Course guide
220025 - EAE - Aerospace Structures

Last modified: 02/04/2024

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

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

Academic year: 2024 **ECTS Credits:** 7.5 **Languages:** Catalan, Spanish

LECTURER

Coordinating lecturer: JUAN CARLOS CANTE TERAN
LLUIS GIL ESPERT

Others: LLUIS GIL ESPERT

PRIOR SKILLS

The student must have solid knowledge of algebra, infinitesimal calculus and basic physics. Knowledge of elasticity, strength of materials and structures.

REQUIREMENTS

For the correct use of the subject is recommended to have studied Physics I, II and III, Mechanics and Theory of structures.

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:
1. GrETA/GrEVA - An understanding of the behaviour of structures under stress in ordinary and extreme conditions.

TEACHING METHODOLOGY

The methodology is divided into three parts:
· Attendance lessons of exposition of the contents.
· Attendance lessons of practical work, including exercises and problems.
· Attendance evaluable sessions of practical work
During the exposition sessions, the teacher will introduce the theoretical basis of the subject, concepts, methods and results, along with practical examples in order to easy its comprehension.
In the practical work lessons, the teacher will guide the student into the application of the theoretical concepts to solve problems. Exercises will be proposed to solve at and outside the class, to stimulate the contact and use of the basic tools that are necessary to solve the problems
In the evaluable sessions, the student will solve a problem, using the teaching sinews. The students will have to work autonomously, following the contents explained during the curs.

LEARNING OBJECTIVES OF THE SUBJECT

Introduction to the typology of aerospace structures and the detection of loads. Simplified analysis of semimonocoasque structures. Determination of stresses, limit resistance and ultimate (including nonlinear effects).
Introduction to fracture mechanics.

STUDY LOAD

Type	Hours	Percentage
Hours large group	61,0	32.53
Hours medium group	14,0	7.47
Self study	112,5	60.00

Total learning time: 187.5 h

CONTENTS

Module 1 - Overview of previous concepts of rational mechanics and material resistance.

Description:
· Review of elementary concepts of kinematics and dynamics of point and rigid solid. Relative kinematics and inertial loads.
· Fundamentals of elasticity. Tension and strain tensors. Addresses and main values. Isotropic linear elastic material.
· Fundamentals of resistance of materials. Internal action diagrams.

Related activities:
· Theory classes (Ac. 1)
· Exercise practical exercises individually to assess the mastery of the previous concepts necessary for the proper use of the subject. These exercises will be evaluated and will contribute to the
final mark of the subject (Ac. 2)

Full-or-part-time: 20h
Theory classes: 8h
Practical classes: 2h
Self study : 10h

Module 2 - Thin-wall sections.

Description:
. Introduction to the morphology of aeronautical structures. Semi-hull structures. Typical loads in an aeronautical structure.
· Permissible simplifications in the analysis of thin wall structures. Idealization of the structure in cutting panels and traction cords.
· Thin wall sections subjected to axial, cutting, bending and twisting loads.
· Introduction to the final dimensioning of reinforced panels. Crippling

Related activities:
· Theory classes (Ac. 1)
· Doing exercises that cannot be evaluated in groups so that students are familiar with the concepts exposed to the theory classes (Ac. 3)
· Laboratory practices (Ac. 4)
· Partial examination (Ac. 5)

Full-or-part-time: 73h 45m
Theory classes: 22h 30m
Practical classes: 5h
Self study : 46h 15m

Module 3 - Elastic instability of structures

Description:
· Introduction. Linking columns. Critical load of Euler. Effect of boundary conditions.
· Linear bifurcation analysis. Matrix analysis.
· Instability of plates and sheets.
. Other types of instability

Related activities:
· Theory classes (Ac. 1)
· Doing exercises that cannot be evaluated in groups so that the students become familiar with the concepts presented in the theoretical classes (Ac. 3)
· Exercise practical exercises individually to assess the mastery of the concepts necessary for the proper use of the subject. These exercises will be evaluated and will contribute to the final grade of the subject (Ac. 2)
· Laboratory practices (Ac. 4)
. Final exam (Ac.6)

Full-or-part-time: 49h
Theory classes: 15h
Practical classes: 4h
Self study : 30h

Module 4 - Plastic calculus

Description:
· Introduction. Uniaxial behavior. Bending and plastic ball joints.
· Analysis of beams and porches.
· Analysis of plates.

Related activities:
Theory classes (Ac. 1)
· Doing exercises that cannot be evaluated in groups so that the students become familiar with the concepts presented in the theoretical classes (Ac. 3)
· Exercise practical exercises individually to assess the mastery of the concepts necessary for the proper use of the subject. These exercises will be evaluated and will contribute to the final grade of the subject (Ac. 2)
· Laboratory practices (Ac. 4)
. Final exam (Ac.6)

Full-or-part-time: 27h
Theory classes: 10h
Practical classes: 2h
Self study : 15h

Module 5 - Fracture mechanics.

Description:
· Introduction. Fragile and ductile break.
. Fatigue

Related activities:
· Theory classes (Ac. 1)
· Doing exercises that cannot be evaluated in groups so that the students become familiar with the concepts presented in the theoretical classes (Ac. 3)
· Exercise practical exercises individually to assess the mastery of the concepts necessary for the proper use of the subject. These exercises will be evaluated and will contribute to the final grade of the subject (Ac. 2)
. Final exam (Ac.6)

Full-or-part-time: 17h 45m
Theory classes: 5h 30m
Practical classes: 1h
Self study : 11h 15m

ACTIVITIES

ACTIVITY 1: THEORY SESSIONS

Description:
Large group sessions where the contents of the various modules of the subject will be introduced.

Specific objectives:
Explain the theoretical foundations of the subject and prepare students for the activities 2, 3, 4 and 5.

Material:
Recommended bibliography of the subject and collections of practical examples solved available on the web of the subject.

Delivery:
The evaluation of the use of theoretical lessons will be carried out in activities 2 and 5.

Full-or-part-time: 162h
Theory classes: 56h
Self study: 106h

ACTIVITY 2: ASSESSED EXERCISES

Description:
Exercises individually in medium group sessions that serve to consolidate the teachings of the subject

Specific objectives:
Allow the student to evaluate their level of preparation in the contents of the subject.

Material:
Recommended bibliography of the subject and collections of practical examples solved available on the web of the subject

Delivery:
The exercises will be scored and contribute to the final grade of the course (20%

Full-or-part-time: 4h
Practical classes: 4h

ACTIVITY 3: NOT ASSESSED PRACTICAL EXERCISES

Description:
Exercises in medium group sessions that serve to establish the contents of the theoretical classes.

Specific objectives:
Allow students to assess their familiarity with the concepts presented in the theory classes and to prepare for the exams.

Material:
Class notes and recommended bibliography of the subject.

Delivery:
The exercises serve as preparation for the completion of the exams of the subject.

Full-or-part-time: 7h
Practical classes: 7h

ACTIVITY 4 - LABORATORY PRACTICE

Description:
Practical sessions in which assemblies are analyzed that allow to apply the acquired theoretical knowledge.

Specific objectives:
Allow students to apply their theoretical knowledge to a case study.

Material:
Calculator, class notes and recommended bibliography of the subject.

Delivery:
During class, a practical exercise of analyzing a structure similar to that studied in the laboratory will be performed. This exercise will be scored and will contribute to the final grade of the course (10%).

Full-or-part-time: 9h 30m
Practical classes: 3h
Self study: 6h 30m

ACTIVITY 5: MIDTERM EXAM

Description:
Written test in which problems related to the syllabus of the module 2 of the subject will be solved.

Specific objectives:
Assess the level of use of module 2 of the subject.

Material:
Calculator

Delivery:
The mark of the exam will count 35% of the final grade of the subject.

Full-or-part-time: 2h
Theory classes: 2h

ACTIVITY 6: FINAL EXAM AND MODULE 2 RECOVERY

Description:
Written test in which problems related to the syllabus of modules 3, 4 and 5 will be solved. It also includes an exam of optional recovery of the contents of module 2.

Specific objectives:
Assess the level of proficiency of the subject.

Material:
Calculator and, at the teacher's discretion, class notes.

Delivery:
The mark of the exam will count 35% of the final grade of the subject.

Full-or-part-time: 3h
Theory classes: 3h

GRADING SYSTEM

Mid-term exam (30%)
Final exam (30%)
Evaluable practical exercises, first part (20%)
Evaluable practical exercises and laboratory, scond part (10%)

All those students who fail, want to improve their mark or cannot attend the partial exam, they will have the opportunity to be examined the same day of the final exam. If due to the circumstances it is not viable to do it the same day of the final exam, the teacher responsible for the subject will propose, via the platform Atenea, that the mentioned recovery exam will be carried out another day, in class schedule.

The new mark of the recovery exam will substitute the previous one, unless it is lower.

EXAMINATION RULES.

All the evaluable exams are individual

BIBLIOGRAPHY

Basic:
- Bruhn, E.F. Analysis and design of flight vehicle structures. Carmel: Jacobs, 1973.
- Niu, M.C.Y. Airframe structural design: practical design information and data on aircraft structures. 2nd ed. Hong Kong: Hong Kong Conmilit Press, 2000. ISBN 9627128090.
- Timoshenko, S.P.; Gere, J.M. Theory of elastic stability [on line]. 2nd ed. New York: Dover, 2009 [Consultation: 20/06/2024]. Available on: https://ebookcentral-proquest-com.recursos.biblioteca.upc.edu/lib/upcatalunya-ebooks/detail.action?pq-origsite=primo&docID=1894787. ISBN 9780486472072.
- Broek, D. The practical use of fracture mechanics. Dordrecht: Kluwer Academic Publishers, 1989. ISBN 0792302230.
- Kachanov, L.M. Fundamentals of the theory of plasticity [on line]. New York: Dover, 2013 [Consultation: 25/06/2024]. Available on: https://web-p-ebscohost-com.recursos.biblioteca.upc.edu/ehost/ebookviewer/ebook?sid=eedb260c-7733-480d-9ecc-39ff1fc4d963%40redis&vid=0&format=EK. ISBN 0486150828.

Complementary:
- Niu, M.C.Y. Airframe: stress analysis and sizing. 2nd ed. Dragon Terrance: Hong Kong Conmilt Press, 1999. ISBN 9627128082.
- Niu, M.C.Y. Composite airframe structures: practical design information and data. Hong Kong: Conmilit Press, 1993. ISBN 9627128066.

RESOURCES

Other resources:
Exercise collections solved.
Notes of the subject.