EE 310: Linear Systems & DSP I

Fall 2019
Classroom: KC136
Days: MWF
Time: 3:00-3:50 P.M.

Instructor: Dr. Tony Richardson
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Catalog Description: EE 310 Linear Systems and DSP I (4) Provides a unified treatment of continuous-time and discrete-time linear signals and systems. Topics include introduction to the mathematical representation of signals, system characterization, convolution and system analysis in the time and frequency domains using differential equations, state-vector equations and transform techniques. Fourier, Laplace, *z* and discrete-Fourier transform techniques of signal and system analysis presented. Prerequisites: EE215, MATH324

Credit Hour Policy: This course meets the federal requirements of 15 in-class hours plus an expected 30 hours of out-of-class work per credit hour over a semester. (At least 135 hours total; 9 per week)

Text: *Signals and Systems: Theory and Applications*, F.T. Ulaby, A.E. Yagle, Michigan Publishing, © 2018
This text is available as a free PDF download from: http://bit.ly/ee310pdf. A printed text may be ordered ($70) from: http://bit.ly/ee310text. Additional resources are available from the text website: http://ss2.eecs.umich.edu/

Software: Numerical analysis software (MATLAB/Octave) and circuit simulation software (LTSpice) will be used extensively.

Course Structure: The class will meet three hours a week in lecture. The will be primarily a lecture-discussion course with reading and problem assignments.

Grading: There will be three midterm exams and a comprehensive final exam. The project assignments will typically require the use of one of the software packages listed above. Homework assignments will be given on an approximately weekly basis. Short quizzes will be given at the beginning of almost every lecture period. Quizzes are used to encourage regular and on-time attendance.

Item	Weight
Four Midterm Exams	48%
Final Exam	20%
Projects	12%
Homework	10%
Quizzes	10%

Class Policies: Students are expected to abide by the Academic Honor Code. No aid should be given or requested on any examination. Students may collaborate on homework (in fact, this is encouraged), but each student must submit their own work. Each student is expected to be able to recreate any homework solutions submitted.

Credit Hour Policy: This course meets the federal requirements of 15 in-class hours plus and expected 30 hours of out-of-class work per credit hour.

Disability Policy: It is the policy and practice of the University of Evansville to make reasonable accommodations for students with properly documented disabilities. Students should contact the Office of Counseling and Health Education at 488-2663 to seek services or accommodations for disabilities. Written notification to faculty from the Office of Counseling and Health Education is required for academic accommodations.

Class Communication: To receive notifications (class reminders, assignment hints and corrections, answers to exam questions, etc) from the instructor related to this course do one (or both) of the following: (1) text @ue-ee310 to 81010 (or 812-301-1469) to receive notifications by text, (2) send email (empty subject and body are ok) to ue-ee310@mail.remind.com to receive notifications by email. Alternatively, browse to remind.com/join/ue-ee310 to join OR install the Remind app or your smart phone/pad (Apple, Android) to join and receive notifications. To receive more general notifications from Dr. Richardson (class cancellations, departmental event reminders, winning lottery numbers, etc) please also text @ue-rich to 81010 (or 812-301-1469) or send email to ue-rich@mail.remind.com. Note that I remove all participants from all of my Remind classes at the end of the every semester, so you will need to rejoin the ue-rich class even if you have previously been a member.

Topics:

- Properties of cont-time (CT) and discrete-time (DT) signals.
- Properties of CT and DT systems
- Finding the output of CT and DT systems via convolution.
- Finding the Fourier, Laplace and *z* transforms of signals.
- Find the output of CT and DT systems via transforms
- Determine the signal spectra of CT and DT signals.
- Frequency response of CT and DT systems.
- Modeling of systems using Laplace transforms.
- Sampling of CT signals.

Course Objectives

- Students will characterize continuous time (CT) and discrete time (DT) signals as even, odd, or periodic.
- Students will apply common time and amplitude transformations to CT and DT signals.
- Students will model finite duration CT and DT polynomial signals using a sum of singularity functions.
- Students will characterize CT and DT systems as being: memoryless, invertible, causal, stable, time invariant, or linear.
- Students will be able to use convolution to determine the system output for both CT and DT systems.
- Student will determine the output of a CT or DT system given the system transfer function and a complex-exponential input.
- Given a differential (CT) or difference (DT) equation model, students will represent the system using simulation diagrams.
- Students will be able to determine the Fourier series of common periodic CT signals.
- Students will apply common CT signal transformations to extend the applicability of tables of Fourier series representations.
- Given a Fourier series (FS) of a system input and the transfer function, students will be able to determine the FS of the output.
- Students will be able to apply the Fourier transform to determine the frequency spectra of common CT signals.
- Given a frequency spectrum, students will be able to find the corresponding magnitude and phase spectrum.
- Students will be able to determine the output of a CT system using Fourier transform techniques.

- Students will be able to explain the relationship between the impulse and frequency responses.
- Students will be able to find energy and power spectra of common CT signals.
- Students will be able to find the Laplace transform of common engineering CT signals.
- Students will be able to apply Laplace transform methods to determine the output of a given CT system.

University Objectives
- Students will acquire a depth of knowledge in one or more disciplines of their choice.
- Students will master communication, organizational and critical thinking skills.
- Students will develop skills and competencies to be productive team members and leaders.
- Students will seek and use available resources, including technology, to answer questions and solve problems.

Lecture Schedule
This schedule is tentative. The instructor reserves the right to change it.

Monday	***Wednesday***	***Friday***
	Period 1 (Aug 21) S 1.1-1.3: Types of Signals, Signal Transformations, Waveform Properties	**Period 2 (Aug 23)** S 1.4-1.5: Nonperiodic Waveforms, Signal Power and Energy
Period 3 (Aug 26) S 2.1-2.2: Linear Time-Invariant (LTI) Systems, Impulse Response	**Period 4 (Aug 28)** S 2.3-2.4: Convolution, Graphical Convolution	**Period 5 (Aug 30)** S 2.4-2.5: Convolution Properties
Sep 2 **Labor Day** **NO CLASS**	**Period 6 (Sep 4)** S 2.6-2.7: Causality and BIBO Stability, LTI Sinusoidal Response	**Period 7 (Sep 6)** S 2.8-2.9*: Impulse Response of Second-Order LCCDEs, Car Suspension System
Period 8 (Sep 9) **EXAM I** **Chapters 1 - 2**	**Period 9 (Sep 11)** S 3.1-3.3: Laplace Transform (LT), Poles and Zeros, LT Properties	**Period 10 (Sep 13)** S 3.4-3.5: Circuit Analysis Example, Partial Fraction Expansion
Period 11 (Sep 16) S 3.5-3.6: Transfer Function H(s)	**Period 12 (Sep 18)** S 3.7-3.9: Poles and System Stability, Invertible Systems, Sinusoidal Signals	**Period 13 (Sep 20)** S 3.10-3.11: Comparing LTI System Descriptions, LTI System Partitions
Period 14 (Sep 23) S 4.1-4.2: s-Domain Circuit Element Models, s-Domain Circuit Analysis	**Period 15 (Sep 25)** S 4.5: Op-Amp Circuits	**Period 16 (Sep 27)** S 4.6-4.7: Configurations of Multiple Systems, System Synthesis
Period 17 (Sep 30) EXAM II REVIEW	**Period 18(Oct 2)** **EXAM II** **Chapters 3 - 4**	**Period 19 (Oct 4)** S 5.1-5.3: Phasors, Fourier Series (FS) Analysis, FS Representations
Oct 7 **Fall Break** **NO CLASS**	**Period 20 (Oct 9)** S 5.4: Computation of Fourier Series Coefficients	**Period 21 (Oct 11)** S 5.5-5.6: Circuit Analysis with FS, Parseval's Theorem
Period 22 (Oct 14) S 5.7-5.8: Fourier Transform (FT), FT Properties	**Period 23 (Oct 16)** S 5.8-5.9: Parseval's Theorem for FTs	**Period 24 (Oct 18)** S 5.10-5.12: FT Attributes, Phasor vs. Laplace vs. Fourier, FT Circuit Analysis
Period 25 (Oct 21) S 6.1-6.2: Types of Filters	**Period 26 (Oct 23)** S 6.3: Passive Filters	**Period 27 (Oct 25)** S 6.4-6.5: Active Filters, Ideal Filters
Period 28 (Oct 28) S 6.6-6.7: Filter Design by Poles and Zeros, Frequency Rejection Filters	**Period 29 (Oct 30)** S 6.13: Sampling Theorem	**Period 30 (Nov 1)** EXAM III REVIEW
Period 31 (Nov 4) **EXAM III** **Chapters 5 - 6**	**Period 32 (Nov 6)** S 7.1-7.2: Discrete Signal Properties, Discrete-Time (DT) Signal Functions	**Period 33 (Nov 8)** S 7.3-7.4: Discrete-Time LTI Systems, Properties of Discrete-Time LTI Systems
Period 34 (Nov 11) S 7.5: Discrete-Time Convolution	**Period 35 (Nov 13)** S 7.6-7.7: The z-Transform, Properties of the z-Transform	**Period 36 (Nov 15)** S 7.8: Inverse z-Transform
Period 37 (Nov 18) S 7.9-7.11: Solving Difference Equations, The System Transfer Function, Stability	**Period 38 (Nov 20)** S 7.12: System Frequency Response	**Period 39 (Nov 22)** S 7.13-7.14: DT Fourier Series (DTFS), DT Fourier Transform (DTFT)
Period 40 (Nov 25) S 7.15: Discrete Fourier Transform (DFT)	**Nov 27** **Thanksgiving Break** **NO CLASS**	**Nov 29** **Thanksgiving Break** **NO CLASS**
Period 41 (Dec 2) EXAM IV REVIEW	**Period 42 (Dec 4)** **EXAM IV** **Chapter 7**	

The Final Exam is on Wednesday, December 11th at 2:00 PM