Universitat de Lleida

DEGREE CURRICULUM

# SYSTEMS ENGINEERING

Coordination: CLARIA SANCHO, FRANCISCO

Academic year 2021-22

## Subject's general information

<table>
<tr><td>Subject name</td><td>SYSTEMS ENGINEERING</td></tr>
<tr><td>Code</td><td>14536</td></tr>
<tr><td>Semester</td><td>1st Q(SEMESTER) CONTINUED EVALUATION</td></tr>
<tr><td>Typology</td><td>
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<tr><th>Degree</th><th>Course</th><th>Character</th><th>Modality</th></tr>
<tr><td>Master's Degree in Industrial Engineering (M 2021)</td><td>1</td><td>OPTIONAL</td><td>Attendance-based</td></tr>
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<tr><td>Course number of credits (ECTS)</td><td>6</td></tr>
<tr><td>Type of activity, credits, and groups</td><td>
<table>
<tr><th>Activity type</th><td>PRAULA</td><td>TEORIA</td></tr>
<tr><th>Number of credits</th><td>3</td><td>3</td></tr>
<tr><th>Number of groups</th><td>1</td><td>1</td></tr>
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<tr><td>Coordination</td><td>CLARIA SANCHO, FRANCISCO</td></tr>
<tr><td>Department</td><td>COMPUTER SCIENCE AND INDUSTRIAL ENGINEERING</td></tr>
<tr><td>Teaching load distribution between lectures and independent student work</td><td>(40% ) 60 h classroom or online<br>(60%) 90 h autonomous work</td></tr>
<tr><td>Important information on data processing</td><td>Consult this link for more information.</td></tr>
<tr><td>Language</td><td>Castellano</td></tr>
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| Teaching staff | E-mail addresses | Credits taught by teacher | Office and hour of attention |
|---|---|---|---|
| CLARIA SANCHO, FRANCISCO | francisco.claria@udl.cat | 6 | |

## Subject's extra information

It is a subject that is offered in the first year and the first quarter of master's degree in industrial engineering.

This subject aims to familiarize students with the transformation of circuits and systems to the Laplace domain. We study the temporal response of circuits using the Laplace transform, is given notion of transfer function and introduces the concepts of natural and forced response. We also study the frequency response of circuits, and emphasize the concepts of resonance, spectrum, stability and filtering. With these basics, it becomes apparent association of transfer function and system, marking the way for the analysis and design of electronic systems and control.

This subject is also intended to provide students with ability to analyze, simulate and design systems in which input signals are processed or cause these systems to respond interacting with the physical environment. This is to familiarize students with some of the tools and / or basic methodologies of signal processing such as spectral analysis, convolution and correlation, signal sampling, filtering, and an introduction to analog and pulse modulation.

The continuous-time processing of signals and systems enables, particularly for engineering students, to analyze and design systems with a certain degree of complexity.Moreover, the analysis of continuous-time systems are sometimes not the most suitable. This document presents the tools that extend the concepts of signal processing systems in continuous time and discrete time, preparing access to systems fed back. T

## Learning objectives

**General objective for the subject**

To provide students with basic tools and methodologies for the analysis of linear systems and signal processing.

**This general objective is summed in:**

- Know and use the Laplace Transform (TL) to transform circuits and systems.
- Calculate the time response of circuits or systems.
- Understand the concept and get the transfer function of circuits and systems.
- Knowing the meaning of amplitude spectrum and phase spectrum of a transfer function.
- Understand the concept of convolution of two signals and their reach in analysis, design and simulation.
- Understand the meaning of the spectral Fourier Transform.
- Relate correlation and convolution.
- Knowing the relationship between sampling time and spectrum of a signal.

## Competences

**General** competences set in ORDEN CIN/311/2009 and EPS criteri

- **CG1** Capacity of planning and organizing the personal work.
- **CG3** Capacity to convey information, ideas, problems and solutions both to a specialised and no specialised public.
- **CG4** Capacity to conceive, design and implement projects and/or provide new solutions, using the tools that the engineering offers.

- **CG6** To have suitable knowledge of the scientific and technological issues of: mathematical, analytical and numerical methods in engineering, electrical engineering, energetic engineering, chemical engineering, mechanical engineering, mechanics of continuous means, industrial electronics, automation, manufacture, material, quantitative methods of management, industrial computing, urbanism, infrastructures, etc.

**Specific** competences set in ORDEN CIN/311/2009

- **CE7** Capacity to design electronic and industrial instrumentation systems.

**Cross-disciplinary** competences approved by the Plenary Commission of the Degrees of Industrial Engineering, Computer Engineering and Building Engineering, gathered in June 16th, 2008

- **CT1** Appropriate skills in oral and written language.
- **CT3** Mastering ICT's.

## Subject contents

CHAPTER 1
1. SIGNALS AND THEIR CHARACTERISTICS
1.1 INTRODUCTION
1.2 SIGNALS
1.2 STEP FUNCTION
1.3 RAMP FUNCTION
1.4 RECTANGULAR PULSE FUNCTION
1.5 IMPULSE FUNCTION
1.6 PROPOSED PROBLEMS

CHAPTER 2
2. CIRCUITS ANALYSIS IN THE LAPLACE DOMAIN
2.1 INTRODUCTION
2.2 THE LAPLACE TRANSFORM
2.2.1 USEFUL PROPERTIES
2.2.2 TRANSFORMING SOME FUNCTIONS OF INTEREST
2.3 THE TRANSFORMED CIRCUIT
2.3.1 INTRODUCTION
2.3.2 TRANSFORMING VARIABLES AND VOLTAGE-CURRENT.
2.4 CIRCUIT ANALYSIS TECHNIQUES IN THE LAPLACE DOMAIN
2.5 DETERMINATION GENERAL OF THE RESPONSE
2.6 PROPOSED PROBLEMS

CHAPTER 3
3. RESPONSE IN TIME OF LINEAR CIRCUITS
3.1 LAPLACE INVERSE TRANSFORM
3.2 DETERMINATION OF THE RESPONSE TEMPORAL IN LINEAR CIRCUITS
3.2.1 COMPONENTS OF THE RESPONSE NATURAL AND FORCED
3.2.2 RESPONSE TO ZERO STATE AND ZERO ENTRY
3.3 TRANSFER FUNCTION
3.3.1 RELATIONSHIP BETWEEN TRANSFER FUNCTION AND DIFFERENTIAL EQUATION OF A CIRCUIT
3.4 POLES AND ZEROS OF A TRANSFER FUNCTION
3.4.1 STABILITY
3.4.2 POLE-ZERO DIAGRAM
3.4.3 STUDY OF A SECOND ORDER CIRCUIT
3.5 PROPOSED PROBLEMS

CHAPTER 4
4. FREQUENCY RESPONSE OF LINEAR CIRCUITS
4.1 INTRODUCTION
4.2 SPECTRUM

CHAPTER 9

9. PRINCIPLES OF DIGITAL SYSTEMS
9.1. Z TRANSFORM
9.2. INVERSE TRANSFORM
9.3. PRESENTATION SYSTEM
9.4. IMPULSE INVARIANCE
9.5. POLE POSITION AND PERIOD OF SAMPLING
9.6. PARAMETERS OF A SECOND ORDER
9.7. SPECIAL FEATURES: POLE, SAMPLING FREQUENCY, TRANSIENT RESPONSE
9.8. REDUCED EQUIVALENT SYSTEM

CHAPTER 10

10. SAMPLE AND HOLD
10.1. SAMPLE RETAINING
10.2. Z BLOCKS DIAGRAMS
10.3. CLOSED LOOP
10.4. SYSTEMS WITH CONTINUOUS AND DISCRETE BLOCKS
10.5. CONTINUOUS SCANNING SYSTEM
10.6. MATCHING METHOD OF POLES AND ZEROS
10.7. TRANSFORMATION AND FREQUENCY RESPONSE

## Methodology

**Master class:** In the master classes the contents of the subject are presented orally by a professor without the active participation of students

**Problem-based learning:** Problem-based learning is used as a method of promoting the learning from selected problems of real life.

## Development plan

| Week | Metodologi | Agenda | Classroom | Autonomous work |
|---|---|---|---|---|
| 1-2 | Master class<br>Problem-based learning | SIGNALS AND THEIR CHARACTERISTICS<br>CIRCUITS ANALYSIS IN THE LAPLACE DOMAIN | 8 | 12 |
| 3-5 | Master class<br>Problem-based learning | RESPONSE IN TIME OF LINEAR CIRCUITS<br>FREQUENCY RESPONSE OF LINEAR CIRCUITS | 12 | 18 |
| 6 | Master class<br>Problem-based learning | SIGNALS AND FOURIER ANALYSIS | 4 | 6 |
| 7-8 | Master class<br>Problem-based learning | FOURIER TRANSFORM AND ITS APPLICATION | 8 | 12 |
| 9-11 | Master class<br>Problem-based learning | SPECTRAL DENSITY AND CORRELATION<br>ANALOGICAL MODULATIONS | 12 | 18 |

| | | | | |
|---|---|---|---|---|
| 12-14 | Master class<br>Problem-based learning | PRINCIPLES OF DIGITAL SYSTEMS<br>SAMPLE AND HOLD | 12 | 18 |

# Evaluation

**Evaluation Method**

| Objectives | Evaluación Activities | Criteria | % | Dates | O/V (1) | I/G (2) | Observations |
|---|---|---|---|---|---|---|---|
| Chapters 1-6 | Test 1 written exam (*)<br><br>Practice/problems 1 | | 30%<br><br>10% | Week 9 | O<br>V | I<br>I/G | The document of practical/ problems work will be delivered on the date proposed. |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Chapters 7-10 | Test 2 written exam (*)<br>Practice/problems 2 | | 50%<br>10% | Week 15 | O<br>V | I<br>I/G | The document of practical/ problems work will be delivered on the date proposed. |
| Recovering the entire agenda | Recovery Written exam | (**) | 80% | Week 17 | O/V | I | |

(1) Mandatory / Voluntary.

(2) Individual / Group.

(*) Written exam consisting of problems with documentation.

(**) See explanatory text of the evaluation

**Explanatory text**

During the semester, there shall be four assessments in the form of two written tests and two papers that account for the study and the work done in the labs. These documents will have a maximum score of 1 point each and not considered any improvement threshold. The two written tests will be held on dates determined by the EPS for this purpose.

In this course, by its nature, has little sense to evaluate parts of avoiding your stuff previous contents. Thus, each written test will be on all the stuff that has been given so far.

The first written test will have a maximum score of 3 points and be considered approved if the score is greater than or equal to 1.5 points. The second written test will have a maximum score of 5 points and will be considered approved if the score is greater than or equal to 2.5 points.

As the material is cumulative in each written test, if the second test is passed, then the first test will be compensated if the latter has not been surpassed, with half its maximum score (1.5 points).

-The total score is the sum of the notes of the 4 reviews. **(This is the first of the two possible pathways of qualifications that are contemplated)**.

-If the second written test you get a lower score to 2.5 points, you must use the recovery activity, to be performed on the date set by the EPS. The written test will have a valuation recovery maximum 8 points and be deemed to have been passed if you get a note added to the laboratory practice notes and document preparation practices study is greater than or equal to 5 points. (**This is the second pathway**)

In addition:

Any person enrolled in this course, that have made the 2nd written test whether or not it has been overcome, be furnished to the recovery activity to increase the final grade. If the 2nd test had been overcome the final grade will never be lower than it would have obtained by the first approach.

# Bibliography

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