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: 2022 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 sàpiguen aplicar els coneixements adquirits al seu treball o vocació d'una forma professional i tinguin les 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>Hours small group</td>
<td>13.0</td>
<td>8.67</td>
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<tr>
<td>Hours large group</td>
<td>52.0</td>
<td>34.67</td>
</tr>
<tr>
<td>Self study</td>
<td>85.0</td>
<td>56.67</td>
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</tbody>
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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: