



Course guides

295105 - 295II021 - Control Systems

Last modified: 04/06/2021

Unit in charge: Barcelona East School of Engineering
Teaching unit: 707 - ESAII - Department of Automatic Control.

Degree: MASTER'S DEGREE IN INTERDISCIPLINARY AND INNOVATIVE ENGINEERING (Syllabus 2019). (Compulsory subject).

Academic year: 2021 **ECTS Credits:** 6.0 **Languages:** English

LECTURER

Coordinating lecturer: Pere Ponsa

Others: Segon quadrimestre:
JAVIER FRANCISCO GÁMIZ CARO - T11
PEDRO PONSAS ASENSIO - T11, T12
ABEL TORRES CEBRIAN - T11, T12
RAMON VILANOVA ARBOS (UAB)
ESTEFANIA MARTINEZ LARA (YWP)

PRIOR SKILLS

This is an intermediate level subject in control systems. For a good understanding, a previous background is required: PID control, MATLAB-SIMULINK software, matrix algebra, ordinary differential equations and process instrumentation.

REQUIREMENTS

It is recommended to have passed the subjects "Data acquisition Instrumentation" and "Systems Modeling".
It is recommended have a basic level of knowledge in control theory.

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.

TEACHING METHODOLOGY

The methodologies used are:

- Master class
- Seminars
- Case study
- Project based learning

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

Type	Hours	Percentage
Hours large group	34,0	22.67
Self study	96,0	64.00
Hours small group	20,0	13.33

Total learning time: 150 h

CONTENTS

1. Introduction

Description:

- 1.1 Terminology. Definitions. Diagrams.
- 1.2 Modern control and intelligent control.
- 1.3 Skills in control systems.
- 1.4 Basic examples.
- 1.3 Control with MATLAB and SIMULINK.

Specific objectives:

Know how understand control systems and use of software resources.

Related activities:

Master Class. Use of software resources.

VIDEO: MATLAB. How to get started with Control Systems in MATLAB. At URL: <https://youtu.be/MyJIqVVNr0>, last visited 11 th December 2020.

Full-or-part-time: 4h

Theory classes: 2h

Self study : 2h



2. PID Control

Description:

- 2.1 Introduction.
- 2.2 PID controllers.
- 2.3 Process models: static, dynamics.
- 2.4 PID design. Tuning of PID controllers.

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.

Related activities:

Master class. Case study. Examples, Laboratory practices

Full-or-part-time: 16h

Theory classes: 8h
Self study : 8h

3. Water management

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.

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

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)

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.

Related activities:

Master class. Exam. Case study. Examples. Seminars.

Full-or-part-time: 16h

Theory classes: 8h
Self study : 8h



4. Integrated Automation

Description:

- 4.1 Industrial automation.
- 4.2 Supervisory control.
- 4.3 Display design.
- 4.4 Water chlorination SCADA example.
- 4.5 Fuzzy logic MATLAB example.

Specific objectives:

Provide an integrated vision of human-supervisory systems from the point of view of human, technology and systems engineering.

Related activities:

Master Class. Exam. Case study. Examples. Use of SCADA software.

Full-or-part-time: 16h

Theory classes: 8h

Self study : 8h

5. Industrial control

Description:

- 5.1 Introduction
- 5.2 Internal model control.
- 5.3 Cascade control.
- 5.4 Feedforward control.
- 5.5 Time delay compensation.
- 5.6 Multivariable control.

Specific objectives:

Learn an integrated vision of industrial control.

Related activities:

Master class. Exam. Case study, MATLAB examples.

Full-or-part-time: 16h

Theory classes: 8h

Self study : 8h

6. Laboratory practices.

Description:

PART 1

- 6.1 Obtaining a plant model experimentally
- 6.2 Implementation of an industrial PID controller for a temperature control process.
- 6.3 Model of level and flow control systems.
- 6.4 Frequency response of level and flow control systems.
- 6.5 PID design of level and flow control systems in academic plant.
- 6.6. PID control with MATLAB-SIMULINK.

PART 2

- 6.6 Using MATLAB and SIMULINK for system identification.
- 6.7 PI controller self tuning for an aeration control system.
- 6.8 Detection of inefficiencies with PID fixed gain
- 6.9 A PID-Fuzzy control approach.

Specific objectives:

The practical part of the subject contributes to the integration between various software, the acquisition of technical ability in PID control and industrial process control with advanced algorithms.

Related activities:

In the Laboratory A5.6 Automatic Control is available:

- academic plants for level and flow 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
- Rockwell automation, PLC controllers

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

Full-or-part-time: 82h

Laboratory classes: 20h

Self study : 62h

GRADING SYSTEM

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

Exam1*(0,25)+Exam2*(0,25)+Practices_1*(0,20)+Practices_2*(0,20)+Exercises*(0,1)

Exam1: Module 2

Exam2: Module 5

Exercises: Modules 3,4

Practices_1: Practices 1,2,3,4,5

Practices_2: Practices 6,7,8,9,10

EXAMINATION RULES.

The Exams are test.

The Exercises are open answers.

Virtual practices or/and Laboratory practices are mandatory. Laboratory practices 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:

- Alfaro, Victor M.; Vilanova i Arbós, Ramon. Model-reference robust tuning of PID controllers [on line]. Cham: Springer International, 2016 [Consultation: 24/04/2020]. Available on: <https://dx.doi.org/10.1007/978-3-319-28213-8>. ISBN 9783319282138.
- Seborg, Dale E.; Mellichamp, Duncan A.; Doyle III, Francis J.; Edgar, Thomas F. Process Dynamics and Control. Fourth edition. Hoboken, NJ: Wiley, [2017]. ISBN 9781119285915.

Complementary:

- Dorf, Richard C.; Bishop, Robert H. Modern control systems. 12th ed., international ed. Boston [etc.]: Pearson, cop. 2011. ISBN 9780131383104.
- Ivergård, Toni; Hunts, Brian. Handbook of control room design and ergonomics : a perspective for the future. London ; New York: Taylor & Francis, cop. 2009. ISBN 9781420064292.
- Macaulay, T.; Singer, B. Cybersecurity for industrial control systems : SCADA, DCS, PLC, HMI, and SIS. Boca Raton, FL: CRC Press, [2012]. ISBN 9781439801963.
- Samad, T., Weyrauch, J. [eds.]. Automation, control and complexity : an integrated approach. Chichester: Jhon Wiley and Sons, 2000. ISBN 9780471816546.

RESOURCES

Other 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>

International Water Association IWA: <https://www.iwapublishing.com/>

MATLAB Control Systems Toolbox: <https://es.mathworks.com/help/control/index>