Course guide
3200331 - MASD1 - Modelling and Analysis of Dynamic Systems I

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: 2022  ECTS Credits: 4.5  Languages: Catalan

LECTURER
Coordinating lecturer: Josep Cugueró Escofet
Others: Ramon Pérez Magrané

PRIOR SKILLS
Students are expected to have passed Mathematics I and II, Physics, Chemistry, Fundamentals of Computer Science, Probability and Statistics, Electrical Systems, Mechanical Systems, and Industrial Control and Automation.

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES
Specific:
1. ELO: skills for The modelling and simulation of systems.

TEACHING METHODOLOGY
- 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 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

<table>
<thead>
<tr>
<th>Type</th>
<th>Hours</th>
<th>Percentage</th>
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</thead>
<tbody>
<tr>
<td>Hours large group</td>
<td>30,0</td>
<td>26.67</td>
</tr>
<tr>
<td>Hours small group</td>
<td>15,0</td>
<td>13.33</td>
</tr>
<tr>
<td>Self study</td>
<td>67,5</td>
<td>60.00</td>
</tr>
</tbody>
</table>

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:** 14h
Theory classes: 4h
Laboratory classes: 2h
Self study : 8h

## TOPIC 2: Cases of dynamical system modelling

**Description:**
2.1. Models of electrical systems.
2.2. Models of mechanical translational systems.
2.3. Models of mechanical rotational systems.
2.4. Models of thermal systems.
2.5. Models of hydraulic systems.
2.6. Models of economic and social systems.
2.7. Analogies between systems.

**Specific objectives:**
The ability to create unified mathematical models for various types of systems.
The ability to draw analogies between different types of systems.

**Related activities:**
Lectures, laboratory practicals and examinations.

**Full-or-part-time:** 14h
Theory classes: 4h
Laboratory classes: 2h
Self study : 8h
TOPIC 3: Temporal analysis of continuous dynamical systems

Description:
3.1. Time response of systems.
3.2. Time-response characteristics.
3.3. Stability.
3.4. Speed.
3.5. Accuracy.

Specific objectives:
The ability to calculate the time response of a system.
The ability to temporarily interpret first- and second-order (or higher) mathematical models.
The ability to define and calculate the various time-response characteristics of a feedback system exposed to external signals and disturbances.
The ability to assess the stability, speed and accuracy of a feedback system on the basis of its time response.

Related activities:
Lectures, laboratory practicals and examinations.

Full-or-part-time: 20h
Theory classes: 6h
Laboratory classes: 2h
Self study: 12h

TOPIC 4: Frequency analysis of continuous dynamical systems

Description:
4.1. System frequency response.
4.2. Characteristics of frequency response.
4.3. Stability.
4.4. Bandwidth.
4.5. Accuracy.

Specific objectives:
The ability to represent system frequency response.
The ability to define and calculate the various frequency-response characteristics of a feedback system.
The ability to assess the stability, speed and accuracy of a feedback system on the basis of its frequency response.

Related activities:
Lectures, laboratory practicals and examinations.

Full-or-part-time: 27h
Theory classes: 6h
Laboratory classes: 5h
Self study: 16h
**TOPIC 5: Interface between continuous and discrete systems**

**Description:**
5.1. Sampling and reconstruction.
5.2. Quantification.
5.3. Discrete model of a mixed system.

**Specific objectives:**
The ability to mathematically represent mixed (continuous and discrete) dynamical systems.
The ability to choose the sampling period and quantification accuracy on the basis of the desired application.
The ability to construct simulation models of mixed systems.

**Related activities:**
Lectures, laboratory practicals and examinations.

**Full-or-part-time:** 17h
Theory classes: 5h
Laboratory classes: 2h
Self study: 10h

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**TOPIC 6: Discrete systems analysis**

**Description:**
6.1. Difference equations.
6.2. Transfer function.
6.3. Time response.
6.4. Time-response characteristics.
6.5. Stability.
6.6. Speed.
6.7. Accuracy.

**Specific objectives:**
The ability to represent a discrete system mathematically using a difference equation.
The ability to represent a discrete system mathematically using a transfer function.
The ability to calculate the time response of a discrete system using its mathematical model.
The ability to assess the stability, accuracy and speed of a discrete system on the basis of its mathematical representations.

**Related activities:**
Lectures, laboratory practicals and examinations.

**Full-or-part-time:** 20h 30m
Theory classes: 5h
Laboratory classes: 2h
Self study: 13h 30m

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**ACTIVITIES**

**EXAMS**

**Full-or-part-time:** 7h
Theory classes: 4h
Laboratory classes: 3h
LECTURES

Full-or-part-time: 26h
Theory classes: 26h

LABORATORY SESSIONS

Full-or-part-time: 12h
Laboratory classes: 12h

SELF STUDY

Full-or-part-time: 67h 30m
Self study: 67h 30m

GRADING SYSTEM

Each student’s final mark is obtained by weighting his/her marks on the following:
- Examinations: 70%: two possibilities exist:
  1) if the mark of the second exam is less than the mark of the first one: 35% first exam, 35% second exam
  2) if the mark of the second exam is greater or equal than the mark of the first one: 70% second exam
- Continuous assessment in laboratory sessions: 30%.

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: