Course guide
230924 - CTR - Control Systems

Unit in charge: Barcelona School of Telecommunications Engineering
Teaching unit: 710 - EEL - Department of Electronic Engineering.
Degree: BACHELOR’S DEGREE IN ELECTRONIC ENGINEERING AND TELECOMMUNICATION (Syllabus 2018).
(A compulsory subject).

Academic year: 2023 ECTS Credits: 6.0 Languages: Catalan, Spanish, English

LECTURER

Coordinating lecturer: Consultar aquí / See here:
https://telecos.upc.edu/ca/estudis/curs-actual/professorat-responsables-coordinadors/responsables-assignatura

Others: Consultar aquí / See here:
https://telecos.upc.edu/ca/estudis/curs-actual/professorat-responsables-coordinadors/professorat-assignat-idioma

PRIOR SKILLS

Circuit theory.
Signal processing.
Basic electronics.

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

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).

Basic:
CB2. (ENG) GREELEC: Que els estudiants sàpiguin 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.

TEACHING METHODOLOGY

Expository method / Lecture
Laboratory practice
Autonomous work

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>Type</th>
<th>Hours</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Self study</td>
<td>85.0</td>
<td>56.67</td>
</tr>
<tr>
<td>Hours large group</td>
<td>52.0</td>
<td>34.67</td>
</tr>
<tr>
<td>Hours small group</td>
<td>13.0</td>
<td>8.67</td>
</tr>
</tbody>
</table>

Total learning time: 150 h

CONTENTS

1. Introduction

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.

Full-or-part-time: 5h
Theory classes: 2h
Self study: 3h

2. System Modelling

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.

Full-or-part-time: 8h
Theory classes: 4h
Self study: 4h

3. Dynamic behaviour

Description:
3.1. Autonomous and non-autonomous systems.
3.2. Equilibrium points, invariant sets and limit cycles.

Full-or-part-time: 19h
Theory classes: 9h
Self study: 10h
### 4. Linear Systems

**Description:**
4.1. Linear system state space representation.
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.

**Full-or-part-time:** 22h  
Theory classes: 9h  
Self study: 13h

### 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.

**Full-or-part-time:** 26h  
Theory classes: 10h  
Self study: 16h

### 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.

**Full-or-part-time:** 23h  
Theory classes: 8h  
Self study: 15h

### 7. Frequency-domain control design

**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.

**Full-or-part-time:** 21h  
Theory classes: 10h  
Self study: 11h
Experience 1: Control Systems Introduction

Description:

Full-or-part-time: 4h
Laboratory classes: 2h
Self study: 2h

Experience 2: System identification

Description:
System identification using numerical tools.

Full-or-part-time: 4h
Laboratory classes: 2h
Self study: 2h

Experience 3: PID controller design

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

Full-or-part-time: 12h
Laboratory classes: 6h
Self study: 6h

Experience 4: Discrete-time control systems introduction

Description:
Discrete-time control systems introduction

Full-or-part-time: 6h
Laboratory classes: 3h
Self study: 3h

GRADING SYSTEM

The course grade will be obtained from two marks, the laboratory mark (LAB) and the theory mark. The theory mark considers two exams, a mid-term exam (ME) and a final exam (FE). The final mark (FM) will be FM = 0.2*LAB + 0.8*max(FE, 0.65*FE + 0.35*ME). The laboratory is not re-evaluable.

BIBLIOGRAPHY

Basic:

Complementary: