EECS 361-Course Objectives, Outcomes, and Topics

Course Objectives: Students will be able to:

1. Describe continuous and discrete signals and systems in the time and frequency domains.
2. Understand how to classify signals as periodic or aperiodic and power or energy signals,
3. Understand how to classify systems as linear/non-linear, time-invariant/time-varying, causal/non-causal, and BIBO stable/unstable.
4. Understand and be able to use the special functions, including impulse, step, and pulse functions.
5. Perform continuous and discrete time convolution.
6. Determine the time and frequency characteristics of continuous and discrete time systems.
7. Represent periodic signals using Fourier series and construct spectral plots.
8. Represent aperiodic signals using the Fourier transform.
9. Understand the properties of the Fourier transform.
10. Use Parsaval's theorem for periodic and aperiodic signals to determine signal power and energy.
11. Determine the output of linear time-invariant systems with a periodic and aperiodic inputs.
12. Understand the concept of bandwidth and the signal duration/bandwidth relationship.
13. Understand the characteristics of ideal filters.
14. Understand the criteria for distortionless transmission.
15. Understand the Sampling Theorem and its application.
16. Understand how to apply the z-transform to discrete time signals and systems.
17. Understand digital filters, transfer functions for discrete systems, and digital filter design.
18. Understand the Discrete Fourier Transform (DFT), its parameters and properties, including spectral leakage and windowing.
19. Understand how to use the DFT to perform linear convolution.
20. Analyze a basic feedback control system for stability and how to design for stability.
21. Determine appropriate tools to apply to signals and systems problems.

Outcomes: Students should be capable of:

1. Performing continuous and discrete time convolution
2. Determining properties of time linear time invariant systems and performing linear system analysis
3. Using Fourier transforms of signals and impulses responses for linear system analysis.
4. Forming discrete time Fourier transforms of signals for linear system analysis.
5. Forming z-transforms and application to discrete time linear system analysis
6. Discrete time filter design.

<u>**Topic/Chapter/Section**</u>

1. Class introduction and discussion of class syllabus.

2. Signals (~2 weeks)
   - 2.1. Types of signals
   - 2.2. Review of complex numbers
   - 2.3. Signal transformations
   - 2.4. Waveform properties
   - 2.5. Nonperiodic waveforms
   - 2.6. Signal power and energy

3. Linear Time-Invariant Systems - Continuous Time (~2 week)
   - 3.1. Linear time-invariant systems
   - 3.2. Impulse response
   - 3.3. Convolution
   - 3.4. Graphical convolution
   - 3.5. Convolution properties

3.6. Causality and BIBO stability
3.7. LTI sinusoidal response
3.8. Impulse response of second-order systems

4. Fourier Analysis Techniques (~5 weeks)
   4.1. Phasor-domain technique
   4.2. Fourier series analysis technique
   4.3. Fourier series representations
   4.4. Sine/Cosine representation of Fourier series
   4.5. Amplitude/phase representation of Fourier series
   4.6. Exponential representation of Fourier series
   4.7. Fourier series symmetry considerations
   4.8. Circuit analysis with Fourier series
   4.9. Parseval's theorem for periodic waveforms
   4.10. Fourier transform
   4.11. Fourier transform properties
   4.12. Fourier transform pairs
   4.13. Parseval's theorem for Fourier transforms
   4.14. Additional attributes of the Fourier transform
   4.15. Phasor vs. Laplace vs. Fourier
   4.16. Circuit analysis with the Fourier transform
   4.17. The importance of frequency domain phase information
5. Applications of the Fourier Transform (~1.5 Weeks)
   5.1 Filtering a 2-D image
   5.2 Filter types
   5.6 Bandpass filters
   5.7 RLC highpass, lowpass and bandreject filters
   5.8 Filter order and second order filters
   5.9 Ideal brick-wall filters
   5.10 Signal bandwidth
   5.12 Double-sideband amplitude modulation (DSB-AM)
   5.13 Mixing, frequency division multiplexing (FDM)
   5.14 Sampling analog signals
   5.15 Shannon's sampling theorem
   5.16 Aliasing

6. Discrete-Time Signals and Systems with Applications (~5 weeks)
   6.1 Discrete signal notation and properties
   6.2 Discrete-time signal functions
   6.3 Discrete-time LTI systems
   6.4 Properties of discrete-time LTI systems
   6.5 Discrete-time convolution
   6.6 The z-transform
   6.7 Properties of the z-transform
   6.8 Inverse z-transform
   6.9 Partial fractions method for inverse z-transform
   6.10 System transfer function H(z)
   6.11 BIBO stability of H(z)
   6.12 System frequency response
   6.13 Discrete-time filters, and role of poles and zeros
   6.14 Discrete-time filter types
   6.15 Notch filters
   6.16 Comb filters
   6.17 Discrete-time Fourier series (DTFS)

6.18 Discrete-time Fourier transform (DTFT)
6.19 Discrete Fourier transform (DFT)
6.20 Windowing in DFT
6.21 DFT and convolution
6.22 Data windows
6.23 Deconvolution and filtering using the DFT
6.24 Finite impulse response (FIR) filters, and FIR design by windowing
6.25 FIR filter design methods
6.26 Infinite impulse response (IIR) filters
6.27 IIR bilinear transform filter design

7. Basic Control Theory (~0.5 weeks)

8. Spectrograms