ECE 161A - Introduction to Digital Signal Processing

Fall 2025 - Syllabus

Digital Signal Processing (DSP) is a cornerstone of modern electrical engineering, powering technologies from smartphones and wireless communication to medical imaging, ocean exploration, and earthquake monitoring. Its methods also play a central role in audio, speech, and emerging areas such as robotics and machine learning.

In this introductory course, students will explore the fundamentals of signal representation and analysis. Key topics include the z-transform, the fast Fourier transform (FFT) for efficient spectral analysis, and the design of digital filters—both finite impulse response (FIR) and infinite impulse response (IIR). We will also discuss how filters are implemented in real systems and how practical issues such as finite precision effects influence performance.

This class blends theory with applications, equipping students with the mathematical tools and practical skills to tackle real-world engineering challenges where signals and data drive innovation.

Time and place: Lectures are on Tuesdays and Thursdays 3:30PM – 4:50PM in FAH 1450. A discussion session will be held on Wednesdays 2:00PM – 2:50PM in PODEM 1A20.

Instructor:

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Teaching Assistant (TA):

Luisa Watkins
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Course Website: Handouts and homework assignments will be posted on the Canvas website.

Bibliography: Our main textbook will be

> *Discrete-Time Signal Processing*, Alan V. Oppenheim and Ronald W. Schafer, Prentice Hall, 2009.

In particular, the course will cover the following sections in the main textbook. The learning objectives of this course are to master the concepts covered in these sections listed below.

- Chapter 3: 3.1 – 3.5 (Z-transforms)
- Chapter 5: 5.1, 5.5, 5.7 (Group delay, All-Pass Filters, linear phase filters)
- Chapter 6: 6.1 – 6.5, 6.7, 6.8 (Filter implementation and finite precision effects)

- Chapter 7: 7.1 – 7.7 (Filter design: IIR and FIR)
- Chapter 8: 8.1 – 8.7 (DFT and linear convolutions using DFT)
- Chapter 9: 9.2, 9.3 (FFT)

This textbook will be on reserve at the UCSD library. Additional references are the following textbooks.

- *Signals, Systems, and Signal Processing*, Palghat P. Vaidyanathan, 2024.
- *Digital Signal Processing using Matlab*, Vinay Ingle and John Proakis, Cengage Learning, 2016.

Prerequisites: A required prerequisite for this course is ECE 101A. In particular, you must be familiar with discrete-time systems, the Fourier transform of discrete signals, and the sampling theorem. These concepts are covered by the following sections in the textbook.

- Chapter 2: 2.1 – 2.9 (LTI systems, Fourier transform of discrete-time signals)
- Chapter 4: 4.1 – 4.5 (Sampling theorem)
- Chapter 5: 5.2 – 5.3 (Difference equations, transfer functions, poles and zeros)

Grades: Grades will be assigned based on the weekly homework and the mid-term/final exams. The homework assignments count 25%, the mid-term exam counts 25%, and the final exam counts 50%. Homework consists of weekly assignments (20%) and online quizzes (5%).

Homework: Theoretical problems and problems to be solved in Matlab will be posted every Thursday on the course website and will be due one week later.

Office Hours: Office hours are Wednesdays 3:30PM – 4:30PM via Zoom with Florian Meyer (Class Material) and at the same time in Jacobs Hall, Room 4312 with Luisa Watkins (Homework). Zoom links are available on the Canvas calendar.