Course guide
240AR051 - 240AR051 - Sensors, Instrumentation and Communications

Last modified: 16/05/2023

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

Degree: MASTER'S DEGREE IN AUTOMATIC CONTROL AND ROBOTICS (Syllabus 2012). (Optional subject).
MASTER'S DEGREE IN INDUSTRIAL ENGINEERING (Syllabus 2014). (Optional subject).

Academic year: 2023 **ECTS Credits:** 4.5 **Languages:** English

LECTURER

Coordinating lecturer: MANUEL VELASCO GARCIA

Others: ENRIC XAVIER MARTÍN RILL

PRIOR SKILLS

Basic knowledge in maths (linear algebra, elementary calculus, complex variables and linear differential equations) of automatic control (continuous-time linear systems, in its temporal and frequency approach) and physics and mechanics.

TEACHING METHODOLOGY

Lectures are combined of theory and simultaneous practices. The theoretical concepts are exposed by the teacher and immediately the students put into practice the exposed concepts in order to clarify the possible doubts that may arise in the use and application of the theory. The active participation of students in the development of the class is promoted. Some of the theoretical concepts require that the practice be at group level, others require individual work.

Due to the COVID-19 pandemic, the theoretical concepts will have to be presented remotely and synchronously and the practical concepts will be carried out in person. In case the crisis worsens, all class processes will be carried out remotely.

LEARNING OBJECTIVES OF THE SUBJECT

Introduce the students to the techniques of analysis and design of feedback control systems that involve both the specification and use of sensors and actuators, and communication systems that link sensors, controllers and actuators.

Students will be able to apply the technologies of sensors, actuators and specifically communication systems in applications and examples of control systems. This includes the specification of the characteristics required for sensors, actuators and communication systems. Students will be able to use tools and methods of analysis and technology assessment of the sensors, actuators and communication systems for control. The student will be able to assess the difficulty of using the required technology for controlling certain plants and implementing the developed controllers.

Learning Outcomes
- Knowledge of the general characteristics of measuring systems.
- Ability for specification actuators and sensors for a control implementation.
- Skill with industrial communications for control.

STUDY LOAD

Type	Hours	Percentage
Hours small group	20,3	18.03
Hours large group	20,3	18.03
Self study	72,0	63.94

Total learning time: 112.6 h

CONTENTS

1. Introduction to the control systems technologies.

Description:
Technological evolution. Analog Control. Computer control. Elements of a control system. Sensors, actuators, controllers, interfaces. Communications systems and interconnections. To determine the actual structure of the components of the control systems in industrial applications and in other social settings. Knowing the technological, economic and security implementation of control systems.

Specific objectives:
CE13, CG1, CB7, CT3.

Related activities:
Lectures and contact with laboratory devices and systems

Full-or-part-time: 1h
Theory classes: 1h

2. Measurement and instrumentation

Description:
Basic principles of measurement systems. Static characteristics of instruments: Linearity, resolution, accuracy, hysteresis. Physical principles of operation of the sensors and actuators. Introduce the abstract structure of the measurement and detection of physical parameters systems. Analyze common structures for adapting the physical parameters to electrical signals. Define the static and dynamic characteristics of the sensors as a system and their effects on the acquired signal. Exposing the abstract model of the control actuators.

Specific objectives:
CE13, CG1, CB7, CT3.

Related activities:
Lectures, problem sessions and laboratory practices by preparing a first draft for an instrumentation and control project.

Full-or-part-time: 2h
Theory classes: 1h
Laboratory classes: 1h

4. Industrial communication systems

Description:
Fundamentals of communications. Open interconnection model. Fieldbuses and sensor and actuator buses. Operating characteristics. Network evaluation models.
The SPI bus
The I2C bos
The CAN (Control Area Network) bus

Specific objectives:
To know the formalization of communication systems. Adapt networks to industrial needs. Know the physical, link, application and user layers of industrial networks. Analyze the specific characteristics of field buses. Learn to evaluate the capabilities of networks in control applications. Know one of the most common field buses, the CAN.

Related activities:
Lectures, problem sessions and laboratory practices through the development of an instrumentation and control project.

Full-or-part-time: 9h
Theory classes: 3h
Practical classes: 6h

4 Industrial communication Protocols

Description:
Description and implementation using:
The TCP / IP protocol
The Websockets protocol
The MQTT protocol

Specific objectives:
Learn the basics of industry 4.0 communication and monitoring systems

Full-or-part-time: 9h
Theory classes: 3h
Practical classes: 6h

GRADING SYSTEM

The skills and abilities acquired will be assessed based on the assignments and questionnaires.
During the term of the 2020-2021 academic year, and as a result of the health crisis due to Covid19, the grading method will be:
Arithmetic mean of the tests and deliverable to Athena.
During the spring semester of the 2019-2020 academic year, and as a result of the health crisis due to Covid19, the qualification method will be:
Arithmetic mean of the tests and deliverable on athena.

EXAMINATION RULES.

The assessment tests will be carried out with all the written documentation (books and notes) that the students want to bring.

BIBLIOGRAPHY

Basic:
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- Shinskey, F. Greg; Pérez Castellanos, José Hernán. Sistemas de control de procesos : aplicación, diseño y sintonización. México: McGraw-Hill, cop. 1996. ISBN 9701009347.
- Bateson, Robert N. Introduction to control system technology. 7th ed. Upper Saddle River ; Columbus: Prentice Hall, cop. 2001. ISBN 0130306886.
- Brignell, John; White, Neil. Intelligent sensor systems. Rev. ed. Bristol, UK ; Philadelphia: Institute of Physics Pub, 1996. ISBN 0750303891.
- Creus Solé, Antonio. Instrumentación industrial [on line]. 8ª ed. Barcelona: Marcombo, 2011 [Consultation: 23/11/2021]. Available on: http://www.ingebook.com/ib/NPcd/IB_BooksVis?cod_primaria=1000187&codigo_libro=9767. ISBN 9788426716682.

Complementary:
- Casals, Alícia. Sensor devices and systems for robotics. Berlin: Springer-Verlag, cop. 1989. ISBN 3540508856.
- Castro Gil, Manuel-Alonso; Fuertes, J. M. Comunicaciones industriales : principios básicos. Madrid: UNED, 2007. ISBN 9788436254600.
- Castro Gil, Manuel-Alonso; Fuertes, J. M. Comunicaciones industriales : sistemas distribuidos y aplicaciones. Madrid: UNED, 2007. ISBN 9788436254679.
- Chesmond, Colin J. Control system technology. London: Edward Arnold, 1984. ISBN 0713135085.
- Considine, Douglas M; McMillan, Gregory K. Process/industrial instruments and controls handbook. 5th ed. New York: McGraw-Hill, 1999. ISBN 0070125821.
- De Silva, Clarence W. Control sensors and actuators. Englewood Cliffs: Prentice-Hall, cop. 1989. ISBN 0131717456.
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- Ollero de Castro, Pedro; Fernández Camacho, Eduardo. Control e instrumentación de procesos químicos. Madrid: Síntesis, DL 1997. ISBN 8477385173.
- Pallás Areny, Ramón. Sensores y acondicionadores de señal. 4ª ed. Barcelona: Marcombo Boixareu, cop. 2003. ISBN 8426713440.