3200332 - MASD2 - Modelling and Analysis of Dynamic Systems II

Coordinating unit: 205 - ESEIAAT - Terrassa School of Industrial, Aerospace and Audiovisual Engineering
Teaching unit: 707 - ESAII - Department of Automatic Control
Academic year: 2019
Degree: BACHELOR'S DEGREE IN INDUSTRIAL ELECTRONICS AND AUTOMATIC CONTROL ENGINEERING (Syllabus 2009). (Teaching unit Compulsory)
ECTS credits: 4.5  Teaching languages: Catalan

Teaching staff
Coordinator: Ramon Pérez Magrané
Others: Josep Cugueró Escofet

Prior skills
Modelització o Anàlisi de sistemes Dinàmics I

Degree competences to which the subject contributes

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
- 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>Total learning time: 112h 30m</th>
<th>Hours large group:</th>
<th>15h</th>
<th>13.33%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hours medium group:</td>
<td>0h</td>
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<td>0.00%</td>
</tr>
<tr>
<td>Hours small group:</td>
<td>30h</td>
<td></td>
<td>26.67%</td>
</tr>
<tr>
<td>Guided activities:</td>
<td>0h</td>
<td></td>
<td>0.00%</td>
</tr>
<tr>
<td>Self study:</td>
<td>67h 30m</td>
<td></td>
<td>60.00%</td>
</tr>
</tbody>
</table>
# Content

## TOPIC 1: Introduction

<table>
<thead>
<tr>
<th>Description:</th>
<th>Learning time: 9h</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.1. Definitions.</td>
<td>Theory classes: 2h</td>
</tr>
<tr>
<td>1.2. Objectives of dynamical system modelling.</td>
<td>Laboratory classes: 3h</td>
</tr>
<tr>
<td>1.3. Model classification and examples.</td>
<td>Self study: 4h</td>
</tr>
<tr>
<td>1.4. External representation of continuous and discrete system models.</td>
<td></td>
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<tr>
<td>1.5. System modelling stages.</td>
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<tr>
<td>1.6. Model simplification.</td>
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<tr>
<td>1.7. Tools for simulating mathematical models.</td>
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</tbody>
</table>

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

**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.

## TOPIC 2: Parametric identification of linear models

<table>
<thead>
<tr>
<th>Description:</th>
<th>Learning time: 35h</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.1. Structure of discrete linear models.</td>
<td>Theory classes: 6h</td>
</tr>
<tr>
<td>2.2. Least squares method.</td>
<td>Laboratory classes: 9h</td>
</tr>
<tr>
<td>2.3. Model order selection criteria and validation.</td>
<td>Self study: 20h</td>
</tr>
</tbody>
</table>

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

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

<table>
<thead>
<tr>
<th>Description:</th>
<th>Learning time: 33h</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.1. Experimental design.</td>
<td>Theory classes: 4h</td>
</tr>
<tr>
<td>3.2. Data pre-processing.</td>
<td>Laboratory classes: 9h</td>
</tr>
<tr>
<td>3.3. Transient response analysis.</td>
<td>Self study: 20h</td>
</tr>
<tr>
<td>3.4. Correlation methods.</td>
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</tr>
<tr>
<td>3.5. Frequency response analysis.</td>
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</tbody>
</table>

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

**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.

### THEME 4. Model calibration

<table>
<thead>
<tr>
<th>Description:</th>
<th>Learning time: 17h</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.1. Complex systems models</td>
<td>Theory classes: 2h</td>
</tr>
<tr>
<td>4.2. Parameter tuning</td>
<td>Laboratory classes: 5h</td>
</tr>
<tr>
<td>4.3. Optimisation methods</td>
<td>Self study: 10h</td>
</tr>
</tbody>
</table>

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

**Specific objectives:**
Complex models manipulation  
Parameter calibration
### TOPIC 5. Dynamical systems simulation

**Learning time:** 18h 30m  
- Theory classes: 1h  
- Laboratory classes: 4h  
- Self study: 13h 30m

**Description:**  
9.1. Digital simulation of mathematical models.  
9.3. Model validation.

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

**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.

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### Qualification 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.

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### Regulations for carrying out activities

Attendance and participation in laboratory sessions is compulsory.
Bibliography

Basic:


Others resources: