Course guide
820228 - REGA - Automatic Regulation

Last modified: 02/02/2025

Unit in charge: Barcelona East School of Engineering
Teaching unit: 707 - ESAII - Department of Automatic Control.

Degree: BACHELOR'S DEGREE IN INDUSTRIAL ELECTRONICS AND AUTOMATIC CONTROL ENGINEERING (Syllabus 2009). (Compulsory subject).

Academic year: 2024 **ECTS Credits:** 6.0 **Languages:** Catalan, Spanish

LECTURER

Coordinating lecturer: BEATRIZ FABIOLA GIRALDO GIRALDO

Others: Primer quadrimestre:
CARLOS CONEJO BARCELO - Grup: M11, Grup: M12, Grup: M15, Grup: M16
BEATRIZ FABIOLA GIRALDO GIRALDO - Grup: M11, Grup: M12, Grup: M13, Grup: M14, Grup: M15, Grup: M16
FRANCESC MELIÀ SUÑÉ - Grup: M13, Grup: M14
ABEL TORRES CEBRIAN - Grup: M11, Grup: M12, Grup: M13, Grup: M14, Grup: M15, Grup: M16

Segon quadrimestre:
BEATRIZ FABIOLA GIRALDO GIRALDO - Grup: T11, Grup: T12, Grup: T13, Grup: T14
ANTONIO LÓPEZ FERNÁNDEZ - Grup: T11, Grup: T12, Grup: T13, Grup: T14
ABEL TORRES CEBRIAN - Grup: T11, Grup: T12, Grup: T13, Grup: T14

PRIOR SKILLS

Electrical systems, mechanical systems, Mathematics III

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:
CEEIA-25. Model and simulate systems.

Transversal:
2. TEAMWORK - Level 3. Managing and making work groups effective. Resolving possible conflicts, valuing working with others, assessing the effectiveness of a team and presenting the final results.
3. EFFECTIVE USE OF INFORMATI0N RESOURCES - Level 3. Planning and using the information necessary for an academic assignment (a final thesis, for example) based on a critical appraisal of the information resources used.

TEACHING METHODOLOGY

The course uses expositive methodology by 20%, an individual class work (problems) by 10%, teamwork (laboratory) by 10%, and non-attendance individual and group work 60%.

LEARNING OBJECTIVES OF THE SUBJECT

At the end of the course the student will be able to:
1. To acquire basic skills in modeling dynamic systems.
2. To define and know how to apply the general methods of systems analysis.
3. To define and know how to apply the general methods of designing control systems in continuous time.
4. To know how to configure and tune different types of controllers used in the industry.
5. Teamwork.
6. Manage information resources in the field of control systems.

STUDY LOAD

Type	Hours	Percentage
Hours small group	15,0	10.00
Self study	90,0	60.00
Hours large group	45,0	30.00

Total learning time: 150 h

CONTENTS

1. Introduction to feedback control systems

Description:
Introduction. Examples of control systems. Loop systems open and closed. Definitions and terminology of control systems. Classification of control systems. Signals (Systems) of continuous and discrete time. Transducers and conditioners signal. Advantages and disadvantages of feedback system.

Specific objectives:
- Define different types of physical systems and signals.
- Understand and know how to differentiate the terminology of control systems and their definitions.
- Know how to use the appropriate transformation methods for each type of signal.
- Know the advantages and disadvantages of systems with feedback.

Related activities:
- Face-to-face sessions, examples of systems
- Problems resolution
- Laboratory practice: simulation of control systems.

Full-or-part-time: 10h
Theory classes: 3h
Practical classes: 2h
Self study : 5h

2. Models of dyanmic systems

Description:
Dynamic system concept. Invariant linear systems in time (LTI). Transfer function of linear systems. Linearization of physical systems. Electrical, mechanical and electro-mechanical systems: servomotors. Models of block diagrams. Simplifying of block diagrams. Models of signal flow graphs. Transfer functions using Mason's rule. Model of state variable. Transformation of transfer function to state variable and vice versa. Simulation of systems.

Specific objectives:
- Apply the generalizing concept of a dynamic system to a real physical system.
- Establish the hypotheses necessary to characterize the system in a simplified way.
- Apply physical laws to obtain a mathematical model of a system.
- Express this model in the form of a transfer function or a state variable model.
- Convert the model of a given system as a transfer function to a state variable model, and vice versa.

Related activities:
- Face-to-face sessions, examples of systems.
- Problems resolution
- Laboratory practice: Analysis of different control systems through simulation

Full-or-part-time: 30h
Theory classes: 7h 30m
Laboratory classes: 2h
Self study : 20h 30m

3. Analysis of time domain systems

Description:
Standard input signals. Calculating of the time response of systems using the convolution integral. Calculating the time response of systems using Laplace transform. First order systems. Second-order systems. Specifications functioning (transient response). Systems higher than second order. Resolution of the state equation. Location of poles in the plane s, and analysis of the transient response. The steady-state error.

Specific objectives:
- Systematically analyze temporal response of first and second order systems to standard test signals.
- Classify the responses of these systems based on previously defined specifications, which can be measured in a simple way, and which allow an assessment of the system's performance to be obtained.
- Establish a correlation between the location of the poles of the system and its transient response.
- Calculate the steady state error in a control system.
- Solve the state equation of a dynamic system.
- Define error rates to be able to quantitatively express the performance of a system.

Related activities:
- Face-to-face sessions, examples of systems.
- Problems resolution.
- Laboratory practice: Simulation systems using the "State Variable" model.

Full-or-part-time: 30h
Theory classes: 9h
Laboratory classes: 3h
Self study : 18h

4. Stability of linear systems

Description:
The stability concept. Stability criterion of Routh-Hurwitz. Special cases. Relative stability. Stability in state space.

Specific objectives:
- Propose procedures to follow to determine the stability of dynamic systems.
- Determine the stability of linear systems, based on their transfer function model or their state variable model.

Related activities:
- Face-to-face sessions, examples.
- Problems resolution.
- Laboratory practice: Study of a speed and position control servosystem. Cascade control.

Full-or-part-time: 20h
Theory classes: 6h
Laboratory classes: 2h
Self study : 12h

5. Root locus method

Description:
Concept of the root locus. Application of the root locus method to the analysis and design of control systems.

Specific objectives:
- Know how to use the root locus method as a technique to determine specifications of the dynamic system when a parameter varies.
- Apply this method to analyze and design control systems.

Related activities:
- Face-to-face sessions, examples.
- Problem resolution.
- Laboratory practice: Temperature control with a PID regulator.

Full-or-part-time: 10h
Theory classes: 3h
Laboratory classes: 2h
Self study : 5h

6. Controllers

Description:
P, I, PI, PD and PID controllers. Modifications of the standard PID controller: PID controller with approximate derivative action. Integral action "antiwindup". Controllers with two degrees of freedom: PI-D and I-PD controller.
Empirical and analytical tuning of controllers.
Controller by state vector feedback: controllability concept.

Specific objectives:
- Define the basic control actions, P, I and D, as well as the combined control actions.
- Identify which are the most appropriate control actions for a particular type of process.
- Identify which modifications of the standard PID regulator occur in practice, as well as their usefulness.
- Know how to tune a PID controller for a given process, by empirical and analytical methods.
- Distinguish between the different types of nonlinear controller used in control systems, knowing qualitatively the type of response they produce.

Related activities:
- Face-to-face sessions, examples.
- Problems resolution.
- Laboratory practice: Application of an industrial controller to the control of a real process.

Full-or-part-time: 40h
Theory classes: 10h 30m
Laboratory classes: 3h
Self study : 26h 30m

GRADING SYSTEM

Partial controls (2): 30%
Last control: 40%
Practices: 15%
Others test/projects: 15%
It is mandatory to carry out the practices to pass the subject
The assessment of the general competence "Teamwork" corresponds to the marks of the activities done in groups.

In this subject will schedule a reassessment. The students will be able to access the re-assessment test that meets the requirements set by the EEBE in its Assessment and Permanence Regulations (https://eebe.upc.edu/ca/estudis/normatives-academiques/documents/eebe-normativa-avaluacio-i-permanencia-18-19-aprovat-je-2018-06-13.pdf)

EXAMINATION RULES.

The written tests take place within the class schedule.
Practical tests carried out in the laboratory.

BIBLIOGRAPHY

Basic:
- Dorf, Richard C.; Bishop, Robert H. Sistemas de control moderno. 10ª ed. Madrid [etc.]: Prentice Hall, cop. 2005. ISBN 8420544019.
- Ogata, Katsuhiko. Ingeniería de control moderna [on line]. 5ª ed. Madrid: Pearson Educación, cop. 2010 [Consultation: 10/06/2020]. Available on: http://www.ingebook.com/ib/NPcd/IB_BooksVis?cod_primaria=1000187&codigo_libro=1259. ISBN 8420536784.

Complementary:
- Kuo, Benjamin C. Sistemas automáticos de control. 9ª ed. México: Compañía Editorial Continental, 1991. ISBN 9682611393.

- Lewis, Paul H.; Yang, Chang. Sistemas de control en ingeniería. Madrid [etc.]: Prentice Hall, cop. 1999. ISBN 8483221241.