Signals, systems and circuits

Academic Year: (2023 / 2024) **Review date: 12/02/2024 11:18:34**

Department assigned to the subject: Electronic Technology Department

Coordinating teacher: FERNANDEZ HERRERO, CRISTINA

Type: Compulsory ECTS Credits : 6.0

Year : 2 Semester : 2

LEARNING OUTCOMES

CB1. Students have demonstrated possession and understanding of knowledge in an area of study that builds on the foundation of general secondary education, and is usually at a level that, while relying on advanced textbooks, also includes some aspects that involve knowledge from the cutting edge of their field of study.
CB2. Students are able to apply their knowledge to their work or vocation in a professional manner and possess the competences usually demonstrated through the development and defence of arguments and problem solving within their field of study.
CB3. Students have the ability to gather and interpret relevant data (usually within their field of study) in order to make judgements which include reflection on relevant social, scientific or ethical issues.
CB4. Students should be able to communicate information, ideas, problems and solutions to both specialist and non-specialist audiences.
CB5. Students will have developed the learning skills necessary to undertake further study with a high degree of autonomy.
CG1. Analyze and synthesize basic problems related to physics and engineering, solve them and communicate them efficiently.
CG2. Learn new methods and technologies from basic scientific and technical knowledge, and being able to adapt to new situations.
CG3. Solve problems with initiative, decision making, creativity, and communicate and transmit knowledge, skills and abilities, understanding the ethical, social and professional responsibility of the engineering activity. Capacity for leadership, innovation and entrepreneurial spirit.
CG5. Use the theoretical and practical knowledge acquired in the definition, approach and resolution of problems in the framework of the exercise of their profession.
CG6. Develop new products and services based on the use and exploitation of new technologies related to physical engineering.
CE4. Analyze and manipulate analog and digital signals in the temporal and frequency domains, and understand and master the basic concepts of linear systems and related functions and transforms, as well as apply them to circuit design.
CE14. Specify and use electronic instrumentation, measurement systems, sensors, techniques and experimental procedures usual and advanced in physics, engineering and biology, including electromechanical and microfluidic microdevices, and design experiments using the scientific method.
CT1. Work in multidisciplinary and international teams as well as organize and plan work making the right decisions based on available information, gathering and interpreting relevant data to make judgments and critical thinking within the area of study.

RA1. To have acquired sufficient knowledge and proved a sufficiently deep comprehension of the basic principles, both theoretical and practical, and methodology of the more important fields in science and technology as to be able to work successfully in them.
RA2. To be able, using arguments, strategies and procedures developed by themselves, to apply their knowledge and abilities to the successful solution of complex technological problems that require creating and innovative thinking.
RA3. To be able to search for, collect and interpret relevant information and data to back up their conclusions including, whenever needed, the consideration of any social, scientific and ethical aspects relevant in their field of study.
RA6. To be aware of their own shortcomings and formative needs in their field of specialty, and to be able to plan and organize their own training with a high degree of independence.

OBJECTIVES

- Characterize and analyze signals and systems, continuous and discrete, in the time domain and in the frequency domain.
- Understand and master the concept of frequency response
- Understand the process of digitizing analog signals.
- Develop the ability to analyze and design systems.
- Learn the analysis of circuits in the time domain, in permanent sinusoidal regime and in the frequency domain.
- Learn the transitory analysis of first and second order circuits.

DESCRIPTION OF CONTENTS: PROGRAMME

A. Signals

1.Taxonomy of signals

1.1. Introduction: functions and signals. Continuous and Discrete time domain. Sampling. Basic Taxonomy of signals

1.2. Properties of signals: periodicity, symmetry, energy signal, power signal

1.3. Basic operations with signals: level shift, time shift, reflection, scaling.

1.4. Signals characterization: mean and root mean square value, energy, average power

1.5. Basic Signals: sine wave, complex exponential, impulse, unit step

2. Representation of signals

2.1 From time domain to frequency domain: Signal transforms, Fourier revision

2.2 The decibel

2.3 Fourier transform of basic signals

2.4. properties of Fourier Transform. Convolution property and Parseval Theorem

2.5 Power spectrum of a signal

2.6 Basic estimation of power spectrum

2.7 Signals in Matlab

B. Systems

3.-Signal processing: LTI systems

3.1. System definition and block diagram. Classification

3.2. Systems interconnection: series, parallel, feedback

3.3. System properties: memory, invertibility, causality, stability, time invariance, linearity

3.4. Linear and Time invariant systems (LTI). Impulse response and transfer fucntion. Palace and Z transform as an extension of Fourier

3.5 Convolution

4. Representation of LTI systems

4.1 Pole-Zero plot

4.2 BIBO estability

4.3 First order system: impulse response, step response. Frequency response

4.4 Real and asymptotic Bode Plot

4.5 Second order systems: impulse response, step response. Frequency response. Overdamped systems, underdamped systems, and critically damped systems.

4.6 LTI systems in Matlab

5. Sampling and reconstruction

5.1 Discrete-Time Processing of Analog signals

5.2 Ideal and Periodic sampling

5.3. Sampling Theorem

5.4 Prefiltering

5.5 Ideal reconstruction

5.6 Reconstruction with a zero-order hold

C. Circuits

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6. Introduction to circuit theory

6.1. Definition of circuits: fundamental variables, basic elements, connections

6.2. Energy and power
6.3. Kirchhoff¿s laws. KVL and KCL
6.4. Electric components. Resistor, inductor, capacitor. Independent and dependent voltage and current sources
6.5. Series and parallel connection
6.6. Superposition
6.7. Thevenin equivalent
6.8. Norton equivalent

7. Transient analysis
7.1. Transients in first order circuits
7.2. Transients in second order systems: overdamped systems, underdamped systems and critically damped systems

8. Sinusoidal steady-state analysis
8.1. Impedance model
8.2. Frequency response of RC and RL circuits
8.3. Frequency response: magnitude and phase

LEARNING ACTIVITIES AND METHODOLOGY

THEORY CLASS. Classroom presentations by the teacher in which the subject`s main concepts are developed, while providing material and bibliography to complement student learning
PRACTICAL CLASS. Resolution of practical cases and problem, posed by the teacher, and carried out individually or in a group
TUTORING SESSIONS. Individualized attendance (individual tutoring sessions) or in-group (group tutoring sessions) for students with teacher as tutor.
LABORATORY PRACTICAL SESSIONS. Applied/experimental learning/teaching in workshops and laboratories under the tutor's supervision.

ASSESSMENT SYSTEM

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

- Laboratory (20%).
- Exams during the course (20%).
- Final exam oriented to problems (60% with a minimum grade).

BASIC BIBLIOGRAPHY

- Alan Oppenheim, Alan Willsky Signals and systems, Prentice-hall, 1996

- Anant Agarwal, Jeffrey H. Lang Foundations of Analog and Digital Electronic Circuits, Morgan Kaufmann Publishers, Elsevier, 2005

ADDITIONAL BIBLIOGRAPHY

- Dutta Roy, Suhash Chandra Circuits, Systems and Signal Processing: A Tutorials Approach Dutta Roy, Suhash Chandra, Singapore: Springer Singapore Pte. Limited, 2018