

ECE/MATH 430: Fourier and Wavelet Analysis with Apps

IN

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

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, C_k , L_1 , L_2 , and Hilbert spaces
- Fourier transform on L_1 and L_2
- 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

OUT

Real and Functional Analysis

- Understand metric spaces, Cauchy sequences, limits, and convergence
- Understand functional spaces including L_1 and L_2
- 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