



Universitat de Lleida

DEGREE CURRICULUM  
**FLUID MECHANICS**

Coordination: ILLA ALIBES, JOSEP

Academic year 2023-24

Subject's general information

<b>Subject name</b>	FLUID MECHANICS			
<b>Code</b>	102112			
<b>Semester</b>	1st Q(SEMESTER) CONTINUED EVALUATION			
<b>Typology</b>	<b>Degree</b>	<b>Course</b>	<b>Character</b>	<b>Modality</b>
	Bachelor's Degree in Automation and Industrial Electronic Engineering	2	COMPULSORY	Attendance-based
	Bachelor's Degree in Energy and Sustainability Engineering	2	COMPULSORY	Attendance-based
	Bachelor's Degree in Mechanical Engineering	2	COMPULSORY	Attendance-based
	Common branch in industrial engineering programs - Lleida	2	COMPULSORY	Attendance-based
	Double bachelor's degree: Degree in Mechanical Engineering and Degree in Energy and Sustainability Engineering	2	COMPULSORY	Attendance-based
	Master's Degree in Industrial Engineering	1	COMPLEMENTARY TRAINING	Attendance-based
<b>Course number of credits (ECTS)</b>	6			
<b>Type of activity, credits, and groups</b>	<b>Activity type</b>	<b>PRALAB</b>	<b>PRAULA</b>	<b>TEORIA</b>
	<b>Number of credits</b>	0.4	2.6	3
	<b>Number of groups</b>	10	4	2
<b>Coordination</b>	ILLA ALIBES, JOSEP			
<b>Department</b>	INDUSTRIAL AND BUILDING ENGINEERING			

<b>Teaching load distribution between lectures and independent student work</b>	Attendance time: 60 h. Home work: 90 h.
<b>Important information on data processing</b>	Consult <a href="#">this link</a> for more information.
<b>Language</b>	Catalan
<b>Distribution of credits</b>	Theory: 3 cr Problems: 2.5 cr Practicum: 0.5 cr

Teaching staff	E-mail addresses	Credits taught by teacher	Office and hour of attention
CRESPO GUTIÉRREZ, ALICIA	alicia.crespo@udl.cat	3	
FONS SOLE, ESTANISLAU	estanislaou.fons@udl.cat	9,4	
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## Subject's extra information

A fluid is a state of matter aggregation characterized by the property of adopting the form of the vessel which contains it, and mainly refers to liquids and gases. The Fluid Mechanics is the wide branch of physics concerned with the phenomena related to fluid movement. In the present course, based on physics and on differential and integral calculus, the basic principles of the mechanics of incompressible fluids will be explained using a deductive conceptual approach.

In order to successfully follow the course it is strongly recommended to refresh the basic concepts of physics and calculus. Some of the problems proposed during the course will require the use of numerical computational techniques, for that reason it is greatly valuable the ability to use a programmable pocket calculator or having the knowledge of some programming language (Basic, Fortran, C, Matlab,...). The default language used in the course will be Matlab, available at the computers from the EPS.

It is **COMPULSORY** that the students bring the following elements of individual protection (EPI) to the practices at the laboratory.

- Blue laboratory gown from UdL (unisex)
- Protection glasses
- Mechanical protection gloves

They can be purchased through the shop Údels of the UdL:

C/ Jaume II, 67 baixos

Centre the Cultures i Cooperació Transfronterera: <http://www.publicacions.udl.cat/>

The use of other elements of protection (for example caps, masks, gloves of chemical or electrical risk, etc.) will depend on the type of practice to be done. In that case, the teacher will inform of the necessity of specific EPI.

Not bringing the EPI's described or not fulfilling the norms of general security that are detailed below imply that the student can not access to the laboratories or have to go out of them. The no realisation of the practices for this reason imply the **consequences in the evaluation** of the subject that are described in this course guide.

### GENERAL NORMS OF SECURITY IN LABORATORY PRACTICES

- Keep the place of realisation of the practices clean and tidy. The table of work has to be free from backpacks, folders, coats...
- No short trousers or short skirts are allowed in the laboratory.

- Closed and covered footwear is compulsory in the laboratory.
- Long hair needs to be tied.
- Keep the laboratory gown laced in order to be protected from spills of chemicals.
- Bangles, pendants or wide sleeves are not allowed as they can be trapped.
- Avoid the use of contact lenses, since the effect of the chemical products is much bigger if they enter between the contact lens and the cornea. Protection over-glasses can be purchased.
- No food or drink is allowed in the laboratory.
- It is forbidden to smoke in the laboratories.
- Wash your hands whenever you have contact with a chemical product and before going out of the laboratory.
- Follow the instructions of the teacher and of the laboratory technicians and ask for any doubt on security.

For further information, you can check the following document of the *Servei de Prevenció de Riscos Laborals de la UdL*: <http://www.spri.udl.cat/alumnes/index.html>

## Learning objectives

- To understand the properties of a fluid and the concept of pressure.
- Determine the hydrostatic pressure distribution inside a fluid and the force on a submerged surface.
- Deduce the basic equations of fluid mechanics, continuity, energy and momentum, from the basic laws of physics.
- Apply the fluid mechanics equations to elemental facilities problems.
- Calculate the charge losses in a pipe.
- Interpret the characteristic curves of pumps and use them in the design and operation of elemental facilities.

## Competences

### Degree-specific competences

- GEM7. Knowledge of applied thermodynamics and heat transfer. Basic principles and their application to solve engineering problems.
- GEM8. Knowledge of the basic principles of fluid mechanics and its application to solve problems in the field of engineering. Calculation of pipes, channels and fluid systems.

### Degree-transversal competences

- EPS1. Capacity to solve problems and prepare and defence arguments inside the area of studies.
- EPS2. Capacity to gather and interpret relevant data, within the area of study, to judge and think about relevant subjects of social, scientific and ethical nature.
- EPS7. Capacity to work in situations with a lack of information and/or under pressure.

## Subject contents

### Chapter 1 HYDROSTATICS

1. Properties of fluids
2. Pressure. Definition and properties. Absolute and relative pressure
3. General equation of hydrostatics
4. Pressure force on submerged surfaces
5. Instruments for measuring the pressure

### Chapter 2 HYDRODYNAMICS

1. Basic concepts. The continuity equation
2. The energy or Bernoulli equation
3. Applications of the Bernoulli equation
  - Tubes of Pitot, Prandtl and Venturi
  - Diaphragm and nozzle
  - Fluid flow through a thin wall hole
4. The momentum equation.
5. Applications of the momentum equation
6. Generalization of the energy equation. Coefficient for correction of kinetic energy
7. Generalization of the momentum equation. Coefficient for correction of momentum
8. The kinetic momentum equation
9. Rocket propulsion

### Chapter 3 HEAD LOSSES

1. Laminar and turbulent flow
2. General head losses: equation of Darcy-Weisbach
3. Head losses in laminar flow: Poiseuille's law
4. Head losses in turbulent flow. Experiences of Nikuradse.
5. Local head losses
6. Optimal diameter for a pipeline

### Chapter 4 CENTRIFUGAL PUMPS

1. Classification of pumps
2. Centrifugal pumps. Euler equation
3. Head losses, power and yield of a pump
4. Characteristic performance. Operation point
5. Cavitations. The NPSH concept
6. Similitude in turbo machines.

## Methodology

**Master class**, where the basic concepts are exposed in a deductive sequence.

**Problem solving**. The methodology to solve the typical problems is exposed, starting from the basic concepts.

**Practicum**, will be performed at the laboratory in groups of 5 people. Each group will then present a report analyzing the experimental data.

**Written exam**. At day and time established by the study board. Each student has to solve by its own the proposed questions in a limited time. The students know the punctuation criteria.

## Development plan

Week	Methodology	Contents	Attendance hours	Autonomous working hours
1-8	Master class Problems	Chapters 1 and 2	32	48
9	Written exam (E1)	Chapters 1 and 2	3	
10-13	Master class Problems	Chapters 3 and 4	16	24
14-15	Practicum	Practicum at laboratory	4	12
16	Written exam (E2)	Chapters 1 a 4 Practicum	3	

## Evaluation

By mid semester there will be an exam (E1) including all subjects taught during that period. By the end of the semester, there will be another exam (E2) including all subjects discussed during the semester. There will be also a mark on the laboratory work (P). The final mark of the course, based on the three blocs: exam E1, exam E2 and laboratory, will be calculated as:

$$NJ_a = 0.8 * \max\{(E1+E2)/2, E2\} + 0.2 * P$$

If anyone does not succeed in this first attempt there will be a second opportunity to pass the course through a final examination (EJ) which includes all stuff of the course. The mark of this second opportunity will be calculated as:

$$NJ_b = 0.8 * EJ + 0.2 * P$$

The professor can round up or down the obtained marks to a multiple of 0.5.

All exams will be in the dates established by the Direction of the EPS. Practicum at the laboratory will be carried

out during the last weeks of the semester in a timetable agreed with the students. Practicum is subject of the exams too.

The students under 'alternative evaluation' system will have the mark obtained from exam E2, and if a second attempt is needed, they can do it taking the final exam EJ.

## Bibliography

### Recommended bibliography

#### **Basic references**

- J.Agüera Soriano, "Mecánica de fluidos incompresibles y turbomáquinas hidráulicas", 5ª ed., Editorial Ciencia3 S.A., 2002 (ISBN: 84-95391-01-05)
- Claudio Mataix, "Mecánica de fluidos y máquinas hidráulicas", 2ª ed., Ediciones del Castillo S.A., Madrid 1986 (ISBN: 84-219-0175-3).
- J.B.Franzini, E.J.Finnemore, "Mecánica de fluidos con aplicaciones en Ingeniería", 9ª ed., McGraw-Hill, 1999, (ISBN: 84-481-2474-X)
- V.L. Streeter, E.Benjamin, K.W. Bedford, "Mecánica de los fluidos", Ed. McGraw-Hill, 9ª ed., 2000 (ISBN: 968-600-987-4).

#### **Additional references**

- Merle C. Potter; David C. Wiggert, "Mecánica de fluidos, 3ª ed", Ed. Thomson, 2002.
- Irving H. Shames, "Mecánica de fluidos", Ed. McGraw-Hill, 1995.
- Frank M.White, "Fluid Mechanics", Ed. McGraw-Hill, 1986