ECE 251A / SIO207B – Digital Signal Processing I

Winter 2025 – Syllabus

Digital signal processing is a key subject in electrical engineering, with applications in wireless communication, medical analytics, ocean sciences, seismology, and related areas. This course covers advanced statistical and adaptive signal processing methods. In particular, we will discuss discrete random signals, conventional (FFT-based) spectral estimation, model-based spectral estimation, linear prediction and AR modeling, the Levinson-Durbin algorithm and lattice filters, as well as minimum variance spectrum estimation.

Summary of topics discussed:

1. Short-time Fourier transform (STFT)
2. FFT-based power spectrum estimation (periodograms, modified periodogram, ..)
3. Model-based power spectrum estimation including moving average (MA), autoregressive (AR), and ARMA models
4. AR models and linear minimum mean squared estimation (Levinson-Durbin algorithm and lattice filters)
5. Minimum variance distortionless response (MVDR) power spectrum estimation

Time and place: Lectures are on Mondays and Wednesdays 12:30PM – 1:50PM in PODEM 1A18.

Instructor:

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Teaching Assistant (TA):

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

Prerequisites: The prerequisites for the course are a ECE 161A and ECE 153. In particular, students should be familiar with the following topics and concepts: discete-time Fourier transform, z-transforms, FIR filters, discrete Fourier transform (DFT), linear time-invariant (LTI) systems, wide sense stationary (WSS) random processes, power spectrum.

Bibliography: The main reference for this course is the textbook

- *Statistical and Adaptive Signal Processing: Spectral Estimation, Signal Modeling, Adaptive Filtering, and Array Processing*, Dimitris G. Manolakis, Vinay K. Ingle, and Stephen M. Kogon. McGraw-Hill, 2000.

Additional references include the following

- *Discrete-Time Signal Processing*, Alan V. Oppenheim and Ronald W. Schafer. Pearson Education, 2014.
- *Introduction to Spectral Analysis*, Petre Stoica and Randolph L. Moses. Prentice Hall, 1997.
- *Adaptive Filter Theory*, Simon O. Haykin, Pearson Higher Education, 2013.
- *Fundamentals of Adaptive Filtering*, Ali H. Sayed. John Wiley & Sons, 2003.

Grades: Grades will be assigned based on the weekly homework problems and the mid-term/final exams. The homework assignments count 25%, the mid-term exam counts 30%, and the final exam counts 45%.

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

Collaboration Policy: The goal of homework is to give you practice in mastering the course material. The developed solutions you hand in must be original work. Do not study old solutions. You are encouraged to form study groups to discuss the course material and problem sets. Please review the academic integrity document at *academicintegrity.ucsd.edu*.

Office Hours: Office hours are every Friday at 2 PM via Zoom with Florian Meyer (Class Material) and Mingchao Liang (Homework).