270151 - FOMAR - Physics of Realistic Modelling and Animation

Coordinating unit: 270 - F1B - Barcelona School of Informatics
Teaching unit: 748 - F1S - Department of Physics
Academic year: 2016
Degree: BACHELOR'S DEGREE IN INFORMATICS ENGINEERING (Syllabus 2010). (Teaching unit Optional)
BACHELOR'S DEGREE IN ENGINEERING PHYSICS (Syllabus 2011). (Teaching unit Optional)
ECTS credits: 6
Teaching languages: Catalan

Teaching staff
Coordinator: Joaquim Casulleras Ambros (joaquim.casulleras@upc.edu)

Prior skills

Degree competences to which the subject contributes

Specific:
CCO2.2. Capacity to acquire, obtain, formalize and represent human knowledge in a computable way to solve problems through a computer system in any applicable field, in particular in the fields related to computation, perception and operation in intelligent environments.
CT1.2A. To interpret, select and value concepts, theories, uses and technological developments related to computer science and its application derived from the needed fundamentals of mathematics, statistics and physics. Capacity to solve the mathematical problems presented in engineering. Talent to apply the knowledge about: algebra, differential and integral calculus and numeric methods; statistics and optimization.
CT1.2B. To interpret, select and value concepts, theories, uses and technological developments related to computer science and its application derived from the needed fundamentals of mathematics, statistics and physics. Capacity to understand and dominate the physical and technological fundamentals of computer science: electromagnetism, waves, circuit theory, electronics and photonics and its application to solve engineering problems.
CT5.1. To choose, combine and exploit different programming paradigms, at the moment of building software, taking into account criteria like ease of development, efficiency, portability and maintainability.
CT5.2. To know, design and use efficiently the most adequate data types and data structures to solve a problem.
CT5.5. To use the tools of a software development environment to create and develop applications.

Generical:
G9. PROPER THINKING HABITS: capacity of critical, logical and mathematical reasoning. Capacity to solve problems in her study area. Abstraction capacity: capacity to create and use models that reflect real situations. Capacity to design and perform simple experiments and analyse and interpret its results. Analysis, synthesis and evaluation capacity.

Teaching methodology

Learning objectives of the subject

1. To know, understand and use correctly the relationships between reference frame transformations.
2. To be able to develop mathematical models of articulated rigid bodies systems.
4. To be able to identify the appropriate set of variables for the physical system studied. To be able to determine the joint variable values in order to achieve a given configuration in static conditions.

5. To build a mathematical model of the physical properties of large bodies (a rock, a rigid element of arbitrary shape), articulated rigid systems (robots, industrial manipulators). To understand the concept of inertia tensor to describe the mass distribution of an object.

6. To understand and to be able to use the laws of kinematics and dynamics in systems of many particles.

7. Understand and properly use conservation theorems for some quantities of motion.

8. To know how to describe and determine the effects of various forces: gravity, aerodynamic drag, elastic forces.

9. To use the Lagrangian formalism in order to determine statics and dynamics equations.

10. To identify the relevant variables in systems acting under restricted dynamic conditions.

11. To be able to incorporate the effects of constraint conditions on the dynamic equations.

12. To know and be able to use computer mathematical methods for the integration of dynamic equations.

13. Being able to build an animation on the basis of the computer numerical solution of the dynamic equations of the system.

### Study load

<table>
<thead>
<tr>
<th>Total learning time: 150h</th>
<th>Theory classes: 30h</th>
<th>20.00%</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Practical classes: 15h</td>
<td>10.00%</td>
</tr>
<tr>
<td></td>
<td>Laboratory classes: 15h</td>
<td>10.00%</td>
</tr>
<tr>
<td></td>
<td>Guided activities: 6h</td>
<td>4.00%</td>
</tr>
<tr>
<td></td>
<td>Self study: 84h</td>
<td>56.00%</td>
</tr>
</tbody>
</table>
## Content

### Geometric transformations in space. Denavit-Hartenberg formalism.

**Degree competences to which the content contributes:**

**Description:**

### Rigid body physics.

**Degree competences to which the content contributes:**

**Description:**
Mathematical modelling of the physical properties of large bodies (a rock, a rigid element), articulated rigid systems (robots, industrial handling devices). Mass distribution, inertia tensor.

### Interacting N-body systems.

**Degree competences to which the content contributes:**

**Description:**
Kinematics and dynamics in many particles systems. Conservation theorems. Types of relevant forces: gravity, aerodynamic drag, elastic forces. Collisions.

### Dynamics of N degrees of freedom systems. Dynamics in restricted conditions.

**Degree competences to which the content contributes:**

**Description:**

### Physically realistic animations.

**Degree competences to which the content contributes:**

**Description:**
Integration of dynamic equations. Trajectory. Visualization of objects and systems in motion subject to kinematic constraints.
## Planning of activities

<table>
<thead>
<tr>
<th>Activity</th>
<th>Hours</th>
<th>Description</th>
<th>Specific objectives</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Partial exam</strong></td>
<td>10h</td>
<td>Written examination.</td>
<td>1, 2, 3, 4, 5</td>
</tr>
<tr>
<td><strong>Final exam</strong></td>
<td>15h</td>
<td>Course final exam.</td>
<td>1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11</td>
</tr>
<tr>
<td><strong>Execution and delivery of the final practice</strong></td>
<td>12h</td>
<td>Preparation of the final practice with its report.</td>
<td>1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13</td>
</tr>
<tr>
<td><strong>Development of Theory classes</strong></td>
<td>28h</td>
<td>Combining blackboard expositions and projection of multimedia content.</td>
<td>1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13</td>
</tr>
</tbody>
</table>
### problems classes

**Description:** Discussing and solving problems.

**Specific objectives:** 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11

**Hours:** 15h
- Theory classes: 0h
- Practical classes: 15h
- Laboratory classes: 0h
- Guided activities: 0h
- Self study: 0h

### Lab work

**Description:** Develop the scheduled laboratory work.

**Specific objectives:** 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13

**Hours:** 15h
- Theory classes: 0h
- Practical classes: 0h
- Laboratory classes: 15h
- Guided activities: 0h
- Self study: 0h

### Study and preparatory work for lab sessions

**Description:** Students will study the material provided, and on the basis of the theoretical tools explained in class, prepare work to be held in the laboratory.

**Specific objectives:** 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13

**Hours:** 30h
- Theory classes: 0h
- Practical classes: 0h
- Laboratory classes: 0h
- Guided activities: 0h
- Self study: 30h

### Solving problems and exercises

**Hours:** 20h 30m
- Theory classes: 0h
- Practical classes: 0h
- Laboratory classes: 0h
- Guided activities: 0h
- Self study: 20h 30m
Description:
Personal work, solving problems and exercises

Specific objectives:
1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11

Qualification system

The assessment of transversal competence G9.1 will be made through a weighted average of the grades assigned to this competence in the partial and final exams, with the same weights of 25% and 75% respectively (0% and 100% should the final exam result be better than the partial one).

Bibliography

Basic: