Course guide
240043 - 240043 - System Dynamics

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' fundamentals 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 fundamentals of automatisms and control methods.
STUDY LOAD

<table>
<thead>
<tr>
<th>Type</th>
<th>Hours</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hours large group</td>
<td>37.5</td>
<td>33.33</td>
</tr>
<tr>
<td>Hours small group</td>
<td>7.5</td>
<td>6.67</td>
</tr>
<tr>
<td>Self study</td>
<td>67.5</td>
<td>60.00</td>
</tr>
</tbody>
</table>

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:**

**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:**

**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:**

**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:**

**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. Controllers design with phase delay.

**Related competencies:**
CE12. Knowledge on automatisms' fundamentals 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)

\[ N_{\text{final}} = 0.5 \times \text{Nef} + 0.3 \times \max\{\text{Npp},\text{Nef}\} + 0.2 \times \text{Nep} \]

Re-assessment of knowledge is considered. In this case \( N_{\text{final}} = 0.8 \times \text{Ner} + 0.2 \times \text{Nep} \), where \( \text{Ner} \) is the mark obtained in a new final exam

BIBLIOGRAPHY

Basic:

Complementary:
- Villà, Ricard ; Robert Grifò ; Mañanas Miguel Angel Mañanas ; Pere Caminal ; Enric Fossas ; Jordi Riera. Dinàmica de sistemes : problemes d'exàmen. Barcelona: Serveis Gràfics Copisteria Imatge, 2011.