320015 - CAI - Industrial Automation and Control

**Coordinating unit:** 205 - ESEIAAT - Terrassa School of Industrial, Aerospace and Audiovisual Engineering  
**Teaching unit:** 707 - ESAII - Department of Automatic Control  
710 - EEL - Department of Electronic Engineering  
709 - DEE - Department of Electrical Engineering  

**Academic year:** 2019  
**Degree:**  
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 TEXTILE TECHNOLOGY AND DESIGN 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 ELECTRICAL ENGINEERING (Syllabus 2009). (Teaching unit Compulsory)

**ECTS credits:** 6  
**Teaching languages:** Catalan, Spanish

### Teaching staff

**Coordinator:** MASIP ALVAREZ, ALBERT  
**Others:**  
AJENJO ESCOLANO, ENRIQUE JAVIER  
CAYERO BECERRA, JULEN  
DAMUNT MASIP, JORDI  
DELGADO PRIETO, MIGUEL  
FERNANDEZ SOBRINO, ANGEL  
LAVERNIA FERRER, DAVID  
LOPEZ GONZALEZ, ALEJANDRO ESTEBAN  
MASIP ALVAREZ, ALBERT  
QUEVEDO CASIN, JOSEBA-JOKIN  
ROMERAL MARTINEZ, JOSÉ LUIS  
ROMERO DURAN, DAVID  
ROMERO PEREZ, DANIEL  
ROTONDO, DAMIANO  
SOLA DE LAS FUENTES, GLORIA

### Opening hours

**Timetable:** It will be published during the lectures.

### Prior skills

It is recommended to have passed the following subjects:  
- Maths (I, II and III)  
- Physics  
- Electrical systems  
- Mechanical systems  
- Fundamentals of computer science  
for the proper understanding of the subject.

### Degree competences to which the subject contributes

**Specific:**
Establish the theoretical fundamentals of automatic control. Link the techniques in this discipline to others previously learnt (mathematics, physics, circuits). Solve automatic control problems that may go beyond what is strictly covered in theoretical sessions by working in teams, finding information and taking decisions.

Describe the structure and importance of systems that make possible the automation of manufacturing and production processes in industrial environments. Identify and apply the various types of components used in automation processes.

Use the tools and criteria to ensure that the most suitable components are selected. Establish the settings for programming programmable industrial systems and solve basic automation problems using the tools available.

**Transversal:**

06 URI N2. 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**

- In-class lecture sessions.
- In-class practical work sessions.
- Autonomous learning and exercises.
- Preparation and completion of group activities subject to assessment.

The lecturer will introduce the theoretical fundamentals of the subject, concepts, methods and results during the in-class lectures. Every concept will be illustrated with relevant examples to ease their understanding. Students will be expected to study in their own time so that they are familiar with concepts and are able to solve the exercises set.

**Learning objectives of the subject**

Establish the theoretical fundamentals of automatic control. Link the techniques in this discipline to others previously learnt (mathematics, physics, circuits). Solve automatic control problems that may go beyond what is strictly covered in theoretical sessions by working in teams, finding information and taking decisions.

Describe the structure and importance of systems that make possible the automation of manufacturing and production processes in industrial environments. Identify and apply the various types of components used in automation processes.

Use the tools and criteria to ensure that the most suitable components are selected. Establish the settings for programming programmable industrial systems and solve basic automation problems using the tools available.

**Study load**

<table>
<thead>
<tr>
<th><strong>Total learning time:</strong> 144h</th>
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</thead>
<tbody>
<tr>
<td>Hours large group:</td>
</tr>
<tr>
<td>30h</td>
</tr>
<tr>
<td>20.83%</td>
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<tr>
<td>Hours medium group:</td>
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<tr>
<td>0h</td>
</tr>
<tr>
<td>0.00%</td>
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<tr>
<td>Hours small group:</td>
</tr>
<tr>
<td>30h</td>
</tr>
<tr>
<td>20.83%</td>
</tr>
<tr>
<td>Guided activities:</td>
</tr>
<tr>
<td>0h</td>
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<tr>
<td>0.00%</td>
</tr>
<tr>
<td>Self study:</td>
</tr>
<tr>
<td>84h</td>
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<tr>
<td>58.33%</td>
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</tbody>
</table>
## Content

### TOPIC 1 on INDUSTRIAL CONTROL: MODELLING AND ANALYSIS OF DYNAMIC SYSTEMS

**Learning time:** 35h  
Theory classes: 7h  
Laboratory classes: 7h  
Self study: 21h

**Description:**  
1.1. Fundamental concepts in dynamic systems: systems, models, linearity, static behaviour, dynamic behaviour  
1.2. Modelling of continuous dynamic systems  
1.3. Definition of transfer function. Block diagrams  
1.4. Time response in linear systems

**Related activities:**  
Activity 1: Laboratory deliverables  
Activity 2: Individual assessment test

**Specific objectives:**  
For students to:  
- Understand and have a full command of the basic concepts of continuous control.  
- Understand and have a full command of modelling and simulation in continuous systems.  
- Outline and solve problems in the field of industrial automation and control.

### TOPIC 2 on INDUSTRIAL CONTROL: AUTOMATIC CONTROL

**Learning time:** 40h  
Theory classes: 8h  
Laboratory classes: 8h  
Self study: 24h

**Description:**  
2.1. Concepts of feedback. Robustness, stability, accuracy, ability to follow set-points  
2.2. PID control. Empirical tuning and analytical tuning  
2.3. Feedback loop instrumentation  
2.4. Control structures

**Specific objectives:**  
For students to:  
- Analyse dynamic systems and design control systems.  
- Outline and solve problems in the field of industrial automation and control.
<table>
<thead>
<tr>
<th>TOPIC 3 on AUTOMATION: INTRODUCTION TO INDUSTRIAL AUTOMATION</th>
<th>Learning time: 10h</th>
</tr>
</thead>
<tbody>
<tr>
<td>Description:</td>
<td>Theory classes: 2h</td>
</tr>
<tr>
<td>3.1. Concept of industrial automation</td>
<td>Laboratory classes: 2h</td>
</tr>
<tr>
<td>3.2. Continuous and discrete systems</td>
<td>Self study: 6h</td>
</tr>
<tr>
<td>3.3. Integrated production systems: CAD/CAM, CAE and CIM</td>
<td></td>
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<tr>
<td>3.4. General structure of an automated system</td>
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<tr>
<td>3.5. Examples of automated production systems</td>
<td></td>
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<tr>
<td>Related activities:</td>
<td></td>
</tr>
<tr>
<td>Activity 1: Laboratory practicals</td>
<td></td>
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<tr>
<td>Activity 2: Individual assessment test</td>
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<tr>
<td>Specific objectives:</td>
<td></td>
</tr>
<tr>
<td>For students to:</td>
<td></td>
</tr>
<tr>
<td>- Understand and have a full command of the basic concepts of automation.</td>
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<tr>
<td>- Identify the components used in automated processes.</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>TOPIC 4 on AUTOMATION: COMPONENTS OF AN AUTOMATED SYSTEM</th>
<th>Learning time: 25h</th>
</tr>
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<tbody>
<tr>
<td>Description:</td>
<td>Theory classes: 5h</td>
</tr>
<tr>
<td>4.1. Control devices</td>
<td>Laboratory classes: 5h</td>
</tr>
<tr>
<td>4.2. Sensors</td>
<td>Self study: 15h</td>
</tr>
<tr>
<td>4.3. Actuators</td>
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<tr>
<td>Related activities:</td>
<td></td>
</tr>
<tr>
<td>Activity 3: Laboratory practicals</td>
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<tr>
<td>Activity 4: Individual assessment test</td>
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<tr>
<td>Specific objectives:</td>
<td></td>
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<tr>
<td>For students to:</td>
<td></td>
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<tr>
<td>- Select and connect the peripherals used in automated processes.</td>
<td></td>
</tr>
<tr>
<td>- Select and connect the control devices used in automated processes.</td>
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</tbody>
</table>
### TOPIC 5 on AUTOMATION: PROGRAMMABLE CONTROLLERS

**Description:**
- 5.1. General structure. Scan cycles
- 5.2. Programming programmable controllers
- 5.3. Selection criteria of automation components

**Related activities:**
- Activity 3: Laboratory practicals
- Activity 4: Individual assessment test

**Specific objectives:**
For students to:
- Design and program automated industrial processes.

<table>
<thead>
<tr>
<th>Learning time: 28h</th>
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</thead>
<tbody>
<tr>
<td>Theory classes: 4h</td>
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<tr>
<td>Laboratory classes: 8h</td>
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<tr>
<td>Self study: 16h</td>
</tr>
</tbody>
</table>

### TOPIC 6 on AUTOMATION: DISTRIBUTED PROGRAMMABLE CONTROLLER SYSTEMS

**Description:**
- 6.1. Interconnection of components: Industrial communication networks
- 6.2. Monitoring and control systems
- 6.3. Remote control

**Related activities:**
- Activity 3: Laboratory practicals
- Activity 4: Individual assessment test

**Specific objectives:**
For students to:
- Gain an initial understanding of the distributed automated systems used in industrial communication networks and process monitoring systems.

<table>
<thead>
<tr>
<th>Learning time: 12h</th>
</tr>
</thead>
<tbody>
<tr>
<td>Theory classes: 4h</td>
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<tr>
<td>Self study: 8h</td>
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</tbody>
</table>
Planning of activities

**ENG ACTIVITAT 1: PRÀCTIQUES; ACTIVITATS DE LABORATORI DE CONTROL**
**Hours:** 15h
- Practical classes: 15h

**ENG ACTIVITAT 2: PROVA INDIVIDUAL D’AVALUACIÓ DE CONTROL**
**Hours:** 3h
- Theory classes: 3h

**ENG ACTIVITAT 3: PRÀCTIQUES DE LABORATORI D’AUTOMATITZACIÓ**
**Hours:** 15h
- Laboratory classes: 15h

**ENG ACTIVITAT 4: PROVA INDIVIDUAL D’AVALUACIÓ D’AUTOMATITZACIÓ**
**Hours:** 3h
- Theory classes: 3h

Qualification system

Oral and written exams (60%):
- Control, theoretical: 30%
- Automation, theoretical: 30%

Laboratory (30%):
- Control, laboratory: 15%
- Automation, laboratory: 15%

Generic competence "Effective use of information resources level 2" (10%):
- Questionnaires related to the training activity in the Campus Library of Terrassa: 5%
- Evaluable work linked to generic competence: 5%

In order to return the unsatisfactory results of the theoretical midterm exam you have the chance of doing, in the act of evaluation of the second exam, a final theoretical exam that includes the contents of the first and second parts of the subject. All the students can accede to this modality. The grade of this final theory exam corresponding to the issues of the first part will replace that obtained in the first part only if it is higher.

Whoever wants to opt for this mechanism of renewal can do it by previous enrollment in the Digital Campus of the subject until 48 hours before the date of the final examination. Laboratory practice notes are excluded from this re-engaging mechanism.

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.

Regulations for carrying out activities

Lab sessions, theoretical exams and generic competence work are all mandatory.
Bibliography

Basic:


Masip-Alvarez, Albert. Ingeniería de control. Terrassa: Universitat Politècnica de Catalunya. Departament d'Enginyeria de Sistemes, Automàtica i Informàtica Industrial,