Course guides
230924 - CTR - Control Systems

Last modified: 29/04/2020

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). (Compulsory subject).

Academic year: 2020 **ECTS Credits:** 6.0 **Languages:** Catalan, English, Spanish

LECTURER

Coordinating lecturer: Biel Sole, Domingo

Others: Biel Sole, Domingo
Dominguez Pumar, Manuel M.

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 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

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

Type	Hours	Percentage
Hours large group	52,0	34.67
Hours small group	13,0	8.67
Self study	85,0	56.67

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.
3.3. Stability. Lyapunov stability analysis.

Full-or-part-time: 19h
Theory classes: 9h
Self study : 10h

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.
4.6. Higher order systems: transient response approximation through dominant poles and zero-pole cancellation.
4.7. Routh-Hurtwitz stability criteria.
4.8. Steady-state error.

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:
7.1. Frequency response of SISO system. Nyquist diagram and Bode diagram.
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:
Control system description. Control goals. Characteristic signals. Numerical simulation results.

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

BIBLIOGRAPHY

Basic:
- Ogata, K. Modern control engineering. 5th ed. Boston: Pearson, 2010. ISBN 9780137133376.
- Khalil, H.K. Nonlinear systems. 3rd ed., international ed. New Jersey: Pearson Education, 2014. ISBN 9781292039213.
- Åström, K.J.; Murray, R.M. Feedback systems: an introduction for scientists and engineers. Princeton: Princeton University, 2008. ISBN 9780691135762.

Complementary:
- Golnaraghi, F.; Kuo, B.C. Automatic control systems. 10th ed. New York: McGraw-Hill Education, 2017. ISBN 9781259643835.
- Slotine, J.-J.E.; Li, W. Applied nonlinear control. Englewood Cliffs, NJ: Prentice-Hall, 1991. ISBN 0130408905.