



Course guide

220112 - FT - Fluid Technology

Last modified: 04/07/2023

Unit in charge: Terrassa School of Industrial, Aerospace and Audiovisual Engineering
Teaching unit: 729 - MF - Department of Fluid Mechanics.

Degree: BACHELOR'S DEGREE IN INDUSTRIAL TECHNOLOGY ENGINEERING (Syllabus 2010). (Compulsory subject).

Academic year: 2023 **ECTS Credits:** 4.5 **Languages:** Catalan

LECTURER

Coordinating lecturer: Pedro Javier Gamez-Montero

Others:

PRIOR SKILLS

It is believed to be essential to have passed the subject of Fluid Mechanics.

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:

CE26T-GETI. Applied knowledge of the fundamentals of fluid mechanics and systems. (Specific Technology Module - ESEIAAT Itinerary)

TEACHING METHODOLOGY

Large group: Calculation and Design Methodologies

In the face-to-face presentation sessions, the teacher will introduce the theoretical bases of the subject, concepts, methods and results, illustrating them with convenient examples to facilitate their understanding. Theory classes combine expository method and active learning directly related to Activity 1 and particular examples and applications related to Activity 2 will be worked on.

Small Group: Lab / Application Workshops

The laboratory classes, in small groups, will be held in the laboratory or in computer rooms. The practical work is carried out individually, in pairs and teams, to be specified in each laboratory / workshops. The objective is for students to be able to collect data, process it, analyse it and draw conclusions, comparing the results with other reference, theoretical, numerical, or experimental data. The classes are directly related to the activities of seminars I to VI.

Autonomous Learning

Students should autonomously study and exercise to assimilate and learn the concepts, solve the proposed exercises either manually or with the help of the computer. The activities programmed outside the classroom will be designed to serve as self-learning, carrying out evaluable activities and solving the questionnaires.

LEARNING OBJECTIVES OF THE SUBJECT

After completing the course, students must have achieved Level 3 (application) with general learning objectives:

Technology in the field of specialty

- Understand the scientific foundations
- Know how to use the technology and the necessary engineering

professional performance

- Analyze specific situations, define problems, make decisions and implement plans of action in the search for solutions.
- Apply knowledge to real situations, managing resources appropriately.
- Interpret studies, reports, and analyze data numerically.
- Select and manage the information sources.
- Use existing tools as support.
- Working in a multidisciplinary team.
- Evaluate the integral, personal motivation, mobility.

communication

- Understand and speak with the proper terminology.
- Discuss and argue on various forums.

Technology transfer.

- Analyze and evaluate the environmental, social and ethical profession.
- Have a critical and innovative spirit.
- Retraining in new technological developments through continuous learning.

STUDY LOAD

Type	Hours	Percentage
Hours small group	14,0	12.44
Self study	67,5	60.00
Hours large group	31,0	27.56

Total learning time: 112.5 h

CONTENTS

Module 1: INTRODUCTION TO FLUID-DYNAMIC DESIGN

Description:

- 1.1. Analysis / Design (direct problem and inverse problem)
- 1.2. Types of analysis: integral, differential, and dimensionless
- 1.3. Fluids
- 1.4. Examples of applications

Related activities:

- Theory lectures with examples and problems / applications
- Activity 1 (active learning in the classroom)
- Activity 2 (exercises / applications)
- Activity 3 (self-learning questionnaires)
- Activity 4 (knowledge control)
- Activity 5 (partial exam)

Full-or-part-time: 5h

- Theory classes: 2h
- Self study : 3h



Module 2: HYDROSTATIC ANALYSIS

Description:

- 2.1. Hydrostatic gravity field
- 2.2. Hydrostatic forces on surfaces
- 2.3. Buoyancy
- 2.4. Stability of floating and submerged bodies
- 2.5. Examples of applications

Related activities:

- Theory lectures with examples and problems / applications
- Activity 1 (active learning in the classroom)
- Activity 2 (exercises / applications)
- Activity 3 (self-learning questionnaires)
- Activity 4 (knowledge control)
- Activity 5 (partial exam)
- Activity 8 (seminar I: problem solving strategies)

Full-or-part-time: 10h

- Theory classes: 2h
- Laboratory classes: 2h
- Self study : 6h

Module 3: INTEGRAL DYNAMIC ANALYSIS

Description:

- 3.1. Propaedeutic concepts: conservation laws
- 3.2 Integral and differential formulation
- 3.3 Macroscopic isothermal systems
- 3.4 Design and calculation examples of elements, machinery and equipment for handling fluids (agitators, jets, tanks, piping systems turbomachinery control systems, etc.)
- 3.5 Use of macroscopic balances to raise unsteady flow problems
- 3.6 Examples and practical cases

Related activities:

- Theory lectures with examples and problems / applications
- Activity 1 (active learning in the classroom)
- Activity 2 (exercises / applications)
- Activity 3 (self-learning questionnaires)
- Activity 4 (knowledge control)
- Activity 5 (partial exam)
- Activity 7 (lab/workshop final test)
- Activity 9 (workshop II: introduction to CFD)

Full-or-part-time: 30h

- Theory classes: 10h
- Laboratory classes: 2h
- Self study : 18h



Module 4: DIFFERENTIAL DYNAMIC ANALYSIS

Description:

- 4.1. Propaedeutic concepts: equations of motion: Cauchy, Navier-Stokes, Reynolds, Euler, Bernoulli
- 4.2 Flow dominated by viscosity (Low Re). Couette flow and Hagen-Poiseuille flow.
- 4.3. Examples of applications of low Re flows: bearings (hydrostatic and dynamic fluid), lubrication, food handling, flow in porous media, etc.
- 4.4 Ideal flow (High Re). Euler's equation and study of the fluid particle along and normal to a stream line.
- 4.5. Examples of applications of high Re flows: objects submerged in a stream, drag and lift for symmetric and asymmetric objects
- 4.6 Introduction to non-Newtonian flow in pipes with a circular straight section. Potential law. Bingham plastic.
- 4.7 Examples of applications of food handling flows, flow in porous media, etc.
- 4.8. Practical cases

Specific objectives:

Related activities:

- Theory lectures with examples and problems / applications
- Activity 1 (active learning in the classroom)
- Activity 2 (exercises / applications)
- Activity 3 (self-learning questionnaires)
- Activity 6 (final exam)
- Activity 7 (lab/workshop final test)
- Activity 10 (workshop III: flow with dominant viscosity in CFD with rectangular geometry)
- Activity 11 (workshop IV: flow with dominant viscosity in CFD with circular geometry)

Full-or-part-time: 40h

- Theory classes: 10h
- Laboratory classes: 6h
- Self study : 24h

Module 5: DIMENSIONALESS ANALYSIS

Description:

- 5.1. The laws of similarity (geometric, kinematic and dynamic)
- 5.2. Dimensional numbers
- 5.3. Theory models, design of experiments and the correlation of experimental data.
- 5.4. Examples of applications

Related activities:

- Theory lectures with examples and problems / applications
- Activity 1 (active learning in the classroom)
- Activity 2 (exercises / applications)
- Activity 3 (self-learning questionnaires)
- Activity 6 (final exam)
- Activity 7 (lab/workshop final test)
- Activity 12 (workshop V: dimensionless numbers and model theory)

Full-or-part-time: 15h

- Theory classes: 2h
- Laboratory classes: 4h
- Self study : 9h



Module 6: PUMP-PIPES FLUID SYSTEMS

Description:

- 6.1 Generalized Bernoulli equation
- 6.2 Pressure losses. Darcy-Weisbach, Moody, Friction Factor and Elements
- 6.3 System curve
- 6.4 Centrifugal pump performance curves
- 8.5 Centrifugal pump to system. Operating point
- 8.6 Flow control

Related activities:

- Theory lectures with examples and problems / applications
- Activity 1 (active learning in the classroom)
- Activity 2 (exercises / applications)
- Activity 3 (self-learning questionnaires)
- Activity 6 (final exam)

Full-or-part-time: 7h 30m

Theory classes: 3h

Self study : 4h 30m

Module 7: GUIDE AND BEST PRACTICES IN READING PRIMARY LITERATURE

Description:

- 7.1 Introduction
- 7.2 What are research articles? Why read 'primary literature'?
- 7.3 The game of language, science and philosophy.
- 7.4 Is this 'primary literature'. Always in English?
- 7.5 Innovation: one word
- 7.6 The anatomy of 'paper'. Sections and in practice
- 7.7 How to read research articles? In practice: hypotheses and research questions, research argumentation, concepts and results.
- 7.8 Overall, what to take into account. In practice

Related activities:

- Theory lectures with examples and problems / applications
- Activity 1 (active learning in the classroom)
- Activity 2 (exercises / applications)
- Activity 3 (self-learning questionnaires)
- Activity 6 (final exam)

Full-or-part-time: 5h

Theory classes: 2h

Self study : 3h



ACTIVITIES

ACTIVITY 1. ACTIVE LEARNING IN THE CLASSROOM

Description:

Active learning in the classroom in order to enhance motivation, reinforce critical thinking and activate learning, thus adapting to the specific needs of the classroom, among others, such as:

- Classic hobbies created by the ad-hoc teacher and delivered on photocopies / slides (word searches, crossword puzzles, the N differences, pairing, etc.)
- Multiplatform electronic mobile learning and gamification tools
- H5P interactive resources for web learning (open and completely free technology)
- Other tools and resources available

Material:

Photocopies, multiplatform tools, applications, interactive resources, etc.

Delivery:

The activities are carried out, commented and corrected in the classroom between students and between teacher and students. This activity does not have a direct specific weight in the overall grade of the course.

Full-or-part-time: 12h

Theory classes: 4h

Self study: 8h

ACTIVITY 2. PROBLEMS/APPLICATIONS

Description:

Basic exercises presented in the theoretical documentation of the subject. Problems and proposed applications to solve in class. The statements of the problems and applications are discussed, previously prepared by the instructor, in class.

Material:

Notes of the subject in ATENEA (learning management tool of the UPC based on Moodle).

Book of the subject at ATENEA.

Delivery:

The resolution of the problem must include the following sections: (a) Hypothesis, (b) Drawing of the scheme, (c) Basic principles, (d) Resolution, (e) Results, (f) Conclusions and (g) Explanation: within Each section should always include a small explanation to reason and argue the steps that have been taken.

This activity does not have a direct specific weight in the overall grade of the course.

Full-or-part-time: 18h

Theory classes: 10h

Self study: 8h

ACTIVITY 3. SELF-LEARNING QUESTIONNAIRES

Description:

Individual test questionnaires of conceptual exercises as part of autonomous learning.

Material:

Online questionnaires developed on the ATENEA platform of the subject (learning management tool of the UPC based on Moodle)

Delivery:

Each questionnaire is evaluated and its grade is part of the 10% corresponding to the final grade of the self-learning questionnaire tests.

Full-or-part-time: 18h

Theory classes: 10h

Self study: 8h



ACTIVITY 4. KNOWLEDGE CONTROL

Description:

Control type test carried out in class in pairs.

Material:

A4 crib sheet hand-made by the student.

Delivery:

The test is evaluated, and its grade has a weight of 5%, of the final grade for the course.

Full-or-part-time: 5h

Theory classes: 1h

Self study: 4h

ACTIVITY 5. MID-TERM EXAM

Description:

Individual mid-term exam.

Material:

A4 crib sheet hand-made by the student.

Delivery:

The exam is 30% of the final grade of the course.

Full-or-part-time: 13h

Theory classes: 3h

Self study: 10h

ACTIVITY 6. FINAL EXAM

Description:

Individual mid-term exam.

Material:

A4 crib sheet hand-made by the student.

Delivery:

The exam is 40% of the final grade of the course.

Full-or-part-time: 13h

Theory classes: 3h

Self study: 10h



ACTIVITY 7. LAB/WORKSHOP FINAL TEST

Description:

Control type test carried out in class individually.

Material:

Crib sheet or dossier delivered to the student by the instructor to carry out the test. Upon completion, it must be returned to the instructor.

Delivery:

The test is evaluated and its grade is 10% corresponding to the final grade of the lab/workshop final test.

Full-or-part-time: 5h

Laboratory classes: 2h

Self study: 3h

ACTIVITY 8. WORKSHOP I: PROBLEM SOLVING STRATEGIES

Description:

Strategies, guides and guidelines in the process of solving calculation problems and fluid dynamic design.

Material:

Book of this subject in ATENEA (learning management tool of the UPC based on Moodle).

Delivery:

The correct delivery of the report is part of the 5% of the overall grade for the course, corresponding to the lab/workshop grade.

Full-or-part-time: 12h

Laboratory classes: 2h

Self study: 10h

ACTIVITY 9. WORKSHOP II: INTRODUCTION TO CFD

Description:

Practical workshop where the student is introduced to the Computational Fluid Dynamics (CFD) tools that will be used in the workshops.

Material:

CFD software.

Computer classroom.

Notes of the subject in ATENEA (learning management tool of the UPC based on Moodle).

Workshop script at ATENEA. The language of the workshop scripts is English.

Delivery:

The correct delivery of the report is part of the 5% of the overall grade for the course, corresponding to the lab/workshop grade.

Full-or-part-time: 3h 30m

Laboratory classes: 2h

Self study: 1h 30m



ACTIVITY 10. WORKSHOP III: FLOW WITH DOMINANT VISCOSITY IN CFD WITH RECTANGULAR GEOMETRY

Description:

Practical workshop with Computational Fluid Dynamics (CFD) software. Flow cases with dominant viscosity in rectangular geometries are simulated and the results are compared with the theoretical calculations from theory class and/or problem solving.

Material:

CFD software.

Computer classroom.

Notes of the subject in ATENEA (learning management tool of the UPC based on Moodle).

Workshop script at ATENEA. The language of the workshop scripts is English.

Delivery:

The correct delivery of the report is part of the 5% of the overall grade for the course, corresponding to the lab/workshop grade.

Full-or-part-time: 3h

Laboratory classes: 2h

Self study: 1h

ACTIVITY 11. WORKSHOP IV: FLOW WITH DOMINANT VISCOSITY IN CFD WITH CIRCULAR GEOMETRY

Description:

Practical workshop with Computational Fluid Dynamics (CFD) software. Flow cases with dominant viscosity in circular geometries are simulated and the results are compared with the theoretical calculations from theory class and/or problem solving.

Material:

CFD software.

Computer classroom.

Notes of the subject in ATENEA (learning management tool of the UPC based on Moodle).

Workshop script at ATENEA. The language of the workshop scripts is English.

Delivery:

The correct delivery of the report is part of the 5% of the overall grade for the course, corresponding to the lab/workshop grade.

Full-or-part-time: 3h

Laboratory classes: 2h

Self study: 1h



ACTIVITY 12. WORKSHOP V: DIMENSIONLESS NUMBERS AND MODEL THEORY

Description:

Introduction to dimensional analysis.

Once the dimensionless numbers have been identified, the similarity and model theory allows predicting the behavior of a prototype from the measurements made on the model.

Intervention through flipped learning in flipped classroom.

Material:

Detailed planning of the flipped learning in ATENEA (learning management tool of the UPC based on Moodle).

Notes of the subject in ATENEA

Specific ad-hoc materials of the workshop at ATENEA.

Delivery:

Online questionnaire in the classroom developed on the ATENEA platform of the subject.

The questionnaire is evaluated and its grade is part of the 5% of the overall grade for the course, corresponding to the laboratory/workshop practice grade.

Full-or-part-time: 3h 30m

Laboratory classes: 2h

Self study: 1h 30m

ACTIVITY 13. WORKSHOP VI: SUSTAINABILITY, INTERNATIONALIZATION AND FLUIDS

Description:

Laboratory practice in which the student is introduced to the concepts of sustainability and internationalization in higher education in fluid engineering. The seminar looks at the strategic plan and the SDGs of the UPC. With good practices in reading articles, it focuses on learning about world news regarding new and innovative proposals.

Intervention through flipped learning in flipped classroom.

Material:

Detailed planning of the flipped learning in ATENEA (learning management tool of the UPC based on Moodle).

Notes of the subject in ATENEA

Specific ad-hoc materials of the workshop at ATENEA.

Delivery:

Online questionnaire in the classroom developed on the ATENEA platform of the subject.

The questionnaire is evaluated and its grade is part of the 5% of the overall grade for the course, corresponding to the laboratory/workshop practice grade.

Full-or-part-time: 3h 30m

Laboratory classes: 2h

Self study: 1h 30m

GRADING SYSTEM

1st Evaluation: midterm exam, weight: 30%
2nd Evaluation: final exam, weight: 40%
Questionnaires (type self-test individual), weight: 10%
Basic test, weight: 5%
Lab/Workshop sessions, weight: 5%
Lab/Workshop final test, weight: 10%

*The unsatisfactory results of the examination of the first mid-term, may be re-conducted only by students with a grade lower than 5. The second mid-term exam will be replaced by a final examination with the content of the whole subject of the course, with parts differentiated by terms. The final mark corresponding to the term exams (70%) will be the highest between the final examination and the weighting between the first mid-term exam and the parts of the second mid-term exam in the final examination.

EXAMINATION RULES.

Individual autotests as independent learning.
The exams consist of two exercises lasting approximately two hours.

*The unsatisfactory results of the examination of the first mid-term, may be re-conducted only by students with a grade lower than 5. The second mid-term exam will be replaced by a final examination with the content of the whole subject of the course, with parts differentiated by terms. The final mark corresponding to the term exams (70%) will be the highest between the final examination and the weighting between the first mid-term exam and the parts of the second mid-term exam in the final examination.

BIBLIOGRAPHY

Basic:

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- Yeong, Foong May. How to read and critique a scientific research article: notes to guide students reading primary literature [on line]. Hackensack, NJ: World Scientific, 2013 [Consultation: 16/11/2022]. Available on: <https://www.worldscientific-com.recursos.biblioteca.upc.edu/worldscibooks/10.1142/9051#t=aboutBook>. ISBN 9789814579162.
- Çengel, Yunus A. [et al.]. Mecánica de fluidos: fundamentos y aplicaciones [on line]. 4a ed. México D.F.: McGraw-Hill, 2018 [Consultation: 20/09/2022]. Available on: https://www-ingebook-com.recursos.biblioteca.upc.edu/ib/NPcd/IB_BooksVis?cod_primaria=1000187&codigo_libro=8102. ISBN 9781456260941.
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- Round G.F.; Garg, V.K. Applications of fluid dynamics. London: Edward Arnold, 1986. ISBN 0713135468.
- Shames, I.H. Mecánica de fluidos. 3ª ed. Santafé de Bogotá: McGraw-Hill, 1995. ISBN 9586002462.
- Spurk, J.H. Fluid mechanics: problems and solutions. Berlín: Springer, 1997. ISBN 3540616527.
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Complementary:

- Gillen, Christopher M. Reading primary literature: a practical guide to evaluating research articles in biology. San Francisco, CA: Pearson Benjamin Cummings, 2007. ISBN 9780805345995.



- Kundu, Pijush K.; Cohen, Ira M.; Dowling, David R. Fluid mechanics [on line]. 5th ed. Amsterdam: Elsevier, 2012 [Consultation: 22/06/2022]. Available on: <https://www.sciencedirect-com.recursos.biblioteca.upc.edu/book/9780123821003/fluid-mechanics>. ISBN 9780123821003.
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RESOURCES

Other resources:

Notes and transparencies in ATENEA.

Web links:

Series of 39 videos and accompanying texts that revolutionized the teaching of Fluid Mechanics

<http://web.mit.edu/hml/ncfmf.html> />Computational Fluid Dynamics (CFD) website:

www.cfd-online.com