Course guide
820252 - CAEIA - Advanced Control

Last modified: 02/10/2025

Unit in charge: Barcelona East School of Engineering
Teaching unit: 707 - ESAII - Department of Automatic Control.

Degree: BACHELOR'S DEGREE IN ELECTRICAL ENGINEERING (Syllabus 2009). (Optional subject).
BACHELOR'S DEGREE IN ENERGY ENGINEERING (Syllabus 2009). (Optional subject).
BACHELOR'S DEGREE IN INDUSTRIAL ELECTRONICS AND AUTOMATIC CONTROL ENGINEERING (Syllabus 2009). (Optional subject).

Academic year: 2025 **ECTS Credits:** 6.0 **Languages:** Catalan, Spanish

LECTURER

Coordinating lecturer:

Others:

REQUIREMENTS

Automatic Control. Basic control theory.

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Transversal:
1. 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

The course uses an expository and project-based methodology. In the expository part, the lecturer will explain the theoretical concepts using examples of real control problems. The laboratory work will focus on experimenting with the theoretical concepts through the implementation of various control systems using models and prototypes. Students will take one hour of theory class and three hours of practical classes per week. However, the timetables will not be uniform, so that at the beginning of the course there will be sessions of two hours of theory plus two hours of practice per week. In the final weeks of the course, the number of laboratory hours will be increased and, in some cases, the theory hour may be eliminated.
The laboratory work will be based on learning how to program a microcontroller using Matlab Simulink, which will then be used to test the different control problems that will arise. In the final part of the course, students are expected to be able to develop a controller for a specific problem independently. The laboratory work will be done in groups of two people (maximum 3).

LEARNING OBJECTIVES OF THE SUBJECT

- Increase the knowledge on automatic control acquired in the subjects Industrial Control and Automation, Automatic Regulation and Control Techniques/Control of Energy Systems.
- Reinforce the modelling and linearisation of dynamic systems.
- To broaden and deepen the concept of system stability.
- Introduce state feedback control methods.
- Controllability and Observability. Observers design.
- Introduction to methods of analysis and design of non-linear control systems.
- Study of discrete-time systems.
- Methods of frequency design in discrete time.

STUDY LOAD

Type	Hours	Percentage
Hours small group	15,0	10.00
Hours large group	45,0	30.00
Self study	90,0	60.00

Total learning time: 150 h

CONTENTS

Modelling and stability.

Description:
Modelling. Linear and non-linear systems. State space representation. Linearisation of dynamic systems. Laplace transform, transfer functions. Temporal responses. Definition and stability criteria.

Full-or-part-time: 2h
Theory classes: 2h

Frequency compensation.

Description:
Bode diagrams. Polar curves and Nyquist stability criterion. Relative stability margins (gain and phase). Frequency compensation lag, lead and lead-lag structure. Frequency compensation + PID controller.

Full-or-part-time: 2h
Theory classes: 2h

The root locus method. Analisys and controller design.

Description:
Root locus graph (LGR). Rules for the construction of LGR. LGR with Matlab. Systems with delay. Controller design with LGR.

Full-or-part-time: 3h
Theory classes: 3h

Full state feedback control.

Description:
State space system definition. Linearization by feedback. Eigenvalues (eigenvalues). Control design by pole/eigenvalue assigment. Ackerman's formula. Perturbations and integral action.

Full-or-part-time: 2h
Theory classes: 2h

Observability. Observer design.

Description:
Observality. Luenberger Observer. Kalman filters.

Full-or-part-time: 2h
Theory classes: 2h

Nonlinear control

Description:
Introduction to non-linear control. Liapunov stability criterion. The describing function. Sliding mode control.

Full-or-part-time: 2h
Theory classes: 2h

System discretitzation.

Description:
Systems discretitzation. Z-transform. Discrete-time realitzation of controllers. The Bi-linear transformation. Discretitzation with zero-order hold and direct digital design.

Full-or-part-time: 2h
Laboratory classes: 2h

ACTIVITIES

Lab session1

Full-or-part-time: 3h
Theory classes: 3h

Lab 2. Design and implementation of a PLL.

Full-or-part-time: 4h
Laboratory classes: 4h

Lab Session 3. Design and implementation of a buck converter.

Full-or-part-time: 6h
Theory classes: 6h

Lab session 4. Design and implementation of controllers for DC motor.

Full-or-part-time: 6h
Laboratory classes: 6h

Lab Session 5. Design and implementation of controllers for a SegWay.

Full-or-part-time: 6h
Laboratory classes: 6h

Lab session 6. Design and implementation of a line tracker robot.

Full-or-part-time: 6h
Theory classes: 6h

GRADING SYSTEM

Follow-up of the course (lectures, laboratory) 15 %.
Practical implementations in the lab 50%.
Implementation of final project in the laboratory 20%
Final report 15%

EXAMINATION RULES.

L'avaluació es realitzarà mtijançant la valoració objectiva dels exàmens, la realització d'informes de pràctiques de laboratori i els exercicis entregats al llarg del curs.

BIBLIOGRAPHY

Basic:
- Ogata, Katsuhiko. Sistemas de control en tiempo discreto. 2ª ed. México [etc.]: Prentice Hall Hispanoamericana, cop. 1996. ISBN 9688805394.
- Slotine, Jean-Jacques E; Li, Weiping. Applied nonlinear control. Englewood Cliffs, NJ: Prentice-Hall, cop. 1991. ISBN 0130408905.
- Model Predictive control. 2nd ed. London: Springer London, 2007. ISBN 9781852336943.

Complementary:
- Ogata, Katsuhiko; Dormido Canto, Sebastián; Dormido Canto, Raquel. Ingeniería de control moderna. 5ª ed. Madrid [etc.]: Pearson Educación, cop. 2010. ISBN 9788483226605.