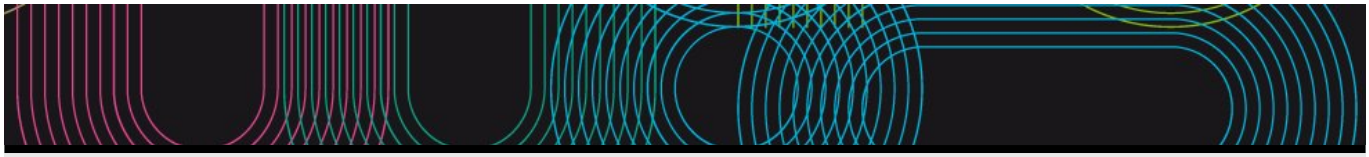

IDENTIFYING DATA				
Fluid mechanics				
Subject	Fluid mechanics			
Code	V09G291V01204			
Study programme	Grado en Ingeniería de la Energía			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	6	Mandatory	2nd	1st
Teaching language	Spanish Galician English			
Department				
Coordinator	Conde Fontenla, Marcos Molares Rodríguez, Alejandro			
Lecturers	Conde Fontenla, Marcos Molares Rodríguez, Alejandro			
E-mail	mfontenla@uvigo.gal a.molares@uvigo.es			
Web	http://moovi.uvigo.gal			
General description	The course of Fluid Mechanics represents a basic course in any enginerring degree. The main target, concerning students of energy engineering and mining and energy resources, is to acquire the knowledge and needed tools to know how to analyze and understand fluid problems of different types, supporting other later and advenced courses, centered in the dynamic fluids, both basic and oriented to real problems in the field of engineering. The development of generic skills and competences such as teamwork and autonomous learning is also encouraged. Fluid Mechanics describes the relevant physical phenomena of fluid motion, describing the general equations of such motions. This knowledge provides the basic principles needed to analyze any system concerning liquids and gases. The field of application of Fluid Mechanics is very wide: transport of fluids in pipelines, aeronautics, engines, ships, biological flows, aerodynamics, etc. The principles of Fluid Mechanics are necessary for fields so diverse as: - Design of hydraulic machinery. - Lubrication. - A/C and ventilation systems. - Design of pipelines. - Transport sector: transmission, air conditioning, exhaust system, aerodynamics and hydrodynamics, cooling, etc. - Aerodynamics of structures and buildings - Conventional and renewable thermal and fluid power plants			

Training and Learning Results	
Code	
A1	That the students demonstrate to possess and understand knowledge in an area of study that is part of the general education (second level), and often found at a level that, although based on advanced textbooks, also includes some aspects that involve knowledge from the avant-garde of the field of study
A2	That the students know how to apply their knowledge to their work or vocation in a professional way and that they possess the competences that are usually demonstrated through the elaboration and defense of arguments and the resolution of problems within their area of study
A3	That the students have the capability to gather and interpret relevant data (usually within their area of study) to issue judgments that include a reflection on relevant social, scientific or ethical issues
A4	That the students can transmit information, ideas, problems and solutions to a specialized and non-specialized audience
A5	That the students develop those learning capabilities necessary to undertake further studies with a high degree of autonomy.
B1	Ability to draw links between the different elements of all the knowledge acquired, understanding them as components of a body of knowledge with a clear structure and strong internal cohesion.

B3	To suggest and develop practical solutions, using the relevant theoretical knowledge, to phenomena and problems-situations of ordinary reality that are specific to engineering, developing appropriate strategies.
B4	To foster collaborative working, communication, organization and planning skills, along with the ability to take responsibilities in a multilingual, multidisciplinary work environment that promotes education for equality, peace and respect for fundamental rights.
B5	To be familiar with the relevant sources of information, including constant updating, in order to practice one□s profession competently, accessing all the present and future tools of information search, constantly adapting to technological and social changes.
C15	Knowledge of the principles of fluid mechanics and hydraulics.
D5	To become aware of the need for continuous training and the constant improvement of quality, developing the values that are characteristic of scientific thinking, showing flexible, open and ethical attitudes in the face of different situations and opinions, particularly as regards non-discrimination on the grounds of gender, race or religion, respect for fundamental rights, accessibility, etc.

Expected results from this subject

Expected results from this subject	Training and Learning Results		
To understand the basic topics of fluid mechanics and hydraulics	A1	C15	
To acquire the capacity to apply these basic knowledge to problem solvign concerning fluid mechanics and hydraulics	A2 A3	B1 B3	
To know the most used experimental processes employed in fluids flow	A5	B1 B3 B4	
To master the current available techniques for the analysis of fluid flow	A3	B4 B5	
To acquire skills in the process of industrial problems analysis concerning fluids	A4 A5	B5	D5

Contents

Topic	
1.- Fundamental concepts of the fluids	1.1.- Concept of fluid. 1.2.- Continuum hypothesis. 1.3.- Viscosity. 1.4.- Basic rheology: Navier-Poisson's law and Newton's law of the viscosity. 1.5.- Pressure and head: static, dynamic and piezometric. 1.6.- Forces on fluids: body and surface forces. 1.7.- Stress tensor on a fluid particle. 1.8.- Other properties of interest in fluid mechanics.
2.- General study about the movement of the fluids	2.1.- Classical approaches: Euler vs. Lagrange. 2.2.- Concept of velocity field. 2.3.- Cinematic basic: acceleration and tensor of velocity variation. 2.4.- Stresses and deformations of the fluid particle: relationship with the tensor of velocity variation. 2.5.- Classification of fluid flows: - according to cinematic conditions - according to geometrical conditions - according to mechanical conditions of the boundary - according to conditions of the internal movement 2.6.- System vs. volume of control 2.7.- Integrals extended to fluid volumes: Reynolds Transport theorem. 2.8.- Integral relations for a volume of control: conservation of mass, conservation of momentum and conservation of energy. 2.9.- Differential relations for a fluid particle: continuity and second Newton's law. Navier-Stokes equations. 2.10.- Particular cases: Euler's equation, Bernoulli's theorem, in-compressible flow, and vorticity.
3.- Dimensional analysis and similarity flowed-dynamic. Applications.	3.1.- Introduction to the dimensional analysis. 3.2.- Pi Buckinghan's theorem. 3.3.- Dimensionless main groups in Fluid mechanics: physical significance. 3.4.- Similarity: partial and total. Effect of scale.
4.- Laminar flow	4.1.- Introduction. 4.2.- Simplified Navier-Stokes' equations: One-dimensional steady flow of liquids. 4.3.- Particular cases: Couette's flow and Hagen-Poiuseuille's flow. 4.4.- Head loss in laminar flow: friction factor.

5.- Turbulent flow	5.1.- Introduction. 5.2.- Statistical approach of the turbulence. 5.3.- RANS models for the turbulence. 5.4.- Other models of interest in modelling the turbulence. 5.5.- Description of the boundary layer. 5.6.- Measure and estimation of the head loss in turbulent flows: - Nikuradse's chart - Moody's diagram - empirical formulae for flow in pipes
6.- Flow of liquids in pipes of variable section	6.1.- Introduction 6.2.- Secondary head loss: - Loss at the entrance of a tube - Loss at the tube exit - Losses in valves - Losses in elbows and other adapters - Losses in valves 6.3.- Systems of pipes: series and parallel. 6.4.- Networks of pipes: equations for the nodes and equations for the meshes. 6.5.- System-pump coupling.
7.- Steady flow in channels	7.1.- Introduction. 7.2.- Energy losses. 7.3.- Equations for uniform steady flow: Optimal section. 7.4.- Equations for non-uniform steady flow. 7.5.- Energy conservation in transitions. 7.6.- Hydraulic jump. 7.7.- Measurement of flow and regulation: gates.

Planning

	Class hours	Hours outside the classroom	Total hours
Lecturing	15	29	44
Practices through ICT	4	4.5	8.5
Laboratory practical	14	20	34
Problem solving	17	3	20
Autonomous problem solving	0	41	41
Essay questions exam	0.83	0	0.83
Problem and/or exercise solving	1.67	0	1.67
*The information in the planning table is for guidance only and does not take into account the heterogeneity of the students.			

Methodologies

	Description
Lecturing	Oral presentations and dissertations in the classroom, developing the different topics of the course. It is strongly recommended that the student have previous read the material at home in order to contribute with questions or doubts in class-time.
Practices through ICT	They will tackle some basic method of resolution of problems associated the networks of pipe employing programs of generic calculation: leaf of calculate and/or software of mathematics. The licence of the same will be GNU GPL, or commercial subsidised by the school/university.
Laboratory practical	Up to ten laboratory practices will be carried out in order to clarify knowledge acquired in the classroom. The relevant guides will be provided for each practice in such a way that, after data collection, they can return to the teacher the results and conclusions of the experimental work, after a deep analysis of them.
Problem solving	Exercises are previously given to the students, bringing them a try to solve by themselves. Later, some of them will be solved in class by the students and/or the teacher
Autonomous problem solving	The students will solve the proposed problems. They can ask for support during the scheduled tutorship hours

Personalized assistance

Methodologies	Description
Autonomous problem solving	Personalized attention will be given to the students during class (throughout the possible questions that could arise) and during the specific timetable of the teacher for tutorship. Updated information of the tutorship timetables will be given to the students during first week of class. Tutorshiping will take place both in face-to-face or distance modes, by means of the e-learning applications offered by the University of Vigo or equivalent methods.

Assessment

	Description	Qualification	Training and Learning Results
Laboratory practical	Delivery of a report/questionnaire and/or completion of an oral test of at least two experimental/ICT practices throughout the course EXPECTED RESULTS FROM THIS SUBJECT: Understand the basics of fluid mechanics and hydraulics through experimentation or simulation. Ability to apply these basic knowledge in solving fluid mechanics and hydraulics problems. Know the most used experimental processes when working with fluid flows. Employ current techniques available for fluid flow analysis. Acquire skills in the process of analyzing industrial problems concerning fluids.	10	A1 B1 C15 D5 A2 B3 A3 B4 A4 B5 A5
Problem solving	These are two continuous assessment tests that will be carried out throughout the school year. They will consist of written exercises/problem solving tests. Each one will have a weight of 12.5% of the total grade. Consult detailed methodology in the "other comments on the evaluation". EXPECTED RESULTS FROM THIS SUBJECT: Understand the basics of Fluid Mechanics and Hydraulics. Ability to apply basic knowledge in solving fluid mechanics and hydraulics problems. Acquire skills on the process of analysis of industrial processes where fluids play a main role.	25	A1 B1 C15 D5 A2 B3 A3 B4 A4 A5
Essay questions exam	It will consist of two written tests that may consist of: theoretical / practical questions that include resolution of exercises and problems and/or topic to be developed. Each test will represent 12.5% of the total grade. For more information, see the detailed methodology in the section "other comments on the evaluation" EXPECTED RESULTS FROM THIS SUBJECT: Understand the basics of Fluid Mechanics and Hydraulics. Ability to apply basic knowledge in solving fluid mechanics and hydraulics problems. Acquire skills on the process of analysis of industrial processes where fluids play a main role.	25	A1 B1 C15 D5 A2 B3 A3 B4 A4 B5 A5
Problem and/or exercise solving	This test will coincide with the official exam established in the center's calendar. It will consist of a written test for the resolution of exercises / problems. Consult the detailed methodology in the "other comments on the evaluation" section. EXPECTED RESULTS FROM THIS SUBJECT: Understand the basics of Fluid Mechanics and Hydraulics. Ability to apply basic knowledge in solving fluid mechanics and hydraulics problems. Acquire skills on the process of analysis of industrial processes where fluids play a main role.	40	A1 B1 C15 D5 A2 B3 A3 B4 A4 A5

Other comments on the Evaluation

The student will be able to freely choose the evaluation methodology (Global or Continuous) within the established deadline and procedure set by the school, and in any case in accordance with current regulations.

The problem of students choosing one evaluation methodology or another, according to the maximum weights established, is most dramatically manifested in the case of two students who take the final exam/retest and obtain exactly the same grade (for example, 6/10); one passes because he has chosen the global evaluation, while the other fails because of selecting the continuous evaluation and only obtained a 4.2 out of 10 in the average of the continuous evaluation tests.

To mitigate this contradiction in the regulations in the case of continuous assessment mode, two grades will be calculated for each student, and the higher of the two will be selected.

Continuous Evaluation Mode

In the calculation of the final grade, four evaluation blocks will be considered with the following weights:

· First partial test of continuous evaluation, weight: 25%. Test consisting of theoretical/practical questions, including problem-solving and/or a topic to develop. It may include multiple-choice questionnaires.

· Second partial test of continuous evaluation, weight: 25%. Test consisting of theoretical/practical questions, including problem-solving and/or a topic to develop. It may include multiple-choice questionnaires.

· Final test of continuous evaluation (retest), weight: 40%. Test consisting of theoretical/practical questions, including problem-solving and/or a topic to develop. It may include multiple-choice questionnaires.

· Practical work, weight: 10%. Submission of a report/questionnaire and/or oral examination of at least two

experimental/IT practices to be carried out throughout the course.

In the spirit of the above paragraph, the final course grade will be assigned to all students using the following formula:

Final Grade = max {0.6 NC + 0.4 NF , NF + (1/20)NC(10 - NF)}

where NC is the weighted average of the two continuous evaluation tests and practical (in the range of 0 to 10) and NF is the grade of the final exam (retest) (also out of 10).

Global Evaluation Mode

A final exam will be held on the official date approved by the school, with a maximum score of 100%.

Second opportunity call

In the second opportunity call (extraordinary in July), the same methodology as in the first opportunity will apply, with a new final evaluation test for students who choose continuous evaluation and a new final exam for those following the global evaluation. In the continuous evaluation mode, therefore, the grades of the partial tests and practical work are retained.

Exam calendar. Check/consult the center's web page for updates:

http://minaseenerxia.uvigo.es/é/docencia/examenes

Sources of information

Basic Bibliography

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Crespo Martinez, Antonio, **Mecánica de fluidos**, 1ª, Thomson, 2006

Complementary Bibliography

Streeter, Victor L. et al, **Fluid Mechanics**, 9ª, McGraw-Hill, 2000

Heras, Salvador de las, **Mecánica de fluidos en ingeniería**, 1ª, Iniciativa Digital Politècnica, 2012

Barrero Ripoll, Antonio et al., **Fundamentos y Aplicaciones de la Mecánica de Fluidos**, 1ª, McGraw-Hill, 2005

Batchelor, G. K., **An introduction to fluid dynamics**, Cambridge Mathematical Library edition, Cambridge Cambridge University Press, 2000

Hernández Krahe, J. M, **Mecánica de Fluidos y Máquinas Hidráulicas**, 1ª, Servicio de publicaciones de la UNED, 2000

Agüera Soriano, José, **Mecánica de fluidos incompresibles y turbomáquinas hidráulicas**, 1ª, Ciencia 3, 1996

Fox, Robert W.; McDonald, Alan T, **Introducción a la Mecánica de Fluidos**, 2ª, Interamericana - Mc-Graw Hill, 1995

Recommendations

Subjects that are recommended to be taken simultaneously

Materials resistance/V09G311V01203
Thermal systems/V09G311V01205

Subjects that it is recommended to have taken before

Physics: Physics I/V09G311V01102
Physics: Physics II/V09G311V01107
Mathematics: Linear algebra/V09G311V01103
Mathematics: Calculus I/V09G311V01104
Mathematics: Calculus II/V09G311V01109