Teaching Guide				
Identifying Data				2015/16
Subject (*)	COMPUTATIONAL HYDRODYNAMIC		Code	730G01144
Study programme	Grao en Arquitectura Naval			
Descriptors				
Cycle	Period	Year	Type	Credits
Graduate	1st four-month period	Fourth	Obligatoria	6
Language	SpanishGalicianEnglish			
Teaching method	Face-to-face			
Prerequisites				
Department	Enxeñaría Naval e Oceánica			
Coordinador	Fariñas Alvariño, Pablo	E-mail	pablo.farinas@udc.es	
Lecturers	Fariñas Alvariño, Pablo	E-mail	pablo.farinas@udc.es	
Web				
General description	In this subject the fundamentals and theoretical background of computational naval hydrodynamics, as well as its applicability are studied. The course is based on the finite volume method and the main objective is to allow the pupils to acquire a knowledge level which permits them to develop their own basic naval models.			

Study programme competences / results	
Code	Study programme competences / results
A1	Capacidade para a resolución dos problemas matemáticos que poidan formularse na enxeñaría. Aptitude para aplicar os coñecementos sobre: álxebra lineal; xeometría; xeometría diferencial; cálculo diferencial e integral; ecuacións diferenciais e en derivadas parciais; métodos numéricos; algorítmica numérica; estatística e optimización.
A2	Comprensión e dominio dos conceptos básicos sobre as leis xerais da mecánica, termodinámica, campos e ondas e electromagnetismo e a súa aplicación para a resolución de problemas propios da enxeñaría.
A4	Coñecementos básicos sobre o uso e programación dos ordenadores, sistemas operativos, bases de datos e programas informáticos con aplicación en enxeñaría.
A19	Coñecemento da hidrodinámica naval aplicada.
A28	Coñecemento dos métodos de proxecto da súa tecnoloxía específica.
B1	Aprender a aprender.
B2	Resolver problemas de forma efectiva.
B3	Aplicar un pensamento crítico, lóxico e creativo.
B4	Traballar de forma autónoma con iniciativa.
B5	Traballar de forma colaboradora.
B8	Actitude orientada ao traballo persoal intenso.
B9	Capacidade de integrarse en grupo de traballo.
B10	Actitude orientada á análise.
B11	Actitude creativa.
B12	Capacidade para encontrar e manexar a información.
B13	Capacidade de comunicación oral e escrita.
B14	Manexo de sistemas asistidos por ordenador.
B15	Concepción espacial.
B16	Fixar obxectivos e tomar decisións.
B17	Analizar e descompoñer procesos.
B18	Capacidade de abstracción, comprensión e simplificación de problemas complexos.
B19	Motivar ao grupo de traballo.
B20	Capacidade de negociación.
B21	Abertos ao cambio.
B22	Vontade de mellora continua.
B23	Positivos fronte a problemas.

C3	Utilizar as ferramentas básicas das tecnoloxías da información e as comunicacións (TIC) necesarias para o exercicio da súa profesión e para a aprendizaxe ao longo da súa vida.
C6	Valorar criticamente o coñecemento, a tecnoloxía e a información dispoñible para resolver os problemas cos que deben enfrontarse.
C7	Asumir como profesional e cidadán a importancia da aprendizaxe ao longo da vida.
C8	Valorar a importancia que ten a investigación, a innovación e o desenvolvemento tecnolóxico no avance socioeconómico e cultural da sociedade.

Learning outcomes			
Learning outcomes	Study programme competences / results		
Knowing and understanding the numerical model based on the fundamental equations.	A1	B1	C3
Modelling and understanding the fundamental phenomenologies which govern the hydrodynamics.	A2	B2	C6
Analyzing the computational results, from a general perspective, in complex hydrodynamic cases.	A4	B3	C7
	A19	B4	C8
	A28	B5	
		B8	
		B9	
		B10	
		B11	
		B12	
		B13	
		B14	
		B15	
		B16	
		B17	
		B18	
		B19	
		B20	
		B21	
		B22	
		B23	

Contents	
Topic	Sub-topic
Remembering conservation laws:	Conservation laws (mass and momentum). Partial differential equations (elliptic, parabolic and hyperbolic). Discretization methods (FVM, FEM, FD).
Pure diffusion:	Discretization for the one dimensional case. Extension for 2D and 3D cases. Implementing cases.
Combined diffusion and advection:	Discretization approach and different interpolation schemes families Classical interpolation schemes family. Power law interpolation schemes family. Normalized variable diagram interpolation schemes family. Total variation diminishing interpolation schemes family. Implementing cases.

Pressure velocity coupling algorithms:	Introduction to the closure problem. Numerical versus physical incompressibility. Staggered grids. SIMPLE/ER/C and PISO methods for staggered grids. SIMPLE/ER/C and PISO methods for collocated grids. Implementing cases.
Linear equations systems:	Sparse matrix systems. Point to point, line to line and plane to plane methods. High and low frequency errors. Multigrid methods. Conjugate gradient method. Implementing cases
Unsteady problems:	Explicit, implicit and fully implicit schemes in 1D transient pure diffusive case. Extension to 3D case. Combined advection diffusion transient case. Transient pressure velocity coupling. Implementing cases.
Special Boundaries:	Remembering Dirichlet and von Newmann boundaries. Combined boundary conditions. Wall laws. Special boundaries. Free surface.
Cases over commercial software:	Proposed cases by the professor.

Planning				
Methodologies / tests	Competencies / Results	Teaching hours (in-person & virtual)	Student?s personal work hours	Total hours
Introductory activities	A1 A2 A4 A19 A28 B1 B2 B3 B4 B8 B10 B11 B12 B14 B15 B16 B17 B18 B21 B22 C3 C6 C7 C8	2	2	4
Guest lecture / keynote speech	A1 A2 A4 A19 A28 B1 B2 B3 B4 B5 B8 B9 B10 B11 B12 B14 B15 B16 B17 B18 B19 B20 B21 B22 B23 C3 C6 C7 C8	20	30	50
Case study	A1 A2 A4 A19 A28 B1 B2 B3 B4 B5 B8 B9 B10 B11 B12 B14 B15 B16 B17 B18 B19 B20 B21 B22 B23 C3 C6 C7 C8	5	1	6
Problem solving	A1 A2 A4 A19 A28 B1 B2 B3 B4 B5 B8 B9 B10 B11 B12 B13 B14 B15 B16 B17 B18 B19 B20 B21 B22 B23 C3 C6 C7 C8	1	17	18

Simulation	A1 A2 A4 A19 A28 B1 B2 B3 B4 B5 B8 B9 B10 B11 B12 B13 B14 B15 B16 B17 B18 B19 B20 B21 B22 B23 C3 C6 C7 C8	14	52	66
Objective test	A1 B2 B3 B4 B10 B13 B15	4	0	4
Personalized attention		2	0	2
(*)The information in the planning table is for guidance only and does not take into account the heterogeneity of the students.				

Methodologies	
Methodologies	**Description**
Introductory activities	Remembering fluid mechanics fundamentals.
Guest lecture / keynote speech	Are the typical lectures.
Case study	Cases resolutions solved during the lectures.
Problem solving	Autonomous homework on implementing cases.
Simulation	Running a commercial solver.
Objective test	Is the exam.

Personalized attention	
Methodologies	**Description**
Guest lecture / keynote speech Simulation Problem solving	Is the support for the homework development.

Assessment			
Methodologies	**Competencies / Results**	**Description**	**Qualification**
Simulation	A1 A2 A4 A19 A28 B1 B2 B3 B4 B5 B8 B9 B10 B11 B12 B13 B14 B15 B16 B17 B18 B19 B20 B21 B22 B23 C3 C6 C7 C8	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.	20
Objective test	A1 B2 B3 B4 B10 B13 B15	Is the exam.	60
Problem solving	A1 A2 A4 A19 A28 B1 B2 B3 B4 B5 B8 B9 B10 B11 B12 B13 B14 B15 B16 B17 B18 B19 B20 B21 B22 B23 C3 C6 C7 C8	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.	20

Assessment comments
In order to pass this subject it is compulsory to attain, at least, four (4.0) points over ten (10) in the exam qualification. Furthermore, it is also compulsory to deliver any homework proposed by the professor on time. In case the students do not deliver heir home tasks on the required time they will not be allowed to pass this subject.

Sources of information	
Basic	- Hildebrand F.B. (1976). Advanced calculus for applications. Prentice hall - Versteeg H.K. & Malalasekera W. (1995). Computational fluid dynamics, the finite volume method.. Longmann - Maliska C.R. (1995). Transferencia de calor e mecánica de fluidos computacional.. LTC editora - Pablo Fariñas (2013). Apuntes de clase.
Complementary	

Recommendations
Subjects that it is recommended to have taken before
CALCULUS/730G01101 PHYSICS I/730G01102 ENGINEERING DRAWING/730G01103 LINEAR ALGEBRA/730G01106 PHYSICS II/730G01107 INTRODUCTION TO COMPUTER SCIENCE AND PROGRAMMING/730G01109 DIFFERENTIAL EQUATIONS/730G01110 THERMODYNAMICS/730G01115 MECHANICS/730G01118 STATISTICS/730G01111 ELASTICITY AND STRENGTH OF MATERIALS/730G01117 FLUID MECHANICS/730G01119 SHIP´S HYDROSTATIC AND STABILITY/730G01122 NAVAL STRUCTURES 1/730G01125 NAVAL STRUCTURES 2/730G01126 MARINE HYDRODINAMIC/730G01127
Subjects that are recommended to be taken simultaneously
SHIP NOISE AND VIBRATIONS/730G01121 3D MODEL OF HULL AND SHIP STRUCTURE /730G01166
Subjects that continue the syllabus
Other comments

(*)The teaching guide is the document in which the URV publishes the information about all its courses. It is a public document and cannot be modified. Only in exceptional cases can it be revised by the competent agent or duly revised so that it is in line with current legislation.