Course guide
230475 - TCTRL - Control Theory

Last modified: 24/05/2024

Unit in charge: Barcelona School of Telecommunications Engineering
Teaching unit: 710 - EEL - Department of Electronic Engineering.

Degree: BACHELOR'S DEGREE IN ENGINEERING PHYSICS (Syllabus 2011). (Compulsory subject).

Academic year: 2024 **ECTS Credits:** 6.0 **Languages:** Catalan, Spanish

LECTURER

Coordinating lecturer: JOSEP MARIA OLM MIRAS

Others: Segon quadrimestre:
DOMINGO BIEL SOLE - 10
JOSEP MARIA OLM MIRAS - 10

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:
1. Knowledge of control theory. Knowledge of feedback procedures. Ability to design a process control system.

Generical:
1. ABILITY TO IDENTIFY, FORMULATE, AND SOLVE PHYSICAL ENGINEERING PROBLEMS. Planning and solving physical engineering problems with initiative, making decisions and with creativity. Developing methods of analysis and problem solving in a systematic and creative way.

7. They will have acquired knowledge related to experiments and laboratory instruments and will be competent in a laboratory environment in the ICC field. They will know how to use the instruments and tools of telecommunications and electronic engineering and how to interpret manuals and specifications. They will be able to evaluate the errors and limitations associated with simulation measures and results.

Transversal:
2. THIRD LANGUAGE. Learning a third language, preferably English, to a degree of oral and written fluency that fits in with the future needs of the graduates of each course.
3. EFFICIENT ORAL AND WRITTEN COMMUNICATION - Level 3. Communicating clearly and efficiently in oral and written presentations. Adapting to audiences and communication aims by using suitable strategies and means.
4. TEAMWORK - Level 3. Managing and making work groups effective. Resolving possible conflicts, valuing working with others, assessing the effectiveness of a team and presenting the final results.
5. EFFECTIVE USE OF INFORMATI0N RESOURCES - Level 3. Planning and using the information necessary for an academic assignment (a final thesis, for example) based on a critical appraisal of the information resources used.
6. SELF-DIRECTED LEARNING - Level 3. Applying the knowledge gained in completing a task according to its relevance and importance. Deciding how to carry out a task, the amount of time to be devoted to it and the most suitable information sources.

TEACHING METHODOLOGY

There will be three theoretical and two practical weekly sessions. The theoretical lectures will be devoted to a careful presentation of the basic concepts and the main results, which will be illustrated with some examples. The practical sessions will be devoted to the solution of a variety of exercises and problems.

LEARNING OBJECTIVES OF THE SUBJECT

* To understand the basic concepts related to feedback systems in continuous time.
* To apply the root locus technique and the Routh stability criterion in the analysis of control systems.
* To design the proper controllers to verify specifications in the time and/or frequency domain.

STUDY LOAD

Type	Hours	Percentage
Self study	85,0	56.67
Hours large group	65,0	43.33

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: 3h
Theory classes: 1h
Self study : 2h

2. System modelling

Description:
2.1. Mathematical models
2.2. State space models
2.3. Linear systems
2.4. Linearization of nonlinear systems
2.5. Examples

Full-or-part-time: 9h
Theory classes: 2h
Practical classes: 2h
Self study : 5h

3. Stability of linear and nonlinear systems

Description:
3.1. Dynamic analysis of control systems
3.2. Phase plane analysis
3.3. Definition of stability: equilibrium points, limit cycles
3.4. Stability of linear systems
3.5. Stability of nonlinear systems

Full-or-part-time: 23h
Theory classes: 6h
Practical classes: 4h
Self study : 13h

4. Time and frequency response of linear systems

Description:
4.1. Time response of LTI systems
4.2. Frequency response of LTI systems
4.3. Block diagram transformation

Full-or-part-time: 14h
Theory classes: 4h
Practical classes: 2h
Self study : 8h

5. State feedback

Description:
5.1. Reachability (controllability)
5.2. Stabilization by state feedback
5.3. Integral action
5.4. Linear quadratic regulators (LQR)

Full-or-part-time: 26h
Theory classes: 6h
Practical classes: 5h
Self study : 15h

6. Control using state observers

Description:
6.1. Observability
6.2. State observer design
6.3. General control scheme: state feedback and observer

Full-or-part-time: 12h
Theory classes: 3h
Practical classes: 2h
Self study : 7h

7. Output feedback

Description:
7.1. Input/output systems
7.2. PID controllers
7.3. PID tuning: Routh criterion and Ziegler-Nichols method
7.4. The root locus method
7.5. Zero-pole and pole-zero controllers
7.6. Additional elements
7.7. Implementation issues

Full-or-part-time: 32h
Theory classes: 8h
Practical classes: 6h
Self study : 18h

8. Frequency domain control design

Description:
8.1. Frequency response of SISO systems
8.2. Nyquist stability criterion
8.3. Gain and phase margins
8.4. Control design using the frequency domain
8.5. Describing function

Full-or-part-time: 31h
Theory classes: 9h
Practical classes: 4h
Self study : 18h

GRADING SYSTEM

The regular assessment will consist of a final exam (EF) and a mid term exam (EP). The final score (NF) will be computed as NF=max{EF,0.65*EF+0.35*EP}.

The students with NF below 5 will have the chance to attend a resit exam (ER). In this case the final score (NFR) will be computed as: NFR=max{NF,ER}.

BIBLIOGRAPHY

Basic:
- Aström, K.J.; Murray, R.M. Feedback systems: an introduction for scientists and engineers. Princeton: Princeton University, 2008. ISBN 978-0-691-13576-2.
- Ogata, K. Modern control engineering. 5th ed. Boston: Pearson, 2010. ISBN 9780137133376.
- Slotine, J.-J.E.; Li, W. Applied nonlinear control. Englewood Cliffs, NJ: Prentice-Hall, 1991. ISBN 0130408905.
- Khalil, H.K. Nonlinear Systems. 3rd ed. New Jersey: Pearson Education, 2014. ISBN 9781292039213.

Complementary:
- Golnaraghi, F.; Kuo, B.C. Automatic control systems. 10th ed. New York: McGraw Hill Education, 2017. ISBN 9781259643835.