820230 - TCEIA - Control Techniques

**Coordinating unit:** 295 - EEBE - Barcelona East School of 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:** 6  
**Teaching languages:** Spanish

### Teaching staff

**Coordinator:** JOSÉ MARÍA HUERTA SÁNCHEZ  
**Others:**  
**Primer quadrimestre:**  
José María Huerta Sánchez - T11, T12, T13, T14  
**Segon quadrimestre:**  
Joaquín Blesa Izquierdo - M11, M12, M13, M14  
Beatriz Fabiola Girardo Giraldo - M11, M12, M13, M14, M15  
José María Huerta Sánchez - M11, M12, M13, M14, M15

### Prior skills

Automatic regulation

### Requirements

REGULACIÓ AUTOMÀTICA - Prerequisite

### Degree competences to which the subject contributes

**Specific:**  
CEEIA-26. Understand automatic regulation and control techniques and their application to industrial automation.

**Transversal:**  
1. TEAMWORK - Level 3. Managing and making work groups effective. Resolving possible conflicts, valuing working with others, assessing the effectiveness of a team and presenting the final results.

### Teaching methodology

The methodologies used are:  
Theoretical sessions (20%), individual working problems (10%) and team-working in laboratory sessions (10%).

### Learning objectives of the subject
1. To know and apply the frequencial methods in order to determine the stability and to design compensators.
2. To present the tools for modeling and analysis of discrete time systems.
3. To present methods for design of discrete time systems.
4. To show the possibilities and limitations of computers in the control algorithms implementation.

### Study load

<table>
<thead>
<tr>
<th></th>
<th>Large group:</th>
<th>Medium group:</th>
<th>Small group:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total learning time:</td>
<td>150h</td>
<td>45h</td>
<td>15h</td>
</tr>
<tr>
<td>Hours large group:</td>
<td>45h</td>
<td>0h</td>
<td>15h</td>
</tr>
<tr>
<td>Hours medium group:</td>
<td>0h</td>
<td>0h</td>
<td>0h</td>
</tr>
<tr>
<td>Hours small group:</td>
<td>15h</td>
<td>0h</td>
<td>0h</td>
</tr>
<tr>
<td>Guided activities:</td>
<td>0h</td>
<td>0h</td>
<td>0h</td>
</tr>
<tr>
<td>Self study:</td>
<td>90h</td>
<td>0%</td>
<td>10%</td>
</tr>
</tbody>
</table>

Study load

- Total learning time: 150h
- Hours large group: 45h (30.00%)
- Hours medium group: 0h (0.00%)
- Hours small group: 15h (10.00%)
- Guided activities: 0h (0.00%)
- Self study: 90h (60.00%)
<table>
<thead>
<tr>
<th><strong>Content</strong></th>
<th><strong>Learning time:</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1. Stability in frequency domain of continuous time systems.</strong></td>
<td>25h</td>
</tr>
<tr>
<td><strong>Description:</strong></td>
<td></td>
</tr>
<tr>
<td>To know all the graphical methods concerned with frequencial response, in</td>
<td></td>
</tr>
<tr>
<td>order to apply the general stability criterion.</td>
<td></td>
</tr>
<tr>
<td><strong>Related activities:</strong></td>
<td></td>
</tr>
<tr>
<td>Problem solving sessions.</td>
<td></td>
</tr>
<tr>
<td><strong>Specific objectives:</strong></td>
<td></td>
</tr>
<tr>
<td>Frequency response representations: Bode and polar diagrams. Performance</td>
<td></td>
</tr>
<tr>
<td>specifications in frequency domain.</td>
<td></td>
</tr>
<tr>
<td>Nyquist stability criterion. Gain and phase margins. Simplified Bode's</td>
<td></td>
</tr>
<tr>
<td>stability criterion. Stability of systems with time delays.</td>
<td></td>
</tr>
<tr>
<td><strong>2. Design and compensation of control systems by frequencial methods.</strong></td>
<td>10h</td>
</tr>
<tr>
<td><strong>Description:</strong></td>
<td></td>
</tr>
<tr>
<td>Design of lead compensators and lag compensators using frequencial methods.</td>
<td></td>
</tr>
<tr>
<td><strong>Related activities:</strong></td>
<td></td>
</tr>
<tr>
<td>Problem solving sessions.</td>
<td></td>
</tr>
<tr>
<td><strong>Specific objectives:</strong></td>
<td></td>
</tr>
<tr>
<td>To apply the lag and lead compensation technics.</td>
<td></td>
</tr>
<tr>
<td>To know the advantages and drawbacks of this compensation technics.</td>
<td></td>
</tr>
</tbody>
</table>
### 3. Introduction to digital control of dynamic systems.

**Description:**
To describe the functions and characteristics of the elements and signals belonging to a computer controlled system.

**Related activities:**
Problem solving sessions.

**Specific objectives:**
To consider the effect of the presence of sampled data signals in the control loop and to know the problems associated with the choice of the sampling period, and Shannon's theorem.

**Learning time:** 10h
- Theory classes: 3h
- Laboratory classes: 1h
- Self study: 6h

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### 4. The z-transform.

**Description:**
Introduction to the z-transform in order to represent signals of sampled data systems.

**Learning time:** 15h
- Theory classes: 4h 30m
- Laboratory classes: 1h 30m
- Self study: 9h

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### 5. Stability of sampled data systems.

**Description:**
Study of the stability of sampled data systems.

**Specific objectives:**

**Learning time:** 10h
- Theory classes: 3h
- Laboratory classes: 1h
- Self study: 6h

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### 6. Design of digital controllers.

**Specific objectives:**

**Learning time:** 30h
- Theory classes: 9h
- Laboratory classes: 3h
- Self study: 18h
Partial controls (2): 30%
Last control: 40%
Practices: 15%
Exercises / problems: 15%
Other tests / projects: 35%
Generic competition, self-directed learning, represents 15% of the global evaluation.

The students will be able to access the re-assessment test that meets the requirements set by the EEBE in its Assessment and Permanence Regulations (https://eebe.upc.edu/ca/estudis/normatives-academiques/documents/eebe-normativa-avaluacio-i-permanencia-18-19-aprovat-je-2018-06-13.pdf)

### Qualification system

<table>
<thead>
<tr>
<th>State model of discrete systems.</th>
<th>Learning time: 20h</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Description:</strong></td>
<td>Theory classes: 6h</td>
</tr>
<tr>
<td>To obtain models of discrete</td>
<td>Laboratory classes: 2h</td>
</tr>
<tr>
<td>time systems in the state space.</td>
<td>Self study: 12h</td>
</tr>
</tbody>
</table>

**Specific objectives:**
- State model of discrete systems.
- Discrete time state equation solution.
- Discretization of the state equation of continuous time systems.

<table>
<thead>
<tr>
<th>State space control.</th>
<th>Learning time: 30h</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Specific objectives:</strong></td>
<td>Theory classes: 9h</td>
</tr>
<tr>
<td>Controlability.</td>
<td>Laboratory classes: 3h</td>
</tr>
<tr>
<td>Observability.</td>
<td>Self study: 18h</td>
</tr>
<tr>
<td>Canonical forms.</td>
<td></td>
</tr>
<tr>
<td>Pole placement by</td>
<td></td>
</tr>
<tr>
<td>state feedback.</td>
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<tr>
<td>State observers.</td>
<td></td>
</tr>
</tbody>
</table>

**Learning time:**
- Theory classes: 6h
- Laboratory classes: 2h
- Self study: 12h

**Learning time:**
- Theory classes: 9h
- Laboratory classes: 3h
- Self study: 18h

**Description:**
To obtain models of discrete time systems in the state space.

**Specific objectives:**
- State model of discrete systems.
- Discrete time state equation solution.
- Discretization of the state equation of continuous time systems.

**Specific objectives:**
- Controlability.
- Observability.
- Canonical forms.
- Pole placement by state feedback.
- State observers.
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Bibliography

Basic:


Complementary:
