

**ECE Department
University of Arizona**

ECE 429/529: Digital Signal Processing

Spring 2008

Instructor

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Textbook

- J. G. Proakis, and D. G. Manolakis, *Digital Signal Processing: Principles, Algorithms, and Applications*, 4th edition, Prentice-Hall, 2007.

References:

- V. K. Ingle, and J. G. Proakis, *Digital Signal Processing using MATLAB*, Brooks/Cole, 2nd edition, 2007.

Office Hours

- 2:00 PM – 4:00 PM, Wednesday
- 2:00 PM – 4:00 PM, Friday

Prerequisites

ECE 340 and Math 322 – You **must** understand Fourier principles.

Homeworks and Computer Assignments

- Homeworks will be assigned approximately every 1-2 weeks and will be due the following week at the beginning of class.
- Two computer assignments will be given

Exams

No makeup exams will be offered. If you miss an exam (due to legitimate, and unavoidable circumstances), the score for that exam will be 90% of the average of your two other exams.

- **Exam I** is scheduled for Thursday, February, 21, 2008
- **Exam II** is scheduled for Thursday, April 3, 2008

Final Exam

Scheduled for Tuesday, May 13, 2008, 11:00 a.m. - 1:00 p.m.

Grading

	ECE 429	ECE 529
Homework	10%	10%
Computer Assignments	25%	30%
Exam #1	20%	20%
Exam #2	20%	20%
Final Exam	25%	20%

Attendance

If your score is between two grades, the attendance will determine the final grade.

Tentative Course Outline

<i>Topic</i>	<i>Text Chapter</i>
Introduction	1
Discrete-Time Signals and Systems	2
The z-Transform	3.1-3.5
Frequency Analysis of Signals and Systems	4
Frequency-Domain Analysis of LTI Systems	5
The Discrete Fourier Transform (DFT)	7
Implementation of Discrete-Time Systems	9.1-9.3
Design of Digital Filters	10.1-10.4
Sampling and Reconstruction of Signals	6
Other Topics (if Time Permits)	

Course Objectives

To give the student the mathematical tools and intuition for processing digital signals in the time, frequency and z domains. Students will learn how to filter, modify, analyze, and extract information from digital signals.

Upon completion of the course, the student should be able to:

- Apply simple sequences (unit sample, step, sinusoid) to low-order system block diagrams (2-tap FIR, 1-delay IIR) and hand-calculate the system output.
- Given the difference equation of a DT system, be able to apply tests to demonstrate linearity, time-invariance, causality, and stability.
- Perform discrete-time convolution.
- Find the impulse response of a digital filter from a linear difference equation using the homogeneous solution method.

- Perform tabular calculations to find autocorrelations and cross-correlations for discrete sequences and be able to estimate the delay from the cross-correlation in a simple radar application.
- Calculate the z-transform of simple sequences (exponentials, sinusoids), specify the region of convergence (ROC) and the bounding poles, state whether the DTFT exists, and predict whether the sequence is left-hand, righthand, or two-sided.
- Apply z-transform properties and theorems, notably time shifting, convolution, time reversal, and multiplication by an exponential sequence.
- Find the time sequence corresponding to a rational z-transform and a given ROC, using power series expansion and partial fraction expansion.
- Apply z-transforms to find the (output) response of a digital filter.
- Calculate and plot the steady-state frequency response of an LTI system and thence the steady-state output when an input sinusoid is given.
- Apply the inverse DTFT to design ideal filters (lowpass, highpass, ...); apply DTFT theorems to compute spectra of sampled, compressed, and expanded sequences.
- Explain the relationship between linear phase and time delay; design simple digital filters such as comb and notch filters to remove unwanted interference and noise.
- From the poles and zeros of a transfer function, sketch the gain response $|H(e^{j\omega})|$.
- Convert digital filters to minimum-phase filters & explain why this is advantageous.
- Apply DFT properties and symmetry relationships to compute forward and inverse transforms of simple sequences.
- Use the DFT to compute convolutions and cross-correlations between sequences.
- Design the parameters associated with DFT implementation (sampling rate, record length, and window type) to provide an accurate analysis of the frequency and strength of dominant frequency components in a signal.
- From a given signal flow graph, derive the transfer function $H(z)$; design simple filter architectures (signal flow graphs) to realize digital filter transfer functions.
- Design digital FIR filters to meet specific filtering criteria, including linear phase properties.
- Design digital IIR filters to satisfy given cutoff frequencies and attenuation factors.
- Explain how and why continuous signals can be sampled and reconstructed with little or no distortion.
- Design block diagram systems for signal interpolation and decimation.
- Verify many of the above phenomena using Matlab software applied to audio and other waveforms, and submit written reports supporting all results.

Academic Integrity: The University's Code of Academic Integrity (available at <http://dos.web.arizona.edu/uapolicies/>) is based on the guiding principle that a student's submitted work must be the student's own. This policy will be applied to all work

submitted for a grade, including exams, projects, and homework. Copying previously posted solutions or solution manuals is strictly forbidden; anyone violating this policy will receive zero credit for homework for the entire semester. All work must be original. The minimum penalty for submitting work that is not your own is an E grade. Repeated violations may result in expulsion from the university.

Study Groups: Working in study groups can be beneficial if everyone participates. Therefore, while working in study groups is allowed and even encouraged, all work submitted for a grade must be your own. When this rule is violated, the guilty student will receive a grade of zero on the offending item. Cheating will not be tolerated.