

APM 598 -- Fourier Analysis and Wavelets, Fall 2018

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Course Description

Fourier series and Wavelets are important mathematical building blocks for signal analysis and many other areas in science and engineering. Fourier series is the study of how a function (or signal) can be decomposed into a sum of sine and cosine waves of various frequencies. Wavelets are similar to sines and cosines in that they look like waves of various frequencies. However, they are different in that wavelets have localized support (unlike sine and cosine waves which keep repeating forever). This localization feature of wavelets allows the user to filter or modify certain parts of the signal without affecting other parts.

This course will present an overview of Fourier and Wavelet Analysis along with some applications. The goal of this course is to present the general ideas behind the construction of Fourier series and Wavelets with a 50/50 mix of theory and computation/applications. The technical jargon of signal analysis and other fields of applications will be minimized.

No prior knowledge of Fourier series or wavelets will be assumed. The prerequisites are a three semester calculus sequence, linear algebra (MAT 343) and being comfortable with epsilon-delta proofs in analysis. Some computer programming experience would be very helpful (especially with Matlab).

Text

The required text for this course is *A First Course in Wavelets and Fourier Analysis, 2nd Edition*, by Boggess & Narcowich, 2009, Wiley.

Other (optional) references include:

- *A First Course in Wavelets* by Hernandez, CRC Press, 1996 (in the library QA403.3.H47).
- *Wavelets and Other Orthogonal Systems with Applications*, by Walter, CRC Press, 1994 (in the library QA403.3.W34)

- *Wavelets, Mathematics and Applications*, edited by Benedetto and Frazier, CRC Press, 1993. See especially the article by Strichartz (pg 23-51) (in the library QA403.3.W4)
- *Introduction to Wavelets and Wavelet Transforms, a Primer* by Burns, Gopinath, Guo, Prentice Hall, 1998.
- *Wavelets, Algorithms and Applications*, by Meyer, SIAM Publications, 1993.
- *Fourier Series*, by Tolstov, Dover Press, 1962 (in library QA404.T573).

Grading

Grades will be determined by problem sets, one midterm exam and a final exam. Depending on the class size and schedule, oral presentations of problems by students on the board will occur from time to time.

The grade weights are as follows:

- Problem Sets – 30%
- Midterm – 30%
- Final Exam – 40%

The midterm and final exam will be in-class exams and you will be required to do your own work without help from others. You will be allowed to use your text and notes during the exams. You may consult with each other on homework problem sets, BUT only submit work which is in your own words AND be sure to cite any sources of help (either texts or people).

Tentative Schedule

Fourier series and inner products (4 weeks; chapter 1, parts of chapter 0)

Fourier transform (2 weeks; chapter 2)

Discrete Fourier analysis (1 week; chapter 3)

Haar wavelet (1.5 weeks; chapter 4)

Multiresolution analysis (2.5 weeks; chapter 5)

Daubechies wavelets (2 weeks; chapter 6)

Other wavelet topics (1 week; chapter 7)