Learning objectives of the subject:

The aim of this course is to introduce the students in time-domain and frequency-domain methods used to analyse and design linear control systems in both continuous and discrete-time fields.

Learning results of the subject:

- Ability to understand the basic concepts related to feedback system in both continuous-time and discrete-time fields.
- Ability to apply the root locus technique and the Routh stability criteria for the analysis of control systems.
- Ability to design the proper controllers to verify some control specifications in both time-domain and frequency domain.
## Study load

<table>
<thead>
<tr>
<th>Total learning time: 125h</th>
<th>Hours large group:</th>
<th>39h</th>
<th>31.20%</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Hours medium group:</td>
<td>0h</td>
<td>0.00%</td>
</tr>
<tr>
<td></td>
<td>Hours small group:</td>
<td>0h</td>
<td>0.00%</td>
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<tr>
<td></td>
<td>Guided activities:</td>
<td>0h</td>
<td>0.00%</td>
</tr>
<tr>
<td></td>
<td>Self study:</td>
<td>86h</td>
<td>68.80%</td>
</tr>
</tbody>
</table>
# Content

## 1. Introduction to linear control systems

**Learning time:** 10h  
Theory classes: 2h  
Self study: 8h

**Description:**  
- Basic components of a control system, reference, control, output and disturbance signals.  
- Control system goals.  
- Continuous-time control and discrete-time control.  
- Dynamic systems classification: linear and nonlinear systems, time-varying and time-invariant systems.  
- Transfer function of linear systems.

## 2. Continuous-time control systems analysis

**Learning time:** 24h  
Theory classes: 6h  
Self study: 18h

**Description:**  
- Transient and steady-state time-response of linear systems.  
- First and second-order systems.  
- Transient response characterization: settling time, maximum overshoot, etc.  
- Higher order systems: transient response approximation through dominant poles and zero-pole cancellation.  
- Routh-Hurwitz stability criteria.  
- Root locus analysis.  
- Steady-state error.

## 3. Continuous-time control systems design

**Learning time:** 28h  
Theory classes: 6h  
Laboratory classes: 6h  
Self study: 16h

**Description:**  
- Control design through root locus.  
- First and second-order controllers.  
- PID controllers.  
- Implementation issues of PID controllers.
## 4. Analysis of control systems in frequency domain

**Description:**
- Frequency response of linear systems.
- Nyquist diagram and Bode diagram.
- Relative stability: gain margin and phase margin.

**Learning time:** 9h
- Theory classes: 3h
- Self study: 6h

## 5. Frequency-domain control design

**Description:**
- Frequency-domain specifications: relative stability margins and bandwidth of a control system.
- Lead-lag and phase-lag compensations.

**Learning time:** 24h
- Theory classes: 5h
- Laboratory classes: 2h
- Self study: 17h

## 6. Discrete-time control systems

**Description:**
- Introduction to discrete-time control systems.
- The Z transform.
- Z Plane analysis of discrete-time systems.
- Design of discrete-time control systems by conventional methods.

**Learning time:** 30h
- Theory classes: 4h
- Laboratory classes: 5h
- Self study: 21h
## Planning of activities

### LECTURES

### EXERCISES

**Description:**
Exercises to strengthen the theoretical knowledge.

### OTHER ACTIVITIES

**Description:**
Numerical simulation homework

### EXTENDED ANSWER TEST (FINAL EXAM)

**Description:**
Final examination.

## Qualification system

- Mid course exam (50%)
- Final exam (50%)

## Bibliography

### Basic:


### Complementary: