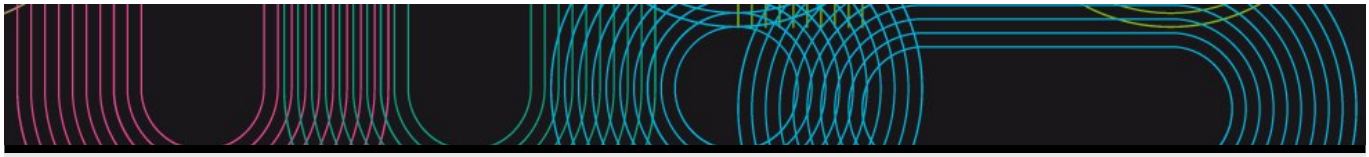

IDENTIFYING DATA				
Simulation applied to design and manufacturing				
Subject	Simulation applied to design and manufacturing			
Code	V04M183V01205			
Study programme	M.U. Industry 4.0			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	4.5	Mandatory	1st	2nd
Teaching language	Spanish Galician English			
Department				
Coordinator	Cerqueiro Pequeño, Jorge			
Lecturers	Cerqueiro Pequeño, Jorge Comesaña Campos, Alberto Santos Esterán, David			
E-mail	jcerquei@uvigo.es			
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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.			

Competencies	
Code	
A1	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
A3	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.
B1	Organization and planning skills
B2	Problem solving.
B7	Computer skills related to the field of study.
C21	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)
C22	Select the appropriate finite element difference (FEM) and computerized fluid dynamics (CFD) modeling and simulation tools to solve design and manufacturing engineering problems
D1	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
D2	Incorporate criteria of sustainability and environmental commitment into professional practice. To acquire skills in the equitable, responsible and efficient use of resources
D3	Multidisciplinary teamwork

Learning outcomes	
Expected results from this subject	Training and Learning Results

Knowing different modeling and simulation tools such as finite elements (FEM), finite difference (FDM) and computerized fluid dynamics (CFD).	A1 B2 B7 C21 D2
Applying different modeling and simulation techniques such as finite elements (FEM), finite differences (FDM) and computerized fluid dynamics (CFD) as Assisted Engineering (CAE) tools.	A3 B2 B7 C21 D2 D3
Selecting the most appropriate modeling and simulation tools for solving specific design and manufacturing engineering problems in the context of Industry 4.0.	A1 A3 B1 B2 C22 D1 D3

Contents

Topic	
1. Introduction to the simulation of components and processes.	1.1. Models and simulation. 1.2. Tools for component simulation. 1.3. Tools for process simulation.
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 modeling and simulation tools for design and manufacturing.	6.1. Assessment of modelling and simulation needs in the design and manufacturing Engineering processes. 6.2. Performance analysis of modelling and simulation systems. 6.3. Methodology for the selection of modelling and simulation systems.
Practical exercise nr. 1.	Elaboration of a FEM study for the detail design engineering stage of an industrial product.
Practical exercise nr. 2.	Elaboration of an FDM study for the manufacturing engineering stage of an industrial product.
Practical exercise nr. 3.	Elaboration of a CFD study for the detail design engineering stage of an industrial product.

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	Training and Learning Results			
Objective questions exam	Tests composed of objective questions. Mid-term and final objective tests.	40	A1	B1 B7	C21	D2
Presentation	Presentations. Assignments. Projects. Laboratory work reports.	40	A1 A3	B1 B2	C21 C22	D1 D2 D3
Systematic observation	Systematic observation. Complementary activities of continuous assessment.	20	A3	B2		D1 D3

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**, 979-8616069115, 1ª, Editor independiente, 2020

Fontes, Ed, **FEM vs. FVM**, https://www.comsol.com/blogs/fem-vs-fvm/, --------, COMSOL Blog, 2018

Gunal, Murat M., **Simulation for Industry 4.0: Past, Present, and Future**, 978-3030041366, 1ª, Springer, 2019

Lee, Huei-Huang, **Finite Element Simulations with ANSYS Workbench 2019**, 978-1630572990, SDC Publications, 2019

Vásquez Angulo, José Antonio, **Análisis y Diseño de Piezas de Máquinas con CATIA V5**, 978-8426715241, 1ª, Marcombo, 2008

Complementary Bibliography

Adams, Vince; Askenazi, Abraham, **Building Better Products with FEM**, 978-1566901604, 1ª, Delmar Cengage Learning, 1998

CADArtifex; Willis, John; Dogra, Sandeep, **SOLIDWORKS Simulation 2019: A Power Guide for Beginners and Intermediate Users**, 978-1078110204, 3ª, Independently published, 2019

DASSAULT SYSTÈMES, **3DS ACADEMY**, https://academy.3ds.com/en, 2020, DASSAULT SYSTÈMES, 2020

Fritzson, Peter, **Introducción al Modelado y Simulación de Sistemas Técnicos y Físicos con Modelica**, 978-1118010686, 1ª, Wiley-IEEE Press, 2015

Law, Averill M., **Simulation, modeling and analysis**, 978-0073401324, 5ª, McGraw-Hill Education, 2015

Tezuka, Akira, **Finite Element and Finite Difference Methods**, 978-3540303008, 1ª, Springer, 2006

Ustundag, Alp; Cevikcan, Emre, **Industry 4.0: Managing The Digital Transformation**, 978-3319578699, 1ª, Springer, 2018

Versteeg, H.K.; Malalasekera, W., **An Introduction to Computational Fluid Dynamics: The Finite Volume Method**, 978-0131274983, 2ª, Prentice Hall, 2007

Zamani, Nader G., **CATIA V5 FEA Tutorials: Release 21**, 978-1585037643, 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.

Contingency plan

Description

In the face of the uncertain and unforeseeable evolution of the health alert caused by COVID-19, University of Vigo has established an exception planning that will be activated at the time the government offices and the own University mandate it. Such decision will be made based on safety, health and responsibility criteria, always guaranteeing the continuity of the teaching processes in a partial or full non-classroom scenario. Those already-planned steps will guarantee, at the moment it is required, the development of the teaching processes in a more streamlined and effective way as both the students and the lecturers will know about them beforehand (or with a broad anticipation), by means of the DOCNET standard institutional tool.

According to the instructions provided by the Vice-Rectorate for Learning Organization and Teaching Staff, the following three scenarios are required to be taken into account with their corresponding contingency level:

SCENARIO 1. Full-classroom modality.

All teaching activities will be carried out at the classroom, both for theory and laboratory classes, according to the typical way for the course in the years before 2020.

SCENARIO 2. Half-classroom modality.

In the case the half-classroom teaching modality is activated by the University government, such event will involve a reduction in the capacity of the usual teaching spaces where the full-classroom modality is developed. Because of that, as a first measure the School will provide the teaching staff of the course with the information regarding the new authorized capacities for such teaching spaces so that the teaching activities can be re-organized for the remaining time of the term. It must be pointed out that the necessary re-organization to implement will depend on the specific moment in the term in which this teaching modality is activated. The following guidelines will be followed in the re-organization or the teaching activities:

a) Communication. All students in the course will be informed through the FAITIC teaching portal on the specific conditions for the development of the teaching and the evaluation activities that remain until the end of the term.

b) Adaptation of the tutorial and personalized attention to students. The tutorial sessions may be carried out by means of IT tools (email, video-call, FAITIC forums, etc.), according to the modality of prior concertation of the date and time for the session in the lecturers virtual offices.

c) Classroom and non-classroom activities. From the teaching activities that remain until the end of the term, those that could be carried out by all students in class need to be identified (prioritizing laboratory activities when possible), and those other that will be carried out remotely (theory classes are the ones that usually decrease in effectiveness less in this modality), to the effects of the planning of its efficient performance.

d) Teaching contents and learning goals. There will be no changes neither in the contents to be taught nor in the learning goals, as a consequence of this teaching modality.

e) Teaching schedule. The class timetable and the calendar of the different activities in the course will be maintained as initially planned and scheduled.

f) Bibliography or additional materials to facilitate self-learning. The teaching staff for the course will provide the students with the necessary learning materials to attend to the specific help needs of the students with respect to the course, according to the circumstances that turn out at any particular time, through the FAITIC portal.

With regard to the tools used for the teaching activities in the non-classroom modality, the CAMPUS REMOTO and FAITIC portals will be of preferential use, complemented if necessary with other solutions in order to address specific needs arising along the lecturing period.

SCENARIO 3. Non-classroom modality.

In the case the full non-classroom modality (discontinuation of all on-class learning and evaluation activities) is activated, the tools offered by the platforms currently available at University of Vigo -CAMPUS REMOTO and FAITIC- will be of preferent use. The specific conditions for the reo-organization to be carried out will depend of the particular time in the term in which such modality is mobilized. The following guidelines will be followed in the re-organization of the teaching activities:

a) Communication. All students in the course will be informed through the FAITIC teaching portal on the specific conditions for the development of the teaching and the evaluation activities that remain until the end of the term.

b) Adaptation and/or modification of the teaching methodologies. Even if the teaching methodologies for the course were fundamentally conceived towards the full-classroom modality, the teaching staff considers that they keep in essence their effectiveness in the non-classroom modality. That is why it is proposed to keep them as they are, even if special attention will be payed to their right development and results. Therefore, no changes will be made to the teaching methodologies initially defined for the course.

c) Adaptation of the tutorial and personalized attention to students. The tutorial sessions may be carried out by means of IT tools (email, video-call, FAITIC forums, etc.), according to the modality of prior concertation of the date and time for the session in the lecturers virtual offices.

d) Teaching contents and learning goals. There will be no changes neither in the contents to be taught nor in the learning goals, as a consequence of this teaching modality.

e) Teaching schedule. The class timetable and the calendar of the different activities in the course will be maintained as initially planned and scheduled.

f) Evaluation. No changes will be made neither to the evaluation tests, nor to their corresponding score weights, nor to their set dates.

g) Bibliography or additional materials to facilitate self-learning. The teaching staff for the course will provide the students with the necessary learning materials to attend to the specific help needs of the students with respect to the course, according to the circumstances that turn out at any particular time, through the FAITIC portal.