240133 - Mechanics

Coordinating unit: 240 - ETSEIB - Barcelona School of Industrial Engineering
Teaching unit: 712 - EM - Department of Mechanical Engineering
Academic year: 2019
Degree: BACHELOR'S DEGREE IN INDUSTRIAL TECHNOLOGY ENGINEERING (Syllabus 2010). (Teaching unit Compulsory)
ECTS credits: 6  Teaching languages: Catalan, Spanish

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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.
240133 - Mechanics

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 hands. 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 roadmap 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>Total learning time: 150h</th>
<th>Hours large group: 55h</th>
<th>36.67%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hours medium group:</td>
<td>0h</td>
<td>0.00%</td>
</tr>
<tr>
<td>Hours small group:</td>
<td>5h</td>
<td>3.33%</td>
</tr>
<tr>
<td>Guided activities:</td>
<td>0h</td>
<td>0.00%</td>
</tr>
<tr>
<td>Self study:</td>
<td>90h</td>
<td>60.00%</td>
</tr>
</tbody>
</table>
# Content

<table>
<thead>
<tr>
<th>Space and time. Vector time derivation</th>
<th>Learning time: 17h</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Theory classes: 6h</td>
</tr>
<tr>
<td></td>
<td>Practical classes: 0h</td>
</tr>
<tr>
<td></td>
<td>Laboratory classes: 1h</td>
</tr>
<tr>
<td></td>
<td>Self study: 10h</td>
</tr>
</tbody>
</table>

**Description:**

<table>
<thead>
<tr>
<th>Point kinematics</th>
<th>Learning time: 15h</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Theory classes: 6h</td>
</tr>
<tr>
<td></td>
<td>Practical classes: 0h</td>
</tr>
<tr>
<td></td>
<td>Self study: 9h</td>
</tr>
</tbody>
</table>

**Description:**

<table>
<thead>
<tr>
<th>Rigid body kinematics</th>
<th>Learning time: 21h</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Theory classes: 8h</td>
</tr>
<tr>
<td></td>
<td>Practical classes: 0h</td>
</tr>
<tr>
<td></td>
<td>Laboratory classes: 0h</td>
</tr>
<tr>
<td></td>
<td>Self study: 13h</td>
</tr>
</tbody>
</table>

**Description:**

<table>
<thead>
<tr>
<th>Kinematics of multibody systems</th>
<th>Learning time: 6h</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Theory classes: 2h</td>
</tr>
<tr>
<td></td>
<td>Practical classes: 0h</td>
</tr>
<tr>
<td></td>
<td>Laboratory classes: 1h</td>
</tr>
<tr>
<td></td>
<td>Self study: 3h</td>
</tr>
</tbody>
</table>

**Description:**
### Particle dynamics

**Description:**

**Learning time:** 21h
- Theory classes: 8h
- Practical classes: 0h
- 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.

**Learning time:** 11h
- Theory classes: 4h
- Practical classes: 0h
- Laboratory classes: 1h
- Self study: 6h

### Geometry of masses

**Description:**

**Learning time:** 6h
- Theory classes: 2h
- Practical classes: 0h
- 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.

**Learning time:** 37h
- Theory classes: 14h
- Practical classes: 0h
- Laboratory classes: 1h
- Self study: 22h
Energy theorem

Learning time: 16h
- Theory classes: 6h
- Practical classes: 0h
- Self study: 10h

Description:
## Planning of activities

| ABSTRACT EXAM | Hours: 1h 15m  
Theory classes: 1h 15m |
<table>
<thead>
<tr>
<th></th>
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</thead>
<tbody>
<tr>
<td><strong>Description:</strong></td>
<td>multiple-choice questions basically related to kinematics.</td>
</tr>
<tr>
<td><strong>Support materials:</strong></td>
<td>Standard summary of equations.</td>
</tr>
<tr>
<td><strong>Description of the assignments due and their relation to the assessment:</strong></td>
<td>Optical marks sheet with the answers to the test.</td>
</tr>
<tr>
<td><strong>Specific objectives:</strong></td>
<td>Assessment of acquired knowledge.</td>
</tr>
</tbody>
</table>

| FINAL EXAM | Hours: 3h 30m  
Theory classes: 3h 30m |
<table>
<thead>
<tr>
<th></th>
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<tbody>
<tr>
<td><strong>Description:</strong></td>
<td>multiple-choice test and two exercises covering the entire syllabus.</td>
</tr>
<tr>
<td><strong>Support materials:</strong></td>
<td>Standard summary of equations.</td>
</tr>
<tr>
<td><strong>Description of the assignments due and their relation to the assessment:</strong></td>
<td>Optical marks sheet with the answers to the test; exercises written resolution (whole development).</td>
</tr>
<tr>
<td><strong>Specific objectives:</strong></td>
<td>Assessment of acquired knowledge.</td>
</tr>
</tbody>
</table>

| REASSESSMENT | Hours: 3h 30m  
Theory classes: 3h 30m |
<table>
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<tr>
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<tr>
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</tbody>
</table>
It is based on 3 elements of evaluation:

- Test-1 (multiple-choice questions, basically kinematics) \( NT_1 \)
- Test-2 (multiple-choice questions, the entire syllabus) \( NT_2 \)
- Written exercises (related to the entire syllabus) \( NP \)

The final mark of the student is:

\[
N_{\text{final}} = \max (0.25 \, NT_1 + 0.3 \, NT_2 + 0.45 \, NP; 0.4 \, NT_2 + 0.6 \, NP)
\]

The reassessment exam will contain a test and an exercise. In that case, the final mark will be:

\[
N_{\text{final}} = \max (0.25 \, NT_1 + 0.35 \, NT_R + 0.4 \, NP_R; 0.5 \, NT_R + 0.5 \, NP_R)
\]

Qualification system

Regulations for carrying out activities

Only the use of a standard equations summary is allowed.

Bibliography

Basic:


Complementary:


Others 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.