The University of Texas at Austin
Department of Electrical and Computer Engineering

ECE313: Linear Systems and Signals (17140) — Fall 2024

Syllabus and Class Policy

Lecture:

- *Time*: Tuesday and Thursday, 12:30 pm – 2:00 pm
- *Location*: CPE 2.218

Instructor:

- *Name*: Prof. Aryan Mokhtari (`https://sites.utexas.edu/mokhtari/`)
- *Email*: mokhtari@austin.utexas.edu
- *Office*: EER 6.826
- *Office hours*: Tuesday 2:30pm – 3:30pm and Thursday 11:00am – 12:00pm

Graduate TA:

- *Name*: Sol Lim
- *Email*: sollim@utexas.edu
- *Office hours*: TBD.

Course Outline:

This course builds a mathematical foundation for analyzing linear signal processing, communication, and control systems. In particular, it presents and integrates the foundations of Continuous-Time (C.T.) and Discrete-Time (D.T.) signals and systems. The first part of the class covers basic operations on signals, classification of signals and systems, LTI systems and their impulse response properties, convolution and its properties, and discerption of systems via differential/difference equations. The second part of the class covers the Fourier series representation of periodic C.T. and D.T. signals and their properties, C.T. and D.T. Fourier Transforms and their convolution and multiplication properties, as well as Laplace Transform and Z Transform. The third part covers filtering and filter design, modulation, and sampling.

Course Objective:

After taking this course, students should be able to (i) characterize the basic properties of discrete-time and continuous-time signals and systems, (ii) understand the time and frequency representations of signals and systems and their relationships, and (iii) have a good understanding of how filtering, sampling, and modulation of signals work. Also, after taking this course, students should be ready to take more advanced courses in the area of signals and systems, such as image and video processing, digital signal processing, communication systems, and control theory.

Prerequisites:

Biomedical Engineering 311, Electrical and Computer Engineering 331 with a grade of at least B; Mathematics 427J or 427K with a grade of at least C-; and credit with a grade of at least C- or registration for Mathematics 340L.

Required Textbook:

"**Signals and Systems**", 2nd Edition, by A. V. Oppenheim, A. S. Willsky, with S. H. Nawab.

Online Tools:

The course will use several online tools:

- **Canvas**: Announcements, scanned class notes, assignments, grades for homework and exams.
- **Ed Discussion**: It is primarily a venue to get basic help from your student peers. Office hours are the best way to get guidance on solutions from the TAs and the instructors. The TAs will answer questions on Ed Discussion to the best of their bandwidth.
- **Gradescope**: Electronic homework submission and homework/exam grading platform.

Homework Sets:

There will be homework due approximately **once every week**, and it will be released on Canvas and Gradescope. Homework needs to be scanned and submitted via Gradescope before 11:59pm on the day it is due. Solutions will be released the day after when the homework was due.

Important notes about the Homework Sets:

- Submissions outside of Gradescope, and late submissions, will not be accepted
- One homework (the one with lowest score) will be dropped from the final grading.
- Discussing homework problems is encouraged. Copying is considered cheating. Be absolutely certain to submit your own independent homework solutions.

Exams:

- **Midterm 1**: Tuesday, October 1, 2024, 12:30 pm - 2:00 pm (in person, in class)
- **Midterm 2**: Thursday, November 7, 2024, 12:30 pm - 2:00 pm (in person, in class)
- **Final Exam**: Thursday, December 12, 2024, 1:00 pm - 3:00 pm: (in person, in class)

Grading:

Homework Sets	Midterm 1	Midterm 2	Final Exam
25%	20%	20%	35%

Remark: The plus/minus grading system will be used.

Lecture Topics and Tentative Agenda:

Lecture (date)	**Topic(s) covered in the lecture**	**Sections from the textbook**
Lecture 1 (8/27)	- Basics of signals and systems (definitions and examples) - Review of complex numbers, integrations, and series	Section 1.1
Lecture 2 (8/29)	- Energy and power of signals - Odd and even signals - Elementary operations on signals	Section 1.1
Lecture 3 (9/3)	- Periodic signals - Complex exponentials and sinusoidal signals - Unit impulse and unit step signals	Sections 1.2, 1.3, 1.4
Lecture 4 (9/5)	- System properties (causality, memoryless, invertibility, stability, linearity, time-invariance) - Interconnections of systems	Sections 1.5, 1.6
Lecture 5 (9/10)	- Impulse response for DT LTI systems - Convolution for DT signals	Section 2.1
Lecture 6 (9/12)	- Impulse response for CT LTI systems - Convolution for CT signals	Section 2.2
Lecture 7 (9/17)	- Connections between properties of LTI systems and their impulse response	Section 2.3
Lecture 8 (9/19)	- Causal DT/CT LTI systems and their connections with difference/differential equations	Section 2.4
Lecture 9 (9/24)	- Eigenfunction property of complex exp. for CT LTI systems - Fourier Series (FS) of periodic C.T. signals	Sections 3.1, 3.2, 3.3
Lecture 10 (9/26)	- Examples of computing FS of periodic C.T. signals	Section 3.3
(10/1/2024)	Midterm 1	
Lecture 11 (10/3)	- Properties of CT Fourier Series	Section 3.5
Lecture 12 (10/8)	- Discrete-Time (DT) Fourier Series (FS) for periodic signals	Section 3.6
Lecture 13 (10/10)	- Properties of DT Fourier Series	Section 3.7
Lecture 14 (10/15)	- Continuous-Time Fourier Transform (CTFT)	Sections 4.0, 4.1

Lecture (date)	**Topic(s) covered in the lecture**	**Sections from the textbook**
Lecture 15 (10/17)	- Basic properties of CTFT	Section 4.3
Lecture 16 (10/22)	- CT Fourier Transform of periodic signals - The convolution property of CTFT	Sections 4.2, 4.4
Lecture 17 (10/24)	- Filtering and its connections with the convolution property - Different types of filters	Sections 3.8, 3.9
Lecture 18 (10/29)	- The Multiplication property of CTFT (Modulation) - Amplitude Modulation, Frequency division multiplexing	Sections 4.5, 4.6 Sections 8.1, 8.2, 8.3
Lecture 19 (10/31)	- CTFT and differential equations - Discrete-Time Fourier Transform (DTFT) and its properties	Sections 4.7, 5.1, 5.2
Lecture 20 (11/5)	- Filtering for Discrete time signals and systems	Sections 3.9, 3.11
(11/7/2024)	Midterm 2	
Lecture 21 (11/12)	- Sampling and signal reconstruction - Undersampling and aliasing	Sections 7.1, 7.2, 7.3
Lecture 22 (11/14)	- DT processing of CT signals - Sampling of DT signals	Sections 7.4, 7.5
Lecture 23 (11/19)	- Laplace Transform (Definition, ROC, pole-zero plot, inverse, properties, Laplace pairs)	Sections 9.1, 9.2, 9.3, 9.5, 9.6
Lecture 24 (11/21)	- Laplace Transform (Connection between LT and LTI systems, differential equations and LT, Filter design)	Section 9.7, 9.8, 9.9
Lecture 25 (12/3)	- Z Transform (Definition, ROC, inverse, properties)	Sections 10.1, 10.2, 10.3, 10.5, 10.6
Lecture 26 (12/5)	Topics TBA - Review lecture	
(12/12/2024)	Final Exam	

University Honor Code:

"The core values of The University of Texas at Austin are learning, discovery, freedom, leadership, individual opportunity, and responsibility. Each member of the University is expected to uphold these values through integrity, honesty, trust, fairness, and respect toward peers and community."

College of Engineering Drop/Add Policy:

The Dean must approve adding or dropping courses after the fourth-class day of the semester.

Accessible, Inclusive, and Compliant Statement:

The university is committed to creating an accessible and inclusive learning environment consistent with university policy and federal and state law. Please let me know if you experience any barriers to learning so I can work with you to ensure you have equal opportunity to participate fully in this course. If you are a student with a disability, or think you may have a disability, and need accommodations please contact Disability and Access (D&A). Please refer to D&A's website for contact and more information: http://diversity.utexas.edu/disability/. If you are already registered with D&A, please deliver your Accommodation Letter to me as early as possible in the semester so we can discuss your approved accommodations and needs in this course.

Emergency Preparedness:

Every member of the university community must take appropriate and deliberate action when an emergency strikes a building, a portion of the campus, or entire campus community. Emergency preparedness means we are all ready to act for our own safety and the safety of others during a crisis. Students requiring assistance in evacuation must inform the instructor in writing of their needs during the first week of class. This information must then be provided to the Fire Prevention Services office by fax (5122322759), with "Attn. Mr. Roosevelt Easley" written in the subject line. You may want to bookmark the emergency Web site http://www.utexas.edu/emergency/ because it is updated with information during actual emergencies or campus closures. The university collects cell phone numbers from members of the campus community for emergency text messages. You can sign up for campus text alerts online. If you would like more information regarding emergency preparedness, visit http://www.utexas.edu/safety/preparedness