220027 - Flight Mechanics

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

Teaching staff
Coordinator: Del Campo Sud, David
Others: Del Campo Sud, David

Opening hours
Timetable: To be arranged with the teacher.

Prior skills
Flight Mechanics require an accurate knowledge of Calculus, Differential Geometry, Classical Mechanics, Aerodynamics and Rigid Body Physics. The subjects that should have been taken in order to follow normally Flight Mechanics are: all related to Mathematics, Physics and Mechanics of the first years, plus Aerospace Vehicles (2nd A), Propulsive Systems (2nd B) and Aerodynamics (3rd A).

Degree competences to which the subject contributes

Specific:
1. GrETA - An adequate understanding of the following, as applied to engineering: physical phenomena of flight, flight qualities and control, aerodynamic and propulsive forces, performance and stability.

Teaching methodology
The theory lessons will consist in 2 hours-long lessons in which the teacher will introduce the basic fundamentals of the applied science “flight mechanics”.

The practical lessons will consist in 2 hours long tutored sessions where the teacher will present practical cases and the students, individually or in small groups, will have to solve them in order to obtain practical learning. The teacher will support the students, guiding them without harming the autonomous learning.

The mid-term and final exams will consist in a test, to evaluate theory, and a practical exercise with the same level of difficulty of the ones solved in class.

Learning objectives of the subject

The main objectives are:
1. Introduce the fundamental ideas in a rigorous way and calculus techniques of performances, stability and static and dynamic control of the airplanes.
2. Get the students to understand the fundamentals of Flight Mechanics.
3. Get the students to acquire the basic skills associated with the discipline.

Furthermore, it is intended to promote the use of self-criteria and the application of the critic sense to the applied science of Flight Mechanics. It will be emphasised the formulation of physical and mathematical models of simple flight that allow to approach more complex situations, in the extraction of conclusions about the influence of the parameters of design in airplane flight, in the application of theoretical methods that take place at non-conventional situation, and in the recognition of the conditions of validity of the obtained results.

**Study load**

<table>
<thead>
<tr>
<th>Total learning time: 150h</th>
<th>Hours large group:</th>
<th>32h</th>
<th>21.33%</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Hours medium group:</td>
<td>28h</td>
<td>18.67%</td>
</tr>
<tr>
<td></td>
<td>Self study:</td>
<td>90h</td>
<td>60.00%</td>
</tr>
</tbody>
</table>
## 1. Introduction to Flight Mechanics

**Description:** Introduction to Flight Mechanics

**Learning time:** 6h
- Theory classes: 2h
- Practical classes: 2h
- Self study: 2h

## 2. Basic reference systems

**Description:** The main reference systems employed in Flight Mechanics and the angular relationships between them are defined.

**Learning time:** 10h
- Theory classes: 2h
- Practical classes: 2h
- Self study: 6h

## 3. General equations of motion of a plane

**Description:** The Euler equations of motion of the plane are formulated.

**Learning time:** 10h
- Theory classes: 2h
- Practical classes: 2h
- Self study: 6h

## 4. Basic relations for the determination of performances

**Description:** The momentum theorem is set, the linear kinematic equations are developed, and the generic functional relationships for the aerodynamic and propulsive characteristics of the aircraft are established.

**Learning time:** 20h
- Theory classes: 4h
- Practical classes: 4h
- Self study: 12h
### 5. Glider performance

**Learning time:** 10h  
Theory classes: 2h  
Practical classes: 2h  
Self study: 6h

**Description:**  
Closed analytical solutions are deduced from the equations of quasi-stationary and quasi-rectilinear symmetric flight in a vertical plane, for the case of a glider.

### 6. Performance of planes with turbojets

**Learning time:** 18h  
Theory classes: 4h  
Practical classes: 4h  
Self study: 10h

**Description:**  
Integral and single-point performance of turbojet planes are analyzed.

### 7. Static longitudinal stability

**Learning time:** 18h  
Theory classes: 4h  
Practical classes: 2h  
Self study: 12h

**Description:**  
The static longitudinal stability of the aircraft is studied.

### 8. Static longitudinal control

**Learning time:** 10h  
Theory classes: 2h  
Practical classes: 2h  
Self study: 6h

**Description:**  
The static longitudinal controllability of the airplane is studied.
The final mark will be calculated from 2 exams and 2 practical exercises.

The partial exam (Ex_P) will evaluate lessons 1 - 7, and the final exam will evaluate lessons 8 - 12.

The exercises (Ej_1 and Ej_2) will be 2 practical exercises and they will take place in the practical lessons (medium group).

Final Mark = 0.4*Ex_P + 0.1*Ej_1 + 0.4*Ex_F + 0.1*Ej_2

The unsatisfactory results of the partial exam can be corrected through a written exam that will take place the same day of the final exam. This exam can be taken by students with a mark lower than 5 in the partial exam. The mark obtained in this exam will replace the initial mark only when it is higher than this one.

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### 9. Command systems. Lever forces

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

**Description:**  
The stability of the plane with free controls and its relationship with the lever forces is studied.

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### 10. Static lateral-directional stability and control

**Learning time:** 18h  
- Theory classes: 4h  
- Practical classes: 2h  
- Self study: 12h

**Description:**  
The concepts of stability and controllability of the aircraft in the lateral-directional case are studied.

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### 1. Take-Off and landing performances

**Learning time:** 10h  
- Theory classes: 4h  
- Practical classes: 2h  
- Self study: 6h

**Description:**  
Aircraft performances in each of the phase of take-off and landing are analyzed.

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### Qualification system

The final mark will be calculated from 2 exams and 2 practical exercises.

The partial exam (Ex_P) will evaluate lessons 1 - 7, and the final exam will evaluate lessons 8 - 12.

The exercises (Ej_1 and Ej_2) will be 2 practical exercises and they will take place in the practical lessons (medium group).

Final Mark = 0.4*Ex_P + 0.1*Ej_1 + 0.4*Ex_F + 0.1*Ej_2

The unsatisfactory results of the partial exam can be corrected through a written exam that will take place the same day of the final exam. This exam can be taken by students with a mark lower than 5 in the partial exam. The mark obtained in this exam will replace the initial mark only when it is higher than this one.
Regulations for carrying out activities

The exams will consist in a theoretical part and a practical exercise. The theory will be evaluated by a test, and will be done without help of auxiliary material. The practical exercise will be done with the help of an equations sheet given by the teacher.

The deliverable exercises will take place during class time (medium group) and the auxiliary material available will depend on the type of exercise.

Bibliography

Basic:

Complementary: