Course guide
220055 - DA - Aircraft Design

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Unit in charge: Terrassa School of Industrial, Aerospace and Audiovisual Engineering
Teaching unit: 220 - ETSEIAT - Terrassa School of Industrial and Aeronautical Engineering.

Degree: BACHELOR'S DEGREE IN AEROSPACE TECHNOLOGY ENGINEERING (Syllabus 2010). (Compulsory subject).

Academic year: 2024 **ECTS Credits:** 6.0 **Languages:** Catalan, Spanish

LECTURER

Coordinating lecturer: Martí Coma

Others: Jordi Estrada

PRIOR SKILLS

The student must arrive with knowledge of aerodynamics, flight mechanics and aerospace structures. During the course, you must also apply concepts related to economics and materials science.
It is also recommended that students master technical English as it will be used throughout the course.

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:
1. Adequate and applied knowledge in the engineering of: design and project calculation methods in aeronautics; the use of aerodynamic experimentation and the most significant parameters in theoretical application; handling of experimental techniques, equipment, and measurement instruments specific to the discipline; simulation, design, analysis, and interpretation of experimentation and flight operations; aircraft maintenance and certification systems. (Specific technology module)
3. Applied knowledge of: aerodynamics; mechanics and thermodynamics, flight mechanics, aircraft engineering (fixed wing and rotary wing), and theory of structures. (Specific technology module)

Transversal:
4. ENTREPRENEURSHIP AND INNOVATION - Level 3. Using knowledge and strategic skills to set up and manage projects. Applying systemic solutions to complex problems. Devising and managing innovation in organizations.
5. EFFECTIVE USE OF INFORMATI0N RESOURCES - Level 3. Planning and using the information necessary for an academic assignment (a final thesis, for example) based on a critical appraisal of the information resources used.

TEACHING METHODOLOGY

Teacher will introduce basic fundamentals of aircraft design in the theory classes.
Practical exercises of each subject will be presented in the practical sessions.

LEARNING OBJECTIVES OF THE SUBJECT

The main objective of this course is to approach students to different aspects related with aircraft design:
1. Economic and planning items. Project phases
2. Functional design of the different parts of an airplane. Integration and interference.
3. Influence of the airplane performances and the aerodynamics on the design process
4. Identifying different elements and systems which compose a rotating wings aircraft (mainly the helicopter).
5. To understand physical principles of theory of the flight of rotatory wings aircraft.
6. To acquire knowledge which allow to design a helicopter and to know how to justify the techniques of a determinate design.

STUDY LOAD

Type	Hours	Percentage
Self study	90,0	60.00
Hours medium group	14,0	9.33
Hours large group	32,0	21.33
Hours small group	14,0	9.33

Total learning time: 150 h

CONTENTS

Introduction to aircraft design

Description:
Topic 1: Situation of the aeronautical industry
Topic 2: Phases of the project

Full-or-part-time: 8h
Theory classes: 2h
Practical classes: 1h
Laboratory classes: 1h
Self study : 4h

Design of different functional blocks of an aircraft

Description:
Topic 3: Design of the fuselage
Topic 4: Design of the wings
Topic 5: Design of tail surfaces
Topic 6: Design of the landing gear

Full-or-part-time: 23h
Theory classes: 4h
Practical classes: 2h
Laboratory classes: 2h
Self study : 15h

Performances and global design of aircraft

Description:
Topic 7: Methods of estimating actions
Topic 8: Weights and centering of the aircraft
Topic 9: Initial sizing
Topic 10: Weight-range diagram
Topic 11: Polar and aerodynamic coefficients

Full-or-part-time: 31h
Theory classes: 6h
Practical classes: 3h
Laboratory classes: 4h
Self study : 18h

Structural design of aircraft

Description:
Topic 12: Architecture of aircraft and loads in flight.

Full-or-part-time: 12h
Theory classes: 2h
Practical classes: 2h
Laboratory classes: 2h
Self study : 6h

General Concepts and Description of Helicopters

Description:
Tema 13. Introducció als helicòpters i les aeronaus diverses
Tema 14. Definició i descripció dels components d'un helicòpter

Full-or-part-time: 16h
Theory classes: 2h
Practical classes: 1h
Laboratory classes: 1h
Self study : 12h

Theory of Helicopters

Description:
Tema 15. Teoria de la quantitat de moviment. Vol axial
Tema 16. Teoria de l'element de pala. Vol axial
Tema 17. Combinació de les dues teories
Tema 18. Rotors de velocitat induïda constant
Tema 19. Teoria de la quantitat de moviment. Vol endavant
Tema 20. Teoria de l'element de pala. Vol endavant
Tema 21. Equilibri de moments. Rotor antiparell

Full-or-part-time: 25h
Theory classes: 5h
Practical classes: 2h
Laboratory classes: 2h
Self study : 16h

Performances of Helicopters

Description:
Topic 22. Method of energy
Topic 23. Axial flight
Topic 24. Horizontal flight
Topic 25. Floor effect
Topic 26. Inclined trajectory flight
Topic 27. Flight in autorotation
Topic 28. Takeoff and landing. Critical height

Full-or-part-time: 30h
Theory classes: 7h
Practical classes: 3h
Laboratory classes: 2h
Self study : 18h

Aircraft Certification

Description:
The aim of this block is for the student to become familiar with the different aeronautical regulations both in terms of initial Air Navigation and in terms of Continuous Airworthiness.

Full-or-part-time: 5h
Theory classes: 4h
Self study : 1h

ACTIVITIES

THEORY CLASSES

Description:
Sessions where teachers will explain the basic theory of the subject.

Full-or-part-time: 103h
Self study: 80h
Theory classes: 23h

PRACTICAL CLASSES

Description:
Sessions where students will work on Practical Exercises with the help of teachers.

Full-or-part-time: 24h
Practical classes: 10h
Laboratory classes: 14h

CERTIFICATION EXAM AND BASIC CONCEPTS OF HELICOPTERS

Description:
Initial airworthiness
Continuous airworthiness
Helicopter systems

Specific objectives:
Exam to assess the learning about helicopter certification and basic concepts

Full-or-part-time: 5h
Self study: 3h
Theory classes: 2h

EXAM 2

Description:
Second Partial Exam

Full-or-part-time: 5h
Self study: 3h
Theory classes: 2h

DELIVERABLE

Description:
Practical exercises done in the problem classes (middle group).

Full-or-part-time: 8h
Self study: 4h
Practical classes: 4h

CERTIFICACION WORK

Description:
Completion of a draft Compliance Checklist according to the applicable CS-XX

Related competencies :
CE25-GRETA. Applied knowledge of: aerodynamics; mechanics and thermodynamics, flight mechanics, aircraft engineering (fixed wing and rotary wing), and theory of structures. (Specific technology module)
CE24-GRETA. Adequate and applied knowledge in the engineering of: design and project calculation methods in aeronautics; the use of aerodynamic experimentation and the most significant parameters in theoretical application; handling of experimental techniques, equipment, and measurement instruments specific to the discipline; simulation, design, analysis, and interpretation of experimentation and flight operations; aircraft maintenance and certification systems. (Specific technology module)
06 URI N3. EFFECTIVE USE OF INFORMATI0N RESOURCES - Level 3. Planning and using the information necessary for an academic assignment (a final thesis, for example) based on a critical appraisal of the information resources used.

Full-or-part-time: 5h
Theory classes: 5h

GRADING SYSTEM

The grading system will consist of 2 main blocks:

1. Evaluation part Aircraft 50% of the subject:
- 1 group work and 2 presentations of group work. In part, there will be a presentation of the work (with the sections of the theory explained so far) and a presentation. At the end the complete work will be delivered and the second presentation will be made. Each student must submit once, either in part or at the end.

N_avions = 0.2 x N_work_p + 0.2 x N_work_final + 0.1 x N_individual_presentation

Students who want to improve the grade for the delivery of the partial aircraft work, will have the opportunity to modify its content and present it at the final delivery, so that the (0.2 x N_work_p) would be evaluated us.

2. Evaluation part Helicopters 50% of the subject:
- 2 Partial Exams and 1 Exercise deliverable.

All those students who fail the helicopter part of the partial exam, want to improve their mark or are unable to attend the partial exam, will have the opportunity to be examined on the same day of the final exam. If the circumstances do not make it feasible that it is the same day of the final exam, the teacher responsible for the subject will propose, via the Atenea platform, that the said resit exam be held another day, during class hours. .

N_helicopters = 0.25 x N_ex_teory + 0.15 x N_ex_cert + 0.1 x N_work_cert

Final grade of the subject:

N_final = N_avions + N_helicopters

EXAMINATION RULES.

The exams will consist of theory and practical exercises. The theory will be assessed through short questions and the practical part will be evaluated through real case studies.

The deliverables exercises will be made outside the class.

BIBLIOGRAPHY

Basic:
- Torenbeek, Egbert. Synthesis of subsonic airplane design. Delft: Delft University Press, 1982. ISBN 9024727243.
- Leishman, J. Gordon. Principles of helicopter aerodynamics. 2nd ed. Cambridge: Cambridge University Press, 2006. ISBN 9780521858601.
- Bramwell, A.R.S.; Done, G.; Balmford, D. Bramwell's helicopter dynamics [on line]. 2nd ed. Reston: American Institute of Aeronautics and Astronautics, 2001 [Consultation: 16/07/2024]. Available on: https://www-sciencedirect-com.recursos.biblioteca.upc.edu/book/9780750650755/bramwells-helicopter-dynamics. ISBN 1563475006.
- Padfield, Gareth D. Helicopter flight dynamics: the theory and application of flying qualities and simulation modeling [on line]. 2nd ed. Oxford: Blackwell Publishing, 2007 [Consultation: 07/03/2023]. Available on: https://onlinelibrary-wiley-com.recursos.biblioteca.upc.edu/doi/book/10.1002/9780470691847. ISBN 9780470691847.