EEE 407/591: Digital Signal Processing–Spring 2020

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Course Canvas Site: `https://myasucourses.asu.edu`

Laboratory Site: `http://eee407.engineering.asu.edu`

Meeting Time, Room: T Th 12:00–1:15 pm, SCOB 101

Office Hours, Room: T Th 2:00-3:30 pm, GWC 312

Prerequisites

– EEE 203 (Signal and Systems) or equivalent: continuous/discrete time signals & systems, linear time-invariant systems, convolution, Laplace/Fourier transforms, frequency response, transfer function
– MAT 342 (Linear Algebra) or equivalent: fundamentals, matrices, inverses, eigendecomposition
– Basic calculus: integration, differentiation, complex numbers
– Basic knowledge of MATLAB programming

Required Textbooks

– Course: A. V. Oppenheim and R. W. Schafer, *Discrete-Time Signal Processing*. Prentice Hall, 2009 (3rd ed)
– Laboratory: A. Spanias, *Digital Signal Processing: An Interactive Approach*. Lulu Publisher, 2014 (2nd ed)

Supplemental Materials

– MATLAB (software access at *MyASU apps*)
– Internet-based J-DSP Editor (`http://jdsp.engineering.asu.edu/jdsp.html`)

Reference Books (see *ASU Library Reading Lists* on Canvas)

– L. R. Rabiner and B. Gold, *Theory and Application of Digital Signal Processing*. Prentice-Hall, 1975
– W. D. Stanley, *Digital Signal Processing*. Reston, 1984 (2nd ed)
– A. Antoniou, *Digital Filters: Analysis, Design, and Applications*. McGraw-Hill, 1993 (2nd ed)
– A. V. Oppenheim and A. S. Willsky, *Signals and Systems*. Prentice Hall, 1997 (2nd ed)
– S. D. Stearns, *Digital Signal Processing With Examples in MATLAB*. CRC Press, 2003
– R. G. Lyons, *Understanding Digital Signal Processing*. Prentice Hall, 2004. Also available, Pearson Ed., 2011
– V. K. Ingle and J. G. Proakis, *Digital Signal Processing Using MATLAB*. Nelson, 2006 (2nd ed)
– J. G. Proakis and D. G. Manolakis, *Digital Signal Processing: Principles, Algorithms, and Applications*. Prentice Hall, 1996 (3rd ed). Also available, *Digital Signal Processing* Pearson, 2006 (4th ed)
– A. Antoniou, *Digital Signal Processing*. McGraw-Hill, 2006
– J. W. Leis, *Digital Signal Processing Using MATLAB for Students and Researchers*. Wiley, 2011 (*online access*)

Course Outline (Chapters from course textbook)

– Chapter 2

Review: discrete-time signals and systems; basic signal sequences and operations; linear time-invariant (LTI) systems; convolution; discrete-time Fourier transform (DTFT)

– Chapter 3

Z-transform (ZT): computation and region of convergence; inverse transform; properties

– Chapter 4

Sampling continuous-time signals: frequency domain representation; signal reconstruction and aliasing issues; effects of changing the sampling rate; conversion from analog-to-digital (A/D) and digital-to-analog (D/A)

– Chapter 5

Transform analysis of LTI systems: frequency response; magnitude response; poles and zeros of a system; all-pass, minimum phase, linear phase systems, FIR and IIR filters

– Chapter 7

Filter design techniques: design of discrete-time IIR filters using continuous-time filters; impulse invariance and bilinear transformation; design of FIR filters using windowing techniques

– Chapter 8

Discrete Fourier transform (DFT): representation of periodic sequences; Fourier transform (FT) of periodic signals; sampling the FT; DFT and properties

– Chapter 9

Computation of the DFT: fast Fourier transform (FFT) using decimation-in-time and decimation-in-frequency algorithms

Course Learning Objectives

The course is designed to study methods for analyzing signals and systems in the time and frequency domains. At the completion of the course, you will be able to:

1. Perform ZT analysis; compute the ZT and find its region of convergence; use ZT to identify system properties
2. Understand the issues and methods associated with sampling continuous-time signals; evaluate the minimum sampling frequency to represent a continuous-time signal given its spectrum without aliasing; explain the frequency domain effects of undersampling
3. Design IIR and FIR filters given filter specifications; use MATLAB tools to assist in filter design; apply filtering to real data
4. Use the DFT to analyze discrete-time signals and systems
5. Use FFT programs to analyze real data and systems in digital signal processing (DSP) applications
6. Develop software to simulate a modest DSP task associated with a modern application

Grading Policy

Assessment	Planned Date	Duration	Grade Percentage
Exam 1	Thursday, February 20 or 27	75 minutes	18%
Exam 2	Thursday, April 9 or 16	75 minutes	22%
Final Exam	Tuesday, May 5, 12:10–2:00 pm	110 minutes	30%
Laboratory			15%
Homework			10%
Participation			5%

Letter Grade Assignment

Separate exam score point distributions (average and standard deviation) are used for undergraduate (EEE 407) and graduate (EEE 591) student groups. The point distributions will be made available after each exam. Exam scores are not posted on Canvas. Letter grades are only assigned at the end of the semester. Considering each group separately, if the group final average is 85% or above, the letter grade is assigned as follows:

Percentage	100%	93-99%	89-92 %	86-88%	82-85%	76-81%	70-75%	60-69%	50-59%	$< 50\%$
Letter grade	A+	A	A−	B+	B	B−	C+	C	D	E

If the group final average is less than 85%, the grades are proportionally curved so that the new average is 85% and the same letter assignment is used.

Information on Exams

- Exams are closed book and closed notes; the final exam is cumulative.
- Exam problems are designed to test the understanding of the material covered in class; they are similar to homework and class examples but different enough to test comprehension and problem solving skills.
- Handheld wireless devices (e.g., tablet, smart phone, laptop, smartwatch, and personal digital assistant) cannot be used during exams; all handheld wireless devices must be placed in your backpacks and backpacks must be placed in the front of the classroom (and not on or near your desk); if you do not have a backpack, handheld wireless devices must be powered off and placed face down on your desk.
- Items allowed during exams:
  - scientific calculator & writing supplies (pen/pencil/eraser)
  - letter-size (8.5 inches wide and 11 inches long) paper crib sheets with writing allowed on both sides; writing can include important equations; one sheet is allowed for each exam and three sheets are allowed for the final exam; the sheets will be collected after each exam.
- *No cheating* during exams is tolerated; students suspected of cheating during an exam will receive a zero for the exam; students will fail the course if suspected of cheating in more than one exam and will be reported to the Dean of Academic and Student Affairs for further disciplinary action.
- *Make-up exams* require instructor's permission at least two days before the exam date; the request must include credible documentation (e.g., doctor's note, proof of travel). In case of emergency, notification should be attempted as soon as possible.

Information on Homework Assignments

There will be 4-5 assignments, some of which will include MATLAB-based questions. For full credit, all problems must be attempted. If any part of an assignment is copied from other students, including MATLAB code, all students involved will receive a zero grade for that assignment. Assignment solutions will be posted within 72 hours of the due date. If an urgent situation arises and the assignment cannot be submitted on time, the instructor should be notified before the assignment's due date.

Laboratory

The J-DSP Editor is an Internet based signal processing laboratory that provides hands-on learning experience in distributed learning environments using a Java-based graphical user interface (GUI). No knowledge of Java programming is required. To run the GUI, you will require a computer with internet connection, running Internet Explorer with Java execution capabilities. The laboratory is mandatory for both undergraduate and graduate students. The lab coordinators will provide you with an account to enable lab access. There will be four lab exercises, with fixed deadlines, on course material. The lab coordinators have office hours to answer all relevant lab questions (see lab website). The lab exercises and their associated reports must be completed online.

Participation

Class participation includes attending class, asking questions and/or visiting office hours as needed, and taking unannounced quizzes. Although the quizzes will not be graded, they will be used to mark your participation. Note that participation is very important and could affect your overall grade, especially if the grade is border line.

Classroom Behavior

Cell phones and pagers must be turned off during class to avoid causing distractions. The use of cameras or recording devices is not permitted during class. Any violent or threatening conduct by an ASU student in this class will be reported to the ASU Police Department and the Office of the Dean of Students.

Absence and Make-Up Policies

Accommodations will be made for religious observances provided that students notify the instructor at the beginning of the semester concerning those dates. Students who expect to miss class due to officially university-sanctioned activities should inform the instructor early in the semester. Alternative arrangements will generally be made for any examinations and other graded in-class work affected by such absences. The preceding policies are based on ACD 30404 *Accommodation for Religious Practices* and ACD 30402, *Missed Classes Due to University-Sanctioned Activities*.

Academic Integrity

All students in this class are subject to ASU's Academic Integrity Policy (available at `http://provost.asu.edu/academicintegrity`) and should acquaint themselves with its content and requirements, including a strict prohibition against plagiarism. All violations will be reported to the Dean's office, who maintain records of all offences. Students are expected to abide by the FSE Honor Code (`http://engineering.asu.edu/integrity/`). Examples of plagiarism include: copying assignments from other students; allowing other students to copy assignments; submission of identical MATLAB code (or code from any other software) and/or plots. Penalties include a zero grade for submitted work, a failing grade in the class, a note on your official transcript that shows you were punished for cheating, suspension, expulsion and revocation of already awarded degrees. The university requires that the faculty should implement any of these penalties, and report the matter to the Dean's office.

Disability Accommodations

Suitable accommodations will be made for students having disabilities and students should notify the instructor as early as possible if they will require same. Such students must be registered with the Disability Resource Center (`https://eoss.asu.edu/drc`) and provide documentation to that effect.

Sexual Discrimination

Title IX is a federal law that provides that no person be excluded on the basis of sex from participation in, be denied benefits of, or be subjected to, discrimination under any education program or activity. Both Title IX and university policy make clear that sexual violence and harassment based on sex is prohibited. An individual who believes they have been subjected to sexual violence or harassed on the basis of sex can seek support, including counseling and academic support, from the university. If a student in this class or someone that a student in this class knows has been harassed on the basis of sex or sexually assaulted, information and resources can be found at `https://sexualviolenceprevention.asu.edu/faqs` As a mandated reporter, the instructors is obligated to report any information she becomes aware of regarding alleged acts of sexual discrimination, including sexual violence and dating violence. ASU Counseling Services, `https://eoss.asu.edu/counseling`, is available if you wish to discuss any concerns confidentially and privately.

Syllabus Disclaimer

The syllabus is a statement of intent and serves as an implicit agreement between the instructor and the student. Every effort will be made to avoid changing the course schedule but the possibility exists that unforeseen events will make syllabus changes necessary. Remember to check your ASU email and the course site often.