



## Teaching Guide

| Teaching Guide      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |        |                       |           |
|---------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------|-----------------------|-----------|
| Identifying Data    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |        |                       | 2022/23   |
| Subject (*)         | Fluid Mechanics                                                                                                                                                                                                                                                                                                                                                                                                                                                             |        | Code                  | 631G02258 |
| Study programme     | Grao en Tecnoloxías Mariñas                                                                                                                                                                                                                                                                                                                                                                                                                                                 |        |                       |           |
| Descriptors         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |        |                       |           |
| Cycle               | Period                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Year   | Type                  | Credits   |
| Graduate            | 2nd four-month period                                                                                                                                                                                                                                                                                                                                                                                                                                                       | Second | Obligatory            | 6         |
| Language            | SpanishGalician                                                                                                                                                                                                                                                                                                                                                                                                                                                             |        |                       |           |
| Teaching method     | Face-to-face                                                                                                                                                                                                                                                                                                                                                                                                                                                                |        |                       |           |
| Prerequisites       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |        |                       |           |
| Department          | Ciencias da Navegación e Enxeñaría Mariña                                                                                                                                                                                                                                                                                                                                                                                                                                   |        |                       |           |
| Coordinador         | Baaliña Insua, Alvaro                                                                                                                                                                                                                                                                                                                                                                                                                                                       | E-mail | alvaro.baalina@udc.es |           |
| Lecturers           | Baaliña Insua, Alvaro                                                                                                                                                                                                                                                                                                                                                                                                                                                       | E-mail | alvaro.baalina@udc.es |           |
| Web                 | www.udc.es                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |        |                       |           |
| General description | <p>The objectives of Fluid Mechanics focus on the study of fluids at rest or in motion, as well as the corresponding effects on contours. The knowledge of the basic principles of the fluid behaviour is essential when analyzing and designing a entire system that has an operating fluid, such as hydraulic equipment and machines.</p> <p>The student must have knowledge of Thermodynamics and Mechanics as well as a solid physical and mathematical foundation.</p> |        |                       |           |

## Study programme competences

| Code | Study programme competences                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
|------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| A1   | CE1 - Capacidade para a realización de inspeccións, medicións, valoracións, taxacións, peritacións, estudos, informes, planos de labores e certificacións nas instalacións do ámbito da súa especialidade.                                                                                                                                                                                                                                                                                                                                                                                                                  |
| A6   | CE6 - Coñecementos e capacidade para a realización de auditorías enerxéticas de instalacións marítimas.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| A7   | CE7 - Capacidade para a operación e posta en marcha de novas instalacións ou que teñan por obxecto a construción, reforma, reparación, conservación, instalación, montaxe ou explotación, realización de medicións, cálculos, valoracións, taxacións, peritacións, estudos, informes, e outros traballos análogos de instalacións enerxéticas e industriais mariñas, nos seus respectivos casos, tanto con carácter principal como accesorio, sempre que quede comprendido pola súa natureza e característica na técnica propia da titulación, dentro do ámbito da súa especialidade, é dicir, operación e explotación.     |
| A14  | CE14 - Avaliación cualitativa e cuantitativa de datos e resultados, así como a representación e interpretación matemáticas de resultados obtidos experimentalmente.                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| A21  | CE37 - Capacidad para ejercer como Oficial de Máquinas de la Marina Mercante, una vez superados los requisitos exigidos por la Administración Marítima.                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| A30  | CE42 - Operar, reparar, manter, reformar, optimizar a nivel operacional as instalacións industriais relacionadas coa enxeñaría mariña, como motores alternativos de combustión interna e subsistemas; turbinas de vapor, caldeiras e subsistemas asociados; ciclos combinados; propulsión eléctrica e propulsión con turbinas de gas; equipos eléctricos, electrónicos, e de regulación e control do buque; as instalacións auxiliares do buque, tales como instalacións frigoríficas, sistemas de goberno, instalacións de aire acondicionado, plantas potabilizadoras, separadores de sentinas, grupos electrógenos, etc. |
| A31  | CE43 - Operar, reparar, manter e optimizar as instalacións auxiliares dos buques que transportan cargas especiais, tales como quimiqueiros, LPG, LNG, petroleiros, cementeiros, Ro-Ro, Pasaxe, botes rápidos, etc.                                                                                                                                                                                                                                                                                                                                                                                                          |
| A41  | CE48 - Operar os sistemas de bombeo e de control correspondentes.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| A63  | CE53 - Supervisar o funcionamento dos sistemas eléctricos, electrónicos e de control                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| B2   | CT2 - Resolver problemas de forma efectiva.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| B7   | CT7 - Capacidade para interpretar, seleccionar e valorar conceptos adquiridos noutras disciplinas do ámbito marítimo, mediante fundamentos físico-matemáticos.                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| B9   | CT9 - Capacidade para a aprendizaxe de novos métodos e teorías, que lle doten dunha gran versatilidade para adaptarse a novas situacións.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| B11  | CT11 - Capacidade para resolver problemas con iniciativa, toma de decisións, creatividade, razoamento crítico e de comunicar e transmitir coñecementos habilidades e destrezas.                                                                                                                                                                                                                                                                                                                                                                                                                                             |



|     |                                                                                                                                                                                                     |
|-----|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| C1  | C1 - Expresarse correctamente, tanto de forma oral coma escrita, nas linguas oficiais da comunidade autónoma.                                                                                       |
| C2  | C2 - Dominar a expresión e a comprensión de forma oral e escrita dun idioma estranxeiro.                                                                                                            |
| C3  | 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  | C6 - Valorar criticamente o coñecemento, a tecnoloxía e a información dispoñible para resolver os problemas cos que deben enfrontarse.                                                              |
| C9  | CB1 - Demostrar que posúen e comprenden coñecementos na área de estudo que parte da base da educación secundaria xeneral, e que inclúe coñecementos procedentes da vangardia do seu campo de estudo |
| C11 | CB3 - Ter a capacidade de reunir e interpretar datos relevantes para emitir xuízos que inclúan unha reflexión sobre temas relevantes de índole social, científica ou ética                          |

| Learning outcomes                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |     |                             |     |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|-----------------------------|-----|
| Learning outcomes                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |     | Study programme competences |     |
| Recognize the basic properties of fluids.<br>Static and dynamic analysis. Pressure and velocity fields.<br>Ability to determine energy losses in fluid systems.<br>Ability to solve fluid problems applying precise hypotheses and appropriate physical models.<br>Planning and decision making when managing an industrial fluid handling facility.<br>Ability to understand the processes that occur in hydraulic machinery.                                                                                                                                                                                                                                                                  | A1  | B2                          | C1  |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | A6  | B7                          | C2  |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | A7  | B9                          | C3  |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | A14 | B11                         | C6  |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | A21 |                             | C9  |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | A30 |                             | C11 |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | A31 |                             |     |
| Ability to reason and understand energy interactions in various fluid systems<br>Ability to solve problems and perform maintenance and optimization actions for fluid systems.<br>Planning and making decisions regarding fluid management in industrial facilities.<br>Critical Thinking About Applicable Physical Models<br>Study habit and structuring of information through tables and diagrams.<br>The following competencies are included in Table A-III / 1 of the STCW Code as amended by Manila; Function: Naval machinery, at the operational level<br>-1.1 Carry out a safe machinery watch<br>-1.2 Operate the main and auxiliary machinery and the corresponding control systems. | A1  | B2                          | C2  |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | A6  | B7                          | C3  |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | A7  | B9                          | C6  |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | A14 | B11                         | C9  |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | A21 |                             | C11 |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | A30 |                             |     |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | A31 |                             |     |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | A41 |                             |     |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | A63 |                             |     |

| Contents                                                              |                                                                                                                                                                                                               |
|-----------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Topic                                                                 | Sub-topic                                                                                                                                                                                                     |
| PART I.- BASIC CONCEPTS AND KINEMATICS. LESSON 1.- PRESENTATION.      | 1.1.- DEFINITIONS AND MAGNITUDES<br>1.2.- FORCES FIELD IN FLUIDS. MOTION EQUATION<br>1.3.- VELOCITY FIELD.<br>1.4.- DIFFERENTIATION AND INTEGRATION IN THE FLUID FIELD                                        |
| PART II.- STATICS. LESSON 2.- FLUID STATICS.                          | 2.1.- FLUID STATICS<br>2.2.- FLUID DYNAMICS<br>2.3.- PRESSURE DISTRIBUTION IN SOLID RIGID MOTION                                                                                                              |
| PART III.- DYNAMICS. LESSON 3.- INTEGRAL ANALYSIS OF CONTROL VOLUMES. | 3.1.- CONSERVATION LAWS IN A CONTROL VOLUME.<br>3.2.- CONTINUITY EQUATION.<br>3.3.- CONSERVATION OF MOMENTUM.<br>3.4.- CONSERVATION OF ANGULAR MOMENTUM.<br>3.5.- CONSERVATION OF ENERGY. BERNOULLI EQUATION. |



|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                                                                                                                                                                                                               |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| LESSON 4.- DIFFERENTIAL ANALYSIS OF CONTROL VOLUMES.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | 4.1.- WAYS TO OBTAIN THE GENERAL DIFFERENTIAL EQUATIONS.<br>4.2.- DIFFERENTIAL EQUATION OF CONTINUITY.<br>4.3.- DIFFERENTIAL EQUATION OF MOMENTUM.<br>4.4.- DIFFERENTIAL EQUATION OF ENERGY.                                                  |
| LESSON 5.- DIMENSIONAL ANALYSIS. SIMILITUDE.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | 5.1.- INTRODUCTION. BUCKINGHAM PI THEOREM.<br>5.2.- SIGNIFICANT DIMENSIONLESS GROUPS. SIMILARITY LAWS.                                                                                                                                        |
| LESSON 6.- INTERNAL INCOMPRESSIBLE VISCOUS FLOW                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | 6.1.- INTERNAL LAMINAR FLOW.<br>6.2.- FULLY DEVELOPED LAMINAR FLOW.<br>6.3.- FULLY DEVELOPED TURBULENT FLOW.<br>6.4.- FLOW IN PIPES AND DUCTS.                                                                                                |
| PART IV.- FLUID MACHINERY. LESSON 7.- TURBOMACHINERY.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | 7.1.- CLASSIFICATION OF FLUID MACHINERY.<br>7.2.- EULER EQUATION OF TURBOMACHINERY.<br>7.3.- PUMPS. PERFORMANCE CHARACTERISTICS.<br>7.4.- DIMENSIONLESS GROUPS OF PUMPS.<br>7.5.- CAVITATION AND NPSH.<br>7.6.- APPLICATION TO FLUID SYSTEMS. |
| STCW<br>The development and overcoming of these contents, together with those corresponding to other subjects that include the acquisition of specific competencies of the degree, guarantees the knowledge, comprehension and sufficiency of the competencies contained in Table AIII / 2, of the STCW Convention, related to the level of management of First Engineer Officer of the Merchant Navy, on ships without power limitation of the main propulsion machinery and Chief Engineer officer of the Merchant Navy up to a maximum of 3000 kW. | Table A-III / 2 of the STCW Convention.<br>Specification of the minimum standard of competence for Chief Engineer Officers and First Engineer Officers on ships powered by main propulsion machinery of 3000 kW or more.                      |

| Planning                                                                                                                        |                                                                           |                      |                               |             |
|---------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------|----------------------|-------------------------------|-------------|
| Methodologies / tests                                                                                                           | Competencies                                                              | Ordinary class hours | Student?s personal work hours | Total hours |
| Guest lecture / keynote speech                                                                                                  | A1 A6 A7 A14 A21<br>A30 A31 A41 A63 B2<br>B7 B9 B11 C1 C2 C3<br>C6 C9 C11 | 30                   | 56                            | 86          |
| Problem solving                                                                                                                 | A1 A6 A7 A14 A21<br>A30 A31 A41 A63 B2<br>B7 B9 B11 C6 C9<br>C11          | 19                   | 25                            | 44          |
| Supervised projects                                                                                                             | A1 A6 A7 A14 A21<br>A30 A31 A41 A63 B2<br>B7 B9 B11 C1 C2 C3<br>C6 C9 C11 | 0                    | 15                            | 15          |
| Objective test                                                                                                                  | A1 A6 A7 A14 A21 B2<br>B7 B11 C1 C3 C6 C9<br>C11                          | 3                    | 0                             | 3           |
| 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                                                                                                                                                                                                                                                                                                                                                                                                                                      |
|--------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Guest lecture / keynote speech | There will be a detailed explanation of the contents of the subject distributed in topics. The student will have at all times a typed copy of the topic to be discussed in each lesson speech. Class participation is encouraged through comments that relate the theoretical content to real life experiences.                                                                                                                                  |
| Problem solving                | The collections of exercises proposed for each topic will be solved, allowing the application of the most appropriate mathematical models to each case, including handling of tables, application of the most appropriate hypotheses, relationship with the theoretical content developed in the lectures and with the professional exercise. Real equipment related to the subject will be displayed both in the classroom and in the workshop. |
| Supervised projects            | Solution of problems not completed in-class sessions, with generic instructions from the teacher for their resolution and/ or presentation of topics or problems of calculation and design of special relevance.                                                                                                                                                                                                                                 |
| Objective test                 | 3 partial written tests will be carried out, with the possibility of recovering material from the previous test. It will consist of a theoretical part and a practical part, in such a way that both count for 50% of the grade. The ordinary and extraordinary exams will be governed by the same format.                                                                                                                                       |

## Personalized attention

| Methodologies                                                            | Description                                                                                                                                                                                                                                                                                                                                                   |
|--------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Guest lecture / keynote speech<br>Problem solving<br>Supervised projects | The student will be helped in those questions related to the subject taught that are particularly difficult for their understanding. Corresponding exam reviews are also included. The information and contact channels will be the Virtual Faculty, individualized tutorials that take place for six hours throughout the week and videoconference sessions. |

## Assessment

| Methodologies                  | Competencies                                                     | Description                                                                                                                                                                                                                                                                       | Qualification |
|--------------------------------|------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------|
| Guest lecture / keynote speech | A1 A6 A7 A14 A21 A30 A31 A41 A63 B2 B7 B9 B11 C1 C2 C3 C6 C9 C11 | Attendance at the sessions will count to a maximum of 10 % as part of the final grade providing that such attendance is not less than 90 % of the whole lessons. The student must sign a sheet of attendance to every lecture as evidence for the assessment of this methodology. | 10            |
| Objective test                 | A1 A6 A7 A14 A21 B2 B7 B11 C1 C3 C6 C9 C11                       | The student will demonstrate proficiency in the theoretical and practical learning of the issues.                                                                                                                                                                                 | 70            |
| Supervised projects            | A1 A6 A7 A14 A21 A30 A31 A41 A63 B2 B7 B9 B11 C1 C2 C3 C6 C9 C11 | Presentation and defence of the work. It will be valued structure, neatness, originality and expository method. This is an optional methodology. For students who don't do the project, the qualification percentage of this methodology will be added to the objective test.     | 20            |

## Assessment comments



The official tests of the first opportunity, will include the different evaluation methodologies and must be completed by those students who have not passed the continuous evaluation as a whole. This test will be designed in such a way that the student can examine the objective test, where they have not reached at least 30% of the total grade.

Students obliged to attend the official "second chance" tests will keep the grade achieved in all methodologies, with the exception of the one obtained in the objective tests of the 1st opportunity, which will be replaced by that of the 2nd. In the same way, the students will only be eligible for honors if the maximum number of these for the corresponding course is not covered in its entirety at the "first opportunity".

For students with recognition of part-time dedication and academic exemption from attendance, the grade obtained in the activities associated with the personalized tutoring system will correspond to the evaluation of the problem-solving methodology and objective tests, with a weighting of 30 and 70%, respectively.

Fraudulent performance of the tests or evaluation activities, once verified, will directly imply a failing grade "0" in the subject and in the corresponding call, besides invalidating any grade obtained in either evaluation activity for the extraordinary call.

The evaluation system meets the competency evaluation criteria set out in Column 4 of the following Tables of the STCW Convention, modified by Manila 2010:

1.- Table A-III / 1 of Specification of the minimum standards of competence applicable to officers in charge of the watch in a permanently manned engine-room and those appointed to serve in an unmanned engine-room.

Function: Naval machinery, at the operational level Competencies:

-1.1 Carry out a safe machinery watch

-1.2 Operate the main and auxiliary machinery and the corresponding control systems.

## Sources of information

|                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
|----------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Basic</b>         | <ul style="list-style-type: none"> <li>- Streeter, V. L. et al. (1998) (1998). Fluid Mechanics. McGraw-Hill, USA</li> <li>- (). .</li> <li>Streeter, V. L. et al. (1998). Fluid Mechanics. McGraw-Hill, USA Kundu, P. K. y Cohen, I. M. (2002). Fluid Mechanics. Academic Press, New York White, F. M. (1995). Mecánica de Fluidos. McGraw-Hill, Madrid Robert L. Mott (6ª Edición). Mecánica de Fluidos. Prentice Hall. Agüera, J. S. (1996). Mecánica de Fluidos Incompresibles y Turbomáquinas Hidráulicas. Ciencia, Madrid</li> </ul> |
| <b>Complementary</b> | <ul style="list-style-type: none"> <li>Munson, B. R. et al. (1999). Fundamentos de Mecánica de Fluidos. Limusa-Wiley, México Fox, R. W. y McDonald, A. T. (1998). Introduction to Fluid Mechanics . Wiley, USA</li> </ul>                                                                                                                                                                                                                                                                                                                 |

## Recommendations

### Subjects that it is recommended to have taken before

Mathematics I/631G02151  
 Physics I/631G02153  
 Mathematics II/631G02156  
 Physics II/631G02158

### Subjects that are recommended to be taken simultaneously

Mathematics III/631G02260

### 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.