320020 - CAIA - Advanced Industrial Control and Automation

Coordinating unit: 205 - ESEIAAT - Terrassa School of Industrial, Aerospace and Audiovisual Engineering
Teaching unit: 707 - ESAII - Department of Automatic Control
709 - EE - Department of Electrical Engineering

Academic year: 2018
Degree: BACHELOR'S DEGREE IN ELECTRICAL ENGINEERING (Syllabus 2009). (Teaching unit Compulsory)
ECTS credits: 6
Teaching languages: Catalan

Teaching staff

Coordinator: Romero Duran, David
Perez Magrane, Ramon

Others: Comasolivas Font, Ramon

Prior skills

Students will be expected to have passed Industrial Control and Automation.

Degree competences to which the subject contributes

Basic:
CB01. IND_DIS_AUD: That students have demonstrated knowledge and understanding in a field of study that part of the basis of general secondary education, and is typically at a level which, although it is supported by advanced textbooks, includes some aspects that involve knowledge of the forefront of their field of study.
CB02. IND_DIS_AUD: That students can apply their knowledge to their work or vocation in a professional manner and have competences typically demonstrated through devising and defending arguments and solving problems within their field of study.

Specific:
CE25. ELE: Applied knowledge of power electronics.
CE21. ELE: Understanding of machine control, electric drive systems and their applications.
CE22. ELE: Ability to calculate and design high-voltage electrical installations.
CE26. ELE: Understanding of the principles of automatic control and their application to industrial automation.

Teaching methodology

Face-to-face sessions
a) Classroom sessions. The lecturer presents the theoretical content of the subject, performs demonstrations using a computer, assigns exercises and answers questions.
b) Laboratory sessions. Students carry out a series of laboratory practicals.
c) Assessment sessions. Individual tests on the material. Take-home work.
d) Individual study and exercise completion.
e) Completion of assignments and exercises to be handed in.

Learning objectives of the subject
This subject introduces students to various technologies used in automatic systems and provides the basic knowledge necessary to assess, design, program and maintain industrial automation and process-control systems.

In the first part of the subject, students learn about the basic concepts and characteristics of wired and programmable automation systems, as well as the various technologies that comprise them. Students study programmed systems (the basic elements of automation systems) and learn the generic structure of programmable automatons (PLCs), which is the basic element used in the laboratory practicals.

In the second part of the subject, students study the characteristics of continuous and discreet feedback control systems and controller design. This portion of the subject is conducted in the laboratory. Special emphasis will be placed on performance analysis (stability, precision and velocity). Students' training in automatic control skills is concentrated in this subject and in Industrial Control and Automation.

<table>
<thead>
<tr>
<th>Study load</th>
<th>Hours large group:</th>
<th>30h</th>
<th>20.00%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total learning time: 150h</td>
<td>Hours medium group:</td>
<td>0h</td>
<td>0.00%</td>
</tr>
<tr>
<td></td>
<td>Hours small group:</td>
<td>30h</td>
<td>20.00%</td>
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<tr>
<td></td>
<td>Guided activities:</td>
<td>0h</td>
<td>0.00%</td>
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<tr>
<td></td>
<td>Self study:</td>
<td>90h</td>
<td>60.00%</td>
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</table>
## Content

### AUTOMATION PART

Degree competences to which the content contributes:

<table>
<thead>
<tr>
<th>TOPIC 1: INTRODUCTION (Automation)</th>
<th>Learning time: 10h</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Theory classes: 2h</td>
</tr>
<tr>
<td></td>
<td>Laboratory classes: 2h</td>
</tr>
<tr>
<td></td>
<td>Self study : 6h</td>
</tr>
</tbody>
</table>

**Description:**
- Objective of the subject.
- Review of the basics of automation.
- Distributed automation systems.

<table>
<thead>
<tr>
<th>TOPIC 2: IEC-61131 STANDARDISED SYSTEMS (Automation)</th>
<th>Learning time: 20h</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Theory classes: 4h</td>
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<tr>
<td></td>
<td>Laboratory classes: 4h</td>
</tr>
<tr>
<td></td>
<td>Self study : 12h</td>
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</tbody>
</table>

**Description:**
- Types of data.
- Organisational units of an automation project.
- Standard programming languages: IL, Ladder, FBD, SFC, ST.

<table>
<thead>
<tr>
<th>TOPIC 3: STANDARD PROGRAMMING LANGUAGES (Automation)</th>
<th>Learning time: 30h</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Theory classes: 5h</td>
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<tr>
<td></td>
<td>Laboratory classes: 7h</td>
</tr>
<tr>
<td></td>
<td>Self study : 18h</td>
</tr>
</tbody>
</table>

**Description:**
- Basic elements.
- Evolution rules.
- SFC (Grafnet) structures. Macrosteps.
- Programming in SFC.
- Introduction to PLC programming using high-level languages: ST.
- Variables.
- Programming functions and structures.
### TOPIC 4: ANALOGUE SIGNAL PROCESSING  
**(Automation)**

<table>
<thead>
<tr>
<th>Description:</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Types of signals in automation systems.</td>
</tr>
<tr>
<td>- Analogue sensors and actuators.</td>
</tr>
<tr>
<td>- Structure of analogue input and output modules.</td>
</tr>
<tr>
<td>- Programming of automation applications with analogue signals.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Learning time: 15h</th>
</tr>
</thead>
<tbody>
<tr>
<td>Theory classes: 4h</td>
</tr>
<tr>
<td>Laboratory classes: 2h</td>
</tr>
<tr>
<td>Self study : 9h</td>
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</tbody>
</table>

### (ENG) BLOC DE CONTROL

#### Degree competences to which the content contributes:

#### TOPIC 5: FEEDBACK CONTROL

<table>
<thead>
<tr>
<th>Learning time: 25h</th>
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<tbody>
<tr>
<td>Theory classes: 5h</td>
</tr>
<tr>
<td>Laboratory classes: 5h</td>
</tr>
<tr>
<td>Self study : 15h</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Description:</th>
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<tbody>
<tr>
<td>- Control systems, description.</td>
</tr>
<tr>
<td>- Dynamic systems models.</td>
</tr>
<tr>
<td>- Feedback control.</td>
</tr>
</tbody>
</table>

Laboratory description:
- Identification of laboratory plant

**Related activities:**
- Master class, problems and lab.

**Specific objectives:**
- Description of control systems
- Creation of dynamic systems models
- Analysis of feedback control systems
### TOPIC 6: ANALYSIS AND DESIGN OF CONTROL SYSTEMS

**Description:**
- Precision analysis
- Stability analysis
- Velocity analysis
- Controller tunning

**Laboratory description:**
- Study of control system characteristics
- Controller tuning

**Related activities:**
- Master class, problems and lab

**Specific objectives:**
- Analyse the precision, stability and velocity of a control loop
- Controller tuning

**Learning time:** 25h
- Theory classes: 5h
- Laboratory classes: 5h
- Self study : 15h

### TOPIC 7: DISCREET CONTROL SYSTEMS

**Description:**
- Discrete models
- Discrete control laws

**Laboratory description:**
- Discrete control of the laboratory plant

**Related activities:**
- Master class, problems and lab

**Specific objectives:**
- Discrete models construction
- Discretized systems models
- Discrete controllers design

**Learning time:** 25h
- Theory classes: 5h
- Laboratory classes: 5h
- Self study : 15h
Qualification system

- 1st exam: 25%
- 1st lab exam: 15%
- Second exam: 25%
- 2nd lab exam: 15%
- Laboratory: 20%

For those students who meet the requirements and submit to the reevaluation examination, the grade of the reevaluation exam will replace the grades of all the on-site written evaluation acts (tests, midterm and final exams) and the grades obtained during the course for lab practices, works, projects and presentations will be kept. If the final grade after reevaluation is lower than 5.0, it will replace the initial one only if it is higher. If the final grade after reevaluation is greater or equal to 5.0, the final grade of the subject will be pass 5.0.

Bibliography

Basic:


Complementary:


Others resources: