Course guide
320015 - CAI - Industrial Automation and Control

Last modified: 19/04/2023

Unit in charge: 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.

Degree: BACHELOR'S DEGREE IN CHEMICAL ENGINEERING (Syllabus 2009). (Compulsory subject).
BACHELOR'S DEGREE IN ELECTRICAL ENGINEERING (Syllabus 2009). (Compulsory subject).
BACHELOR'S DEGREE IN INDUSTRIAL ELECTRONICS AND AUTOMATIC CONTROL ENGINEERING (Syllabus 2009). (Compulsory subject).
BACHELOR'S DEGREE IN MECHANICAL ENGINEERING (Syllabus 2009). (Compulsory subject).
BACHELOR'S DEGREE IN TEXTILE TECHNOLOGY AND DESIGN ENGINEERING (Syllabus 2009). (Compulsory subject).

Academic year: 2023 **ECTS Credits:** 6.0 **Languages:** Catalan, Spanish

LECTURER

Coordinating lecturer: MASIP ALVAREZ, ALBERT

Others: David Lavèrnia Ferrer
Miquel A. Cugueró
Enrique Ajenjo Escolano
Julen Cayero Becerra
Albert Masip-Alvarez
Joan Valls Pérez
David Urbano Bravo
Lorenzo Marín Merchán
David Romero Durán
Jonathan Achcaoucaou Carbó
Daniel Romero Pérez

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:
CE12-INDUS. Knowledge of the basics of automation and control methods. (Common module in the industrial branch)

Generical:
CG04-INDUS. Ability to solve problems with initiative, decision-making, creativity, critical reasoning, and to communicate and transmit knowledge, skills, and abilities in the field of Industrial Engineering.

Transversal:
CT05 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

Type	Hours	Percentage
Hours small group	30,0	20.00
Hours large group	30,0	20.00
Self study	90,0	60.00

Total learning time: 150 h

CONTENTS

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

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

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.

Related activities:
Activity 1: Laboratory deliverables
Activity 2: Individual assessment test on problems based on theory sessions
Activity 3: Individual assessment test on problems based on laboratory sessions

Full-or-part-time: 35h
Theory classes: 7h
Laboratory classes: 7h
Self study : 21h

TOPIC 2 on INDUSTRIAL CONTROL: AUTOMATIC CONTROL

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.

Related activities:
Activity 1: Laboratory deliverables
Activity 2: Individual assessment test on problems based on theory sessions
Activity 3: Individual assessment test on problems based on laboratory sessions

Full-or-part-time: 40h
Theory classes: 8h
Laboratory classes: 8h
Self study : 24h

TOPIC 3 on AUTOMATION: INTRODUCTION TO INDUSTRIAL AUTOMATION

Description:
3.1. Concept of industrial automation
3.2. Continuous and discrete systems
3.3. Integrated production systems: CAD/CAM, CAE and CIM
3.4. General structure of an automated system
3.5. Examples of automated production systems

Specific objectives:
For students to:
- Understand and have a full command of the basic concepts of automation.
- Identify the components used in automated processes.

Related activities:
Activity 1: Laboratory practicals
Activity 2: Individual assessment test

Full-or-part-time: 10h
Theory classes: 2h
Laboratory classes: 2h
Self study : 6h

TOPIC 4 on AUTOMATION: COMPONENTS OF AN AUTOMATED SYSTEM

Description:
4.1. Control devices
4.2. Sensors
4.3. Actuators

Specific objectives:
- Select and connect the peripherals used in automated processes.
- Select and connect the control devices used in automated processes.

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

Full-or-part-time: 25h
Theory classes: 5h
Laboratory classes: 5h
Self study : 15h

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

Specific objectives:
- Design and programming of automated industrial processes.

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

Full-or-part-time: 30h
Theory classes: 4h
Laboratory classes: 8h
Self study : 18h

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

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

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

Full-or-part-time: 10h
Theory classes: 4h
Self study : 6h

ACTIVITIES

LABORATORY WORK ON AUTOMATIC CONTROL

Description:
Control laboratory practice; the student, at the end of the laboratory work, must be able to design and carry out, using classical techniques, a PID monovariable analog regulator to control a dynamic system by means a closed loop strategy (feedback).
The activities are:
- Basic concepts of Automatic Control
- Identification of dynamic systems
- Feedback in dynamic systems
- Effects of P, I and D control actions
- PID tuning

Specific objectives:
- Understanding and mastering the basic concepts of continuous control.
- Understanding and mastering the concepts of modeling and simulation of continuous systems.
- Train the student for the synthesis and resolution of problems in the field of industrial control.

Material:
Laboratory Practice Statements

Delivery:
Laboratory work reports

Full-or-part-time: 15h
Practical classes: 15h

INDIVIDUAL EXAM ON AUTOMATIC CONTROL

Description:
Written test of the subject

Specific objectives:
- Understanding and mastering the basic concepts of continuous control.
- Understanding and mastering the concepts of modeling and simulation of continuous systems.
- Train the student for the synthesis and resolution of industrial control problems.

Material:
Exam statement

Delivery:
Answered exam

Full-or-part-time: 3h
Theory classes: 3h

AUTOMATION LABORATORY PRACTICE

Description:
Industrial automation practice

Specific objectives:
Understanding and mastering the basic concepts of automation.
Identification of the elements involved in an automated process.
Train the student for the selection and connection of the peripherals involved in an automated process.
Train the student to select and connect the command teams involved in an automated process.
Design and programming of automated industrial processes.

Material:
Automation laboratory practice statements

Delivery:
Laboratory reports

Full-or-part-time: 15h
Laboratory classes: 15h

INDIVIDUAL EXAM ON AUTOMATION

Description:
Written exam on automation

Specific objectives:
Understanding and mastering the basic concepts of automation.
Identification of the elements involved in an automated process.
Train the student for the selection and connection of the peripherals involved in an automated process.
Train the student to select and connect the command teams involved in an automated process.
Design and programming of automated industrial processes.

Material:
Exam statement

Delivery:
Answered exam

Full-or-part-time: 3h
Theory classes: 3h

GRADING SYSTEM

+ Individual exams (70%):
- Control (midterm exam): 35%
- Automation (final exam): 35%
+ Laboratory (20%):
- Control laboratory: 10% lab reports
- Automation laboratory: 10% lab reports
+ Generic competence "Effective use of information resources level 2" (10%)
- Individual training activity by the Terrassa Campus Library.

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.

EXAMINATION RULES.

Lab sessions 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,
- Dorf, Richard C. Sistemas modernos de control. 2ª ed. Argentina: Addison-Wesley Iberoamericana, 1989. ISBN 0201644177.
- Ogata, Katsuhiko. Ingeniería de control moderna [on line]. 5ª ed. Madrid: Pearson Educación, 2010 [Consultation: 09/05/2022]. Available on: https://www-ingebook-com.recursos.biblioteca.upc.edu/ib/NPcd/IB_BooksVis?cod_primaria=1000187&codigo_libro=1259. ISBN 9788483229552.
- Aström, Karl; Murray, Richard M. Feedback systems: an introduction for scientists and engineers. Princeton: Princeton University Press, 2008. ISBN 9780691135762.
- Goodwin, G.; Graebe, S. F.; Salgado, M. Control system design. Upper Saddle River, N.J: Prentice-Hall, 2001. ISBN 0139586539.
- Piedrafita, R. Ingeniería de la automatización industrial. Madrid: Ra-ma, 1999. ISBN 8478973842.
- Mandado Pérez, Enrique [et al.]. Autómatas programables: entorno y aplicaciones. Madrid: International Thomson Paraninfo, 2005. ISBN 8497323289.
- Bryan, L. A.; Bryan, E. A. Programmable controllers: theory and implementation. 2nd ed. Atlanta: Industrial Text, 1997. ISBN 094410732X.
- Stallings, William. Comunicaciones y redes de computadores [on line]. 7ª ed. Madrid: Pearson Educación, 2004 [Consultation: 09/05/2022]. Available on: https://www-ingebook-com.recursos.biblioteca.upc.edu/ib/NPcd/IB_BooksVis?cod_primaria=1000187&codigo_libro=1245. ISBN 8420541109.
- Groover, Mikell P. Automation, production systems and computer-integrated manufacturing. 3rd ed. Upper Saddle River, NJ: Prentice-Hall, 2008. ISBN 9780132070737.