240AR051 - Sensors, Instrumentation and Communications

Coordinating unit: 240 - ETSEIB - Barcelona School of Industrial Engineering
Teaching unit: 707 - ESAII - Department of Automatic Control
Academic year: 2019
Degree: MASTER'S DEGREE IN AUTOMATIC CONTROL AND ROBOTICS (Syllabus 2012). (Teaching unit Optional)
MASTER'S DEGREE IN INDUSTRIAL ENGINEERING (Syllabus 2014). (Teaching unit Optional)
ECTS credits: 4,5
Teaching languages: English

Teaching staff
Coordinator: MANUEL VELASCO GARCIA

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 will be combined with supervised learning based on the development of a pre-project and independent learning. Classes are organized in theoretical sessions and practical sessions in the laboratory. The lectures will focus on explaining the theoretical concepts, encouraging the active participation of students.
In practical classes in the laboratory, the teacher will propose pre-projects that require the use of the knowledge gained in the field of control technology and for the actuators and sensors to design prototypes that have capacities as controlled systems.

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 where appropriate 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

<table>
<thead>
<tr>
<th>Total learning time: 112h 30m</th>
<th>Hours large group: 20h 15m</th>
<th>18.00%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hours small group: 20h 15m</td>
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<tr>
<td>Self study: 72h</td>
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<td>64.00%</td>
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</table>
## 1. Introduction to the control systems technologies.

**Learning time:** 16h 30m  
Theory classes: 3h  
Practical classes: 3h  
Self study: 10h 30m

**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.

**Related activities:**  
Lectures and contact with laboratory devices and systems

**Specific objectives:**  
CE13, CG1, CB7, CT3.

## 2. Measurement and instrumentation

**Learning time:** 16h 30m  
Theory classes: 3h  
Practical classes: 3h  
Laboratory classes: 10h 30m

**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.

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

**Specific objectives:**  
CE13, CG1, CB7, CT3.
### 3. Structure and characteristics of the transducers

**Learning time:** 16h 30m  
- Theory classes: 3h  
- Practical classes: 3h  
- Self study: 10h 30m

**Description:**
Sensors for measuring mechanical quantities, mainly in the field of robotics: position, velocity, acceleration. Sensors for the process industries: pressure, temperature, flow, pH. Actuators: Servo motors, DC, AC and Step motors, hydraulic and pneumatic positioners, servo valves, cylinders and pumps. Transmitters, intelligent sensors and actuators (Smart). Describe the significant parameters in sensors and actuators, describe the operation of the bridge circuit and configurations with multiple connections, describe and specify sensors and actuators for different magnitudes and different environments indicate typical power sources for the actuators, show the structure of intelligent sensors and actuators.

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

**Specific objectives:**
CE13, CG1, CB7, CT3.

### 4. Industrial communication systems

**Learning time:** 33h  
- Theory classes: 6h  
- Practical classes: 6h  
- Self study: 21h

**Description:**
Fundamentals of communications. Open interconnection model. Field buses and buses of sensors and actuators. Operating characteristics. Network evaluation models. The bus CAN (Control Area Network). Know the basics of communication systems. How communication networks adapt to industrial needs. Knowing the physical, link, application and user layers of industrial networks. Analyze the specificities of fieldbuses. Learning to assess the capabilities of networks in control applications. Meet one of the most common fieldbus, CAN.

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

**Specific objectives:**
CE13, CG1, CB7, CT3.
### 5. Practical application and dedicated systems

**Learning time:** 16h 30m  
- Theory classes: 3h  
- Practical classes: 3h  
- Self study: 10h 30m

**Description:**  

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

**Specific objectives:**  
CE13, CG1, CB7, CT3, CT7

### Qualification system

The evaluation system will consist on the following elements:

**Rating System:** The competence and skills are assessed against three scores: the score from a theoretical exam (50%), the score from the evaluation of the pre-projects (30%), and a discretional assessment score from the practical work sessions (20%).

### Regulations for carrying out activities

**Standards tests realization:** The evaluation tests are to be conducted with the written documentation (books and notes) that students wish to take, except during the conceptual evaluation. The evaluation of the pre-projects there will use presentations and demonstrations.
Bibliography

Basic:


Complementary:


