ECE3331, 002: DISCRETE-TIME SIGNALS AND SYSTEMS

SYLLABUS: SPRING 2024, (CRN: 26906) (Ver. 2, updated 1/19/2024)

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OFFICE HRS.: Mon., Tues., Wed., Thurs. 1:00-2:00 PM (between two class periods) in person.
(updated Jan. 19) Or by appointment on Teams or in person most Fridays around 11:00 -12:00 noon

CLASS TIME/PLACE: **Monday and Wednesday, 4:30 PM – 5:50 PM**
Room: Business Bldg. 321, UTEP Campus

TEXTBOOK: ***DSP First, Second Edition*** by James H. McClellan, Ronald Schafer, and Mark Yoder, Pearson, 2016 (use of earlier editions is NOT recommended, there are too many differences).
This is the companion URL Web site: **https://dspfirst.gatech.edu/**
This is the companion **Matlab toolbox available** to you from me or the companion URL: **spfirst_v173**
The textbook may be available through the UTEP Bookstore as an e-book purchase. Alternatively, to buy the e-book directly from the publisher visit: **https://www.pearson.com/us/higher-education/program/Mc-Clellan-DSP-First-2nd-Edition/PGM86857.html**

PREREQUISITE: EE2350 Electric Circuits 1 and CS1320 both with a minimum grade of "C".

CATALOG DESCRIPTION: Representation and analysis of discrete time signals and systems, digital filtering, sampling, spectrum analysis, Z-transform, DT Fourier transform, and the DFT. Emphasizes computer simulations and some basic applications to communications, control and signal processing.

PREREQUISITE BY TOPIC: calculus and differential equations; complex numbers and functions; basic time-domain and steady-state circuit analysis; basic familiarity with MATLAB software tools.

COURSE DELIVERY, RECENT MODIFICATIONS, AND OVERVIEW: The class is starting 100% in-person with support and enhancements using Blackboard (BB) (possible recorded videos, document handouts, turning in take-home assignment, if any, etc.). Quizzes and exams will be in-person, face-to-face. The companion Web site of the textbook is very extensive, make sure to access it as soon as possible. We will be continuing with the new scheme where EE2353 is NOT a pre-requisite for this course. Thus, it covers the material at a lower level than past EE3353 courses.

The modified approach will follow the textbook with an accelerated pace on the first few chapters covering sinusoids and spectra of signals which build on Steady-State Circuit analysis. Also, there will be reduced coverage of Discrete Fourier Transform (DFT) or Infinite Impulse Response (IIR) filters to reduce the end-of-semester rush. First, there is review of basic topics related to real and complex exponentials (AKA complex sinusoids) and sums and other basic combinations of sinusoids. The phasor concept is re-visited from Circuits to relate real and complex sinusoids. For sums of sinusoids, a graphical complex spectrum representation is presented and illustrated. Basic time-domain signal transformations and their effect on the spectrum are discussed. A brief introduction to continuous-time Fourier Series is

presented as a special case of sums of sinusoids but it is not covered in depth as done in EE2353, see Appendix C in our textbook.

Next we make the transition to discrete-time signals by considering sampled sinusoidal signals. The basic linear system concepts are then introduced with running average systems and other simple finite-impulse-response (FIR) digital filters. Impulse sequences are presented leading also to the impulse response characterization of a filter. Convolution is treated as a numerical operation using discrete-time signals and systems. The key concept of frequency response is derived and interpreted for FIR filters emphasizing the magnitude and phase changes experienced by sums of sinusoid when filtered by a linear time-invariant system. Next, the concept of discrete-time Fourier transform (DTFT) arises naturally including the inverse DTFT allowing us to define ideal filters. We then move to the discrete Fourier transform (DFT) deriving it as a sampled version of the DTFT and computable through popular fast algorithms that are not discussed in detail. The ideas of DTFT and DFT allows for an understanding of practical spectrum analysis to successfully employ the powerful spectrum analysis tools readily available in software environments such as MATLAB.

Finally, the z-transform is introduced in Chapter 9 and (Infinite Impulse Response) IIR systems in Chapter 10. At this stage, a student will be rewarded with the ability to understand applications involving the sampling theorem, discrete-time filtering, and spectrum analysis. Furthermore, they will be prepared to move on to courses in linear analog circuits, continuous-time signals and systems. In general, this course will also helps prepare students for Senior (and graduate) level courses in Controls, Communications and Signal and Image Processing.

COURSE GRADING

• In-class Semester Exams (2 in-class exams, with self-prepared notes)	**40% (*or 25%)**
• Homeworks (**P/F graded**), Matlab Projects/Labs., Quizzes	**30% (*same 30%)**
• Exam 3 with Comprehensive Final Exam (with self-prepared notes),	**30% (*or 45%)**
TOTAL	**100%**

* Alternative weighting indicates that the grade will be the highest of two grades determined from the two computed total score for the semester, both ways. It will be used only **if class attendance is high** and **teaching evaluation completion rate is high** (details TBD soon) From experience, the alternative weighting helps some students improve one grade level if they are on the borderline between two grades using the standard percentages.

KEY DATES:

Exams 1 and 2 **dates:**	**TBD**
Final Exam **actual date:**	**Finals Week: May 6-10**

USE OF E-MAIL: Each student is required to read their officially registered UTEP e-mail account often enough to monitor ongoing information related to this course including Blackboard announcements.

USE OF BLACKBOARD: This course will make use of the official UTEP Blackboard platform to distribute and collect documents and to send announcements and reminders.

COMPUTER USAGE: The MATLAB software package (with many Toolkits and Toolboxes) is made available via download or a DVD or direct install on your laptop to all Engineering Students from the Engineering Technology Center (ETC). **http://etc.utep.edu/** Tel. (915)747-5223, E-mail: **etchelpdesk@utep.edu**
There is an option to simply download Matlab to your computer from **www.utep.edu/matlab** (it is big, at least 6+ Gbytes). You need to have an account with The Mathworks. More on this as we get the updated details from ETC.

IMPORTANT POLICY:

- Homeworks will be graded pass-fail to emphasize attempting the problems and using the solutions later to check your work. Some problems will be solved in class, solutions or brief answers will be provided well before quizzes are given.
- Quizzes will be based on (similar to) the homework problems expecting that each student has attempted the problems and used the provided 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**. By design, quizzes will be more-or-less impossible to solve by anyone not attempting the homework problems. Quiz problems are to be solved by hand on paper, with limited time allowed during the class time period. Textbook Tables will be provided.
- Exams rules will be finalized in detail the week prior to its offering. The typical rules for exams are expected to be: solve by hand, **handwritten self-prepared notes allowed but excluding copies of entire solved problems,** copies of key slides and textbook Tables to be provided.
- **If there is any suspected copying on quizzes or exams,** seating arrangements will be used. In all cases, the uniqueness of the solution process will be evaluated and suspected actors will be tracked and documented for eventual reporting to the University academic dishonesty authorities.

Specific Outcomes for the Course (version C). 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.
- Apply transformations to and determine properties of discrete-time signals.
- 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.
- **Time-permitting: Use of the Discrete Fourier Transform (DFT) as a tool to compute DTFTs and for spectral analysis of discrete-time and sampled analog signals.**

TOPICS TO BE COVERED (the exact order, pages and/or sections and subsections will be listed in homework handouts and/or will be sent via Blackboard announcements sent to your e-mail accounts).

I- Sinusoids, Spectrum Representation, Sampling and Aliasing (focus on sums of sinusoids, Chapters 2-4, Appendix C)

II- Basic discrete-time signals, signal transformations and signal properties (Supplementary material).

III- Finite Impulse Response (FIR) filter impulse response and convolution (Chapter 5).

IV- FIR filter Frequency Response and its application to filtering of sinusoidal signals (Chapter 6).

V- Discrete-Time Fourier Transform (DTFT) pairs and properties and its application to analysis and design of FIR filters (Chapter 7).

VI- Z-Transform (Chapter 9)

VII- Infinite Impulse Response (IIR) Filters basic introduction (parts of Chapter 10)

VIII- Time-permitting: Computation of the DTFT using the Discrete Fourier Transform (DFT) and applications to spectrum analysis of discrete-time and sampled analog signals (parts of Chapters 8)

EFFORT, PARTICIPATION and ETIQUETTE:

- Students (domestic or international, no exceptions) that are clearly not doing the homeworks, are failing quizzes, and who fail Exam 1 will be dropped from the course unless there are extenuating circumstances or Visa complications (let's discuss it).
- Come to class and show up on time. Habitual late comers may not be allowed in class without a justification if this is disruptive.
- Leaving early should be kept to a minimum; **it can be interpreted as rude behavior**. Inform the instructor ahead of time if you must leave early and sit near the door to minimize disruptions.
- Ask questions of broad interest, your fellow students will also benefit.
- Bring your book to class if possible.
- Turn down the sound on cell phones, beepers, i-pods, etc. during the class period.
- The use of cellular phones during exams and quizzes is strictly prohibited, put them away and out of reach.
- Do not bring ***smelly food*** into the classroom, it makes everybody hungry. Eating other things during class should be done very quietly and as a last resort.

- **Fairness statement** (**version 6**): the key fairness criterion for this course is equal opportunity for all students to receive feedback, help, information, scores, handouts, etc., individual requests cannot be accommodated. Variability in the difficulty of quizzes and exams is adjusted by curving the scores before entering into the final semester score formula. Typically, this means obtaining a score on a scale of 100% by dividing the raw score by a constant S=approximately the 3^{rd} – 5^{th} highest score in the class on that Exam or for the total score for all homeworks and quizzes. Grades are not negotiable individually but fair adjustments can be made for the whole class upon a noteworthy event or my own personal realization that it will improve fairness. The Final Exam **will not be returned**, and will **not be shown** to students under normal circumstances; your trust is appreciated.

ACADEMIC INTEGRITY: Please review the statements below and UTEP's Web page on Policy on Academic Integrity at: **https://www.utep.edu/student-affairs/osccr/student-conduct/academic-integrity.html**

GUIDANCE ON ARTIFICIAL INTELLIGENCE:

AI prohibited

Use of AI technologies or automated tools, particularly generative AI such as **ChatGPT** or **DALL-E**, is ***not allowed*** for assignments in this class. Each student is expected to use critical and creative thinking skills to complete tasks and not rely on computer-generated ideas. Any direct use of AI-generated materials submitted as your own work will be treated as plagiarism and reported to the Office of Student Conduct and Conflict Resolution (OSCCR).

Using AI for reviewing/preparation for Exams

Some AI technologies or automated tools, particularly generative AI such as **ChatGPT** or **DALL-E**, can be beneficial to review or summarize knowledge and you are welcome to explore them for that purpose. However, keep in mind that AI-generated ideas are not your own and may hinder your ability to think critically and creatively about a problem. It is also important to remember that these technologies often "hallucinate" or produce materials and information that are inaccurate or incomplete.

NOTE ABOUT THIS SYLLABUS:

The instructor reserves the right to make any changes to the syllabus during the term of the semester. The instructor will notify any changes made to the syllabus to the students prior to applying any changes.