Course guide
320183 - ISCA - Introduction to Advanced Control Systems

Last modified: 19/04/2023

Unit in charge: Terrassa School of Industrial, Aerospace and Audiovisual Engineering
Teaching unit: 707 - ESAII - Department of Automatic Control.

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

Academic year: 2023 **ECTS Credits:** 6.0 **Languages:** Catalan

LECTURER

Coordinating lecturer: - Vicenç Puig

Others: - Carlos Trapiello

PRIOR SKILLS

- Control and automation
- Modelling and analysis of dynamic systems
- Control engineering.

REQUIREMENTS

- Students should have a background in automatic control.

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:
1. ELO: skills for The modelling and simulation of systems.

2. ELO: Understanding of automatic control and various control techniques, as well as their application to industrial automation.

3. ELO: Ability to design and control automation systems.

TEACHING METHODOLOGY

The teaching methodology includes:
- Face-to-face theoretical sessions to present the contents of each chapter.
- Face-to-face laboratory sessions to develop projects in a group.
- Self-study work and exercises.

LEARNING OBJECTIVES OF THE SUBJECT

- The objective of this subject is to introduce the students advanced subjects of the control area through projects.
- In particular, advanced control techniques will be introduced while showing applications that will illustrate their field of application.
- The course will also introduce techniques that go beyond control such as fault diagnosis and supervision (including tolerant control).

STUDY LOAD

Type	Hours	Percentage
Self study	90,0	60.00
Hours large group	30,0	20.00
Hours small group	30,0	20.00

Total learning time: 150 h

CONTENTS

Chapter 1: Advanced Control Systems

Description:
1.1 Introduction
1.2 State-space models
1.3 Dynamics of linear systems
1.4 Design of state-feedback controllers
1.5 State observers
1.6 Optimal and model predictive control

Specific objectives:
- To understand the need for advanced control techniques beyond standard control techniques to solve complex problems
- To understand and learn the fundamentals of advanced control techniques in state space

Related activities:
Activity 1: Theory sessions
Activity 2: Laboratory sessions

Full-or-part-time: 50h
Theory classes: 10h
Laboratory classes: 10h
Self study : 30h

Chapter 2: Fault diagnosis

Description:
2.1 Introduction
2.2 Fault detection
2.3 Fault isolation
2.4 Generation of analytical redundancy relations

Specific objectives:
To understand and to know the fundamentals of fault diagnosis techniques as well as the related tasks: fault detection and isolation.
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Related activities:
Activity 1: Theory sessions
Activity 2: Laboratory sessions

Full-or-part-time: 50h
Theory classes: 10h
Laboratory classes: 10h
Self study : 30h

Chapter 3: Fault-tolerant control

Description:
3.1 Data validación
3.2 Data reconstruction
3.3 Supervision
3.4 Fault-tolerant control

Specific objectives:
-To understand and learn the fundamentals of data validation/reconstruction, supervision and fault-tolerant control.

Related activities:
Activity 1: Theory sessions
Activity 2: Laboratory sessions

Full-or-part-time: 50h
Theory classes: 10h
Laboratory classes: 10h
Self study : 30h

ACTIVITIES

THEORY SESSIONS

Description:
Exhibition of the contents of the subject following an expository and participative class model.

Specific objectives:
At the end of these classes, the student must be able to consolidate and acquire the necessary knowledge listed in the section "General learning objectives of the subject".

Material:
Basic and specific bibliography.
Notes of the professor (Digital campus).

Delivery:
This activity is evaluated with the projects developed during the lab sessions.

Full-or-part-time: 75h
Theory classes: 30h
Self study: 45h

LAB SESSIONS

Description:
Project 1: Advanced control
In this project, the students will design an advanced controller for a complex system (autonomous vehicle, UAV or industrial process).
Project 2: Fault diagnosis
In this project, the students will design a fault diagnosis system for a complex system (autonomous vehicle, UAV or industrial process).
Project 3: Advanced control
In this project, the students will design a fault tolerant controller for a complex system (autonomous vehicle, UAV or industrial process).

Specific objectives:
To apply the concepts presented in the theoretical sessions using real case studies.

Material:
- Description of the project.
- Bibilography.

Delivery:
Project report developed in a team.

Full-or-part-time: 75h
Laboratory classes: 30h
Self study: 45h

GRADING SYSTEM

Two written exams (midterm and final) with a 35% of weight each and lab reports with a 30% of weight.

All those students who cannot attend the mid-term exam, or who want to improve their grade, will have the option of taking an additional written exam that will be done on the same day than the final exam. The score for this additional exam will be between 0 and 10, and will replace the mark of the midterm exam as long as it is higher.

For all those students who meet the requirements and attend to the reassessment exam, the qualification of the reassessment exam will replace the grades of all the assessment acts that are face-to-face written tests (midterm and final exams) and the qualifications of the laboratory work done during the course.

If the final grade after the reassessment is less than 5.0, it will replace the initial one only if it is higher. If the final mark after the reassessment is greater than or equal to 5.0, the final mark of the subject will be approved 5.0.

EXAMINATION RULES.

- All assessment activities are mandatory.
- Students should attend all lab sessions.

BIBLIOGRAPHY

Basic:
- Ofsthun, S. "Integrated vehicle health management for aerospace platforms". IEEE instrumentation & measurement magazine [on line]. Vol. 5, núm. 3 (2002), p.21-24 [Consultation: 09/05/2022]. Available on: https://ieeexplore-ieee-org.recursos.biblioteca.upc.edu/document/1028368.- Albertos, P.; Mareels, I. Feedback and control for everyone. Berlin: Springer, 2009. ISBN 9783642034459.
- Isermann, Rolf. Fault-diagnosis systems: an introduction from fault detection to fault tolerance. Berlin: Springer, 2006. ISBN 3540241124.

Complementary:
- Gertler, Janos J. Fault detection and diagnosis in engineering systems. New York: Marcel Dekker, 1998. ISBN 0824794273.
- Blanke, Mogens [et al.]. Diagnosis and fault-tolerant control. Berlin: Springer, 2003. ISBN 3540010564.
- Albertos, P.; Sala, A. Multivariable control systems: an engineering approach [on line]. London: Springer, 2004 [Consultation: 11/05/2022]. Available on: https://link-springer-com.recursos.biblioteca.upc.edu/book/10.1007/b97506. ISBN 1852337389.
- Maciejowski, J.M. Predictive control: with constraints. New York: Prentice Hall, 2001. ISBN 0201398230.

RESOURCES

Other resources:
- Class slides prepared by the professors.
- Exercises and problems of self-learning prepared by teachers.
- Statements and materials to develop the projects.