240401 - Advanced Mechanics

Degree competences to which the subject contributes

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 enlarge the training on Mechanics with an introduction to Analytical Mechanics, Percussive Mechanics and Mechanical Vibrations.
To deepen the study of redundancy in constraints, and to illustrate practical aspects of gyroscopy.

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 and methods.
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 Digital Campus is used to provide the figures associated with the questions and exercises discussed in the classroom. Collections of four questions, dealing with the concepts presented throughout the week, are also provided weekly for self-evaluation.

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 enlarge the training on Mechanics with an introduction to Analytical Mechanics, Percussive Mechanics and Mechanical Vibrations.
To deepen the study of redundancy in constraints, and to illustrate practical aspects of gyroscopy.
## Study load

| Total learning time: 75h | Hours large group: 0h 0.00% | Hours medium group: 30h 40.00% | Hours small group: 0h 0.00% | Guided activities: 0h 0.00% | Self study: 45h 60.00% |
# 240401 - Advanced Mechanics

<table>
<thead>
<tr>
<th>Content</th>
<th>Learning time: 14h</th>
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</thead>
<tbody>
<tr>
<td>Redundancy in constraints</td>
<td>Theory classes: 3h</td>
</tr>
<tr>
<td></td>
<td>Practical classes: 2h</td>
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<tr>
<td></td>
<td>Self study: 9h</td>
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</tbody>
</table>

**Description:**

Total redundancy and tangent redundancy. Underdetermined and ill conditioned constraint forces.

<table>
<thead>
<tr>
<th>Method of virtual work</th>
<th>Learning time: 16h</th>
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<tbody>
<tr>
<td></td>
<td>Theory classes: 4h</td>
</tr>
<tr>
<td></td>
<td>Practical classes: 2h</td>
</tr>
<tr>
<td></td>
<td>Self study: 10h</td>
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</tbody>
</table>

**Description:**

D'Alembert inertia forces. Particular case of the rigid body. Virtual motions and works. Determination of equations of motion and constraint forces.

<table>
<thead>
<tr>
<th>Lagrange equations</th>
<th>Learning time: 10h</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>Theory classes: 2h</td>
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<tr>
<td></td>
<td>Practical classes: 2h</td>
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<tr>
<td></td>
<td>Self study: 6h</td>
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</tbody>
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**Description:**


<table>
<thead>
<tr>
<th>Introduction to vibrations of N DOF</th>
<th>Learning time: 16h</th>
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<tbody>
<tr>
<td></td>
<td>Theory classes: 4h</td>
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<tr>
<td></td>
<td>Practical classes: 2h</td>
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<tr>
<td></td>
<td>Self study: 10h</td>
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**Description:**

Qualification is based on three evaluation tests:

- Test 1: 3 questions of constraint analysis and 1 problem of the virtual power method (2 hours).
- Test 2: Monographic work on vibrations of a mechanical system.
- Test 3: 3 questions of percussive dynamics, and 1 problem of mechanical vibrations and percussive dynamics (2 hours).

Final exam.

The final qualification is obtained through the expression:

\[ \text{Final grade} = 0.4 \times \text{Test 1} + 0.2 \times \text{Test 2} + 0.4 \times \text{Test 3} \]

During the spring semester of the 2019-2020 academic year, and as a result of the health crisis due to Covid19, the qualification method will be:

- Test 1: Test corresponding to constraint analysis.
- Test 2: Exercises of virtual power method.
- Test 3: Exercises of Lagrange equations.
- Test 4: Exercises of vibrations.
- Test 5: Exercises of percussive dynamics.

The final qualification is obtained through the expression:

\[ \text{Final Grade} = 0.2 \times \text{Test 1} + 0.2 \times \text{Test 2} + 0.2 \times \text{Test 3} + 0.2 \times \text{Test 4} + 0.2 \times \text{Test 5} \]
Bibliography

Basic:


Complementary:


Others resources:

- What can be found in the Digital Campus:
  - Work material for theory and practical lectures.
  - The publication "Ampliació de Mecànica, resolucions de qüestions i problemes. Vol.1" (J. Agulló i Batlle. Publicacions OK Punt) with the explained resolution of 23 Test questions and 2 problems.
  - Self-evaluation questions for the weekend.
  - 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.