Math 2025, Section I
Wavelets and other Integral Transforms

Textbook: Wavelets made easy. Author: Yves Nievergelt. Also **lecture notes** published on my web-page

Time: 9:10–10:30, Tuesday and Thursday in Lockett 239

Instructor: Gestur Olafsson

Office: 322 Lockett

Office Hours: T, Th 12:10–1:00 PM and W. 2:00-300. You can also contact me after class or by e-mail for other appointments.

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web-page: www.math.lsu.edu/~olafsson . This syllabus along lecture notes, homework problems, test dates, and solutions to tests, quizzes and homeworks will be available at this address. You can also find old quizzes and tests, with solution, here.

Syllabus

- Functions, translation and dilation.
- Chapter 1: Haar's Simple Wavelets
- Parts of chapter 2: Multidimensional wavelets and applications
- Chapter 4, Vector spaces, inner product, linear transformations, projections. The wavelet transform as a linear projection/
- Material on the Discrete Fourier Transform and the Fast Fourier Transform from chapter 5
- Material from chapter 6 on Fourier series
- If there is still some time left, some material from chapter 7 on Fourier Integrals.

The theory of wavelets is a relatively recent mathematical theory. It is the basic theory behind several modern applications in storage of electronic information, data compression, image reconstruction and electronic transmission of information. The applications includes the storage of finger prints, and the new jpg-standard. In the first part we will mainly be working with average and details of functions (or signals). The second part is linear algebra and applications to spaces of functions. In the third part more knowledge of calculus, in particular integration, will be required.

We start by discussing the simplest wavelets, the Haar wavelet in one dimension. The main topics are the **fast Haar wavelet transform**. But first we give a short overview over **functions**, and **translation** and **dilation** of functions. In the next section we discuss the **two dimensional Haar wavelet** and some applications.
The next topic is **basic linear algebra**. In particular we discuss vector spaces, linear transformations, orthogonal basis, subspaces, and the applications to the theory of wavelets.
Finally, few aspects of **the Fourier Transform** are discussed. We start by introducing the complex exponential function, the **Fast Fourier Transform (FFT)** and the **Discrete Fourier Transform (DFT)**. If we still have time left, then we will also introduce the **Fourier Transform** and discuss its basic properties.

There will be **three** tests in class (each 100 points): **Th Sept 26, T. Oct. 29, T. Nov. 26**, and the final exam (200 points): **M. Dec. 9, 7:30–9:30 AM** (this class room). There will be home work and irregularly unannounced quizzes in class **at least onceevery week**, 8 highest scores will be counted towards to final grade (80 points).

	Points
Tests in class	300
Homework/Quizzes	80
Final	200
Total	580

Final Grades

A>522, B>464, C>406, D≥348. F<348

There are several good and readable books on wavelets. Here are few of them:

M.W. Frazier: *An Introduction to Wavelets Through Linear Algebra* (Springer)
B.B. Hubbard: *The World According to Wavelets: The Story of a Mathematical Technique in the Making.* Second ed.
A.K. Peters, 1998. (Great reading for every one who is interested in the subject!)