ENEE222: Elements of Discrete Signal Analysis

Credits: 4

Description

Prerequisite: Minimum grade of C- in MATH141; and permission of ENGR-Electrical & Computer Engineering department. And minimum grade of C- in ENEE140; or minimum grade of C- in CMSC131.

Restriction: Must be in one of the following programs (Engineering: Electrical; Engineering: Computer).

Credit only granted for: ENEE222, ENEE241, or MATH242.

Formerly: ENEE241.

Discrete-time and continuous-time signals, sampling. Linear transformers, orthogonal projections. Discrete Fourier Transform and its properties. Fourier Series. Introduction to discrete-time linear filters in both time and frequency domains.

Semesters Offered

Fall 2017, Spring 2018, Fall 2018, Spring 2019, Fall 2019, Spring 2020, Fall 2020, Spring 2021

Testudo

Learning Objectives

- Interpolate discrete-time sinusoids using knowledge of sampling rate and bandwidth
- Use complex phasors to represent and manipulate real-valued sinusoids
- Represent finite-dimensional linear transformations by matrices; interpret the latter in terms of the former
- Calculate orthogonal projections and least-squares approximations for both real and complex vectors
- Compute simple low-dimensional DFTs and their inverses from first principles
- Correctly interpret the information in a DFT spectrum and use it to reconstruct a time-domain signal as a sum of its Fourier components
- Understand and apply DFT properties pertaining to index reversal, index shift, modulation, periodic extension and zero-padding
- Compute Fourier series coefficients of simple periodic signals in continuous time
- Determine the frequency response of a FIR filter; interpret the frequency response in the context of frequency selection
- Compute the time-domain response of a FIR filter to exponential, periodic and finite-duration inputs

- Use MATLAB to visualize, analyze and process signals and images, thereby applying the theory and tools taught in the lectures

Topics Covered

- Real and complex sinusoids in continuous time
- Sampling of sinusoids, discrete-time sinusoids, aliasing
- Matrices and linear transformations, linear systems
- Matrix inversion, Gaussian elimination
- Inner products, norms, projections; orthogonal bases
- DFT as an orthogonal projection, interpretation of the DFT
- Signal transformations and the DFT, symmetry, duality
- Zero-padded and periodic extensions and the DFT
- Periodicity in continuous time, sums of harmonically related sinusoids
- Fourier series of a periodic signal; evaluation of coefficients, properties
- LTI filters and impulse response, FIR filters
- FIR filters and finite duration inputs: linear convolution
- FIR filters with sinusoidal and exponential inputs: frequency response, system function

Learning Outcomes

- Ability to apply knowledge of math, science, & engineering (Significant)
- Ability to design/conduct expt. & analyze/interpret data (Moderate)
- Ability to identify, formulate, and solve engineering problems (Moderate)
- Techniques, skills, and modern engineering tools necessary for engineering practice (Significant)