# Discrete-Time Signals and Systems

### Electrical and Computer Engineering

## SYLLABUS

**Instructor:**

Wei Qian, Ph.D.
Professor
Department of Electrical and Computer Engineering
College of Engineering, University of Texas, El Paso
PH: (915) 747-8090
wqian@utep.edu

**Office Hours:**

| | |
|---|---|
| 9:00am - 11:00am | MWF |
| 3:00pm – 5:00pm | TRF |

**Prerequisites:**

1. Calculus
2. Linear Algebra
2. Circuit and System
3. Matlab

This course requires the desire to learn, enjoy challenges, ability to work in a team, curiosity, and knowledge of basic mathematics, physics, or consent of the instructor.

**Textbooks:**

C. Phillips, J. Parr, E. Riskinm S*ignal, Systems, and Transforms,* 5th Edition, Prentice Hall, 2008.

**Course Objectives:**

1. To give students the mathematical tools to analyze and understand how signals and systems are processed in both the time and frequency domains, so that students have the foundations to excel in future required courses.
2. Understanding of the theory of A/D and D/A signal conversion, digital filtering and spectral analysis.
3. Experience in the design and implementation of digital filters and spectral analyzers, and in their application to real signals (e.g., speech, images).

**Course Outcomes:**

Students completing this course will be able to:

**1.** Use Digital processing of continuous-time signals; aliasing; sampling theorem; analog lowpass filter design.
**2.** Understand the characteristics of Discrete -Time signals; such as periodic, aperiodic, energy, and power signals.
**3.** Understand the characteristics of Discrete-Time systems; LTI; causality; BIBO stability; convolution; interconnected systems; impulse response.
**4.** Understand the Linear, Constant Coefficient Difference Equations, Block diagrams of difference equations and Solution of difference equations in the time/frequency domains.
**5.** Use the Z-Transform; ROC; causality; inverse z-transform, to analyze Discrete-Time signals and Discrete-Time-Invariant Systems.
**6.** Use the Discrete-Time Fourier Transform; finite-length sequences; circular convolution, to analyze Discrete-Time signals and Discrete-Time-Invariant Systems.

**Topics:**

1) Chapter 1: Samplers and Discrete-Time Physical Systems

    a) To understand the time- and frequency-domain concepts related to A/D conversion.
    b) To understand the time- and frequency-domain concepts related to D/A conversion.
    c) To understand the role of oversampling in A/D and D/A conversion.
    d) To understand the roles of downsampling and upsampling in digital processing of analog signals

2) Discrete-Time (D-T) Signals and Systems (Chapter 9).

    a) Axis and amplitude transformations and basic properties.
    b) Common D-T signals used in the course.
    c) Definition and properties of discrete-time systems.

3) Discrete-Time LTI Systems (Chapter 10)

   a) Impulse response of D-T LTI systems
   b) D-T convolution: its role and computation
   c) Properties of D-T LTI systems
   d) Linear, Constant Coefficient Difference Equations
   e) Block diagrams of difference equations
   f) Solution of difference equations in the time domain
   g) Difference Equations and Digital Filters

4) The z-transform (Chapter 11)
   a) Definition and computation of z-transform for basic signals
   b) z-transform properties
   c) LTI systems analysis using the z-transform.
   d) Two-sided z-transform and region of convergence.
   e) Solution of Difference Equations using the z-transform

5) Discrete-Time Fourier Transform (DTFT) (Chapter 12)
   a) Definition and basic transform pairs
   b) Properties of the DTFT
   c) Frequency Response of a Difference Equation
   d) Windowing and the Discrete Fourier Transform (DFT)
   e) Basic applications of the DFT
   f) Computation of the DFT using the Fast Fourier Transform (FFT)
   g) Intro. to Discrete Cosine Transform

6) Supplementary material (Optional): applications and implementation issues and the use of digital systems to process D-T signals and implement D-T systems.
   a) Transfer function; frequency response; ideal filters; zero phase and linear phase; FIR transfer functions
   b) Simple digital filters: lowpass, highpass; IIR filters; stability
   c) Minimum phase and maximum phase transfer functions; complementary transfer functions
   d) Digital filter structure; digital filter design

**Grading & Evaluation**

The course grade will be determined by homework (40%), and one midterm examination (30% total), and final examination (30%).

**Academic Integrity**

The University of Texas at El Paso prides itself on its standards of academic excellence. In all matters of intellectual pursuit, UTEP faculty and students must strive to achieve based on the quality of the worked produced by the individual. In the classroom and in all other academic activities, students are expected to uphold the highest standards of academic integrity. Any form of scholastic dishonesty is an affront to the pursuit of knowledge and jeopardizes the quality of the degree awarded to all graduates of UTEP. Any student who commits an act of scholastic dishonesty is subject to discipline. Scholastic dishonesty includes, but is not limited to, cheating, plagiarism, collusion, the submission for credit of any work or materials that are attributable in whole or in part to another person, any act designed to give unfair advantage to a student or the attempt to commit such acts. Proven violations of the detailed regulations, as printed in the Handbook of Operating Procedures (HOP) and available in the office of the Dean of Students, may result in sanctions ranging from disciplinary probation, to failing grades on the work in question, to failing grades in the course, to suspension or dismissal, among others.

## Students with Disabilities

If you believe you may have a disability that requires accommodations, contact the Disabled Student Services Office at 747-5148, go to room 306 E. Union, or email: dss@utep.edu.

## Student Responsibility

Individual students must operate with integrity in their dealings with faculty and other students; engage the learning materials with appropriate attention and dedication; maintain their engagement when challenged by difficult learning activities; contribute to the learning of others; and perform to standards set by the faculty

## Policies & Procedures

1. The instructor reserves the right to change the class schedule as needed during the semester.
2. All students are expected to arrive in class prepared, i.e., assigned readings completed and homework ready to turn in for grading.
3. If there is a problem taking an exam at the assigned time, students MUST contact the instructor PRIOR to the day of the exam or NO make-up test will be allowed and the student will receive a zero for the missed exam.
4. NO projects and/or homework will be accepted after the due date and time.
5. Project and/or homework material left with the instructor at the end of the semester will be retained only four (4) weeks into the next semester, after which they will be destroyed.
6. There will be no make-ups for missed quizzes.
7. Cell phones, beepers and other electronic devices must be turned off during class.
8. Please see attached sheet on UTEP policy on academic dishonesty.

### ATTENDANCE

You are expected to attend classes regularly and on time. You take full responsibility when you miss class or come to class late. If you miss class, it is your responsibility to find out about new assignments/exercises and pick up missed handouts.

**EXAMINATION POLICIES:**

The midterm and final exams will be essay and short answer. Both exams will be closed book, open notes, and you are required to do your own work on the exams. University policy states that missed exams receive a grade of 0. If you miss the midterm exam, the weight of the mid-term exam will be placed on the final. If you miss the final exam, you will receive a 0.