Course guide
330517 - EME1 - Mechanical Engineering 1

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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:** 6.0 **Languages:** Catalan, Spanish

LECTURER

Coordinating lecturer: Al Omar Mesnaoui, Anas

Others: Alcelay Larrión, José Ignacio
Peña Pitarch, Esteban
Ortuño Martin, Jose

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:
CE11. Knowledge and application of the theory principles of machines, mechanisms and dynamics of the vehicle.

Generical:
CG3. Knowledge of basic and technological subjects that will enable students to learn new methods and theories and that will endow them with the versatility needed to adapt to new situations.
CG4. Ability to solve problems with initiative, decision-making, creativity, critical reasoning and to communicate and transmit knowledge, skills and skills in the field of automotive engineering.

Transversal:
1. EFFICIENT ORAL AND WRITTEN COMMUNICATION - Level 2. Using strategies for preparing and giving oral presentations. Writing texts and documents whose content is coherent, well structured and free of spelling and grammatical errors.
2. TEAMWORK - Level 2. Contributing to the consolidation of a team by planning targets and working efficiently to favor communication, task assignment and cohesion.
3. 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.

Basic:
CB3. That students have the ability to gather and interpret relevant data (usually within their area of study) to make judgments that include a reflection on relevant social, scientific or ethical issues.
CB4. Students can transmit information, ideas, problems and solutions to a specialized and non-specialized audience.

TEACHING METHODOLOGY

MD1 Master class or lecture (EXP)
MD2 Problem solving and case study (RP)
MD3 Practical work in laboratory or workshop (TP)
MD5 Small-scale project, activity or assignment (PR)
MD7 Assessment activities (EV)

LEARNING OBJECTIVES OF THE SUBJECT

At the end of the course the student must be able to:
- Understand and use the basic concepts of mechanics so that he can properly assimilate the contents of following courses and solve a wide range of problems in the field of mechanics that will appear in the development of his professional life.
- To solve problems of a mechanical system from the static, kinematic and dynamic point of view and to be able to link the movement of the system with the causes that produce it.
- To explain with fluency and clarity how a problem is solved and how it is set out from a mechanical point of view.

STUDY LOAD

Type	Hours	Percentage
Hours large group	45,0	30.00
Self study	90,0	60.00
Hours small group	15,0	10.00

Total learning time: 150 h

CONTENTS

• Topic 1: Systems of forces

Description:
Application of basic concepts of vector algebra for obtaining force resultants, momentum caused by any forces, pairs of forces, etc. Equivalent force systems. Reduction of a system of forces. Torsional and minimum moment of a system of forces.

Specific objectives:
- Know the characteristics of a system of forces, applied to a mechanical system.
- Calculate the resultant and the resulting moment of a system of forces.
- Understand the concept of equivalent force systems.
- Reduce a system of forces, by far complex as it is, to a torsional moment.

Related activities:
Type 1 activity: Problem solving
Type 2 activity: Proposed problems assignment
Type 3 activity: Partial continuous assessment test
Type 4 activity: Final test

Full-or-part-time: 14h
Theory classes: 7h
Self study : 7h

Topic 2: Mass geometry

Description:

- Centres of mass and centroids.
- Theorems of Pappus-Guldinus.
- Moments of inertia.
- Steiner's theorem (parallel axis theorem).

Specific objectives:
- Understand and apply to mechanical systems the concepts of center of mass and inertia.
- Determine the location of the center of mass and centroid of a rigid body.
- Use the Pappus-Guldin theorems to find the area and volume of a solid of revolution.
- Define and calculate the different amounts of inertia of a rigid body.

Related activities:
Type 1 activity: Problem solving
Type 2 activity: Proposed problems assignment
Type 3 activity: Partial continuous assessment test
Type 4 activity: Final test

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

Topic 3: Rigid body statics

Description:
Free body diagram. Reactions to the joints and supports of a mechanical system. Equilibrium equations in 2D and 3D. Application of equilibrium equations to structural frameworks and machines.

Specific objectives:
- Identify the reactions in the different joints and supports of a mechanical system. Calculate the reactions in the supports of an isostatic structure, both two and three dimensions
- Draw correctly a free-body diagrams, considering the reactions at the supports. Properly define a rigid body and a deformable solid, an isostatic structure, and an hyperstatic (indeterminate) structure.
- Define general conditions of static equilibrium in 2D and 3D, and the equations to represent these conditions.
- Analyze and solve problems of balance of rigid body, structural frameworks and machines

Related activities:
Type 1 activity: Problem solving
Type 2 activity: Proposed problems assignment
Type 3 activity: Partial continuous assessment test
Type 4 activity: Final test

Full-or-part-time: 10h
Theory classes: 5h
Self study : 5h

Topic 4: Friction

Description:
Types of friction. Dry friction of Coulomb friction. Static and Kinetic friction. Applications with friction (wedges, flat-head screws, straps, flexible elements, bearings, clutches, brakes...). Concept of rolling resistance.

Specific objectives:

- Identify the types of friction and analyze the balance of various mechanical systems taking into account the effect of the frictional forces present at various surfaces or points of the mechanical system.
- Correctly apply the laws of friction to solve the problems of mechanical systems containing the different engineering components: wedges, flat-head screws, straps, flexible elements, bearings, clutches, brakes...
- Understand and apply the concept of rolling resistance in different engineering applications.

Related activities:
Type 1 activity: Problem solving
Type 2 activity: Proposed problems assignment
Type 3 activity: Partial continuous assessment test
Type 4 activity: Final test

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

Topic 5: Rigid body kinematics

Description:
Frame of reference. Vector derivation in a moving frame of reference. Rigid bodies and types of movement. Rotation with respect to a fixed axis. General plane motion: velocities and accelerations. Instant center of rotation. Relative motion with rotating axes.

Specific objectives:

- Know how to calculate the speeds and accelerations of the different parts of a mechanical system and interpret the results obtained.
- Study the general plane motion by means of a kinematic analysis.
- Calculate the velocity and acceleration of relative motion in a moving frame of reference.
- Find the instant center of rotation and determine the velocity of the different parts of a mechanical system using this method.
- Determine the speed and acceleration of relative motion in a rotating reference system.

Related activities:
Type 1 activity: Problem solving
Type 2 activity: Proposed problems assignment
Type 3 activity: Partial continuous assessment test
Type 4 activity: Final test

Full-or-part-time: 18h
Theory classes: 8h
Self study : 10h

Topic 6: Rigid body dynamics

Description:
Newton's laws. Momentum. Angular momentum. Kinetic energy theorem. General equations of general plane motion: derivation of second law of motion. D'Alembert's principle. Energy method: virtual powers. Energy theorems. Lagrange equations. Application of equations of motion.

Specific objectives:

- Understand and apply general dynamics equations from general plane motion to problem solving.
- Understand and apply fundamental theorem of rigid bodies dynamics, in their motion with respect to the center of mass.

Related activities:
Type 1 activity: Problem solving
Type 2 activity: Proposed problems assignment
Type 3 activity: Partial continuous assessment test
Type 4 activity: Final test

Full-or-part-time: 18h
Theory classes: 8h
Self study : 10h

ACTIVITIES

• Type 1 activity: Group problem solving of Systems of Forces.

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

Material:
Problems list and professor notes.

Delivery:
The group prepares a problem-solving report and hands it to the teacher at the end of the session.

Full-or-part-time: 4h
Laboratory classes: 2h
Self study: 2h

Type 1 activity: Group problem solving of Mass geometry

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

Specific objectives:
At the end of the activity, the student must be able to:
- Understand and apply the concepts involved in the activity.

Material:
Problems list and professor notes.

Delivery:
The group prepares a problem-solving report and hands it to the teacher at the end of the session.

Full-or-part-time: 4h
Laboratory classes: 2h
Self study: 2h

Type 1 activity: Group problem solving of rigid body statics

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

Specific objectives:
At the end of the activity, the student must be able to:
- Understand and apply the concepts involved in the activity.

Material:
Problems list and professor notes.

Delivery:
The group prepares a problem-solving report and hands it to the teacher at the end of the session.

Full-or-part-time: 4h
Laboratory classes: 2h
Self study: 2h

Type 1 activity: Group problem solving of Friction

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

Specific objectives:
At the end of the activity, the student must be able to:
- Understand and apply the concepts involved in the activity.

Material:
Problems list and professor notes.

Delivery:
The group prepares a problem-solving report and hands it to the teacher at the end of the session.

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

Type 1 activity: Group problem solving of Rigid body kinematics

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

Specific objectives:
At the end of the activity, the student must be able to:
- Understand and apply the concepts involved in the activity.

Material:
Problems list and professor notes.

Delivery:
The group prepares a problem-solving report and hands it to the teacher at the end of the session.

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

Type 1 activity: Group problem solving of Rigid body dynamics

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

Specific objectives:
At the end of the activity, the student must be able to:
- Understand and apply the concepts involved in the activity.

Material:
Problems list and professor notes.

Delivery:
The group prepares a problem-solving report and hands it to the teacher at the end of the session.

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

Type 2 activity: Individual proposed problems assignment of systems of forces

Description:
Individual activity that consists of solving a series of problems proposed for each topic

Specific objectives:
At the end of the activity, the student must be able to:
- Understand and apply the concepts involved in the activity.

Material:
Problems list and professor notes.

Delivery:
The student prepares a problem-solving report and hands it to the teacher at the end of the session.

Full-or-part-time: 2h
Self study: 2h

Type 2 activity: Individual proposed problems assignment of mass geometry

Description:
Individual activity that consists of solving a series of problems proposed for each topic

Specific objectives:
At the end of the activity, the student must be able to:
- Understand and apply the concepts involved in the activity.

Material:
Problems list and professor notes.

Delivery:
The student prepares a problem-solving report and hands it to the teacher at the end of the session.

Full-or-part-time: 2h
Self study: 2h

Type 2 activity: Individual proposed problems assignment of rigid body statics

Description:
Individual activity that consists of solving a series of problems proposed for each topic

Specific objectives:
At the end of the activity, the student must be able to:
- Understand and apply the concepts involved in the activity.

Material:
Problems list and professor notes.

Delivery:
The student prepares a problem-solving report and hands it to the teacher at the end of the session.

Full-or-part-time: 2h
Self study: 2h

Type 2 activity: Individual proposed problems assignment of friction

Description:
Individual activity that consists of solving a series of problems proposed for each topic

Specific objectives:
At the end of the activity, the student must be able to:
- Understand and apply the concepts involved in the activity.

Material:
Problems list and professor notes.

Delivery:
The student prepares a problem-solving report and hands it to the teacher at the end of the session.

Full-or-part-time: 2h
Self study: 2h

Type 2 activity: Individual proposed problems assignment of rigid body kinematics

Description:
Individual activity that consists of solving a series of problems proposed for each topic

Specific objectives:
Specific objectives:
At the end of the activity, the student must be able to:
- Understand and apply the concepts involved in the activity.

Material:
Problems list and professor notes.

Delivery:
The student prepares a problem-solving report and hands it to the teacher at the end of the session.

Full-or-part-time: 2h
Self study: 2h

Type 2 activity: Individual proposed problems assignment of rigid body dynamics

Description:
Individual activity that consists of solving a series of problems proposed for each topic

Specific objectives:
Specific objectives:
At the end of the activity, the student must be able to:
- Understand and apply the concepts involved in the activity.

Material:
Problems list and professor notes.

Delivery:
The student prepares a problem-solving report and hands it to the teacher at the end of the session.

Full-or-part-time: 2h
Self study: 2h

Type 3 activity: First partial continuous assessment test

Description:
First individual test on the basic concepts corresponding to the first three topics studied with resolution of problems related to the learning objectives.

Specific objectives:
At the end of the activity, the student must be able to:
- Know, understand and apply the concepts from the first three topics.

Material:
Wording and calculator.

Delivery:
Test resolution

Full-or-part-time: 8h
Theory classes: 2h
Self study: 6h

Type 3 activity: Second partial continuous assessment test

Description:
Second individual test on the basic concepts corresponding to the last three topics studied with resolution of problems related to the learning objectives.

Specific objectives:
At the end of the activity, the student must be able to:
- Know, understand and apply the concepts from the last three topics.

Material:
Wording and calculator.

Delivery:
Test resolution

Full-or-part-time: 8h
Theory classes: 2h
Self study: 6h

Type 4 activity: Final test

Description:
Test on all the basic concepts from the course.

Specific objectives:
At the end of the activity, the student must be able to:
- Know, understand and apply the concepts from the course.

Material:
Wording and calculator.

Delivery:
Test resolution

Full-or-part-time: 12h
Theory classes: 3h
Self study: 9h

GRADING SYSTEM

Activity type 1: 15%
Activity type 2: 15%
Activity type 3: 35%
Grade from partial tests, NPP=35%*(First partial test)+35%*(Second partial test)+15%*(Average activities type 1)+15%*(Average activities type 2).
Activity 4: if NPPFinal course grade, NFA=MAX(NPP:NPF)

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Complementary:

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