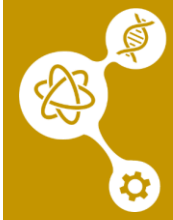
Academic Year 2026/2027

Course Guide:

FLUID MECHANICS



FACULTY OF CHEMICAL SCIENCES

1. IDENTIFICATION

Degree Program	Bachelor's Degree in Chemical Engineering			Code	801542
Couse	Fluid Mechanics			ECTS	9
Subject Areea	Bases of Engineering				
Module	Industrial Engineering				
Course Type	Required	Course	Second	Semester	Second
Responsible Department	Chemical and Materials Engineering				

Teaching staff

Activity	Lecturer	Email	Office
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Fluid Mechanics Laboratory

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2. OBJECTIVES

General Objective

Study of the compressible and incompressible flow of fluids and the unit operations in said fluid flow.

Specific objectives

- Identify the different types of fluids and fluid flow.
- Rheologically classify a fluid.
- Deduce, describe, and understand the physical meaning of the macroscopic equations of conservation of total matter, total energy, internal, and mechanical, and quantity of motion.
- Calculate frictional energy losses in different types of fluids.
- Determine minor losses in a fluid flow system.
- Establish the power required for the flow of a fluid in an installation.
- Solve complex fluid flow systems, networks, using the iterative Hardy-Cross method.
- Know and understand the different types of flow in open channels.
- Calculate the characteristic parameters of uniform flow in open channels.
- Apply the macroscopic conservation equations to compressible flow.
- Understand the relationship between velocity, pressure and section in isentropic flow and isothermal flow.
- Determine the design pressure in convergent and extended nozzles.
- Calculate the compression work performed by a compressor.
- Analyze the concepts of pressure in a fluid and how to measure it.
- Know the different types of instruments used to measure the flow of a fluid.
- Know the different types of pumps and selection criteria.
- Know and calculate the characteristic parameters of a centrifugal pump, as well as its operating point.
- Understand the concept of boundary layer.
- Analyze the external flow around submerged bodies.
- Analyze and quantify flow through particle beds.
- Know the particularities of fluid flow in heat exchange devices.
- Know the different types of filters.
- Design discontinuous and continuous filters.
- Distinguish the different types of sedimentation.
- Size sedimentators and centrifuges.
- Know the elements involved in agitation and mixing of fluids.
- Calculate the power needed for the agitation of a given system.

3. PRIOR KNOWLEDGE AND RECOMMENDATIONS

Prior knowledge

Following this course satisfactorily requires the student to have previously acquired the knowledge and competences corresponding to the following courses: "*Fundamentals of Chemical Engineering*", *"Mathematics I"*, *"Mathematics II"* and "*Basic Physics*. Although enrolment is not formally conditioned on these prior knowledge, effective mastery of this knowledge is essential to follow this course with a reasonable prospect of success.

Recommendations

It is recommended that the student has a basic level of English that allows him or her to handle bibliography in English, and to search for information, and to communicate in writing and orally in that language.

4. CONTENTS

Brief description

Properties of fluids. Kinematics and fluid dynamics. Flow of compressible and incompressible fluids by pipelines. Flow in open channels. Hydraulic machines: pumps and compressors. Circulation through porous beds. Fluidization. Filtration. Relative particle-fluid motion. Sedimentation. Centrifugation. Fluid agitation. Experimentation in fluid flow installations.

Course syllabus

Topic 1: Introduction

Introduction. Fluids and fluid flow: definition and types. Fluid dynamics and kinematics. Rheological classification of fluids. Equipment for the flow of fluids (pipes, fittings and valves).

Topic 2: Macroscopic conservation equations

Macroscopic conservation equations applied to the internal flow of fluids. Total or continuity matter. Total energy, internal and mechanical.

Topic 3: Solid-fluid friction

Friction between solids and fluids. Calculation of friction energy losses in internal flow of Newtonian and non-Newtonian fluids: friction factors. Minor losses.

Topic 4: Incompressible internal flow

Incompressible flow. Calculation of the power required for the flow. Examples. Hydraulic machines: Pumps.

Topic 5: Complex systems in internal flow

Complex systems. Flow network analysis. Flow in open channels and in partially filled pipes.

Topic 6: Compressible internal flow

Compressible flow. Ideal isothermal and adiabatic gas flow. Introduction to nozzle and diffuser design. Flow of real gases. Compression work. Stepwise compression. Hydraulic machines: Compressors.

Topic 7: Instrumentation in fluid flow

Instrumentation in fluid flow: pressure, speed and flow meters.

Topic 8: Introduction to External Flow

External flow: boundary layer concept. Flow around submerged bodies: flat plates, cylindrical and rounded bodies.

Topic 9: External flow through particle beds.

Fixed bed and fluidized bed.

Topic 10: Two-phase liquid-gas flow.

Flow patterns. Flow maps. Flow models.

Topic 11: Leaking

Discontinuous filtration at constant pressure and flow. Continuous filtration. Compressible and incompressible cakes. Practical aspects of filtration.

Topic 12: Sedimentation

Particle sedimentation in gravitational and centrifugal field. Free and impeded sedimentation. Sizing of sedimentation equipment.

Topic 13: Agitation

Agitation and mixing of fluids. Team. Calculation of the necessary power.

5. COMPETENCIES

General

CG1-MII2	Use the basic principles of fluid mechanics.

Specific

CE8-B1	Describe the properties of fluids.
CE8-B2	Apply the principles of fluid flow (kinematics and dynamics) to the design of liquid and gas transport systems.
CE8-B3	Size and select the equipment and fittings involved in the flow of liquids and gases.
CE8-B4	Size fixed and fluidized beds, sedimentation, filtration, centrifugation and agitation equipment.

Cross-cutting

CT2-II1	Demonstrate capacity for analysis and synthesis in Industrial Engineering.
CT5-II1	Consult, use and analyse bibliographic sources.
CT5-II2	Use bibliography, specialised databases and resources accessible through the Internet.
CT6-III	Use computer tools and programs.
CT7-II1	Work in a team.
CT10-II1	Integrate acquired knowledge and apply it to solving problems in Industrial Engineering
CT11-II1	Learn autonomously
CT13-II1	Demonstrate initiative and creativity in solving new situations.

6. WORKLOAD DISTRIBUTION BY ACTIVITY

Activity	In-class (hours)	Self-study (hours)	Credits
Lectures	45	65	4,4
Seminars	15	22,5	1,5
Tutorials/Guided Work	4	6	0,4
Laboratories	30	22,5	2,1
Preparation of assignments and exams	6	9	0,6
Total	**100**	**125**	**9**

7. METHODOLOGY

Teaching practice will follow a mixed methodology based on cooperative learning, collaborative learning and self-learning. This methodology will be developed through theoretical classes, seminar classes, individual or group work, directed tutorials and laboratory practices.

The **lectures** will consist, as a priority, of master classes in which the complete syllabus of the subject will be presented in an orderly manner with the help of audiovisual material.

The **seminars** will consist of the formulation and resolution of problems, previously proposed to the student, which involve the application of theoretical knowledge, as well as the development of some complementary and eminently practical topics.

The **tutorials**, which will be carried out in two groups, will consist of directing and supervising the progress of the students in their personalized work, as well as resolving the doubts raised and carrying out multiple-choice tests. Part of the tutorials will be carried out interactively through the virtual campus and using the Microsoft Excel tool.

The **laboratory practices** will consist of the collection of experimental data and the calculation of the different parameters involved in the development of the practice. The critical discussion and analysis of the results obtained in each practice will constitute the fundamental part of the technical reports to be delivered in each case.

Before the completion of the first laboratory of the subject, the student must confirm in writing that he or she has read, understood and accepted the safety rules of the laboratory.

The UCM Virtual Campus **will be used** as an instrument to make available to students the material that will be used in theoretical classes, seminars, tutorials and laboratories, and as a means of communication between the professor and the students. Part of the recommended bibliography and the support material that is deposited on the virtual campus for the development of the teaching activities of this subject will be in English.

8. BIBLIOGRAPHY

Basic

- Franzini, J.B.; Finnemore, E.J.: "*Fluid Mechanics with Applications in Engineering*", 9th ed., McGraw-Hill, 1999.
- Munson, B.R.; Young, D.F.; Okiishi, T.H.: "*Fundamentals of Fluid Mechanics*", John Wiley & Sons Inc., 1990.

Complementary

- Costa, E. et al., "*Chemical Engineering. Vol. 3. Fluid Flow",* Alhambra, 1985.
- Streeter, V. L.; Wylie E. Benjamin/Bedford; Keith W.: "*Fluid Mechanics*", 9th ed., McGraw Hill, Santa Fé de Bogotá., 1999.
- Wilkes, J.O.: "*Fluid Mechanics for Chemical Engineers*", Prentice Hall, 1999.
- Holland, F.A.; Bragg, R.: "*Fluid Flow for Chemical Engineers*", 2ª ed., Butterworth-Heinemann, 1995.
- Mott, R.L.: "*Applied Fluid Mechanics*", 6ª ed., Pearson-Prentice Hall, 2005.
- Daugherty, R.L. y col.: "*Fluid Mechanics with Engineering Applications*", McGraw-Hill, New York, 1985.
- McCabe, W.L.; Smith, J.C.; Harriot, P.: "*Basic Operations of Chemical Engineering*", McGraw-Hill, 1991.
- White, F.M.: "*Fluid Mechanics*", 6th ed., McGraw-Hill, 2008.
- Miranda, R.: "*Process Engineering*", 1st ed., DEXTRA, 2020

9. ASSESSMENT

It is mandatory to attend all directed tutorials, as well as all laboratory sessions. In order to access the final evaluation, the student must have participated in at least 70% of the classroom activities.

The final course grade will be calculated as the weighted average of the different assessable activities. However, to pass the course, students must obtain the minimum grade established for each activity. If this requirement is not met, the final grade will be the weighted average, capped at 4.5 out of 10. This criterion shall apply to both the ordinary and extraordinary assessment periods.

❖ WRITTEN EXAMS: 70%

The assessment of the competences acquired in the subject (CG1-MII1, CE8-B1, CE8-B2, CE8-B3, CE8-B4, CT2-II1, CT10-II1) will be carried out by taking two written exams in the ordinary call in June and the extraordinary exam in July, mainly of a practical nature, which will represent 70% of the overall assessment. It will be necessary to obtain a minimum score of 5.0 points out of 10 in the final exam in order to pass the subject.

❖ INDIVIDUAL WORK AND GUIDED ACTIVITIES: 15%

A set of model problems will be proposed for each of the parts of the subject so that the student can develop a personalized work, the evolution of which will be contrasted in the supervised tutorials. Likewise, formative tests of a theoretical-practical nature will be carried out for continuous evaluation, discussing the results to improve student learning (feedback). The assessment will provide information on the degree of achievement of competences CG1-MII2, CE8-B2, CE8-B3, CE8-B4, CT2-II1, CT5-II1, CT5-II2, CT10-II1, CT11-II1, CT13-II1. All this will represent 15% of the global evaluation. For the extraordinary call, the qualification of the personal work and the directed activities will be maintained.

❖ LABORATORY PRACTICES: 15%

Attendance at all laboratory sessions is mandatory. The evaluation in the ordinary call will be carried out considering the aptitude and attitude of the student in the practical sessions, their answers to specific questions posed by the teacher, as well as the quality of the technical report on the practices carried out and presented by each student. The assessment will provide information on the degree of achievement of competences CG1-MII2, CE-B3, CE-B4, CT2-II1, CT5-II1, CT5-II2, CT7-II1, CT10-II1, CT11-II1 and CT13-II1.

In the extraordinary call, a laboratory practice exam will be held for those students who have not passed this section in the ordinary call.

Students who have carried out the internship in previous years will have the option of requesting the non-repetition of these as long as no more than 2 years have elapsed since they carried out these internships.

The grades of the activities planned for the evaluation of the subject (intermediate tests, laboratories, tutorials, delivery of problems...) will be communicated to students sufficiently in advance before the final exam, so that they can properly plan the study of this or other subjects.

In particular, the marks of the partial exams will be communicated within a maximum period of 20 days, except in the case of the second midterm, in which the period may be shorter to adapt to the final exam. In any case, the minimum period of seven days between the publication of the grades and the date of the final exam of the subject will be respected.

ACTIVITY PLANNING - SCHEDULE

UNIT	ACTIVITY	HOURS	GROUPS	START	END
1. Introduction	Theory	2	1	1st Week	1st Week
	Seminar	1	2	1st Week	
2. Macroscopic conservation equations	Theory	3	1	1st Week	2nd Week
	Seminar	1	2	2nd Week	
3. Solid-fluid friction	Theory	3	1	2nd Week	Week 3
	Seminar	1	2	Week 3	
4. Incompressible internal flow	Theory	6	1	Week 3	Week 5
	Seminar	2	2	Week 4	Week 5
5. Complex systems in internal flow	Theory	4	1	Week 5	Week 6
	Seminar	2	2	Week 6	Week 7
6. Compressible internal flow	Theory	6	1	Week 7	Week 8
	Seminar	3	2	Week 8	Week 10
7. Instrumentation in fluid flow	Theory	2	1	Week 9	Week 9
8. Introduction to External Flow	Theory	3	1	Week 9	Week 10
9. External flow through particle beds	Theory	3	1	Week 10	Week 11
	Seminar	1	2	Week 11	
10. Two-phase liquid-gas flow	Theory	3	1	Week 11	Week 12
	Seminar	1	2	Week 12	
11. Filtration	Theory	3	1	Week 12	Week 13
	Seminar	1	2	Week 13	
12. Sedimentation	Theory	3	1	Week 13	14th Week
	Seminar	1	2	14th Week	
13. Agitation	Theory	4	1	14th Week	15th Week
	Seminar	1	2	15th Week	
TUTORIALS	Tutoring*	4	4	Weeks 5, 8, 10 and 13	
LABORATORIES	Internship	30	2	3rd Week	7th Week

* Scheduled tutorials and lab sessions are subject to possible modifications according to the joint course planning.

SUMMARY OF THE ACTIVITIES

ACTIVITY	ASSOCIATED COMPETENCIES	TEACHING ACTIVITY	STUDENT ACTIVITY	ASSESSMENT	P	NP	TOTAL	C
Theory	GC1-MII2, CE-B1, CE-B2	Verbal presentation of the main lines of each agenda item.	Attention and active participation in the development of the class.	Written exams.	45	65	110	
Seminars	CG1-MII2, CE-B2, CE-B3, CE-B4, CT2-II1, CT5-II1, CT5-II2, CT10-II1	Posing and resolving questions and problems of a numerical nature	Discussion and resolution of the proposed issues and problems	Written exams and student participation in the resolution of the proposed questions and problems.	15	22,5	37,5	**15%**
Tutorials / Directed Work	CG1-MII2, CT2-II1, CT5-II1, CT5-II2, CT10-II1, CT11-II1, CT13-II1	Supervision of students' progress in their personal work.	Development of your personal work	Assessment of the work carried out by the student in the development of the proposed personal work.	4	6	10	
Laboratory Practices	CG1-MII2, CE-B3, CE-B4, CT2-II1, CT5-II1, CT5-II2, CT7-II1, CT10-II1, CT11-II1, CT13-II1	Explanation and monitoring of the development of the practice	Learn the necessary content to understand and carry out the experimental part. Collection, analysis and discussion of experimental data to calculate the different parameters. Preparation of the technical report on the development of the practice.	Assessment of the student's work during the development of the practice and the technical report	30	22,5	52,5	**15%**
Exams	CG1-MII2, CE-B1, CE-B2, CE-B3, CE-B4, CT2-II1, CT10-II1	Design and correction of the exam. Student's grade.	Performing the exam.	Exam	6	9	15	**70%**

P: Contact activities

NP: Non-contact activities (independent study)

C: Grade