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

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

### 1. Introduction

#### Learning time: 5h
- Theory classes: 2h
- Self study: 3h

**Description:**
1.1. What is a control system? Basic components of a control system, reference, control, output and disturbance signals.
1.2. Control system goals.
1.3. Continuous-time control and discrete-time control. Examples.

### 2. System Modelling

#### Learning time: 8h
- Theory classes: 4h
- Self study: 4h

**Description:**
2.1. Dynamic systems classification: linear and nonlinear systems, time-varying and time-invariant systems.
2.2. State space models.
2.3. SISO and MIMO Systems.
2.4. Nonlinear system linearization. Examples.

### 3. Dynamic behaviour

#### Learning time: 19h
- Theory classes: 9h
- Self study: 10h

**Description:**
3.1. Autonomous and non-autonomous systems.
3.2. Equilibrium points, invariant sets and limit cycles.
### 4. Linear Systems

**Description:**
1. Linear system state space representation.
3. Transfer function for SISO systems.
4. First and second-order systems.
5. Transient response characterization: settling time, maximum overshoot, etc.
7. Routh-Hurwitz stability criteria.
8. Steady-state error.

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<th>Learning time: 22h</th>
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<td>Theory classes: 9h</td>
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<td>Self study: 13h</td>
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### 5. State Feedback

**Description:**
1. Reachability.
3. Integral action.
4. Observability.
5. State observer design.

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<th>Learning time: 26h</th>
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<td>Theory classes: 10h</td>
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<td>Self study: 16h</td>
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### 6. Output Feedback

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

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<th>Learning time: 23h</th>
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<td>Theory classes: 8h</td>
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<td>Self study: 15h</td>
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### 7. Frequency-domain control design

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

**Description:**
- 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
Bibliography

**Basic:**


**Complementary:**
