

Academic Year: ( 2019 / 2020 )

Review date: 10-04-2019

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

Coordinating teacher: LÓPEZ SANTIAGO, JAVIER

Type: Compulsory ECTS Credits : 6.0

Year : 2 Semester : 1

**STUDENTS ARE EXPECTED TO HAVE COMPLETED**

Calculus I  
 Calculus II  
 Linear Algebra  
 Differential Equations

**COMPETENCES AND SKILLS THAT WILL BE ACQUIRED AND LEARNING RESULTS.**

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 an exam in the lab.

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

<b>% end-of-term-examination:</b>	60
<b>% of continuous assessment (assignments, laboratory, practicals...):</b>	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