

## Course guide

### 330106 - RA - Automatic Regulation

**Last modified:** 30/08/2023

<b>Unit in charge:</b>	Manresa School of Engineering		
<b>Teaching unit:</b>	750 - EMIT - Department of Mining, Industrial and ICT Engineering.		
<b>Degree:</b>	BACHELOR'S DEGREE IN INDUSTRIAL ELECTRONICS AND AUTOMATIC CONTROL ENGINEERING (Syllabus 2009). (Compulsory subject). BACHELOR'S DEGREE IN AUTOMOTIVE ENGINEERING (Syllabus 2017). (Optional subject).		
<b>Academic year:</b> 2023	<b>ECTS Credits:</b> 6.0	<b>Languages:</b> Catalan	

#### LECTURER

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**Coordinating lecturer:** Escobet Canal, Teresa

**Others:** Leon Pardo, Miguel

#### PRIOR SKILLS

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Students are expected to have passed Mathematics I and II, Physics I and II, Introduction to Computing, Mechanical Systems, Electrical Systems, Electronic Systems and Industrial Control and Automation

#### DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

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**Specific:**

1. Knowledge of frequency-domain analysis properties for designing feedback controllers for both continuous and discrete time systems.
2. Knowledge of space state techniques for modeling complex systems.
3. Modelling and simulating dynamic systems.
4. Knowledge applied to discrete time systems.
5. Ability to synthesize and solve problems related to the automatic control discipline.

**Transversal:**

6. TEAMWORK - Level 2. Contributing to the consolidation of a team by planning targets and working efficiently to favor communication, task assignment and cohesion.
7. EFFECTIVE USE OF INFORMATION 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.
8. 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

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- Face-to-face lecture sessions.
- Face-to-face practical work sessions.
- Independent learning and exercises.
- Preparation and completion of group activities subject to assessment.

## LEARNING OBJECTIVES OF THE SUBJECT

This subject provides students with the necessary theoretical and practical knowledge to do the following:

- Build mathematical and simulation models corresponding to real systems and use them to study and analyse the dynamic behaviour of the systems.
- Design and implement analogue and digital controllers.
- Analyse and solve industrial-control problems.

## STUDY LOAD

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

**Total learning time:** 150 h

## CONTENTS

### Topic 1. MODELLING AND ANALYSIS OF DYNAMIC SYSTEMS

#### Description:

- 1.1. Introduction and presentation of the study cases
- 1.2. Tools for simulating mathematical models.
- 1.3. Temporal analysis of continuous dynamical systems
- 1.4. Frequency analysis of continuous dynamical systems
- 1.5. Discrete systems analysis

#### Specific objectives:

- The ability to create unified mathematical models for various types of systems.
- The ability to represent dynamical system using state space techniques.
- The ability to use tools to simulate systems on the basis of their models.
- The ability to define and calculate the time-response characteristics of a feedback system exposed to external signals and disturbances.
- The ability to define and calculate the various frequency-response characteristics of a feedback system.
- The ability to mathematically represent mixed (continuous and discrete) dynamical Systems.
- The ability to understand the differences between a continuous system and a discrete system.

#### Related activities:

Lectures, laboratory practicals and examinations.

#### Full-or-part-time: 22h

Theory classes: 18h

Practical classes: 4h

## Topic 2. CONTINUOUS CONTROL OF DYNAMICAL SYSTEMS

### Description:

- 2.1. Command-following specifications
- 2.2. Analytical design of regulators
- 2.3. Frequential design of regulators

### Specific objectives:

- The ability to define and recognise the effect of an external signal on P, I and D actions.
- The ability to forecast the effect of a change in any control action on the behaviour of a feedback system.
- The ability to calculate the parameters of PID controllers that modify the behaviour of physical systems in order to meet certain operation and disturbance specifications

### Related activities:

Lectures, laboratory practicals and an examination.

### Full-or-part-time: 19h

Theory classes: 15h

Practical classes: 4h

## TOPIC 3. DESIGN OF DISCRETE CONTROL SYSTEMS

### Description:

- 3.1. Introduction to digital controller
- 3.2. Command-following specifications
- 3.3. Analytical tuning

### Specific objectives:

The ability to design and implement digital controllers for processes with continuous variables that meet command-following and rejection specifications.

### Related activities:

Lectures, laboratory practicals and an examination.

### Full-or-part-time: 19h

Theory classes: 15h

Laboratory classes: 4h

## ACTIVITIES

### ACTIVITY 1: EXPLANATORY SESSION

#### Description:

Sessions that combine master classes, where theoretical concepts are explain, with exercise and problem resolution.

#### Material:

Matlab Program.

Matlab tutorial.

Collection of problems of the subject.

Basic Bibliography.

#### Full-or-part-time: 2h

Theory classes: 2h

## ACTIVITY 2: PROBLEM SESSION

### Description:

They are face-to-face classes specifically dedicated to problem solving. They are made in the laboratory, as the Matlab is available to obtain the solution. They are classes that require the participation of students, as they will solve the problems in group and / or individually.

### Material:

Matlab Program.

Matlab tutorial.

Collection of problems of the subject.

**Full-or-part-time:** 33h

Laboratory classes: 13h

Self study: 20h

## ACTIVITY 3: EVALUATION

### Description:

Individual classroom test related to the learning objectives of the subject's contents.

### Material:

Statement of the test delivered at the time of the test.

**Full-or-part-time:** 46h

Theory classes: 6h

Self study: 40h

## ACTIVITY 4: SOLVING EXERCISES

### Description:

It is an activity that the student does autonomously and consists in solving problems that have been proposed in class.

### Material:

Statements delivered in each case.

Matlab Program.

Basic Bibliography.

**Full-or-part-time:** 30h

Self study: 30h

## GRADING SYSTEM

Each student's final mark is obtained by weighting his/her marks on the following:

1. Two control tests performed throughout the course with a weight of 20% each.
2. Continuous assessment in laboratory sessions, with a weight of 25%.
3. A final evaluation test with a weight of 35%.

## EXAMINATION RULES.

Attendance and participation in laboratory sessions is compulsory.



## BIBLIOGRAPHY

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### Basic:

- Nise, Norman S. Control systems engineering. 7th ed. Hoboken: John Wiley & Sons, 2015. ISBN 9781118800829.

### Complementary:

- Ogata, K. Ingeniería de control moderna [on line]. 5ª ed. Madrid: Pearson Educación, 2010 [Consultation: 02/06/2022]. Available on: [https://www-ingebook-com.recursos.biblioteca.upc.edu/ib/NPcd/IB\\_BooksVis?cod\\_primaria=1000187&codigo\\_libro=1259](https://www-ingebook-com.recursos.biblioteca.upc.edu/ib/NPcd/IB_BooksVis?cod_primaria=1000187&codigo_libro=1259). ISBN 9788483226605.

- Bolzern, Paolo; Scattolini, Riccardo; Schiavoni, Nicola. Fundamentos de control automático. 3ª ed. Madrid: McGraw-Hill, 2008. ISBN 9788838664342.