230924 - CTR - Control Systems

Coordinating unit: 230 - ETSETB - Barcelona School of Telecommunications Engineering
Teaching unit: 710 - EEL - Department of Electronic Engineering
Academic year: 2019
Degree: BACHELOR'S DEGREE IN ELECTRONIC ENGINEERING AND TELECOMMUNICATION (Syllabus 2018). (Teaching unit Compulsory)
ECTS credits: 6
Teaching languages: Catalan, Spanish, English

Teaching staff
Coordinator: Biel Sole, Domingo
Others: Biel Sole, Domingo
Dominguez Pumar, Manuel M.

Degree competences to which the subject contributes

Basic:
CB2. (ENG) GREELEC: Que els estudiants sàpiguen aplicar els coneixements adquirits al seu treball o vocació d'una forma professional i tinguin las competències que solen desmostrar-se per mitjà de l'elaboració i defensa d'arguments i la resolució de problemes dins de la seva àrea d'estudi.

Specific:
CE26. (ENG) GREELEC: Capacitat per a comprendre i utilitzar la teoria de la realimentació i els sistemes electrònics de control. (Mòdul de tecnologia específica- Sistemes electrònics).

Learning objectives of the subject

. To get the capability to set the control specifications.
. To get the ability to design and verify the proper performance of a control system.
. To design the proper controllers to verify specifications in both time domain and frequency domain

Study load

<table>
<thead>
<tr>
<th>Total learning time: 150h</th>
<th>Hours large group:</th>
<th>52h</th>
<th>34.67%</th>
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<tbody>
<tr>
<td></td>
<td>Hours small group:</td>
<td>13h</td>
<td>8.67%</td>
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<tr>
<td></td>
<td>Self study:</td>
<td>85h</td>
<td>56.67%</td>
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</tbody>
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## Content

<table>
<thead>
<tr>
<th>Section</th>
<th>Learning time:</th>
<th>Description:</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1. Introduction</strong></td>
<td>5h</td>
<td><strong>Description:</strong> 1. What is a control system? Basic components of a control</td>
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<tr>
<td></td>
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<td>system, reference, control, output and disturbance signals.</td>
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<td>1.2. Control system goals.</td>
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<td>1.3. Continuous-time control and discrete-time control. Examples.</td>
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<tr>
<td><strong>2. System Modelling</strong></td>
<td>8h</td>
<td><strong>Description:</strong> 2.1. Dynamic systems classification: linear and nonlinear</td>
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<td>systems, time-varying and time-invariant systems.</td>
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<td>2.2. State space models.</td>
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<td>2.3. SISO and MIMO Systems.</td>
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<td>2.4. Nonlinear system linearization. Examples.</td>
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<tr>
<td><strong>3. Dynamic behaviour</strong></td>
<td>19h</td>
<td><strong>Description:</strong> 3.1. Autonomous and non-autonomous systems.</td>
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<td>3.2. Equilibrium points, invariant sets and limit cycles.</td>
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<thead>
<tr>
<th>Theory classes:</th>
<th></th>
<th>Self study:</th>
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<tbody>
<tr>
<td>1. Introduction</td>
<td>2h</td>
<td>3h</td>
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<tr>
<td>2. System Modelling</td>
<td>4h</td>
<td>4h</td>
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<tr>
<td>3. Dynamic behaviour</td>
<td>9h</td>
<td>10h</td>
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</table>
### 4. Linear Systems

**Description:**
- 4.1. Linear system state space representation.
- 4.2. The matrix exponential. Eigenvalues. Transient and steady-state time-response of linear systems.
- 4.3. Transfer function for SISO systems.
- 4.4. First and second-order systems.
- 4.5. Transient response characterization: settling time, maximum overshoot, etc.
- 4.7. Routh-Hurwitz stability criteria.

**Learning time:** 22h
- Theory classes: 9h
- Self study: 13h

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### 5. State Feedback

**Description:**
- 5.1. Reachability.
- 5.2. Stabilization by state feedback. Poles-placement design through state feedback. Ackermann's formula.
- 5.3. Integral action.
- 5.4. Observability.
- 5.5. State observer design.

**Learning time:** 26h
- Theory classes: 10h
- Self study: 16h

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### 6. Output Feedback

**Description:**
- 6.1. Control design in SISO systems through root locus. First and second-order controllers. PID controllers.
- 6.2. Implementation issues of PID controllers.

**Learning time:** 23h
- Theory classes: 8h
- Self study: 15h
### 7. Frequency-domain control design

**Learning time:** 21h  
Theory classes: 10h  
Self study: 11h

**Description:**  
7.2. Nyquist stability criterion.  
7.3. Relative stability: gain margin and phase margin.  
7.4. Frequency-domain specifications: relative stability margins and bandwidth of a control system.  
7.5. Frequency domain control design. Lead-lag and phase-lag compensations.

### Experience 1: Control Systems Introduction

**Learning time:** 4h  
Laboratory classes: 2h  
Self study: 2h

**Description:**  

### Experience 2: System identification

**Learning time:** 4h  
Laboratory classes: 2h  
Self study: 2h

**Description:**  
System identification using numerical tools.

### Experience 3: PID controller design

**Learning time:** 12h  
Laboratory classes: 6h  
Self study: 6h

**Description:**  
PID control design implemented by means of electronic circuitry.

### Experience 4: Discrete-time control systems introduction

**Learning time:** 6h  
Laboratory classes: 3h  
Self study: 3h

**Description:**  
Discrete-time control systems introduction
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**Bibliography**

**Basic:**


**Complementary:**
