Course guide
220029 - SM - Mechanical Systems

Last modified: 19/04/2023

Unit in charge: Terrassa School of Industrial, Aerospace and Audiovisual Engineering
Teaching unit: 712 - EM - Department of Mechanical Engineering.

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

Academic year: 2023 **ECTS Credits:** 6.0 **Languages:** Catalan, Spanish

LECTURER

Coordinating lecturer: JOSE ANTONIO ORTIZ MARZO

Others: Ortiz Marzo, José Antonio
Diaz Gonzalez, Carlos Gustavo
Marañon, Ana

PRIOR SKILLS

In the development of this course have to take into consideration the properties and characteristics of the different materials used in aerospace machinery as well as manufacturing processes applicable to both the object of optimizing the design of the mechanical elements as their manufacture. It should also be interaction with this subject matter in the field of engines and the strength of materials.
The subjects of the qualifications that are more directly related to the design of the machines are linked to the Aeronautics Materials, Production Aerospace, Motors, Mechanical and Structural Theory.

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:
CE21. Adequate and applied knowledge in engineering: fundamentals of sustainability, maintainability, and operability of aerospace vehicles. (Specific technology module: Aircraft)
CE24. Adequate and applied knowledge in engineering: aircraft systems and automatic flight control systems for aerospace vehicles. (Specific technology module: Aircraft).

TEACHING METHODOLOGY

The teaching methodology is divided in three different types of activities:
*Presentations of contents.
*Practical sessions where professor mainly solve problems
*Autonomous work to study and develop proposed activities

During the contents presentation, the professor will introduce the basic theory of the subject, methodologies to solve the problems and examples to ease the comprenhension.
In the practical sessions, the professor will guide the student to apply the contents presented in the theoretical sessions to applied problems. Homework problems will also be proposed, in order to expose the students to the typical tools used to solve that problems.
Student will have to self work with the material provided by the professor in order to fix the contents presented in the theoretical sessions. The professor will provide a programme in the Atenea

LEARNING OBJECTIVES OF THE SUBJECT

The main goal of the subject Machine design in Aeronautics is that Aeronautical Engineers have the needed tools to successfully address any question related with the mechanical elements and machinery of the aircraft and of the space vehicles, from the design and maintenance point of view, as well as with the systems and the machinery of the airports.

STUDY LOAD

Type	Hours	Percentage
Hours large group	46,0	30.67
Self study	90,0	60.00
Hours small group	14,0	9.33

Total learning time: 150 h

CONTENTS

Module 1: Theory of fatigue

Description:
Introduction to Mechanical Design
Theories of fracture at constant load
Fatigue in machine elements
Calculation of axles and drive shafts

Related activities:
Activities 1-2-3-4-5

Full-or-part-time: 41h
Theory classes: 12h
Laboratory classes: 4h
Self study : 25h

Module 2: Design of mechanical elements

Description:
Design of screw connections
Design of forced unions
Design of other union elements
Design of suspension elements , springs
Mechanical transmissions with flexible elements
Clutches and brakes

Related activities:
Activities 1-2-3-4-5

Full-or-part-time: 33h
Theory classes: 10h
Laboratory classes: 3h
Self study : 20h

Module 3: Kinematics and dynamics of mechanisms

Description:
Straight gears
Helical gears
Hyperbolic gears
Calculation of the Module
Gearbox

Related activities:
Activities 1-2-3-4-5

Full-or-part-time: 40h
Theory classes: 12h
Laboratory classes: 3h
Self study : 25h

Module 4: Bearings and Lubrication

Description:
Anti-friction bearings
Sliding bearings.
Lubrication.
Type of lubrication

Related activities:
Activities 1-2-3-4-5

Full-or-part-time: 36h
Theory classes: 12h
Laboratory classes: 4h
Self study : 20h

ACTIVITIES

ACTIVITY 1: LARGE GROUP SESSIONS / THEORY

Description:
Prior and subsequent preparation of the theory sessions and attendance at them.

Specific objectives:
At the end of this activity, the student must be able to master the knowledge acquired, consolidate it and apply it correctly to technical problems that involve real situations.

Material:
Notes on the Atenea platform
General bibliography of the subject

Delivery:
During some of the sessions there will be face-to-face exercises in class.

Full-or-part-time: 60h
Theory classes: 40h
Self study: 20h

ACTIVITY 2: SMALL GROUP SESSIONS / PRACTICES

Description:
Pre and post-preparation of problem sessions, internships and attendance at them.

Specific objectives:
Acquire the necessary skills for a correct interpretation of the problems and practices of the subject, as well as one satisfactory resolution of these.

Material:
Notes on the Atenea platform
General bibliography of the subject

Delivery:
During these sessions, teachers and students will develop practical, face-to-face or virtual exercises, individually or in small groups.

Full-or-part-time: 34h
Laboratory classes: 14h
Self study: 20h

ACTIVITY 3: MIDTERM EXAM

Description:
Individual and written test on the contents of modules 1, 2.

Specific objectives:
The test must show that the student has acquired and assimilated the basic concepts, principles and foundations related to modules 1, 2.

Material:
Statement of the partial test.

Delivery:
The material to be delivered will be the resolution of the test individually.

Full-or-part-time: 12h
Theory classes: 2h
Self study: 10h

ACTIVITY 4: FINAL EXAM

Description:
Individual and written test on the contents of modules 3, 4.

Specific objectives:
The test must show that the student has acquired and assimilated the basic concepts, principles and foundations related to modules 3, 4.

Material:
Statement of the final test.

Delivery:
The material to be delivered will be the resolution of the test individually.

Full-or-part-time: 12h
Theory classes: 2h
Self study: 10h

ACTIVITY 5: PROBLEMS PROPOSED

Description:
A collection of problems related to the modules of the subject is proposed and each student will have to solve and deliver individually through ATENEA the justified solution.

Specific objectives:
Correctly apply the principles introduced in modules 1, 2, 3 and 4.
Generic skills: Analysis and synthesis; Efficient use of information resources; Autonomous learning and written communication.

Material:
Statement and work guidelines (ATENEA)
Course notes
Official support websites (Internet)
Textbooks recommended in the bibliography of the subject

Delivery:
Problems must be submitted in digital format through ATENEA.
The date of delivery will be exposed at the beginning of the course in the tasks of ATENEA that are planned for this purpose.

Full-or-part-time: 32h
Theory classes: 2h
Self study: 30h

GRADING SYSTEM

The mark of the course depens on 5 items:
*2nd activity: 20%
*3rd activity (midterm exam): 35%
*4th activity (final exam):35%
*5th activity(homeworks): 10%

The result of unsatisfactory Activity 3 (partial exam) can redirect through a written test to be held on the day fixed for the final exam scheduled on the same track (3 hours). This test can be accessed by students with a grade of less than 5 self assessment). The rating of the test will be between 0 and 10, will have the weight corresponding to that activity. The grade for the application of renewal replace the initial qualification provided that it is superior.

For those students who meet the requirements and submit to the reevaluation examination, the grade of the reevaluation exam will replace the grades of all the on-site written evaluation acts (tests, midterm and final exams) and the grades obtained during the course for lab practices, works, projects and presentations will be kept.
If the final grade after reevaluation is lower than 5.0, it will replace the initial one only if it is higher. If the final grade after reevaluation is greater or equal to 5.0, the final grade of the subject will be pass 5.0.

EXAMINATION RULES.

Activities 1 and 2 are done in group and written.
Activities 3 and 4 are done individually and written.

BIBLIOGRAPHY

Basic:
- Budynas, R. G.; Nisbett, J. K. Diseño en ingeniería mecánica de Shigley [on line]. 10a ed. México: McGraw-Hill, 2019 [Consultation: 15/06/2022]. Available on: https://ebookcentral-proquest-com.recursos.biblioteca.upc.edu/lib/upcatalunya-ebooks/detail.action?pq-origsite=primo&docID=5485813. ISBN 9781456267568.
- Pedrero, J. I. Tecnología de máquinas. Madrid: Universidad Nacional de Educación a Distancia, 2005. ISBN 9788436251258.
- Gibert, J. Ingeniería de los engranajes. Barcelona: l'autor, 2005. ISBN 8460954552.
- Norton, Robert L.; Rios Sánchez, Miguel Àngel. Diseño de maquinaria: síntesis y análisis de máquinas y mecanismos [on line]. 5a ed. México: McGraw-Hill, 2013 [Consultation: 15/06/2022]. Available on: https://www-ingebook-com.recursos.biblioteca.upc.edu/ib/NPcd/IB_BooksVis?cod_primaria=1000187&codigo_libro=5701. ISBN 9786071509352.
- Khamashta, M.; Álvarez, L.; Capdevila, R. Problemas de cinemática y dinámica de máquinas. Vol. 1, Problemas resueltos de cinemática de mecanismos planos. 2a ed. Barcelona: UPC. Departament d'Enginyeria Mecànica, 1993. ISBN 8476530048.
- Khamashta, M.; Álvarez, L.; Capdevila, R. Problemas de cinemática y dinámica de máquinas. Vol. 2, Problemas resueltos de dinámica de mecanismos planos. 2a ed. Barcelona: UPC. Departament d'Enginyeria Mecànica, 1994. ISBN 8476530048.

Complementary:
- Mott, R. L. Diseño de elementos de máquinas. 4ª ed. México: Prentice Hall, 2006. ISBN 9702608120.
- Avilés, R. Análisis de fatiga en máquinas. Madrid: International Thomson Paraninfo, 2005. ISBN 8497323440.