront the students, working in teams, in open problems. They to allow to train, among others, the capacities of cooperative learning, leadership, organization, communication and strengthening of personal relationships.
Lecturing	Presentation by the teacher of the contents on the subject of study, theoretical bases and/or guidelines of a work, exercise that the student has to develop

Personalized assistance

Methodologies	Description
Practices through ICT	Monitoring and individual evaluation of activities. Even if the activities are carried out autonomously, the students will have tutorial sessions at all times so that the teachers can monitor the activity.
Project based learning	To design a real project that allows the students to deepen their skills. Monitoring and individual evaluation of activities. Even if the activities are carried out autonomously, the students will have tutorial sessions at all times so that the teachers can monitor the activity.
Tests	**Description**
Objective questions exam	Individualized attention to students during the tests. Review of tests and evaluation activities.
Project	Preparation of evaluation activities and evaluation criteria/indicators. Review of evidence and evaluation activities. Communication of results (publication of notes and data and/or review procedure).
Systematic observation	Monitoring and individual evaluation of activities. Even if the activities are carried out autonomously, the students will have tutorial sessions at all times so that the teachers can monitor the activity.

Assessment

	Description	Qualification	Evaluated Competencess			
Project based learning	Objectives: To assess higher thinking skills. Analysis, synthesis and evaluation are valued. The project evaluates knowledge, skills and attitudes	25	CB2 CB3 CB4	CG1 CG3 CG4 CG6 CG7	CE25 CE26	CT1 CT2 CT3
Objective questions exam	Tests that evaluate knowledge that include questions closed with different response alternatives (true/false, multiple choice, matching of elements...). The students choose an answer from a limited number of possibilities (preferably four) with a reduction for failure equal to success probability (-0.25 pts. in the case of four possible answers, if the value of the question is 1 pt). The test of objective questions only evaluates knowledge. Does not assess skills and attitudes. Assesses thinking skills inferior, knowledge, understanding and application.	20	CB1 CB2 CB3	CG2 CG6 CG7	CE25 CE26	
Project	Objectives: To assess higher thinking skills. Analysis, synthesis and evaluation are valued. The project evaluates knowledge, skills and attitudes	25	CB2 CB3 CB4	CG1 CG3 CG6 CG7	CE25 CE26	CT1 CT2 CT3
Systematic observation	Careful, rational, planned and systematic perception to describe and record the manifestations of student behaviour. It is possible to assess learning and actions and how they are carried out by evaluating order, precision, skill, efficiency... The aim is to evaluate higher thinking.	30	CB1 CB2 CB3 CB4	CG1 CG3 CG4	CE26	CT1 CT2 CT3

Other comments on the Evaluation

Students who do not pass the subject in continuous training at the first opportunity of each academic year, in which the distribution of evaluation weights is as stablished above, will have the possibility of having an exam of objective questions, worth 100% of the final mark, in successive calls that are not the first opportunity of each academic year.

Ethical commitment: Students are expected to behave ethically. If unethical behaviour is detected (copying, plagiarism, use of unauthorised electronic devices,...), the student will be considered to be no apt to pass the subject. Depending on the type of unethical behaviour detected, it could be concluded that the student has not reached the necessary skills to overcome the subject. Students are expected to behave in a respectful and dignified manner and to collaborate with the teaching system, teaching staff, the coordination and the administrative and services personnel of the Master's degree. Any question due to the lack of ethical and dignified behaviour of the student body may have repercussions on the evaluation of the subject.

Sources of information
Basic Bibliography
Averill M. Law, **Simulation modeling and analysis**, 5th, McGraw-Hill Education, 2015
W. David Kelton, Jeffrey S. Smith, David T. Sturrock, **Simio and simulation : modeling, analysis, applications**, 3rd, Simio LLC, 2014
W. David Kelton, Randall P. Sadowski, David T. Sturrock,, **Simulación con software Arena,**, 4ª, McGraw-Hill interamericana, 2007
Mikel ArmendiaMani GhassempouriErdem OzturkFlavien Peysson, **Twin-Control**, Springer, Cham, 2019
Complementary Bibliography
Antoni Guasch ... [et al.], **Modelado y simulación : aplicación a procesos logísticos de fabricación y servicios**, 2ª, UPC, 2003
Altiok, Tayfur; Melamed, Benjamin,, **Simulation modeling and analysis with Arena**, Academic Press, 2007
W. David Kelton, Randall P. Sadowski, Nancy B. Swets,, **Simulation with arena**, 6th, McGraw-Hill, 2015
A. Bauer ... [et al.], **Shop floor control systems : from design to implementation**, Chapman & Hall, 1994
Haruhiko Suwa, Hiroaki Sandoh, **Online Scheduling in Manufacturing**, Springer London, 2013

Recommendations

IDENTIFYING DATA				
Industrialization and industrial innovation. Lean Approach				
Subject	Industrialization and industrial innovation. Lean Approach			
Code	V04M183V01109			
Study programme	Máster Universitario en Industria 4.0			
Descriptors	ECTS Credits	Type	Year	Quadmester
	3	Optional	1st	1st
Teaching language	Spanish			
Department				
Coordinator	Peláez Lourido, Gustavo Carlos			
Lecturers	Peláez Lourido, Gustavo Carlos			
E-mail	gupelaez@uvigo.gal			
Web	http://guiadocente.unileon.es/docencia/guia_docent/doc/asignatura.php?assignatura=1744009&any_academic=2020_21&idioma=cast&doc=N			
General description				

Skills
Code

Learning outcomes	
Learning outcomes	Competences

Contents
Topic

Planning			
	Class hours	Hours outside the classroom	Total hours

*The information in the planning table is for guidance only and does not take into account the heterogeneity of the students.

Methodologies	
	Description

Personalized assistance

Assessment		
Description	Qualification	Evaluated Competencess

Other comments on the Evaluation

Sources of information
Basic Bibliography
Complementary Bibliography

Recommendations

IDENTIFYING DATA				
Horizontal competencies and talent management				
Subject	Horizontal competencies and talent management			
Code	V04M183V01110			
Study programme	Máster Universitario en Industria 4.0			
Descriptors	ECTS Credits	Type	Year	Quadmester
	3	Optional	1st	1st
Teaching language	Spanish Galician English			
Department				
Coordinator	Peláez Lourido, Gustavo Carlos			
Lecturers	Formoso Vérez, Daniel González Cespón, José Luis Graña Escalante, Roberto Peláez Lourido, Gustavo Carlos Suárez Alonso, Ramón Carlos			
E-mail	gupelaez@uvigo.gal			
Web	http://masterindustria40.webs7.uvigo.es/wordpress/			
General description	It is essential for managers in the new 4.0 industry paradigms to acquire the professional skills necessary to lead change and direct the roadmap by understanding the horizontal competencies and managing the talent of their team members			

Skills	
Code	
CB1	Possess and understand knowledge that provides a basis or opportunity to be original in the development and/or application of ideas, often in a research context
CB2	Students should be able to apply their acquired knowledge and problem-solving skills in new or unfamiliar environments within broader (or multidisciplinary) contexts related to their area of study.
CB3	Students are able to integrate knowledge and deal with the complexity of making judgements based on information which, being incomplete or limited, includes reflections on the social and ethical responsibilities linked to the application of their knowledge and judgements.
CB4	Students should be able to communicate their findings - and the ultimate knowledge and reasons behind them - to specialist and non-specialist audiences in a clear and unambiguous manner
CG1	Organization and planning skills
CG2	Problem solving.
CG3	Descion making
CG4	Information management capacity.
CG5	Oral and written communication in your own language.
CG7	Computer skills related to the field of study.
CE33	Identify and develop key skills and abilities in multidisciplinary teams for the processes of implementation and evolution towards industry 4.0
CE34	Develop skills for competency-based management of people in high-performance teams in the context of Design and Manufacturing
CT1	Ability to understand the meaning and application of the gender perspective in different areas of knowledge and in professional practice with the aim of achieving a more just and equal society
CT2	Incorporate criteria of sustainability and environmental commitment into professional practice. To acquire skills in the equitable, responsible and efficient use of resources
CT3	Multidisciplinary teamwork
CT4	Initiative and entrepreneurial aptitudes and actitudes.

Learning outcomes	
Learning outcomes	Competences

Identify and develop key skills and abilities in multidisciplinary teams for the processes of implementation and evolution towards industry 4.0	CB1 CG1 CG2 CG4 CG7 CE33 CT1 CT2 CT3 CT4
Develop skills for competency management of people in high performance teams in the context of Design and Manufacturing industry 4.0	CB2 CB3 CB4 CG1 CG2 CG3 CG4 CG5 CG7 CE34 CT1 CT2 CT3 CT4

Contents	
Topic	
Evolution of the industry to the paradigms of the smart factories or 4.0: Roadmap of the digital transformation and how will affect to the human resources.	- Preliminary study of the Digital Transformation. Historical evolution. - Roadmap to the Factories of the Future: review of ideas, approaches and regulations.
Professional skills in the Connected Industry: current deficiencies, future perspectives.	- What will the work in the factories of the future be like? - New career perspectives: Skills most in demand during the digitalization process and after the transition. - Communication and Public Speaking - Leadership - Equipment management
How to drive the 4.0 paradigm implementation roadmap in the industry: opportunities, risks, preparation for change.	- Leadership skills and team management - Digital transition. Establishment, monitoring and control of the Roadmap. - Management of a Transition Project
Skills needed for change, techniques to support change: design & lean thinking, canvas and start-up models, disruptive thinking, NLP	- Entrepreneurship: capabilities for self-employment - Desgn & Lean Thinking - Startup Canvas - Disruptive Thinking - NLP
Talent management: What is talent and how can its evolution be interpreted? How is it activated, maintained and used in the industries of the future?	- What is talent and how is it interpreted in the digital transition? - How is talent activated, maintained and used in the Factories of the Future?
The values in the factory of the future: Social and human responsibility in the evolution towards industry 4.0.	- The Key Values in the Digital World - Corporate Social Responsibility - Transparency in Business - Sustainability: environmental and social aspects - Just Transition to the new industrial reality

Planning

	Class hours	Hours outside the classroom	Total hours
Case studies	5	7	12
Debate	5	7	12
Seminars	5	5	10
Mentored work	5	19	24
Lecturing	2.5	7	9.5
Objective questions exam	0.5	2	2.5
Presentation	1	3	4
Systematic observation	1	0	1

*The information in the planning table is for guidance only and does not take into account the heterogeneity of the students.

Methodologies	
	Description
Case studies	Analysis of an event, issue or actual event in order to know, interpret, solve, generate hypotheses, comparing data, reflect, complete knowledge, diagnose and training in alternative dispute resolution procedures.
Debate	Open discussion between a group of students. You can focus on a topic of subject content, the analysis of a case, the outcome of a project, exercise or problem previously developed a keynote address ...
Seminars	Activity focused on the work on a specific topic, which allows to deepen or complement the contents of the subject. They can be used as a complement to the theoretical classes.
Mentored work	The student, individually or in groups, prepares a paper on the subject of matter or prepare seminars, research, memoirs, essays, summaries of readings, lectures, etc.. Generally it is an autonomous activity of the student that includes finding and collecting information, reading and literature management, writing ...
Lecturing	Presentation by the teacher of the contents on the subject under study, theoretical and / or guidelines for a job, exercise or project to be developed by the student.

Personalized assistance	
Methodologies	**Description**
Case studies	To propose a series of cases and situations. - Develop and provide a script to guide the analysis and focus the points of interest for further discussion (background material) - Correct and provide feedback to students on the process and results of the proposed activities. Even if the activities are carried out autonomously, students will have access for tutoring sessions so that teachers can follow up on the activity.
Debate	Select topics, energize the debate and evaluate the students. Revise of tests and evaluation activities. Communication of the results (publication of notes and data and/or review procedure). Even if the activities are carried out autonomously, the students will have tutorial sessions at all times so that the teaching staff can monitor the activity.
Seminars	Preparation of documentation to guide the individual or group development of activities. Dynamization of the session. Even if the activities are carried out autonomously, the students will have tutorial sessions at all times so that the teachers can monitor the activity.
Mentored work	Determine or propose the topic of study. Monitoring and evaluating the work, both during the process and the final result. Even if the activities are carried out autonomously, the students will have tutorial sessions at all times so that the teachers can monitor the activity.
Tests	**Description**
Objective questions exam	Individualized attention to students during the tests. Review of the tests and evaluation activities.
Presentation	Preparation of evaluation activities and evaluation criteria/indicators Review of evidence and evaluation activities. Communication of results (publication of notes and data and/or review procedure). Even if the activities are carried out autonomously, the students will have tutorial sessions at all times so that the teaching staff can monitor the activity.
Systematic observation	Preparation of a list of aspects to be evaluated. Observation of the students.

Assessment				
	Description	Qualification	Evaluated Competencess	
Debate	Open talk among a group of students. Can be focused on a subject of the contents of the subject, on the analysis of a case, on the result of a project, exercise or problem previously developed in a master session... In the discussion, knowledge, skills and attitudes are evaluated. Objectives: To evaluate higher thinking (analysis and synthesis).	18	CB3 CB4	CG1 CG3 CG4 CG5 CE33 CE34 CT1 CT2 CT3 CT4
Mentored work	The students, individually or in groups, carry out activities, which can be - Monographic works, search for information in publications, databases, articles, books... on a specific topic. - Preparation of seminars, research, reports, essays, conferences, etc. - Reviews of current scientific articles. - Projects (design and development of projects). Objectives: - Acquire and consolidate knowledge - Evaluate knowledge. - Developing transversal skills and competences	15	CB1 CB2 CB4	CG1 CG4 CG5 CG7 CE33 CE34 CT1 CT2 CT3

Objective questions exam	Tests that evaluate knowledge that include closed questions with different answer alternatives (true/false, multiple choice, matching of elements...). Students select an answer from a limited number of possibilities (preferably four) with a reduction for failure of a value equal to the percentage of success (-0.25 pts. in the case of four possible answers, if the value of the question was 1 pt). The test of objective questions only evaluates knowledge. It does not evaluate skills or attitudes. It evaluates thinking skills inferior. It assesses knowledge, understanding and application.	20	CB1 CB2 CB3	CG2 CG4	CE33		
Presentation	Exposure by the students to the teacher and/or a group of students of an aspect of the subject's contents or results of a work, exercise, project... You can carry out individually or in a group. In the presentation, knowledge, skills and attitudes are evaluated. The objectives are to evaluate higher thinking (analysis and synthesis).	17					
Systematic observation	Careful, rational, planned and systematic perception to describe and record the manifestations of student behaviour. It is possible to assess learning and actions and how they are carried out valuing order, precision, dexterity, efficiency... The aim is to evaluate higher thinking.	30	CB1 CB2 CB3 CB4	CG1 CG3 CG7	CE33 CE34	CT1 CT2 CT3 CT4	

Other comments on the Evaluation

Students who do not pass the subject in continuous training at the first opportunity of each academic year, in which the distribution of evaluation weights is as stablished above, will have the possibility of having an exam of objective questions, worth 100% of the final mark, in successive calls that are not the first opportunity of each academic year.

Ethical commitment: Students are expected to behave ethically. If unethical behaviour is detected (copying, plagiarism, use of unauthorised electronic devices,...), the student will be considered to be ineligible to pass the subject. Depending on the type of unethical behaviour detected, it could be concluded that the student has not reached the necessary skills to overcome the subject. Students are expected to behave in a respectful and dignified manner and to collaborate with the teaching system, teaching staff, coordination and administrative and services personnel of the Master's degree. Any question due to the lack of ethical and dignified behaviour of the student body may have repercussions on the evaluation of the subject.

Sources of information

Basic Bibliography

Gómez Mejía, Luis R, **Gestión de recursos humanos**, 8ª, Pearson, 2016

Goleman, Daniel, **Liderazgo : el poder de la inteligencia emocional**, Ediciones B, 2013

Arturo Merayo, **Curso práctico de técnicas de comunicación oral**, 3ª, Tecnos, 2012

Nayyar, Anand, Kumar, Akshi, **A Roadmap to Industry 4.0: Smart Production, Sharp Business and Sustainable Development**, 1st, Springer, 2020

Alp Ustundag, Emre Cevikcan, **Industry 4.0: Managing The Digital Transformation**, 1st, Springer, Cham, 2018

Ries, Eric, **El Método Lean Startup**, 11ª, Ediciones Deusto, 2017

Alexander Osterwalder, Yves Pygneur, **Generación de modelos de negocio : un manual para visionarios, revolucionarios y retadores**, 19ª, Ediciones Deusto, 2018

Juanma Romero, Luis Oliván, **Emprender en la era digital**, RTVE, 2017

Alex López, **Cliente Digital, Vendedor Digital**, 2ª, Códice, 2017

Complementary Bibliography

Ruiz Otero, Eugenio,, **Recursos humanos y responsabilidad social corporativa**, McGraw-Hill Educación, 2017

Beatriz Valderrama, **Gestión del Talento en la Era Digital**, 1ª, Eos, 2018

Recommendations

IDENTIFYING DATA				
Development and management of R + D + i projects				
Subject	Development and management of R + D + i projects			
Code	V04M183V01111			
Study programme	Máster Universitario en Industria 4.0			
Descriptors	ECTS Credits	Type	Year	Quadmester
	3	Optional	1st	2nd
Teaching language	Spanish			
Department				
Coordinator	Cerqueiro Pequeño, Jorge			
Lecturers	Cerqueiro Pequeño, Jorge			
E-mail	jcerquei@uvigo.es			
Web	http://guiadocente.unileon.es/docencia/guia_docent/doc/asignatura.php?assignatura=1744016&any_academic=2020_21&idioma=cast&doc=N			
General description				

Skills
Code

Learning outcomes	
Learning outcomes	Competences

Contents
Topic

Planning			
	Class hours	Hours outside the classroom	Total hours
*The information in the planning table is for guidance only and does not take into account the heterogeneity of the students.			

Methodologies	
	Description

Personalized assistance

Assessment		
Description	Qualification	Evaluated Competencess

Other comments on the Evaluation

Sources of information
Basic Bibliography
Complementary Bibliography

Recommendations

IDENTIFYING DATA				
Advanced calculation tools for engineering				
Subject	Advanced calculation tools for engineering			
Code	V04M183V01112			
Study programme	Máster Universitario en Industria 4.0			
Descriptors	ECTS Credits	Type	Year	Quadmester
	3	Optional	1st	2nd
Teaching language	Spanish Galician English			
Department				
Coordinator	Peláez Lourido, Gustavo Carlos			
Lecturers	Karkkainen , Tatja Peláez Lourido, Gustavo Carlos Vidal Vázquez, Ricardo			
E-mail	gupelaez@uvigo.gal			
Web	http://masterindustria40.webs7.uvigo.es/wordpress/			
General description	More than one million jobs in STEM (Science, Technology, Engineering and Mathematics) profiles will be created in the next four years in Spain, according to estimates by the Spanish Association for Digitalization, DigitalES. The last letter of the acronym is where this subject is headed. Mathematics is a catalyst discipline for the transition to the Fourth Industrial Revolution. They were an essential tool in many fields of the past, are on the present and will be in the future. Maths, in fact, command in some way the ship of the new digital age. And the fact is that, although the main work of mathematics is to make people think, its applications are fundamental in the world of the real and palpable. Therefore, it is important to highlight the importance and role of this discipline in the new era of digitalisation. In this subject we have focused on two main areas of action: - On the one hand, the application of Differential Equations in Engineering, implementation of numerical integration algorithms in mathematical software environments. The application can be made multiple problems, among them those related to manufacturing processes. - On the other hand, the second major application that will study mathematics within the scope of Industry 4.0 is called 'topological data analysis' and deals with how to analyze large data, trying to understand what information can be extracted from a site and the different ways in which the data is shaped. This is a field where Big Data and Machine Learning represent recent fields of great actuality and demand of professionals for the jobs of the future. In this section these techniques will be applied to problems of Industrial Organization such as Resource Allocation or routes.			

Skills	
Code	
CB2	Students should be able to apply their acquired knowledge and problem-solving skills in new or unfamiliar environments within broader (or multidisciplinary) contexts related to their area of study.
CB3	Students are able to integrate knowledge and deal with the complexity of making judgements based on information which, being incomplete or limited, includes reflections on the social and ethical responsibilities linked to the application of their knowledge and judgements.
CG2	Problem solving.
CG4	Information management capacity.
CG7	Computer skills related to the field of study.
CE31	Know the advanced computer tools for mathematical calculation and their use in design and manufacturing engineering applications
CE32	Select and apply advanced calculation tools for solving mathematical problems in the field of design engineering and manufacturing
CT1	Ability to understand the meaning and application of the gender perspective in different areas of knowledge and in professional practice with the aim of achieving a more just and equal society
CT2	Incorporate criteria of sustainability and environmental commitment into professional practice. To acquire skills in the equitable, responsible and efficient use of resources

Learning outcomes	
Learning outcomes	Competences

The student knows for what, in which tasks and how the advanced software tools of mathematical calculation can be used, in the industrial environment.	CB3 CG2 CG4 CG7 CE31 CT1 CT2
The student acquires the necessary skills in the use of advanced mathematical calculation software environments to pose and solve engineering problems in industry.	CB2 CG2 CG7 CE31 CT1 CT2
The student acquires basic and advanced skills in programming languages for scientific use.	CB2 CG2 CG7 CE31 CE32 CT1 CT2
The student is able to use programming languages for problem solving in engineering.	CB2 CG2 CG4 CG7 CE32 CT1 CT2
El/La estudiante diagnostica problemas y propone soluciones con herramientas de cálculo y cómo se deben integrar estas en los procesos orientados a la implantación de paradigmas 4.0	CB2 CB3 CG4 CE32 CT1 CT2

Contents	
Topic	
1.- Differential Equations applied in Engineering	Implementation of numerical integration algorithms of differential equations in mathematical software environments. Application to different types of problems related to manufacturing processes.
2.- Implementation of Algorithms for the Industry 4.0	Study problems in the production organization environment by reviewing algorithms, implementing them and applying them in real situations in the context of Industry 4.0

Planning			
	Class hours	Hours outside the classroom	Total hours
Problem solving	9	15	24
Practices through ICT	7.5	7.5	15
Project based learning	2.5	14.5	17
Lecturing	4	6	10
Objective questions exam	0.5	5	5.5
Presentation	0.5	2	2.5
Systematic observation	1	0	1
*The information in the planning table is for guidance only and does not take into account the heterogeneity of the students.			

Methodologies	
	Description
Problem solving	Activity in which problems and/or exercises related to the subject are formulated. The student must develop the appropriate solutions by means of the execution of routines, the application of formulas or algorithms, the application of procedures of transformation of the available information and the interpretation of the results. It is usually used as a complement to a master class.
Practices through ICT	Activities for applying knowledge to specific situations and acquiring basic and procedural skills related to the subject matter. They are developed through ICTs in an autonomous way.
Project based learning	Carrying out activities that allow the interaction of several subjects and train students in teamwork, with open problems. They allow to form, among others, the capacities of learning in cooperation, leadership, organization, communication and strengthening of the interpersonal relations.

Lecturing	Presentation by the teacher of the contents on the subject of study, theoretical bases and/or guidelines of a work, exercise or project to be developed by the student.

Personalized assistance

Methodologies	Description
Problem solving	The teachers propose, guide, review and correct the approach and resolution of problems and/or exercises individually or in groups. Even if the activities are carried out autonomously, the students will have tutorial sessions at all times so that the teachers can control the activity.
Practices through ICT	Develop and provide a script to guide the resolution of the problem or activities. To carry out the follow-up evaluation of the activities. Control and individual evaluation of activities. Even if the activities are carried out autonomously, the students will have tutorial sessions at all times so that the teachers can control the activity.
Project based learning	Design a real project that allows students to deepen their skills. Control and individual evaluation of activities. Even if the activities are carried out autonomously, the students will have tutorial sessions at all times so that the teachers can control the activity.
Tests	**Description**
Objective questions exam	Individualized attention to students during the tests. Review of tests and evaluation activities.
Presentation	Preparation of evaluation activities and evaluation criteria/indicators Review of evidence and evaluation activities. Communication of results (publication of notes and data and/or review procedure). Even if the activities are carried out autonomously, the students will have tutorial sessions at all times so that the teaching staff can monitor the activity.
Systematic observation	Preparation of a list of aspects to be evaluated. Observation of the students.

Assessment

	Description	Qualification	Evaluated Competencess			
Problem solving	Test in which students must solve a series of problems and/or exercises in a time/conditions established by the teacher. In this way, students must apply the knowledge they have acquired. Different tools can be used to apply this technique such as, for example, chat, mail, forum, audio conference, video conference, etc. Problem solving evaluates knowledge and skills, but not attitudes.	15	CB2	CG2 CG4 CG7	CE32	
Project based learning	Presentation of a project by a group or individually Objectives: To evaluate higher thinking. Analysis, synthesis and evaluation are valued. The project evaluates knowledge, skills and attitudes.	20	CB2 CB3	CG4 CG7	CE31 CE32	CT1 CT2
Objective questions exam	Tests that evaluate knowledge that include closed questions with different answer alternatives (true/false, multiple choice, matching of elements...). Students select an answer from a limited number of possibilities (preferably four) with a reduction for failure of a value equal to the percentage of success (-0.25 pts. in the case of four possible answers if the value of the question is 1 pt). The test of objective questions only evaluates knowledge. It does not evaluate skills or attitudes. It evaluates skills of inferior thinking. It assesses knowledge, understanding and application.	20	CB2 CB3	CG7	CE31	
Presentation	Presentation by the students to the teacher and/or a group of students of an aspect on the contents of the subject or the results of a work, exercise, project... It can be carried out individually or in a group. In the presentation, knowledge, skills and attitudes are evaluated. The objective is to evaluate higher thinking (analysis and synthesis).	15	CB2	CG4	CE31 CE32	CT1 CT2
Systematic observation	Careful, rational, planned and systematic perception to describe and record the manifestations of student behaviour. It is possible to assess learning and actions and how they are carried out valuing order, precision, dexterity, efficiency... The aim is to evaluate higher thinking.	30	CB2 CB3	CG2 CG4 CG7	CE31 CE32	CT1 CT2

Other comments on the Evaluation

Students who do not pass the subject in continuous training at the first opportunity of each academic year, in which the distribution of evaluation weights is as stablished above, will have the possibility of having an exam of objective questions, worth 100% of the final mark, in successive calls that are not the first opportunity of each academic year

Ethical commitment: Students are expected to behave ethically. If unethical behaviour is detected (copying, plagiarism, use of unauthorised electronic devices,...), the student will be considered to be ineligible to pass the subject. Depending on the

type of unethical behaviour detected, it could be concluded that the student has not reached the necessary skills to overcome the subject. Students are expected to behave in a respectful and dignified manner and to collaborate with the teaching system, teaching staff, coordination and administrative and services personnel of the Master's degree. Any question due to the lack of ethical and dignified behaviour of the student body may have repercussions on the evaluation of the subject.

Sources of information

Basic Bibliography

de Arriba et al., **Implementación e desenvolvemento de aulas de xeometría Euclídea e diferencial en SAGE**, 1ª, Servicio de publicaciones de la UVigo, 2020

Amos Gilat, **MATLAB : una introducción con ejemplos prácticos**, 1ª, Reverté, 2006

Heiner Lasi, Peter Fettke, Thomas Feld, Michael Hoffmann, **Industry 4.0**, Vol. 6: Iss. 4, 239-242, Business & Information Systems Engineering, AI, 2014

Complementary Bibliography

Crouzeix, M., Mignot, A.L., **Analyse Numerique des équations différentielles**, 2eme. ed. révisée et augm., Masson, 1992

Gekeler, Eckart,, **Mathematical methods for mechanics : a handbook with MATLAB experiments**, 1st, Springer, 2008

A Charnes, WW Cooper, E Rhodes, **Measuring the efficiency of decision making units**, 2, 429-444., European Journal of Operational Research, Elsevier, 1978

Muhammad A.Razi, Kuriakose Athappilly, **A comparative predictive analysis of neural networks (NNs), nonlinear regression and classification and regression tree (CART) models**, Volume 29, Issue 1, 65-74, Expert Systems with Applications, Elsevier, 2005

Recommendations

IDENTIFYING DATA				
Industrial Internet of Things (IIoT)				
Subject	Industrial Internet of Things (IIoT)			
Code	V04M183V01201			
Study programme	Máster Universitario en Industria 4.0			
Descriptors	ECTS Credits	Type	Year	Quadmester
	4.5	Mandatory	1st	2nd
Teaching language	Spanish Galician English			
Department				
Coordinator	Garrido Campos, Julio			
Lecturers	Garrido Campos, Julio Riveiro Fernández, Enrique			
E-mail	jgarri@uvigo.es			
Web	http://masterindustria40.webs7.uvigo.es/wordpress/			
General description	The problem of access to machine information is a key aspect within the digitization of industrial processes promoted by the Industry 4.0 paradigm, and it is the IIoT technologies that lead to its implementation. With these technologies it is possible to connect ubiquitously with a controller and access a series of variables. The course uses an industrial approach when analyzing the different methodologies to access data of the industrial process. It focuses on giving a clear vision of the architectures used that are having a greater impact in the framework of Industry 4.0. To this end, all the elements involved in the chain of transmission and exploitation of industrial data will be analysed: the different hardware architectures, software communication resources and the most used data protocols (MQTT, AMQP, OPC UA), and finally, their storage. With this, students should have a clear idea of what strategy and methodology is currently used when implementing data access in industrial environments.			

Skills	
Code	
CB1	Possess and understand knowledge that provides a basis or opportunity to be original in the development and/or application of ideas, often in a research context
CB2	Students should be able to apply their acquired knowledge and problem-solving skills in new or unfamiliar environments within broader (or multidisciplinary) contexts related to their area of study.
CB5	Students have got the learning skills that will enable them to continue studying in a largely self-directed or autonomous manner
CG1	Organization and planning skills
CG2	Problem solving.
CG7	Computer skills related to the field of study.
CE9	Know the principles, techniques and systems that comprise the concept of Industrial Internet of Things (IIoT) and its relationship with design and manufacturing
CE10	Knowing how to implement robust, flexible and fault-tolerant industrial control systems, through data acquisition and decision making systems appropriate to each situation.
CT1	Ability to understand the meaning and application of the gender perspective in different areas of knowledge and in professional practice with the aim of achieving a more just and equal society
CT2	Incorporate criteria of sustainability and environmental commitment into professional practice. To acquire skills in the equitable, responsible and efficient use of resources
CT3	Multidisciplinary teamwork

Learning outcomes	
Learning outcomes	Competences
To know the principles, techniques and systems that comprise the concept of Industrial Internet of Things (IIoT).	CB1 CG7 CE9
To know the application of the IIoT in the design and the manufacture in the frame of the Industry 4.0	CB1 CB2 CE9 CE10
Know the robust, reliable and fault-tolerant control systems best suited for applications in Industry 4.0.	CB1 CB2 CG1 CG2

Implement data acquisition and decision making systems based on IIoT in manufacturing and supply chain contexts	CB2 CB5 CG1 CE10 CT1 CT2 CT3
Apply control systems for real time decision making in Industry 4.0 contexts.	CB2 CG1 CG2 CE10

Contents	
Topic	
1. Industrial Internet of Things in Industry 4.0.	1.1 Introduction to IIoT. Historical evolution. 1.2 Technological alternatives
2. Nature, principles, techniques and systems associated with IIoT	2.1 IIoT Architectures 2.2 IIoT Hardware devices 2.3 IIoT Protocols
3. IIoT applied to design and manufacture.	3.1. Control systems in the context of Industry 4.0. 3.2. IIoT systems in production facilities 3.3. IIoT systems in the supply chain

Planning			
	Class hours	Hours outside the classroom	Total hours
Problem solving	9	21	30
Laboratory practical	5	15	20
Project based learning	4	16	20
Lecturing	14	25	39
Objective questions exam	0.5	3	3.5
*The information in the planning table is for guidance only and does not take into account the heterogeneity of the students.			

Methodologies	
	Description
Problem solving	Execution of exercises based on real cases, with audiovisual support
Laboratory practical	Activities to apply the knowledge acquired in theory classes to certain situations that can be developed in the subject's laboratory
Project based learning	The students, individually, will have to design and implement a system (or a part of it) proposed by the teacher applying the knowledge and skills acquired as a result of the master sessions, the laboratory practices and the personal work of the student.
Lecturing	Presentation by the teacher of the contents of the subject.

Personalized assistance	
Methodologies	**Description**
Laboratory practical	Develop and provide a script to guide the resolution of the problem or activities. Monitoring and evaluating the activities.
Project based learning	Design a real project that allows the students to improve their skills
Tests	**Description**
Objective questions exam	- Review of evidence and evaluation activities. - Communication of results (publication of grades and data and/or review procedure)

Assessment				
	Description	Qualification	Evaluated Competencess	
Laboratory practical	It is necessary to exceed 50% of the assessment to pass the course. There will be continuous evaluation.	30	CG2 CG7	CE10 CT1 CT2 CT3
Project based learning	It is necessary to exceed 50% of the assessment to pass the course. There will be continuous evaluation.	50	CG1 CG7	CE9 CE10

Objective questions exam	Tests that evaluate knowledge that include closed questions with different answer alternatives (true/false, multiple choice, matching of elements...). Students select an answer from a limited number of possibilities. The test of objective questions evaluates knowledge. It does not evaluate skills or attitudes. Objectives: To assess lower thinking skills. Assesses knowledge, understanding and application.	20	CB1 CB2 CB5	CG1 CG2	CE9

Other comments on the Evaluation

Students who do not pass the subject in continuous training at the first opportunity of each academic year, in which the distribution of evaluation weights is as stablished above, will have the possibility of having an exam of objective questions, worth 100% of the final mark, in successive calls that are not the first opportunity of each academic year.

Ethical commitment: Students are expected to behave ethically. If unethical behaviour is detected (copying, plagiarism, use of unauthorised electronic devices,...), the student will be considered to be ineligible to pass the subject. Depending on the type of unethical behaviour detected, it could be concluded that the student has not reached the necessary skills to overcome the subject. Students are expected to behave in a respectful and dignified manner and to collaborate with the teaching system, teaching staff, coordination and administrative and services personnel of the Master's degree. Any question due to the lack of ethical and dignified behaviour of the student body may have repercussions on the evaluation of the subject.

Sources of information

Basic Bibliography

Julio Garrido Campos, **Transparencias asignatura**,

GENG, Hwaiyu (ed.)., **Internet of things and data analytics handbook**, John Wiley & Sons, 2017

Complementary Bibliography

MAHNKE, Wolfgang; LEITNER, Stefan-Helmut; DAMM, Matthias, **OPC unified architecture**, Springer Science & Business Media, 2009

Recommendations

IDENTIFYING DATA				
Additive manufacturing				
Subject	Additive manufacturing			
Code	V04M183V01202			
Study programme	Máster Universitario en Industria 4.0			
Descriptors	ECTS Credits	Type	Year	Quadmester
	3	Mandatory	1st	2nd
Teaching language	Spanish			
Department				
Coordinator	Cerqueiro Pequeño, Jorge			
Lecturers	Cerqueiro Pequeño, Jorge			
E-mail	jcerquei@uvigo.es			
Web	http://guiadocente.unileon.es/docencia/guia_docent/doc/asignatura.php?assignatura=1744012&any_academic=2020_21&idioma=cast&doc=N			
General description				

Skills
Code

Learning outcomes	
Learning outcomes	Competences

Contents
Topic

Planning			
	Class hours	Hours outside the classroom	Total hours

*The information in the planning table is for guidance only and does not take into account the heterogeneity of the students.

Methodologies	
	Description

Personalized assistance

Assessment		
Description	Qualification	Evaluated Competencess

Other comments on the Evaluation

Sources of information
Basic Bibliography
Complementary Bibliography

Recommendations

IDENTIFYING DATA				
Advanced verification and inspection systems				
Subject	Advanced verification and inspection systems			
Code	V04M183V01203			
Study programme	Máster Universitario en Industria 4.0			
Descriptors	ECTS Credits	Type	Year	Quadmester
	3	Mandatory	1st	2nd
Teaching language	Spanish			
Department				
Coordinator	Peláez Lourido, Gustavo Carlos			
Lecturers	Peláez Lourido, Gustavo Carlos			
E-mail	gupelaez@uvigo.gal			
Web	http://guiadocente.unileon.es/docencia/guia_docent/doc/asignatura.php?assignatura=1744013&any_academic=2020_21&idioma=cast&doc=N			
General description				

Skills
Code

Learning outcomes	
Learning outcomes	Competences

Contents
Topic

Planning			
	Class hours	Hours outside the classroom	Total hours
*The information in the planning table is for guidance only and does not take into account the heterogeneity of the students.			

Methodologies	
	Description

Personalized assistance

Assessment		
Description	Qualification	Evaluated Competencess

Other comments on the Evaluation

Sources of information
Basic Bibliography
Complementary Bibliography

Recommendations

IDENTIFYING DATA				
Robotics and virtual reality in the industry				
Subject	Robotics and virtual reality in the industry			
Code	V04M183V01204			
Study programme	Máster Universitario en Industria 4.0			
Descriptors	ECTS Credits	Type	Year	Quadmester
	3	Mandatory	1st	2nd
Teaching language	Spanish			
Department				
Coordinator	Garrido Campos, Julio			
Lecturers	Garrido Campos, Julio			
E-mail	jgarri@uvigo.es			
Web	http://guiadocente.unileon.es/docencia/guia_docent/doc/asignatura.php?assignatura=1744014&any_academic=2020_21&idioma=cast&doc=N			
General description				

Skills
Code

Learning outcomes	
Learning outcomes	Competences

Contents
Topic

Planning			
	Class hours	Hours outside the classroom	Total hours
*The information in the planning table is for guidance only and does not take into account the heterogeneity of the students.			

Methodologies	
	Description

Personalized assistance

Assessment		
Description	Qualification	Evaluated Competencess

Other comments on the Evaluation

Sources of information
Basic Bibliography
Complementary Bibliography

Recommendations

IDENTIFYING DATA				
Simulation applied to design and manufacturing				
Subject	Simulation applied to design and manufacturing			
Code	V04M183V01205			
Study programme	Máster Universitario en Industria 4.0			
Descriptors	ECTS Credits	Type	Year	Quadmester
	4.5	Mandatory	1st	2nd
Teaching language	Spanish Galician English			
Department				
Coordinator	Cerqueiro Pequeño, Jorge			
Lecturers	Cerqueiro Pequeño, Jorge Comesaña Campos, Alberto Santos Esterán, David			
E-mail	jcerquei@uvigo.es			
Web	http://masterindustria40.webs7.uvigo.es/wordpress/			
General description	This course aims to train students in the selection of modeling and simulation tools applied to design and manufacturing processes, taking into account the specific circumstances in the Industry 4.0 paradigm framework. The subject will provide students with the experience in the use of different modeling and simulation tools for industrial systems and components, allowing them to analyze their capabilities and limitations, ending with the elaboration of benchmarkings between different solutions and the elaboration of specifications for the selection of an optimal proposal.			

Skills	
Code	
CB1	Possess and understand knowledge that provides a basis or opportunity to be original in the development and/or application of ideas, often in a research context
CB3	Students are able to integrate knowledge and deal with the complexity of making judgements based on information which, being incomplete or limited, includes reflections on the social and ethical responsibilities linked to the application of their knowledge and judgements.
CG1	Organization and planning skills
CG2	Problem solving.
CG7	Computer skills related to the field of study.
CE21	To know and be able to use modeling and simulation tools by finite elements, finite differences and computerized fluid dynamics (CFD) as tools of Assisted Engineering (CAE)
CE22	Select the appropriate finite element difference (FEM) and computerized fluid dynamics (CFD) modeling and simulation tools to solve design and manufacturing engineering problems
CT1	Ability to understand the meaning and application of the gender perspective in different areas of knowledge and in professional practice with the aim of achieving a more just and equal society
CT2	Incorporate criteria of sustainability and environmental commitment into professional practice. To acquire skills in the equitable, responsible and efficient use of resources
CT3	Multidisciplinary teamwork

Learning outcomes	
Learning outcomes	Competences
Knowing different modeling and simulation tools such as finite elements (FEM), finite difference (FDM) and computerized fluid dynamics (CFD).	CB1 CG2 CG7 CE21 CT2
Applying different modeling and simulation techniques such as finite elements (FEM), finite differences (FDM) and computerized fluid dynamics (CFD) as Assisted Engineering (CAE) tools.	CB3 CG2 CG7 CE21 CT2 CT3

Selecting the most appropriate modeling and simulation tools for solving specific design and manufacturing engineering problems in the context of Industry 4.0.	CB1 CB3 CG1 CG2 CE22 CT1 CT3

Contents	
Topic	
1. Introduction to the simulation of components and processes.	1.1. Models and simulation. 1.2. Tools for the simulation of components. 1.3. Tools for the simulation of processes. 1.4. Symbolic modelling tools.
2. The role of modelling and simulation in Industry 4.0.	2.1. Purposes of modelling and simulation. 2.2. Strategies for modelling and simulation in Industry 4.0.
3. Finite Element Modeling and simulation (FEM).	3.1. Fundamentals and concepts in FEM techniques. 3.2. Applications of FEM tools in Engineering. 3.3. FEM tools for mechanical modelling and simulation. 3.4. Applications of FEM tools in Industry 4.0. 3.5. Selection of FEM tools in Industry 4.0.
4. Finite difference modeling and simulation (FDM): techniques, tools, concepts and applications.	4.1. Fundamentals and concepts in FDM techniques. 4.2. Applications of FDM tools in Engineering. 4.3. FDM tools for modelling and simulation of manufacturing processes. 4.4. Applications of FDM tools in Industry 4.0.
5. Modeling and simulation with computerized fluid dynamics (CFD).	5.1. Fundamentals and concepts in CFD techniques. 5.2. Applications of CFD tools in Engineering. 5.3. CFD tools for mechanical modelling and simulation. 5.4. Applications of CFD tools in Industry 4.0.
6. Selection of modelling and simulation tools for design and manufacture.	6.1. Evaluation modelling and simulation needs in the processes of design and manufacture engineering. 6.2. Performance analysis of modelling and simulation systems. 6.3. Methodology for the selection of modelling and simulation systems. 6.4. Proprietary calculation and simulation tools.
Practical exercise nr 1.	Development of a practical case of multi-technology systems simulation using symbolic modelling tools.
Practical exercise nr. 2.	Elaboration of a FEM study for the detail design engineering stage of an industrial product.
Practical exercise nr. 3.	Elaboration of an FDM study for the manufacturing engineering stage of an industrial product.
Practical exercise nr. 4.	Elaboration of a CFD study for the detail design engineering stage of an industrial product.
Practical exercise nr. 5.	Elaboration of a simulation of a mechanical system using proprietary calculation tools.

Planning			
	Class hours	Hours outside the classroom	Total hours
Lecturing	9	16	25
Autonomous problem solving	9	16	25
Practices through ICT	13	32.5	45.5
Project based learning	2	12	14
Objective questions exam	1	0	1
Presentation	1	0	1
Systematic observation	1	0	1
*The information in the planning table is for guidance only and does not take into account the heterogeneity of the students.			

Methodologies	
	Description
Lecturing	Presentation by the lecturer of the contents on the subject of study, its theoretical bases and/or guidelines of a work or exercise that the student has to develop.
Autonomous problem solving	Activity in which problems and/or exercises related to the subject are formulated. The student must develop the analysis and resolution of the problems and/or exercises in an autonomous way.
Practices through ICT	Activities for the application of knowledge in a given context and the acquisition of basic and procedural skills in relation to the subject through ICT tools.

Project based learning	To carry out activities that allow the cooperation of several subjects and confront the students, working in teams, with open problems. They will allow to hone, among others, the capabilities for cooperative learning, leadership, organization, communication and strengthening of personal relationships.

Personalized assistance

Methodologies	Description
Autonomous problem solving	Activity in which problems and/or exercises related to the subject are formulated. The student must develop the analysis and resolution of the problems and/or exercises in an autonomous way. For all the teaching modalities contemplated in the Contingency Plan, the tutoring sessions may be carried out by telematic means (e-mail, videoconference, FAITIC forums, etc.) under the modality of prior arrangement of virtual place, date and time.
Practices through ICT	Activities for the application of knowledge in a given context and the acquisition of basic and procedural skills in relation to the subject through ICT tools. For all the teaching modalities contemplated in the Contingency Plan, the tutoring sessions may be carried out by telematic means -e-mail, videoconference, FAITIC forums, etc.- under the modality of prior arrangement of virtual place, date and time.
Project based learning	Carrying out activities that allow the cooperation of several subjects so the students confront, working in teams, some open problems. They will allow to train, among others, the capabilities for cooperative learning, leadership, organization, communication and the strengthening of personal relationships. For all the teaching modalities contemplated in the Contingency Plan, the tutoring sessions may be carried out by telematic means -e-mail, videoconference, FAITIC forums, etc.- under the modality of prior arrangement of virtual place, date and time.

Assessment

	Description	Qualification	Evaluated Competencess			
Objective questions exam	Tests composed of objective questions. Mid-term and final objective tests.	40	CB1	CG1 CG7	CE21	CT2
Presentation	Presentations. Assignments. Projects. Laboratory work reports.	40	CB1 CB3	CG1 CG2	CE21 CE22	CT1 CT2 CT3
Systematic observation	Systematic observation. Complementary activities of continuous assessment.	20	CB3	CG2		CT1 CT3

Other comments on the Evaluation

Students who do not pass the subject in continuous training at the first opportunity of each academic year, in which the distribution of evaluation weights is as stablished above, will have the possibility of having an exam of objective questions, worth 100% of the final mark, in successive calls that are not the first opportunity of each academic year.

Ethical commitment: Students are expected to behave ethically. If unethical behaviour is detected (copying, plagiarism, use of unauthorised electronic devices,...), the student will be considered to be ineligible to pass the subject. Depending on the type of unethical behaviour detected, it could be concluded that the student has not reached the necessary skills to overcome the subject. Students are expected to behave in a respectful and dignified manner and to collaborate with the teaching system, teaching staff, coordination and administrative and services personnel of the Master's degree. Any question due to the lack of ethical and dignified behaviour of the student body may have repercussions on the evaluation of the subject.

Sources of information

Basic Bibliography

ANSYS Inc., **ANSYS Fluent Tutorial Guide, Release 2019 R1**, 2019 R1, ANSYS Inc., 2018

Fernández, Mario, **INDUSTRIA 4.0: Tecnologías y Gestión en la Transformación Digital de la Industria**, 1ª, Editor independiente, 2020

Fontes, Ed, **FEM vs. FVM**, --------, COMSOL Blog, 2018

Gunal, Murat M., **Simulation for Industry 4.0: Past, Present, and Future**, 1ª, Springer, 2019

Lee, Huei-Huang, **Finite Element Simulations with ANSYS Workbench 2019**, SDC Publications, 2019

Vásquez Angulo, José Antonio, **Análisis y Diseño de Piezas de Máquinas con CATIA V5**, 1ª, Marcombo, 2008

Complementary Bibliography

Adams, Vince; Askenazi, Abraham, **Building Better Products with FEM**, 1ª, Delmar Cengage Learning, 1998

CADArtifex; Willis, John; Dogra, Sandeep, **SOLIDWORKS Simulation 2019: A Power Guide for Beginners and Intermediate Users**, 3ª, Independently published, 2019

DASSAULT SYSTÈMES, **3DS ACADEMY**, 2020, DASSAULT SYSTÈMES, 2020

Fritzson, Peter, **Introducción al Modelado y Simulación de Sistemas Técnicos y Físicos con Modelica**, 1ª, Wiley-IEEE Press, 2015
Law, Averill M., **Simulation, modeling and analysis**, 5ª, McGraw-Hill Education, 2015
Tezuka, Akira, **Finite Element and Finite Difference Methods**, 1ª, Springer, 2006
Ustundag, Alp; Cevikcan, Emre, **Industry 4.0: Managing The Digital Transformation**, 1ª, Springer, 2018
Versteeg, H.K.; Malalasekera, W., **An Introduction to Computational Fluid Dynamics: The Finite Volume Method**, 2ª, Prentice Hall, 2007
Zamani, Nader G., **CATIA V5 FEA Tutorials: Release 21**, SDC Publications, 2012

Recommendations

Other comments

The communication with the students will be made through the FAITIC distance learning platform, for which it will be necessary that the student accesses the course space in the platform previously to the start of the lecturing period.

Before the realisation of the evaluation tests, it is recommended that the students consult with the FAITIC platform to confirm the tests' date, place, recommendations, etc., as well as the needs regarding using manuals or any another material for carrying out the tests and elaborating the home assignment works.

IDENTIFYING DATA				
Internships				
Subject	Internships			
Code	V04M183V01206			
Study programme	Máster Universitario en Industria 4.0			
Descriptors	ECTS Credits	Type	Year	Quadmester
	6	Mandatory	1st	2nd
Teaching language	Spanish Galician English			
Department				
Coordinator	Peláez Lourido, Gustavo Carlos			
Lecturers	Cerqueiro Pequeño, Jorge Garrido Campos, Julio Peláez Lourido, Gustavo Carlos			
E-mail	gupelaez@uvigo.gal			
Web	http://masterindustria40.webs7.uvigo.es/wordpress/			
General description	Compulsory subject through which students carry out a period of practice in companies, technology centres or institutions, which allows them to develop practical skills and make contact with the reality of industrial agents by integrating into their teams within activities and / or projects related to the subjects of the master.			

Skills	
Code	
CB2	Students should be able to apply their acquired knowledge and problem-solving skills in new or unfamiliar environments within broader (or multidisciplinary) contexts related to their area of study.
CB3	Students are able to integrate knowledge and deal with the complexity of making judgements based on information which, being incomplete or limited, includes reflections on the social and ethical responsibilities linked to the application of their knowledge and judgements.
CB4	Students should be able to communicate their findings - and the ultimate knowledge and reasons behind them - to specialist and non-specialist audiences in a clear and unambiguous manner
CG1	Organization and planning skills
CG2	Problem solving.
CG3	Descion making
CG4	Information management capacity.
CG5	Oral and written communication in your own language.
CG6	Knowledge and use of the English language.
CG7	Computer skills related to the field of study.
CE1	Knowing the concepts of product life cycle to learn how to apply them with an integral approach, with sustainability criteria through software tools and infrastructure and digital media.
CE2	To know and apply the principles and tools of Lean Manufacturing in the processes of design and development of products of the Industry 4.0 to materialize proposals of innovation through concurrent engineering and ICT of collaborative engineering.
CE3	Learn the basics of cloud computing, components, tools and its orientation as an Internet-based service.
CE4	Know and apply tools and techniques to capture, store, smart analysis and visualize massive data.
CE5	To know and know how to implement in the factories the architectures, technologies and protocols used in communication systems and local industrial networks.
CE6	Knowing the role of cyber security in the factories of the future, the methods, techniques and limitations to be able to implement safe industrial infrastructures.
CE7	To know the fundamentals of Artificial Intelligence and its most important practical applications for its implementation in the design and manufacturing processes.
CE8	Know how to use artificial intelligence methods to model, design and develop applications based on reasoning and inference engines to be implemented in the Industry.
CE9	Know the principles, techniques and systems that comprise the concept of Industrial Internet of Things (IIoT) and its relationship with design and manufacturing
CE10	Knowing how to implement robust, flexible and fault-tolerant industrial control systems, through data acquisition and decision making systems appropriate to each situation.
CE11	Know and use the elements and principles of operation of cyberphysical systems resulting from the integration of physical, computational and communication processes.
CE12	Develop cyberphysical systems for application to product and process solutions in factories, using Systems Engineering procedures.
CE13	Use the integration of different data sources for the definition of flexible, reliable and efficient supply chain management systems, supported by the Industrial Internet of Things and optimized logistics management software tools

CE14	Know the concepts, principles and tools of intelligent manufacturing systems, which facilitate access to information and production data through automated tools for capturing, processing and displaying information
CE15	To know and apply the additive manufacturing technologies, the materials used and the application strategies in the design and manufacture of products.
CE16	Develop models, mock-ups and prototypes using additive manufacturing techniques and tools
CE17	Know the advanced techniques and tools of metrology, calibration and accreditation.
CE18	Develop advanced dimensional verification strategies for application to components and products in the connected industry
CE19	To know, use and know how to implement principles, applications, components, instrumentation and installations of advanced robotic systems for industry.
CE20	To know and know how to apply principles, techniques and equipment of immersion in virtual, augmented and hybrid reality for its implementation in the industry
CE21	To know and be able to use modeling and simulation tools by finite elements, finite differences and computerized fluid dynamics (CFD) as tools of Assisted Engineering (CAE)
CE22	Select the appropriate finite element difference (FEM) and computerized fluid dynamics (CFD) modeling and simulation tools to solve design and manufacturing engineering problems
CE23	Know and select the most suitable advanced CAD/CAM/CAE environments to be integrated and implemented in the Industry.
CE24	Knowing how to apply advanced design, manufacturing and engineering tools to the modeling and manufacturing of complex mechanical parts and assemblies in the industry
CE25	Know and be able to use techniques and tools for mathematical modeling and simulation of discrete event systems and dynamic systems for application in production environments.
CE26	Apply simulation tools to solve specific problems in plant management and integrate them into the implementation process of the 4.0 paradigms.
CE27	To know and apply the engineering techniques and tools for the industrialization of the product in Lean contexts
CE28	Developing strategies for the use of innovation capacity in design and manufacturing in industrial companies
CE29	To know and integrate rigorously the procedures and techniques necessary for the elaboration and implementation of research, development and innovation projects in the context of Industry 4.0
CE30	To develop critical/self-critical and communication skills in a research project, with excellence and quality criteria in national and international fields
CE31	Know the advanced computer tools for mathematical calculation and their use in design and manufacturing engineering applications
CE32	Select and apply advanced calculation tools for solving mathematical problems in the field of design engineering and manufacturing
CE33	Identify and develop key skills and abilities in multidisciplinary teams for the processes of implementation and evolution towards industry 4.0
CE34	Develop skills for competency-based management of people in high-performance teams in the context of Design and Manufacturing
CT1	Ability to understand the meaning and application of the gender perspective in different areas of knowledge and in professional practice with the aim of achieving a more just and equal society
CT2	Incorporate criteria of sustainability and environmental commitment into professional practice. To acquire skills in the equitable, responsible and efficient use of resources
CT3	Multidisciplinary teamwork

Learning outcomes

Learning outcomes	Competences
The student is exposed to real situations in the company to experience and channel his professional potential	CB3 CB4 CG4 CG5 CG6 CE33 CE34 CT1 CT2 CT3
The student has to integrate in multidisciplinary teams.	CB3 CB4 CG4 CG5 CG6 CE34 CT1 CT2 CT3

The student recognizes and adapts to the different levels and types of work environment to which he or she is exposed.	CB3 CB4 CG1 CG4 CG5 CG6 CG7 CE33 CE34 CT1 CT2 CT3
The student interacts with the teams where he or she integrates with professional criteria of responsibility and autonomy at work.	CB2 CB3 CB4 CG1 CG2 CG3 CG4 CG5 CG6 CG7 CE1 CE2 CE3 CE4 CE5 CE6 CE7 CE8 CE9 CE10 CE11 CE12 CE13 CE14 CE15 CE16 CE17 CE18 CE19 CE20 CE21 CE22 CE23 CE24 CE25 CE26 CE27 CE28 CE29 CE30 CE31 CE32 CE33 CE34 CT1 CT2 CT3

Contents	
Topic	
Previous activities to the allocation of the destination	- Preparation of CV - Interview with the personnel of the máster commissioned of the external practices - Interview with the responsible personnel of the institution or company where will be developed the practices.

Allocation of destination	- Allocation of Activities and preparation of Dossier - Identification and Allocation of functions to develop
Realisation of the period/s of practices:	- Integration in a group of work - development of activities during the stay that have relation with the subjects and aims of the máster. - Preparation of a dossier of activities made and functions exerted.

Planning

	Class hours	Hours outside the classroom	Total hours
Practicum, External practices and clinical practices	0	149	149
Report of practices, practicum and external practices	0	1	1

*The information in the planning table is for guidance only and does not take into account the heterogeneity of the students.

Methodologies

	Description
Practicum, External practices and clinical practices	The student develops the activities in a context related to the exercise of his/her professional career, during a determined period, carrying out the functions assigned and foreseen in the internship proposal. Objectives: - To reflect on professional practice. - To put knowledge and skills into practice in a real professional environment. Mode: Guided. Nature: Practical. Scenario: They are developed in external non-academic spaces (companies, institutions, technological centres, laboratories, ...) of academic-professional interest for the students. Groups: Individual During the activity, the students will collect data, carry out personal interviews... depending on the activity itself and what the teachers request. Write a report of the practices.

Personalized assistance

Methodologies	Description
Practicum, External practices and clinical practices	To put students in contact with companies, institutions,... so that they can do the internship. To follow up the activities and transmit observations to the students once the internship is over. Control and Evaluation of the internship.

Tests	Description
Report of practices, practicum and external practices	- Preparation of evaluation activities and evaluation criteria/indicators - Review of the evidence of the evaluation activities. - Communication of the results (publication of notes and data and/or review procedure)

Assessment

Description	Qualification	Evaluated Competencess

Report of practices, practicum and external practices	Preparation of a report by the student reflecting the characteristics of the work carried out. The students must describe the tasks and procedures developed, show the results obtained or observations made, as well as the analysis and treatment of data. The report evaluates knowledge, skills and attitudes. Objectives: To evaluate higher thinking. Analysis, synthesis and evaluation are valued.	100	CB2 CB3 CB4	CG1 CG2 CG3 CG4 CG5 CG6 CG7	CE1 CE2 CE3 CE4 CE5 CE6 CE7 CE8 CE9 CE10 CE11 CE12 CE13 CE14 CE15 CE16 CE17 CE18 CE19 CE20 CE21 CE22 CE23 CE24 CE25 CE26 CE27 CE28 CE29 CE30 CE31 CE32 CE33 CE34	CT1 CT2 CT3

Other comments on the Evaluation

Sources of information

Basic Bibliography

Universidade de Vigo. EEI, **Regulamento de prácticas en empresa da Escola de Enxeñería Industrial**, Universidade de Vigo, 2012

Universidade de Vigo, **Regulamento de prácticas académicas**, Universidade de Vigo, 2012

Ministerio de Educación, Cultura y Deporte, **Real Decreto 592/2014, de 11 de julio, por el que se regulan las prácticas académicas externas de los estudiantes universitarios.**, BOE, 2014

UVigo, **Instrucións sobre o procedemento para a realización das prácticas académicas externas: Curriculares**, UVigo, 2013

Complementary Bibliography

Universidade de Vigo, **Instrucións sobre o procedemento para a realización das prácticas académicas externas: Extracurriculares**, UVigo, 2013

Universidade de Vigo, **Nomeamento de titores/as nas prácticas académicas extracurriculares**, UVigo, 2013

Recommendations

IDENTIFYING DATA				
Master's thesis				
Subject	Master's thesis			
Code	V04M183V01207			
Study programme	Máster Universitario en Industria 4.0			
Descriptors	ECTS Credits	Type	Year	Quadmester
	6	Mandatory	1st	2nd
Teaching language	Spanish Galician English			
Department				
Coordinator	Peláez Lourido, Gustavo Carlos			
Lecturers	Alegre Gutiérrez, Enrique Alfageme González, Norberto Areal Alonso, Juan José Barreiro García, Joaquín Bua Domínguez, José María Castro Sastre, Mª Ángeles Cerqueiro Pequeño, Jorge Comesaña Campos, Alberto Conde González, Miguel Ángel Domínguez González, Manuel Fernández Abia, Ana Isabel Fernández Llamas, Camino Fernández Robles, Laura Fidalgo Fernández, Eduardo Garrido Campos, Julio Giganto Fernández, Sara González Castro, Víctor González Cespón, José Luis Graña Escalante, Roberto Karkkainen , Tatja Lamilla Curros, Francisco Abelardo Larsson , Olof Christian Martínez Martínez, David Mártínez Pellitero, Susana Moreno Collado, Ana María Naderi , Mahdi Peláez Lourido, Gustavo Carlos Pereira Domínguez, Alejandro Pérez García, Hilde Prada Medrano, Miguel Ángel Riveiro Fernández, Enrique Rodríguez Barbosa, Cristian Rodríguez de Soto, Adolfo Rodríguez Lera, Francisco Javier Santos Esterán, David Soto Campos, Enrique Suárez Alonso, Ramón Carlos Tjahjono , Benny Eko Vidal Vázquez, Ricardo Villar García, Marcos			
E-mail	gupelaez@uvigo.gal			
Web	http://masterindustria40.webs7.uvigo.es/wordpress/			
General description	Elaboration, presentation and defence, after all the credits of the syllabus have been obtained, of an original piece of work made individually, in front of an university board. That work that will have a sufficient entity and will address a problem, development, study, etc. related to the Industry 4.0 paradigm and its facllitating technologies, with a professional approach, and in which the competitions acquired in the courses coalesce.			

Skills	
Code	
CB2	Students should be able to apply their acquired knowledge and problem-solving skills in new or unfamiliar environments within broader (or multidisciplinary) contexts related to their area of study.

CB3	Students are able to integrate knowledge and deal with the complexity of making judgements based on information which, being incomplete or limited, includes reflections on the social and ethical responsibilities linked to the application of their knowledge and judgements.
CB4	Students should be able to communicate their findings - and the ultimate knowledge and reasons behind them - to specialist and non-specialist audiences in a clear and unambiguous manner
CG1	Organization and planning skills
CG2	Problem solving.
CG3	Descion making
CG4	Information management capacity.
CG5	Oral and written communication in your own language.
CG6	Knowledge and use of the English language.
CG7	Computer skills related to the field of study.
CE1	Knowing the concepts of product life cycle to learn how to apply them with an integral approach, with sustainability criteria through software tools and infrastructure and digital media.
CE2	To know and apply the principles and tools of Lean Manufacturing in the processes of design and development of products of the Industry 4.0 to materialize proposals of innovation through concurrent engineering and ICT of collaborative engineering.
CE3	Learn the basics of cloud computing, components, tools and its orientation as an Internet-based service.
CE4	Know and apply tools and techniques to capture, store, smart analysis and visualize massive data.
CE5	To know and know how to implement in the factories the architectures, technologies and protocols used in communication systems and local industrial networks.
CE6	Knowing the role of cyber security in the factories of the future, the methods, techniques and limitations to be able to implement safe industrial infrastructures.
CE7	To know the fundamentals of Artificial Intelligence and its most important practical applications for its implementation in the design and manufacturing processes.
CE8	Know how to use artificial intelligence methods to model, design and develop applications based on reasoning and inference engines to be implemented in the Industry.
CE9	Know the principles, techniques and systems that comprise the concept of Industrial Internet of Things (IIoT) and its relationship with design and manufacturing
CE10	Knowing how to implement robust, flexible and fault-tolerant industrial control systems, through data acquisition and decision making systems appropriate to each situation.
CE11	Know and use the elements and principles of operation of cyberphysical systems resulting from the integration of physical, computational and communication processes.
CE12	Develop cyberphysical systems for application to product and process solutions in factories, using Systems Engineering procedures.
CE13	Use the integration of different data sources for the definition of flexible, reliable and efficient supply chain management systems, supported by the Industrial Internet of Things and optimized logistics management software tools
CE14	Know the concepts, principles and tools of intelligent manufacturing systems, which facilitate access to information and production data through automated tools for capturing, processing and displaying information
CE15	To know and apply the additive manufacturing technologies, the materials used and the application strategies in the design and manufacture of products.
CE16	Develop models, mock-ups and prototypes using additive manufacturing techniques and tools
CE17	Know the advanced techniques and tools of metrology, calibration and accreditation.
CE18	Develop advanced dimensional verification strategies for application to components and products in the connected industry
CE19	To know, use and know how to implement principles, applications, components, instrumentation and installations of advanced robotic systems for industry.
CE20	To know and know how to apply principles, techniques and equipment of immersion in virtual, augmented and hybrid reality for its implementation in the industry
CE21	To know and be able to use modeling and simulation tools by finite elements, finite differences and computerized fluid dynamics (CFD) as tools of Assisted Engineering (CAE)
CE22	Select the appropriate finite element difference (FEM) and computerized fluid dynamics (CFD) modeling and simulation tools to solve design and manufacturing engineering problems
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CE27	To know and apply the engineering techniques and tools for the industrialization of the product in Lean contexts
CE28	Developing strategies for the use of innovation capacity in design and manufacturing in industrial companies
CE29	To know and integrate rigorously the procedures and techniques necessary for the elaboration and implementation of research, development and innovation projects in the context of Industry 4.0

CE30	To develop critical/self-critical and communication skills in a research project, with excellence and quality criteria in national and international fields
CE31	Know the advanced computer tools for mathematical calculation and their use in design and manufacturing engineering applications
CE32	Select and apply advanced calculation tools for solving mathematical problems in the field of design engineering and manufacturing
CE33	Identify and develop key skills and abilities in multidisciplinary teams for the processes of implementation and evolution towards industry 4.0
CE34	Develop skills for competency-based management of people in high-performance teams in the context of Design and Manufacturing
CT1	Ability to understand the meaning and application of the gender perspective in different areas of knowledge and in professional practice with the aim of achieving a more just and equal society
CT2	Incorporate criteria of sustainability and environmental commitment into professional practice. To acquire skills in the equitable, responsible and efficient use of resources
CT3	Multidisciplinary teamwork
CT4	Initiative and entrepreneurial aptitudes and actitudes.

Learning outcomes

Learning outcomes	Competences
Knowing and applying an appropriate methodology for the development of R+D+i projects and activities.	CB2 CG1 CG2 CG3 CG4 CE1 CE2 CE14 CT2 CT3 CT4
Using ICT tools in SMARTCloud, BPM, PLM, videoconferencing or other environments that allow the sharing of information and communication between the student and his/her tutor(s).	CB4 CG5 CG6 CG7 CT1 CT3
Search, arrangement and structuring of information about any subject matter.	CB3 CG1 CG4 CG5 CG6 CG7 CT1 CT2 CT3

Elaboration of a report that addresses, among others, the following aspects: backgrounds, issues or state of the art, objectives, phases of the project, development of the project, conclusions and future lines of work.	CB2 CB3 CB4 CG1 CG2 CG3 CG4 CG5 CG6 CG7 CE1 CE2 CE3 CE4 CE5 CE6 CE7 CE8 CE9 CE10 CE11 CE12 CE13 CE14 CE15 CE16 CE17 CE18 CE19 CE20 CE21 CE22 CE23 CE24 CE25 CE26 CE27 CE28 CE29 CE30 CE31 CE32 CE33 CE34 CT2 CT3 CT4

Elaboration of scientific-technical documents for the communication and exhibition of the work done.	CB3 CB4 CG1 CG3 CG4 CG5 CG6 CG7 CE1 CE2 CE3 CE4 CE5 CE6 CE7 CE8 CE9 CE10 CE11 CE12 CE13 CE14 CE15 CE16 CE17 CE18 CE19 CE20 CE21 CE22 CE23 CE24 CE25 CE26 CE27 CE28 CE29 CE30 CE31 CE32 CE33 CE34 CT1 CT2 CT3

Design of equipment, prototypes, simulation programs, cloud applications, etc., according to project specifications and/or needs.	CB2 CB3 CG1 CG2 CG3 CG4 CG7 CE1 CE2 CE3 CE4 CE5 CE6 CE7 CE8 CE9 CE10 CE11 CE12 CE13 CE14 CE15 CE16 CE17 CE18 CE19 CE20 CE21 CE22 CE23 CE24 CE25 CE26 CE27 CE28 CE29 CE30 CE31 CE32 CE33 CE34 CT2 CT3 CT4
Application and extension of the knowledge acquired in various subjects for the elaboration of the work.	CB2 CB3 CG1 CG2 CG3 CG4 CG5 CG6 CG7 CT1 CT2 CT3 CT4

Contents	
Topic	
1. Classical Engineering projects.	1.1. Classical Engineering projects.
2. Technical, organisational and economic studies.	2.1. Technical, organisational and economic studies.
3. Theoretical and experimental work.	3.1. Theoretical and experimental work.
4. Works in R+D+i environments.	4.1. Works in R+D+i environments.

Planning

	Class hours	Hours outside the classroom	Total hours
Project based learning	3	101	104
Mentored work	6	15	21
Portfolio/dossier	1	21	22
Essay	1	0	1
Presentation	1	0	1
Portfolio / dossier	1	0	1

*The information in the planning table is for guidance only and does not take into account the heterogeneity of the students.

Methodologies

	Description
Project based learning	Carrying out activities that allow the cooperation of several subjects so that the students confront, working in teams, some open problems. They will allow to train, among others, the capabilitiies for cooperative learning, leadership, organization, communication and the strengthening of personal relationships.
Mentored work	The student, individually or in groups, either elaborates a document on the subject matter, or prepares seminars, research, reports, essays, summaries of readings, conferences, etc.
Portfolio/dossier	Compilation of the student's work aiming to demonstrate his/her efforts, progress and achievements in an subject area. That collection should include content chosen by the student, selection criteria and evidence of self-reflection.

Personalized assistance

Methodologies	Description
Project based learning	Carrying out activities that allow the cooperation of several subjects so that the students confront, working in teams, some open problems. They will allow to train, among others, the capabilitiies for cooperative learning, leadership, organization, communication and the strengthening of personal relationships. For all the teaching modalities contemplated in the Contingency Plan, the tutoring sessions may be carried out by telematic means -e-mail, videoconference, FAITIC forums, etc.- under the modality of prior arrangement of virtual place, date and time.
Mentored work	The student, individually or in groups, either elaborates a document on the subject matter, or prepares seminars, research, reports, essays, summaries of readings, conferences, etc.

Assessment

Description	Qualification	Evaluated Competencess

Essay	A text prepared on a subject and which must be written in accordance with established rules.	50	CB2 CB3 CB4	CG1 CG2 CG3 CG4 CG5 CG6 CG7	CE1 CE2 CE3 CE4 CE5 CE6 CE7 CE8 CE9 CE10 CE11 CE12 CE13 CE14 CE15 CE16 CE17 CE18 CE19 CE20 CE21 CE22 CE23 CE24 CE25 CE26 CE27 CE28 CE29 CE30 CE31 CE32 CE33 CE34	CT1 CT2 CT3 CT4
Presentation	Presentation by the student to the teacher(s) of a subject, about the contents of that subject or about the results of a work.	40	CB4	CG1 CG4 CG5 CG6 CG7		CT1 CT2 CT3
Portfolio / dossier	Compilation of the student's work aiming to demonstrate his/her efforts, progress and achievements in a subject area. That collection should include content chosen by the student, selection criteria and evidence of self-reflection.	10	CB3 CB4	CG1 CG4 CG5 CG6 CG7		CT1 CT2 CT3 CT4

Other comments on the Evaluation

The students that do not pass the course in the 'continuous assessment' modality in the ordinary evaluation period will be given the chance to attend the final course exams.

Ethical commitment: Students are expected to behave ethically. If unethical behaviour is detected (copying, plagiarism, use of unauthorised electronic devices,...), the student will be considered to be ineligible to pass the subject. Depending on the type of unethical behaviour detected, it could be concluded that the student has not reached the necessary skills to overcome the subject. Students are expected to behave in a respectful and dignified manner and to collaborate with the teaching system, teaching staff, coordination and administrative and services personnel of the Master's degree. Any question due to the lack of ethical and dignified behaviour of the student body may have repercussions on the evaluation of the subject.

Sources of information

Basic Bibliography

AENOR, **UNE 157001: Criterios generales para la elaboración formal de los documentos que constituyen un proyecto técnico**, AENOR, 2014

Universidade de Vigo. EEI, **Recomendaciones generales para la elaboración de TFG/TFM**, 1ª, EEI-Vigo, 2016

Complementary Bibliography

UNE, **UNE 1039: Dibujos técnicos. Acotación. Principios generales, definiciones, métodos de ejecución e indicaciones especiales**, AENOR, 1994

UNE-EN ISO, **Especificación geométrica de productos (GPS). Tolerancia geométrica. Tolerancias de perfiles (ISO 1660:2017)**, AENOR, 2017
Mª Luisa Rodriguez i Juan Llanes, **Cómo elaborar, tutorizar y evaluar un Trabajo de Fin de Máster**, 1ª, AQU, 2013

Recommendations

Other comments

The communication with the students will be made through the FAITIC distance learning platform, for which it will be necessary that the student accesses the course space in the platform previously to the start of the lecturing period.

Before the realisation of the evaluation tests, it is recommended that the students consult with the FAITIC platform to confirm the tests' date, place, recommendations, etc., as well as the needs regarding using manuals or any another material for carrying out the tests and elaborating the home assignment works.