Systems and Signals

Academic Year: (2019 / 2020) **Review date: 29-04-2020**

Department assigned to the subject: Signal and Communications Theory Department

Coordinating teacher: LÓPEZ SANTIAGO, JAVIER

Type: Compulsory ECTS Credits : 6.0

Year : 2 Semester : 1

REQUIREMENTS (SUBJECTS THAT ARE ASSUMED TO BE KNOWN)

Calculus I
Calculus II
Linear Algebra
Differential Equations

OBJECTIVES

The goal of the course is to provide the students with the theoretical and methodological knowledge necessary to work with continuous and discrete-time signals and LTI (linear and time-invariant) systems in the time and frequency domain.

Upon successful completion of the course a student will meet the following ABET Program Outcomes (PO): a, b, e, k.

1. GENERAL/TRANSVERSAL COMPETENCES:
1.1. Individual-work skills (PO: a, b, e, k)
1.2. Capacity for analysis and synthesis (PO: b, e)
1.3. Ability to apply theoretical concepts to practice (PO: a, b, e, k)
1.4. Skills related to group work, collaboration and coordination with other students (PO: a, e, k)
2. SPECIFIC COMPETENCES:
2.1. Theoretical knowledge of signals and systems representation in the time domain (PO: a, b, e, k)
2.2. Theoretical knowledge of signals and systems representation in the frequency domain (PO: a, b, e, k)
2.3. Capacity for analyzing signals and systems in the frequency domain, with emphasis in applications related to Bioengineering (PO: a, b, e, k)
2.4. Use of fundamental tools for the analysis of signals and systems in the frequency domain, with emphasis in Bioengineering (PO: b, e, k)

DESCRIPTION OF CONTENTS: PROGRAMME

Unit 1. Signals
1.1. Definition and introduction to biomedical signals
1.2. Properties of the signals: regularity, symmetry, etc.
1.3. Characterization of signals: energy and average power.
1.4. Basic operations with signals: time reversal, scaling, shifting.
1.5. Introduction to random processes.

Unit 2. Systems
2.1. Introduction. Examples of systems in biomedical engineering.
2.2. Properties of the systems: causality, stability, time invariance, linearity.
2.3. Linear Time-Invariant Systems (LTI).
2.4. Convolution.
2.5. Properties of LTI systems.
2.6. Random Processes and LTI systems.

Unit 3. Fourier Series Representation of Continuous-Time Periodic Signals and sequences
3.1. Introduction: Response of LTI Systems to Complex Exponentials.
3.2. Fourier Series Representation of Continuous-Time Periodic Signals: Analysis and Synthesis Equations.
3.3. Properties of Continuous-Time Fourier Series. Examples.
3.4. Fourier Series Representation of Discrete-Time Periodic Signals: Analysis and Synthesis Equations.

3.5. Properties of Discrete-Time Fourier Series and comparisons with the Continuous Case. Examples.

Unit 4. The Continuous-Time Fourier Transform
4.1. Introduction.
4.2. The Continuous-Time Fourier Transform for Aperiodic Signals.
4.3. The Continuous-Time Fourier Transform for Periodic Signals.
4.4. Properties of the Continuous-Time Fourier Transform. Examples. Parseval's Theorem.
4.5. The Discrete-Time Fourier Transform. Properties.
4.6. Characterization of random processes in the frequency domain.

Unit 5. Sampling
5.1. Introduction.
5.2. The Sampling Theorem.
5.3. Reconstruction of Continuous-Time Signals from Its Samples Using Interpolation.
5.4. Discrete-Time Processing of Continuous-Time Signals.
5.5. Decimation and Interpolation.
5.6. Examples and applications.

Unit 6. Discrete Fourier Transform
6.1. Introduction.
6.2. Sampling of the Fourier Transform.
6.3. Discrete Fourier Transform.
6.4. Properties.
6.5. Circular Convolution and Linear Convolution.

Unit 7. The z-Transform
7.1. Introduction.
7.2. The z-Transform.
7.3. The Region of Convergence. Properties.
7.4. The Inverse z-Transform.
7.5. Properties of the z-Transform.
7.6. Evaluation of the Frequency Response from the Pole-Zero Plot.
7.7. Analysis and Characterization of LTI Systems Using the z-Transform.
7.8. Block Diagram Representation.

ASSESSMENT SYSTEM

The final exam will determine 60% of the total course grade (6 points). (PO a, PO c, PO e, PO g, and PO k)

Quizzes, homework and lab sessions will be used to award the remaining 4 points (40% of the final grade).

1. At the end of each unit or couple of units there will be a. The total maximum grade for these exercises will be 3 points. (PO a, PO c, PO e, PO g, and PO k)

2. Laboratory sessions. There are 3 sessions, the total grade here is 1 point, which is evaluated in an additional lab session as an exam (PO b y PO k). This block is evaluated by a group work to create a computer code with a practical example of signal processing in Biomedical Engineering.

The students need 3.5 out 10 points in the final exam to successfully pass the course.

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

BASIC BIBLIOGRAPHY

- Alan Oppenheim and Alan Willsky Signal and Systems, Prentice Hall, 1997
- Alan Oppenheim, Ronald W Schafer and John R Buck Discrete-time signal processing, Prentice-Hall International, 1999
- B. . Lathi Linear Systems and Signals, Oxford University Press, 2005
- Hwei Hsu Signals and Systems, Schaum's Outlines, 2011