820012 - CIA - Industrial Control and Automation

Coordinating unit: 295 - EEBE - Barcelona East School of Engineering
Teaching unit: 707 - ESAII - Department of Automatic Control
Academic year: 2019

Degree:
- BACHELOR’S DEGREE IN ELECTRICAL ENGINEERING (Syllabus 2009). (Teaching unit Compulsory)
- BACHELOR’S DEGREE IN MECHANICAL ENGINEERING (Syllabus 2009). (Teaching unit Compulsory)
- BACHELOR’S DEGREE IN CHEMICAL ENGINEERING (Syllabus 2009). (Teaching unit Compulsory)
- BACHELOR’S DEGREE IN BIOMEDICAL ENGINEERING (Syllabus 2009). (Teaching unit Compulsory)
- BACHELOR’S DEGREE IN ENERGY ENGINEERING (Syllabus 2009). (Teaching unit Compulsory)
- BACHELOR’S DEGREE IN INDUSTRIAL ELECTRONICS AND AUTOMATIC CONTROL ENGINEERING (Syllabus 2009). (Teaching unit Compulsory)
- BACHELOR’S DEGREE IN MATERIALS ENGINEERING (Syllabus 2010). (Teaching unit Compulsory)
- BACHELOR’S DEGREE IN BIOMEDICAL ENGINEERING (Syllabus 2009). (Teaching unit Compulsory)
- BACHELOR’S DEGREE IN ELECTRICAL ENGINEERING (Syllabus 2009). (Teaching unit Compulsory)
- BACHELOR’S DEGREE IN ENERGY ENGINEERING (Syllabus 2009). (Teaching unit Compulsory)
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- BACHELOR’S DEGREE IN INDUSTRIAL ELECTRONICS AND AUTOMATIC CONTROL ENGINEERING (Syllabus 2009). (Teaching unit Compulsory)
- BACHELOR’S DEGREE IN MECHANICAL ENGINEERING (Syllabus 2009). (Teaching unit Compulsory)

ECTS credits: 6
Teaching languages: Catalan, Spanish

Teaching staff
Coordinator: JOAN DOMINGO PEÑA - JOAN SEGURA CASANOVAS
Others:
- Primer quadrimestre:
  - JOSÉ AROCAS PÉREZ - M11, M12, M23, M24, M31, M32
  - JOAQUIN BLESÀ IZQUIERDO - T11, T12, T13, T14
  - ANTONIO CALOMARDE PALOMINO - M11, M12, M13, M14, M41, M42, M43, M44
  - MANUEL LOZANO GARCÍA - M33, M34, M43
  - VICTOR REPECHO DEL CORRAL - M21, M22, M41, M42, M44
  - JOAN SEGURA CASANOVAS - M21, M22, M23, M24, M31, M32, M33, M34, T21, T22, T23, T24
  - JORDI SOLA SOLER - M11, M12, M13, M14
  - CONGCONG SUN - M13, M14, T11, T12, T13, T14

- Segon quadrimestre:
  - JOAQUIN BLESÀ IZQUIERDO - M21, M22, M23, M24, M25
  - JOAN DOMINGO PEÑA - M11, M12, M13, M14, M15, T11, T12, T13, T14
  - VICTOR REPECHO DEL CORRAL - M21, M22, T11, T12
  - PABLO SEGOVIA CASTILLO - M15, M24
  - JOAN SEGURA CASANOVAS - M25, M31, M32, M33, M34, T13, T14
  - CONGCONG SUN - M11, M12, M13, M14, M23

Opening hours
Timetable: Previous hours to the class in teacher desk and preferably by appointment by e-mail.
820012 - CIA - Industrial Control and Automation

**Prior skills**

For good follow the subject, is recommended to have passed the following subjects:
- Mathematics (I and II)
- Physics
- Electrical Systems
- Mechanical systems
- Computer Basics

**Degree competences to which the subject contributes**

**Specific:**

CEI-12. Understand the fundamentals of automatic control methods.

**Transversal:**

1. TEAMWORK - Level 2. Contributing to the consolidation of a team by planning targets and working efficiently to favor communication, task assignment and cohesion.
2. EFFECTIVE USE OF INFORMATION RESOURCES - Level 2. Designing and executing a good strategy for advanced searches using specialized information resources, once the various parts of an academic document have been identified and bibliographical references provided. Choosing suitable information based on its relevance and quality.

**Teaching methodology**

The course uses approximately methodology expositive/participative by 25%, the 50% is individual work, and group work by 25%. We also used the techniques of cooperative learning and project/problem-based learning. The practical realization is essential to better understand the concepts worked.

**Learning objectives of the subject**

1. Acquire basic skills in design, analysis and implementation of automated systems.
2. Knowing different devices, components and systems involved in the process automation industry.
4. Know the basics of continuous systems dynamics.
5. Know methods of regulation and control of continuous systems.
6. Teamwork.
7. Efficient use of information resources in the field of automation of industrial processes.

**Study load**

<table>
<thead>
<tr>
<th>Total learning time: 150h</th>
<th>Hours large group: 45h</th>
<th>30.00%</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Hours medium group: 0h</td>
<td>0.00%</td>
</tr>
<tr>
<td></td>
<td>Hours small group: 15h</td>
<td>10.00%</td>
</tr>
<tr>
<td></td>
<td>Guided activities: 0h</td>
<td>0.00%</td>
</tr>
<tr>
<td></td>
<td>Self study: 90h</td>
<td>60.00%</td>
</tr>
</tbody>
</table>
820012 - CIA - Industrial Control and Automation

Content

<table>
<thead>
<tr>
<th>- Unit 1_1</th>
<th>Learning time: 9h 30m</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Theory classes: 3h</td>
</tr>
<tr>
<td></td>
<td>Laboratory classes: 1h</td>
</tr>
<tr>
<td></td>
<td>Guided activities: 0h 30m</td>
</tr>
<tr>
<td></td>
<td>Self study : 5h</td>
</tr>
</tbody>
</table>

Description:

Related activities:
- Read complete guide (without annexes)
- Reading the information in Annex 1
- Reflection synthesis
- Reading the text of Annex 2
- Assignment 1: Self evaluation
- Assignment 2: Write a definition of control law
- Assignment 3: Make a list of advantages and disadvantages of industrial control and self-matització
- Reading the text of Annex 3
- Fill the template of time spent
- Send files to Virtual Campus
- Lab practices
- Classroom problems/exercicies
- Homework problems/exercicies

Specific objectives:
Upon completion of the activities students will be able to:
- Be able to explain the scope and content of the subject and details relating to staff, dedication weekly regimen of practices, assessment system and bibliography.
- Make a definition of Control Law using quality criteria.
- Differentiate the control to open loop and closed loop.
- Be aware of the scope and usefulness of industrial automation and its consequences.
- Be able to differentiate single-phase and tri-phase systems and use and explain protections of electrical installations.
- **Unit 1_2**

**Learning time:** 9h 30m  
- Theory classes: 3h  
- Laboratory classes: 1h  
- Guided activities: 0h 30m  
- Self study: 5h

**Description:**  
Sensors; classification, characteristics, and connection type.

**Related activities:**  
- Reading the text of Annex 1  
- Reflection synthesis  
- Assignment 1: Finding information  
- Assignment 2: Finding information  
- Assignment 3: Finding information  
- Assignment 4: Work on sensors and actuators  
- Fill in file time  
- Shipping to Virtual Campus  
- Practice lab  
- Problem/exercicies sessions  
- Homework problem/exercises

**Specific objectives:**  
Upon completion of the activities the student will be able to:  
- Differentiate sensor transducer.  
- Learn the most common sensors and ways of wiring.
### Unit 1_3

**Learning time:** 9h 30m  
- Theory classes: 3h  
- Laboratory classes: 1h  
- Guided activities: 0h 30m  
- Self study: 5h

#### Description:

#### Related activities:
- Reading the text of Annex 1  
- Reflection synthesis  
- Assignment 1: Finding information  
- Assignment 2: solving exercise  
- Fill in file time  
- Shipping to Virtual Campus  
- Practice lab  
- Problem sessions  
- Homework problems

#### Specific objectives:
Upon completion of the activities the student will be able to:
- Being able to explain what a GRAFCET.  
- Know the most common structures GRAFCET.
### Unit 1_4

**Learning time:** 10h 30m  
- Theory classes: 3h  
- Laboratory classes: 1h  
- Guided activities: 0h 30m  
- Self study: 6h

**Description:**  

**Related activities:**  
Access to information  
Reading the text of Annex 1  
Reflection synthesis  
Assignment 1: resolution of exercise  
Fill in file time  
Shipping to Virtual Campus  
Practice lab  
Problem sessions  
Homework problems

**Specific objectives:**  
At the end of the activities the student will be able to:  
- Differentiate the different types of actuators.  
- The autoenclavaments relays as memory circuits.  
- Be able to make schematic connection of actuators and pre-actuators.
- **Unit 2_1**

  **Learning time:** 12h
  - Theory classes: 3h
  - Laboratory classes: 1h
  - Guided activities: 6h
  - Self study : 2h

<table>
<thead>
<tr>
<th>Description:</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Introduction to PLC.</td>
<td></td>
</tr>
</tbody>
</table>

| Related activities: |  |
| Access to information |  |
| Reading the text of Annex 1 and web |  |
| Reflection synthesis |  |
| Assignment 1: resolution of issues |  |
| Fill in file time |  |
| Shipping to Virtual Campus |  |
| Practice lab |  |
| Problem sessions |  |
| Homework problems |  |

| Specific objectives: |  |
| Upon completion of the activities the student will be able to: |  |
| - Understand PLC types. |  |
| - Write a PLC program. |  |
| - Identify the elements of the programming language of PLCs. |  |
| - Learn what are the languages of IEC 61131. |  |
# Unit 2_2

<table>
<thead>
<tr>
<th>Learning time: 9h 30m</th>
</tr>
</thead>
<tbody>
<tr>
<td>Theory classes: 3h</td>
</tr>
<tr>
<td>Laboratory classes: 1h</td>
</tr>
<tr>
<td>Guided activities: 0h 30m</td>
</tr>
<tr>
<td>Self study: 5h</td>
</tr>
</tbody>
</table>

## Description:

## Related activities:
- Reading Annex 1
- Assignment 1: Questionnaire
- Reading Annex 2
- Assignment 2: Questionnaire
- Reading Annex 3
- Assignment 3: Exercise
- Shipping to Virtual Campus
- Practice lab
- Problem sessions
- Homework problems

## Specific objectives:
Upon completion of the activities the student will be able to:
- Explain what is a Programmable Logic Controller (PLC) and its use in automation systems.
- Understand the internal architecture of a PLC.
- Explain characteristics of this technology in relation to technology
- Be able to write simple PLC programs wired.
- Explain what is a PLC scan cycle.
- Explain how is structured the PLC memory and his addressing systems.
**- Unit 2_3**

**Learning time:** 10h 30m  
- Theory classes: 3h  
- Laboratory classes: 1h  
- Guided activities: 0h 30m  
- Self study: 6h

**Description:**
PLC Programming: combinational elements and sequences with scales, timers, counters and others. Analog part of PLC and connection to and from analog components. Control of induction motors with inverters; connection and programatic. Examples.

**Related activities:**
- Reading the text of Annex 1  
- Reflection synthesis  
- Assignment 1: resolution of issues  
- Fill in file time  
- Shipping to Virtual Campus  
- Practice lab  
- Problem sessions  
- Homework problems

**Specific objectives:**
Upon completion of the activities the student will be able to:
- Programming a PLC using ladder diagrams.  
- Use the resources of programming a PLC.  
- Explain how the map is distributed memory of the PLC.  
- Connect sensors and actuators, digital and analog, to PLC.  
- Use timers and counters a PLC.  
- Know, connect and program inverters for control of induction motors.
- **Unit 3_1**

**Learning time:** 20h
- Theory classes: 5h
- Laboratory classes: 2h
- Guided activities: 1h
- Self study: 12h

**Description:**

**Related activities:**
- Reading the text of Annex 1
- Reflection synthesis
- Assignment 1: resolution of issues
- Reading the text of Annex 2
- Fill in file time
- Shipping to Virtual Campus
- Reading the example of Annex 3
- Practice lab
- Problem sessions
- Homework problems

**Specific objectives:**
At the end of the activities the student will be able to:
- Differentiate automation and control
- Be able to explain what they are and how they respond systems order 0, 1 and 2
- Recognize whether a system is stable or not
- Identify the behavior of a system and the type of response from the canonical functions
- Establish the equivalent mathematical model of simple physical system
### Unit 3.2

**Learning time:** 21h 30m  
- Theory classes: 6h  
- Laboratory classes: 2h  
- Guided activities: 1h 30m  
- Self study: 12h

**Description:**


**Related activities:**
- Training groups  
- Identification systems, simulators, classroom  
- Solving exercises related to transfer functions and block diagrams  
- Solving exercises related to stability  
- Applying the Routh criteria  
- Using graphics of roots locus and Nyquist

**Specific objectives:**

- Upon completion of the activities the student will be able to:  
  - Make "s" transfer functions from differential equations.  
  - Build and simplify block diagrams.  
  - Use a simulator as help of characterization of systems  
  - To determine the stability of a system in open and closed loop  
  - Compensate poles and zeros.  
  - Use root locus and Nyquist graphics.
<table>
<thead>
<tr>
<th>Units 3_3 &amp; 3_4</th>
<th>Learning time: 10h 30m</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Theory classes: 3h</td>
</tr>
<tr>
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</tr>
<tr>
<td></td>
<td>Guided activities: 0h 30m</td>
</tr>
<tr>
<td></td>
<td>Self study: 6h</td>
</tr>
</tbody>
</table>

**Description:**

**Related activities:**
- Reading and study of teaching materials
- Practices
- Exercises solved in class
- Exercises to be solved in class, team
- Homeworks
- Use of simulators

**Specific objectives:**
At the end of the activities the student will be able to:
- Recognize the effect of P, I and D actions and their combined
- Tune regulator
- Discussion of the stability of open and closed loop systems
- Wear simulators
- Perform practically a PID control of a second order system with a PLC as a regulator
## - Unit 4 (Project)

**Learning time:** 25h  
Theory classes: 3h  
Guided activities: 2h  
Self study : 20h

<table>
<thead>
<tr>
<th>Description:</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Resolution of a project. The Gantt diagram. Team work. The documentation of the projects. Work methodologies. Make a project of automation with PLC justifying calculations, selection of materials, GRAFCETs, securities, programs, electrical diagrams, connection to PLC, use of expansion modules of inputs and outputs and preparation of budget and calculation of energy consumption.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Related activities:</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Complete reading of this guide (without annexes)</td>
<td></td>
</tr>
<tr>
<td>Elaboration of a Gantt chart</td>
<td></td>
</tr>
<tr>
<td>Rules teamwork</td>
<td></td>
</tr>
<tr>
<td>Attainment Targets</td>
<td></td>
</tr>
<tr>
<td>Completion of a technical report sections</td>
<td></td>
</tr>
<tr>
<td>Sending Athena</td>
<td></td>
</tr>
</tbody>
</table>

### Specific objectives:

At the end of the activities the student will be able to:

- Do a full automation project.
- Make Gantt charts.
- Make project reports.
- Teamwork.
- Search and find information related to the materials of the project.
**Unit 5**

**Learning time:** 2h
- Theory classes: 1h
- Self study: 1h

**Description:**
Introduction to data acquisition systems, supervision and control. Basic Elements. Distribution of basic elements and communication between them. The graphical interface with the latest features and typical components. Data acquisition and control variables: characteristics and configuration. Introduction to industrial communications.

**Related activities:**
- Complete reading of study guide
- Read Chapter 1 Systems Supervisión CEA-IFAC (CEA-IFAC_Cuadernos_Supervisión_1.pdf file)
- Taking a Reading Annex 1
- Taking 2 Reading Annex 2
- Taking 3 Reading Annex 3
- 4 Commissioning
- Fill the template of time spent
- Shipping to Virtual Campus
- Homework problems

**Specific objectives:**
Upon completion of the activities the student will be able to:
- Explain what we mean by data acquisition system, supervision and control and what are its basic elements.
- Recognize the responsibility of a monitoring system and control the operation of the plant controlled.
- Explain the basic capabilities offered by commercial software monitoring and control its use.

**Qualification system**
- Partial Exams: 40% (20% each of the 2 that will be carried out). These exams will be individual, writing and performed during class hours.
- Practice control: 10%
- Exercises and class room problems: 20%
- Practices: 10%
- Competence "efficient use of information resources": 10%. This competency must be demonstrated by the complete and correct selection of the components of the course project.
- Course project: 10%

This subject has no re-evaluation because it is based on a continuous assessment system in which each student has to add up grades throughout the course, many of them derived from teamwork both in class and out of class.
Regulations for carrying out activities

No further delivery to the campus, or in hand when this is proposed, which is made entirely by computer and office tools, and PDF format file. Only be given exercises hand writted when carried out in the same class session. Which are outside of class, will always be machine made and PDF. Practices are hand delivered solved unless otherwise indicated.

For partial controls, one page, with annotations only for one side, will be allowed for issues which should not be relied on in memory and, if necessary, a scientific calculator. It is completely forbidden to use mobile telephony. In case of need to wait for a telephone call o message, the professor must be notified before the exam.

Bibliography

Basic:


Complementary:


Others resources:

Study material for each unit or topic of the subject related to the theory, practices and exercises.

Computer material

Notes and materials for the course