220352 - Advanced Aerodynamics

**Coordinating unit:** 205 - ESEIAAT - Terrassa School of Industrial, Aerospace and Audiovisual Engineering

**Teaching unit:** 220 - ETSEIAT - Terrassa School of Industrial and Aeronautical Engineering

**Academic year:** 2017

**Degree:** MASTER'S DEGREE IN AERONAUTICAL ENGINEERING (Syllabus 2014). (Teaching unit Optional)
MASTER'S DEGREE IN SPACE AND AERONAUTICAL ENGINEERING (Syllabus 2016). (Teaching unit Optional)

**ECTS credits:** 5

**Teaching languages:** English

### Prior skills

A basic understanding of low-speed aerodynamics is required.

### Degree competences to which the subject contributes

**Specific:**

- CEEVEHI1. MUEA/MAS: Sufficient applied knowledge of advanced, experimental and computational aerodynamics (specific competency for the specialisation in Aerospace Vehicles).
- CEEVEHI3. MUEA/MASE: Applied knowledge of composite materials technology and a capacity for designing the basic elements of these materials (specific competency for the specialisation in Aerospace Vehicles).
- CEEVEHI2. MUEA/MAS: Sufficient applied knowledge of the aeroelasticity and structural dynamics of aircraft (specific competency for the specialisation in Aerospace Vehicles).

### Teaching methodology

- **Theory lessons:** During these lectures the teacher will introduce the theoretical basis, analysis methods and important results. Where appropriate, illustrative examples will be discussed to improve the student's understanding of the subject.

- **Practice lessons:** During the practice sessions the student will solve, under supervision of the teacher, review exercises in order to gain experience in the application of the analysis methods taught during the theoretical lectures.

- **Exams:** During the exam sessions the student will demonstrate his understanding of the theory and problem solving skills. There will be an exam for each of the course modules.

- **Self-study:** While the teacher will present a short overview of the subjects in the classroom, it remains the duty of the student to gain a more in-depth understanding by going over the recommended references. This is fundamental in order to acquire the necessary abilities of critical thinking and autonomous problem-solving.

### Learning objectives of the subject

This course serves as an extension of the introductory aerodynamics subject taught to undergraduate students. Starting with a review of the foundations of low-speed aerodynamics, the students will be presented with an array of numerical techniques to obtain approximate solutions to real-world problems. The course focuses on inviscid flows, while also featuring a short introduction to the computation of viscous effects.
### Study load

<table>
<thead>
<tr>
<th>Total learning time: 125h</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>
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</tbody>
</table>
## 220352 - Advanced Aerodynamics

### Content

<table>
<thead>
<tr>
<th>Module 1: Review of low speed aerodynamics</th>
<th>Learning time: 34h</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Theory classes: 8h</td>
</tr>
<tr>
<td></td>
<td>Practical classes: 4h</td>
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<tr>
<td></td>
<td>Self study: 22h</td>
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</tbody>
</table>

**Description:**
1. Review of the fundamentals of fluid dynamics:
   - Basic equations
   - Dimensionless parameters
   - Incompressible potential flow

**Related activities:**
- Theory lessons
- Practice lessons
- Module 1 exam

<table>
<thead>
<tr>
<th>Module 2: Panel methods for low speed flows</th>
<th>Learning time: 66h</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Theory classes: 16h</td>
</tr>
<tr>
<td></td>
<td>Practical classes: 8h</td>
</tr>
<tr>
<td></td>
<td>Self study: 42h</td>
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</tbody>
</table>

**Description:**
- Green’s theorem
- Low order and high order panel methods for airfoil analysis
- Lifting-line method for slender wings
- Panel methods for lifting surfaces
- Panel methods for arbitrary 3D shapes

**Related activities:**
- Theory lessons
- Practice lessons
- Module 2 exam
In principle, the final course grade is a weighted average of the grades awarded in the exams of the 3 course modules. However, the final exam includes all the contents of the course, so it serves also as a retake for students whose average grade is not satisfactory. The final course grade shall be the maximum of the weighted average and the final exam result:

$$\text{Final grade} = \text{MAX}(\text{Exam}_3, \text{Average\_grade})$$

where

$$\text{Average\_grade} = 0,30\cdot\text{Exam}_1 + 0,35\cdot\text{Exam}_2 + 0,35\cdot\text{Exam}_3$$

### Bibliography

#### Basic:


#### Complementary: