ELE 201 – Information Signals

Spring Semester, 2018

Instructor

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Graduate Teaching Assistants

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Course Information

Meeting times: Tuesday and Thursday, 11:00AM-12:20PM
Prerequisites: Single-variable calculus

Course Description

Signals that carry information play a central role in technology and engineering, ranging from sound and images to MRI, communication, radar, multimedia interaction, and robotic control. This course teaches mathematical tools to analyze, manipulate, dissect, and preserve information signals. A major focus of the course is transforms – in particular, the Fourier, Laplace, and z-transforms – which reveal the frequency spectrum of signals and can make them easier to manipulate. We also study sampling, the process of converting a signal from continuous to digital, and which transforms to use depending on the waveform. Additional topics covered include linear time-invariant systems, modulation, quantization, and stability. Lab design projects will use MATLAB.

Required Textbooks

Signals and Systems (Second Edition), By Oppenheim and Willsky

Tentative Schedule

The following is a tentative schedule of lecture topics, exams, labs, and due dates for problem sets and writeups.

Unit	Week	Lecture	Date	Topics	Reading	Due
I. Signals and Systems	1	1	2/06	• Course Introduction • Continuous-time Signals • Discrete-time Signals	1.0-1.2	
		2	2/08	• Even vs. Odd Functions • Exponential and Sinusoidal Signals • Periodicity	1.2-1.3	
	2	3	2/13	• Impulse and Unit Step Functions • Continuous-time and Discrete-time Systems	1.4-1.5	
		4	2/15	• System Properties: Linear, Time Invariant, Causal, Stable, Other	1.6-1.7	PS #1
II. Linear Time Invariant (LTI) Systems	3	5	2/20	• Discrete-time Impulse Response • Convolution for Discrete-time LTI Systems	2.1	
		6	2/22	• Continuous-time Impulse Response • Convolution for Continuous-time LTI Systems • Properties: Commutative, Distributive, Associative	2.2, 2.3	Lab #1
	4	7	2/27	Class Canceled		
		8	3/01	• Properties: Invertibility, Stability, Other	2.3, 2.4	PS #2

				• Difference/Differential Equations for Discrete-time LTI Systems		
III. Fourier Series	5	9	3/06	• Block Diagram Representations • Fourier Series for Continuous Time Periodic Signals • Sinusoidal and Exponential Representations • Properties of Continuous Time Fourier Series	2.4, 3.1-3.5	
		10	3/08	• Fourier Series for Discrete Time Periodic Signals • Properties of Discrete Time Fourier Series	3.6-3.8	Lab #2
IV. Continuous Time Fourier Transform (CTFT)	6	11	3/13	• Fourier Series and LTI Systems • Examples of Continuous and Discrete Time Filters	3.9-3.11	
		12	3/15	• The Continuous Time Fourier Transform (CTFT) • Linearity and Time Shifting Properties of the CTFT • Other CTFT Properties: Differentiation, Integration, …	4.1-4.3	PS #3
			3/20	**Spring Break: No Class**		
			3/22			
	7	13	3/27	• Other CTFT Properties: Differentiation, Integration, … • The CTFT Convolution Property • The CTFT Multiplication Property	4.3-4.5	
		14	3/29	**Midterm Exam: Units I-IV**		
V. Discrete Time Fourier Transform (DTFT)	8	15	4/03	• Fourier Transform Table • Frequency Response of a Continuous-Time LTI System • Fourier transform solution to differential equations	4.5-4.7	

		16	4/05	• The Discrete Time Fourier Transform (DTFT) • Periodicity, Linearity, Time Shifting, and Frequency Shifting	5.1, 5.3	PS #4, Lab #3
	9	17	4/10	• Other DTFT Properties: Differencing, Accumulation, … • The DTFT Convolution and Multiplication Property • Fourier Transform Table • Frequency Response of a Discrete-Time LTI System	5.3-5.5, 5.7 5.6, 5.8	
VI. Sampling and Com. Systems		18	4/12	• Sampling (Nyquist's) Theorem • Impulse-Train Sampling • Undersampling and Aliasing • Discrete-Time Processing of Continuous-Time Signals	7.1, 7.3, 7.4	Lab #4
	10	19	4/17	No lecture		PS #5
		20	4/19	Gerard Wysocki lecture	8.1-8.3, 8.7	
VII. Laplace Transform	11	21	4/24	• The Laplace Transform • Pole-Zero Plot • Region of Convergence	9.1-9.3	
		22	4/26	• Properties of the Laplace Transform • Some transform pairs	9.3, 9.5-9.6	PS #6, Lab #5
	12	23	5/01	• Examples • Analyzing LTI Systems with the Laplace Transform	9.6, 9.7	
		24	5/03	• Butterworth Filters • Block Diagram Representations	9.8	PS #7
			5/16	**Final Exam: Units I-VIII**		PS #8

Evaluation

This class will have four types of evaluations:

Midterm Exam (20%)

There will be one midterm exam. It will be administered during the last class before Spring break. It will cover the first four Units, except for the last lecture on Unit IV (which will occur after break).

The exams will be closed book and closed notes, with the exception of a single-sided formula sheet on an 8.5x11 sheet of paper that you can create for yourself.

Problem Sets (25%)

There will be eight problem sets, one for every unit covered. These will generally be released before the last week in which a unit is covered and due one week later. They must be submitted as a hardcopy to the course mailbox.

Late submissions will be accepted for three days, with points deducted for each day late. The lowest homework grade will be dropped.

Labs (20%)

There will be five labs, each of which will use MATLAB extensively. All of the labs will be two weeks in duration with the exception of the fourth, which will be only one week. Week 1, Week 6, and Week 12 will not have labs.

Generally speaking, the writeup will be due at the end of the second week of the lab. The submission must be in hardcopy form to the course mailbox. All parts of the lab which ask for a demonstration to the TA should be submitted as part of the writeup.

Final Exam (35%)

The final exam will be comprehensive, though it can be expected to emphasize Units V-VIII slightly more as these are not tested on the midterm. The questions will be of similar style to the midterm.

You are permitted to reuse the previous formula sheet, as well as to create a second one for the second half of the course.

Grading Policy and Procedures

Grading in this class will be performed in accordance with the policies set forth here by the Office of the Dean of the College (ODOC). The teaching staff will take responsibility for ensuring that each assessment – problem sets, labs, and exams – is marked in a manner that constitutes “substantive feedback to give students clear information about the quality of their work.”

Note also that there are no exact numerical ranges associated with how letter grades will be allocated. For this reason, the instructors reserve the right to institute curves, both on individual assessments and on the final grades, as they see fit. Both upward and downward curves as possible, though the former is more likely if at all. That being said, students can also expect that their final letter grades will not deviate too substantially far from what would be expected on a traditional scale.