

## Course guide

### 340039 - MFLU-F3O29 - Fluid Mechanics

**Last modified:** 17/05/2023

**Unit in charge:** Vilanova i la Geltrú School of Engineering  
**Teaching unit:** 729 - MF - Department of Fluid Mechanics.

**Degree:** BACHELOR'S DEGREE IN ELECTRICAL ENGINEERING (Syllabus 2009). (Compulsory subject).  
BACHELOR'S DEGREE IN INDUSTRIAL ELECTRONICS AND AUTOMATIC CONTROL ENGINEERING (Syllabus 2009). (Compulsory subject).  
BACHELOR'S DEGREE IN MECHANICAL ENGINEERING (Syllabus 2009). (Compulsory subject).

**Academic year:** 2023    **ECTS Credits:** 6.0    **Languages:** Catalan

#### LECTURER

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**Coordinating lecturer:** Carbonell Ventura, Montserrat

**Others:** Buera Muñoz, Blai  
Vidal Rubio, Jordi

#### REQUIREMENTS

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Subjects:  
340023 - Physics I  
340026 - Advanced Calculus

#### DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

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**Specific:**

1. CE8. Knowledge of basic principals of fluid mechanic and its application to resolve problems in engineering area. Calculus of channels, canals and fluids.

**Transversal:**

07 AAT N2. SELF-DIRECTED LEARNING - Level 2: Completing set tasks based on the guidelines set by lecturers. Devoting the time needed to complete each task, including personal contributions and expanding on the recommended information sources.

04 COE N2. EFFICIENT ORAL AND WRITTEN COMMUNICATION - Level 2. Using strategies for preparing and giving oral presentations. Writing texts and documents whose content is coherent, well structured and free of spelling and grammatical errors.

05 TEQ N2. TEAMWORK - Level 2. Contributing to the consolidation of a team by planning targets and working efficiently to favor communication, task assignment and cohesion.

#### TEACHING METHODOLOGY

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- Lectures and participatory classes, consisting of explanation and development of the theory, and the resolution of problems. The material user will be available to the student in the Digital Campus section of the subject.
- Practical lessons in problem-solving, where it will seek the maximum involvement of students through their direct involvement in solving the problems. Students must solve in class / outside of class, individually, problems that are assigned. In the Digital Campus section of the subject, the student can look up the list of problems before they are done in class.
- Hand in resolved problems by students. Submittals will consist on individual solution, in class or outside class, of some problems of the list or similar, the student will have in the Digital Campus. This activity will be evaluated.
- Laboratory practical classes, made directly by students, guided by the teacher, allowing them to directly observe relevant aspects of the theory. The student can look up the explanatory text of the practices to develop in the Digital Campus. The students will give the teacher a copy of the experimental extracted data. Later, students must make a report of the practices carried out. This report will be evaluated and will be delivered before the date set by the professor.
- Tutorial classes in group or individual.
- Students will make two exams of all theoretical and practical knowledge developed in the subject.

## LEARNING OBJECTIVES OF THE SUBJECT

When the student finishes the subject, he/she has to be capable of:

- Understanding the basic principles of the behavior of fluids, when static and in movement, as well as the principles of applied thermodynamics and heat transfer.
- Knowing the principles of fluid mechanics in fluidodynamics systems.
- Solving problems of pipelines and simple fluid systems.
- Analyzing and solving problems in the area of fluid engineering.
- Interpreting, analyzing, synthesizing and extracting conclusions of results of measurements and tests.
- Writing texts with the structure adapted to the aims of communication.
- Knowing and putting into practice the dynamics teamwork.
- Carrying out assignments from basic directions given by the teacher.

## STUDY LOAD

Type	Hours	Percentage
Hours large group	52,5	35.00
Hours small group	7,5	5.00
Self study	90,0	60.00

**Total learning time:** 150 h

## CONTENTS

### 1. INTRODUCTION TO FLUID MECHANICS. FLUID'S MECHANICAL PROPERTIES.

#### Description:

- 1.1 Fluid's definition.
- 1.2 Forces acting on a fluid.
- 1.3 Continuum media. Non-Slip condition
- 1.4 Mechanical Properties of Fluids
- 1.5 Dimensions and systems of units.

#### Specific objectives:

- Define the concept of a fluid.
- Interpret the continuous medium and non-slip condition hypothesis.
- Formulate the principal mechanical properties of fluids.
- Have an applied knowledge of the fluid's mechanical properties.
- Understand the influence of viscosity on friction in fluid flow.

#### Related activities:

- A1. Applied exercises
- A7. Laboratory: Determination of density and viscosity of liquids.
- A12. Individual exam.

#### Full-or-part-time: 22h 50m

Theory classes: 7h

Laboratory classes: 1h 30m

Self study : 14h 20m

## 2. FLUIDS STATICS

### Description:

- 2.1. Fundamental equation of hydrostatics. Applications.
- 2.2. Pressure measurement.
- 2.3. Pressure forces on flat and curved surfaces.
- 2.4. Stability of total or partially submerged bodies

### Specific objectives:

- Interpret the fundamentals for the fluid static equation.
- Interpret the equation of hydrostatic in the gravity field.
- Describe the methods and instruments for the measurement of the pressure.
- Calculate the pressure read on a gauge.
- Determine the pressure distribution in a static fluid and its effects on solid surfaces.
- Calculate the hydrostatic forces acting on a flat or curved surface.
- Interpret the Archimedes' principle.
- Calculate the buoyancy force acting on total or partially submerged bodies.

### Related activities:

- A2. Applied exercises
- A12. Individual exam.

**Full-or-part-time:** 21h 20m

Theory classes: 7h

Self study : 14h 20m

## 3. PRINCIPLE OF CONSERVATION OF MASS

### Description:

- 3.1 Control systems and volumes.
- 3.2 Methods of movement description.
- 3.3 Viewing the speed field. Flow lines.
- 3.4 Material derivative.
- 3.5 Volumetric and mass flow rate. Average speed.
- 3.6 Reynolds Transportation Theorem.
- 3.7 Principle of Conservation of Mass.

### Specific objectives:

- Know the Eulerian and Lagrangian descriptions of fluid flow.
- Know techniques for visualization of fluxes.
- Understand the meaning of the material derivative.
- Calculate volumetric and mass flow rates, and average velocity.
- Interpret the principle of the conservation of mass using the Reynolds transport theorem.
- Calculate mass balances in stationary and non-stationary flows.
- Apply the equation of conservation of the mass to the resolution of problems of fluids.

### Related activities:

- A3. Applied exercises
- A12. Individual exam.

**Full-or-part-time:** 20h 50m

Theory classes: 6h 30m

Self study : 14h 20m

#### 4. PRINCIPLE OF CONSERVATION OF ENERGY. FLOW SYSTEM ANALYSIS.

##### Description:

- 4.1 Mechanical energy equation
- 4.2 Applications of Bernoulli's equation for an ideal fluid. Velocity and flow rate meters.
- 4.3 Generalized Bernoulli's equation.
- 4.4 Flow regimes in pipes.
- 4.5 Head losses in pipes: linear and secondary.
- 4.6 Energy grade line and the hydraulic grade line.
- 4.7 Non-circular section ducts. Hydraulic radius and hydraulic diameter.
- 4.8 Operating point of a pumping installation.
- 4.9 Pipe systems: serial-parallel arrangements.
- 4.10 Open-channel flow.

##### Specific objectives:

- Identify and correctly evaluate the different forms of mechanical energy.
- Understand l'ús i limitacions de l'equació de Bernoulli.
- Apply the Bernoulli's equation in solving basic hydraulic problems. in velocity and flow rate meters.
- Apply the Bernoulli's equation in velocity and flow rate meters.
- Calculate the operating point of a pumping installation.
- Interpret the operating point of a pump.
- Calculate installations with pipes in series and / or in parallel.
- Calculate flows through weirs.
- Calculate the discharge in the case of open channels.
- Define hydraulic jump.

##### Related activities:

- A4. Applied exercises.
- A5. Applied exercises.
- A8. Laboratory: Measurement of the flow rate of a fluid flowing under pressure: Flowmeters.
- A9. Laboratory: Analysis of the flow in open channels. Flow measurement with weirs.
- A10. Laboratory: Determination of linear pressure losses and by accessories in air flow.
- A13. Individual exam.

**Full-or-part-time:** 38h 20m

Theory classes: 16h

Laboratory classes: 4h

Self study : 18h 20m

## 5. PRINCIPLE OF CONSERVATION OF MOMENTUM

### Description:

- 5.1 Principle of the conservation of the quantity of movement.
- 5.2 Action and reaction forces due to fluid movement.
- 5.3 Angular momentum equation.
- 5.4 Application to Turbomachines: characteristic curves.

### Specific objectives:

- Identify the forces and torques over a control volume.
- Determine resulting forces due to flow streams.
- Determine torques generated by flow streams.
- Apply angular momentum equation to turbomachines.

### Related activities:

- A5. Applied exercises.
- A13. Individual exam.

**Full-or-part-time:** 20h 20m

Theory classes: 6h

Self study : 14h 20m

## 6. FUNDAMENTAL PNEUMATIC PRINCIPLES

### Description:

- 7.1 Introduction to pneumatics.
- 7.2 Working pneumatic components.
- 7.3 Pneumatic control elements. Valves.
- 7.4 Basic pneumatic circuits.

### Specific objectives:

- Know the fundamentals of the production of compressed air.
- Know the elements of a pneumatic system.
- Know the actuators and distributors. Pneumatic symbols and design of basic circuits.

### Related activities:

- A11: Laboratory: Elemental pneumatic circuits with double-acting cylinder. Festo panel-mounting valves and actuating attachments.
- A13. Individual exam.

**Full-or-part-time:** 26h 20m

Theory classes: 10h

Laboratory classes: 2h

Self study : 14h 20m

## GRADING SYSTEM

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The different concepts that make up the continuous assessment are:

- Written individual examinations (77%)
- Laboratory practical and reports (10%)
- Submission of resolved problems (13%)

The re-evaluation will consist of a Global Exam of the subject corresponding to the theory and problems of CP1 and CP2, independent of the grade obtained in each of the partial controls (be less than, equal to or greater than 5.0). The Global Exam will weigh 77% of the final revaluation grade.

Students who meet the requirements set by the EPSEVG in its Evaluation and Permanence Regulations will be able to access the re-evaluation test.

## EXAMINATION RULES.

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Each of the two individual exams will consist of two parts:

Part 1: a theory test (maximum 20% of the exam).

Part 2: with a number of problems that will contemplate the score until completing the 100% of the exam.

## BIBLIOGRAPHY

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### Basic:

- Heras, Salvador de las. Mecánica de fluidos en ingeniería [on line]. Barcelona: Iniciativa Digital Politècnica, 2012 [Consultation: 05/04/2022]. Available on: <https://upcommons.upc.edu/handle/2099.3/36608>. ISBN 9788476539354.
- White, Frank M. Mecánica de fluidos [on line]. 6a ed. Madrid [etc.]: McGraw-Hill, 2008 [Consultation: 16/02/2024]. Available on: [https://www-ingebook-com.recursos.biblioteca.upc.edu/ib/NPcd/IB\\_BooksVis?cod\\_primaria=1000187&codigo\\_libro=4144](https://www-ingebook-com.recursos.biblioteca.upc.edu/ib/NPcd/IB_BooksVis?cod_primaria=1000187&codigo_libro=4144). ISBN 9788448166038.
- Çengel, Y.A.; Cimbala, John M. Mecánica de fluidos : fundamentos y aplicaciones [on line]. 4a ed. México, DF: McGraw-Hill, 2018 [Consultation: 20/02/2024]. Available on: [https://www-ingebook-com.recursos.biblioteca.upc.edu/ib/NPcd/IB\\_BooksVis?cod\\_primaria=1000187&codigo\\_libro=8102](https://www-ingebook-com.recursos.biblioteca.upc.edu/ib/NPcd/IB_BooksVis?cod_primaria=1000187&codigo_libro=8102). ISBN 9781456260941.

### Complementary:

- Potter, Merle C [et al.]. Mecánica de fluidos. 4a ed. México [etc.]: Cengage, 2012. ISBN 9786075194509.
- Franzini, Joseph B.; Finnemore, E. John. Mecánica de fluidos con aplicaciones en ingeniería. 9a ed. Madrid [etc.]: McGraw-Hill, 1999. ISBN 844812474X.
- Bergadà Granyó, Josep M. Mecánica de fluidos : breve introducción teórica con problemas resueltos [on line]. 3a ed. Barcelona: Iniciativa Digital Politècnica, 2017 [Consultation: 05/04/2022]. Available on: <https://upcommons.upc.edu/handle/2117/111266>. ISBN 9788498806885.