ECE/MATH 430: Fourier and Wavelet Analysis with Apps

**Concepts:**
- Elementary signals and systems
- Periodic and trigonometric signals
- Fourier series for periodic signals
- Pointwise representation and convergence
- Expanding a function in an orthogonal basis
- Discrete Fourier transform
- Fast Fourier transform
- Lebesgue integration and measurable functions
- Function spaces, Ck, L1, L2, and Hilbert spaces
- Fourier transform on L1 and L2
- Convolution and Fourier transform
- Tempered distributions and generalized functions
- Fourier transform of distributions
- Sampling
- Uncertainty principle
- Poisson formula and aliasing
- Limitations of Fourier transform for time-frequency analysis
- The continuous wavelet transform and its inverses
- Multiresolution analysis
- The discrete wavelet transform and its inverse

**Applications:**
- Communication
- Signal Processing
- Control
- Circuits
- Optics

**Tools:**
- MATLAB

**Real and Functional Analysis**
- Understand metric spaces, Cauchy sequences, limits, and convergence
- Understand functional spaces including L1 and L2
- Understands functions as vectors
- Understand Hilbert spaces, inner products, and orthogonality
- Understand the basics of distribution theory

**Time-Frequency Analysis**
- Use Fourier methods to analyze frequency content of signals
- Understand spectra and frequency harmonics
- Understand convergence results for Fourier series and transform
- Understand Fourier transform of distributions
- Understand the uncertainty principle and its consequences
- Use MATLAB for time-frequency analysis with FFT and iFFT

**Multi-Resolution Analysis**
- Understand limitations of Fourier transform for time-frequency analysis and the need for wavelets
- Understand continuous wavelet transform and multi-resolution analysis
- Understand discrete wavelet transform and multi-resolution analysis
- Use MATLAB for wavelet transform

**Calculus**
- Understand limits and continuity
- Integrate and differentiate
- Determine sums of basic series
- Understand and apply trigonometric identities

**Complex Arithmetic**
- Understand fundamentals of complex numbers
- Express complex numbers in Cartesian and polar coordinates

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

**Pre-requisites**
- MATH 340 or MATH 345

Reviewed 2/2021