295105 - 295II021 - Control Systems

Coordinating unit: 295 - EEBE - Barcelona East School of Engineering
Teaching unit: 707 - ESAII - Department of Automatic Control

Academic year: 2019
Degree: MASTER'S DEGREE IN INTERDISCIPLINARY AND INNOVATIVE ENGINEERING (Syllabus 2019).
(Teaching unit Compulsory)
ECTS credits: 6

Teaching languages: English

Teaching staff

Coordinator: Pere Ponsa

Others:
Segon quadrimestre:
JAVIER FRANCISCO GÁMIZ CARO - T11
PEDRO PONSA ASENSIO - T11, T12
ABEL TORRES CEBRIAN - T11, T12

Degree competences to which the subject contributes

Specific:
CEMUEII-09. Design, implement and manage automated systems for the control and supervision of processes in engineering.

Generical:
CGMUEII-01. Participate in technological innovation projects in multidisciplinary problems, applying mathematical, analytical, scientific, instrumental, technological and management knowledge.

Transversal:
05 TEQ. TEAMWORK. Being able to work as a team player, either as a member or as a leader. Contributing to projects pragmatically and responsibly, by reaching commitments in accordance to the resources that are available.
06 URI. EFFECTIVE USE OF INFORMATION RESOURCES. Managing the acquisition, structure, analysis and display of information from the own field of specialization. Taking a critical stance with regard to the results obtained.
03 TLG. THIRD LANGUAGE. Learning a third language, preferably English, to a degree of oral and written fluency that fits in with the future needs of the graduates of each course.
The purpose of this course is to integrate knowledge and skills in the design, development and performance of processes control in industrial domain. The course establishes the relationship between facilities and equipment, people and management systems. The main part of this subject is understand the automatic control using PID law and development of supervisory control scenarios using SCADA Applications. The course applies study cases in industrial context through examples of processes control and environmental management of wastewater plants.

**Learning objectives of the subject**

The purpose of this course is to integrate knowledge and skills in the design, development and performance of processes control in industrial domain. The course establishes the relationship between facilities and equipment, people and management systems. The main part of this subject is understand the automatic control using PID law and development of supervisory control scenarios using SCADA Applications. The course applies study cases in industrial context through examples of processes control and environmental management of wastewater plants.

**Study load**

<table>
<thead>
<tr>
<th>Total learning time: 150h</th>
<th>Hours large group:</th>
<th>%</th>
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<tbody>
<tr>
<td></td>
<td>34h</td>
<td>22.67%</td>
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<tr>
<td>Hours medium group:</td>
<td>0h</td>
<td>0.00%</td>
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<tr>
<td>Hours small group:</td>
<td>20h</td>
<td>13.33%</td>
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<tr>
<td>Guided activities:</td>
<td>0h</td>
<td>0.00%</td>
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<tr>
<td>Self study:</td>
<td>96h</td>
<td>64.00%</td>
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The methodologies used are:
- Master class
- Seminars
- Case study
- Project based learning
# Control Systems

## Content

| 1. Introduction | Learning time: 4h  
Theory classes: 2h  
Self study: 2h |
|------------------|-----------------------|
| **Description:** | 1.1 Module-based production in the process industry.  
1.2 Life cycle management: process, product, services.  
1.3 Standardization. |
| **Related activities:** | Master Class. |
| **Specific objectives:** | Know productive models and their transformation to improve performance. |

| 2. PID Control | Learning time: 16h  
Theory classes: 8h  
Self study: 8h |
|------------------|-----------------------|
| **Description:** | 2.1 Dynamic modeling and control.  
2.2 PID control law.  
2.3 PID structures.  
2.4 Tuning of PID controllers. |
| **Related activities:** | Master class. Case study. Examples, Laboratory practices |
| **Specific objectives:** | Learn how link the dynamic model of a system with the control law. Learn how configure the PID control law for various applications. |
### 3. Water management

**Learning time:** 16h  
Theory classes: 8h  
Self study: 8h

**Description:**
3.1 Water resources  
Description of the water resources available, identifying the characteristics of each according to its origin and the different methods of exploitation of each of them. Alternative resources are also exposed with their advantages and disadvantages to be included in the global management of water resources.

3.2 Sustainability  
Essential knowledge to understand Sustainable Development and detect the impacts related to water resources. The technologies and solutions that ensure sustainable management of these water resources.

3.3 Digital transformation of water management in the industry.

Main actors of the global economy and components of the strategic framework of the companies (mission, vision, values, etc.) most relevant aspects of innovation in the organizations. Open innovation, tools for development and later evaluation of innovation projects according to the objectives sought and the characteristics of the organization.

3.4 Collaborative models Industry, University and City.

Understand how the actors of each of the three areas mentioned collaborate, challenges that arise in our country and at European level to carry out activities of collaboration. Examples and current real cases will be detailed.

3.5 Case study: Wastewater treatment Plant (EDAR Besós)

**Related activities:**

**Specific objectives:**
General description of the water cycle concept, with special attention to the urban water cycle and its management. All the stages that make up this cycle will be explained and the different characteristics, both of the water and the infrastructures involved from a holistic vision and without forgetting the interrelations between each of stages and their involvement in sustainable resource management within their own cycle.

### 4. Integrated Automation

**Learning time:** 16h  
Theory classes: 8h  
Self study: 8h

**Description:**
4.1 Levels of automation.
4.2 Modeling of human-machine systems.
4.3 Control room design.
4.4 Supervisory control and display design.

**Related activities:**

**Specific objectives:**
Provide an integrated vision of human-automation systems from the point of view of human, technology and systems engineering.
5. Industrial control

<table>
<thead>
<tr>
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<tbody>
<tr>
<td>5.1 Industrial control systems.</td>
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<tr>
<td>5.2 Cascade control. Feedforward control. Ratio control.</td>
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<td>5.3 Internal model control.</td>
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<td>5.4 Smith predictor.</td>
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<table>
<thead>
<tr>
<th>Related activities:</th>
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<tbody>
<tr>
<td>Master class. Exam. Case study, Examples, Laboratory Practices.</td>
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<table>
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<tr>
<th>Specific objectives:</th>
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<tbody>
<tr>
<td>Learn an integrated vision of industrial control.</td>
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<tr>
<td>16h</td>
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<td>Theory classes: 8h</td>
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<tr>
<td>Self study: 8h</td>
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</table>
The qualification system includes activities (written exam) and laboratory practices:

- Exam1: Modules 2,3
- Exam2: Modules 4,5
- Practices_1: Practices 1,2,3,4,5
- Practices_2: Practices 6,7,8,9,10

Learning time:
- Laboratory classes: 20h
- Self study: 62h

Description:

PART 1
6.1 Obtaining a plant model and industrial controller applied to temperature control.
6.2 MATLAB Control Systems Toolbox.
6.3 PID Control with MATLAB/SIMULINK.
6.4 Tuning of PID controllers with MATLAB/SIMULINK.
6.5 Process Control in academic plant.

PART 2
6.5 MATLAB Fuzzy Logic Designer Toolbox.
6.6 SCADA interface design.
6.7 PLC-SCADA simulated scenarios.
6.8 Process Control.

Related activities:
In the Laboratory A5.6 Automatic Control is available:
- academic plants for process control
- MATLAB V. R2018b

In the Laboratory A5.4 Automation and Industrial Robotics, is available:
- Assembly academic system FAS200
- MATLABSIMULINK v. R2018b
- Wonderware SCADA InTouch 2014
- Rockell automation, PLC controllers

At the end of each part of practices, the student’s group delivers a report

Specific objectives:
The practical part of the subject contributes to the integration between various software, the acquisition of technical ability in PID control, sequential control with PLC controllers, SCADA application design, and industrial process control.

Qualification system

The qualification system includes activities (written exam) and laboratory practices:

Exam1: Modules 2,3
Exam2: Modules 4,5
Practices_1: Practices 1,2,3,4,5
Practices_2: Practices 6,7,8,9,10
Regulations for carrying out activities

The Exams are test.
Laboratory practices are mandatory and are carried out in groups of 3/4 people in Laboratory A5.6 (PART I) and in Laboratory A5.4 (Part II).
The evaluation method of this course meets the current academic regulations to be qualified: NO REVALUABLE.

Bibliography

Basic:

Complementary:

Others resources:
It has the collaboration of professionals of Wonderware, Rockwell and SMC that can provide a more industrial vision of the subject.
Magazine Control Engineering: https://www.controleng.com/magazine
MATLAB Control Systems Toolbox: https://es.mathworks.com/help/control/index