Course Syllabus

ECE 346: Digital Signal Processing
(14:332:346:01, :02, and :03)
Spring 2021

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1 Instructional Staff

Instructor

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Teaching Assistant

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Means of Communication

Piazza: https://piazza.com/rutgers/spring2021/ece346/home — **All non-personal questions**
YouTube Channel: http://youtube.com/c/SigProcessing — **Only for questions related to the videos**
Canvas LMS Site: https://bit.ly/ECE346Sp21 — **Overall course management**
Emails to the Instructor and/or the TA: **Only for questions of personal nature**

2 Mode of Instruction

The course is being offered as a *hybrid* between asynchronous and synchronous learning, with the synchronous component of the course mainly focused on Q&A, problem solving, and active learning. Specifically, every week students would engage in the following set of activities, which are expected to total approx. 7 to 9 hours per week:

- Asynchronous: Watch approx. 2 to 2.5 hours of videos and read assigned passages
- Asynchronous: Take two short Canvas quizzes pertaining to the watched videos
- Synchronous: Two Zoom-based, 80-minutes lectures focused on Q&A, problem solving, and active learning
- Synchronous: One Zoom-based, 80-minutes recitation focused on Q&A, problem solving, and active learning
- Asynchronous: One longer Canvas quiz pertaining to concepts covered within the lectures and the recitation
- Asynchronous: A small set of mandatory paper-and-pencil homework problems
- Asynchronous: A set of optional paper-and-pencil practice problems

3 Lecture / Recitation Timings and Office Hours

Synchronous Zoom Lectures

Tuesdays and Thursdays: 1:40 – 3:00 PM

Synchronous Zoom Recitations *(starting Jan. 25)*

Section 1: Mondays, 5 – 6:20 PM
Section 2: Wednesdays, 5 – 6:20 PM
Section 3: Fridays, 5 – 6:20 PM

Instructor Zoom Office Hours

Tuesdays: 3:00 – 3:30 PM
Thursdays: 3:00 – 3:30 PM

TA Zoom Office Hours

To Be Decided (will be announced on Canvas)

4 Course Prerequisites

ECE 345: Linear Systems and Signals. In particular, students should be comfortable with the concepts of complex numbers, Fourier, Laplace, and z-transforms, continuous and discrete signals and systems, time-domain and frequency-domain relationships between the input and output of linear, time-invariant (LTI) systems, continuous and discrete convolutions, etc. The students are also expected to be comfortable with the use of MATLAB for some activities in the course.

5 Learning Outcomes

- Mastery of the basic terminology and concepts in digital signal processing (DSP)
- Understanding of the basic building blocks of practical DSP systems
- Mathematical understanding of the Shannon–Nyquist sampling theorem
- Mastery of practical implications of the Shannon–Nyquist sampling theorem
- Ability to understand data sheets pertaining to DSP integrated circuits (ICs)
- Mathematical understanding of the discrete Fourier transform (DFT)
- Mastery of practical implications of the DFT for linear systems
- Understanding of the mathematical and practical aspects of spectral analysis
- Understanding of the mathematical and practical aspects within design of digital filters
- Ability to design finite impulse response (FIR) digital filters using the window method
- Basic understanding of the concepts involved in design of infinite impulse response (IIR) digital filters

6 Required Textbook

The textbook traditionally used for this course seems to be out of print. We will instead be providing scanned passages from parts of the book under the "fair use" doctrine for reading purposes.

7 Grading Policy

The final course grade will be based upon:

1. Video Canvas quizzes (5%)
2. Assessment Canvas quizzes (10%)
3. Lecture and recitation attendance (2.5%)
4. Homework (5%)
5. In-class exam #1 (20%)

6. In-class exam #2 (20%)
7. Final exam (25%)
8. Group term project (12.5%)

Grades will be assigned on a relative basis. The relative scale though will vary based upon the performance of the overall class. In an ideal setting, students above class average will get B and higher and students at and below class average will get C+ and lower, respectively. If the class performs really well, however, then the B will turn into B+ (or even A!). Similarly, if the class performs really bad then the B will turn into C+ (or even C). In short, I have no hesitation giving the entire class A's, if the class deserves them (or vice versa for F's).

8 Lecture and Recitation Attendance Policy

Synchronous lectures and recitations within this course are meant to reinforce the concepts covered in the videos. Therefore, unless someone has a time zone conflict that cannot be overcome, it is expected that students will attend the 26 lectures and 11 recitations on a regular basis. In particular, attendance will be taken during the lectures and recitations, and 2.5% of the course grade is reserved for this attendance. The attendance grading will be on a binary basis, with any one attending 30 or more combined lectures and recitations (out of a total of 37 lectures and recitations) getting full credit and any one attending less than 30 combined lectures and recitations getting no credit for attendance.

Note. Students having unavoidable time zone conflicts that would prevent them from attending the synchronous components of the course should reach out to the instructor so that a resolution can be reached regarding the 2.5% of attendance grade. The deadline to report such conflicts is January 29, 2021.

9 Exam Policy

A tentative schedule of the three exams in the course is as follows:

- In-class exam #1: March 2, 2021, 1:40 – 3:00 PM
- In-class exam #2: April 13, 2021, 1:40 – 3:00 PM
- Final exam: May 7, 2021, 8:00 – 11:00 AM

Please mark your calendars for these dates. As a general policy, there will be no makeup exams. I will allow exceptions for rare emergency situations, but this would require at least 7 days advance approval to skip an exam. Any one not appearing in an exam without such prior approval will automatically get a 0.

10 Late Submission Policy

Every student gets an automatic submission grace period of up to 3 days each for a maximum of two video Canvas quizzes, two assessment Canvas quizzes, and two homeworks. Utilization of the first grace period within each category (video Canvas quiz, assessment Canvas quiz, and homework) is without any penalty. Utilization of the second grace period comes with a 30% penalty. No late submissions within the categories of video Canvas quizzes, assessment Canvas quizzes, and homeworks will be accepted from a student who has utilized both these grace periods for a given category, regardless of the emergency or unique circumstances. It is therefore advised that students avail themselves of these grace periods in true emergencies.

11 Academic Integrity Policy

It is important that the students enrolled in this course familiarize themselves with the Rutgers Academic Integrity Policy, `http://nbacademicintegrity.rutgers.edu/home/academic-integrity-policy/`, and the definition of plagiarism (`www.plagiarism.org/plagiarism-101/what-is-plagiarism/`), which includes code plagiarism. It is also important for the students to realize that pseudo-tutoring from platforms such as *Chegg* and *Course Hero* that result in solutions to homeworks, assignments, exams, etc., is serious academic misconduct. Note that all cases of academic misconduct in the course, whether minor or major, will not only be reported to the Office of Student Conduct, but will, in most cases, also result in loss of one or more letter grades.

12 General Advice for the Students

Let's admit it, digital signal processing is a hard course. But we can work together in a team to make it a fun, enjoyable, and rewarding course. I will work hard to achieve this goal, but all of you have to work equally hard to make this a reality. In particular, as you will realize during the course of the semester, a hybrid of asynchronous and synchronous classroom means a lot of work for the teaching staff. At the same time, it will also be a lot of work for you, ranging from coming to the lectures and recitations prepared (see below) to actively engaging during the lectures and recitations with the teaching staff (no more snoozing, unfortunately). But I am confident that we can work together as a team during this semester and successfully achieve our learning goals.

Some tips for making the learning of course material easier!

- Keep up with the assigned videos and readings, quizzes, and mandatory/optional homeworks to benefit from the hybrid nature of the course.
- If you feel lost at any time during the semester, please do not hesitate to reach out to the teaching staff.
- Pay attention to the flow of information via email, Canvas, and Piazza. Stay engaged, both within and outside the lectures and recitations. Make good use of Piazza for clarifying any doubts and also helping your fellow students.
- Because of the mathematically intensive nature of the course, one cannot learn it by forgetting about it till it is time for an exam. It is therefore important that you try to keep up with the course material on a regular basis, especially if you are either late to a lecture/recitation and/or end up missing a lecture or recitation.
- While the idea of this course offering is that most of the learning would take place during the lectures and recitations, this alone would not be enough for you to retain all the information. You have to ensure that you revisit the exercises done during lectures and recitations for full retention.

13 A Tentative Course Outline

- Revisiting key LSS concepts that overlap with digital signal processing
  - Class 1: Introduction to signal processing
  - Class 2: Review of signals, systems, and convolution
  - Classes 3, 4: Review of continuous-time and discrete-time Fourier transforms (CTFT and DTFT)
- Sampling theory for bandlimited signals
  - Classes 5, 6: Basic sampling theory
  - Class 7: Aliasing in sampling theory
  - Classes 8, 9: Discrete-time processing of continuous-time signals

  - Classes 10, 11: Practical issues associated with A/D and D/A conversion
  - Class 12: Capping off the material learned so far
- The discrete Fourier transform (DFT)
  - Class 13: Introduction to the DFT
  - Class 14: Relationship between the DFT and the DTFT
  - Classes 15, 16: Properties of the DFT
  - Class 17: The fast Fourier transform (FFT)
  - Class 18: Capping off the material learned so far
- Spectral analysis
  - Class 19: Spectral analysis using the DFT
  - Class 20: Spectral analysis using the short-time Fourier transform (STFT)
  - Class 21: Capping off the material learned so far
- Design of digital filters
  - Class 22: Digital filters and the z-transform
  - Class 23: Understanding the response of filters in terms of the pole-zero placements
  - Classes 24, 25: Design techniques for FIR filters
  - Class 26: Design techniques for IIR filters

While there are a total of 28 lecture slots in a semester, the remaining two slots will be used for in-class exams. Please note that this is a "tentative" course outline and we will go faster or slower depending upon how the semester unfolds.