240IAU11 - Fundamentals of Robotics

Degree competences to which the subject contributes

Specific:
CEEAUT5. Design, project and program robotic systems for industrial and service applications.
CEMEI08. Ability to design and project automatic production systems and advanced control processes.

Teaching methodology

Methodology
The methodology of the course will be through master classes of 2 h/session, where the teacher will explain the theory and will introduce exercises to improve the understanding of the subject. Moreover there will be laboratory classes of 2 h/session, where the student will program an industrial robot. The student will also solve exercises that will be delivered through the course.

Learning objectives of the subject

The Fundaments de Robòtica subject goal is to teach to the students the basic principles of design and control of robots, as well as how to apply them in industrial environments. It will be explained by one side the cinematic models, dynamic models, control and robot programing, and by the other side how to design industrial applications. The theoretical issues will be combined with lab practices in the department robotic lab, in order that the students learn a robot programing language, and how to design an application with industrial robots.

Study load

<table>
<thead>
<tr>
<th>Total learning time: 112h 30m</th>
<th>Hours large group: 27h</th>
<th>24.00%</th>
</tr>
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<tbody>
<tr>
<td>Hours small group:</td>
<td>13h 30m</td>
<td>12.00%</td>
</tr>
<tr>
<td>Guided activities:</td>
<td>0h</td>
<td>0.00%</td>
</tr>
<tr>
<td>Self study:</td>
<td>72h</td>
<td>64.00%</td>
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# 240IAU11 - Fundamentals of Robotics

## Content

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<th>Section</th>
<th>Learning time</th>
<th>Description</th>
<th>Specific objectives</th>
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| **1. Introduction**                  | 4h            | **Description:** An introduction to robotics                                                 | 1.1 Historical robotics evolution  
1.2 Definition and classification of robots  
1.3 Robot applications                 |
|                                      |               | **Theory classes:** 2h  
**Self study:** 2h                      |                                                                                       |
| **2. Robot morphology**              | 7h            | **Description:** Description of the robot morphology, the architectures and basic components  | 2.1 Basic robot architectures  
2.2 Robot features  
2.3 Mechanical structure  
2.4 Transmission  
2.5 Actuators  
2.6 Sensors  
2.7 Control subsystem  
2.8 Terminal components               |
|                                      |               | **Theory classes:** 3h  
**Self study:** 4h                      |                                                                                       |
| **3. Kinematic model**               | 23h           | **Description:** Description of the robot kinematic models                                     | 3.1 Geometric representation of point in 3d space  
3.2 Direct kinematic model  
3.3 Inverse kinematic model  
3.4 Differential model. Jacobian      |
|                                      |               | **Theory classes:** 7h  
**Self study:** 16h                      |                                                                                       |
### 4. Dynamic model

**Description:**
Description of the robot dynamic models

**Specific objectives:**
- 4.1 Lagrange-Euler model
- 4.2 Newton-Euler model
- 4.3 Dynamic model of the actuators

**Learning time:** 11h  
Theory classes: 3h  
Self study: 8h

### 5. Control

**Description:**
Description of the different robot control levels, joint path generation and control techniques of a joint.

**Related activities:**
Master class, problem solving and independent learning through exercises

**Specific objectives:**
- 5.1 Control levels
- 5.2 Joint path generation
- 5.3 Control at joint level
- 5.4 Control techniques

**Learning time:** 15h  
Theory classes: 5h  
Self study: 10h

### 6. Robot Programming

**Description:**
Description of the different robot programing languages and robot lab practices

**Specific objectives:**
- 6.1 Programing methods
- 6.2 System requirements for programing robots
- 6.3 Programing languages

**Learning time:** 20h  
Theory classes: 4h  
Self study: 16h
### 7. Environment robot interaction

| Description: | Description of how the robot interact with the environment using sensors |
| Specific objectives: | 7.1 Robot environment  
7.2 Environment data acquisition  
7.3 Control based on sensors |

**Learning time:** 12h  
Theory classes: 4h  
Self study: 8h

### 8. System implementation issues for an industrial robot

| Description: | It is described the system requirements for a robotic cell, what are the important robot features for an industrial application, the safety issues and the standard procedures to be taken into account for industrial robot applications |
| Related activities: | Master class, problem solving and independent learning through exercises |
| Specific objectives: | 8.1 Design and control of a robotic cell  
8.2 Features to be consider in the selection of an industrial robot  
8.3 Robot safety issues  
8.4 Standard norms for industrial robots |

**Learning time:** 10h 30m  
Theory classes: 4h  
Self study: 6h 30m

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### Qualification system

**Grading**

There will be a continuous evaluation system. The evaluation will consist of two exams, a short one in the middle of the course and a final one at the end of the course. Moreover, there will be a lab practice exam. The final grade will be obtained in the following way:

- First exam: 20%
- Final exam: 60%
- Lab practices: 20%
- Total: 100%
Regulations for carrying out activities

The exam will have two parts, one of theoretical concepts and the second one of exercises.

Bibliography

**Basic:**


**Complementary:**