ECE 311: Linear Systems Analysis I

IN

Calculus

- Integrate and differentiate
- Determine sums of basic series
- Understand the fundamental theorem of calculus
- Understand and apply trigonometric identities

Complex Arithmetic

- Analyze signals via Fourier Transform (forward and inverse using tables) for frequency content
- Understand properties of Fourier Transform, especially time-domain convolution versus frequency domain multiplication
- Analyze causal signals via one-sided Laplace Transform (forward and inverse tables)
- Understand properties of Laplace Transform, especially time-domain convolution versus frequency domain multiplication AND final value theorem for steady state analysis

ODEs

- Solve linear ordinary differential equations
- Identify homogenous and particular solutions to an ODE

RLC and Op AMP

- Analyze n^{th} order RLC and Op Amp circuits and create a corresponding ordinary differential equation

Pre-requisites

- ECE202 with a minimum grade of C; MATH340 with a minimum grade of C; ECE331, may be taken concurrently; ECE341, may be taken concurrently OR ECE202 with a minimum grade of C; MATH340 with a minimum grade of C; ECE451, may be taken concurrently or ECE528, may be taken concurrently or CS356, may be taken concurrently

Concepts:

- Continuous-time and discrete-time test signals:
  - Impulses
  - Unit-steps
  - Sinusoids
  - Complex exponentials
- Periodic signals in continuous-time and discrete-time
- Energy and power of a signal
- Linearity, time-invariance, causality, and stability for continuous-time and discrete-time systems
- Impulse response, convolution integral, and convolution sum for LTI systems
- Complex exponentials as eigenfunctions of LTI systems
- Fourier series for continuous-time and discrete-time periodic signals
- Fourier transforms for continuous-time and discrete-time aperiodic signals
- Energy/power spectral density and Parseval identities
- Frequency response, magnitude spectrum, and phase spectrum of LTI systems
- Connection between frequency response, impulse response, and ordinary differential equation representations of LTI systems
- Ideal lowpass, bandpass, and highpass filters
- Basic modulation and demodulation
- Shannon-Nyquist sampling and aliasing

Applications:

- Communication
- Signal Processing
- Control
- Circuits
- Optics

Tools:

- MATLAB

OUT

Signals

- Understand standard test signals in continuous-time and discrete-time and their connections via sampling
- Understand periodicity and compute the period of a periodic signal
- Understand energy and power and compute them

Fourier Analysis

- Understand frequency harmonics and spectrum, and bandwidth of signals
- Compute Fourier transforms and Fourier series for standard signals
- Understand the impact of elementary transformations on the spectrum of a signal

LTI Systems

- Understand causality, stability, and their connections with impulse response
- Understand linearity and time invariance
- Understand convolution and compute the response of an LTI system to an arbitrary input
- Understand complex exponentials as eigenfunctions of LTI systems
- Understand frequency response of an LTI system and compute magnitude and phase spectra
- Understand the interplay between time domain and frequency domain analyses of LTI systems

Sampling

- Understand Shannon-Nyquist sampling theorem
- Understand the consequences of aliasing
- Specify anti-aliasing filter and sampling rate for alias-free A/D conversion

Simulation

- Analyze systems in time and frequency domain using MATLAB and/or Simulink tools

Reviewed 2/2024