

## Course guide

# 3200332 - MASD2 - Modelling and Analysis of Dynamic Systems II

Last modified: 02/04/2024

**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). (Compulsory subject).

**Academic year:** 2024    **ECTS Credits:** 4.5    **Languages:** Catalan

## LECTURER

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**Coordinating lecturer:** Ramon Pérez Magrané

**Others:** Josep Cugueró Escofet

## PRIOR SKILLS

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Modelització o Anàlisi de sistemes Dinàmics I

## DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

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### Specific:

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

### Transversal:

2. SELF-DIRECTED LEARNING - Level 2: Completing set tasks based on the guidelines set by lecturers. Devoting the time needed to complete each task, including personal contributions and expanding on the recommended information sources.  
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.

## 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

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This subject will provide students with the necessary theoretical and practical knowledge and skills to build mathematical and simulation models corresponding to real systems and use them to study and analyse the dynamic behaviour of the systems. In particular, students will study the control of the dynamic behaviour of systems.

## STUDY LOAD

Type	Hours	Percentage
Hours large group	15,0	13.33
Hours small group	30,0	26.67
Self study	67,5	60.00

**Total learning time:** 112.5 h

## CONTENTS

### TOPIC 1: Introduction

#### Description:

- 1.1. Definitions.
- 1.2. Objectives of dynamical system modelling.
- 1.3. Model classification and examples.
- 1.4. External representation of continuous and discrete system models.
- 1.5. System modelling stages.
- 1.6. Model simplification.
- 1.7. Tools for simulating mathematical models.

#### Specific objectives:

- The ability to distinguish between the various system model types.
- The ability to distinguish between the various modelling stages.
- The ability to represent systems mathematically using transfer functions and block flow diagrams.
- The ability to use tools to simulate systems on the basis of their models.

#### Related activities:

Lectures, laboratory practicals and examinations.

#### Full-or-part-time: 9h

Theory classes: 2h

Laboratory classes: 3h

Self study : 4h

### TOPIC 2: Parametric identification of linear models

#### Description:

- 2.1. Structure of discrete linear models.
- 2.2. Least squares method.
- 2.3. Model order selection criteria and validation.

#### Specific objectives:

- The ability to pre-specify model structure.
- The ability to estimate model parameters using experimental data.
- The ability to validate a model using experimental data.

#### Related activities:

Lectures, laboratory practicals and examinations.

#### Full-or-part-time: 35h

Theory classes: 6h

Laboratory classes: 9h

Self study : 20h

### TOPIC 3: Non-parametric identification of linear models

**Description:**

- 3.1. Experimental design.
- 3.2. Data pre-processing.
- 3.3. Transient response analysis.
- 3.4. Correlation methods.
- 3.5. Frequency response analysis.

**Specific objectives:**

The ability to design experiments to estimate the transfer function of a linear system.  
The ability to experimentally estimate the impulse response of a linear system.  
The ability to experimentally estimate the frequency response of a linear system.

**Related activities:**

Lectures, laboratory practicals and examinations.

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

Theory classes: 4h

Laboratory classes: 9h

Self study : 20h

### THEME 4. Model calibration

**Description:**

- 4.1. Complex systems models
- 4.2. Parameter tuning
- 4.3. Optimisation methods

**Specific objectives:**

Complex models manipulation  
Parameter calibration

**Related activities:**

Lectures, laboratory practicals and examinations.

**Full-or-part-time:** 17h

Theory classes: 2h

Laboratory classes: 5h

Self study : 10h

## TOPIC 5. Dynamical systems simulation

### Description:

- 9.1. Digital simulation of mathematical models.
- 9.2. Model parameterisation.
- 9.3. Model validation.

### Specific objectives:

- The ability to construct a simulation model on the basis of a mathematical model.
- The ability to calibrate a simulation model using experimental data.
- The ability to validate a simulation model using experimental data.

### Related activities:

Lectures, laboratory practicals and examinations.

### Full-or-part-time: 18h 30m

Theory classes: 1h

Laboratory classes: 4h

Self study : 13h 30m

## GRADING SYSTEM

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

- Two examinations: 70%
- Continuous assessment in class and laboratory sessions: 30%

In order to redirect the little satisfactory results of the first exam the second exam includes all the course and the result of this final exam substitute the first one in case of being higher.

For those students who meet the requirements and submit to the reevaluation examination, the grade of the reevaluation exam will replace the grades of all the on-site written evaluation acts (tests, midterm and final exams) and the grades obtained during the course for lab practices, works, projects and presentations will be kept.

If the final grade after reevaluation is lower than 5.0, it will replace the initial one only if it is higher. If the final grade after reevaluation is greater or equal to 5.0, the final grade of the subject will be pass 5.0.

## EXAMINATION RULES.

Attendance and participation in laboratory sessions is compulsory.

## BIBLIOGRAPHY

### Basic:

- Ljung, Lennart; Glad, Torkel. Modeling of dynamic systems. Englewood Cliffs: Prentice Hall, 1994. ISBN 0135970970.
- Phillips, Charles L.; Nagle, H. Troy. Sistemas de control digital: análisis y diseño. 2ª ed. Barcelona: Gustavo Gili, 1993. ISBN 8425213355.
- Åström, Karl J.; Wittenmark, Björn. Sistemas controlados por computador. Madrid: Paraninfo, 1988. ISBN 8428315930.
- Ogata, Katsuhiko. Sistemas de control en tiempo discreto [on line]. 2ª ed. México: Prentice Hall, 1996 [Consultation: 16/01/2025]. Available on : [https://www-ingebook-com.recursos.biblioteca.upc.edu/ib/NPcd/IB\\_BooksVis?cod\\_primaria=1000187&codigo\\_libro=18906](https://www-ingebook-com.recursos.biblioteca.upc.edu/ib/NPcd/IB_BooksVis?cod_primaria=1000187&codigo_libro=18906). ISBN 9688805394.