Course guide
330524 - FLU - Fluid Dynamics

Last modified: 04/05/2023

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:** 6.0 **Languages:** English

LECTURER

Coordinating lecturer: Vives Costa, Jordi

Others: Felipe Blanch, Jose Juan De

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.

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

MD1 Master class or conference (EXP)
MD2 Problem solving and case studies (PR)
MD3 Practical work in laboratory or workshop (TP)
MD5 Reduced scope project, activity or work (PR)
MD7 Evaluation activities (EV)

LEARNING OBJECTIVES OF THE SUBJECT

The learning objectives of the course are:

1.- The application of the principles of Fluid Mechanics for the study and solution of real problems within the scope of Automotive Engineering, such as Aerodynamics as well as the Machines and Hydraulic Systems incorporated in Automobiles.
2.- To use the fundamentals of Fluid Mechanics in the design and optimization of automotive vehicles.
3.- Solving complex aerodynamic problems through CFD methodologies.

STUDY LOAD

Type	Hours	Percentage
Self study	90,0	60.00
Hours large group	30,0	20.00
Hours small group	30,0	20.00

Total learning time: 150 h

CONTENTS

Title of the content 1: External Flow. Principles of Aerodynamics.

Description:
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Specific objectives:
To know Prandtl's theory of the Boundary Layer.
To know the resistance on flat smooth and rough plate.
To know the aerodynamic forces on a body, the sustenance and the resistance of form.
To know the phenomena associated with external flow on a body, such as Von Karmán's vortexes, vibrations and aerodynamic noise.

Related activities:
Specific work on the contents (Activity 1)
Individual Evaluation (Activity 5)

Full-or-part-time: 30h
Theory classes: 4h
Laboratory classes: 8h
Self study : 18h

Title of content 2: Aerodynamics applied to the automotive industry.

Description:
Application of the principles of Aerodynamics in the design and optimization in the automotive field.

Specific objectives:
Elaboration of the Aero-maps.
Knowing the aerodynamic elements of a vehicle
Knowing the aero post rig methodology.

Related activities:
Specific work on the contents (Activity 2)
Individual Evaluation (Activity 5)

Full-or-part-time: 45h
Theory classes: 6h
Laboratory classes: 12h
Self study : 27h

Title of contents 3: Hydraulic machines.

Description:
Study of hydraulic machines applied in the field of automotive engineering.

Specific objectives:
To know the different types of hydraulic machines: volumetric and fluid-dynamics, both the generating and the motor ones.
To know Euler's laws for hydraulic turbomachines.
To know the similarity laws for hydraulic turbomachines.
To know the cavitation phenomenon as well as the transitory phenomena in hydraulic machines, such as the water hammer.
Design of pumps, turbines and fans.

Related activities:
Specific work on the contents (Activity 3)
Individual Evaluation (Activity 5)

Full-or-part-time: 45h
Theory classes: 6h
Laboratory classes: 12h
Self study : 27h

Title of the content 4: Fluid dynamic systems.

Description:
Fluid-dynamic systems for power transmission and control.

Specific objectives:
To know the elements that compose the pneumatic and oil-hydraulic systems.
To know the applications of pneumatic and oil-hydraulic systems in the field of automotive engineering.
Design of pneumatic and oil-hydraulic circuits and their control systems.

Related activities:
Specific work on the contents (Activity 4)
Individual Evaluation (Activity 5)

Full-or-part-time: 30h
Theory classes: 4h
Laboratory classes: 8h
Self study : 18h

ACTIVITIES

Title of the activity 1: 2D simulation through CFD

Description:
Construction of a CFD model to study the aerodynamic behavior of 2D bodies. Study of the current lines and calculation of the resistance and lift coefficients.

Specific objectives:
Introduction to CFD simulation. Construction of the model, choice of the mesh, establishment of the boundary conditions, control variables of the solver, analysis and validation of the results.

Material:
Software HYPERWORKS.
ATENEA digital campus documentation and bibliography.

Delivery:
10 % of the continuous assessment grade.

Full-or-part-time: 6h
Laboratory classes: 2h
Self study: 4h

Title of activity 2: 3D simulation of a vehicle using CFD

Description:
Building a CFD model for the study of the aerodynamic behavior of a car in 3D. Study of current lines, vortexes, calculation of Drag and Lift coefficients and proposals for improvement.

Specific objectives:
Develop the pre-process, solver and post-process of a 3D vehicle CFD simulation. Construction of the model, choice of the mesh, establishment of the boundary conditions, control variables of the solver, analysis and validation of results. Elaboration of improvement proposals.

Material:
Software HYPERWORKS.
ATENEA digital campus documentation and bibliography.

Delivery:
30 % of the continuous assessment grade.

Full-or-part-time: 18h
Laboratory classes: 6h
Self study: 12h

Title of the activity 3: Design of the drive unit for a thermal engine cooling system

Description:
Design a drive unit for a heat engine cooling system.

Specific objectives:
Apply the principles of fluid dynamic machines and CFD simulation techniques in the design of a coolant drive unit for a heat engine.

Material:
Software HYPERWORKS.
ATENEA digital campus documentation and bibliography.

Delivery:
10 % of the continuous assessment grade.

Full-or-part-time: 6h
Laboratory classes: 2h
Self study: 4h

Title of the activity 4: Pneumatic and oil-hydraulic systems

Description:
Design of a pneumatic and/or oil-hydraulic power transmission and control system.

Specific objectives:
Learn about pneumatic and oil-hydraulic technology.
Design a pneumatic and/or oil-hydraulic power transmission and control system, choose its components and assemble the system in the laboratory.

Material:
Laboratory material.
ATENEA digital campus documentation and bibliography.

Delivery:
10 % of the continuous assessment grade.

Full-or-part-time: 6h
Laboratory classes: 2h
Self study: 4h

Title of Activity 5: Individual Assessment Test

Description:
Individual written test on the contents of the course.

Specific objectives:
Develop techniques and reasoning strategies for analysis.

Material:
Scientific form and calculator.

Delivery:
Scientific calculator and forms.

Full-or-part-time: 2h
Laboratory classes: 2h

GRADING SYSTEM

Activity 1: 10 % of the grade
Activity 2: 30 % of the grade
Activity 3: 10 % of the grade
Activity 4: 10 % of the grade
Activity 5: 40 % of the grade

EXAMINATION RULES.

It is necessary to have done all the activities to pass the course.

BIBLIOGRAPHY

Basic:
- Anderson, John David. Fundamentals of aerodynamics [on line]. 6th ed. New York: McGraw-Hill Education, 2017 [Consultation: 31/05/2022]. Available on: https://ebookcentral-proquest-com.recursos.biblioteca.upc.edu/lib/upcatalunya-ebooks/detail.action?docID=5662650. ISBN 9781259129919.
- Sánchez Domínguez, Urbano. Máquinas hidráulicas. San Vicente (Alicante): Club Universitario, 2012. ISBN 9788415613008.
- Katz, Joseph. Race car aerodynamics: designing for speed. Revised 2nd ed. Cambridge: Bentley, 2006. ISBN 9780837601427.
- Creus Solé, Antonio. Neumática e hidráulica. 2ª ed. Barcelona: Marcombo, 2011. ISBN 9788426716774.

Complementary:
- Wendt, John F., ed. Computational fluid dynamics: an introduction [on line]. Berlin: Springer, 2009 [Consultation: 19/11/2020]. Available on: http://dx.doi.org/10.1007/978-3-540-85056-4. ISBN 9783540850557.
- Aragón González, Gerardo; Canales Palma, Aurelio; León Galicia, Alejandro. Introducción a la potencia fluida: neumática e hidráulica para ingenieros. Barcelona: Reverté, 2014. ISBN 9788429148039.

RESOURCES

Other resources:
Resources available on the ATENEA digital campus