ECE 3331 – Discrete-Time Signals & Systems – Spring 2024

Department of Electrical and Computer Engineering, University of Texas at El Paso

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Class Meeting Time: Tuesday and Thursday, 4:30 pm – 5:50 pm

Classroom: Cotton Memorial Building 201

Office Hours: Tuesday & Thursday 1:30 – 3:00 PM @ ENGR A-318, or by appointment

Class Website: Blackboard

Course ID: ECE 3331-001, CRN-26237

Prerequisite

EE 2350 and CS 1320 both with a grade "C" or better. Required topics include calculus and differential equations, complex numbers and functions, basic time-domain and steady-state circuit analysis, familiarity with MATLAB software.

Catalog Description

Representation and analysis of discrete time signals and systems, digital filtering, sampling, spectrum analysis, z-transform, discrete-time Fourier transform, and the discrete Fourier transform (DFT). Emphasizes computer simulations and some basic applications to communications, control, and signal processing.

Textbook

- J. H. McClellan, R. W. Schafer, and M. A. Yoder. *DSP First.* Pearson, New York, NY, 2nd edition, 2016
- Companion website: https://dspfirst.gatech.edu. The textbook is available through the UTEP Bookstore. To buy the e-book directly from the publisher, please visit: https://www.pearson.com/us/higher-education/program/Mc-Clellan-DSPFirst-2nd-Edition/PGM86857.html

Expected Learning Outcomes

By the end of the semester the student will demonstrate the ability to:

- Carry out analysis and graphical representations of the spectra of sums of sinusoids and signals with time-varying frequencies.
- Convert sums of sinusoids from analog to discrete-time domains and back with and without aliasing.
- Compute the response of a Finite Impulse Response (FIR) digital filter produced by input signals defined in the time domain using the Linear Time-Invariant (LTI) properties and the convolution sum.

- Use the D-T Fourier transform (DTFT) to analyze the frequency response of FIR and ideal frequency-selective filters and to find responses produced by analog and D-T sums of sinusoids.
- Use z-transforms to analyze and design FIR filters based on the relationship to the frequency response.
- Use the DTFT and the z -transform to analyze and find the responses of simple Infinite Impulse Response (IIR) digital filters produced by analog and D-T sums of sinusoids.
- Use the Discrete Fourier Transform (DFT) as a tool for spectral analysis of discrete-time and sampled analog signals.

Assessment of Learning Outcomes

The learning outcomes will be assessed through the students' performance in quizzes, homework assignments, and exams tailored to evaluate fundamental knowledge, and MATLAB projects designed to assess practical skills.

Computer Resources

The MATLAB software package, along with numerous Toolkits and Toolboxes, is accessible for download, installation via DVD, or direct installation on your laptop. Engineering students can obtain it from the Engineering Technology Center (ETC) through the following link: http://etc.utep.edu/. For assistance, students may contact ETC at tel. (915) 747-5223 or via e-mail at etchelpdesk@utep.edu.

An alternative option is to download MATLAB directly to your computer from https://www.utep.edu/technologysupport/servicecatalog/software_pages/soft_matlab.html. Note that the file size is substantially large (at least 6+ gigabytes). To proceed with the software download, you must have a MathWorks account.

Grading

Homework, Quizzes, and MATLAB Projects/Lab. Assignments:	30%
Exam I and II:	45%
Comprehensive Final Exam:	25%

Exam I, II, and the Comprehensive Final Exam will be taken in the classroom.
Letter grades will be assigned according to the following scale:
A = 100 − 90%, B = 90 − 80%, C = 80 − 70%, D = 70 − 60% and F = 60 − 0%.

Course Delivery

- The class will have in-person sessions supplemented and enhanced through Blackboard, which will be utilized for accessing recorded videos, distributing document handouts, and submitting take-home assignments.
- Quizzes and exams will take place during the face-to-face classes.

- The companion website for the textbook is quite extensive, so please access it at your earliest convenience. We will continue with the new approach, where EE2353 is not a prerequisite for this course.
- We will cover the introductory chapters on sinusoids and spectra of signals at an accelerated pace. We will start by providing a review of fundamental topics related to real and complex exponentials, also known as complex sinusoids, along with sums and other basic combinations of sinusoids. The phasor concept will be revisited, transitioning from Circuits to establish a connection between real and complex sinusoids. Regarding sums of sinusoids, a graphical complex spectrum representation will be introduced and illustrated. We will also discuss basic time-domain signal transformations and their impact on the spectrum. While a brief introduction to continuous-time Fourier Series is provided as a special case of sums of sinusoids, it will not be covered in depth, as seen in EE2353. Please refer to Appendix C in our textbook for further details.
- We will make a transition to discrete-time signals by examining sampled sinusoidal signals. The introduction of basic linear system concepts will be followed by including moving average systems and other finite-impulse-response (FIR) digital filters. Impulse sequences and impulse response characterization of a filter will be introduced. Convolution will be addressed as a numerical operation involving discrete-time signals and systems. The fundamental concept of frequency response will be derived and explained for FIR filters, with a focus on the magnitude and phase changes experienced by sums of sinusoids when filtered by a linear time-invariant system. The concept of discrete-time Fourier transform (DTFT) will naturally emerge, including the inverse DTFT, allowing us to define ideal filters. The course will then progress to the discrete Fourier transform (DFT), derived as a sampled version of the DTFT and computable through popular fast algorithms, although not discussed in detail. Understanding the ideas of DTFT and DFT facilitates practical spectrum analysis, enabling the effective use of powerful spectrum analysis tools available in software environments such as MATLAB.
- The final sessions will be dedicated to z-transform and infinite impulse response (IIR) systems, which will be introduced in chapters 9 and 10. At this stage, students will gain the ability to comprehend applications related to the sampling theorem, discrete-time filtering, and spectrum analysis. They will be prepared to advance to courses in linear analog circuits and continuous-time signals and systems. Overall, this course will also assist in preparing students for senior and graduate level courses in Controls, Communications, Image Processing, and Radar Signal Processing.

Course Policy

- Homework assignments should be scanned and uploaded to Blackboard in PDF format. Some problems will be solved in class, and solutions or brief answers will be provided well before quizzes are administered. Late homework assignments are not allowed without valid reasons (written medical, legal, military, or work justification). Special circumstances will be considered if reported on time.

- Quizzes (every 1-2 weeks) will be based on homework problems expecting that each student attempted the problems and used the homework solutions to correct mistakes and improve understanding. The approach for quizzes will be to allow each student to use their own handwritten paper solution of the current homework assignment as a reference during the quiz. Quizzes will be more-or-less impossible to solve by anyone not attempting the homework problems. Quizzes must be solved by hand on paper, with limited time allocated during the class time period. Textbook tables may be provided.
- The specific rules for exams will be determined and communicated in detail the week before their administration.
- If there is any suspicion of copying during quizzes or exams, seating arrangements will be implemented. In all cases, the uniqueness of the solution process will be assessed, and individuals suspected of academic dishonesty will be identified and documented for potential reporting to the University academic dishonesty authorities.

Attendance, Participation, and Etiquette

- Students are required to attend class, show up to lectures on time, and not leave the lecture early. The course instructor reserves the right to turn away late comers and to withdraw students from the course that are repeatedly absent.
- Students missing more than two lectures should seriously reflect on their commitment to this course, as missing classes is highly correlated with poor performance.
- Students absent from lecture are still held responsible for all information discussed, homework assigned, and quizzes administered during that missed lecture. In some cases, absence can be forgiven if the reason is not frivolous and coordinated with the course instructor well before the lecture is missed.
- The use of any electronic devices such as smartphones and laptops during exams and quizzes is strictly prohibited. Please put them away and out of reach.

Exam Policy

Three in-class exams will be offered. If you miss Exam I or Exam II without an acceptable excuse, you will receive zero points for the missed exam. You may be excused from a scheduled exam time due to serious illness, funeral attendance, courtroom appearance, or an UTEP athletic participation. In the case of a missed exam, you must communicate and submit the appropriate documentation to me no after than seven days after the date of the missed exam. The make-up exam for either Exam I or Exam II is comprehensive on the Friday of the finals' week (tentatively, May 10th, 4:00 pm to 6:45 pm). Note that there is no make-up exam for the Comprehensive Final Exam or for more than one missed exam. The Comprehensive Final Exam will not be returned and will not be shown to students under normal circumstances.

Fairness Statement

The key fairness criterion for this course is equal opportunity for all students to receive feedback, help, information, scores, handouts, etc. Individual requests will not be accommodated. Grades are not negotiable individually, but fair adjustments can be made for the whole class.

Course Outline

1. Sinusoids, spectrum representation, sampling, and aliasing
2. Basic discrete-time signals, signal transformations, and signal properties
3. Finite impulse response (FIR) filters: impulse response and convolution
4. FIR filters: frequency response and its application to filtering of sinusoidal signals
5. Discrete-time Fourier transform pairs and properties and its application to analysis and design of FIR filters
6. Concise overview of computation of the DTFT using the discrete Fourier transform
7. z-Transform
8. Infinite impulse response (IIR) filters: basic introduction

Drop Policy

Students can drop the course before March 28th with a grade of “W”. Students who drop the course after March 28th will be assigned the grade earned in the course.

Academic Integrity

The University of Texas at El Paso's faculty strives to cultivate an atmosphere characterized by unwavering honesty and a strong commitment to ethical standards. Any effort by students to claim work as their own that they have not genuinely undertaken is viewed as a grave transgression by both the faculty and administration, resulting in potential severe consequences, including suspension. Please review and comply with the academic integrity policy available on: https://www.utep.edu/student-affairs/osccr/student-conduct/academic-integrity.html.

Accommodation for Students with Disabilities

If a student requires an accommodation, they should reach out to the Office of Disabled Student Services at UTEP, as stipulated in Section 504 of the Vocational Rehabilitation Act of 1973 and the Americans with Disabilities Act (ADA) of 1990. If you have a condition that might impact your performance in this course, you must have a confidential discussion with the instructor and/or the director of Disabled Student Services. Please ensure that you provide this instructor with written accommodation guidelines for class BEFORE the course begins. If you have a disability and need classroom accommodation, please contact CASS at 747-5148, or by email to cass@utep.edu, or visit their office located in UTEP Union East, Room 106. For additional information, please visit the CASS website at www.sa.utep.edu/cass. CASS’ Staff are the only individuals who can validate and if need be, authorize accommodations for students with disabilities.