220024 - 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: 2018
Degree: BACHELOR’S DEGREE IN AEROSPACE TECHNOLOGY ENGINEERING (Syllabus 2010). (Teaching unit Compulsory)
BACHELOR’S DEGREE IN AEROSPACE VEHICLE ENGINEERING (Syllabus 2010). (Teaching unit Compulsory)
ECTS credits: 6
Teaching languages: Spanish

Teaching staff
Coordinator: Ortega, Enrique
Others: A definir

Opening hours
Timetable: To be scheduled at the beginning of the course

Prior skills
This course requires background knowledge of fluid mechanics and basic concepts of thermodynamics and mechanics. It is also recommended that students have basic programming skills (high-level languages) and reading comprehension in English, as the literature for this subject comes mostly from sources in that language.

Degree competences to which the subject contributes
Specific:
- TA/VA-CE10. GrETA/GrEVA - An understanding of how aerodynamic forces determine flight dynamics and the role of the different variables involved in flight.
- TA/VA-CE20. GrETA/GrEVA - Adapted and applied to engineering knowledge: fracture mechanics and continuum approaches dynamic fatigue of structural instability and aeroelasticity.

Teaching methodology
During the course two weekly sessions will be held (2 hours each). Each session will be divided into a theoretical part, in which the contents of the subject will be developed, and a practical part, where typical application problems will be solved in order to provide students with a better understanding of the theoretical contents. The percentage of time devoted to theory and problem solving in each session will be adjusted to the specific needs of each topic.

The course consists of 6 modules of study. For each module, students will have to resolve practical problems in an autonomous manner. The doubts that may arise in their solution will be fixed during the practical part of the classes, as well as during the hours of individualized tutoring.

The course will be graded by means of two written exams including both theoretical and practical parts. In addition, two homework activities (to be developed in small groups) will be proposed. These will be also taken into account to compute the final grade of the course (see "Sistema de Calificación").
The main objective of this course is to help students to acquire an adequate understanding of the fundamental concepts behind aerodynamic external flows, and develop their ability to analyze and solve aeronautics problems. The specific objectives of the course are the following:

- Analysis and prediction of aerodynamic performance of airfoils and wings using classical methods for incompressible and compressible flows.
- Analysis of the main aerodynamic characteristics of typical wing-body and wing-body-tail configurations.
- Introduction to simple numerical techniques for aerodynamic analysis and computational implementation. Application of the tools developed to solve typical airfoil and wing problems.
- Development of a critical attitude to assess the extent and suitability of the different methods available for solving specific problems in aerodynamics.

In order to achieve the objectives listed above, the incompressible thin-airfoil theory will be studied first, and applications to the solution of typical airfoil aerodynamics problems will be carried out. For the analysis of three-dimensional wings and related problems the classical finite-wing theory will be used. It is expected that during the course students implement simple numerical applications to solve both, airfoils and wings. Concerning compressible flows, the linearized theory for thin sections will be studied and aspects concerning the aerodynamic behavior of typical three-dimensional configurations in transonic and supersonic flows will be discussed.

### Study load

<table>
<thead>
<tr>
<th>Total learning time: 150h</th>
<th>Hours large group: 46h</th>
<th>30.67%</th>
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</thead>
<tbody>
<tr>
<td>Hours medium group:</td>
<td>14h</td>
<td>9.33%</td>
</tr>
<tr>
<td>Hours small group:</td>
<td>0h</td>
<td>0.00%</td>
</tr>
<tr>
<td>Guided activities:</td>
<td>0h</td>
<td>0.00%</td>
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<tr>
<td>Self study:</td>
<td>90h</td>
<td>60.00%</td>
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</table>
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## Content

<table>
<thead>
<tr>
<th>Module 1: Basic principles</th>
<th>Learning time: 15h</th>
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<tbody>
<tr>
<td></td>
<td>Theory classes: 5h</td>
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<tr>
<td></td>
<td>Practical classes: 1h</td>
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<td></td>
<td>Self study: 9h</td>
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</tbody>
</table>

**Description:**

<table>
<thead>
<tr>
<th>Module 2: Airfoils in ideal incompressible flow</th>
<th>Learning time: 51h</th>
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<tbody>
<tr>
<td></td>
<td>Theory classes: 13h</td>
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<tr>
<td></td>
<td>Practical classes: 6h</td>
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<td></td>
<td>Self study: 32h</td>
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**Description:**

<table>
<thead>
<tr>
<th>Module 3: Finite wing in ideal incompressible flow</th>
<th>Learning time: 45h</th>
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<tbody>
<tr>
<td></td>
<td>Theory classes: 13h</td>
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<td></td>
<td>Practical classes: 5h</td>
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<td></td>
<td>Self study: 27h</td>
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</table>

**Description:**
The course will be graded according to

\[ NF = 0.4 \times N_{EX1} + 0.1 \times N_{HW1} + 0.1 \times N_{HW2} + 0.40 \times N_{EX2} \]

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 second (final) written exam, and \( N_{HW1} \) and \( N_{HW2} \) are the grades obtained in the two homework assignments.

Both theoretical and practical (problem solving) aspects will be evaluated in the first and final written exams. Students having a mark below 5 in the mid-term exam may repeat that test on the date scheduled for the final exam (additional time will be provided for this purpose). The resulting final mark for the mid-term exam will be a weighted average between the original (0.15) and the second-chance examination (0.85). If the grade obtained is lower than that corresponding to the original exam, the latter is preserved.

### Module 4: Ideal compressible flow analysis

**Description:**

**Learning time:** 25h
- Theory classes: 6h
- Practical classes: 4h
- Self study: 15h

**Qualification system**

The written exams will be performed in an individual manner and no additional material is allowed for their solution to that provided by the professors. The homework activities will be performed in small groups to be composed at the beginning of the course.
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Bibliography

Basic:


Complementary:


