28823 - Automatic Regulation and Control

Información del Plan Docente

Academic Year	2016/17
Academic center	175 - Escuela Universitaria Politécnica de La Almunia
Degree	424 - Bachelor's Degree in Mechatronic Engineering
ECTS	6.0
Course	3
Period	First semester
Subject Type	Compulsory
Module	---

1.Basic info

1.1.Recommendations to take this course

In order to be successful in this subject the student must pass the following subjects: Automatic foundation, Math I, II & III, Mechanical engineering, Electrical engineering, and its recommended to have Physics I, Physics II and Informatics.

1.2.Activities and key dates for the course

The activities of this subject and its temporal schedule depend on the academic organization proposed by the faculty in EUPLA and you can read it in section 5, activities and resources.

In the www.eupla.unizar.es you can check the exams dates.

2.Initiation

2.1.Learning outcomes that define the subject

The student in order to pass the subjects must demonstrate the following results:

1. **1.** He needs to understand the automation fundaments and industrial control.
2. **2.** He needs to have a good command of modeling tools, analysis and design of control systems and automation.

Get some basis in industrial communications.

2.2.Introduction

Brief introduction to the subject

The Automatic Regulation and Control is a compulsory subject with six ECTS credits that is lectured in the first four-month period in the third year of the Mechatronics degree and forms part of the topic Automatic Control. This subject develops the design and analysis of digital controllers taking on account the different variables that form part of a process. In order to realize this design process, we started in the classical systems theory learned in Automatic Foundations and go beyond that to obtain specific techniques used in these systems.

28823 - Automatic Regulation and Control

Every lesson of this subject shows the theoretical background that is supplemented with practical exercises and simulation studies. Therefore, students work in the class and have some homework in order to get the main role of their learning process.

3.Context and competences

3.1.Goals

The expected result of the subject responds to the following goals

The Automatic Regulation and Control is the second subject in the Mechatronics degree that studies the fundaments of the control techniques. Therefore, the student may improve its scientific and technological foundations in systems automation, modelling, simulation and control.

This subject forms part of the topic Automatic Control and it requires from others competencies in subjects of the previous courses. The student must rule the theory of analog automatic systems, calculus of the complex variable, Laplace transform, Z transforms, differential equations, algebra, physic and mechanic.

This subject finalizes the basis of regulation and control theory, the students find in the upper courses some subjects that let extend their knowledge in control systems, like robotics or advanced control techniques.

3.2.Context and meaning of the subject in the degree

The Automatic Regulation and Control is a subject that forms part of the Mechatronics Engineering Degree which is imparted in EUPLA, the subjects are englobed inside the Control module. This compulsory subject of six ECTS credits is lectured in the first four-month of the third year.

This subject has an extraordinaire importance in the acquisition of the competences of the degree. Moreover, it gives additional useful skills for the Mechatronics Engineering work in industrial control.

It's important that students have strong knowledge in math, physic, mechanic, circuit theory and analog automatic systems. This subject is the fundament for automatization and industrial informatics, robotics, advanced automatization and control engineering, those subjects are essentials in the Mechatronics Engineering Degree.

3.3.Competences

The student must be able to...

General competencies:

1. Have the knowledge in basics subjects and technologies that make the students capable learning new methods and theories and give their necessary versatility in order to adopt new sceneries.
2. Have the ability to solve problems with initiative, take decisions, creativity, critical reasoning and communicate and transmit knowledge, abilities and skills in the field of Industrial Engineering and especially in Industrial Electronic
3. Have the ability to handle specifications, regulations, and compulsory norms.
4. Interpret experimental dates, contrast them with theoretical foundations and extract conclusions.
5. Have the capability in abstract and logical thinking
6. Have the capability to learn in a continuous way, self-directed and autonomous.
7. Be capable evaluating the alternatives.

8. Have the ability in adaptation to the fast evolution of technology.
9. Be capable leading a team and be a committed member of the team.
10. Have the ability to find technical information, understand it and value it.
11. Have a positive attitude to technological innovation.
12. Have the ability to write technical documentation and represent it with informatics tools.
13. Be capable communicating their thinking and designs in an easy way to specialized and nonspecialized audiences.
14. Have the ability to understand the operation and develop maintenance of devices in mechanical, electrical and electronics installations.
15. Be capable analyzing and put on simplified models to the devices and technological applications that allow making provisions about their behavior.
16. Have the ability to configure, simulate, build and test the prototypes of electronics and mechanical systems.
17. Be capable in the right interpretation of plans and technical documentation.

Specific competences:

1. Have the knowledge about the fundaments of automatic and control methodology.
2. Have the knowledge and the capability to the model and simulation of electronic systems.
3. Have the applied knowledge of industrial informatics and communications.
4. Have the ability to design control systems and industrial automation systems.
5. Have the knowledge of automatic regulation and control techniques and their application to the industrial automation.

3.4.Importance of learning outcomes

This subject has a strong engineering character. It offers an important quantity of contents that are very useful to the market labor and professional market. When the student reaches the learning outcomes he obtains the necessaire capability to understand the control systems, which are essential to the design and setup of each application, working plant, industrial process, etc. included in the Mechatronic Engineering field.

In addition, this subject gives the fundaments in developing of future subjects in the field of control.

4.Evaluation

The student must demonstrate that he has reached the expected learning results with the next evaluation activities:

1. Practical work (30%). These Works included laboratory workshop and problem-solving. In the laboratory workshop, the student must make a pervious study that must give before the beginning of the practice. The final mark is based on the quality of the analysis and the obtained results given in a written document. In order to pass the subject, the student must have a mark of at least five points.
2. Written test (70%), the student can find some questions or need to solve an engineering problem like the ones resolved in the theoretical lessons. We value the quality and clarity of the provided solution, the used concepts, the absence of errors in developing and solution, and the right use of the terminology and notation. In order to pass the subject, the student must have a mark of at least five points in each test.

The student may choose between continuous evaluation or global evaluation. The continuous evaluation consists of two write test plus written essays in laboratory workshop. The global evaluation consists of a written test at the end of the course and the written essays in laboratory workshop.

The student that suspends any part of the continuous evaluation can pass it in the global test.

5.Activities and resources

5.1.General methodological presentation

28823 - Automatic Regulation and Control

There are a strong interaction between teacher and student. This interaction is brought into being through a division of work and responsibilities between the students and the teacher. Nevertheless, it must be taken into account that, to a certain degree, students can set their learning pace based on their own needs and availability, following the guidelines set by the teacher.

The current subject Automatic Foundation is conceived as a stand-alone combination of contents, yet organized into three fundamental and complementary forms, which are: the theoretical concepts of each teaching unit, the solving of problems or resolution of questions and laboratory work, at the same time supported by other activities

The organization of teaching will be carried out using the following steps:

- **Theory Classes** : Theoretical activities carried out mainly through exposition by the teacher, where the theoretical supports of the subject are displayed, highlighting the fundamental, structuring them in topics and or sections, interrelating them.
- **Practical Classes** : The teacher resolves practical problems or cases for demonstrative purposes. This type of teaching complements the theory shown in the lectures with practical aspects.
- **Laboratory Workshop** : The lecture group is divided up into various groups, according to the number of registered students, but never with more than 20 students, in order to make up smaller sized groups.
- **Individual Tutorials** : Those carried out giving individual, personalized attention with a teacher from the department. Said tutorials may be in person or online.

5.2.Learning activities

Involves the active participation of the student, in a way that the results achieved in the learning process are developed, not taking away from those already set out, the activities are the following:

— **Face-to-face generic activities** :

● **Theory Classes** : The theoretical concepts of the subject are explained and illustrative examples are developed as support to the theory when necessary.

● **Practical Classes** : Problems and practical cases are carried out, complementary to the theoretical concepts studied.

● **Laboratory Workshop** : This work is tutored by a teacher, in groups of no more than 20 students.

— **Generic non-class activities** :

● Study and understanding of the theory taught in the lectures.

● Understanding and assimilation of the problems and practical cases solved in the practical classes.

● Preparation of seminars, solutions to proposed problems, etc.

● Preparation of laboratory workshops, preparation of summaries and reports.

28823 - Automatic Regulation and Control

● Preparation of the written tests for continuous assessment and final exams.

The subject has 6 ECTS credits, which represents 150 hours of student work in the subject during the trimester, in other words, 10 hours per week for 15 weeks of class.

A summary of a weekly timetable guide can be seen in the following table. These figures are obtained from the subject file in the Accreditation Report of the degree, taking into account the level of experimentation considered for the said subject is moderate.

Activity	Hours per week
Lectures	3
Laboratory workshop	1
Other activities	6

Nevertheless the previous table can be shown into greater detail, taking into account the following overall distribution:

— 44 hours of lectures, with 50% theoretical demonstration and 50% solving type problems.

— 12 hours of laboratory workshop, in 1 or 2 hour sessions.

— 4 hours of written assessment tests, one hour per test.

— 40 hours of teamwork divided up over the 15 weeks of the semester.

— 50 hours of personal study, divided up over the 15 weeks of the semester.

5.3.Program

The theoretical program .

1. Introduction to the digital control systems	-The computer as a control device

28823 - Automatic Regulation and Control

	-Advantage and disadvantage of the computer control systems -Functions in a control computer -Schema control by computer
1. Sequences	-Sequences and discrete systems -Stability in discrete systems -Frequency representation of a discrete system -Fourier Transform of a sequence -Laplace Transform of a sequence
1. Z-transform	-Z transform definition -Convergence analysis -Z-transform properties -Z inverse transform
1. Discrete systems	-Transfer function in Z domain -Graphical representation of discrete systems -Signal sampling -Sampling theorem -Block systems • Ideal • Limited band • Causals • Order zero • Order one • Superior orders
1. Sampling systems	

28823 - Automatic Regulation and Control

	-Introduction. -Discrete representation of the continuous system. -Z modified transform -Loop closed systems. -Multivariant systems. -Stability
1. Dynamic analysis of the discrete systems	-Response to the unitary impulse -Influence of the real poles -Influence of the complex poles -Response to the unitary step -Equivalent reduced system -First order systems -Second order systems
1. Design of discrete regulators	-Classical design and fast sampling -Dominant poles method -Solved exercises

Laboratory workshop

1. Design of digital filters
2. Digital sensors
3. PID discrete controllers
4. The design of digital control systems.

Materials

28823 - Automatic Regulation and Control

Material	Soporte
Topic theory notes Topic problems	Paper/repository
Topic theory notes Topic presentations Topic problems Related links	Digital/Moodle E-Mail
Educational software	Web page

5.4.Planning and scheduling

Class hall sessions & work presentations timetable

Activity	Week															Hours
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	P
Topic 1	4															4
Topic 2		3	3	3												9
Topic 3					3	3										6
Topic 4							3	3								6
Topic 5									2	3						5
Topic											3	3				6

28823 - Automatic Regulation and Control

6																
Topic 7													3	3	2	8
Laboratory 1		1	1													2
Laboratory 2				1	1	1	1									4
Laboratory 3								1		1						2
Laboratory 4											1	1				2
Laboratory 5													1	1		2
Test 1									2							2
Test 2															2	2
Teamwork	3	3	3	3	3	3	3	3	0	3	3	3	3	3	1	40
Personal study	3	3	3	3	3	3	3	3	6	3	3	3	3	3	5	50
Total	**10**	**10**	**10**	**10**	**10**	**10**	**10**	**10**	**10**	**10**	**10**	**10**	**10**	**10**	**10**	**150**

The dates of the final exams will be those that are officially published at http://www.eupla.es/secretaria/academica/examenes.html.

The written assessment tests will be related to the following topics:

— **Test 1** : Topic 1, 2, 3 y 4.

— **Test 2** : Topic 5, 6 y 7.

28823 - Automatic Regulation and Control

At the end of every topic the student can find some reinforce exercises in order to guide him in their personal homework.

5.5.Bibliography and recomended resources

Dorf, R. C. (1991). *Modern Control Systems* (6th ed.). Boston, MA, USA: Addison-Wesley Longman Publishing Co., Inc.

Franklin, G. F., Workman, M. L., & Powell, D. (1997). *Digital control of dynamic systems* . Addison-Wesley Longman Publishing Co., Inc. Retrieved from http://dl.acm.org/citation.cfm?id=550726

Halme, A. (1989). Discrete-time control systems: K. Ogata. *Automatica* , *25* (5), 788-789.

Kuo, B. C. (1996). *Sistemas de control automáticos de control* . Pearson Educación.

Ogata, K. (1997). *Modern control systems* . Prentice Hall.

Phillips, C. L., & Nagle, H. T. (2007). *Digital control system analysis and design* . Prentice Hall Press. Retrieved from http://dl.acm.org/citation.cfm?id=1534856

Salgado, M. E., Yuz, J. I., & Rojas, R. A. (2005). *Análisis de sistemas lineales* . Prentice Hall.

Skogestad, S., & Postlethwaite, I. (2007). *Multivariable feedback control: analysis and design* (Vol. 2). Wiley New York. Retrieved from http://alexandria.tue.nl/openaccess/Metis208895.pdf

Truxal, J. G. (1955). *Automatic feedback control system synthesis* . McGraw-Hill.