This course is about autonomous mobile robots as seen from the control point of view. The main types of mobile robots (ground, aerial and underwater) are reviewed and their common control architecture is presented. This architecture introduces four control problem categories which are examined (planning, navigation, perception and control). The course is about the control problems and the control tools to solve some of them.

One of the main objectives of the course is to acquire a hands-on experience, which will be obtained through the robotic control projects.

The principal tools of advanced control system design are introduced in the theory lectures and applied in the lab. These tools are the operational aspects of discrete control theory and the state space representation and analysis framework.
which allows the natural introduction of advanced control techniques, such as optimal control, model predictive control, etc.

Study load

<table>
<thead>
<tr>
<th>Total learning time: 75h</th>
<th>Hours large group: 30h</th>
<th>40.00%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Self study:</td>
<td>45h</td>
<td>60.00%</td>
</tr>
</tbody>
</table>
# Module 1: Mobile Robotics

**Description:**
- Mobile robots
- Control architecture of autonomous mobile robots
- Representative control problems

**Related activities:**
1, 2, 3

**Specific objectives:**
- To classify and to describe the most usual types of mobile robots.
- To arrange the information and decisions flow that autonomy imposes in the control of a mobile robot.
- Distinguish the control problems that need to be solved in an autonomous mobile robot.

## Learning time:
- Theory classes: 13h
- Self study: 20h

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# Module 2: Control Design

**Description:**
- Introduction to model-based control
- Non-linear models and linearisation
- Models for control: transfer functions and state-space representation
- Controllability and observability
- Controller design based on pole placement using transfer functions
- Controller/observer design based on pole placement using the state-space representation
- Relation between transfer function and state-space design
- Controller/observer design based on optimization using the state-space representation

**Related activities:**
1, 2, 3

**Specific objectives:**
- Design controllers with pole placement and optimization techniques.
- Design observers with pole placement and optimization techniques.
- Compare representation methods and select the most suitable to design controllers and observers.

## Learning time:
- Theory classes: 17h
- Self study: 25h
# Planning of activities

| 1. Theory lectures | Hours: 10h  
| Theory classes: 10h |
|---------------------|----------------------|
| **Description:** | Exposition of the subject theory contents. |
| **Support materials:** | Slide compilations and handouts at Atenea  
| General bibliography of the subject |
| **Specific objectives:** | Knowledge transfer, creation of a conceptual reference frame, solving questions and generating interest about the subject. |

| 2. Laboratory projects | Hours: 53h  
| Theory classes: 18h  
| Self study: 35h |
|------------------------|----------------------|
| **Description:** | Students, in groups, follow the instructions to resolve a practical control problem. These sessions take place at the lab and there are two problems to solve. Terrestrial and aerial mobile robots are the platforms used in the projects developed in the lab sessions. |
| **Support materials:** | Project instructions at Atenea  
| Simulation software (Matlab)  
| Lab plants (aerial and mobile robots)  
| Course handouts and notes |
| **Descriptions of the assignments due and their relation to the assessment:** | Each group has to deliver a report describing the results of the projects, the methodology and techniques applied to obtain the final results. A practical demonstrations is also required. |
| **Specific objectives:** | Proper application of control design methodology. |

| 3. Final examination | Hours: 12h  
| Theory classes: 2h  
| Self study: 10h |
|---------------------|----------------------|
| **Description:** | Written individual examination about the concepts of theory modules. The examination includes conceptual questions, test questions, and problems to be solved by hand. |
| **Support materials:** | Examination instructions. |
| **Descriptions of the assignments due and their relation to the assessment:** | Answers to the questions and solutions to the problems posed in the instructions. |
| **Specific objectives:** | Assess the knowledge acquisition of activities 1, 2.  
| Distinguish from the group evaluation in activity 2. |
Quality System

Written individual examination: 34%
Project I assessment: 33%
Project II assessment: 33%
The students who do not pass the subject can take an additional global written exam that will take place the date stated in the calendar of final exams. The grade obtained in this exam will replace the one of the final exam in case it is higher. The maximum final mark in this case will be 5.0

Bibliography

Basic: