Course guide
330523 - EME2 - Mechanical Engineering 2

Last modified: 04/05/2023

Unit in charge: Manresa School of Engineering
Teaching unit: 712 - EM - Department of Mechanical Engineering.

Degree: BACHELOR'S DEGREE IN AUTOMOTIVE ENGINEERING (Syllabus 2017). (Compulsory subject).

Academic year: 2023 **ECTS Credits:** 4.5 **Languages:** Catalan, Spanish

LECTURER

Coordinating lecturer: Alcelay Larrión, José Ignacio

Others: Peña Pitarch, Esteban
Al Omar Mesnaoui, Anas

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:
1. Knowledge of the principles of theory of machines and mechanisms.
2. Knowledge and skills for the calculation, design and testing of machines.

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.
4. SELF-DIRECTED LEARNING - Level 2: Completing set tasks based on the guidelines set by lecturers. Devoting the time needed to complete each task, including personal contributions and expanding on the recommended information sources.

TEACHING METHODOLOGY

MD1 Master class or lecture (EXP)
MD2 Problem solving and case study (RP)
MD5 Small-scale project, activity or assignment (PR)
MD7 Assessment activities (EV)

LEARNING OBJECTIVES OF THE SUBJECT

General objectives:
- Integrate the Mechanics and Mechanism Theory within the studies of Engineering using the previous knowledge imparted in the previous courses, working the own capacities of the engineering and doing it attractive and useful for the student body, whether they opt for a mechanical profile or not
- To make students aware of the relationship between technology and society by analyzing the role that machines play in this binomial and the sustainability of the current model of human activity.
Specific:
- Carry out, from the concepts of rigid solid mechanics and basic and operative tools, kinematic analyzes, statics and dynamics of the mechanisms and of the machines.
- Use computer applications for the calculation and simulation of mechanisms.
- Recognize the basic mechanical elements and mechanical groups of machines and mechanisms from examples taken from real situations.

STUDY LOAD

Type	Hours	Percentage
Hours small group	30,0	26.67
Hours large group	15,0	13.33
Self study	67,5	60.00

Total learning time: 112.5 h

CONTENTS

Topic 1: MACHINE AND MECHANISM

Description:
Definitions of machine, mechanism and kinematic chain. Definitions and classification of the bars and kinematic pairs. Kinematic scheme, modelling and symbols. Bar mechanisms. Grashof's Criterion. Mechanism performance.

Specific objectives:
The activity consists in the problem solving oriented to the design by means of computer programs (spreadsheets, programs to solve equations and programs to draw graphs).

Related activities:
Solving specific exercises about the contents (Activity 1).

Full-or-part-time: 4h 30m
Theory classes: 1h 30m
Self study : 3h

Topic 2: MOBILITY

Description:
Generalized coordinates and velocities. Independent coordinates. Degrees of freedom of a mechanism. Link equations. Holonomy. Solving the linking equations: Newton-Raphson. Configuration space. Accessible configuration space. Redundancy. Grübler-Kutzbach Criterion. Unique configurations

Specific objectives:
The activity consists in the problem solving oriented to the design by means of computer programs (spreadsheets, programs to solve equations and programs to draw graphs).

Related activities:
Solving specific exercises about the contents (Activity 1).

Full-or-part-time: 4h 30m
Theory classes: 1h 30m
Self study : 3h

Topic 3: KINEMATICS OF MECHANISMS

Description:
Kinematic study of a mechanism from geometric link equations. Redundancy and unique configurations. Kinematics study of mechanisms from kinematic linking equations. Flat motion. Theorem of the three centers.

Specific objectives:
The activity consists in the problem solving oriented to the design by means of computer programs (spreadsheets, programs to solve equations and programs to draw graphs).

Related activities:
Solving specific exercises about the contents (Activity 1).
Individual evaluation. Written Assessment Test (PAE) (Activity 4)

Full-or-part-time: 9h
Theory classes: 3h
Self study : 6h

Topic 4: GEARS AND GEAR TRAINS

Description:
Cogwheels. Gear conditions. Conjugate profiles. Involute profile and cycloidal profile. Gear line and thrust angle. Types of gears. Fixed axle gear trains and epicyclic gear trains. Transmission ratios. Differential mechanism.

Specific objectives:
The activity consists in the problem solving oriented to the design by means of computer programs (spreadsheets, programs to solve equations and programs to draw graphs).

Related activities:
Solving specific exercises about the contents (Activity 2).
Individual evaluation. Written Assessment Test (PAE) (Activity 4)

Full-or-part-time: 9h
Theory classes: 3h
Self study : 6h

Topic 5: DYNAMIC ANALYSIS

Description:
Vector theorems. Free body diagram. D'Alembert's principle of inertial forces. Kinetic energy and mass reduced to one point. Reduced force-mass. Dynamically equivalent systems. Force of inertia. Internal forces and reactions. Energy method: Principle of Virtual Powers. Problems of direct and inverse dynamics. Static and dynamic balancing of rotors.

Specific objectives:
The activity consists in the problem solving oriented to the design by means of computer programs (spreadsheets, programs to solve equations and programs to draw graphs).

Related activities:
Solving specific exercises about the contents (Activity 3).
Individual evaluation. Written Assessment Test (PAE) (Activity 4).

Full-or-part-time: 9h
Theory classes: 3h
Self study : 6h

ACTIVITIES

• Activity 1: kinematics of mechanisms

Description:
Do exercises related to topics 1, 2 and 3.

Specific objectives:
At the end of this activity the student must be able to: Be able to clearly determine the degrees of freedom of a mechanism. To be able to determine positions, speeds and accelerations of the elementary mechanisms, using computer programs. To work autonomously and in team and to communicate effectively and clearly the obtained results.

Material:
Documents in the Atenea virtual campus.
Compulsory reading list.

Full-or-part-time: 28h
Laboratory classes: 13h
Self study: 15h

Activity 2: gears and gear trains

Description:
Do exercises related to topic 4.

Specific objectives:
At the end of this activity the student must be able to: Know, analyze and differentiate the different types of gears used. Calculate the transmission ratios between the different axes and differentials studied. Work autonomously and as a team and communicate effectively and clearly the results obtained.

Material:
Documents in the Atenea virtual campus.
Compulsory reading list.

Full-or-part-time: 18h 30m
Laboratory classes: 8h
Self study: 10h 30m

Activity 3: mechanism dynamics

Description:
Do exercises related to topic 5.

Specific objectives:
At the end of this activity the student must be able to: Interpret the theoretical concepts studied and apply them to the dynamic analysis of the mechanisms used in the activity. Work independently and as a team and communicate effectively and clearly the results obtained.

Material:
Documents in the Atenea virtual campus. Compulsory reading list.

Full-or-part-time: 19h
Laboratory classes: 9h
Self study: 10h

Activity 4: Individual evaluation. Written Assessment Test (PAE)

Description:
Carry out an individual written test of the course contents.

Specific objectives:
At the end of this activity the student must be able to: know, understand and apply the concepts studied in the theoretical sessions and lab sessions.

Material:
Scientific calculator.

Full-or-part-time: 11h
Theory classes: 3h
Self study: 8h

Activity 5: Individual evaluation. New Written Assessment Test (NPAE)

Description:
Carry out an individual written test of the course contents.

Specific objectives:
At the end of this activity the student must be able to: know, understand and apply the concepts studied in the theoretical sessions and lab sessions.

Material:
Scientific calculator.

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

GRADING SYSTEM

Activity 1 (A1): 10%
Activity 2 (A2): 10%
Activity 3 (A3): 10%
Activity 4 (PAE): 70%
Activity 5 (NPAE): 70%
- Delivery of the Proposed Problems (Activity 1, 2 and 3): 30%
- Individual Test of Written Evaluation (PAE) (Activity 4): 70%
- NFinal (NF) = 10% (A1) + 10% (A2) + 10% (A3) + 70% (PAE)
If the student obtains an NF> = 4.95, pass.
Students who fail to pass the subject or those who want to improve their qualification, they will have a second chance with a New Final Written Test (NPFE), which will replace PAE and which will have a value of 70%.
The New Final Grade (NNF) = + 10% (A1) + 10% (A2) +10 % (A3) + 70% (NPAE))
Thus, the Final Mark of the Subject = MAX (NF: NNF).
Attendance to class and participation.

BIBLIOGRAPHY

Basic:
- Beer, Ferdinand P., i altres. Mecánica vectorial para ingenieros [on line]. 11ª ed. México: McGraw-Hill Education, 2017 [Consultation: 08/06/2022]. Available on: https://www-ingebook-com.recursos.biblioteca.upc.edu/ib/NPcd/IB_BooksVis?cod_primaria=1000187&codigo_libro=8077. ISBN 9781456255268.
- Norton, Robert L. Machine design: an integrated approach. 4th ed. Boston: Pearson, 2011. ISBN 9780131384385.
- Cardona i Foix, Salvador; Clos Costa, Daniel. Teoria de màquines [on line]. 2a ed. Barcelona: Edicions UPC, 2008 [Consultation: 19/11/2020]. Available on: http://hdl.handle.net/2099.3/36644. ISBN 9788498803792.

Complementary:
- Hernández, Alfonso. Cinemática de mecanismos: análisis y diseño. Madrid: Síntesis, 2004. ISBN 8497562240.
- Khamashta Shahin, Munir; Álvarez Martínez, Lorenzo; Capdevila Pagés, Ramón. Problemas de cinemática y dinámica de máquinas. 2ª ed. corregida. Terrassa: Departament d'Enginyeria Mecànica, 1993-1994. ISBN 847653003X.
- Bertran Bertran, Juan M. Cinemática y dinámica de máquinas. Manresa: Universitat Politècnica de de Catalunya, 1983.
- Khamashta Shahin, Munir; Álvarez Martínez, Lorenzo; Capdevila Pagès, Ramón. Problemas de cinemática y dinámica de máquinas. Barcelona: Edicions de la Universitat Politècnica de Catalunya, 1986. ISBN 8476530048.
- Suñer Martínez, Josep-Lluís, i altres. Problemas resueltos de teoría de máquinas y mecanismos. Valencia: Universidad Politécnica de Valencia, Departamento de Ingeniería Mecánica y de Materiales, 2001. ISBN 8497050142.
- García Prada, Juan Carlos, i altres. Problemas resueltos de teoría de máquinas y mecanismos. 2ª ed. act. Madrid: Paraninfo, 2014. ISBN 9788428334426.