UNIVERSIDADE DA CORUÑA

| Teaching Guide | | | | |
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| Identifying Data | | | | 2015/16 |
| Subject (*) | Métodos de Cálculo Numérico | | Code | 730112620 |
| Study programme | Enxeñeiro Naval e Oceánico | | | |
| Descriptors | | | | |
| Cycle | Period | Year | Type | Credits |
| First and Second Cycle | 2nd four-month period | Fourth-Fifth | Optativa | 3.5 |
| 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 | |
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| Code | Study programme competences / results |
| A1 | Aplicar os fundamentos da Enxeñaría Naval e Oceánica. |
| A2 | Modelar matematicamente sistemas e procesos complexos de todos os ámbitos da Enxeñaría Naval e Oceánica. |
| A3 | Desenvolver, programar e aplicar métodos analíticos e numéricos para a análise de modelos lineais e non lineais de todos os ámbitos da Enxeñaría Naval e Oceánica. |
| A4 | Participación en proxectos de investigación. |
| A5 | Modelizar  matemática e computación en centros tecnolóxicos e de enxeñaría naval e oceánica. |
| A6 | Participación en proxectos multidisciplinares de enxeñaría naval e oceánica. |
| A7 | Proxectos e cálculo de produtos, procesos, instalacións e factorías navais en todos os ámbitos do sector naval e marítimo. |
| A8 | Investigación, desenvolvemento e innovación en produtos, procesos e métodos relacionados co sector naval e marítimo. |
| B1 | Aprender a aprender. |
| B2 | Resolver problemas de forma efectiva. |
| B3 | Aplicar un pensamento crítico, lóxico e creativo. |
| B5 | Traballar de forma colaborativa. |
| B10 | Actitude orientada á análise. |
| 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. |
| B17 | Analizar e descompoñer procesos. |
| B18 | Capacidade de abstracción, comprensión e simplificación de problemas complexos. |
| C1 | Expresarse correctamente, tanto de forma oral coma escrita, nas linguas oficiais da comunidade autónoma. |
| C2 | Dominar a expresión e a comprensión de forma oral e escrita dun idioma estranxeiro. |
| 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. |
| C4 | Desenvolverse para o exercicio dunha cidadanía aberta, culta, crítica, comprometida, democrática e solidaria, capaz de analizar a realidade, diagnosticar problemas, formular e implantar solucións baseadas no coñecemento e orientadas ao ben común. |
| C5 | Entender a importancia da cultura emprendedora e coñecer os medios ao alcance das persoas emprendedoras. |
| 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. |

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| C8 | Valorar a importancia que ten a investigación, a innovación e o desenvolvemento tecnolóxico no avance socioeconómico e cultural da sociedade. |

| Learning outcomes | | | |
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| Learning outcomes | Study programme competences / results | | |
| Knowing and understanding the numerical model based on the fundamental equations. | A1 | B1 | C1 |
| Modelling and understanding the fundamental phenomenologies which govern the naval hydrodynamics. | A2 | B2 | C2 |
| Analyzing the computational results, from a general perspective, in complex ship hydrodynamic cases. | A3 | B3 | C3 |
| | A4 | B5 | C4 |
| | A5 | B10 | C5 |
| | A6 | B12 | C6 |
| | A7 | B13 | C7 |
| | A8 | B14 | C8 |
| | | B15 | |
| | | B17 | |
| | | B18 | |

| Contents | |
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| Topic | Sub-topic |
| Remembering conservation laws: | Conservation laws (mass and momentum).<br>Partial differential equations (elliptic, parabolic and hyperbolic).<br>Discretization methods (FVM, FEM, FD). |
| Pure diffusion: | Discretization for the one dimensional case.<br>Extension for 2D and 3D cases.<br>Implementing cases. |
| Combined diffusion and advection: | Discretization approach and different interpolation schemes families<br>Classical interpolation schemes family.<br>Power law interpolation schemes family.<br>Normalized variable diagram interpolation schemes family.<br>Total variation diminishing interpolation schemes family.<br>Implementing cases. |
| Pressure velocity coupling algorithms: | Introduction to the closure problem.<br>Numerical versus physical incompressibility.<br>Staggered grids.<br>SIMPLE/ER/C and PISO methods for staggered grids.<br>SIMPLE/ER/C and PISO methods for collocated grids.<br>Implementing cases. |
| Linear equations systems: | Sparse matrix systems.<br>Point to point, line to line and plane to plane methods.<br>High and low frequency errors. Multigrid methods.<br>Conjugate gradient method.<br>Implementing cases |
| Unsteady problems: | Explicit, implicit and fully implicit schemes in 1D transient pure diffusive case.<br>Extension to 3D case.<br>Combined advection diffusion transient case.<br>Transient pressure velocity coupling.<br>Implementing cases. |

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| Special Boundaries: | Remembering Dirichlet and von Newmann boundaries.<br>Combined boundary conditions.<br>Wall laws.<br>Special boundaries.<br>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 A3 A4 A5 A6 A7 A8 B1 B2 B3 B5 B10 B12 B14 B15 B17 B18 C2 C3 C4 C5 C6 C7 C8 | 2 | 2 | 4 |
| Guest lecture / keynote speech | A1 A2 A3 A4 A5 A6 A7 A8 B1 B2 B3 B5 B10 B12 B14 B15 B17 B18 C2 C3 C4 C5 C6 C7 C8 | 20 | 25.5 | 45.5 |
| Case study | A1 A2 A3 A4 A5 A6 A7 A8 B1 B2 B3 B5 B10 B12 B14 B15 B17 B18 C2 C3 C4 C5 C6 C7 C8 | 5 | 1 | 6 |
| Problem solving | A1 A2 A3 A4 A5 A6 A7 A8 B1 B2 B3 B5 B10 B12 B13 B14 B15 B17 B18 C1 C2 C3 C4 C5 C6 C7 C8 | 1 | 5 | 6 |
| Simulation | A1 A2 A3 A4 A5 A6 A7 A8 B1 B2 B3 B5 B10 B12 B13 B14 B15 B17 B18 C1 C2 C3 C4 C5 C6 C7 C8 | 14 | 7 | 21 |
| Objective test | C1 | 4 | 0 | 4 |
| 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 | |
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| 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** |
| Problem solving<br>Guest lecture / keynote speech<br>Simulation | Is the support for the homework development. |

| Assessment | | | |
|---|---|---|---|
| **Methodologies** | **Competencies / Results** | **Description** | **Qualification** |
| Objective test | C1 | Is the exam. | 60 |
| Problem solving | A1 A2 A3 A4 A5 A6 A7 A8 B1 B2 B3 B5 B10 B12 B13 B14 B15 B17 B18 C1 C2 C3 C4 C5 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 |
| Simulation | A1 A2 A3 A4 A5 A6 A7 A8 B1 B2 B3 B5 B10 B12 B13 B14 B15 B17 B18 C1 C2 C3 C4 C5 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 |
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| Sources of information | |
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| **Basic** | - Hildebrand F.B. (1976). Advanced calculus for applications. Prentice hall<br>- Versteeg H.K. & Malalasekera W. (1995). Computational fluid dynamics, the finite volume method.. Longmann<br>- Maliska C.R. (1995). Transferencia de calor e mecánica de fluidos computacional.. LTC editora<br>- Pablo Fariñas (2013). Apuntes de clase. |
| **Complementary** | |

| Recommendations |
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| **Subjects that it is recommended to have taken before** |

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| 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** |
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| **Other comments** |
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**(*)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.**