Course guide
205282 - DCAA - Design, Build and Test a Model Aerostructure

Last modified: 22/01/2025

Unit in charge: Terrassa School of Industrial, Aerospace and Audiovisual Engineering
Teaching unit: 737 - RMEE - Department of Strength of Materials and Structural Engineering.

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

Academic year: 2024 **ECTS Credits:** 3.0 **Languages:** English

LECTURER

Coordinating lecturer: Roger Serra Lopez

Others:

PRIOR SKILLS

The student will make use of knowledge previously acquired in courses Material Science (220017), Structural Theory (220022) and Aerospace Structures (220025). It is advisable, although not essential, to have some fundamentals of the finite element method, both at a conceptual level, as well as in its application through the use of specialized software (ANSYS or similar) and the use of CAD tools (SolidWorks or similar).

TEACHING METHODOLOGY

The course is divided into thematic blocks, each of them with an objective of practical application in the workshop and laboratory. For each of these objectives, the following methodology will be followed:
- Presentation/Reminder of the theoretical concepts involved in the thematic block
- Practical indications for implementing the concepts in real practice
- Construction of physical models in relation to the theoretical concepts
- Testing and documentation of the models made.

LEARNING OBJECTIVES OF THE SUBJECT

The basic objective of the courseis to provide the student with a practical vision of the design, construction and testing of lightweight structures used in aerospace engineering, using scale models. The subject aims to complement the core subjects of a more theoretical nature (Theory of Structures, Aerospace Structures), in order to provide the student with practical experience with aeronautical structures: How to approach their design, how to select the application materials, how to size structural components according to their function, how to assemble the various components and how to evaluate the performance of the designs in the laboratory.
Specific objectives include:
- Learning about the most common aeronautical structure topologies and their components
- Learning about the usual procedures for transferring aerodynamic loads to structural requirements
- Characterising materials and sub-components with laboratory tests
- Dimensioning structures against failure phenomena due to elastic instability
- Studying joining systems between sub-components such as box-pin systems, rivets, adhesives
- Applying the theory of ribbons and panels to structural dimensioning
- Applying MEF methodologies to structural dimensioning
- Placing the student in a real manufacturing context, in the workshop/laboratory, to provide a global vision of the interaction between the design and manufacturing processes (scale construction).

STUDY LOAD

Type	Hours	Percentage
Self study	45,0	60.00
Hours large group	30,0	40.00

Total learning time: 75 h

CONTENTS

Chapter 1: Introduction to aerospace structures

Description:
Aerospace structural topologies. Basic components. Basic concepts of elasticity. Material characterization. Weight considerations. Beam concepts. Inertia, Center of shear, Center of torsion.

Related activities:
Task 1: Characterization tests of materials in tension and compression

Full-or-part-time: 7h
Theory classes: 4h
Self study : 3h

Chapter 2: Failure mechanisms

Description:
Brittle / ductile fracture. Elastic beam buckling. Inelastic beam buckling. Panel buckling. Local buckling. Semi-empirical methods. Diagonal stress field. Concept of stressed skin.

Related activities:
Task 2: Member buckling tests. 1D components, fabrication and testing of panels at scale

Full-or-part-time: 10h
Theory classes: 4h
Self study : 6h

Chaper 3: Joints between subcomponents

Description:
Chapter 3: Transfers and paths of forces, joining methods between sub-components: rivets, pins, adhesives.

Related activities:
Task 3: Test of adhesives and other joints under normal and shear stress

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

Topic 4: Idealized calculation in ribbons and panels

Description:
Transfer of aerodynamic loads. Design for axial forces, shear forces, bending moments and torsional moments. Deformations, stress fields. Design for member buckling.

Related activities:
Task 4: Dimensioning session in analytical calculation. Diagrams. Maximum stresses. Bonding loads. Failure load

Full-or-part-time: 16h
Theory classes: 4h
Self study : 12h

Chapter 5: Computer Aided Calculation

Description:
ANSYS. CAD considerations and geometric simplifications. contacts RBE's. Linear elastic models. Linear bifurcation analysis. Analysis of inelastic instability (plasticity).

Related activities:
Task 5: Computer-aided design. ANSYS

Full-or-part-time: 12h
Theory classes: 4h
Self study : 8h

Chapter 6: Prototype construction

Description:
Manufacturing of the designed structure model to be tested

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

Chapter 7: Prototype testing

Description:
Flexo-torsion laboratory tests of the prototypes carried out

Full-or-part-time: 10h
Theory classes: 4h
Self study : 6h

GRADING SYSTEM

Grading will be based on the evaluation of the reports of the experimental activities carried out in the class sessions (Tasks) and on a final Technical Report that brings together the process of design, construction and tests carried out during the course for the construction and testing of the structural models. The subject does not include the evaluation through written tests.
Task 1: 10%
Task 2: 10%
Task 3: 10%
Task 4: 10%
Task 5: 10%
Technical Report: 50%

BIBLIOGRAPHY

Basic:
- Megson, T. H. G. Aircraft structures for engineering students [on line]. 5th ed. Oxford, England: Butterworth-Heinemann, cop. 2013 [Consultation: 28/01/2025]. Available on: https://www-sciencedirect-com.recursos.biblioteca.upc.edu/book/9780080969053/aircraft-structures-for-engineering-students. ISBN 0080969062.

Complementary:
- Bruhn, E. F. Analysis and design of flight vehicle structures. Carmel, IN: Jacobs, cop. 1973. ISBN 9780961523404.
- Niu, Michael C. Airframe: stress analysis and sizing. 2nd ed. Dragon Terrance: Hong Kong Conmilit Press, 1999. ISBN 9627128082.

RESOURCES

Other resources:
AN INTRODUCTION TO STRUCTURES DESIGN FOR MODEL AIRCRAFT. Rick Pangell. 1998. Self Edited
https://themmmclub.lasercutplanes.com/wp-content/uploads/2012/11/A-Str-Commentary.pdf />
Aerospace Structures. Johnson, Eric R. 2022
https://doi.org/10.21061/AerospaceStructures