220029 - Mechanical Systems

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

**Teaching unit:** 712 - EM - Department of Mechanical Engineering

**Academic year:** 2018

**Degree:** BACHELOR'S DEGREE IN AEROSPACE VEHICLE ENGINEERING (Syllabus 2010). (Teaching unit Compulsory)

**ECTS credits:** 6

**Teaching languages:** Catalan, Spanish

### Teaching staff

**Coordinator:** JOSE ANTONIO ORTIZ MARZO

**Others:** Ortiz Marzo, José Antonio
Díaz Gonzalez, Carlos Gustavo
Marañon, Ana

### Prior skills

In the development of this course have to take into consideration the properties and characteristics of the different materials used in aerospace machinery as well as manufacturing processes applicable to both the object of optimizing the design of the mechanical elements as their manufacture. It should also be interaction with this subject matter in the field of engines and the strength of materials.

The subjects of the qualifications that are more directly related to the design of the machines are linked to the Aeronautics Materials, Production Aerospace, Motors, Mechanical and Structural Theory.

### Degree competences to which the subject contributes

**Specific:**

1. GrETA/GrEVA - An adequate understanding of the following, as applied to engineering: fundamental elements of the various types of aircraft; functional elements of air navigation systems and related electrical and electronic installations; the basics of the design and construction of airports and their various elements

2. GrEVA - An adequate understanding of the following, as applied to engineering: calculation methods for aeronautical design and development; the use of aerodynamic experimentation and the most important parameters in theoretical application; the experimental techniques, equipment and measuring instruments used in the discipline; simulation, design, analysis and interpretation of in-flight experiments and operations; aircraft maintenance and certification systems.

**CE20.** GrETA/GrEVA - An adequate understanding of the following, as applied to engineering: fracture mechanics of continuous media and dynamic approaches, fatigue, structural instability and aeroelasticity.

**Generical:**

3. THE ABILITY TO ANALYSE AND SYNTHESISE: The ability to think abstractly about the fundamental concepts of a text or exposition and to intelligibly present the result of one's work.

**Transversal:**

4. TEAMWORK - Level 1. Working in a team and making positive contributions once the aims and group and individual responsibilities have been defined. Reaching joint decisions on the strategy to be followed.
220029 - Mechanical Systems

Teaching methodology

The teaching methodology is divided in three different types of activities:
* Presentations of contents.
* Practical sessions where professor mainly solve problems
* Autonomous work to study and develop proposed activities

During the contents presentation, the professor will introduce the basic theory of the subject, methodologies to solve the problems and examples to ease the comprehension.
In the practical sessions, the professor will guide the student to apply the contents presented in the theoretical sessions to applied problems. Homework problems will also be proposed, in order to expose the students to the typical tools used to solve that problems.
Student will have to self work with the material provided by the professor in order to fix the contents presented in the theoretical sessions. The professor will provide a programme in the Atenea

Learning objectives of the subject

The main goal of the subject Machine design in Aeronautics is that Aeronautical Engineers have the needed tools to successfully address any question related with the mechanical elements and machinery of the aircraft and of the space vehicles, from the design and maintenance point of view, as well as with the systems and the machinery of the airports.

Study load

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

<table>
<thead>
<tr>
<th>Module 1: Theory of fatigue</th>
<th>Learning time: 41h</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Theory classes: 12h</td>
</tr>
<tr>
<td></td>
<td>Laboratory classes: 4h</td>
</tr>
<tr>
<td></td>
<td>Self study: 25h</td>
</tr>
</tbody>
</table>

**Description:**
- Introduction to Mechanical Design
- Theories of fracture at constant load
- Fatigue in machine elements
- Calculation of axles and drive shafts

**Related activities:**
- Activities 1-2-3-4-5

<table>
<thead>
<tr>
<th>Module 2: Design of mechanical elements</th>
<th>Learning time: 33h</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Theory classes: 10h</td>
</tr>
<tr>
<td></td>
<td>Laboratory classes: 3h</td>
</tr>
<tr>
<td></td>
<td>Self study: 20h</td>
</tr>
</tbody>
</table>

**Description:**
- Design of screw connections
- Design of forced unions
- Design of other union elements
- Design of suspension elements, springs
- Mechanical transmissions with flexible elements
- Clutches and brakes

**Related activities:**
- Activities 1-2-3-4-5

<table>
<thead>
<tr>
<th>Module 3: Kinematics and dynamics of mechanisms</th>
<th>Learning time: 40h</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Theory classes: 12h</td>
</tr>
<tr>
<td></td>
<td>Laboratory classes: 3h</td>
</tr>
<tr>
<td></td>
<td>Self study: 25h</td>
</tr>
</tbody>
</table>

**Description:**
- Straight gears
- Helical gears
- Hyperbolic gears
- Calculation of the Module Gearbox

**Related activities:**
- Activities 1-2-3-4-5
### Module 4: Bearings and Lubrication

**Description:**
- Anti-friction bearings
- Sliding bearings
- Lubrication
- Type of lubrication

**Related activities:**
Activities 1-2-3-4-5

**Learning time:** 36h
- Theory classes: 12h
- Laboratory classes: 4h
- Self study: 20h

### Planning of activities

<table>
<thead>
<tr>
<th>ACTIVITY</th>
<th>Hours</th>
<th>Theory classes</th>
<th>Laboratory classes</th>
<th>Self study</th>
</tr>
</thead>
<tbody>
<tr>
<td>ACTIVITY 1: LARGE GROUP SESSIONS / THEORY</td>
<td>60h</td>
<td>40h</td>
<td>20h</td>
<td></td>
</tr>
<tr>
<td>ACTIVITY 2: SMALL GROUP SESSIONS / PRACTICES</td>
<td>34h</td>
<td>14h</td>
<td>20h</td>
<td></td>
</tr>
<tr>
<td>ACTIVITY 3: MIDTERM EXAM</td>
<td>12h</td>
<td>2h</td>
<td>10h</td>
<td></td>
</tr>
<tr>
<td>ACTIVITY 4: FINAL EXAM</td>
<td>12h</td>
<td>2h</td>
<td>10h</td>
<td></td>
</tr>
<tr>
<td>ACTIVITY 5: PROBLEMS PROPOSED</td>
<td>32h</td>
<td>2h</td>
<td>30h</td>
<td></td>
</tr>
</tbody>
</table>
The mark of the course depends on 5 items:
* 1st and 2nd activity: 10%
* 3rd activity (midterm exam): 30%
* 4th activity (final exam): 40%
* 5th activity (homeworks): 10%

The result of unsatisfactory Activity 3 (partial exam) can redirect through a written test to be held on the day fixed for the final exam scheduled on the same track (3 hours). This test can be accessed by students with a grade of less than 5 self-assessment. The rating of the test will be between 0 and 10, will have the weight corresponding to that activity. The grade for the application of renewal replace the initial qualification provided that it is superior.

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.

Activities 1 and 2 are done in group and written.
Activities 3 and 4 are done individually and written.

Basic:

Complementary: