Course guide

240133 - 240133 - Mechanics

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

Degree: BACHELOR’S DEGREE IN INDUSTRIAL TECHNOLOGY ENGINEERING (Syllabus 2010). (Compulsory subject).

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

LECTURER

Coordinating lecturer: BARJAU CONDOMINES, ANA

Others:

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:
1. Knowledge on machines and mechanisms theory principles.

General:
9. PROJECT MANAGEMENT: Being able to present, execute and direct Industrial Engineering projects, by means of applying scientific and technologic knowledge, attitudes and procedures, once conditions have been identified or valued.

Transversal:
2. EFFICIENT ORAL AND WRITTEN COMMUNICATION. Communicating verbally and in writing about learning outcomes, thought-building and decision-making. Taking part in debates about issues related to the own field of specialization.
3. TEAMWORK. Being able to work as a team player, either as a member or as a leader. Contributing to projects pragmatically and responsibly, by reaching commitments in accordance to the resources that are available.
4. SELF-DIRECTED LEARNING. Detecting gaps in one’s knowledge and overcoming them through critical self-appraisal. Choosing the best path for broadening one’s knowledge.
5. EFFECTIVE USE OF INFORMATION RESOURCES. Managing the acquisition, structure, analysis and display of information from the own field of specialization. Taking a critical stance with regard to the results obtained.
6. SUSTAINABILITY AND SOCIAL COMMITMENT. Being aware of and understanding the complexity of social and economic phenomena that characterize the welfare society. Having the ability to relate welfare to globalization and sustainability. Being able to make a balanced use of techniques, technology, the economy and sustainability.
7. ENTREPRENEURSHIP AND INNOVATION: Knowing about and understanding how businesses are run and the sciences that govern their activity. Having the ability to understand labor laws and how planning, industrial and marketing strategies, quality and profits relate to each other.
8. THIRD LANGUAGE. Learning a third language, preferably English, to a degree of oral and written fluency that fits in with the future needs of the graduates of each course.
**TEACHING METHODOLOGY**

The objectives of the syllabus require a deep understanding of concepts. Such insight is a prerequisite to confidently tackle the great variety of engineering problems at hand. In order to achieve this understanding, all the lectures include the study and resolution of conceptual questions. Some of the lectures include also direct demonstrations with mechanical devices and computer simulations illustrating the concepts concerning the 3D motion of rigid bodies.

Problem-solving sessions are organized around open questions and problem statements that depart from routine rehash. The students are required to think about the behavior of mechanical systems, previously presented in a figure, and discover the most interesting aspects to be studied. Once the questions to be answered have been formulated, a road-map is proposed and followed. The validity of the final results is then assessed, and the relevant mechanical parameters in the system are identified.

The lab sessions confront the students with real mechanical systems. The students are required to apply fast analyses based on rigorous concepts to understand their behavior, and thus discover how misleading intuition can be.

The Digital Campus is used to provide the figures associated with the questions and exercises discussed in the classroom, collections of questions for self-evaluation generated automatically under the student request, as well as the lab sessions description.

**LEARNING OBJECTIVES OF THE SUBJECT**

**General goal**

To deepen in the study of Mechanics so that problems encountered in the field of Industrial Engineering and, more particularly, in that of Mechanical Engineering, can be solved with rigor.

**Specific goals**

To describe with accuracy the general 3D motion of rigid bodies.

To practice the rigorous application of laws and theorems governing the dynamics of rigid bodies systems.

To analyze the results and assess their validity.

**STUDY LOAD**

<table>
<thead>
<tr>
<th>Type</th>
<th>Hours</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hours small group</td>
<td>5,0</td>
<td>3.33</td>
</tr>
<tr>
<td>Hours large group</td>
<td>55,0</td>
<td>36.67</td>
</tr>
<tr>
<td>Self study</td>
<td>90,0</td>
<td>60.00</td>
</tr>
</tbody>
</table>

Total learning time: 150 h

**CONTENTS**

**Space and time. Vector time derivation**

**Description:**


**Related competencies:**

CE13. Knowledge on machines and mechanisms theory principles.

**Full-or-part-time:** 17h

- Theory classes: 6h
- Laboratory classes: 1h
- Self study: 10h
## Point kinematics

**Description:**

**Related competencies:**
CE13. Knowledge on machines and mechanisms theory principles.

**Full-or-part-time:** 15h
- Theory classes: 6h
- Self study: 9h

## Rigid body kinematics

**Description:**

**Related competencies:**
CE13. Knowledge on machines and mechanisms theory principles.

**Full-or-part-time:** 21h
- Theory classes: 8h
- Self study: 13h

## Kinematics of multibody systems

**Description:**

**Related competencies:**
CE13. Knowledge on machines and mechanisms theory principles.

**Full-or-part-time:** 6h
- Theory classes: 2h
- Laboratory classes: 1h
- Self study: 3h

## Particle dynamics

**Description:**
Principles of dynamics for inertial reference frames. Usual inertial reference frames. Extension of dynamics to non inertial frames: inertia force associated with the frame motion and the Coriolis inertia force.

**Related competencies:**
CE13. Knowledge on machines and mechanisms theory principles.

**Full-or-part-time:** 21h
- Theory classes: 8h
- Self study: 13h
Interaction forces

Description:
Formulation of interaction forces: gravitation, springs, dampers, dry friction... Constraint forces: characterization. Constraint torsor characterization: immediate and analytical. Limit conditions for constraints.

Related competencies:
CE13. Knowledge on machines and mechanisms theory principles.

Full-or-part-time: 11h
Theory classes: 4h
Laboratory classes: 1h
Self study: 6h

Geometry of masses

Description:

Related competencies:
CE13. Knowledge on machines and mechanisms theory principles.

Full-or-part-time: 6h
Theory classes: 2h
Self study: 4h

Vectorial theorems

Description:
Linear momentum theorem. Angular momentum theorem for a fixed point, a mobile point, and the center of mass. Rigid body case.

Related competencies:
CE13. Knowledge on machines and mechanisms theory principles.

Full-or-part-time: 37h
Theory classes: 14h
Laboratory classes: 1h
Self study: 22h

Energy theorem

Description:

Related competencies:
CE13. Knowledge on machines and mechanisms theory principles.

Full-or-part-time: 16h
Theory classes: 6h
Self study: 10h
# ACTIVITIES

## PARTIAL EXAM

**Description:**
multiple-choice questions basically related to kinematics.

**Specific objectives:**
Assessment of acquired knowledge.

**Material:**
Standard summary of equations.

**Delivery:**
Optical marks sheet with the answers to the test.

**Full-or-part-time:** 1h 15m  
Theory classes: 1h 15m

## FINAL EXAM

**Description:**
multiple-choice test and two exercises covering the entire syllabus.

**Specific objectives:**
Assessment of acquired knowledge.

**Material:**
Standard summary of equations.

**Delivery:**
Optical marks sheet with the answers to the test; exercises written resolution (whole development).

**Full-or-part-time:** 3h 30m  
Theory classes: 3h 30m

## REASSESSMENT

**Description:**
multiple-choice test and two exercises covering the entire syllabus.

**Specific objectives:**
Assessment of acquired knowledge.

**Material:**
Standard summary of equations.

**Delivery:**
Optical marks sheet with the answers to the test; exercises written resolution (whole development).

**Full-or-part-time:** 3h 30m  
Theory classes: 3h 30m
GRADING SYSTEM

It is based on 3 elements of evaluation:
- Test-1 (multiple-choice questions, basically kinematics) NT1
- Test-2 (multiple-choice questions, the entire syllabus) NT2
- Written exercises (related to the entire syllabus) NP

The final mark of the student is:
\[ N_{\text{final}} = \max \left( 0,25 \cdot N_{\text{TP}} + 0,3 \cdot N_{\text{TF}} + 0,45 \cdot N_{\text{PF}}; 0,4 \cdot N_{\text{TF}} + 0,6 \cdot N_{\text{PF}} \right) \]

The reassessment exam will contain a test and an exercise. In that case, the final mark will be:
\[ N_{\text{final}} = \max \left( 0,25 \cdot N_{\text{TP}} + 0,35 \cdot N_{\text{TR}} + 0,4 \cdot N_{\text{PR}}; 0,5 \cdot N_{\text{TR}} + 0,5 \cdot N_{\text{PR}} \right) \]

EXAMINATION RULES.

Only the use of a standard equations summary is allowed.

BIBLIOGRAPHY

Basic:

Complementary:

RESOURCES

Other resources:
What can be found in the Digital Campus:
- Work material for theory and practical lectures, and lab sessions guidelines.
- Self-evaluation questions.
- A significant sample of past exams, with the complete resolution of exercises and the answer to the multiple-choice tests.
- Information concerning the course organization, the compilation of formulae to be used in exams, the grade lists, the test solutions and problem resolutions of the exams corresponding to the running semester.