Course guide
240043 - 240043 - System Dynamics

Last modified: 15/06/2023

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

Degree: BACHELOR'S DEGREE IN INDUSTRIAL TECHNOLOGY ENGINEERING (Syllabus 2010). (Compulsory subject).
BACHELOR'S DEGREE IN AUTOMOTIVE ENGINEERING (Syllabus 2017). (Optional subject).

Academic year: 2023 **ECTS Credits:** 4.5 **Languages:** Catalan, Spanish

LECTURER

Coordinating lecturer: Enric Fossas Colet

Others:

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:
1. Knowledge on automatisms' fundaments and control methods.

TEACHING METHODOLOGY

There are two types of attendance sessions: theory and practical classes. In the theory lectures (2 hours per week) the basic concepts are exposed from real examples and with the minimum mathematical tools necessary for the monitoring of concepts. The lectures often sandwich exercises or discussions among the students about the subject.
In the practical lectures (2 hours per week) problems and case studies are solved with the help of statistical software.
Students must carry out teamwork where some data will have to be analysed and take decisions depending on the information obtained.

LEARNING OBJECTIVES OF THE SUBJECT

General objective

Providing students the generalising concept of dynamic system, applicable in almost all fields of engineering, and the concept of signal as a variable of this system evolving through time.

Specific objectives

- Providing tools for temporal analysis and frequency systems
- Presenting different methodologies to analyse systems' stability
- Supplying basic concepts of continuous time control system
- Initiating into analysing systems modelled with internal representation
- Learning how to design compensators which improve working specifications of systems
- Learning fundaments of automatisms and control methods.

STUDY LOAD

Type	Hours	Percentage
Hours large group	37,5	33.33
Hours small group	7,5	6.67
Self study	67,5	60.00

Total learning time: 112.5 h

CONTENTS

Topic I. Introduction

Description:
Object and range of the subject. Definitions. Examples of dynamic systems.

Related competencies :
CE12. Knowledge on automatisms' fundaments and control methods.

Full-or-part-time: 2h 30m
Theory classes: 1h 30m
Self study : 1h

Topic II. Modelling systems and external presentation

Description:
Elemental signals. External representation. Transference functions of linear systems. Characteristic equation. Poles and zeros. Canonical form and canonical gain. Pure delay. Block schemes. Block algebra. Systems with several entries and exits. Examples of physical systems models.

Related competencies :
CE12. Knowledge on automatisms' fundaments and control methods.

Full-or-part-time: 17h
Theory classes: 3h 30m
Practical classes: 1h 30m
Laboratory classes: 2h 30m
Self study : 9h 30m

Topic III. Temporal response

Description:
Impulse response of first order systems. Impulse response of second order systems. Indicial response of first order systems. Indicial response of second order systems. Permanent error of feedback systems. Sensibility.

Related competencies :
CE12. Knowledge on automatisms' fundaments and control methods.

Full-or-part-time: 20h 30m
Theory classes: 5h
Practical classes: 2h
Laboratory classes: 2h 30m
Self study : 11h

Topic IV. Systems' stability

Description:
Stability definition. Necessary and sufficient stability condition. Routh criterion.

Related competencies :
CE12. Knowledge on automatisms' fundaments and control methods.

Full-or-part-time: 8h 30m
Theory classes: 1h
Practical classes: 1h 30m
Self study : 6h

Topic V. PID controllers

Description:
Basic control actions. Proportional, integral and derivative control. Effects of PID controls actions. Design of PID controllers.

Related competencies :
CE12. Knowledge on automatisms' fundaments and control methods.

Full-or-part-time: 13h 30m
Theory classes: 1h
Practical classes: 2h
Laboratory classes: 2h 30m
Self study : 8h

Topic VI. Frequency response

Description:
Isochron transference function. Gain and phase. Bode's diagram. Frequency response of linear systems, of canonical elements (constant, integrator, derivative, element of first order, second order element, not minimal gap elements, pure delay). Graphical representation of Bode's diagram of a general transmittance. Polar diagram.

Related competencies :
CE12. Knowledge on automatisms' fundaments and control methods.

Full-or-part-time: 17h
Theory classes: 4h
Practical classes: 2h
Self study : 11h

Topic VII. Stability in the frequency dominion

Description:
Nyquist's stability criterion. Simplified or Bode's criterion. Gain margin and phase margin.

Related competencies :
CE12. Knowledge on automatisms' fundaments and control methods.

Full-or-part-time: 15h
Theory classes: 2h
Practical classes: 3h
Self study : 10h

Topic VIII. Controllers design in the frequency's dominion

Description:
Controllers design with phase advance. Controlers design with phase delay.

Related competencies :
CE12. Knowledge on automatisms' fundaments and control methods.

Full-or-part-time: 18h 30m
Theory classes: 3h
Practical classes: 4h 30m
Self study : 11h

ACTIVITIES

LABORATORY PRACTICES

Description:
Execution of practical work is compulsory. There are three sessions in the laboratory or in the computer room (L1, L2, L3) and a session of autonomous learning in the computer room (AI).

AI. Introduction to Matlab's software to analyse and design systems. Functional block schemes. Time response. Analysis of system's stability. It must be executed in the computer rooms as autonomous learning, without professors in the room.

L1. Identifying and modelling an experimental position and speed control system.

L2 and L3. Experimental study of the control system behaviour analysed in sessions L1, once PID controllers have been incorporated.

Material:
Before executing practices it is necessary to prepare them with the practices handbook: Villà R., Riera J., Caminal P., Giraldo B. "Dinàmica de sistemes. Pràctiques". Campus digital Atenea.

Delivery:
During the execution of each practice a chart must be filled with the obtained results and keep them for the exam of practices..

Full-or-part-time: 13h 30m
Laboratory classes: 12h 30m
Self study: 1h

PARTIAL EXAM

Description:
Assessment of knowledge.

Delivery:
Solved exam.

FINAL EXAM

Description:
Assessment of knowledge.

Delivery:
Solved exam.

GRADING SYSTEM

The final mark will consist in three 'inputs':
1) Mark of laboratory (Nep)
2) Partial exam (Npp)
3) Final exam (Nef)

Nfinal = 0.5 Nef + 0.3 max{Npp,Nef} + 0.2 Nep

Re-assessment of knowledge is considered. In this case Nfinal = 0.8 Ner + 0.2 Nep, where Ner is the mark onbained in a new final exam

BIBLIOGRAPHY

Basic:
- Dorf, Richard C. Sistemas modernos de control. 2a ed. Argentina: Addison-Wesley Iberoamericana, 1989. ISBN 9686048510.
- Villà Millaruelo, Ricard. Dinàmica de sistemes. Barcelona: Serveis Gràfics Copisteria Imatge, 2013.

Complementary:
- Rohrs, Charles E. Sistemas de control lineal. México: McGraw Hill, 1994. ISBN 0070415250.
- Luenberger, David G. Introduction to dynamic systems : Theory, models and applications. New York: John Wiley and Sons, 1979. ISBN 0471025941.
- Villà, Ricard ; Robert Griñó ; Mañanas Miguel Angel Mañanas ; Pere Caminal ; Enric Fossas ; Jordi Riera. Dinàmica de sistemes : problemes d'exàmen. Barcelona: Serveis Gràfics Copisteria Imatge, 2011.