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220013 - Aerospace Vehicles

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: 2019

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: Catalan, Spanish

Teaching staff

Coordinator: García Melendo, Enrique

Requirements

Previous knowledge of the subjects lectured in the first engineering course.

Degree competences to which the subject contributes

Specific:

1. GrETA/GrEVA - An understanding of how aerodynamic forces determine flight dynamics and the role of the different variables involved in flight.
2. GrETA/GrEVA - An adequate understanding of the following, as applied to engineering: concepts and laws that govern the processes of energy transfer, the movement of fluids, the mechanisms of heat transfer and phase transition, and their role in analysis of the main aerospace propulsion systems.
3. GrETA/GrEVA - An adequate understanding of the following, as applied to engineering: the basics of fluid mechanics; the basic principles of flight control and automation; the main characteristics and physical and mechanical properties of materials
4. GrETA/GrEVA - Applied knowledge of materials science and technology; mechanics and thermodynamics; fluid mechanics; aerodynamics and flight mechanics; navigation systems and air traffic; aerospace technology; structural theory; economy and production; projects; environmental impact.

Transversal:

6. SELF-DIRECTED LEARNING - Level 2: Completing set tasks based on the guidelines set by lecturers. Devoting the time needed to complete each task, including personal contributions and expanding on the recommended information sources.

Teaching methodology

The course is divided into four parts:
1. Large group sessions in which is exposed the theory
2. Medium groups sessions in which are explained the theoretical and practical contents, promoting debate and reflection.
3. Medium groups sessions in which students work on practical problems with the help of the teacher.
4. Independent work, study exercises and activities for the student

Learning objectives of the subject

In this course the student will get basic knowledge related to the Earth's atmosphere, fluid dynamics, aerodynamics and the structure and flight mechanics of aircraft (both fixed wing and rotatory wing).
Basic concepts related to orbital mechanics and space missions will also be studied.
The course is an introduction to other subjects within the field of aerospace engineering,

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Study load

Total learning time: 150h	Hours large group:	38h	25.33%
	Hours medium group:	14h	9.33%
	Hours small group:	14h	9.33%
	Self study:	84h	56.00%

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Content

Section 1. Introduction to aerospace vehicles

Learning time: 5h 30m

Theory classes: 1h 30m
Practical classes: 0h 30m
Laboratory classes: 0h 30m
Self study : 3h

Description:
In this section we present the course giving a general idea about the main fields which conform the general aerospace engineering field.
We will explain how the course is graded and recommend bibliography for self-study.

1. Conceptual map of the disciplines that make up the aerospace engineering and identification of the subjects that will be studied within the subject.
2. Classification of aircraft.
3. Classification of space vehicles

Section 2: The Earth's atmosphere

Learning time: 10h

Theory classes: 4h
Practical classes: 0h 30m
Laboratory classes: 0h 30m
Self study : 5h

Description:
Study of the terrestrial planetary environment in which aircraft and space vehicles will carry out all or part of the missions for which they were designed.

1. Earth gravitational force
2. Atmospheric thermal structure
3. Hydrostatic equation
4. International standard atmosphere
5. Altitude-pressure

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Section 3: BASIC FLUID MECHANICS

Learning time: 19h

Theory classes: 6h
Practical classes: 1h
Laboratory classes: 1h
Self study : 11h

Description:
In this section we introduce the aspects of Fluid Mechanics that the student needs to know to understand the rest of the subject course.

1. Introduction to Fluid Mechanics.
2. Hydrostatics equation. Archimedes' principle.
3. Fluid particles.
4. Streamlines.
5. Continuity equation.
6. Linear momentum equation.
7. Bernouilli's theorem.
8. Incompressible flow. Mach number.
9. Potential flow. Reynolds number.
10. Viscous flows.
11. Compressible flows.

Section 4: AIRFOIL AERODYNAMICS

Learning time: 19h 30m

Theory classes: 6h
Practical classes: 1h 30m
Laboratory classes: 1h 30m
Self study : 10h 30m

Description:
In this this section we study of the aerodynamics of bidimensional airfoils.

1. Aerodynamic airfoil. Nomenclature
2. Origin of aerodynamic forces.
3. Generation of lift.
4. Aerodynamic center and pressure center.
5. Boundary layer.
6. Origin of the aerodynamic drag.
7. Forces on a cylinder.
8. Aerodynamic coefficients and airfoil characteristic curves

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Section 5: WING AERODYNAMICS	Learning time: 16h 15m Theory classes: 4h 15m Practical classes: 1h 30m Laboratory classes: 1h 30m Self study : 9h

Description:
In this subject the basic ideas for the study of wing aerodynamics are given.

1. Geometric definition of the wing.
2. Flow in wings of finite span.
3. Induced resistance.
4. Introduction to the theory of long wings.
5. Influence of the shape of the wing.
6. High-lift devices.

Section 6: ORBITAL MECHANICS	Learning time: 19h 30m Theory classes: 4h 30m Practical classes: 2h Laboratory classes: 2h Self study : 11h

Description:
Study of the basic ideas of orbital mechanics for space navigation

1. Introduction to orbital mechanics
2. The Solar System
3. Orbital movements
4. Elliptical orbits
5. Geosynchronous orbits
6. Orbital maneuvers

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Section 7: AIRPLANE DESIGN

Learning time: 10h 45m

Theory classes: 2h 45m
Practical classes: 1h
Laboratory classes: 1h
Self study : 6h

Description:
In this topic we will study the basic anatomy of an airplane, what their main components are and their functions. In addition we will study the most used construction techniques. Finally, operational weights and their implications will be defined in the diagram "Payload vs. Range".

1. General structure of an aircraft.
2. Primary control surfaces.
3. Secondary control surfaces.
4. Instruments on board.
5. Operational weight. Airport Planning.
6. Weight vs. range and payload vs. scope diagrams.
7. Techniques used in the wing and fuselage manufacture.
8. Materials: steel, aluminum alloys, titanium alloys, composite materials.

Section 9: AIRCRAFT PERFORMANCE

Learning time: 24h 45m

Theory classes: 5h 45m
Practical classes: 2h 30m
Laboratory classes: 2h 30m
Self study : 14h

Description:
In this section we describe the movement of the center of gravity of the airplane in response to the aerodynamic, propulsive and gravitational forces acting on it.

1. Reference systems.
2. Equations of movement.
3. Horizontal rectilinear and uniform flight.
4. Range and endurance.
5. Uniform and rectilinear climb and descent.
6. Turning in a horizontal plane and in a vertical plane.
7. Flight envelope.
8. Take-off and landing actions.

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Section 9: HELICOPTERS	Learning time: 24h 45m Theory classes: 6h 45m Practical classes: 2h 30m Laboratory classes: 2h 30m Self study : 13h

Description:
In this section a description of the architecture and components of a helicopter, and the foundations of the flight's fundamentals are presented.

1. Classification of rotating wing aircraft
2. General configuration of a helicopter
3. Anti-torque systems
4. Flight control
5. Axial flight
6. Advance flight
7. Autorotation
8. Aerodynamic interactions

Qualification system

The final grade of the course depends on the following evaluation activities:
a) Partial Exam (20%)
b) Final Exam (20%)
c) Continuous assessment work:
Continuous evaluation exercises at the end of each subject (20%)
Orbital mechanical work (20%)
Construction and flight of a glider participating in the Paper Air Challenge competition (20%)

Regulations for carrying out activities

Partial exams will be written done individually. In none of these examinations the student will be allowed to use programmable calculators, notes or books.

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Bibliography

Basic:

Franchini, S.; López García, O. Introducción a la ingeniería aeroespacial. 2a ed. Madrid: Garceta, 2012. ISBN 9788492812905.

Anderson, John D. Introduction to flight. 7th ed. New York: McGraw-Hill, 2012. ISBN 9780073380247.

Isidoro Carmona, A. Aerodinámica y actuaciones del avión. 12a ed. Madrid: Paraninfo, 2004. ISBN 8428328889.

Complementary:

Meseguer, J.; Sanz, A. Aerodinámica básica. 2a ed. Madrid: Garceta, 2011. ISBN 9788492812714.

Pindado Carrión, S. Elementos de transporte aéreo. Madrid: Escuela Técnica Superior de Ingenieros Náuticos, 2006. ISBN 8492111399.

Gómez Tierno, M.A.; Pérez Cortés, M.; Puentes Márquez, C. Mecánica del vuelo. Madrid: Escuela Técnica Superior de Ingenieros Aeronáuticos, 2009. ISBN 9788493535025.

Cuerva Tejero, A. [et al.]. Teoría de los helicópteros. Madrid: Escuela Técnica Superior de Ingenieros Aeronáuticos, 2009. ISBN 9788493535049.