

## COURSE PROGRAM

**Academic Year: 2020/2021**

Identification and characteristics of the course			
Code	501073 503018	ECTS Credits	6
Course name (English)	Fluid Mechanics		
Course name (Spanish)	Mecánica de Fluidos		
Degree programs	Mechanical Engineering Electrical Engineering Electronical Engineering Materials Engineering Industrial Technologies Engineering		
Faculty/School	School of Industrial Engineering		
Semester	5	Type of course	Obligatory
Module	Industrial Branch		
Matter	Thermodynamics and Fluid Mechanics		
Lecturer/s			
Name	Office	E-mail	Web page
José María Montanero Fernández	D0.6	jmm@unex.es	
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Subject Area	Fluid Mechanics		
Department	Department of Mechanical, Energy, and Materials Engineering		
Coordinating Lecturer (If more than one)	M <sup>a</sup> Guadalupe Cabezas Martín		

Competencies* (see table at <a href="http://bit.ly/competenciasGrados">http://bit.ly/competenciasGrados</a> )											
Basic Competences	Check With an "X"	General Competences	Check With an "X"	Transversal Competences	Check With an "X"	Specific Competences Basic Formation	Check With an "X"	Specific Competences Common to the Industrial Branch	Check With an "X"	Specific Competences Specific Technology	Check With an "X"
CB1	X	CG1	X	CT1	X	CEFB1		CECRI1		CETE1	
CB2	X	CG2		CT2	X	CEFB2		CECRI2	X	CETE2	
CB3	X	CG3	X	CT3	X	CEFB3		CECRI3		CETE3	
CB4	X	CG4	X	CT4	X	CEFB4		CECRI4		CETE4	
CB5	X	CG5	X	CT5	X	CEFB5		CECRI5		CETE5	
		CG6	X	CT6	X	CEFB6		CECRI6		CETE6	
		CG7	X	CT7	X			CECRI7		CETE7	
		CG8		CT8	X			CECRI8		CETE8	
		CG9		CT9	X			CECRI9		CETE9	
		CG10		CT10	X			CECRI10		CETE10	
		CG11	X					CECRI11		CETE11	
		CG12						CECRI12		CETFG	

## Contents

### Course outline\*

Fluid properties, general integral equations, fluid dynamics, hydrostatics, experimental methods, boundary layer, flow in pipes, multiple-pipe systems and flows with free surfaces. Numerical methods in Fluid Mechanics.

### Course syllabus

#### 0. Presentation of the course

Name of lesson 1: Introduction

Contents of lesson 1: Fluids. Continuum hypothesis.

Description of the practical activities of lesson 1:

Name of lesson 2: Kinematics

Contents of lesson 2: Lagrangian and Eulerian descriptions. Streamline and path. Types of flows. Flow rate and mass flow rate.

Description of the practical activities of lesson 2:

Name of lesson 3: Equations for a fluid system

Contents of lesson 3: Introduction. Surface forces. Heat conduction. Mechanical equations for a fluid system.

Description of the practical activities of lesson 3:

Name of lesson 4: Equations for a control volume

Contents of lesson 4: Systems and control volumes. Reynolds transport theorem. Uniform approximation for the flux term. Continuity equation for a control volume. Momentum equation for a control volume. Bernoulli equation. Energy equation for a control volume. Energy equation for a fluid machine.

Description of the practical activities of lesson 4: 6 hours

L1. Design, fabrication and experiment with a rocket model.

L2. Experimental verification of the Bernoulli equation.

Name of lesson 5: Dimensional Analysis

Contents of lesson 5: Introduction, Buckingham · theorem, physical similarity.

Description of the practical activities of lesson 5: 4 hours

L3. Measurement of the drag coefficient of a car.

Name of lesson 6: Hydrostatics

\* The sections concerning competencies, course outline, educational activities, teaching methodologies, learning outcomes and assessment systems must conform to that included in the ANECA verified document of the degree program.

Contents of lesson 6: Introduction. Reduction of a system of forces in hydrostatics. Forces and torques on flat surfaces. Forces and torques on submerged bodies.  
Description of the practical activities of lesson 6:

Name of lesson 7: Essentials of fluid dynamics  
Contents of lesson 7: Introduction. The turbulence phenomenon. Boundary layer. Boundary layer separation.

Description of the practical activities of lesson 7:  
L4. Measurement of the liquid viscosity

Name of lesson 8: Hydraulics  
Contents of lesson 8: Introduction. Flow in pipes. Local losses. Multiple-pipe systems. Multiple-pipe systems with pumps.

Description of the practical activities of lesson 8:  
L5. Measurement of the coefficient of friction of a pipe

Name of lesson 9: Open channels, weirs and sluiceways  
Contents of lesson 9: Introduction. Open flow in channels. Weirs and sluiceways  
Description of the practical activities of lesson 9:

### Educational activities \*

Student workload in hours by lesson		Lectures	Practical activities				Monitoring activity	Homework
Lesson	Total	L	HI	LAB	COM	SEM	SGT	PS
Course presentation	1	1						0
1	2	1						1
2	9.5	4.5						5
3	8.5	4.5						4
4 + Practical Activities L1 y L2	29	10		6				13
ECTS (1-4)	3.5	0					1.5	2
Midterm exam (1-4)	7	1						6
5 + Practical Activity L3	14	3		4				7
6	14	6						8
7 + Practical Activity L4	10.5	2.5		3				5
8 + Practical Activity L5	20	7		2				11
ECTS (Units 5-8)	3.5	0					1.5	2
9	5	2						3
Practical Activities Exam	0.5	0.5						0
<b>Assessment **</b>	22	2						20
<b>TOTAL</b>	150	45	0	15	0	0	3	87

L: Lectures (100 students)

HI: Hospital internships (7 students)

LAB: Laboratory or field practices (15 students)

COM: Computer room or language laboratory practices (30 students)

SEM: Problem classes or seminars or case studies (40 students)

SGT: Scheduled group tutorials (educational monitoring, ECTS type tutorials)

PS: Personal study, individual or group work and reading of bibliography

\*\* Indicate the total number of evaluation hours of this subject.

### Teaching Methodologies\*

Among the teaching methodologies included in the formative program, in this course the following are used:

Teaching methodology	Check with an "X" the ones used
1. Explanation and discussion of contents	X
2. Solution, analysis and discussion of examples and exercises	X
3. Oral presentation of assignments	X
4. Development of practical cases in labs, computer rooms, seminars, etc.	X
5. Attention to the student and advice of the assignments in small groups	X
6. Search of information prior to the explanation of the contents of an unit or search of complementary information once the activities of a unit have been developed	X
7. Elaboration of assignments either individually or in groups	X
8. Study of each unit: study of contents, preparation of exercises or cases, preparation of the final exam, etc.	X

### Learning outcomes \*

The students will learn: how to predict the behavior of a fluid system from the conservation laws for the mechanical quantities; how to determine the dominant factors in fluid dynamics to predict the behavior of a fluid system in complex situations; how to apply the knowledge and skills acquired over the course to the theoretical solution of hydrostatic and hydrodynamics problems; the essential aspects of the interaction between a machine and the fluid processed by that machine; how to predict the behavior of a fluid-mechanic machine from the conservation laws for the mechanical quantities; and how to design and calculate hydraulic facilities of diverse types (multiple-pipe systems, tanks, pumping systems, channels, ...).

### Assessment systems \*

#### **Assessment criteria**

CE1. To demonstrate the understanding of the concepts involved in the course.

Related to the competences CB1-CB5, CT1, CT4, CT6, CT7, CG1, CG3-CG7, CG11, CECRI2

CE2. To know the most important data and results related to the course.

Related to the competences CT1, CT4, CT6, CG3, CG5, CG6, CECRI2

CE3. To solve practical problems by applying theoretical results and experimental data.

Related to the competences CB1, CB2, CT2, CT4, CT6, CT7, CT9, CT10, CG1, CG3, CG4, CG5, CECRI2

CE4. To expose clearly the obtained results.

Related to the competences CB1, CB2, CB3, CB4, CT3, CT5-CT10, CG1, CG4, CG5, CG7 CECRI2

As can be seen, we give greater emphasis to understanding of the contents involved in the course rather than to learning data, results, equations, etc. The resolution of practical problems and cases is also essential too.

### **Assessment activities**

Among the assessment activities included in the formative program, in this course the following are used:

	<b>Range fixed</b>	<b>Ordinary call</b>	<b>Extraordinary call</b>	<b>Global assessment</b>
1. Final exam and/or partial examinations.	0%–80%	80%	80%	80%
2. Practical activities in: classroom, lab, computers room, visits, etc.	0%–50%	20%	20%	20%
3. Solution and submission of activities (cases, exercises, assignments, projects, etc.), individually and/or in groups.	0%–50%	0%	0%	0%
4. Active participation in the learning activities.	0%–10%	0%	0%	---
5. Attendance to the learning activities.	0%–10%	0%	0%	---

### **Description of the assessment activities**

#### **AE1. Midterm Exam**

The student will take a midterm exam about Units 1-4, which will consist of (i) a test of items with four possible answers and (ii) a practical problem. The student will have at his/her disposal the lecture notes to solve the practical problem. Both the test and the practical problem will be graded between 0 and 10. In the test, the errors will be penalized according to the proportion "3 wrong answers cancel out 1 right answer". If the grades of both the test and the practical exercise are equal to or greater than 2.5, the midterm exam global grade will be the mean value. Otherwise, the grade will be either 2.5 or the mean value if the latter is less than 2.5.

This assessment activity is **ELIMINATORY** for those students who obtain a grade equal to or greater than 6. This means that those students do not have to take the corresponding part in the final exam.

This assessment activity is **RECOVERABLE**. This means that all the students can take the corresponding part in the final exam. In this case, the grade obtained in that part will replace that obtained in the midterm exam.

#### **AE2. Final Exam**

The Final Exam will consist of (i) a test of items with four possible answers and (ii) a practical exercise. Both the test and the practical exercise will be graded between 0 and 10. In the test, the errors will be penalized according to the proportion "3 wrong answers cancel out 1 right answer". If the marks of both the test and the practical exercise are equal to or greater than 2.5, the final exam grade will be the mean value. Otherwise, the grade will be either 2.5 or the mean value if the latter is less than 2.5.

The student will have at his/her disposal the lecture notes to solve the practical exercise.

This assessment activity is **RECOVERABLE** in the extraordinary call.

#### **AE3. Practical activities**

This activity will be conducted **IN GROUPS**. Each group will perform 5 practical activities in the laboratory, and will write the corresponding report. The practical activities will be graded with a single mark between 0 and 10, taking into account the accuracy of the measurements, the proper justification and analysis of the results, as well as the quality of the report writing.

This assessment activity is **NOT RECOVERABLE** during the academic course; i.e., it cannot be conducted again in the extraordinary call. In addition, if the student decides so, the mark may be maintained for two additional academic years.

AE4. Practical activities exam

This is an exam taken individually to evaluate the degree of individual achievement of the practical activities. It will consist of one or several problems similar to those solved in the practical activities conducted in the laboratory. It will be graded between 0 and 10.

This assessment activity is NOT RECOVERABLE during the academic course; i.e., it cannot be conducted again in the extraordinary call.

The final grade of the course will be calculated according to the following formulae:

If the student passes the midterm exam and does not take the corresponding part in the final exam:

$$C = 0.8 \left[ \frac{1}{3} CAE1 + \frac{2}{3} CAE2 \right] + 0.1 CAE3 + 0.1 CAE4$$

If the student takes the whole final exam:

$$C = 0.8 CAE2 + 0.1 CAE3 + 0.1 CAE4$$

C=Final Mark; CAE1= global mark of the partial exam; CAE2= global mark of the final exam; CAE3=mark of the practical activities; CAE4=mark of the practical activities exam.

The global assessment will be held the same day scheduled for the final exam of each call. It will consist of the following parts:

AE2. Final Exam

The Final Exam will consist of a test of items with four possible answers and practical problems. Both the test and the practical exercise will be graded between 0 and 10. In the test, the errors will be penalized according to the proportion "3 wrong answers cancel out 1 right answer". If the grades of the test and the practical exercise are equal to or greater than 2.5, the final exam grade will be the mean value. Otherwise, the grade will be either 2.5 or the mean value if the latter is less than 2.5

The student will have at his/her disposal the lecture notes to solve the practical exercise. This assessment activity is RECOVERABLE in the extraordinary call.

AE4. Practical activities exam

This is an individual exam consisting of one or several problems similar to those solved in the practical activities conducted in the laboratory. It will be graded between 0 and 10.

This assessment activity is NOT RECOVERABLE during the academic course; i.e., it cannot be conducted in the extraordinary call.

The final grade of the subject will be calculated according to the following formula:

$$C = 0.8 CAE2 + 0.2 CAE4$$

C=Final Mark; CAE2= global mark of the final exam; CAE4=mark of the practical activities exam.

**Bibliography (basic and complementary)**

**Basic bibliography**

B1. Lecture notes

**Complementary bibliography**

C1. White, F. M. (1983 or latter). Fluid Mechanics. McGraw-Hill.

C2. Fox, R. y McDonald, A. T. (1995 or latter). Introduction to Fluid Mechanics. McGraw-Hill.

**Other resources and complementary educational materials**

**Web pages**

W1. Virtual Campus of the Universidad de Extremadura <http://campusvirtual.unex.es>

W2. National Committee for Fluid Mechanics Films <http://web.mit.edu/hml/ncfmf.html>