



Guía Docente

Guía Docente				
Datos Identificativos			2024/25	
Asignatura (*)	Introdución á Dinámica de Fluídos Computacional (CFD) Mariña		Código	730542011
Titulación				
Descriptor				
Ciclo	Período	Curso	Tipo	Créditos
Mestrado Oficial	2º cuatrimestre	Primeiro	Obrigatoria	6
Idioma	Inglés			
Modalidade docente	Presencial			
Prerrequisitos				
Departamento	Enxeñaría Naval e Industrial			
Coordinación	Gosset , Anne Marie Elisabeth		Correo electrónico	anne.gosset@udc.es
Profesorado	Gosset , Anne Marie Elisabeth		Correo electrónico	anne.gosset@udc.es
	Lema Rodríguez, Marcos			marcos.lema@udc.es
Web	http://www.master-seas40.unina.it			
Descrición xeral	This course is focused on providing the students with an introduction to the field of computational fluid dynamics, with an application to the marine field. The course will cover from the basic principles of conservation and their characteristic equations, its discretization methods, to the finite-volume method and the basics of the CFD codes used for their solution, with a focus in the open source code OpenFoam.			

Competencias / Resultados do título

Código	Competencias / Resultados do título
--------	-------------------------------------

Resultados da aprendizaxe

Resultados da aprendizaxe				
Resultados de aprendizaxe		Competencias / Resultados do título		
Capacity to understand the basic concepts of computational fluid dynamics and to describe physical problems in this field with adequate mathematical models.		AM2	BM1	CM2
Capacity to set up test cases related with the fluid dynamics in the marine field and to solve problems related with numerical and physical errors.			BM2	CM4
			BM3	CM6
			BM4	CM7
			BM5	
			BM6	
			BM7	
			BM10	
		BM12		

Contidos

Temas	Subtemas
Chapter 1. Conservation laws in fluid dynamics (reminder)	1. Principles of conservation in continuum 2. Constitutive equation of fluids 3. Fluid dynamics conservation equations in differential form 4. Initial and boundary conditions 5. Boundary layers and turbulent flows
Chapter 2. Finite volumes method I	1. Discretization methods for Partial Differential Equations 2. Philosophy of Finite Volumes method compared to Finite Differences and Finite Elements 2. Finite Volumes for diffusion problems 3. Finite Volumes for convection-diffusion problems. Resolution of a problem with Matlab as ICT exercise.



Chapter 3. Finite volumes method II	<ol style="list-style-type: none">1. Pressure-velocity coupling in steady flows: Concept of staggered grid, SIMPLE algorithm2. Pressure-velocity coupling in unsteady flows: PISO algorithm. Resolution of a problem with Matlab as ICT exercise.3. Programming of initial and boundary conditions
Chapter 4. Introduction to CFD	<ol style="list-style-type: none">1. History of CFD computation2. Identification of adequate models and approximations in CFD3. Workflow of CFD simulations: Pre-processing, processing and post-processing4. Introduction to OpenFoam. Structure of the code.
Chapter 5. Pre-processing of a CFD simulation	<ol style="list-style-type: none">1. Mesh generation. Open-source solutions with OpenFoam.2. Boundary conditions3. Initial conditions <p>ICT exercise with a simple test case in OpenFoam.</p>
Chapter 6. Processing	<ol style="list-style-type: none">1. Solver parametrization2. Steady and unsteady solvers: time control and solution3. Convergence of the computation: Monitoring the residuals and the solution <p>ICT exercise with a simple test case.</p>
Chapter 7. Post-processing	<ol style="list-style-type: none">1. Post-processing with paraView2. Utilities in Openfoam3. Verification and validation of results4. Evaluation of uncertainty in CFD simulations <p>ICT exercise with a simple test case.</p>
Chapter 8. Turbulence and boundary layers in CFD	<ol style="list-style-type: none">1. Introduction to turbulence2. Boundary layers and their modeling in CFD3. Different strategies for turbulence modeling4. Wall treatment in CFD5. Relevance in marine applications <p>ICT exercise with a characteristic test case in the marine field</p>
Chapter 9. Multiphase flows in CFD	<ol style="list-style-type: none">1. Introduction2. Volume Of Fluid method3. Multiphase solver in OpenFoam4. Setup of a two-phase simulation with interFoam5. Introduction to ship resistance simulation <p>ICT exercise with free surface flow</p>

Planificación				
Metodoloxías / probas	Competencias / Resultados	Horas lectivas (presenciais e virtuais)	Horas traballo autónomo	Horas totais
Prácticas a través de TIC	A2 B2 B3 B4 B6 B11 B13 C7	15	45	60
Traballos tutelados	A2 B2 B3 B4 B5 B6 B7 B8 B11 B13 C2	3	30	33



Presentación oral	B4 B5 B7 B8 B13 C2 C4 C6	2	8	10
Proba mixta	A2 B3 B6 B8 B11 B13 C2	3	0	3
Sesión maxistral	A2 B2 B3 B6 B7 B8 B11 B13	21	21	42
Atención personalizada		2	0	2
*Os datos que aparecen na táboa de planificación son de carácter orientativo, considerando a heteroxeneidade do alumnado				

Metodoloxías	
Metodoloxías	Descrición
Prácticas a través de TIC	Methodology that allows students to learn effectively, through practical activities (calculations and simulations) the theory of fluid mechanics, through the use of information and Communication Technologies.
Traballos tutelados	Methodology designed to promote the autonomous learning of students, with the tutoring of the teacher in class. This teaching system is based on two basic elements: the independent learning of the students and the follow-up of this learning by the teacher-tutor. In this sense, several exercises will be carried out throughout the course during and outside class hours to continuously monitor the students' learning process in the subject.
Presentación oral	Presentation of the students to their peers of the results obtained in their individual tutored work. The presentation is followed by a Q&A session with the professor and the other students.
Proba mixta	Final evaluation exam consisting in a written test in which it will be necessary to answer different types of theoretical questions as well as to solve problems.
Sesión maxistral	Face-to-face activity in the classroom that serves to establish the fundamental concepts of the subject. It consists of oral presentation complemented with the use of audiovisual media and the introduction of some questions addressed to students, in order to transmit knowledge and facilitate learning.

Atención personalizada	
Metodoloxías	Descrición
Prácticas a través de TIC	ICT exercises will consist in basic programming in Matlab, as well as a familiarization with the open source CFD OpenFoam code, including basic tutorials with mesh generation, solver parameterization, and post-processing of results. This activity will be carried out under the direction of the professor, who will solve all the difficulties that students face.
Traballos tutelados	Tutored work will consist in programming basic finite volume methods in Matlab, and solving a case study with OpenFoam. It will start in the classroom with the support of the professor to solve a maximum of doubts and the student will finish it autonomously.

Avaliación			
Metodoloxías	Competencias / Resultados	Descrición	Cualificación
Traballos tutelados	A2 B2 B3 B4 B5 B6 B7 B8 B11 B13 C2	Evaluation of a report based on the results obtained in the tutored works.	60
Presentación oral	B4 B5 B7 B8 B13 C2 C4 C6	Oral presentation of the tutored work results and Q&A session with the professors and other students.	10
Proba mixta	A2 B3 B6 B8 B11 B13 C2	Written exam focused on the theoretical concepts developed in the class.	30

Observacións avaliación



The written exam will consist in a quizz followed by a several questions that need a higher level of reasoning and development. Failure to reach a minimum grade of 4/10 in the exam will impede success in this course, even if the average grade of the student is higher than 5/10.

Tutored works will be

individual or in pairs; there will one individual for the first part of the course (basics of finite volumes) and one for the second part (CFD simulation of a test case) carried out in pairs. It will be necessary to deliver the reports in time and form. In addition, it will require a public oral defense. The report and the presentation given as well as the answers to the professor's questions during the compulsory presentation will be taken into account for the evaluation of this activity. Failure to make the presentation will result in a grade of zero.

General evaluation criteria:

- * Clarity, extent and quality of report.
- * Clarity and quality of oral presentation of the work.
- * Mastery of the topic and adequacy of the student's answers to the teacher's questions in the presentation session. In this course, no academic dispensation is accepted.

If a student fails to pass the course at the first opportunity, there will be a second opportunity for the exam of finite volumes.

Regarding the tutored works, he/she will only be able to submit an improved version of those works and exercise delivered and previously qualified as unsuitable.

The evaluation criteria of the second opportunity are the same as in the first.

General EMJMD Sustainable Ship and Shipping SEAS 4.0 evaluation rules:

- Students will have only two opportunities to pass a course. If failing to do so, they may be forced to leave the degree.
- No part time or lecture attendance exemption are allowed in this degree.

All regulatory aspects related to "academic dispensation," "dedication to study," "continuance," and "academic fraud" will be governed in accordance with the current academic regulations of the UDC.

Fontes de información

Bibliografía básica	<ul style="list-style-type: none"> - H K Versteeg, W. Malalasekera (2007). An introduction to Computational Fluid Dynamics. Pearson. Prentice Hall - J. D. Anderson (1995). Computational fluid dynamics. The basics with applications.. McGraw-Hill Education - C. J. Greenshields (2018). OpenFoam User guide. Version 6. The OpenFoam Foundation - J H Ferziger, M. Peric (2001). Computational Methods for Fluid Dynamics. Springer - C.J. Greenshields, H. Weller (2022). Notes on Computational Fluid Dynamics: General Principles. CFD Direct
----------------------------	---

Bibliografía complementaria

Recomendacións

Materias que se recomenda ter cursado previamente

Materias que se recomenda cursar simultaneamente

Materias que continúan o temario

Métodos CFD Innovadores/730542030

Observacións



To help in achieving a sustainable environment and to get the objective of number 5 action of the "Ferrol Green Campus Action Plan" (Healthy and environmentally and socially sustainable research and teaching): The assignments to be done in this course: - Will be required in digital format. - Will be delivered using Moodle, with no need to print them. In case it is necessary to print them: - Plastics won't be used. - Two side printing will be used. - Recycled paper will be used. - Printing drafts will be avoided. A sustainable use of the resources should be done, together with the prevention of negative impacts on the environment. In this course, an effort will be pursued towards the incorporation of gender inclusion aspects: no sexist language will be allowed, bibliography from authors of both genders will be used, and the participation of students of both gender in class will be promoted. The situations of gender discrimination will be detected, and actions will be implemented to correct them. The full integration of students who for physical, sensorial, psychic, or socio-cultural reasons may have difficulties in their academic life will be promoted.

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