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: Javier Gámiz, Estefanía Martínez, Abel Torres, Ramon Vilanova

Opening hours
Timetable: It will be defined the first day of class.

Prior skills
Previous knowledge of control theory and automation.

Requirements
It is recommended to have passed the subjects "Data acquisition Instrumentation" and "Systems Modeling".

Degree competences to which the subject contributes
Specific:
CEMUIEII-09. Design, implement and manage automated systems for the control and supervision of processes in engineering.

General:
CGMUIEII-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.

Teaching methodology
The methodologies used are:
- Master class
- Seminars
- Case study
- Project based learning

Learning objectives of the subject
295105 - 295II021 - Control Systems

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>34h</th>
<th>22.67%</th>
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<tbody>
<tr>
<td>Hours medium group:</td>
<td>0h</td>
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<td>0.00%</td>
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<tr>
<td>Hours small group:</td>
<td>20h</td>
<td></td>
<td>13.33%</td>
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<tr>
<td>Guided activities:</td>
<td>0h</td>
<td></td>
<td>0.00%</td>
</tr>
<tr>
<td>Self study:</td>
<td>96h</td>
<td></td>
<td>64.00%</td>
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## 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. Integrated Automation

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

**Description:**  
2.1 Levels of automation.  
2.2 Modeling of human-machine systems.  
2.3 Control room design.  
2.4 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.
### 3. PID Control

| Description: | 3.1 Dynamic modeling and control.  
3.2 PID control law.  
3.3 PID structures.  
3.4 Tuning of PID controllers. |
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<tbody>
<tr>
<td>Related activities:</td>
<td>Master class. Case study. Examples, Laboratory practices</td>
</tr>
<tr>
<td>Specific objectives:</td>
<td>Learn how link the dynamic model of a system with the control law. Learn how configure the PID control law for various applications.</td>
</tr>
</tbody>
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| Learning time: | 16h  
Theory classes: 8h  
Self study: 8h |

### 4. Industrial control

| Description: | 4.1 Industrial control systems.  
4.2 Cascade control. Feedforward control. Ratio control.  
4.3 Internal model control.  
4.4 Multivariable control. |
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<tbody>
<tr>
<td>Related activities:</td>
<td>Magiser class. Exam. Case study, Examples, Laboratory Practices.</td>
</tr>
<tr>
<td>Specific objectives:</td>
<td>Learn an integrated vision of industrial control.</td>
</tr>
</tbody>
</table>

| Learning time: | 16h  
Theory classes: 8h  
Self study: 8h |
5. Water management

<table>
<thead>
<tr>
<th>Learning time: 16h</th>
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</thead>
<tbody>
<tr>
<td>Theory classes: 8h</td>
</tr>
<tr>
<td>Self study: 8h</td>
</tr>
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**Description:**

5.1 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.

5.2 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.

5.3 Connection between water, energy and food: how they interact in the integral cycle of the water.
5.4 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.

5.4 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.

5.5 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.
6. Laboratory practices.

**Description:**
6.1 Display design for SCADA interfaces.
6.2 SCADA interface design for an assembly system FAS200.
6.3 SCADA programming of a cwater chlorination system.
6.4 SCADA PLC simulated scenario.
6.5 SCADA PLC simulated scenario for a wastewater SCADA interface.
6.6 Introduction to MATLAB Control Systems Toolbox.
6.7 PID control in MATLAB/SIMULINK.
6.8 Tuning of PID controllers in MATLAB/SIMULINK.
6.9 Processes control in MATLAB/SIMULINK.
6.10 Bilateral control in MATLAB/SIMULINK.

**Related activities:**
In the Laboratory A5.4 Automation and Industrial Robotics, is available:
- Assembly academic system FAS200
- MATLABSIMULINK v. 2017
- Wonderware SCADA InTouch 2014
- Rockell automation, PLC controllers

At the end 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.

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**Qualification system**

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

Exam1*(0,30)+Exam2*(0,30)+Practices_1*(0,20)+Practices_2*(0,2)

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 A5.4.
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