320183 - ISCA - Introduction to Advanced Control Systems

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 Optional)
ECTS credits: 6
Teaching languages: English

Teaching staff
Coordinator: - Vicenç Puig
Others: - Joseba Quevedo
- Albert Masip
- Damiano Rotondo

Opening hours
Timetable: - Agreed with the students through e-mail.

Prior skills
- Control and automation
- Modelling and analysis of dynamic systems
- Control engineering.

Requirements
- Students should have a background in automatic control.

Degree competences to which the subject contributes
Specific:
1. ELO: skills for The modelling and simulation of systems.
2. ELO: Understanding of automatic control and various control techniques, as well as their application to industrial automation.
3. ELO: Ability to design and control automation systems.

Teaching methodology
The teaching methodology includes:
- Face-to-face theoretical sessions to present the contents of each chapter.
- Face-to-face laboratory sessions to develop projects in a group.
- Self-study work and exercises.

Learning objectives of the subject
- The objective of this subject is to introduce the students advanced subjects of the control area through projects.
- In particular, advanced control techniques will be introduced while showing applications that will illustrate their field of application.
- The course will also introduce techniques that go beyond control such as fault diagnosis and supervision (including tolerant control).

### Study load

<table>
<thead>
<tr>
<th>Total learning time: 150h</th>
<th>Hours large group:</th>
<th>30h</th>
<th>20.00%</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Hours small group:</td>
<td>30h</td>
<td>20.00%</td>
</tr>
<tr>
<td></td>
<td>Self study:</td>
<td>90h</td>
<td>60.00%</td>
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</tbody>
</table>
# Content

## Chapter 1: Advanced Control Systems

**Learning time:** 50h  
Theory classes: 10h  
Laboratory classes: 10h  
Self study: 30h

### Description:
- 1.1 Introduction  
- 1.2 State-space models  
- 1.3 Dynamics of linear systems  
- 1.4 Design of state-feedback controllers  
- 1.5 State observers  
- 1.6 Optimal and model predictive control

### Related activities:
- Activity 1: Theory sessions  
- Activity 2: Laboratory sessions

### Specific objectives:
- To understand the need for advanced control techniques beyond standard control techniques to solve complex problems  
- To understand and learn the fundamentals of advanced control techniques in state space

## Chapter 2: Fault diagnosis

**Learning time:** 50h  
Theory classes: 10h  
Laboratory classes: 10h  
Self study: 30h

### Description:
- 2.1 Introduction  
- 2.2 Fault detection  
- 2.3 Fault isolation  
- 2.4 Generation of analytical redundancy relations

### Related activities:
- Activity 1: Theory sessions  
- Activity 2: Laboratory sessions

### Specific objectives:
To understand and to know the fundamentals of fault diagnosis techniques as well as the related tasks: fault detection and isolation.
### Chapter 3: Fault-tolerant control

**Learning time:** 50h  
- Theory classes: 10h  
- Laboratory classes: 10h  
- Self study: 30h

**Description:**

- 3.1 Data validation  
- 3.2 Data reconstruction  
- 3.3 Supervision  
- 3.4 Fault-tolerant control

**Related activities:**

- Activity 1: Theory sessions  
- Activity 2: Laboratory sessions

**Specific objectives:**

- To understand and learn the fundamentals of data validation/reconstruction, supervision and fault-tolerant control.
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## Planning of activities

### THEORY SESSIONS

<table>
<thead>
<tr>
<th>Description:</th>
</tr>
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<tbody>
<tr>
<td>Exhibition of the contents of the subject following an expository and participative class model.</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Support materials:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basic and specific bibliography,</td>
</tr>
<tr>
<td>Notes of the professor (Digital campus).</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Descriptions of the assignments due and their relation to the assessment:</th>
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<tbody>
<tr>
<td>This activity is evaluated with the projects developed during the lab sessions.</td>
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</table>

<table>
<thead>
<tr>
<th>Specific objectives:</th>
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</thead>
<tbody>
<tr>
<td>At the end of these classes, the student must be able to consolidate and acquire the necessary knowledge listed in the section &quot;General learning objectives of the subject&quot;.</td>
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</table>

### LAB SESSIONS

<table>
<thead>
<tr>
<th>Description:</th>
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<tbody>
<tr>
<td>Project 1: Advanced control</td>
</tr>
<tr>
<td>In this project, the students will design an advanced controller for a complex system (autonomous vehicle, UAV or industrial process).</td>
</tr>
<tr>
<td>Project 2: Fault diagnosis</td>
</tr>
<tr>
<td>In this project, the students will design a fault diagnosis system for a complex system (autonomous vehicle, UAV or industrial process).</td>
</tr>
<tr>
<td>Project 3: Advanced control</td>
</tr>
<tr>
<td>In this project, the students will design a fault tolerant controller for a complex system (autonomous vehicle, UAV or industrial process).</td>
</tr>
</tbody>
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<table>
<thead>
<tr>
<th>Support materials:</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Description of the project.</td>
</tr>
<tr>
<td>- Bibliography.</td>
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<tr>
<th>Descriptions of the assignments due and their relation to the assessment:</th>
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<tbody>
<tr>
<td>Project report developed in a team.</td>
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<table>
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<tr>
<th>Specific objectives:</th>
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<tbody>
<tr>
<td>To apply the concepts presented in the theoretical sessions using real case studies.</td>
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Qualification system

Two written exams (midterm and final) with a 35% of weight each and lab reports with a 30% of weight.

All those students who cannot attend the mid-term exam, or who want to improve their grade, will have the option of taking an additional written exam that will be done on the same day than the final exam. The score for this additional exam will be between 0 and 10, and will replace the mark of the midterm exam as long as it is higher.

For all those students who meet the requirements and attend to the reassessment exam, the qualification of the reassessment exam will replace the grades of all the assessment acts that are face-to-face written tests (midterm and final exams) and the qualifications of the laboratory work done during the course.

If the final grade after the reassessment is less than 5.0, it will replace the initial one only if it is higher. If the final mark after the reassessment is greater than or equal to 5.0, the final mark of the subject will be approved 5.0.

Regulations for carrying out activities

- All assessment activities are mandatory.
- Students should attend all lab sessions.

Bibliography

Basic:


Complementary:


Others resources:

- Class slides prepared by the professors.
- Exercises and problems of self-learning prepared by teachers.
- Statements and materials to develop the projects.