Experimental techniques play an essential role in all fields of science and technology. They contribute to the understanding of physical phenomena and facilitate the creation of models for study and analysis. In addition, experimental techniques are vital for the diagnosis, monitoring and control of processes, as well as for product evaluation and certification. The scope of experimental techniques is very extensive and varied, as are the different techniques used. Focusing in the field of low-speed aerodynamics, the main objective of Aerospace Laboratories is to provide students an overview of the most typical experimental techniques applied in sciences and engineering. The course is intended to help the students to acquire an adequate understanding of the principles of operation of the instruments and the methodology to conduct experimental procedures, and to develop their ability to generate and critically analyze experimental data.
220350 - Aerospace Laboratories

<table>
<thead>
<tr>
<th>Study load</th>
<th>Hours large group:</th>
<th>30h</th>
<th>24.00%</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Hours small group:</td>
<td>15h</td>
<td>12.00%</td>
</tr>
<tr>
<td></td>
<td>Self study:</td>
<td>80h</td>
<td>64.00%</td>
</tr>
</tbody>
</table>
### Content

#### Module 1

**Learning time:** 25h  
Theory classes: 8h  
Practical classes: 2h  
Self study: 15h

**Description:**  
Introduction to experimental aerodynamics.  
Fluid governing equations. Dimensional analysis and approximation levels. Similarity requirements and scale effects.  
Basics aspects of instrumentation and design of experiments.  
Errors and uncertainties in measurements.  
Overview of low-speed wind tunnels: constructive and operation features.

**Related activities:**  
Laboratory experiments to be determined.

#### Module 2

**Learning time:** 60h  
Theory classes: 12h  
Practical classes: 8h  
Self study: 40h

**Description:**  
Pressure and temperature measurements: basic instrumentation, operation principles and applications.  
Other typical measurements in fluid flows: velocity, volumetric flow, boundary layers and turbulence. Application of pitot-static probes and hot-wire techniques.  
Flow visualization techniques: overview and typical applications.

**Related activities:**  
Laboratory experiments to be determined.

#### Module 3

**Learning time:** 40h  
Theory classes: 10h  
Practical classes: 5h  
Self study: 25h

**Description:**  
Measurement of aerodynamic forces. Basic principles.  
Aerodynamic balances (internal and external). Indirect measurements (e.g. wake surveys).  
Wind-tunnel interference effects and its correction. Model-support interference. Classic boundary corrections for open and closed-section wind-tunnels.

**Related activities:**  
Laboratory experiments to be determined.
The course will be graded according to:

\[ NF = 0.4 \times N_{EX1} + 0.4 \times N_{EX2} + 0.2 \times N_{HW} \]

where NF is the final grade of the course, N_EX1 is the grade obtained in the first (mid-term) written exam, N_EX2 is the grade corresponding to the final written exam, N_HW is the arithmetic mean of the grades obtained in the lab reports (homework assignments). Both theoretical and practical (problems related to the laboratory work) aspects will be evaluated in the first and final written exams. Students who have not obtained a satisfactory grade in the first (mid-term) exam may repeat that test on the date scheduled for the final exam.

Students with a grade below 5.0 in any of the results, will be able to do an additional exam in order to compensate for the poor results. The new grade will replace the original only if it is higher. The maximum grade that can be obtained with this additional exam is 5.0.

For those students who meet the requirements and submit to the reevaluation examination, the grade of the reevaluation exam will replace the grades of all the on-site written evaluation acts (tests, midterm and final exams) and the grades obtained during the course for lab practices, works, projects and presentations will be kept. If the final grade after reevaluation is lower than 5.0, it will replace the initial one only if it is higher. If the final grade after reevaluation is greater or equal to 5.0, the final grade of the subject will be pass 5.0.

### Bibliography

**Basic:**


**Complementary:**