

DAT-494, MAT 494 -- Fourier Analysis, Wavelets, and Applications - Syllabus (taught as a 3-credit hour I - course – B-session, fall 2022)

Instructor - Al Boggess (boggess@asu.edu)

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 intuitively present the general ideas behind the construction of Fourier series and Wavelets through examples, along with applications to signal analysis. 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 (e.g. MAT 265, 266, 267), and linear algebra (e.g. MAT 343). Some exposure to computer programming experience would be helpful (especially with Matlab).

Text

Lecture notes will be provided (posted) based on the first optional reference listed below. Also, there will a complete set of on-line lectures. You will not need to purchase a text.

Other (optional) references include:

- *A First Course in Wavelets and Fourier Analysis, 2nd Edition*, by Boggess & Narcowich, 2009, Wiley.
- *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.

The grade weights are as follows:

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

The midterm and final exam will be on-line exams and you will be required to do your own work without help from others.

You may consult with other students on homework problem sets, but only submit work which is in your own words. Be sure to cite any sources of help (either texts or people).

Tentative Schedule (B session as an I-course)

Fourier series and inner products (2 weeks)

Fourier transform (1 weeks)

Discrete Fourier analysis (1 week)

Haar wavelet (1/2 week; chapter 4)

Multiresolution analysis (1.5 weeks)

Daubechies wavelets (1 week)

Other wavelet topics (as time permits)

Addendum to the syllabus

Inclusivity.

The School of Mathematical and Statistical Sciences encourages faculty to address and refer to students by their preferred name and gender pronoun. If your preferred name is different than what appears on the class roster, or you would like to be addressed using a specific pronoun, please let me, your instructor, know.

The following items related to students' rights and responsibilities are required by ASU to be included in every syllabus.

Academic Integrity.

Academic honesty is expected of all students in all examinations, papers, laboratory work, academic transactions and records. The possible sanctions include, but are not limited to, appropriate grade penalties, course failure (indicated on the transcript as a grade of E), course failure due to academic dishonesty (indicated on the transcript as a grade of XE), loss of registration privileges, disqualification and dismissal. For more information, see <http://provost.asu.edu/academicintegrity>.

Accommodating Students with Disabilities.

Students who feel they will need disability accommodations in this class but have not registered with the Disability Resource Center (DRC) should contact DRC immediately. The DRC Tempe office is located on the first floor of the Matthews Center Building. DRC staff can also be reached at: (480) 965-1234 (V) or (480) 965-9000 (TTY). For additional information, visit: www.asu.edu/studentaffairs/ed/drc.

Absences.

Please notify the instructor as soon as possible, but no later than the end of the second week of the term, about anticipated excused absences related to religious observances/practices or university sanctioned events activities that are in accordance with [ACD 304-04 "Accommodations for Religious Practices"](#) or [ACD 304-02 "Missed Classes Due to University-Sanctioned Activities"](#) so that your instructor can work with you to reschedule missed tests and due dates.

Policy against threatening behavior. Please see the following link: [\(Student Services Manual "Handling Disruptive, Threatening or Violent Individuals on Campus"\)](#):

Title IX

Title IX is a federal law that provides that no person be excluded on the basis of sex from participation in, be denied benefits of, or be subjected to discrimination under any education program or activity. Both Title IX and university policy make clear that sexual violence and harassment based on sex is prohibited. An individual who believes they have been subjected to sexual violence or harassed on the basis of sex can seek support, including counseling and academic support, from the university. If you or someone you know has been harassed on the basis of sex or sexually assaulted, you can find information and resources at <https://sexualviolenceprevention.asu.edu/faqs>.

As a mandated reporter, I (the instructor) am obligated to report any information I become aware of regarding alleged acts of sexual discrimination, including sexual violence and dating violence. ASU Counseling Services, <https://eoss.asu.edu/counseling>, is available if you wish discuss any concerns confidentially and privately.