Math 2025, Section I
Wavelets made easy

Textbook: Wavelets made easy. Author: Yves Nievergelt, and lecture notes.
Time: 9:10–10:30, Tuesday and Thursday in Lockett 237)
Instructor: Gestur Olafsson
Office: 322 Lockett
Office Hours: T, Th 10:40–11:20. You can also contact me by e-mail for other appointments.
Phone: 225-578-1608
e-mail: olafsson@math.lsu.edu or olafsson@lsu.edu
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

• Chapter 4, Vector spaces, linear transformations, and orthogonal projections;
• Chapter 1: Haar’s Simple Wavelets
• Parts of chapter 2: Multidimensional wavelets and applications;
• Selected material from section 3;
• Material on the Discrete Fourier Transform and the Fast Fourier Transform from chapter 5;
• If there is time, then we will discuss some material from chapter 6 on Fourier series

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 (see: http://www.c3.lanl.gov/brislawn/FBI/FBI.html), and the new jpg-standard.

The basic ideas can be formulated using the language of linear algebra: Vector spaces, subspaces, linear maps, inner product, orthogonal projections, and basis. Related related concept in analysis are: Vector spaces of functions, best approximation of functions, dilation and translation, change of basis.
• We start by discussing some **linear algebra** from chapter 4. The important concepts are as mentioned above: Vector spaces, linear maps, inner product, basis and orthogonal basis, orthogonal projections. We will give several examples, that will be used later.

• Then we discuss the simplest wavelet, the Haar wavelet in one dimension. The main topic is the **fast Haar wavelet transform**. This is a special case of orthogonal projections and change of basic.

• After that we discuss the **two dimensional Haar wavelet**, general construction of wavelets, and some applications.

• The wavelet transform is only one example of **integral transforms**. The **Fourier Transform** is much older. It has become an indispensable tool in mathematics and applied sciences. We will discuss some aspects of the Fourier Transform starting with the Fast Fourier transform. Before doing that, we will need to introduce the field of complex numbers, and the complex exponential function. If there is enough time, then we will also go over the the **Discrete Fourier Transform/Fourier series**.

There will be **two** tests in class (each 100 points, Tuesday, Sept 23 and Tuesday, Oct. ). We will either have a test (Tuesday, Nov25) or a project (100 points, due Dec. 2). The final exam (200 points) will take place **Sat. Dec. 13, 10–Noon**. There will be quizzes in class or homework every week, 7 highest scores will be counted towards to final grade (70 points).

### Points

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<tbody>
<tr>
<td>Tests and project</td>
<td>300</td>
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<tr>
<td>Homework/Quizzes</td>
<td>70</td>
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<td>Final</td>
<td>200</td>
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### Final Grades

A > 513, B > 456, C > 399, D>342. F <342