ECE 311: Linear Systems Analysis I

**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

**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

**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