Systems and Circuits

Academic Year: (2022 / 2023) **Review date: 31-05-2022**

Department assigned to the subject: Department of Signal and Communications Theory

Coordinating teacher: LÓPEZ SANTIAGO, JAVIER

Type: Basic Core ECTS Credits : 6.0

Year : 1 Semester : 2

Branch of knowledge: Engineering and Architecture

REQUIREMENTS (SUBJECTS THAT ARE ASSUMED TO BE KNOWN)

Calculus I, Linear Algebra, Physics

OBJECTIVES

The objectives of the course are 1) to introduce the basic concepts of signals and systems, and 2) as an application of the above, to introduce the basic concepts of electric circuit analysis.

1.- Specific objectives:
- Signal concepts
  - Signal representation of physical magnitudes
  - Classification of signals: continuous and discrete time
  - Time operations: time reversal, scaling, time-shift
  - Signal operations: integration, differentiation
  - Special signals: unit impulse and step; exponentials.
  - Signal Synthesis as linear spaces composition.
- System concepts
  - Interconnection: series, parallel, feedback
  - Properties: memory, causality, time invariance, stability, linearity
  - Impulse response
- Signal Processing
  - Convolution, Filtering
- Application to Electric Circuit Analysis
  - Kirchhoff Laws
  - Sinusoidal steady-state analysis.

1.2.- Instrumental
- Programming
- Signal and Systems simulation
- Analysis of basic electric circuits.
- Using lab. equipment to monitor the circuit implementations

DESCRIPTION OF CONTENTS: PROGRAMME

1. Signals
1.1 Properties of the signals: regularity, symmetry
1.2 Characterization of signals: energy and average power. RMS value
1.3 Basic operations with signals: time reversal, scaling, shifting
1.4 Basic signals.
1.5 Vectorial interpretation of signals
1.6 Introduction to the Fourier Series

2. Systems
2.1 Introduction
2.2 Interconnection of systems: series, parallel and feedback systems
2.3 Properties of the systems: causality, stability, time invariance, linearity
2.4 Linear Time-Invariant Systems (LTI)
2.5 Convolution
2.6 Properties of the SLIT
2.7 Unit Step response 2.8 Interconnection of the SLIT

3. Resistive Circuits
3.1 The electrical case: passive and active circuit elements
3.2 Resolution of circuits by means of Kirchhoff Laws
3.3 Node-Voltage and Mesh-current analysis
3.4 Source Transformations
3.5 Thèvènin and Norton Equivalent Circuits

4. Filters: Time behavior
4.1 Passive circuit elements: resistances, capacitors, and coils.
4.2 Circuit differential equations.
4.3 Natural response.
4.4 Unit step response.
4.5 First order solution.

5. Sinusoidal steady-state analysis
5.1 Phasor
5.2 Impedance
5.3 Kircchoff Laws in the phasor domain
5.4 Circuit Analysis in the phasor domain
5.5 Power in sinusoidal steady-state

LEARNING ACTIVITIES AND METHODOLOGY

The course consists of the following elements: lectures, exercises, and laboratories:

LECTURES (2.5 ECTS)
The lectures provide the students with explanation of the core material in the course. Numerous examples of signals and systems, their properties and behavior will be given using backboard and audiovisual support (slides, video, ...). In the second part of the course, the analysis and design of simple electric circuits will be discussed as a practical example to understand the application of the mathematics for lineal systems.

EXERCISES (2.5 ECTS)
Students will be encouraged to solve the exercises and to organize themselves forming small groups that will have to solve some basic problems given in advance.

LABORATORIES (1 ECTS)
The laboratories provide the students with hands-on experience to understand the fundamentals of signals, systems and circuits. Some basic signals processing demos and simple electric circuits will be analyzed. Students will also learn how to use of Matlab for signal processing and circuit analysis. Students must come prepared for the laboratory sessions.

ASSESSMENT SYSTEM

Assessment includes:
- Lab exercises (10 %)
- Partial exams (40%)
- Final examination (50%)

A mark of at least 4 out of 10 in the final exam will be required in order to be able to take the average with the continuous assessment.

% end-of-term-examination:	50
% of continuous assessment (assigments, laboratory, practicals…):	50

BASIC BIBLIOGRAPHY

- Alan V. Oppenheim, Alan S. Willsky, with S. Hamid Signals and Systems, Prentice Hall; 2 edition (August 16, 1996).

- James W. Nilsson, Susan Riedel Electric Circuits, Prentice Hall; 9 edition (January 13, 2010).