MATH 634
HARMONIC ANALYSIS

SYLLABUS
Fall 2015

Instructor: John J. Benedetto
Time: Tuesday/Thursday, 11 - 12:15
Place: MATH 1311
Prerequisites: Real analysis or permission of instructor
Office hours: To be settled during the first week of class
Grading: Based on homework, a project, and classroom participation.
Text: *Harmonic Analysis and Applications* (by the instructor) and course notes supplied by the instructor.

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COURSE MATERIAL

1. Fourier analysis on Euclidean spaces including Fourier series
2. Distribution theory and applications
3. Fourier analysis on locally compact abelian groups
4. The uncertainty principle
5. Modern applications of Fourier analysis
6. Discrete Fourier series (DFT) and the Fast Fourier Transform (FFT)
5. Sampling theory and the relations between Fourier transforms, Fourier series, and DFTs
6. Background for time-frequency analysis, wavelet theory on Euclidean spaces and local fields, image processing, dimension reduction compressive sensing, Wiener's Generalized Harmonic Analysis, and frames

COURSE THEMES
SPECIAL TOPICS FOR PROJECTS

1. The fundamental relation between Fourier analysis and number theory in topics such as the FFT, spectral synthesis, the p-adics, uniform distribution, Kronecker’s theorem, the HRT conjecture, and the Riemann zeta function.
2. Carleson's theorem for Fourier series and recent related research.
3. Algebraic and geometric fundamentals of harmonic analysis, e.g., factorization and automorphisms of group algebras and the characterization of idempotent measures.
4. Beurling algebras, weighted norm inequalities, spectral analysis.
5. Statements and discussions of specific open problems and general unresolved issues: the uncertainty principle, MRI and non-uniform sampling, the Fuglede conjecture and the results of Tao, deterministic compressive sensing and the results of Bourgain, ambiguity functions and Wigner distributions, waveform design and the construction of sequences in terms of Weil’s solution of the Riemann hypothesis for finite fields, the characterization of the space of absolutely convergent Fourier transforms.

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