Instructor:
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office hours: Wednesdays 1–2pm, AVW 1423 (regular office hours)
Tuesdays 2–3pm, AVW 2328 (group discussion)

Dr. Papadopoulos will be very available during his office hours and you are encouraged to come by to see him during the times indicated.

Course Synopsis:
ENEE 425 is a senior-level introduction to the fundamentals of deterministic discrete-time signal processing. The concepts and techniques we will develop are very versatile and powerful, and form the basis for an enormous class of algorithms used in an extraordinarily diverse range of applications. At the same time, everyone contemplating taking ENEE 425 should understand that this is an intense, fast-paced, and demanding subject. However, assuming you come with the right background (i.e., prerequisites) and are ready to make the serious commitment that the subject demands, it can be a very rewarding experience.

The development of the material that forms the basis of ENEE 425 has historically been driven mostly by applications. However, we emphasize that our focus on the course will not be on the applications—which form the basis for entire courses of their own—but on the common problem solving framework that they share. Nevertheless, we will cite various relevant applications as we develop the material and sometimes extract simplified examples from these contexts.

Prerequisites:
ENEE 322 is an official and essential prerequisite for ENEE 425. In general, ENEE 425 assumes fluency with signals and systems, of the form provided by an introductory-level course on signal and system theory such as ENEE 322, complex variables and some basic linear algebra. Equally important to the specific prerequisites, a certain level of maturity, dedication, and commitment to understanding the concepts in depth is expected of all who take the subject.
Lectures:
Mondays and Wednesdays 3:30pm–4:45pm, EGR 2107.

Attendance to lectures is assumed, but not formally recorded. Lectures work best when they are interactive, so your participation is important and strongly encouraged. Asking questions both in class and in office hours is a sign of engagement in the material, not an expression of weakness.

Required Text:

The majority of students that have (taken this course in the past and) used the above text as the required text have felt that, although fairly fast paced, the book serves as an excellent textbook for ENEE 425.

References:
A list of references on discrete-time signal processing, background material, and advanced topics is appended at the end of this handout.

Course Handouts:
Course handouts will be typically distributed at the beginning and/or end of lectures. Copies of these handouts will also be available at the course web site in pdf format.

Course Web Site:
You may obtain electronic copies of course handouts in pdf format at the course web site:


These handouts include problem sets, problem set solutions, and administrative announcements.

Problem Sets:
There will be quasi-weekly problem set assignments. Each problem set will include a collection of required problems (to be handed in), a random subset of which will be graded each week. Some assignments will also include one or two, often (but not always) more challenging, optional problems. You can make use of these optional problems when you think you might benefit from (and you have time for) extra practice with the material. Although these are not to be turned in, solutions to these problems will be provided along with the regular problems.

Problem sets must be handed in by the end of the class in which they are due. Note that problem set solutions will be available at the end of the due date lecture. Consequently, it is difficult and unfair to seriously evaluate late problem sets.

You are expected to do all the assigned problems. While the grade you get on your homework is only a tiny percentage of your final grade, working through (and, yes, often struggling with) the homework is a crucial part of the learning process. As such, it will invariably have a major impact on your understanding of the material and, in turn, your exam performance and final grade. Moderate collaboration in the form of joint problem solving with one or two of your classmates is permitted provided that

- you struggle with the problems on your own prior to interacting with classmates.
- the write-up you submit is your own.
In making the exams and in assigning a final grade we will assume that you have worked all the problems.

Exams:
There will be three exams, all of which will take place in EGR 2107. The exam dates are as follows:

- **Exam 1:** *Wednesday, October 15, 3:30–4:45pm;*
- **Exam 2:** *Wednesday, November 19, 3:30–4:45pm;*
- **Final Exam:** *Wednesday, December 17, 1:30pm–3:30pm.*

All exams will be closed book. However, you will be allowed to bring one 8.5 × 11-inch sheet of notes (both sides) to Exam 1, two 8.5 × 11-inch sheets of notes (both sides) to Exam 2, and three 8.5 × 11-inch sheets of notes (both sides) to the final exam. Good exam problem suggestions from the class are always welcome (and come with an obvious benefit to you if your problem is chosen).

In the case of a dispute involving an exam grade, a written request to regrade must be submitted including a full explanation of the nature of the dispute.

Course Grade:
The final grade in the course is based upon our best assessment of your understanding of the material and your class participation during the semester. *Roughly,* the weights used in grade assignment are:

- Exams 1 and 2: 25% each
- Final exam: 40%
- Problem-sets, projects and class participation: 10%

Note that interaction with the staff and class participation can make a significant difference in the final grade. In general, the process of assigning a final grade involves our assessment of each student’s mastery of the class material, and very often a careful review of the final exam is involved to examine the kinds of mistakes that were made. Although the focus of the course is learning, not grades, we know that the final grade is important to you, and we want you to know that we take the process seriously.

Disabilities:
If you have a disability, you should contact Dr. Papadopoulos at your earliest convenience.

Photograph:
To help us quickly get up to speed in matching names to faces, we will need to have a photo of each student in the class. We would like to have your photo in before Problem Set 1 is graded and returned. In the first couple of weeks, we will be taking pictures right after class. You can also email us electronic (i.e., digital) photographs.
Course Syllabus:

I. Review of discrete-time signals and systems (2-3 lectures)
   – signals and systems; notation, properties
   – discrete-time LTI systems and properties; LCCDEs
   – frequency domain representations; DTFT; frequency response

II. The z-transform (3 lectures)
   – definition and relation to DTFT; region of convergence
   – the inverse z-transform; z-transform properties

III. Sampling of continuous-time waveforms (5 lectures)
   – Nyquist theorem; ideal C/D and D/C converters; A/D and D/A converters
   – DT processing of CT signals
   – multirate signal processing

IV. Transform analysis of LTI systems (3-4 lectures)
   – system functions for systems described by LCCDEs
   – magnitude and phase distortion; group delay
   – all-pass and minimum-phase systems

V. System structures (2 lectures)
   – signal flow graph representations
   – structures for FIR and IIR LTI systems

VI. Filter Design Techniques (4 lectures)
   – DT IIR filter designs from continuous-time filters
   – FIR filter design; windowing; optimum approximations

VII. The discrete Fourier transform (4 lectures)
   – discrete Fourier series representations and properties
   – discrete Fourier transform (DFT) and properties
   – convolution using the DFT

VIII. The fast Fourier transform (3–4 lectures)
   – efficient computation of the DFT
   – decimation-in-time and decimation-in-frequency FFT algorithms
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Tentative Schedule
References:

- Background material


- Advanced texts in signal processing


- Texts on advanced application-oriented topics