

Course guide

240604 - 240604 - Identification and Simulation of Dynamic Systems

Last modified: 08/04/2026

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

Degree: Academic year: 2026 ECTS Credits: 4.5
Languages: Catalan, Spanish

LECTURER

Coordinating lecturer: YOLANDA BOLEA MONTE

Others: MIGUEL ANGEL MAÑANAS VILLANUEVA - YOLANDA BOLEA MONTE

PRIOR SKILLS

It is assumed that the students will have skills acquired in previous subjects related subjects in the degree study plan.

REQUIREMENTS

Basic knowledge of system dynamics, automatic control, computer science and mathematical modelling (acquired in subjects like Mechanics, Electricity, ...).

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:

1. Capacity to analyse, design, simulating and optimising processes and products.

Transversal:

2. SELF-DIRECTED LEARNING. Detecting gaps in one's knowledge and overcoming them through critical self-appraisal. Choosing the best path for broadening one's knowledge.
3. TEAMWORK. Being able to work as a team player, either as a member or as a leader. Contributing to projects pragmatically and responsibly, by reaching commitments in accordance to the resources that are available.
4. EFFECTIVE USE OF INFORMATION RESOURCES. Managing the acquisition, structure, analysis and display of information from the own field of specialization. Taking a critical stance with regard to the results obtained.

TEACHING METHODOLOGY

The course will be given by means of classes of theory/problems (2 hours per week) and by means of practical labs (2 hours per week).

In the theory/problems classes, professors will introduce basic concepts about the subject, that will allow students to complement with provided literature, and will present and solve problems/case studies.

Lab sessions will be organised in small groups of students (with a maximum of 20), where students will apply the concepts introduced in theory/problem classes using lab facilities in the provided case studies.

LEARNING OBJECTIVES OF THE SUBJECT

To provide the students with the necessary tools for modeling and simulation of dynamic systems (chemical processes, robotic manipulators, bacteriological growth, ...) using physical models and experimental data. At the end of the course, the student has achieved the following specific objectives:

- Mathematical description of physical systems.
- Techniques of modeling and analysis of dynamic systems.
- Identification and parameterization of models from experimental data.
- Knowledge of simulation tools of dynamic systems and their use.

STUDY LOAD

Type	Hours	Percentage
Laboratory classes	15,0	13.33
Self study	67,5	60.00
Practical classes	30,0	26.67

Total learning time: 112.5 h

CONTENTS

1. INTRODUCTION

Description:

- 1.1 Definitions.
- 1.2 Objectives.
- 1.3 Classification and examples of models.
- 1.4 External representation of systems: continuous and discrete-time.
- 1.5 Internal representation of systems: continuous and discrete-time.
- 1.6 Phases of system modelling. Examples.
- 1.7 Model simplification.
- 1.8 Basic concepts of simulation.

Specific objectives:

In this chapter, a unified methodology for modelling dynamic systems as well as the different model types used in simulation will be presented.

Related activities:

Classes of theory/problems

Full-or-part-time: 5h

Theory classes: 3h

Laboratory classes: 2h

2. MODELLING OF DYNAMIC SYSTEMS

Description:

- 2.1 Models of electric systems
- 2.2 Models of mechanical systems
- 2.3 Models of hydraulic and pneumatic systems
- 2.4 Models of economic and social systems
- 2.5 Analogies between systems of different types

Specific objectives:

In this chapter, models of different domains typically used in engineering will be recalled and presented in a unified way by showing their analogies.

Related activities:

Classes of theory/problems

Full-or-part-time: 13h

Theory classes: 9h

Laboratory classes: 4h

3. SIMULATION OF DYNAMIC SYSTEMS

Description:

- 3.1 Numerical methods for solving differential equations
- 3.2 Numerical integration methods
- 3.3 Tools for simulating dynamic systems
- 3.4 Model validation
- 3.5 Anàlisi de validesa de ls models
- 3.6 Exemples

Specific objectives:

In this chapter, methods and tools for numerical simulation of dynamic systems will be introduced.

Related activities:

Classes of theory/problems

Full-or-part-time: 13h

Theory classes: 9h

Practical classes: 4h

4. IDENTIFICATION OF DYNAMIC SYSTEMS

Description:

- 4.1 Input signals
- 4.2 Non-parametric methods in the time domain
- 4.3 Non-parametric methods in the frequency domain
- 4.4 Parametric methods
- 4.5 Least-squares method
- 4.6 Output error method
- 4.7 Prediction error method
- 4.8 Instrument variable method
- 4.9 Recursive methods
- 4.10 Model structure selection and validation
- 4.11 Practical aspects

Specific objectives:

In this chapter, system identification methods that allow to obtain the model structure and parameters from experimental data are presented.

Related activities:

Theory/problem classes

Full-or-part-time: 14h

Theory classes: 10h

Laboratory classes: 4h

ACTIVITIES

LAB 1: NUMERICAL SIMULATION TOOLS

Description:

Introduction to the numerical simulation tools typically used in engineering.

Specific objectives:

To know how to use the numerical simulations tools typically used in engineering

Material:

MATLAB/SIMULINK

Delivery:

Report

Full-or-part-time: 2h

Laboratory classes: 2h

LAB 2: MODELLING OF DYNAMIC SYSTEMS

Description:

In this lab activity, students will learn about generic modelling methodologies for dynamic systems

Specific objectives:

To learn to model dynamic systems appearing in engineering applications using generic modelling methodologies.

Material:

MATLAB/SIMULINK

Delivery:

Report

Full-or-part-time: 2h

Laboratory classes: 2h

LAB 3: SIMULATION OF AUTOMATIC CONTROL SYSTEMS

Description:

In this lab, students will simulated automatic control systems already designed.

Specific objectives:

To learn to simulate systems including automatic control loops.

Material:

MATLAB/SIMULINK

Delivery:

Report

Full-or-part-time: 2h

Laboratory classes: 2h

LAB 4: SYSTEM IDENTIFICATION (I)

Description:

In this lab, students will apply methods of system identification to experimental data obtained from a system.

Specific objectives:

To learn to identify system models from experimental data.

Material:

MATLAB/SIMULINK

Delivery:

Report

Full-or-part-time: 2h

Laboratory classes: 2h

LAB 5: SYSTEM IDENTIFICATION (II)

Description:

In this lab, students will continue Lab 4 by applying other system identification methods.

Specific objectives:

To learn to identify system models from experimental data

Material:

MATLAB/SIMULINK

Delivery:

Report

Full-or-part-time: 2h

Laboratory classes: 2h

LAB 6: SIMULATION MINIPROJECT

Description:

In this lab, students will work on a case study where different methodologies of modelling, identification and simulation studied in the course will be applied.

Specific objectives:

The objective of this miniproject is that student understand the role that the different methodologies presented in the course play when dealing with a real system.

Material:

MATLAB/SIMULINK

Delivery:

Report

Full-or-part-time: 4h

Laboratory classes: 4h

GRADING SYSTEM

The evaluation will be realized by means of

- partial exam (35% of the subject mark)
- final exam (45 % of the subject mark)
- lab reports (20% of the subject mark)

EXAMINATION RULES.

The exam will be realized of individual form with the authorized supporting material and in the dates established in the academic calendar of the School.



BIBLIOGRAPHY

Basic:

- Cellier, François E. Continuous system modeling [on line]. New York: Springer-Verlag, cop. 1991 [Consultation: 04/02/2025]. Available on : <https://ebookcentral-proquest-com.recursos.biblioteca.upc.edu/lib/upcatalunya-ebooks/detail.action?pq-origsite=primo&docID=3085921>. ISBN 0387975020.
- Ljung, Lennart; Glad, Torkel. Modeling of dynamic systems. Upper Saddle River: PTR Prentice Hall, 1994. ISBN 0135970970.
- Johansson, Rolf. System modeling and identification. Englewood Cliffs: Prentice Hall, cop. 1993. ISBN 0134823087.