The aim of this course is to provide basic knowledge of linear control systems description in discrete time in order to be able to design some discrete controllers.

Degree competences to which the subject contributes

Specific:

Teaching methodology

Classroom training activities
- Participatory Lectures
- Conducting individual and team exercises
- Perform computer labs in
- Project Implementation Team
- Report writing and oral defense of problems, practices and projects

Educational activities outside the class:
- Perform exercises and theoretical or practical projects outside the classroom, individual and / or group.
- Review of theoretical concepts, study, work and individual and group analysis
- Tutoring and formative evaluation of the learning process

Learning objectives of the subject

The aim of this course is to provide basic knowledge of linear control systems description in discrete time in order to be able to design some discrete controllers.
## Study load

<table>
<thead>
<tr>
<th>Total learning time: 150h</th>
<th>Hours large group:</th>
<th>30h</th>
<th>20.00%</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Hours medium group:</td>
<td>0h</td>
<td>0.00%</td>
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<tr>
<td></td>
<td>Hours small group:</td>
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<tr>
<td></td>
<td>Guided activities:</td>
<td>0h</td>
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</tr>
<tr>
<td></td>
<td>Self study:</td>
<td>90h</td>
<td>60.00%</td>
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</tbody>
</table>
### Module 1: Introduction to control systems in discrete time

**Description:**
Objective
The aim of this first module is to introduce the basic architecture of digital control systems, applicability and benefits of their use.

Subsections:
* Types of signals
* Digital control systems
* DAC and ADC converters
* Supervisor control vs direct digital control
* Advantages of digital control vs analogic control

**Learning time:** 18h
- Theory classes: 6h
- Self study: 12h

### Module 2: Mathematical models in discrete time

**Description:**
Objective
The aim of this second module is to present the mathematical tools that are used to analyze control systems in discrete time. Will relate these techniques with the techniques used to analyze continuous systems.

Content:
* Z transform definition and properties
* Methods of calculating the Z transform and its inverse

**Learning time:** 18h
- Theory classes: 6h
- Self study: 12h

### Module 3: Signal sampling and reconstruction

**Description:**
Content:
* Ideal sampling or impulse sampling
* Sampled signal spectrum. Shannon Theorem. Ideal filter
* 0 and 1 order holder
* Star transform
* Empiric rule

**Learning time:** 18h
- Theory classes: 6h
- Self study: 12h
## Module 4: Discrete transform function

**Description:**
- Content:
  - Equivalent discrete transform function
  - Blocs diagrams. Simplification

**Learning time:** 24h
- Theory classes: 8h
- Self study: 16h

## Module 5: Time response and stability

**Description:**
- Content:
  - Relation between s and z plains
  - Routh stability criterion (bilinear transform)
  - Jury stability criterion
  - Steady state error in discrete systems

**Learning time:** 18h
- Theory classes: 6h
- Self study: 12h

## Module 6: Discrete controllers design

**Description:**
- Content:
  - Design of conventional controllers in s plane
  - Discretization of continuous controllers
  - Design of discrete controllers in z plane

**Learning time:** 42h
- Laboratory classes: 14h
- Self study: 28h
There will be a first test (P) in the middle of the semester and a second test (F) at the end of the semester. The theory grade of the subject is calculated by the formula $T = \max(0.5 \cdot (P+F), F)$.

In the laboratory part, two exams are proposed: a mid-term exam (LP) and a final exam (LF). The lab grade will be:

$L = 0.5 \cdot LP + 0.5 \cdot LF$

The final grade is calculated as follows: $0.65 \cdot T + 0.35 \cdot L$

Re-assessment can be done by students with grades from 3 and 4.9. Re-assessment substitutes grade F and final grade is calculated as

$\min(5, 0.65 \cdot TR + 0.35 \cdot L)$, where:

$TR = \max(R, (P+R)/2)$

Bibliography

Basic:
