EE 313: *Signals and Systems*

CATALOG DATA:

EE 313 Signals and Systems Credits: (3-0) 3

Characterization of continuous and discrete time signals and systems (linear and time-invariant). Analysis methods, techniques, and topics will include both transform- or frequency-based (e.g., Fourier, discrete Fourier, and z-) and time-based (e.g., differential and difference equations) approaches.

Prerequisites: EE 221/221L with a grade of ”C” or higher and MATH 321.

TEXTBOOK:

Fundamentals of Signals and Systems, Using the Web and MATLAB, 3rd Edition, Kamen and Heck, Prentice-Hall, 2007, ISBN 0-13-168737-9.

COORDINATOR:

Dr. Thomas P. Montoya, Associate Professor

GOALS:

The objective of this course is to provide students a basic understanding of how to analyze and characterize continuous-time and discrete-time signals and systems in both the time domain (e.g., convolution and difference/differential equation representations) and in the frequency domain (e.g., Fourier series/transform & analysis, discrete-time Fourier transform (DTFT) & analysis, discrete Fourier transform (DFT) & analysis, and z-transform & analysis).

CLASS SCHEDULE:

Lecture: 3 hours per week.

TOPICS:

1. Fundamental Concepts:
    a. Continuous-time signals
    b. Discrete-time signals
    c. Basic system properties
2. Difference and Differential Equations:
    a. Linear input/output differential equations with constant coefficients
    b. Linear input/output difference equations with constant coefficients
3. Convolution Representation:
    a. Convolution representation of linear time-invariant discrete-time systems
    b. Discrete-time convolution
    c. Convolution representation of linear time-invariant continuous-time systems
    d. Continuous-time convolution
4. Fourier Series and Transform:
    a. Fourier series of periodic signals
    b. Fourier transform of aperiodic signals
    c. Properties of the Fourier transform

5. Frequency-Domain Analysis:
    a. System response to sinusoidal signals
    b. System response to periodic signals
    c. System response to aperiodic signals
    d. Ideal filters (e.g., lowpass, bandpass, ...)
    e. Sampling (e.g., Nyquist theorem)
6. Fourier Analysis of Discrete-Time Signals & Systems:
    a. Discrete-time Fourier transform (DTFT) and properties
    b. Discrete Fourier transform (DFT) and properties
    c. System analysis with DTFT and DFT
7. *z*-transform and Discrete-Time Systems:
    a. *z*-transform and properties
    b. Inverse *z*-transform
    c. *z*-transform transfer function representation
    d. Stability of discrete-time systems
    e. Frequency response of discrete-time systems

COMPUTER USAGE:

Students heavily use MATLAB to study and implement techniques, analyze signals and systems, and design systems covered in the text.

COURSE LEARNING OBJECTIVES (CLO):

Upon completion of this course, students should demonstrate the ability to:

A. Apply fundamental continuous-time and discrete-time signal properties such as causality, linearity, and time-invariance to signals.
B. Solve linear discrete-time difference equations using recursion and/or finding total solutions when possible.
C. Apply or use the convolution representation for linear, time-invariant continuous-time and discrete-time systems to find the system response to input signals.
D. Be able to perform convolution on continuous-time and discrete-time signals.
E. Be able to compute the Fourier series for simple periodic continuous-time signals and Fourier transform (and inverses) for simple aperiodic continuous-time signals.
F. Apply frequency domain analysis (e.g., Fourier series and transforms) to find the response of systems to periodic and aperiodic continuous-time signals.
G. Apply the properties of ideal filters to find the output of the filter to input signals.
H. Apply the principles of sampling and the resulting consequences in the frequency domain.
I. Be able to compute both the discrete-time Fourier transform (DTFT) and discrete Fourier transform (DFT) and their inverses for discrete-time signals.
J. Be able to compute both the z-transform and inverse z-transform of discrete-time signals.
K. Be able to compute the z-transform transfer function of discrete-time systems.
L. Apply or use frequency-domain analysis (i.e., DTFT, DFT, and z-transforms) to find the response of discrete-time systems to discrete-time signals.

RELATION OF COURSE TO DEPARTMENTAL STUDENT OUTCOMES (SO):

These course objectives fulfill the following student outcomes adopted for the B.S. EE degree:

1) An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics.
2) An ability to apply engineering design to produce solutions that meet specified needs with consideration of public, health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors.
3) An ability to communicate effectively with a range of audiences.
4) An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgements, which must consider the impact of engineering solutions in global, economic, environment, and societal contexts.
5) An ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives.
6) An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions.
7) An ability to acquire and apply new knowledge as needed, using appropriate learning strategies.

The following table indicates the relative strengths of each course objective in addressing the program's student outcomes listed above (on a scale of 1 to 4 where 4 indicates a strong emphasis).

SO / CLO	1	2	3	4	5	6	7
A	2						
B	3						
C	3						
D	4						
E	4						
F	4						
G	4						
H	3						
I	4						
J	4						
K	4						
L	4						

PREPARED BY:

Revised by Thomas P. Montoya, Dates: 8/20/2022, 8/3/2023, & 8/21/2024.