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>Description</th>
<th>Hours</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Total learning time</strong></td>
<td>150h</td>
<td></td>
</tr>
<tr>
<td>Hours large group:</td>
<td>30h</td>
<td>20.00%</td>
</tr>
<tr>
<td>Hours medium group:</td>
<td>0h</td>
<td>0.00%</td>
</tr>
<tr>
<td>Hours small group:</td>
<td>30h</td>
<td>20.00%</td>
</tr>
<tr>
<td>Guided activities:</td>
<td>0h</td>
<td>0.00%</td>
</tr>
<tr>
<td>Self study:</td>
<td>90h</td>
<td>60.00%</td>
</tr>
</tbody>
</table>
# Content

<table>
<thead>
<tr>
<th>Module 1: Introduction to control systems in discrete time</th>
<th>Learning time: 18h</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Theory classes: 6h</td>
</tr>
<tr>
<td></td>
<td>Self study : 12h</td>
</tr>
</tbody>
</table>

**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

<table>
<thead>
<tr>
<th>Module 2: Mathematical models in discrete time</th>
<th>Learning time: 18h</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Theory classes: 6h</td>
</tr>
<tr>
<td></td>
<td>Self study : 12h</td>
</tr>
</tbody>
</table>

**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

<table>
<thead>
<tr>
<th>Module 3: Signal sampling and reconstruction</th>
<th>Learning time: 18h</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Theory classes: 6h</td>
</tr>
<tr>
<td></td>
<td>Self study : 12h</td>
</tr>
</tbody>
</table>

**Description:**
Content:
* Ideal sampling or impulse sampling
* Sampled signal spectrum. Shannon Theorem. Ideal filter
* 0 and 1 order holder
* Star transform
* Empiric rule
# Module 4: Discrete transform function

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

**Description:**  
Content:  
* Equivalent discrete transform function  
* Blobs diagrams. Simplification

# Module 5: Time response and stability

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

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

# Module 6: Discrete controllers design

**Learning time:** 42h  
Laboratory classes: 14h  
Self study : 28h

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

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 (FP). In addition, the attendance and participation will be taken into account (A). The lab grade will be: $L = 0.45 \cdot LP + 0.45 \cdot FP + 0.1 \cdot A$

The final grade is calculated as follows: $0.6 \cdot T + 0.4 \cdot L$

Bibliography

Basic: