# Systems and Circuits

**Academic Year: ( 2019 / 2020 )** **Review date: 18-05-2020**

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

**Coordinating teacher: BOUSOÑO CALZON, CARLOS**

**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 with an emphasis on their use in communication, and 2) as particularization of the above, to introduce the basic concepts of electric circuit analysis.

To achieve these goals, the student must acquire the following ABET program outcomes:
a, b, e, k.
Related to the following competences:
1.- General competences
- Analysis and synthesis (PO: b)
- Problem solving (PO: a, e, k)
- Ability to apply theoretical concepts (PO: a, b, e, k)
- Ability to integrate knowledge (PO: a, b)

2.- Specific competences
2.1.- cognitive (PO: a, b, e, k)
- 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
    - Basic signals: unit impulse and step; exponentials.
    - Signal Synthesis.
- System concepts
    - Interconnection: series, parallel, feedback
    - Properties: memory, causality, time invariance, BIBO stability, linearity
    - Impulse and step response
- Signal Processing
    - Convolution, Filtering
- Electric Circuit Analysis
    - Kirchhoff Laws
    - Node-voltage and mesh current methods
    - Resistive circuits
    - First-order filters.
    - Sinusoidal steady-state analysis.

2.2.- Instrumental (PO: b, e, k)
- Programming with signal processing software (Matlab)
- Signal and Systems simulation
- Analysis and synthetisis of basic electric circuits.
- Using lab. equipment to monitor the circuit implementations

2.3 Attitude (PO: e, k)
- Individual and team work
- Decision making
- Abstraction ability.

## DESCRIPTION OF CONTENTS: PROGRAMME

1. Signals
1.1 Introduction: functions and signals.
1.2 Properties of the signals: symmetries and periodicity.
1.3 Signals characterisation: average value, energy and average power.
1.4 Basic operations with signals: value transformations; and time reversal, scaling, shifting.
1.5 Two special basis functions: deltas and complex exponentials. Signal Spaces.

2. Systems
2.1 Introduction.
2.2 Systems interconnections: series and parallel.
2.3 System Properties: causality, stability, time invariance, linearity.
2.4 Linear Time-Invariant Systems (LTI)
2.5 Convolution.

3. Electrical circuits as LTI.
3.1 Defining electrical circuits: fundamental variables, basic elements and connections. Circuit solutions.
3.2 Steady state and complex exponentials: phasor. Power signal and average power.
3.3 Kirchhoff circuit laws. Mesh and nodal analyses.
3.4 Application: filters.

## LEARNING ACTIVITIES AND METHODOLOGY

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

LECTURES (2.5 ECTS) (PO: a, k)
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 audiovisual support (slides, video, ...). In the second part of the course, the analysis and design of simple electric circuits will be discussed. In both parts, the basic objective is that students understand basic fundamentals in a qualitatively way.

EXERCISES (2.5 ECTS) (PO: a, k)
In these sessions, students will be encouraged to organize themselves forming small groups that will have to solve some basic problems given in advance.

LABORATORIES (1 ECTS) (PO: a, b, k)
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 evaluations (30%)

- Final exam (60 %)

- The final examination is a standard closed-book written examination. The examination will test knowledge and understanding of all major aspects covered in the course.

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| **% end-of-term-examination:** | 60 |
| **% of continuous assessment (assigments, laboratory, practicals…):** | 40 |

## 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).