Course guide
300518 - MF-S - Fluid Mechanics

Last modified: 27/01/2026

Unit in charge:	Castelldefels School of Telecommunications and Aerospace Engineering
Teaching unit:	748 - FIS - Department of Physics.
Degree:	BACHELOR'S DEGREE IN SATELLITE ENGINEERING (Syllabus 2024). (Compulsory subject).

Academic year: 2025 **ECTS Credits:** 5.0 **Languages:** English

LECTURER

Coordinating lecturer: Definits a la web de la universitat.

Others: Definits a la web de la universitat.

PRIOR SKILLS

· Expertise in the differential and integral calculus of vector fields (double and triple integrals, gradient, divergence and curl) and understanding of vector theorems, content of the Advanced Mathematics 1B module.
· Expertise in ordinary differential equations and familiarity with linear partial differential equations, as covered in the Algebra 1A and Advanced Mathematics 1B courses.
· Expertise in the concepts and laws of mechanics and thermodynamics covered in the three physics modules of semesters 1A, 1B and 2A.

Translated with DeepL.com (free version)

TEACHING METHODOLOGY

The course will be taught by combining lectures (group theory sessions) and guided problem-solving activities that students will have previously solved at home. The theory classes will mainly follow an expository model, where the lecturer will introduce the basic concepts and laws of fluid mechanics, supported by the blackboard and/or transparencies. The problem-solving sessions will provide an opportunity to consolidate knowledge of these concepts and apply them to problem-solving. The list of problems for students to work on outside of class will be distributed one week in advance. The problems will be discussed during the guided activity session, and some of them will be solved on the board by the students themselves and/or by the lecturers.

The Athenea Digital Campus will be used regularly for the exchange of documents between students and lecturers and to keep the assessment process up to date. Texts and videos related to the syllabus will also be introduced as necessary to guide students' autonomous learning.

Oral and written expression will be explicitly targeted in the problem-based tutorials (discussion of the methods used and solving problems on the board). It will also be practised implicitly in exams, as students will be asked to justify their problem solutions and to develop theoretical questions. The third language (English) will be used routinely, as the classes will be taught, for the most part, in this language. Furthermore, one of the two core textbooks, some of the content in the Athena, and the problem statements in the collection will be in English. Autonomous learning will be guided by texts with the module's theoretical concepts and/or explanatory videos. In addition, students will be required to solve the problem collection individually at home, learning to apply theoretical knowledge autonomously to solve more specific problems.

LEARNING OBJECTIVES OF THE SUBJECT

Upon completion of the Fluid Mechanics lectures, the students should be able to:
· Define the fundamental variables and concepts of fluid mechanics: pressure, density, velocity, internal energy, viscosity, stress tensor, Lagrangian and Eulerian descriptions, Stokes' derivative, streamline, pathline, vorticity, heat flux, speed of sound, shock wave, boundary layer, turbulence, adiabatic flow, isentropic flow, characteristic dimensionless numbers (Reynolds, Mach, etc.), etc.
· Explain the meaning and implications of the conservation laws governing fluid dynamics, both in integral and differential form: conservation of mass, the momentum balance equation and the energy balance equation.
· Identify the different types of fluids (incompressible/compressible, non-viscous/viscous, subsonic/supersonic) and the specific quantities and laws that describe their motion.
· Use the acquired conservation concepts and laws and the appropriate mathematical tools to solve problems of a certain level of complexity in fluid mechanics.
· Communicate clearly and effectively, both orally and in writing, to justify scientific reasoning with qualitative and quantitative arguments.
· Acquire knowledge autonomously, using the indicated sources of information and guidelines, and identifying any learning gaps.
· Read and interpret technical documents written in English related to Fluid Mechanics, and be able to express oneself in spoken and written English in the context of the subject.
· Apply criteria and propose alternatives that eliminate the causes of gender discrimination in a given context or situation.

STUDY LOAD

Type	Hours	Percentage
Hours large group	55,0	44.00
Self study	70,0	56.00

Total learning time: 125 h

CONTENTS

T1: Introduction to Fluid Mechanics

Description:
· Introduction. Concept of a fluid. Definition of a fluid as a continuum. Fluid models.
· Dimensions and systems of units. Fundamental variables: density, pressure, velocity and temperature.
· Streamlines and pathlines.
· Thermodynamic variables: internal energy and enthalpy. Viscosity and shear stresses.
· Mass and volumetric flows.
· Fluid statics. Principle of hydrostatic equilibrium. Force on submerged surfaces. Force on submerged bodies.
· Classification of flow types according to the fluid's physical properties (viscosity and density), and according to the characteristics of the motion.

Related activities:
· AV1: Problem-solving exam on problems from topics 1 and 2.
· AV2: Resolution of problems from the collection at home by the students. Problems are presented in tutorial sessions by tutors and/or students. Group discussion on the methods used and the results obtained.
· AV4: Mid-term exam.
· AV5: Final-term exam.

Full-or-part-time: 25h
Theory classes: 11h
Self study : 14h

T2: Fluid dynamics: Equations in differential form

Description:
· Stokes derivative.
· Mass conservation.
· Deformation and rotation.
· Momentum balance: pressure force, shear forces and gravity force.
· Energy balance.
· Dimensional analysis and similarity.

Related activities:
· AV1: Problem-solving exam on problems from topics 1 and 2.
· AV2: Resolution of problems from the collection at home by the students. Problems are presented in tutorial sessions by tutors and/or students. Group discussion on the methods used and the results obtained.
· AV4: Mid-term exam.
· AV5: Final-term exam.

Full-or-part-time: 41h
Theory classes: 17h
Self study : 24h

T3: Fluids Dynamics: Equations in integral form

Description:
· Reynolds transport theorem.
· Mass conservation.
· Momentum balance.
· Energy balance.
· Bernoulli equation.

Related activities:
· AV2: Resolution of problems from the collection at home by the students. Problems are presented in tutorial sessions by tutors and/or students. Group discussion on the methods used and the results obtained.
· AV3: Problem-solving exam on problems from topics 3 and 4.
· AV4: Mid-term exam.
· AV5: Final-term exam.

Full-or-part-time: 27h
Theory classes: 12h
Self study : 15h

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T4: Compressible inviscid flow

Description:
· Preliminar contents (sound speed, energy balance for compressible isentropic flows, stagnation conditions).
· Normal shock waves.
· Oblique shock waves.
· Prandtl-Meyer expansion.
· Compressible flow through conducts.

Related activities:
· AV2: Resolution of problems from the collection at home by the students. Problems are presented in tutorial sessions by tutors and/or students. Group discussion on the methods used and the results obtained.
· AV3: Problem-solving exam on problems from topics 3 and 4.
· AV4: Mid-term exam.
· AV5: Final-term exam.

Full-or-part-time: 32h
Theory classes: 14h
Self study : 18h

GRADING SYSTEM

The assessment criteria defined in the course infoweb will be applied.

EXAMINATION RULES.

All proposed activities are compulsory. Any examination, test or assignment that is not submitted will be marked with a score of zero. Examinations and tests will be taken individually.

BIBLIOGRAPHY

Basic:
- White, Frank M; Suárez Porto, Eduardo; Eirís Barca, Antonio; Paz Penín, Concepción. Mecánica de fluidos . Sexta edición. ©2013. ISBN 9788448166038.
- White, Frank M. Fluid mechanics . Eighth edition. Ney Work, NY: McGraw-Hill Education, [2016]. ISBN 9780073398273.
- Anderson, John David. Fundamentals of aerodynamics . 5th ed. New York : McGraw-Hill, cop. 2011. ISBN 9780073398105.
- Anderson, John D; Bowden, Mary L. Introduction to flight . International student edition. New York, New York : McGraw-Hill, [2022]. ISBN 9781264363407.
- Spiegel, Murray R; Lipschutz, Seymour; Liu, John; Haro Canales, Gabriel Alejandro. Fórmulas y tablas de matemática aplicada . Quinta edición. México : McGraw Hill, [2020]. ISBN 9786071514646.

Complementary:
- Batchelor, G. K. An Introduction to fluid dynamics . Cambridge : Cambridge University Press, 1973. ISBN 0521663962.
- Anderson, John David. Introduction to flight . 6th ed. Boston [etc.] : McGraw-Hill, 2008. ISBN 9780073529394.
- Anderson, John David. Computational fluid dynamics . New York [etc.] : McGraw-Hill, cop. 1995. ISBN 0070016852.