Digital Signal Processing
Spring, 2022
Lecture: on M W F, 10:00 – 10:50 in Speare 117
Lab: on M W, 14:00 – 16:50 in Workman 187

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Course Description: Digital signal processing (DSP) uses a sequence of numbers to represent samples of a continuous variable in a domain such as time, space and frequency. Due to its flexibility and economical implementation, DSP has been adopted in a wide range of applications. This course will cover the principles of digital signal processing. Topics include: discrete-time signals and systems, frequency analysis of signals, z-transform, discrete and fast Fourier transform, infinite and finite impulse response filters, and implementation of real-time DSP algorithms on state-of-the-art hardware.

Mode of Instruction: Face-to-face lectures on M W F, 10:00 - 10:50 in Speare 117. Lecture recordings are uploaded to Canvas (access through Canvas – *Panopto Recordings* tab).

Pre-requisites/Co-requisites: *EE 311 (Signals and Linear Systems) and EE 351 (Microcontroller)*

Place in Curriculum: This is a senior level required course for majors in Electrical Engineering.

Course Learning Outcomes:
After completion of this course, students are expected to be able to:
- Analyze discrete-time signals using Fourier series and Fourier transform.
- Analyze and design discrete-time systems using z-transform.
- Perform discrete Fourier transform of discrete-time signals.
- Design FIR and IIR filters to meet expected system specifications.
- Design difference equations to meet expected system specifications.
- Implement digitals filters using MATLAB and on DSP board.
- Use computer and digital signal processor to create, analyze and process signals.
- Understand the limitations of digital signal processing.

Program Learning Outcomes: https://www.nmt.edu/academics/eleceng/undergrad/index.php

Course Requirements:
Textbook: *Proakis and Manolakis, Digital Signal Processing: Principles, Algorithms, and Applications, 4th Edition, Prentice Hall, 2007.*

Grading:

- Homework: 20%
- 2 Midterms: 20% each
- Final: 20%
- Labs: 20%

A	90-100	C	70-72
A-	86-89	C-	66-69
B+	83-85	D+	63-65
B	80-82	D	60-62
B-	76-79	F	<60
C+	73-75		

Homework and exams: There will be 5 homework, 2 midterm exams and 1 final exam. Homework grading is more effort-based while exams require you to complete the problems correctly. In other words, exams are graded more harshly than homework. Homework will be available by the date when the needed materials have been covered in the courses. Homework will be due by one week after the available date, e.g., if HW 1 is available on Feb. 5, it is due by 11:59 pm on Feb. 11. Submission of homework will be done via Canvas online assignment portal. Exams will be done in the classroom on the scheduled dates. Students may work together on homework but must turn in individual assignments that CANNOT BE IDENTICAL. Late homework will not be accepted unless requested via email before the due date with a valid reason. Students must work on exams individually. There will be no make-up exams except in the case of extraordinary circumstances.

Labs: There will be a total of 8 labs. Each lab requires students to submit a report. In the report, students need to clearly explain how the lab is completed, observations and conclusions. The report will be due by 11:59 pm on Wednesday of the first week of the next lab (avoid procrastination), e.g., the first report is due by 11:59 pm on Feb. 9. Late report will not be accepted unless requested via email before the due date with a valid reason. There is no specific formatting requirement for the report. Students do not need to do check-in/out with the TA, and the lab grade only depends on the submitted reports. Students may work together on labs but must turn in individual reports that CANNOT BE IDENTICAL.

In-class open discussion: The 5-10 minutes from the beginning of each class will typically be reserved for an interactive in-class open discussion. The goal of this discussion is to encourage students to regularly review the course contents and practice technical presentation and communication. During this time, students may raise a topic to discuss (e.g., why we need to use digital signal processing), or ask questions about course examples, homework, and labs, or share some personal discovery and knowledge with the classmates. The instructor may also lead the open discussion with a general topic or a specific problem. *The in-class open discussion does NOT have any impact on the course final grade.*

Lecture Schedule:

Date	**Chapter**	**Topic**
Jan. 19		Syllabus and Canvas Navigation
Jan. 21, 24, 26, 28	Chap. 1	Review of Signals and Systems
Jan. 31 & Feb. 2, 4	Chap. 2	Discrete-time Signals and Systems
Feb. 7, 9	Chap. 5	Frequency Response to Complex Exponential
Feb. 11, 14, 16, 18, 21	Chap. 3	Z-Transform
Feb. 23, 25	Chap. 5	Frequency-Selective Filter
Feb. 28		Midterm 1 Review
Mar. 2		Midterm 1
Mar. 4, 7, 9, 11	Chap. 4	Frequency Analysis of Signals
Mar. 14, 16, 18		Holiday
Mar. 21, 23, 25, 28	Chap. 7	Discrete Fourier Transform
Mar. 30 & Apr. 1	Chap. 8	Fast Fourier Transform
Apr. 4	Chap. 9	Implementation of Discrete-time Systems
Apr. 6		Midterm 2 Review
Apr. 8		Midterm 2
Apr. 11, 13	Chap. 9	Implementation of Discrete-time Systems
Apr. 15		Holiday
Apr. 18	Chap. 9	Implementation of Discrete-time Systems
Apr. 20, 22, 25, 27, 29	Chap. 10	Design of FIR and IIR Filters
May 2, 4		Final Review

Lab Schedule:

Date	**Lab Topic**
Jan. 31 & Feb. 2	Using Cypress FM4 with Keil MDK IDE
Feb. 7, 9	Generating a Tone
Feb. 14, 16	Data Acquisition
Feb. 21, 23, 28 & Mar. 2	Aliasing
Mar. 7, 9, 21, 23	IIR Filters by Pole-Zero Placement
Mar. 28, 30 & Apr. 4, 6	FIR Filter Design (Using Windows)
Apr. 11, 13	Sounds effects
Apr. 18, 20, 25, 27 & May 2, 4	IIR Filter Design and Fixed Point Implementations