220351 - Advanced Aeroelasticity

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: 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

Teaching staff
Coordinator: Roberto Flores

Prior skills
A basic understanding of low-speed aerodynamics and structural dynamics is required.

Requirements
Thus subject must be ALWAYS be followed together with the ADVANCED AERODYNAMICS (220352) course.

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).
CEEVEHI2. MUEA/MAS: Sufficient applied knowledge of the aeroelasticity and structural dynamics of aircraft (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).

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 introduction to the field of aeroelasticity. The course starts with a short review of the foundations of low-speed aerodynamics and vibration analysis. The students will then be presented with a qualitative overview of static and dynamic aeroelastic phenomena typical of hypersonic flows. Some numerical analysis techniques suitable for obtaining approximate solutions will also be introduced.
## Study load

<table>
<thead>
<tr>
<th>Description</th>
<th>Hours</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total learning time</td>
<td>125h</td>
<td></td>
</tr>
<tr>
<td>Hours large group</td>
<td>30h</td>
<td>24.00%</td>
</tr>
<tr>
<td>Hours small group</td>
<td>15h</td>
<td>12.00%</td>
</tr>
<tr>
<td>Self study</td>
<td>80h</td>
<td>64.00%</td>
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</tbody>
</table>
# Content

## Module 1: Review of low speed aerodynamics and vibration analysis

**Description:**
- Basic equations of fluid dynamics:
  - Simplifications for high-Re and low-M flows
  - Approximate solution methods
- Fundamentals of structural analysis and vibration analysis:
  - Basic structural theory
  - Vibrations of discrete systems

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

**Learning time:** 39h
- Theory classes: 10h
- Practical classes: 5h
- Self study: 24h

## Module 2: Steady aeroelastic phenomena

**Description:**
- Introduction to static aeroelastic phenomena:
  - Torsional divergence
  - Control reversal
  - Approximate solution methods

**Related activities:**
- Theory lessons
- Practice lessons
- Module 2 exam

**Learning time:** 43h
- Theory classes: 10h
- Practical classes: 5h
- Self study: 28h
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:

\[
\text{Final grade} = \text{MAX} (\text{Exam}_3, \text{Average}_\text{grade})
\]

where

\[
\text{Average}_\text{grade} = 0.30 \cdot \text{Exam}_1 + 0.35 \cdot \text{Exam}_2 + 0.35 \cdot \text{Exam}_3
\]

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.

**Qualification system**

**Module 3: Unsteady aeroelastic phenomena**

- **Learning time:** 43h
  - Theory classes: 10h
  - Practical classes: 5h
  - Self study: 28h

**Description:**
Introduction to dynamic aeroelastic phenomena:
- Gust response
- Flutter
- Buffeting
Approximate solution methods

**Related activities:**
- Theory lessons
- Practice lessons
- Module 3 exam

**Bibliography**

**Basic:**

**Complementary:**