COURSE DATA

Data Subject	
Code	34816
Name	Process dynamics and control
Cycle	Grade
ECTS Credits	6.0
Academic year	2021 - 2022

Study (s)

Degree	Center	Acad. year	Period
1402 - Degree in Telecommunications Electronic Engineering	School of Engineering	3	First term

Subject-matter

Degree	Subject-matter	Character
1402 - Degree in Telecommunications Electronic Engineering	17 - Dynamics and control	Obligatory

Coordination

Name	Department
ESPI HUERTA, JOSE MIGUEL	242 - Electronic Engineering

SUMMARY

This is an obligatory subject taught in the first semester of the third curse of the Telecommunication Electronics Engineering degree. It weights 6 ECTS (European credits). The student dedication is estimated in 150 hours, from which 60 are classroom hours and 90 are non-classroom hours.

This subject configures by itself the whole matter “Dinámica y Control”. It is a multidisciplinary subject that intends to give a global and practical overview of feedback systems.

The subject provides the student the theoretical and practical concepts needed to solve problems in the field of control systems, i.e. to analyze and implement feedback control systems, which are typically present in electronic equipment or in industrial production processes.

The subject aims to give the means to the students to analyze and design control systems. The process modelling and its feedback control are undertaken. There are presented the graphical methods (block and flux diagrams) used to represent feedback systems, and the methods utilized to analyze their stability. Finally the standard methods to design analog PID compensators are described.

PREVIOUS KNOWLEDGE

Relationship to other subjects of the same degree

There are no specified enrollment restrictions with other subjects of the curriculum.

Other requirements

The recommended previous knowledge to follow this subject is:

- Basic contents related with complex variable and Laplace transform, which are taught in the 1st curse subjects Matemáticas I and II.
- Circuit network theory, frequency response and transfer function concepts.
- Analog electronic basics.
- The Newton physics equations for translational and rotational dynamics, covered in the 1st curse subject Física I.

OUTCOMES

1402 - Degree in Telecommunications Electronic Engineering

- G3 - Acquisition of the knowledge of the basic and technological subjects that allows students to learn new methods and theories and endows them with the versatility to adapt to new situations.
- G4 - Ability to solve problems with initiative, decision-making and creativity, and to communicate and transmit knowledge, abilities and skills, understanding the ethical and professional responsibility of the activity of a telecommunications technical engineer.
- G5 - Knowledge to carry out measurements, calculations, assessments, evaluations, loss adjustments, studies, reports, task planning, and other analogous work in the specific field of telecommunications.
- G9 - Ability to work in a multidisciplinary environment and in a multilingual group and to communicate, in writing and orally, knowledge, procedures, results and ideas related to telecommunications and electronics.
- G6 - Ability in the handling of specifications, regulations and norms of compulsory compliance.
- TE6 - Ability to understand and use feedback theory and electronic control systems.

LEARNING OUTCOMES

After having passed the subject, the student should have earned a bundle of skills, among which are:

- Be able to obtain mathematical models of most typical industrial processes (G3).
- Know and manage with the block and flux diagrams that represent feedback systems (G3).
- Analyze whether a feedback system is stable or not, and determine its stability margins (TE6).
- Know the different types of analog compensators that can be used, as well as their implementation with operational amplifiers (TE6)
- Design and implement the analog feedback compensation attending to a given static and dynamic specifications (G4, G6, TE6).

DESCRIPTION OF CONTENTS

1. Introduction to Feedback Control

- Terminology and definitions.
- Examples of control systems.
- History of automatic control.

2. Systems Dynamics

- Introduction.
- Modeling. Obtaining nonlinear differential equations.
- Linearization. Obtaining transfer functions.
- First order systems without zeros. Settling time.
- First order systems with zero.
- Second order systems without zeros. Overdamped system. Underdamped system. Damping coefficient. Overshoot. Frequency response.
- Second order systems with zero.
- Equivalent reduced order system.

3. Drawing and Calculation of Feedback Systems

- Block diagrams: Basic feedback. Loop gain and closed loop gain. Error signal. Rules of graphic simplification. Examples.
- Properties of the feedback systems: Sensitivity. Accuracy. Dynamic correction.
- Signal flow graphs: Rules of graphic simplification. Examples. Transformation of block diagrams to signal flow graphs. Mason's rule. Application examples.

4. Static Analysis of Feedback Systems

- Introduction. Static relationships in a non-linear process.
- Steady-state analysis. Static model of the actuator, process and sensor. Steady-state analysis of the feedback system. Examples.
- Unitary errors: position, speed and acceleration errors. Type 0, 1 and 2 systems.
- Conclusions.

5. Stability of Feedback Systems

- Introduction.
- Closed loop stability: Characteristic polynomial. Necessary condition of stability.
- Absolute stability analysis: Routh-Hurwitz criterion.
- Relative stability analysis: Nyquist stability criterion. Nyquist diagram.
- Phase and gain margins. Margin-based stability. Stability and delays.
- Relationships between open-loop and closed-loop characteristics: Closed-loop Bode diagrams. Settling time and gain crossover frequency. Overshoot and phase margin.

6. Design of Feedback Control Systems

- Introduction.
- Types of analog compensators: P, I, D, PD, PI, PI + pole, PID, Leading, Lagging, Lagging-Leading, PID+pole, PID+2 poles.
- Design based on the loop gain frequency response: Design specifications on the loop gain Bode. Determination of the appropriate type of compensator. Examples.
- Asymptotic frequency design. Design examples.
- Analytical frequency design. Need for pre-filter. Design examples.
- Design on the root locus: Calculation of the dominant poles. Angle and magnitude conditions. Design examples.
- Application example.

WORKLOAD

ACTIVITY	Hours	% To be attended
Theory classes	30,00	100
Laboratory practices	20,00	100
Classroom practices	10,00	100
Development of group work	15,00	0
Study and independent work	40,00	0
Readings supplementary material	5,00	0
Preparing lectures	5,00	0
Preparation of practical classes and problem	25,00	0
TOTAL	**150,00**	

TEACHING METHODOLOGY

THEORY CLASSES.

The theory classes will be taught masterfully. After the introduction of new content, its application will be illustrated with practical examples (G3, G4, G5, G6, TE6). Afterwards, the teacher will be able to propose a related problem as homework (G4, TE6), which will be solved in the following problems class.

PROBLEMS CLASSES.

During the problems classes, the teacher will solve example problems and all the problems proposed to the students as homework.

LABORATORY CLASSES.

They are taught in the ETSE's lab facilities, which are equipped with specific electronic equipment and computers. Students will be organized in groups of 2 or 3. There will be a descriptive guide of each practice.

EVALUATION

For the first call, the student will be able to choose between two evaluation modalities: continuous evaluation or evaluation by final exam. Both are detailed below.

a) CONTINUOUS EVALUATION:

- Evaluation of the theory-problems part:

There will be 2 partial exams throughout the semester. To pass the course, it is necessary to obtain a grade equal to or greater than 4 (out of 10) in both exams, in which case the arithmetic mean of these grades will be performed, obtaining "grade_theorpro". If the mark of the first partial is less than 5, the student will be able to re-examine these contents in the final exam.

- Evaluation of the laboratory part:

The continuous evaluation of the laboratory practices will be carried out. If the student obtains a grade equal to or greater than 4 (out of 10) in all of them, the arithmetic mean "grade_prac" is calculated. Otherwise, the student will have to take the final laboratory exam.

A laboratory test will be carried out which, if passed (5 out of 10), determines “grade_test”. Otherwise grade_test = 0.

The laboratory grade will be calculated as:

grade_lab = 0.7*grade_prac + 0.3*grade_test.

b) Evaluation by FINAL EXAM:

A final theory-problem exam and a laboratory exam will be held on the date set by the center, obtaining the grade_theorpro and grade_lab directly of these exams. To be able to take advantage of this modality, the student must indicate it to the laboratory professor at the beginning of the classes, to avoid being evaluated by him continuously, and will not have to take the first partial exam of theory-problems.

Regardless of the evaluation modality chosen, a minimum of 5 (out of 10) will be necessary both in theory-problems (grade_theorpro) and in laboratory (grade_lab) to pass. In that case, the final grade for the course will be obtained as follows:

Final_Grade = (2*grade_theorpro + grade_lab)/3.

Otherwise: Final_Grade = min(grade_theorpro, grade_lab).

In the second call, the student will always be evaluated by the final exam modality.

In any case, the evaluation system will be governed by the provisions of the Regulation of Evaluation and Qualification of the University of Valencia for Degrees and Masters (https://webges.uv.es/uvTaeWeb/MuestraInformacionEdictoPublicoFrontAction.do?acci%20on=inicio&idEdictoSeleccionado=5639)

REFERENCES

Basic

- Sistemas de Control Moderno. Richard C. Dorf. Ed. Pearson. ISBN: 9788420544014.
- Ingenieria de Control Moderna. Katsuhiko Ogata. Ed. Pearson. ISBN: 9788483226605. ISBN (e-book): 9788483229552.

ADDENDUM COVID-19

This addendum will only be activated if the health situation requires so and with the prior agreement of the Governing Council

- Contents:

The contents initially collected in the teaching guide are maintained.

- Volume of work and temporary planning of teaching:

The different activities described in the Teaching Guide are maintained with the planned dedication.

The material for the follow-up of the theory/lab classroom classes allows to continue with the temporary teaching planning both in days and hours, both if the teaching is classroom-based or not.

- Teaching methodology:

In classroom theory and practical classes there will be as much attendance as possible, always respecting the sanitary restrictions that limit the capacity of the classrooms to 50% of their usual occupation. Depending on the capacity of the classroom and the number of students enrolled, it may be necessary to distribute the students into two groups. If this situation arises, each group will attend classroom theory and practical sessions with a physical presence in the classroom by rotating shifts, thus ensuring compliance with the criteria for occupying spaces. The rotation system will be established once the actual enrollment data is known, guaranteeing, in any case, that the attendance percentage of all the students enrolled in the subject is the same. For non-classroom theory and practical sessions, there will be a preferably synchronous online teaching model, as long as compatibility with other scheduled activities allows. Online teaching will be carried out by synchronous videoconference respecting the schedule, or, if not possible, asynchronous.

With respect to laboratory practices, attendance at sessions scheduled in the schedule will be entirely in person.

Once the actual enrollment data is available and the availability of spaces is known, the Academic Committee of the Degree will approve the Teaching Model of the Degree and its adaptation to each subject, establishing this model the specific teaching conditions in which the subject will be developed.

If there is a closure of the facilities for sanitary reasons affecting totally or partially the classes of the subject, these will be replaced by non-contact sessions following the established schedules.

- Evaluation:

The evaluation system described in the Teaching Guide of the subject in which the different evaluable activities have been specified as well as their contribution to the final grade of the subject is maintained.

If there is a closure of the facilities for health reasons that affect the development of any face-to-face evaluable activity of the subject, it will be replaced by a test of a similar nature that will be carried out in virtual mode using the computer tools licensed by the University of Valencia. The contribution of each evaluable activity to the final grade for the course will remain unchanged, as established in this guide.

- Bibliography:

The bibliography recommended in the Teaching Guide is kept as it is accessible and is complemented with notes, slides and problems uploaded to the Virtual Classroom as subject material.