Universidad Zaragoza

Academic Year/course: 2022/23

30127 - Automatic Systems

Syllabus Information

Academic Year: 2022/23
Subject: 30127 - Automatic Systems
Faculty / School: 175 - Escuela Universitaria Politécnica de La Almunia
179 - Centro Universitario de la Defensa - Zaragoza
Degree: 425 - Bachelor's Degree in Industrial Organisational Engineering
563 - Bachelor's Degree in Industrial Organisational Engineering
ECTS: 6.0
Year: 3
Semester: First semester
Subject Type: Compulsory
Module:

1. General information

1.1. Aims of the course

The course and its expected results respond to the following approaches and objectives:

- To assimilate the representation of systems by means of transfer functions, block diagrams and their rules of operation.
- Assimilate the structure of the classic control loop.
- Understand the function of the controller, actuators and sensors.
- Deepen the analysis and characterization of system response in the time domain.
- Assimilate and understand the analysis and characterization of systems in the frequency domain.
- Describe the relationship between proportional, integral and derivative actions and the steady and transient response of a process.
- Understand and assimilate the technique of designing controllers in the time domain by the methods of pole cancellation and root locus.
- Know the types of control loops, self-tuning techniques and auxiliary functions available in industrial regulators.
- Assimilate and understand the different constructive forms or architectures of programmable logic controllers.
- Initiation to the programming of PLCs.
- Assimilate and understand the process of modelling discrete event systems using Petri networks.
- Acquire the skills to design control and regulation systems.
- Acquire the skills to use programmable controllers in the control of continuous processes.
- Acquire the skills to model and program discrete event systems.

Specialization in Defence: These approaches and objectives are in line with the following Sustainable Development Goals (SDGs) of the United Nations 2030 Agenda (https://www.un.org/sustainabledevelopment/), in such a way that the acquisition of the course learning outcomes provides training and competence to contribute to their achievement to some degree.

- Objective 9: Industry, innovation and infrastructure.

Specialization in Business: These approaches and objectives are aligned with the following Sustainable Development Goals (SDGs) of the United Nations 2030 agenda (https://www.un.org/sustainabledevelopment/es/), in such a way that the acquisition of the learning results of the Subject provides training and competence to contribute to some extent to its achievement:

Goal 7: Ensure access to affordable, reliable, sustainable and modern energy.

Specific goal:

7.3 By 2030, double the global rate of improvement in energy efficiency.

1.2. Context and importance of this course in the degree

This course is part of the basic training module for the acquisition of the knowledge on the fundamentals of automation and control methods.

Specialization in Defence: This subject contributes to the training of the Army Officers, developing the technical knowledge in automatisms and control methods that the Army Officers need to perform their duties.

1.3. Recommendations to take this course

Although not a mandatory requirement, for pedagogical reasons it is advisable to have successfully passed the subjects of Mathematics (30100, 30106, 30111) and Physics (30101, 30107). Having studied these subjects, the student will possess the necessary basic knowledge and tools to follow the course without difficulty.

Diligence, by means of continuous study, is fundamental to successfully pass the course. Students are encouraged to resolve any doubts that arise as soon as possible. Since the course builds incrementally on the explained topics, the lack of comprehension of some subject may hinder the student's ability to assimilate later ideas.

2. Learning goals

2.1. Competences

On passing the subject, the student will have acquired the following competences:

- C04 - Ability to solve problems and take decisions with initiative, creativity and critical reasoning.
- C07 ? Ability to use techniques, skills and tools necessary to practise engineering.
- C33 - Knowledge about the fundamentals of automatic responses and methods of control.

2.2. Learning goals

In order to pass this subject, students must demonstrate the following results:

- Identifies the relevant subsystems and their interconnections to automate the overall system operation.
- Selects the most appropriate modelling, analysis and design techniques according to the control requirements.
- Applies the techniques and methods for the design of the control system complying with the performance specifications.

2.3. Importance of learning goals

The knowledge acquired by students in Automatic Systems initiates them in the control and automation of a large number of industrial activities. A large part of these tasks or processes fall into two main groups:

- Knowledge about continuous systems allows them to tackle tasks such as motor speed control, position of mechanisms, temperature control, torque control, flow control...
- The knowledge about discrete event systems allows them to tackle tasks such as the control of manufacturing operations, assembly lines, maintenance, storage...

Nowadays, a high degree of automation has been reached in these processes. This is achieved by means of regulators, industrial computers, programmable logical controllers, robots...

The learning results of this course provide students with the ability to analyze and control real systems comprising actuators and industrial processes, and enable them to propose control schemes and calculate the appropriate control parameters to meet given operating requirements. These results, and the capacities and skills derived from them, are of great importance in technological and industrial environments, where the control of processes and systems is a key and fundamental piece for the development of the product, enabling costs reductions, both economic and environmental, and increasing the final quality of the product.

3. Assessment (1st and 2nd call)

3.1. Assessment tasks (description of tasks, marking system and assessment criteria)

SPECIALIZATION IN BUSINESS

The elements and detailed evaluation criteria for the business specialization profile are:

1. Continuous evaluation:

- Planned practical work (all of them to be completed).
- Theory-practice tests 80%.
- Proposed individual works 20%.
- At least 80% of the live activities (laboratories, technical visits, classes, etc.) must be attended.

2. Final global test:

- Final theory / practical test: 100 %.

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The evaluation instruments will be the following:

First call

Continuous assessment

The students will be able to pass the total of the subject by the continuous assessment procedure. To do this, they must demonstrate that they have achieved the expected learning outcomes by passing the assessment instruments indicated below, which will be carried out throughout the semester:

1. Laboratory practices and individual work: the students' ability to model and control simulated automatic systems or mock-ups and the ability to interact with the computer to carry out such tasks will be evaluated. At least three practical sessions will be scheduled. Its weight in the final grade is 30%.

2. Theory-practice test 1: it will consist of theoretical questions and exercises on the topics of modeling and analysis. Its weight in the final grade is 20%.

3. Theory-practice test 2: will consist of theoretical questions and exercises on the topics of root locus and control based on this technique. Its weight in the final grade is 30%.

4. Theory-practice test 3: will consist of theoretical questions and exercises on the topics of analysis and control by means of frequency methods. Its weight in the final grade is 20%.

The final grade of continuous assessment (100%) will be calculated according to the specific weight of each continuous evaluation test. To pass the subject, the student must obtain a final grade greater than or equal to 5.

Global exam

Students who do not pass the subject by continuous evaluation or who would like to improve their grade, will have the right to sit for the Global exam set in the academic calendar, prevailing, in any case, the best of the grades obtained. This global test will be equivalent to the continuous evaluation tests described above and will have a weight of 100% in the final grade.

It will consist of a theory-practice test with theoretical questions and exercises on all the topics covered throughout the course. In order to pass the course, the student must obtain a final grade higher or equal to 5.

Second Call

Global exam

Students who do not pass the course in the first call may sit for an overall test set in the academic calendar for the second call. This global test will consist of a theory-practice test with theoretical questions and exercises on all the topics covered throughout the course. In order to pass the course, the student must obtain a final grade higher or equal to 5.

4. Methodology, learning tasks, syllabus and resources

4.1. Methodological overview

If classroom teaching were not possible due to health reasons, it would be carried out on-line.

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The learning process designed for this subject is based on the following:

- Lectures: Theoretical activities imparted in a fundamentally expository way by the teacher, in such a way as to expose the theoretical supports of the subject, highlighting the fundamental content, structuring it in themes and relating those themes to each other.
- Practice Sessions: The teacher explains and helps in understanding the use and management of necessary software for configuring and programming control devices (PLC?s)
- Laboratory practices: Students will perform tests, measurements, assemblies, etc. in the laboratories arranged in groups, following a script provided by the teacher.
- Individual tutorials: They will be carried out in the department through personalized attention to the student, with the goal of solving the doubts and difficulties the student faces. These tutorials can be carried out either face-to-face or virtually.

The approach, methodology and assessment of this guide are intended to be the same for any teaching scenarios. They will be adapted to the social-health situation at any particular time, as well as tothe instructions given by the authorities concerned.

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The methodology followed in this course is oriented towards the achievement of the learning objectives. It is based on structured reasoning, mathematical methods and active engagement that favor the development/acquisition of the ability to solve problems and take decisions with initiative, creativity and critical reasoning; the ability to use techniques, skills and

tools necessary to practise engineering; and the knowledge about the fundamentals of automatic responses and methods of control.

A wide range of teaching and learning tasks are implemented, such as master classes, laboratory sessions, interactive exercise resolution, personal study.

Students are expected to participate actively in the class throughout the semester.

Classroom materials will be available via Moodle. These include a repository of the lecture notes used in class, the course syllabus, as well as other course-specific learning materials, including a discussion forum.

Further information regarding the course will be provided on the first day of class.

The approach, methodology and assessment of this course is prepared to be equivalent in any teaching scenario. It will be adjusted to the socio-sanitary conditions of each moment, as well as to the indications given by the competent authorities.

4.2. Learning tasks

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The course consists of 6 ECTS credits, which represent 150 hours of student?s work during the semester, which would equal to 10 hours every week during the 15 weeks the semester lasts.

The degree of experimentation is deemed high.

The student?s activities in this semester, organised by duration are as follows:

- 25 hours of master classes (theoretical teaching and problem solving)
- 25 hours of laboratory practice, arranged in 2-hour sessions
- 10 hours of tests (written and practical)
- 90 hours of personal studying

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This is a 6 ECTS course organized as follows:

- Master classes (2 ECTS: 44 hours): Theoretical concepts with examples based on real systems; exercises solved in the classroom to help in the assimilation of the theoretical concepts.
- Laboratory sessions (0.25 ECTS: 6 hours): Practical modeling, analysis and control of real systems simulated in a computer.
- Exams and tests (0.25 ECTS: 6 hours).
- Personal study (3.5 ECTS: 90 hours).

4.3. Syllabus

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Theoretical contents

1.- Automatic control systems

- Introduction
- Control systems
- Transfer function. Laplace transform.
    - Poles and zeros
    - Control system stability
    - Control system order
- Regulators
    - (P, I, D, PID, All or Nothing)

2.- Elements of a control system

- Transducers
- Comparators
- Regulators and controllers
- Actuators
    - Servomotors, stepper motors.

3.- PLC architecture

- RAM, ROM, ALU, PSW.
- Digital I/O
- PAE and PAA
- Marks
- Scan cycle

4.- PLC configuring and programming

- Timers and counters
- Flanks
- Comparing and jumps
- Functions

5.- Industrial communications

- Industrial buses. (Profibus, Profinet).

Practical contents

1.- Process control (discrete)

- Industrial processes simulation models
- Flexible cell control

2.- Frequency variable

- Configuring and programming

Three phase asynchronous engine speed control

SPECIALIZATION DEFENCE

Section 1: Systems modeling

Topic 0: Introduction of the subject.

Topic 1: Introduction to Automatic Systems.

- Introduction.
- Definitions and terminology.

Topic 2: Preliminary concepts.

- Complex numbers.
- Laplace Transform.

Topic 3: Modeling of mechanical and electrical systems.

- Translational systems.
- Rotational systems.
- Electrical systems.
- Electrical-mechanical systems: DC motor.
- Transfer function.
- Block diagrams.
- Equivalences and simplification of block diagrams.

Section 2: Analysis of continuous time systems

Topic 4: Model and dynamic response of 1st and 2nd order systems, higher order.

- Elements that influence output behavior.
- Standard inputs.
- Step response of 1st order systems.
- Step response of 2nd order systems.
- Step response of higher order systems.
- Influence of zeros on the output behavior.
- Systems stability.
- System stability analysis through Routh criterion.

Topic 5: Analysis of requisites.

- Analysis of control requisites in the complex plane.
- Feedback systems.
- Steady state error in feedback systems.
- Perturbations.

Section 3: Systems control techniques

Topic 6: Analysis through root locus techniques (RL).

- Definition of root locus.
- Phase and magnitude conditions.
- RL approximation through basic rules.
- Analysis of feedback systems through RL.

Topic 7: Controller design through RL.

- Transient state control.
- Steady state control.
- PID.

Topic 8: Frequency response analysis through Bode diagrams.

- Frequency response of linear systems.
- Representation of the transfer functions using phasors: phase and magnitude.
- Frequency response graphical representation.
- Asymptotic Bode diagrams.

Topic 9: Controllers design using Bode diagrams.

- Analysis of the requisites from the frequency viewpoint.
- Steady and transient states control.

Section 4: Discrete-time systems

Topic 10: Logical sequential and concurrent systems.

- Logical automatism: definition.
- PLC controllers.
- Modeling of DTS using Petri nets.

4.4. Course planning and calendar

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The schedule for the realization of both the masterclasses and the practices will be established by the center at the beginning of each course. (This schedule will be published in the center?s website).

The rest of the activities (Practices handing-in, an evaluation test, etc?.) will be planned according to the necessary groups and will be communicated to the students in advance at the beginning of the course.

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Personal work tasks and deadlines will be advertised during lectures and through the online Moodle platform: http://moodle.unizar.es

Calendar activities and schedule of lectures will be published in the CUD webpage: http://cud.unizar.es.

4.5. Bibliography and recommended resources

http://psfunizar10.unizar.es/br13/egAsignaturas.php?codigo=30127