

Course guide

330518 - MF - Mechanics of Fluids

Last modified: 25/05/2023

Unit in charge: Manresa School of Engineering
Teaching unit: 750 - EMIT - Department of Mining, Industrial and ICT Engineering.

Degree: BACHELOR'S DEGREE IN AUTOMOTIVE ENGINEERING (Syllabus 2017). (Compulsory subject).

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

LECTURER

Coordinating lecturer: Pérez Ràfols, Francisco

Others: Pérez Ràfols, Francisco

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:

CE7. Knowledge of the basic principles of fluid mechanics and its application to problem solving in the field of engineering. Ability to design and interpret fluid dynamics systems.

Generical:

CG3. Knowledge of basic and technological subjects that will enable students to learn new methods and theories and that will endow them with the versatility needed to adapt to new situations.

CG4. Ability to solve problems with initiative, decision-making, creativity, critical reasoning and to communicate and transmit knowledge, skills and skills in the field of automotive engineering.

Transversal:

1. 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.

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

3. 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.

4. THIRD LANGUAGE. Learning a third language, preferably English, to a degree of oral and written fluency that fits in with the future needs of the graduates of each course.

5. SUSTAINABILITY AND SOCIAL COMMITMENT - Level 2. Applying sustainability criteria and professional codes of conduct in the design and assessment of technological solutions.

Basic:

CB3. That students have the ability to gather and interpret relevant data (usually within their area of study) to make judgments that include a reflection on relevant social, scientific or ethical issues.

TEACHING METHODOLOGY

MD2 Problem solving and case study (RP)
MD3 Practical work in a laboratory or workshop (TP)
MD4 Guided theoretical-practical work (TD)
MD5 Small-scale project, activity or work (PR)
MD7 Evaluation Activities (EV)

LEARNING OBJECTIVES OF THE SUBJECT

The subject aims to provide specific knowledge about mechanics of fluids.

The different learning objectives include:

- To know the main kinematic, thermodynamic and physical properties of fluids.
- Know and be able to analyse fluids from the point of view of control volume the conservative equations of mass, amount of movement and energy.
- Know and be able to analyse fluids from the differential point of view the conservative equations of mass, amount of movement and energy.
- Know the different types of fluid flows and their characterization.
- Know the Navier-Stokes equations for an incompressible viscous fluid.
- Know and be able to analyse experimental techniques applied to fluids.
- Know the mathematical methods related to the simulation of fluid flows (internal and external)
- Know and be able to analyse the principal techniques of dimensional analysis

STUDY LOAD

Type	Hours	Percentage
Hours small group	30,0	26.67
Hours large group	15,0	13.33
Self study	67,5	60.00

Total learning time: 112.5 h

CONTENTS

Title of content 1: Introduction to fluids. Properties

Description:

Title of content 1: Introduction to fluids. Properties

Specific objectives:

- Know the mechanical characteristics of fluids.
- To know the treatment of the continuous medium.
- Know the kinematic, thermodynamic and physical properties of fluids.

Related activities:

- Class problems (Activity 1)
- Theory tests (Activity 2)
- Individual evaluation (Activity 4)

Full-or-part-time: 15h

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



Title of content 2: Fluid Statics

Description:

Introduction to fluid statics. Hydrostatic pressure. Pressure forces.

Specific objectives:

To know the concept of hydrostatic pressure

To know, to understand and to analyse the forces that a static fluid impose on a surface, as well as the floatability of bodies.

To know, to understand and to analyse the movement of fluids as rigid solids

Related activities:

Class problems (Activity 1)

Theory tests (Activity 2)

Individual delivery of problems (Activity 3)

Individual evaluation (Activity 4)

Full-or-part-time: 15h

Theory classes: 2h

Laboratory classes: 4h

Self study : 9h

Title of content 3: Comprehensive relationships for control volumes

Description:

Basic laws of fluid mechanics. Reynolds's theorem. Conservative laws from the Eulerian point of view.

Specific objectives:

To know, to understand and to analyse fluids from the point of view of the volume of control, applying the basic laws of the mechanics of fluids

Related activities:

Class problems (Activity 1)

Theory tests (Activity 2)

Individual delivery of problems (Activity 3)

Individual evaluation (Activity 4)

Individual evaluation (Activity 6)

Full-or-part-time: 30h

Theory classes: 4h

Laboratory classes: 8h

Self study : 18h



Title of content 4: Differential relationships for a fluid particle

Description:

Conservative laws from the Lagrangian point of view

Specific objectives:

Know, understand and analyse fluids from a differential point of view, applying the basic laws of fluid mechanics.

Know and understand the Navier-Stokes equations

Know the basic methods used to analyse numerically fluid mechanics problems

Related activities:

Theory tests (Activity 2)

Group work (Activity 5)

Individual evaluation (Activity 6)

Full-or-part-time: 15h

Theory classes: 2h

Laboratory classes: 4h

Self study : 9h

Title of content 5: Dimensional analysis and similarity

Description:

Dimensional analysis and similarity

Specific objectives:

To know and understand the concept of non-dimensional group and how to find them

To know and understand the concept of similarity and understand its use in the experimental study of models

Related activities:

Class problems (Activity 1)

Theory tests (Activity 2)

Individual delivery of problems (Activity 3)

Individual evaluation (Activity 6)

Full-or-part-time: 15h

Theory classes: 2h

Laboratory classes: 4h

Self study : 9h



Title of content 6: Internal flow. Unidirectional flow

Description:

Internal flow. Loss of energy due to friction.

Applications of unidirectional flow: laminar flow, boundary layer, lubrication.

Specific objectives:

Understand the unidirectional flows: laminar and turbulent flows between two surfaces and in pipes.

Know the boundary layer of fluids

Know and understand the basic theory of hydrodynamic lubrication

Related activities:

Class problems (Activity 1)

Theory tests (Activity 2)

Individual delivery of problems (Activity 3)

Individual evaluation (Activity 6)

Full-or-part-time: 22h 30m

Theory classes: 3h

Laboratory classes: 6h

Self study : 13h 30m



ACTIVITIES

Activity 1: Class problems

Description:

Solve and deliver a problem in every small-group class

Specific objectives:

Group work.

Solvent use of the information sources.

Third Language.

Material:

In the virtual campus "ATENEA"

Delivery:

5 % of the grade

Related competencies :

CG3. Knowledge of basic and technological subjects that will enable students to learn new methods and theories and that will endow them with the versatility needed to adapt to new situations.

CG4. Ability to solve problems with initiative, decision-making, creativity, critical reasoning and to communicate and transmit knowledge, skills and skills in the field of automotive engineering.

CE7. Knowledge of the basic principles of fluid mechanics and its application to problem solving in the field of engineering. Ability to design and interpret fluid dynamics systems.

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.

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.

03 TLG. THIRD LANGUAGE. Learning a third language, preferably English, to a degree of oral and written fluency that fits in with the future needs of the graduates of each course.

CB3. That students have the ability to gather and interpret relevant data (usually within their area of study) to make judgments that include a reflection on relevant social, scientific or ethical issues.

Full-or-part-time: 6h

Laboratory classes: 6h



Activity 2: Theory tests in class

Description:

Videlectures must be viewed and theoretical material must be studied prior to class. At the beginning of each large group session, a test will be performed to assess the degree of knowledge on the basic theory.

Specific objectives:

Development of reasoning techniques and strategies for the analysis.

Solvent use of the information sources.

Third Language.

Material:

Video-lectures and theoretical materials in the virtual campus "ATENEA" and bibliografia

Delivery:

5 % of the grade

Related competencies :

CG3. Knowledge of basic and technological subjects that will enable students to learn new methods and theories and that will endow them with the versatility needed to adapt to new situations.

CE7. Knowledge of the basic principles of fluid mechanics and its application to problem solving in the field of engineering. Ability to design and interpret fluid dynamics systems.

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Full-or-part-time: 6h

Self study: 6h



Activity 3: Individual delivery of problems

Description:

Solve and submit, individually, six problems

Specific objectives:

Development of reasoning techniques and strategies for the analysis.

Written and oral communication.

Solvent use of the information sources.

Third Language.

Material:

In the virtual campus "ATENEA"

Delivery:

10 % of the grade

Related competencies :

CG3. Knowledge of basic and technological subjects that will enable students to learn new methods and theories and that will endow them with the versatility needed to adapt to new situations.

CG4. Ability to solve problems with initiative, decision-making, creativity, critical reasoning and to communicate and transmit knowledge, skills and skills in the field of automotive engineering.

CE7. Knowledge of the basic principles of fluid mechanics and its application to problem solving in the field of engineering. Ability to design and interpret fluid dynamics systems.

03 TLG. THIRD LANGUAGE. Learning a third language, preferably English, to a degree of oral and written fluency that fits in with the future needs of the graduates of each course.

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.

Full-or-part-time: 6h

Self study: 6h



Activity 4: Individual evaluation 1

Description:

Written individual test, performed in class.

Specific objectives:

Development of reasoning techniques and strategies for the analysis.

Written and oral communication.

Third Language.

Material:

Calculator, paper, pen

Delivery:

30 % of the grade

Related competencies :

CG3. Knowledge of basic and technological subjects that will enable students to learn new methods and theories and that will endow them with the versatility needed to adapt to new situations.

CG4. Ability to solve problems with initiative, decision-making, creativity, critical reasoning and to communicate and transmit knowledge, skills and skills in the field of automotive engineering.

CE7. Knowledge of the basic principles of fluid mechanics and its application to problem solving in the field of engineering. Ability to design and interpret fluid dynamics systems.

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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.

Full-or-part-time: 2h

Theory classes: 2h



Activity 6: Group Work

Description:

Construct, in groups, a model of internal flow and evaluate it using simulation techniques (using the program SimScale). The results will be presented through a written report and an oral presentation.

Specific objectives:

Development of reasoning techniques and strategies for the analysis.

Written and oral communication.

Teamwork.

Solvent use of the information sources.

Third Language.

Material:

In the virtual campus "ATENEA"

Delivery:

10 % of the grade

Related competencies :

CG4. Ability to solve problems with initiative, decision-making, creativity, critical reasoning and to communicate and transmit knowledge, skills and skills in the field of automotive engineering.

CG3. Knowledge of basic and technological subjects that will enable students to learn new methods and theories and that will endow them with the versatility needed to adapt to new situations.

CE7. Knowledge of the basic principles of fluid mechanics and its application to problem solving in the field of engineering. Ability to design and interpret fluid dynamics systems.

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.

02 SCS N2. SUSTAINABILITY AND SOCIAL COMMITMENT - Level 2. Applying sustainability criteria and professional codes of conduct in the design and assessment of technological solutions.

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CB3. That students have the ability to gather and interpret relevant data (usually within their area of study) to make judgments that include a reflection on relevant social, scientific or ethical issues.

Full-or-part-time: 16h

Laboratory classes: 4h

Self study: 12h



Activity 6: Individual evaluation 2

Description:

Written individual test, performed in class.

Specific objectives:

Development of reasoning techniques and strategies for the analysis.

Written and oral communication.

Third Language.

Material:

Calculator, paper, pen

Delivery:

35 % of the grade

Related competencies :

CG4. Ability to solve problems with initiative, decision-making, creativity, critical reasoning and to communicate and transmit knowledge, skills and skills in the field of automotive engineering.

CG3. Knowledge of basic and technological subjects that will enable students to learn new methods and theories and that will endow them with the versatility needed to adapt to new situations.

CE7. Knowledge of the basic principles of fluid mechanics and its application to problem solving in the field of engineering. Ability to design and interpret fluid dynamics systems.

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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.

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Full-or-part-time: 2h

Theory classes: 2h

GRADING SYSTEM

Activity 1: 5 % grade

Activity 2: 5 % grade

Activity 3: 10 % grade

Activity 4: 35 % grade

Activity 5: 10 % grade

Activity 6: 35 % grade

EXAMINATION RULES.

It is essential to have attended a minimum of four activities to pass the course. Regarding activities 1, 2 and 3, it is necessary to submit a minimum of 60 % of the assignments to consider them attended.



BIBLIOGRAPHY

Basic:

- Currie, Iain G. Fundamental mechanics of fluids. 4th ed. Boca Raton: CRC Press, 2013. ISBN 9781439874608.
- Çengel, Yunus A.; Cimbala, John M. Mecánica de fluidos: fundamentos y aplicaciones [on line]. Cuarta edición. México, DF: McGraw-Hill, 2018 [Consultation: 08/06/2022]. Available on: https://www-ingebook-com.recursos.biblioteca.upc.edu/ib/NPcd/IB_BooksVis?cod_primaria=1000187&codigo_libro=8102. ISBN 9781456260941.
- White, Frank M. Mecánica de fluidos [on line]. 6ª ed. Madrid: McGraw-Hill, 2008 [Consultation: 03/06/2022]. Available on: https://www-ingebook-com.recursos.biblioteca.upc.edu/ib/NPcd/IB_BooksVis?cod_primaria=1000187&codigo_libro=4144. ISBN 9788448166038.

Complementary:

- Fernández Oro, Jesús Manuel. Técnicas numéricas en ingeniería de fluidos: introducción a la dinámica de fluidos computacional (CFD) por el método de volúmenes finitos [on line]. Barcelona: Reverté, 2012 [Consultation: 01/12/2021]. Available on: <https://ebookcentral-proquest-com.recursos.biblioteca.upc.edu/lib/upcatalunya-ebooks/detail.action?docID=3429852>. ISBN 9788429126020.

RESOURCES

Other resources:

Notes, presentations and problems in the digital campus "ATENEA"