Course guide
340034 - SIME-F4O12 - Mechanical Systems

Last modified: 09/02/2024

Unit in charge: Vilanova i la Geltrú School of Engineering
Teaching unit: 712 - EM - Department of Mechanical Engineering.

Degree: BACHELOR'S DEGREE IN ELECTRICAL ENGINEERING (Syllabus 2009). (Compulsory subject).
BACHELOR'S DEGREE IN INDUSTRIAL ELECTRONICS AND AUTOMATIC CONTROL ENGINEERING (Syllabus 2009). (Compulsory subject).
BACHELOR'S DEGREE IN MECHANICAL ENGINEERING (Syllabus 2009). (Compulsory subject).

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

LECTURER

Coordinating lecturer: Magnusson Morer, Ingrid

Others: Escola Fernandez, Marc

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:
1. CE13. Knowledge of theatrical basics of machines and mechanisms
2. CE14. Knowledge and application of basics of material resistance.

Transversal:
3. TEAMWORK - Level 2. Contributing to the consolidation of a team by planning targets and working efficiently to favor communication, task assignment and cohesion.

TEACHING METHODOLOGY

The sessions are divided into classes of theory, problems and laboratory practices. Theory classes integrate the presentation of the basic theoretical concepts of thematic content of the course and applied examples are described as exercises.
In the problems sessions, the teacher proposes exercices to the student to be solved, with the assistance of the teacher.
In the laboratory practical classes, experimental tests are developed and is the student, individually or in groups, who must work aspects ruled by the teacher.

LEARNING OBJECTIVES OF THE SUBJECT

The student will be able to:

- Define and apply the principles of machines and mechanisms.
- Define and correctly apply the principles of strength of materials.
- Analyze structures and give them dimension.
- Define and puts into practice methods of teamwork.

STUDY LOAD

Type	Hours	Percentage
Hours small group	7,5	5.00
Self study	90,0	60.00
Hours large group	52,5	35.00

Total learning time: 150 h

CONTENTS

1- Structural analysis of mechanisms

Description:
1.1 Machine theory definitions
1.2 Joints and kinematic links
1.3 Mechanisms
1.4 Kinematic scheme

Specific objectives:
After completing this unit the student should be able to:

- Analyze the elements that are part of a mechanism and determine its degrees of freedom.
- Understand the Kinematic scheme of a mechanism

Full-or-part-time: 11h
Theory classes: 2h
Laboratory classes: 2h
Self study : 7h

2- Equivalent systems of forces

Description:
2.1 Fundamental concepts of mechanics
2.2 Vectorial operations and trigonometric laws
2.3 Moment of a force and pair of forces
2.4 Equivalent systems of forces

Specific objectives:
At the end of this unit the student should be able to:

- Perform basic operations with vectors in a mechanical study of the rigid solid and correctly use the notation
- Calculate the moment of a force with respect to a point or axis in 2D and 3D
- Identify equivalent systems of forces
- Reduce a system of forces to a force-pair system
- Simplify systems of parallel forces and systems of coplanar forces

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

3- Mass geometry

Description:
3.1 Mass center
3.2 Moments of inertia of surfaces
3.3 Inertial properties of rigid bodies

Specific objectives:
At the end of this unit the student should be able to:

- Determine the centroid of a section
- Locate the center of mass in thin plates and wires and in solids with common shapes.
- Compose different solids of known center of mass to find the center of mass of the solid resulting from the composition
- Determine the rectangular and polar moments of inertia of an area
- Determine the moment of mass inertia of a body with respect to an axis

Full-or-part-time: 9h
Theory classes: 2h
Laboratory classes: 1h
Self study : 6h

4 - Mechanics of deformable solid

Description:
3.1 Diagram of the Free Body
3.2 Equilibrium vectorial equations of the rigid solid
3.3 Structures and mechanisms in equilibrium
3.4 Relative movements and their resistances

Specific objectives:
The objective of this module is to understand that the components of a mechanical system are not indeformable or indefinitely resistant to the forces they are subjected. We introduce the basic concepts of theory of elasticity and strength of materials in order to determine what stresses occur inside a body, and what deformations occur, according to external forces, the dimensions and the material the element is constructed. The purpose of this study is to size the different elements of a system to meet certain requirements of loads and deformations, or based on
an existing design, to determine the extreme conditions, ensuring that the element works within a margin of safety.

Related activities:
At the end of this unit the student should be able to:

- Solve problems of structures and mechanisms in equilibrium
- Modeling resistance to different relative movements, according to the context

Full-or-part-time: 35h
Theory classes: 10h
Self study : 25h

5- Kinematics of mechanisms

Description:
5.1 Kinematic variables
5.2 Study of the position of a mechanism by geometry of triangles
5.3 Simple movements of rigid bodies
5.4 Instantanious Rotation Centers

Specific objectives:
At the end of this unit the student should be able:

- To solve the kinematics of a mechanism, which includes the study of position and the study of velocities

Full-or-part-time: 20h
Theory classes: 5h
Self study : 15h

6- Dynamics of mechanisms

Description:
6.1 Vectorial equations for the dymanic behavior of the rigid solid: theorems of conservation of momentum and angular momentum
6.2 D'Alembert methodology
6.3 Dynamic study of mechanisms using D'Alembert methododology

Specific objectives:
At the end of this unit the student should be able:

- To perform the dynamic study of a mechanism using vectorial theorems

Full-or-part-time: 19h
Theory classes: 6h
Laboratory classes: 1h
Self study : 12h

7 - Mechanics of deformable bodies

Description:
7.1 Introduction to the resistance and elasticity of materials
Hooke's law and the stress-deformation diagram
7.2 Simple loads
Axial strees and deformation
Shear stress
Torque stress
Bending

Specific objectives:
The objective of this module is to understand that the components of a mechanical system are not indeformable or indefinitely resistant to the forces to which they are subjected. The basic concepts of the theory of elasticity and the resistance of materials are introduced, in order to determine what stresses are produced inside a body, and what deformations are produced, depending on the external stresses, of the dimensions of the element and the material with which it is built. The purpose of this study is to be able to dimension the different elements of a system so that they meet certain requirements of loads and deformations, or, starting from an already existing design, determine to what extreme conditions we can submit it, even though the element will work within a margin of safety.

Full-or-part-time: 25h
Theory classes: 8h
Laboratory classes: 2h
Self study : 15h

8 - Preparation and performance of written content evaluation tests

Description:
8.1 Review of concepts worked on in all previous learning activities
8.2 Performing written tests of previous courses in conditions as similar as possible to those that will be on the day of the official exam
8.3 Realization of the official test

Specific objectives:
The objectives of points 8.1 and 8.2 are:
- Discern what is relevant and self-assess the level of learning achieved
- Be used to the specific conditions in which written tests are carried out

The objective of the realization of the official exam is to prove that the learning planned for the subject has been achieved through the planned activities

Full-or-part-time: 19h
Guided activities: 5h
Self study : 14h

GRADING SYSTEM

The final grade of the subject is determined from the expression:
QF = max [QAV1,AP1]·0.1 + max [QAV2,AP2]·0.10 + PR·0.15 + TR·0.05 + max [AP1,RAP1]·0.20 + AP2·0.4, where:

QAV1 and QAV2 are different evaluable questionnaires proposed during the course
PR laboratory practices
TR is a report of an academic work
AP1 is the first partial exam
RAP1 is a recuperation of the first partial exam
AP2 is the second partial exam

There is a re-evaluation exam that you can take if you meet the requirements established by current EPSEVG regulations. The mark of the re-evaluation exam can replace the % of the mark corresponding to the exams and the questionnaires (it does not replace/recover the mark of the academic work, nor the laboratory practices).
QF_R = max [QF , PR·0.15 + TR·0.05 + REAV·0.8] where:
QF_R is the subject qualificaction taking the re-evaluation exam into account (current EPSEVG regulations can fix an upper limit for this qualification)
REAV is the re-evaluation exam

EXAMINATION RULES.

The conditions of realization of each test, will be specified in each particular case, in good time.

BIBLIOGRAPHY

Basic:
- Beer, Ferdinand Pierre. Mecánica vectorial para ingenieros. Vol. 1, Estática [on line]. 11a ed. México: McGraw-Hill Education, 2017 [Consultation: 20/02/2024]. Available on: https://www-ingebook-com.recursos.biblioteca.upc.edu/ib/NPcd/IB_BooksVis?cod_primaria=1000187&codigo_libro=11980. ISBN 9781456255275.
- Beer, Ferdinand Pierre; Johnston, E. Russell; DeWolf, John; Mazurek, David F. Mecánica de materiales [on line]. 7a ed. México: Mc-Graw-Hill Education, 2017 [Consultation: 19/02/2024]. Available on: https://www-ingebook-com.recursos.biblioteca.upc.edu/ib/NPcd/IB_BooksVis?cod_primaria=1000187&codigo_libro=8071. ISBN 9781456260866.
- Beer, Ferdinand Pierre. Mecánica vectorial para ingenieros. Vol. 2, Dinámica [on line]. 11a ed. México: McGraw-Hill Education, 2017 [Consultation: 20/02/2024]. Available on: https://www-ingebook-com.recursos.biblioteca.upc.edu/ib/NPcd/IB_BooksVis?cod_primaria=1000187&codigo_libro=11979. ISBN 9781456255268.

Complementary:
- Erdman, Arthur G.; Sandor, George N.; Kota, Sridhar. Mechanism design: analysis and synthesis. 4th ed. Upper Saddle River, N.J: Prentice-Hall, 2001. ISBN 0130408727.