820461 - SMPM - Simulation of Machines and Processes

Coordinating unit: 295 - EEBE - Barcelona East School of Engineering
Teaching unit: 712 - EM - Department of Mechanical Engineering
Academic year: 2017
Degree: BACHELOR’S DEGREE IN MECHANICAL ENGINEERING (Syllabus 2009). (Teaching unit Optional) BACHELOR’S DEGREE IN MECHANICAL ENGINEERING (Syllabus 2009). (Teaching unit Optional)
ECTS credits: 6 Teaching languages: Catalan, English

Teaching staff
Coordinator: Gil Serrancolí
Others: Alex Guerrero, Gil Serrancolí

Opening hours
Timetable: If you have doubts or questions, please send an email to gil.serrancoli@upc.edu or to alex.guerrero@upc.edu so that we can find a date and time to solve them.

Prior skills
Vectorial Mechanics, kinematics, multibody dynamics, and differential equations

Requirements
Dynamics, Kinematics, Algebra and Calculus

Degree competences to which the subject contributes
Transversal:
04 COE N3. EFFICIENT ORAL AND WRITTEN COMMUNICATION - Level 3. Communicating clearly and efficiently in oral and written presentations. Adapting to audiences and communication aims by using suitable strategies and means.

Teaching methodology
This subject combines theory lectures (approximately 40%) with individual work (approximately 20%) and the work with small groups (cooperative work, 40%). The autonomous learning process is through the Campus Digital Atenea, which contains several academic materials like autoreviewing questions, tips to carry out the work in groups, discussions and proposed assignments and exercises.
The competence “Oral and written efficient communication” is carried out during the oral presentation of the group work where the students will present their work, results and conclusions.

Learning objectives of the subject
1. Calculate velocities and accelerations, and forces and moments, in a software of numerical programming.
2. Learn what the equations of motion are and how to use them.
3. Learn basic trajectory optimization methods.
# Study load

<table>
<thead>
<tr>
<th>Total learning time: 150h</th>
<th>Hours large group: 60h</th>
<th>40.00%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Self study:</td>
<td>90h</td>
<td>60.00%</td>
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</tbody>
</table>

Total learning time: 150h

Hours large group: 60h

Self study: 90h
# Content

Note: This subject is entitled "Movement Simulation"

<table>
<thead>
<tr>
<th>Chapter 1: Kinematic analysis</th>
<th>Learning time: 10h</th>
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</thead>
<tbody>
<tr>
<td>Description:</td>
<td>Theory classes: 6h</td>
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<tr>
<td></td>
<td>Guided activities: 4h</td>
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</tbody>
</table>

- Generalized coordinates (absolute and relative) (1h)
- Open kinematic chain systems (3h)
  - Calculus of velocities in 2D (reminder)
  - Calculus of velocities in 3D
  - Calculus of accelerations (by derivation)
- Closed kinematic chain systems (2h)
  - Articulated quadrilateral (kinematic constraints and velocity calculations)

L1: Calculate velocities of a 2D system of an open kinematic chain and visualize the movement, in Matlab. (2h)
L2: Calculate velocities of a 3D system of an open kinematic chain and, recordatori gràfics, in Matlab. (2h)

<table>
<thead>
<tr>
<th>Chapter 2: Dynamic analysis</th>
<th>Learning time: 10h</th>
</tr>
</thead>
<tbody>
<tr>
<td>Description:</td>
<td>Theory classes: 8h</td>
</tr>
<tr>
<td></td>
<td>Guided activities: 2h</td>
</tr>
</tbody>
</table>

- Linear and angular momentum theorems in 2D (reminder) (1h)
- Inertia tensor, reminder (1h)
- Linear and angular momentum theorems in 3D (3h)
- Equations of motion by momentum theorems (3h)

L3: Calculate the equations of motion by means of dynamics analysis of a double pendulum (2h)
This subject is based on practical lectures, it tries to familiarize the student with numerical methods usually used in movement simulation. The practical assignment, which the student will have to carry out and defend, represents 50% of the mark. This practical assignment will be followed-up during the course. The student will have to propose a mechanism (simple, between 2 and 4 degrees of freedom) and carry out a kinematics and dynamics analyses, and optimize the trajectory of one or more coordinates.

### Qualification system

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### Regulations for carrying out activities

Professors responsible for this subject will give the rules to carry out the exams and what are the materials that the students can bring during the exams. Overall, all exams will be carried out with no books or notes.
Bibliography

Basic:


Complementary: