Teaching Guide					
Identifying Data					2019/20
Subject (*)	Computational Hydrodynamics			Code	730496202
Study programme	Mestrado Universitario en Enxeñaría Naval e Oceánica (plan 2018)				
Descriptors					
Cycle	Period	Year		Type	Credits
Official Master's Degree	1st four-month period	Second		Obligatory	6
Language	SpanishGalicianEnglish				
Teaching method	Face-to-face				
Prerequisites					
Department	Enxeñaría Naval e Industrial				
Coordinador	Fariñas Alvariño, Pablo		E-mail	pablo.farinas@udc.es	
Lecturers	Fariñas Alvariño, Pablo		E-mail	pablo.farinas@udc.es	
Web					
General description	Parametric design of ship propellers and forms. This subject will provide the necessary knowledge to study the ship´s hydrodynamics as well as the propeller design under a particular vessel wake. The hydrodynamics fundamentals are based on the potential field theory and the finite volume method.				

Study programme competences / results	
Code	Study programme competences / results
A3	A02 - Coñecemento avanzado da hidrodinámica naval para a súa aplicación á optimización de carenas, propulsores e apéndices.
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
B2	CB07 Que os estudantes saiban aplicar os coñecementos adquiridos e a súa capacidade de resolución de problemas en ámbitos novos ou pouco coñecidos dentro de contextos máis amplos (ou multidisciplinares) relacionados coa súa área de estudo
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.
C2	C1 Capacidade pra desenrolar a actividade profesional nun entorno multilingue
C3	ABET (a) An ability to apply knowledge of mathematics, science, and engineering.
C4	ABET (b) An ability to design and conduct experiments, as well as to analyze and interpret data.
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 / results		
Technical skill on ships hydrodynamics	AJ2	BC1 BC2 BC3 BC5	CC2 CC3 CC4 CC7 CC12 CC13

Technical skill to develop computational hydrodynamic models in naval and ocean engineering environment.	AJ2	BC1 BC2 BC3 BC5	CC2 CC3 CC4 CC7 CC12 CC13

Contents	
Topic	**Sub-topic**
The blocks or the following contents develop the established topics in the "Memoria de Verifcación".	Finite Volume Method. CFD. Convective Interpolation Schemes. Free surface. P-V Coupling. Boundary layer and wake. Introduction to Hydrofoils Theory and application to marine propellers. Test cases in naval and ocean engineering
Conservation laws	Interpolation schemes for convective transport Non usual boundary conditions
Métodos de acoplamento presión velocidade	Methods SIMPLE/ER/C y PISO for staggered grid Methods SIMPLE/ER/C y PISO for collocated grids.
Sistemas de ecuacións lineais	Sparse matrix algorithms Methods point to point, line to line y plano a plano. Errores de alta y baja frecuencia. Métodos multimalla. El método del gradiente conjugado. Programación de casos
Transient problems	Explicit, implicit and fully implicit schemes for 1D transient diffusion problems. Extension to 3D cases. Transient convection diffusion problems. Transient P-V coupling. Test cases.
Mathematics background	Singular integrals Trigonometric functions Glauert integrals Hilbert transform
2D potential flow theory. Fundamentals.	Complex potential Stream function Potential function Source Sink Vortex
Thin foils theory	Thickness effect Angle of attack effect Camber effect Zero lift angle Ideal angle of attack
Thin foil theory correction in the near leading edge region	Flux arround the apex of a parabola Velocity correction in high curvature regions Velocity prediction along the full foil wall

Cavitation	Pressure coefficient Cavitation number Pressure coefficient along the whole foil wall Bucket diagrams
Tridimensional effects. Application to appendices and forward body.	Tridimensional potential field Velocity field induced by a 3D differential vortex element Free vortex vorticity Bound and free vorticity relation
Lifting line. Control surfaces (rudders).	Induced velocities over a tridimensional foil Prandtl lifting line equation
Application to ship propellers	The open water case Prandtl lifting line theory adaptation to the ship propeller design case Induction coefficients
Optimum propeller performance	Goldstein factors Betz diagram

Planning				
Methodologies / tests	Competencies / Results	Teaching hours (in-person & virtual)	Student?s personal work hours	Total hours
Guest lecture / keynote speech	A3 B1 B2 B3 B5 C2 C3 C4 C7 C12 C13	50	0	50
Problem solving	A3 B1 B2 B3 B5 C2 C3 C4 C7 C12 C13	10	0	10
Supervised projects	A3 B1 B2 B3 B5 C2 C3 C4 C7 C12 C13	0	45	45
Case study	A3 B1 B2 B3 B5 C2 C3 C4 C7 C12 C13	0	43	43
Objective test	A3 B1 B2 B3 B5 C2 C3 C4 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	Exposición oral complementada co uso de medios audiovisuais e a introducción dalgunas preguntas dirixidas ós estudantes, coa finalidade de transmitir coñecementos e facilitar o aprendizaxe.
Problem solving	Técnica mediante a que ha de resolverse unha situación problemática concreta, a partir dos coñecementos que se traballaron, que poden ter máis dunha posible solución.
Supervised projects	Metodoloxía deseñada para promover o aprendizaxe autónomo dos estudantes, baixo la tutela do profesor e en escenarios variados (académicos e profesionais). Está referida prioritariamente ó aprendizaxe do ¿cómo facer as cousas? Constitúe unha opción basada na asunción polos estudantes da responsabilidade polo seu propio aprendizaxe. Este sistema de enseñanza se basa en dous elementos básicos: o aprendizaje independente dos estudantes e o seguemiento dese aprendizaxe polo profesor titor.
Case study	Metodoloxía donde o suxeito se enfrenta ante á descripción dunha situación específica que plantexa un problema que ha de ser comprendido, valorado e resolto por un grupo de persoas, a través de un proceso de discusión. O alumno se sitúa ante un problema concreto (caso), que lle describe una situación real da vida profesional, e debe ser capaz de analizar unha serie de feitos, referentes a un campo particular do coñecemento ou da acción, para chegar a unha decision razoada a través dun proceso de discusión en pequenos grupos de traballo.
Objective test	Is the exam.

Personalized attention	
Methodologies	**Description**
Supervised projects	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 / Results**	**Description**	**Qualification**
Objective test	A3 B1 B2 B3 B5 C2 C3 C4 C7 C12 C13	Is the exam.	60
Supervised projects	A3 B1 B2 B3 B5 C2 C3 C4 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.	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	- J. Kerwin (). Hydrofoils and propellers. MIT - SNAME (). Principles of naval arch. (Propulsion). SNAME - J.N. Newman (1977). Marine Hydrodynamics. MIT press - G. Pérez (). Detailed desighn of ships propellers. FEIN - Apuntes de clase (). . - Maliska, C.K. (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 - Hildebran F.B. (1976). Advanced calculus for applications. Prentice Hall
Complementary	

Recommendations
Subjects that it is recommended to have taken before
Numerical Methods/730496215 Computational Continuous Media Mechanics/730496214
Subjects that are recommended to be taken simultaneously
Subjects that continue the syllabus
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.