UNIVERSIDADE DA CORUÑA

Teaching Guide				
Identifying Data				2023/24
Subject (*)	Computational Continuous Media Mechanics		Code	730496214
Study programme	Mestrado Universitario en Enxeñaría Naval e Oceánica (plan 2018)			
Descriptors				
Cycle	Period	Year	Type	Credits
Official Master's Degree	2nd four-month period	First	Obligatory	4.5
Language	SpanishGalician			
Teaching method	Face-to-face			
Prerequisites				
Department	Enxeñaría Naval e IndustrialEnxeñaría Naval e Oceánica			
Coordinador	Fariñas Alvariño, Pablo	E-mail	pablo.farinas@udc.es	
Lecturers	Almeida Medina, Tanausu Balsa Barros, Saúl Fariñas Alvariño, Pablo	E-mail	tanausu.almeida@udc.es saul.balsa.barros pablo.farinas@udc.es	
Web				
General description	This subject studies fundamental and theoretical background of computational mechanics, as well as its applicability. Fundamental models for fields theory will be analysed and will allow the students to code their own developments.			

Study programme competences	
Code	Study programme competences
B1	CB06 Posuír e comprender coñecementos que acheguen unha base ou oportunidade de ser orixinais no desenvolvemento e/ou aplicación de ideas, a miúdo nun contexto de investigación
B3	CB08 Que os estudantes sexan capaces de integrar coñecementos e enfrontarse á complexidade de formular xuízos a partir dunha información que, sendo incompleta ou limitada, inclúa reflexións sobre as responsabilidades sociais e éticas vinculadas á aplicación dos seus coñecementos e xuízos
B5	CB10 Que os estudantes posúan as habilidades de aprendizaxe que lles permitan continuar estudando dun modo que haberá de ser en boa medida autodirixido ou autónomo.
B6	G01 Capacidade para resolver problemas complexos e para tomar decisións con responsabilidade sobre a base dos coñecementos científicos e tecnolóxicos adquiridos en materias básicas e tecnolóxicas aplicables na enxeñaría naval e oceánica, e en métodos de xestión.
C2	C1 Capacidade pra desenrolar a actividade profesional nun entorno multilingue
C3	ABET (a) An ability to apply knowledge of mathematics, science, and engineering.
C7	ABET (e) An ability to identify, formulate, and solve engineering problems.
C12	ABET (j) A knowledge of contemporary issues.
C13	ABET (k) An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

Learning outcomes			
Learning outcomes	Study programme competences		
Ability for coding numerical methods related to continuum mechanics		BC1 BC3 BC5 BJ1	CC2 CC3 CC7 CC12 CC13
Ability to develop fundamental test cases related to structures and hydrodynamic analysis		BC1 BC3 BC5 BJ1	CC2 CC3 CC7 CC12 CC13

Contents	
Topic	Sub-topic
The blocks or the following contents develop the established topics in the "Memoria de Verifcación".	1.- Finite Difference, Finite Element and Finite Volume Method. 2.- Eliptic PDE. Hydrodynamic and structures application. 3.- Solution to linear equations systems. 4.- Convective interpolation Schemes introduction. 5.- Coding cases.
Remembering conservation laws:	1.- Conservation laws (mass and momentum). 2.- Combined convection / diffusion 3.- Constitutive relations
Pure diffusion	1.-FVM for purely diffusive problems 2.- 1D, 2D and 3D approach. 3.- Coding cases
Convection	1.- FVM for purely convective problems. 2.- 1D, 2D y 3D approach. 3.- Consistency and stability 4.- Coding cases
Linear equations systems	1.- Sparse matrix systems. 2.- Point to point, line to line and plane to plane methods. 3.- High and low frequency errors. Multigrid methods. 4.- Conjugate gradient method. 5.- Coding cases
Introduction to FEM analysis for elastic solids	1.- General procedure 2.- User vs developer perspectives
Equilibrium equations for elastic solids	1.- Methodologies for yielding the equilibrium equation: Weak and strong approaches. 2.- Weak form of equilibrium. Introduction to variational calculus and weighted residuals. Methods of Hamilton and Galerkin
General aspects of FEM procedure	1.- Fundamental approach in FEM. Shape functions. 2.- Basic features of shape functions. Geometric and natural coordinates. Isoparametric elements. 3.- Equilibrium equation for a discrete solid. Weak solution. 4.- Fundamental matrices. Assembling stiffeness matrices of discrete solids. 5.- Numerical integration of Gauss Legendre. Complete and reduced integration. 6.- Introduction to linear equations solvers.
Error and convergence in FEM	1.- Different kind of errors 2.- Convergence conditions 3.- Energetic norm of the error 4.- Introduction to adaptive mesh
Kind of elements	1.- Approach to 1D cases 2.- Approach to 2D cases 3.- Approach to 3D cases
Coding cases	Coding discrete cases for 1D, 2D or 3D applications

Planning				
Methodologies / tests	Competencies	Ordinary class hours	Student?s personal work hours	Total hours
Guest lecture / keynote speech	B1 B3 B5 B6 C2 C3 C7 C12 C13	35	0	35
Problem solving	B1 B3 B5 B6 C2 C3 C7 C12 C13	10	0	10

Supervised projects	B1 B3 B5 B6 C2 C3 C7 C12 C13	0	33	33
Case study	B1 B3 B5 B6 C2 C3 C7 C12 C13	0	32.5	32.5
Objective test	B1 B3 B5 B6 C2 C3 C7 C12 C13	1	0	1
Personalized attention		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	
Methodologies	**Description**
Guest lecture / keynote speech	Oral presentation complemented with the use of multimedia and the introduction of some questions addressed to students, in order to transmit knowledge and facilitate learning.
Problem solving	Technique where a specific complex situation must be solved, based on the knowledge that has been worked on, which can yield more than one possible solution.
Supervised projects	Methodology designed to promote the autonomous learning of students, under the advise of the professor and under varied scenarios (academic and professional). It is referred primarily to learning how to do things. It is an option based on the assumption by students of the responsibility for their own learning. This teaching system is based on two basic elements: the independent learning of the students and the monitoring of that learning by the professor.
Case study	Methodology where the subject faces the description of a specific situation that poses a problem that has to be understood, valued and solved by a group of people, through a process of discussion. The student is faced with a specific problem (case), which describes a real situation of professional life, and must be able to analyze a series of facts, referring to a particular field of knowledge or action, to reach a reasoned decision through a process of discussion in small work groups.
Objective test	Is the exam. Might be written, oral or a mix.

Personalized attention	
Methodologies	**Description**
Supervised projects Guest lecture / keynote speech Case study Problem solving	Is the support for the homework to be developed by the students. Class attendance is not compulsory and will not be scored. Therefore, there will be no differences between part/full time students. All of them will need to attain the same requirements to pass this subject. Students with "dispensa académica" will be constrained by the same requirements than full time students.

Assessment			
Methodologies	**Competencies**	**Description**	**Qualification**
Supervised projects	B1 B3 B5 B6 C2 C3 C7 C12 C13	It is compulsory, under professor demand, to deliver the proposed home tasks and simulations on time along this course. The delivered tasks and simulations will be assessed by the professor and will be considered for the final qualification.	60
Objective test	B1 B3 B5 B6 C2 C3 C7 C12 C13	Is the exam.	40

Assessment comments
In order to pass this subject it is compulsory attain a qualification above four over ten in the exam. It is also necessary to deliver the required homework (EACH/ALL OF THE REQUIRED TASKS) in the correct manner and within the limiting established time. In case the homework be not delivered in the correct way and/or time the possibility to pass this subject will be lost. The students presence will not required and is not scored. Therefore there will be no difference between the partial time and full time students. All of them will develop the same work/requirements in order to pass the subject. The same requirements will be applied to students with "dispensa académica".

Sources of information	
Basic	- Pablo Fariñas (2013). Apuntes de clase. - Maliska C.R. (1995). Transferencia de calor e mecánica de fluidos computacional.. LTC editora - Versteeg H.K. & Malalasekera W. (1995). Computational fluid dynamics, the finite volume method.. Longmann - Hildebrand F.B. (1976). Advanced calculus for applications. Prentice hall - G.R. Liu, S.S Quek (). The Finite Element Method, a practical approach. ELSEVIER Butterworth-Heinemann - O.C Zienkiewicz et al (). The Finite Element Method, its basis and fundamentals. ELSEVIER Butterworth-Heinemann - K.J. Bathe (). Finite Element Procedures. MIT Press
Complementary	

Recommendations
Subjects that it is recommended to have taken before
Subjects that are recommended to be taken simultaneously
Subjects that continue the syllabus
Computational Hydrodynamics/730496202 Numerical Analysis of Structures/730496203
Other comments
In order to attain a sustainable environment and satisfy the action number five: ?Docencia e investigación saudable e sustentable ambiental e social? of the "Plan de Acción Green Campus Ferrol": All documents developed along this subject will: 1.- Be developed in electronic format. 2.- Be released through the Moodle platform, and avoiding printed documents. In case the paper format be necessary: 1.- Plastics will be avoided. 2.- Both faces of paper will be used. 3.- Recycled paper will be used. 4.- Avoid printed test drafts. A sustainable use of resources and facilities must be considered in order to avoid negative impacts over the natural environment.