Universidad Zaragoza

Year : 2019/20

30127 - Automatic Systems

Syllabus Information

Academic Year: 2019/20
Subject: 30127 - Automatic Systems
Faculty / School: 175 - Escuela Universitaria Politécnica de La Almunia
179 - Centro Universitario de la Defensa - Zaragoza
Degree: 457 - Bachelor's Degree in Industrial Organisational Engineering
563 - Bachelor's Degree in Industrial Organisational Engineering
425 - 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.

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.

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:

- They know how to formally model basic electrical and mechanical systems.
- They know the properties of feedback loops and basic control actions.
- They know and are able to apply control design techniques for single-variable continuous systems in the temporal and frequency domains.
- They know and are able to select basic control schemes.
- They know how to design logical automata based on finite-state machines and Petri networks, as well as how to implement them in programmable controllers.

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 test: 30 %.
- Final practical test: 70 %.

SPECIALIZATION IN DEFENSE

The elements and criteria of evaluation that apply for the defense specialization profile are:

- Laboratory practices. The ability to model and control simulated systems or mock-ups and the ability to interact with the computer to carry out these tasks will be evaluated.
- Theory-practice test. It will consist of theory questions and exercises on the topics seen during the course.

The weight of the laboratory practices will be between 15% and 30% (depending on the number of laboratory sessions carried out), so the theory-practice test will weigh between 85% and 70%.

Is a requirement to pass the course to obtain a minimum grade of 5 out of 10 points in each of the two parts. If the laboratory practices are not passed, students will have an exam to be taken together with the final theoretical-practical test.

4.Methodology, learning tasks, syllabus and resources

4.1.Methodological overview

SPECIALIZATION IN BUSINESS

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.

SPECIALIZATION DEFENCE

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

- Presentation of the course contents in masterclasses. During the lectures, the professor will often refer to real-world examples related to the concept being introduced, both from the civilian and military contexts.
- Resolution of problems and exercises with the involvement of the students.
- Laboratory sessions guided by professors using simulation tools with the goal of gaining insight into the theoretical contents.
- Personal study of the subject by students.

It is important to take into account that the course has both theoretical and practical goals. Therefore, the learning process emphasizes student participation in lectures, problem-solving and conducting laboratory sessions.

4.2.Learning tasks

SPECIALIZATION IN BUSINESS

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

SPECIALIZATION DEFENSE

The master classes are organized as:

- Theory: Theoretical concepts are introduced with examples based on real systems related with the future work destinations of the students. Also, exercises will be solved in the classroom to help in the assimilation of the theoretical concepts.
- Laboratory: Practical modeling, analysis and control of real systems simulated in a computer.

The subject consists of 6 ECTS credits that correspond to 150 hours of students' work.

The work is distributed as follows:

- 47-49h of master classes (theory and exercises)
- 6-8h of laboratory sessions (2h each)
- 5h of exams and tests
- 90h of students' personal study

Before the beginning of the semester, the professors will provide to the students the schedule of the activities using the Moodle platform. This can be consulted at http://moodle.unizar.es, authenticating with their username and password.

There, students will find the detailed course program, teaching documents and recommended bibliography in addition to suggestions to follow it.

Additionally, it is possible to find information such as the classes calendar and hours on the web page of the Centro Universitario de la Defensa: http://cud.unizar.es.

4.3.Syllabus

SPECIALIZATION IN BUSINESS

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 phasse asynchronous engine speed control

SPECIALIZATION DEFENCE

Unit 1: Systems modeling

Theme 0: Introduction of the subject.

Theme 1: Introduction to Automatic Systems.

- Introduction.
- Definitions and terminology.

Theme 2: Preliminary concepts.

- Complex numbers.
- Laplace Transform.

Theme 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.

Unit 2: Analysis of continuous time systems

Theme 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.

Theme 5: Feedback systems analysis.

- Feedback systems.
- Steady state error in feedback systems.
- Perturbations.

Unit 3: Systems control techniques

Theme 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.

Theme 7: Controller design through RL.

- Analysis of control requisites in the complex plane.
- Transient state control.
- Steady state control.
- PID.

Theme 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.

Theme 9: Controllers design using Bode diagrams.

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

Unit 4: Discrete-time systems

Theme 10: Logical sequential and concurrent systems.

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

4.4.Course planning and calendar

SPECIALIZATION IN BUSINESS

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.

SPECIALIZATION DEFENCE

Personal work tasks and deadlines will be advertised during lectures or 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://biblos.unizar.es/br/br_citas.php?codigo=30127&year=2019