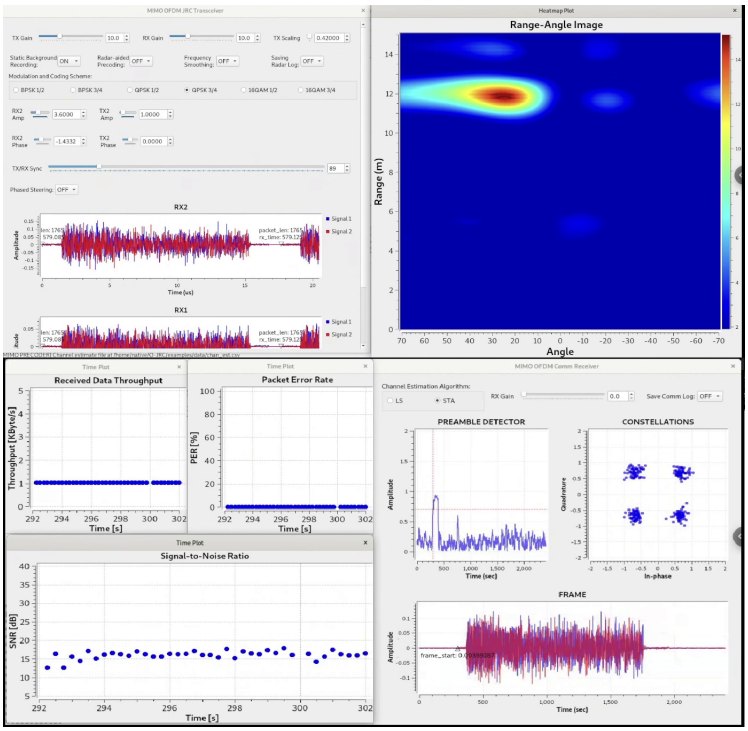
Rutgers University, Department of ECE
ECE 346: Digital Signal Processing, Spring 2026
(14:332:346:01, :02, and :03)
Course Syllabus



Welcome to the ECE 346: Digital Signal Processing (DSP) class; DSP is utilized everywhere! You will learn the foundations, with a deep mathematical support that will allow you to specialize further in the future, towards any direction, e.g., relevant to system design and circuits/electronics, machine learning, machine vision, data analytics, wired and wireless communications. The course continues from Linear Signals and Systems (LSS) and covers in depth sampling, aliasing, spectral analysis, discrete Fourier transform (DFT), fast Fourier transform (FFT) and their utilities, as well as filter design (especially finite impulse response), with many examples and fun exercises.

1 Instructional Staff

Instructor

Prof. Aggelos Bletsas (`aggelos dot bletsas at rutgers dot edu`)
`http://winlab.rutgers.edu/~aggelos`

Teaching Assistants (TA)

Georgios Andreadis (georgios dot andreadis at rutgers dot edu)
Yahya Ayach (ya372 at scarletmail dot rutgers dot edu)
Zhihao Tao (zhihao dot tao at rutgers dot edu)

2 Lecture / Recitation Timings and Office Hours

Lectures (Bletsas)

Tuesday and Friday: 08:30 – 09:50, ARC-103
(pls come on time)

Recitations (Andreadis, *starting Jan. 28*)

Section 1: Wednesday, 08.30 – 09:50, SEC-210
Section 2: Wednesday, 12.10 – 13:30, PH-111
Section 3: Wednesday, 10.20 – 11:40, SEC-210

Instructor Office Hours

Monday 12.00-14.30, CoRE 530 (pls RSVP at least one day before).

TA Office Hours

Georgios Andreadis: Wednesday 14.00-15.00, EE226.
Yahya Ayach (only for Lab-related questions): Thursday 11.30-12.30, EE226.
Zhihao Tao (only for Lab-related questions): Friday, 11.00-12.00, EE226.

3 Course Prerequisites

ECE 345: Linear Systems and Signals (LSS). 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.

4 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

5 Required Textbook

There is no required textbook. We will rely on notes. The following textbooks could serve as references:

- A. Oppenheim and R. Schafer, Discrete-Time Signal Processing, 3rd Edition, Prentice Hall, 2010.
- Sanjit K. Mitra, Digital Signal Processing: A Computer-based Approach, 4th Edition, McGraw Hill, 2011.

6 Grading Policy

The final course grade will be based upon:

1. Problem Sets ($\sim 10\%$)
2. Class Participation ($\sim 10\%$)
3. Group term project ($\sim 10\%$)
4. Midterm exam ($\sim 30\%$)
5. Final exam ($\sim 40\%$)

Final 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 or B+ and higher and students at and below class average will get B or 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).

7 Lecture and Recitation Attendance Policy

Lectures and recitations is an expensive service that you pay for; in addition, it is work time for the student. Missing lectures renders studying more time-consuming and difficult. Therefore, missing classes is equivalent to losing time and increasing probability of performing unsatisfactory (or even failing) in the class.

Therefore, attendance will be sporadically monitored; **in case you miss (the majority of) the participation checks**, your grade will be affected proportionally. Kindly also have in mind that class participation $\neq$ working at the laptop in class on irrelevant tasks. Would you pay for a cinema or theater performance and attend with your laptop on?

In case you miss a lecture, the following link offers videos of the lecture material (thanks to Prof. W. U. Bajwa): `https://www.youtube.com/playlist?list=PLzecsHoSJ8tIS-D94Te5wVm98pc6SsUK4`

8 Exam Policy

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

- Midterm: **Friday March 6, 2026**, 08:30 – 09:50, in class (ARC-103).
- Final: **Friday May 8, 2026**, 08.30 – 11.30, in class (ARC-103).

Please mark your calendars for these dates. As a general policy, there will be no makeup exams. Common sense will be exercised and exceptions may be allowed only for rare, *verifiable* emergency situations; non-emergency situations require *reasonably*-advance notice (from the student) and approval (from the instructor).

8.1 What you can bring in the exam:

Only 4 pages (2 sheets) of handwritten notes (closed-book policy). No electronic devices (e.g., pocket calculators, tablets, smartphones etc) are allowed.

9 (Late) Submission and Collaboration Policy

1. Submission of any deliverable is allowed in pdf format only (unless noted otherwise), through Canvas only (not via email). Deliverables not adhering to this will not be graded.
2. Hand-written (and scanned/converted to pdf using e.g., the camera of your smartphone) deliverables, as response to problem sets are welcomed. You do not need to spend additional time typewriting your answers.
3. Submission via email are not permitted; late submissions will be discounted; submissions after upload of the solutions at Canvas will receive minimum grade. Kindly make sure your deliverable appears without problem at Canvas after upload.
4. You are encouraged to collaborate in groups of 2 or 3 with your classmates; however, in case of collaboration, you need to note down in your deliverable your collaborator and provide your own deliverable. Providing the same code or deliverable document is not allowed. Kindly also see note on *Academic Integrity Policy* below.

10 Academic Integrity Policy

It is important that the students enrolled in this course familiarize themselves with the Rutgers Academic Integrity Policy, `https://nbacademicintegrity.rutgers.edu/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 *ChatGPT*, *Chegg* and *Course Hero* that result in (correct or commonly incorrect) 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.

11 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.

Some tips for making the learning of course material easier!

- Do not miss lectures.
- If you feel lost at any time during the semester, please do not hesitate to reach out to the teaching staff.
- 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.
- You have to ensure that you revisit the exercises done during lectures and recitations for full retention.
- Spend time on the problem sets, as those are the best test of your working knowledge. Make sure ChatGPT is not your best friend...
- When you ask for something and receive a reply, acknowledge the reception.
- (again) Do not miss lectures.

12 A Tentative Course Outline

- Revisiting key LSS concepts that overlap with digital signal processing
  - Class 1: Course bureaucracy - 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 exam and revision. Please note that this is a "tentative" course outline and we will go faster or slower depending upon how the semester unfolds.

[Note: ver 4.9]