240AR013 - Modelling, Identification and Simulation of Dynamical Systems

Coordinating unit: 240 - ETSEIB - Barcelona School of Industrial Engineering
Teaching unit: 707 - ESAII - Department of Automatic Control
Academic year: 2019
Degree: MASTER'S DEGREE IN AUTOMATIC CONTROL AND ROBOTICS (Syllabus 2012). (Teaching unit Compulsory)  
MASTER'S DEGREE IN STATISTICS AND OPERATIONS RESEARCH (Syllabus 2013). (Teaching unit Optional)  
MASTER'S DEGREE IN INDUSTRIAL ENGINEERING (Syllabus 2014). (Teaching unit Optional)
ECTS credits: 4,5
Teaching languages: English

Teaching staff
Coordinator: BERNARDO MORCEGO SEIX
Others: RAMON PEREZ MAGRANE - JOSEP CUGUERÓ ESCOFET

Degree competences to which the subject contributes

Specific:
2. The student will be able to identify, obtain models, simulations, analyze and validate simple dynamic systems in adequate representation for the intended purpose (analysis, simulation and design).
3. The student will be able to use analysis tools and computer-aided design of control systems in the tasks usual analysis, simulation and controller design.

General:
1. Ability to conduct research, development and innovation in the field of systems engineering, control and robotics, and as to direct the development of engineering solutions in new or unfamiliar environments, linking creativity, innovation and transfer of technology

Teaching methodology

face-to-face classes:
- Lectures (MD 1)
- Cooperative learning (MD 3)
Non face-to-face classes:
- Autonomous learning (MD 2)
- Case based learning (MD4)

Learning objectives of the subject

Learning Outcomes
- Use the concepts and basic tools of modeling, identification and dynamic system simulation
- Use the basic software to analyse control systems, as well as and modelling of dynamic systems

Mandatory Contents:
- Model identification methodology
- Parametric estimation techniques of linear and non linear models
## Study load

<table>
<thead>
<tr>
<th>Total learning time: 112h 36m</th>
<th>Hours large group: 20h 18m</th>
<th>18.03%</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Hours small group: 20h 18m</td>
<td>18.03%</td>
</tr>
<tr>
<td></td>
<td>Self study: 72h</td>
<td>63.94%</td>
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</tbody>
</table>

## Content

### Mathematical and computational modeling

<table>
<thead>
<tr>
<th>Description:</th>
<th>External and internal representation of dynamic systems</th>
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<tbody>
<tr>
<td></td>
<td>Representation of continuous and discrete systems</td>
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<td></td>
<td>Linear and nonlinear representation of dynamic systems</td>
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<td></td>
<td>Representation of uncertainty</td>
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<td></td>
<td>Computational representation of dynamic systems for simulation</td>
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</tbody>
</table>

| Related activities: | Activities 1, 2, 3 and 5 |

<table>
<thead>
<tr>
<th>Learning time: 60h 15m</th>
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<tbody>
<tr>
<td>Theory classes: 11h 30m</td>
</tr>
<tr>
<td>Laboratory classes: 6h</td>
</tr>
<tr>
<td>Guided activities: 6h</td>
</tr>
<tr>
<td>Self study: 36h 45m</td>
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</tbody>
</table>

### Identification of dynamic systems

<table>
<thead>
<tr>
<th>Description:</th>
<th>Prediction and simulation models</th>
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<tbody>
<tr>
<td></td>
<td>Identification of linear models</td>
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<tr>
<td></td>
<td>Identification of linear parameter varying models</td>
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<tr>
<td></td>
<td>Identification of nonlinear models</td>
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<tr>
<td></td>
<td>Validation of models and design of experiments</td>
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</tbody>
</table>

| Related activities: | Activities 1, 3, 4 and 5 |

<table>
<thead>
<tr>
<th>Learning time: 52h 15m</th>
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<tbody>
<tr>
<td>Theory classes: 11h 30m</td>
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<tr>
<td>Laboratory classes: 4h</td>
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<tr>
<td>Guided activities: 2h</td>
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<tr>
<td>Self study: 34h 45m</td>
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</tbody>
</table>
# Planning of activities

## 1. THEORY LECTURES

**Hours:** 28h  
Theory classes: 21h  
Self study: 7h

**Description:**  
Exposition of the contents of the subject theory contents following an expositive and participative model of class. In this class, problems will be solved with all the group.

**Support materials:**  
Compilation of slides and notes at Atenea  
General bibliography of the subject

**Descriptions of the assignments due and their relation to the assessment:**  
This activity is evaluated together with activities 2 and 5

**Specific objectives:**  
Knowledge transfer, creation of a conceptual reference frame, solving questions and generating interest about the subject.

## 2. EXERCISES SESSIONS

**Hours:** 30h  
Practical classes: 10h  
Self study: 20h

**Description:**  
Exercises and problems are discussed with the students. These problems will have been previously thought about by the students

**Support materials:**  
Collection of exercises at Atenea

**Descriptions of the assignments due and their relation to the assessment:**  
The resolution of some problems are evaluated.

**Specific objectives:**  
Understanding and acquisition of skills with the concepts explained at theory lectures

## 3. LABORATORY EXERCISES

**Hours:** 12h  
Guided activities: 8h  
Self study: 4h

**Description:**  
Groups of two people follow the instructions to resolve an identification and/or simulation problem. These sessions take place at the lab and there are five sessions.

**Support materials:**  
Lab exercises at Atenea  
Simulation software (Matlab)  
Notes of the subject

**Descriptions of the assignments due and their relation to the assessment:**  
Each group has to deliver a report answering the questions of the exercise and justifying the answers.
Specific objectives:
Proper application of identification and simulation methodologies to dynamic systems.

4. CASE OF STUDY

<table>
<thead>
<tr>
<th>Description:</th>
<th>Hours: 12h</th>
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<tbody>
<tr>
<td>A case of study is carried out in groups of two students.</td>
<td>Self study: 12h</td>
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</table>

Support materials:
- Case description and resolution methodology instructions at Atenea
- Simulation software (Matlab)
- Notes of the course

Descriptions of the assignments due and their relation to the assessment:
A report with the results of the case of study and the justifications that led to those results will have to be delivered.

Specific objectives:
Proper application of the concepts and principles given in theory modules one and two.

5. FINAL EXAMINATION

<table>
<thead>
<tr>
<th>Description:</th>
<th>Hours: 30h 30m</th>
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<tr>
<td>Written individual examination about the concepts of theory modules one and two. The examination includes short answer or test questions, problems to be solved by hand and computer exercises.</td>
<td>Theory classes: 2h</td>
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<tr>
<td></td>
<td>Self study: 28h 30m</td>
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Support materials:
- Examination instructions

Descriptions of the assignments due and their relation to the assessment:
Resolution of the test, in the same sheet of the exam

Specific objectives:
Demonstrate the level of achieved knowledge in the activities 1, 2, 3 and 4.
Activities 3 and 4 are also evaluated individually to distinguish from the group evaluation.

Qualification system

The acquired competences and abilities will be evaluated on the basis of four concepts: problems resolution (15%), practical session questionnaires (25%), final assignment report (15%) and final exam (45%).
Extraordinary evaluation will follow the School rules and it will substitute the final exam.
Regulations for carrying out activities

The written and practical exam will be carried out individually and without notes. The questions, tests, problems and small reports are the result of the autonomous learning or of the activities of the practices. They consist on the delivery of a written document with the resolution of a problem set in class or proposed on the exercise book of the course or proposed on the formulation of the practices and worked in this sessions. The formal reports correspond to the resolution of an applied problem. It consits on a document written by the group carrying out the activity. A formal structure and the resolution of the problem regarding to the formulation of the same must be followed.

Bibliography

Basic:


Complementary: