Systems and Circuits

Academic Year: (2020 / 2021) **Review date: 09-07-2020**

Department assigned to the subject: Signal and Communications Theory Department

Coordinating teacher: GOMEZ GARCIA, MARIA DEL CARMEN

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

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

Unit 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.

Unit 3. Resistive Circuits
3.1. Basic concepts: potential energy and voltage, electric and electronic current, power.
3.2. Ohm's law: resistors and sources. Kirchhoff's laws: meshes and nodes.
3.3. Parallel and series interconexion of resistors. Equivalent resistance. Rules of the current and voltage divisor.
3.4. Circuit analysis: method of current in branches, mesh method and nodes method.
3.5. Source conversion.
3.6. Network theorems: superposition, Thèvènin, Norton and maximum power transfer. Thévénin' and Norton's equivalent circuits.

Unit 4. Sinusoidal steady-state analysis.
4.1. Phasor.
4.2. Pasive elements in steady state.
4.3. Definition of impedance.
4.4. Kircchoff Laws in the phasor domain.
4.5. Circuit Analysis in the phasor domain.
4.6. Norton's and Thèvènin's equivalent circuits.
4.7. Power in sinusoidal steady-state.

Unit 5. Filters: Time behavior.
5.1. Passive circuit elements: resistors, capacitors and inductors.
5.2. Capacitance and inductance.
5.3. First order differential equations. Response to the step signal.
5.4. General equations for charginng and discharging.
5.5. Basic RC and RL circuits.
5.6. RC and RL circuits with switches.

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:
- Laboratory Exercises (10 %) (PO: b, k)
- End-of-topic exams (PO: a, e)
    - Evaluation of units 1 and 2 (Signals and Systems) (20%)
    - Evaluations of units 3, 4 and 5 (Circuits) (20%)
- Final exam (50 %) (PO: a, e)
    - The final examination is a standard closed-book three hours written examination. The examination will test knowledge and understanding of all major aspects covered in the course. To pass the course the students will need to score at least 40% of the mark of the final exam.
- Proposed exercises (optional) that may increase the final vote in 0.5 points over 10.

% 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), 1996
- James W. Nilsson, Susan Riedel Electric Circuits, Prentice Hall; 9 edition (January 13, 2010), 2010

ADDITIONAL BIBLIOGRAPHY

- Allan H. Robbins and Wilhem C. Miller Circuit analisis: theory and practice, Delmar, Cengage learning, Fifth edition, 2013