# EE3353: DISCRETE-TIME SIGNALS AND SYSTEMS

## SYLLABUS: FALL 2022, (CRN: 11272) (Ver. 2, updated 08/25/2022)

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**OFFICE HRS.:** Tuesday, Thursday for 3:00 – 4:20 PM in person and on BlackB, more TBD
Office in Eng. A306 (time may change if not popular)
Friday: 11:00 AM – 12:00PM (send e-mail to confirm I have not conflicts)

**CLASS TIME/PLACE:** **Monday and Wednesday, 10:30 AM – 11:50 AM**
**Liberal Arts Bldg. 202, UTEP Campus (in person)**

**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 is 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 new textbook with an **accelerated pace** on the first few chapters covering sinusoids and spectra of signals. 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 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 help prepare students for Senior (and graduate) level courses in Controls, Communications and Signal and Image Processing.

**COURSE GRADING**

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| • In-class Semester Exams (2 in-class exams, likely with self-prepared notes) | **45% (*or 25%)** |
| • Homeworks (**will count much less**), Matlab Projects/Labs., Quizzes | **30% (*same 30%)** |
| • Comprehensive Final Exam (with self-prepared notes), during Finals week | **25% (*or 40%)** |
| TOTAL | **100%** |

*** Alternative weighting used only if it gives you a higher grade (this sometimes helps a few students improve one grade level if they are on the borderline between two grades)**

**KEY DATES:**

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| Exams 1 and 2 **dates:** | TBD |
| Final Exam **actual date:** | **Friday Dec. 9, 10:00 AM-12:45 PM** |

**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:** Online sessions, recorded materials, office hours, assignment scores, will use the official UTEP Blackboard platform. Key associated tools include the Zoom, Teams, gradescope, etc.) For the most part, blackboard uploading of instructor produced documents replaces the use of direct e-mail delivery.

**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 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.
- ***NEW/Tentative:*** Quizzes (***1-2 times/week***) will be based (modified) on 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**. Additionally, quizzes will be more-or-less impossible to solve by anyone not attempting the homework problems. Quizzes will be solved by hand on paper, with limited time allowed during the class time period. This semester, **papers will be scanned and graded** with gradescope if everything works out well.
- Exams rules will be finalized the week prior to its offering. The typical rules for exams are expected to be: solve by hand, handwritten self-prepared notes allowed, copies of key textbook Tables 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 A).** 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

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

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

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

IV- Computation of the DTFT using the Discrete Fourier Transform (DFT) (parts of Chapters 8)

IV- Z-Transform (Chapter 9)

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

**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 is considered very disruptive and unprofessional, it should be kept to a minimum. 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 unless you are willing to share with me and everyone else that will suddenly become 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 3rd highest score in the class on that Exam or for the total score for all 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. 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**