# 240649 - Aerodynamics

**Coordinating unit:** 240 - ETSEIB - Barcelona School of Industrial Engineering  
**Teaching unit:** 729 - MF - Department of Fluid Mechanics  
**Academic year:** 2018  
**Degree:**  
- BACHELOR'S DEGREE IN INDUSTRIAL TECHNOLOGY ENGINEERING (Syllabus 2010). (Teaching unit Optional)  
- BACHELOR'S DEGREE IN MATERIALS ENGINEERING (Syllabus 2010). (Teaching unit Optional)  
- BACHELOR'S DEGREE IN CHEMICAL ENGINEERING (Syllabus 2010). (Teaching unit Optional)  
**ECTS credits:** 4.5  
**Teaching languages:** Catalan, Spanish

## Teaching staff

**Coordinator:** Carme Valero  
**Others:** Carme Valero  
Eduard Egusquiza Estevez

## Opening hours

**Timetable:**  
- Monday de 10:30-12:30  
- Wednesday de 10:30-12:30  
- Thursday 17:00-19:00

## Prior skills

Students must have basic knowledge of Fluid Mechanics

## Requirements

Recomendable would have passed the course of Fluid Mechanics

## Teaching methodology

There are two types of sessions: theoretical and practical. In the theoretical sessions the teacher will explain the relevant subject. In practical sessions, through a program of simulation, students will implement different studied cases. The theoretical sessions will be on Mondays and practical sessions on Wednesdays.

## Learning objectives of the subject

The aim of the course is to introduce students to the world of aerodynamics. The prediction of forces and moments on different type of bodies moving through a fluid (usually air) is one of the main objectives. First of all, flows over airplane wing profiles both at low and high speeds (sonic or supersonic flow) are studied. Then, will be also study flows around buildings and flows around road vehicles.
## Study load

<table>
<thead>
<tr>
<th>Total learning time: 112h 30m</th>
<th>Hours large group: 0h 0.00%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hours medium group:</td>
<td>45h 40.00%</td>
</tr>
<tr>
<td>Hours small group:</td>
<td>0h 0.00%</td>
</tr>
<tr>
<td>Guided activities:</td>
<td>0h 0.00%</td>
</tr>
<tr>
<td>Self study:</td>
<td>67h 30m 60.00%</td>
</tr>
</tbody>
</table>
### 1. INTRODUCTION

**Description:**
L' aim of this chapter is to introduce students to the basic definitions and objectives of the course.

**Learning time:** 2h  
Practical classes: 2h

### 2. FUNDAMENTAL PRINCIPLES AND BASIC EQUATIONS

**Description:**
This chapter gives an overview of the fundamental equations of fluid mechanics. These equations are then customizing to the case of external turbulent flow, which is what will be discussed throughout the course. Just consider the equations as simplified and ready to use throughout the next chapters.

**Specific objectives:**
Remembering equations of Fluid Mechanics and know how to apply for the case of external flow around bodies.

**Learning time:** 4h  
Practical classes: 4h

### 3. FUNDAMENTALS OF INVISCID AND INCOMPRESSIBLE FLOW. FLOW AROUND A WING PROFILE

**Description:**
Equations for inviscid incompressible flow from the potential flow methods are resolved and applied to the case of an aircraft wing profile to give theoretical results. The validity of the solutions discussed theoretical results contrast with the experimental results found in the literature.

**Specific objectives:**
It obtained the equations for incompressible and irrotational flow. The main simple flows and the most important combinations of simple flows are described. The flow around a cylinder with and without circulation is obtained and its application to flow around a profile.

**Learning time:** 5h  
Practical classes: 5h

### 5. COMPRESSIBLE FLOW AROUND WING PROFILES

**Description:**
An introduction to compressible flow around airplane wing profiles is considered in this chapter. The application of this study is to determine the main features of the flow around a profile of the subsonic and supersonic aircraft in flight, i.e., when the flight speed are of the order or higher than the speed of sound.

**Specific objectives:**
Knowing the peculiarities of compressible and incompressible flow and to know the difference between them. To establish what is the most suitable geometry for subsonic and supersonic flight and why.

**Learning time:** 5h  
Practical classes: 5h
### 5. FLOW CONTROL AND PROFILES DESIGN

**Learning time:** 4h  
**Practical classes:** 4h

**Description:**
This chapter tries to describe simple elements and multielements to maximize aerodynamic lift in the case of airplane wing profiles. To minimize the drag, boundary layer control for the prevention of separation is introduced.

**Specific objectives:**
Students must know the functionality of different elements that can be added to wings to get more lift with minimal drag.

### 6. ROAD VEHICLE AERODYNAMICS

**Learning time:** 5h  
**Practical classes:** 5h

**Description:**
The subject of this part is the analysis of the airflow around a vehicle and the relationship between its shape and the resulting aerodynamic characteristics. The contribution of different parts of the body on the drag and lift force is considered.

**Specific objectives:**
Differences between flow around vehicles and flow around profiles. Evolution of pressure and velocity fields around the main forms of vehicles, knowing how to optimize them and understanding the phenomena that happen locally in areas such as mirrors, wheels, antennas.

### 7. FLOW AROUND BUILDINGS

**Learning time:** 5h  
**Practical classes:** 5h

**Description:**
In this chapter the main features of the flow around buildings are defined. Phenomena are described first from the static point of view (averaged forces and moments) and then a review is made to the different dynamic phenomena that may appear in most modern buildings.

**Specific objectives:**
Understanding the causes and consequences of both static and dynamic forces that makes the wind on buildings.
Planning of activities

<table>
<thead>
<tr>
<th>SIMULATION OF FLOW FLUID AROUND A BODY. AERODYNAMIC OPTIMIZATION OF</th>
<th>Hours: 15h</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Description:</strong></td>
<td>Laboratory classes: 15h</td>
</tr>
<tr>
<td>Some initial geometries of different bodies are presented. Students have to choose one of them. From basic geometry, forces and moments exerted on the body by the fluid are calculated by fluid dynamic simulation (software FLUENT-ANSYS). From there, according to the chosen body, students will propose geometrical improvements to achieve better aerodynamic performance.</td>
<td></td>
</tr>
</tbody>
</table>

Support materials:

Package ANSYS-FLUENT includes CAD program for manipulating geometry, meshing program to define the various points where the fluid equations have to be solved and simulation program to make the calculations and solve the problem. The program is available to students not only during classes but always throughout the school year. Necessary tutorials to get started with the program are also available.

Descriptions of the assignments due and their relation to the assessment:

Deliveries will be made in three parts along the course. The first delivery will be done after the fourth session (20% of mark), the second delivery will be made after the ninth session (20% of mark) and the third delivery will be made in the last session (60% of mark). A document will be delivered in each case with the results achieved. The last delivery will be to a PDF where the work and the objectives achieved will be described. Each group will also conduct a brief oral presentation.

Specific objectives:

The main objective is that the student solves a aerodynamics problem in general. To improve some parts of the geometry, a fluid dynamics analysis of the initial geometry is done. Then he can verify the improvement from the point of view of numerical simulation. This should be done throughout the course, so he can go applying his knowledge.
240649 - Aerodynamics

**Qualification system**

\[
\text{final mark} = 0.4 \times \text{final exam} + 0.2 \times \text{midterm exam} + 0.4 \times \text{simulation work}
\]

**Bibliography**

**Basic:**


**Complementary:**