220124 - Fluid Dynamic Technologies in Vehicles

Degree competences to which the subject contributes

Specific:
1. An understanding of, and skills for, the calculation, design and testing of machines.

2. An understanding of the basic principles of fluid mechanics and their application in solving engineering problems. The ability to calculate pipes, channels and fluid systems.

3. Applied knowledge of the fundamentals of fluid-mechanics systems and machines.

Teaching methodology

The course is divided into parts:
Theory classes
Practical classes
Self-study for doing exercises and activities.
In the theory classes, teachers will introduce the theoretical basis of the concepts, methods and results and illustrate them with examples appropriate to facilitate their understanding.
In the practical classes (in the classroom), teachers guide students in applying theoretical concepts to solve problems, always using critical reasoning. We propose that students solve exercises in and outside the classroom, to promote contact and use the basic tools needed to solve problems.
Students, independently, need to work on the materials provided by teachers and the outcomes of the sessions of exercises/problems, in order to fix and assimilate the concepts.
The teachers provide the curriculum and monitoring of activities (by ATENEA).

Learning objectives of the subject

At the end of the course, the student has to be able to:
Level 1 and 2:
- Describe the role of fluids on the road vehicles performance
- Explain the basic concepts associated with fluid technologies in road vehicles
Level 3
- Solve problems related to fluid flow in a road vehicle
- Use numerical and experimental tools for the analysis of fluid flows in a road vehicle
220124 - Fluid Dynamic Technologies in Vehicles

**Study load**

<table>
<thead>
<tr>
<th>Total learning time: 75h</th>
<th>Hours large group:</th>
<th>30h</th>
<th>40.00%</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Self study:</td>
<td>45h</td>
<td>60.00%</td>
</tr>
</tbody>
</table>

**Content**

**Module 1: Introduction**

<table>
<thead>
<tr>
<th>Description:</th>
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<tbody>
<tr>
<td>1.1 Review of fundamentals fluid dynamics concepts</td>
</tr>
<tr>
<td>1.2 Fluids in a vehicle</td>
</tr>
<tr>
<td>1.3 Aerodynamics of a vehicle</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Learning time: 15h</th>
</tr>
</thead>
<tbody>
<tr>
<td>Theory classes: 5h</td>
</tr>
<tr>
<td>Self study: 10h</td>
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</tbody>
</table>

**Module 2: Numerical techniques**

<table>
<thead>
<tr>
<th>Description:</th>
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</thead>
<tbody>
<tr>
<td>2.1 Introduction to CFD</td>
</tr>
<tr>
<td>2.2 Main numerical methods</td>
</tr>
<tr>
<td>2.3 Modellization of turbulence</td>
</tr>
<tr>
<td>2.4 Meshing</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Learning time: 32h</th>
</tr>
</thead>
<tbody>
<tr>
<td>Theory classes: 12h</td>
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<tr>
<td>Self study: 20h</td>
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</table>

**Module 3: Experimental techniques**

<table>
<thead>
<tr>
<th>Description:</th>
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</thead>
<tbody>
<tr>
<td>3.1 Wind tunnel</td>
</tr>
<tr>
<td>3.2 Anemometry</td>
</tr>
<tr>
<td>3.3 PIV</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Learning time: 28h</th>
</tr>
</thead>
<tbody>
<tr>
<td>Theory classes: 10h</td>
</tr>
<tr>
<td>Self study: 18h</td>
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</tbody>
</table>
# Planning of activities

<table>
<thead>
<tr>
<th>Activity</th>
<th>Description</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>ACTIVITY 1: EXERCISES PROPOSED IN THEORY CLASSES</td>
<td>Simple exercises and problems proposed in the course documentation.</td>
<td><strong>30h</strong>&lt;br&gt;Theory classes: <strong>13h</strong>&lt;br&gt;Self study: <strong>17h</strong></td>
</tr>
<tr>
<td>ACTIVITY 2: CONTROL 1</td>
<td>Control test made in theory class</td>
<td><strong>5h</strong>&lt;br&gt;Theory classes: <strong>1h</strong>&lt;br&gt;Self study: <strong>4h</strong></td>
</tr>
<tr>
<td>ACTIVITY 3: CONTROL 2</td>
<td>Control test made in theory class</td>
<td><strong>5h</strong>&lt;br&gt;Theory classes: <strong>1h</strong>&lt;br&gt;Self study: <strong>4h</strong></td>
</tr>
<tr>
<td>ACTIVITY 4: EXAM</td>
<td>Exam</td>
<td><strong>11h</strong>&lt;br&gt;Theory classes: <strong>3h</strong>&lt;br&gt;Self study: <strong>8h</strong></td>
</tr>
<tr>
<td>ACTIVITY 5: LAB SESSION. INTRODUCTION TO CFD</td>
<td>Lab session for introduction to CFD</td>
<td><strong>4h</strong>&lt;br&gt;Theory classes: <strong>2h</strong>&lt;br&gt;Self study: <strong>2h</strong></td>
</tr>
</tbody>
</table>

**Support materials:**
- CFD software
- Computer
- Course notes
- Lab sessions guide
### ACTIVITY 6: LAB SESSION. AERODYNAMICS OF AN AIRFOIL

**Description:**
The aerodynamics forces over a 2D airfoil will be calculated

**Support materials:**
- CFD software
- Computer
- Course notes
- Lab sessions guide

**Hours:** 4h
- Theory classes: 2h
- Self study: 2h

### ACTIVITY 7: LAB SESSION. AERODYNAMICS OF A VEHICLE

**Description:**
The aerodynamics forces over a 3D vehicle will be calculated

**Support materials:**
- CFD software
- Computer
- Course notes
- Lab sessions guide

**Hours:** 4h
- Theory classes: 2h
- Self study: 2h

### ACTIVITY 8: LAB SESSION. MEASUREMENT OF AERODYNAMIC FORCES

**Description:**
The aerodynamic forces on a vehicle model in a wind tunnel will be measured by means of a balance

**Support materials:**
- Wind tunnel
- Aerodynamic balance
- Computer
- Course notes
- Lab sessions guide

**Hours:** 4h
- Theory classes: 2h
- Self study: 2h

### ACTIVITY 9: LAB SESSION. CTA ANEMOMETRY

**Description:**
The turbulence of an air jet will be measured

**Hours:** 4h
- Theory classes: 2h
- Self study: 2h
ACTIVITY 10: LAB SESSION. PIV

Description:
The velocity field around a body will be measured

Support materials:
- Lab material for PIV
- Computer
- Course notes
- Lab sessions guide

Hours: 4h
- Theory classes: 2h
- Self study: 2h

Qualification system

The final grade depends on the following assessment criteria:

- Exam, weight: 50 %
- Class works, weight: 10 %
- Controls, weight: 20 %
- Laboratory, weight: 20 %

Bibliography

Basic:


Complementary:

