Department of Electrical Engineering and Computer Science
The University of Kansas

EECS 361- Signal and System Analysis

Fall 2025

Catalog Data: EECS 361 (3) Signal and System Analysis: Fourier signal analysis (series and transform); linear system analysis (continuous and discrete); z-transforms, analog and digital filter analysis; analysis and design of continuous and discrete time system using MATLAB. Prerequisite: EECS 212

Prerequisites by Topics:

1. Differential and integral calculus.
2. Concurrent study of simultaneous linear algebraic equations.
3. Concurrent study of differential equations, including solution by Laplace transforms.
4. Sufficient computer familiarity to be able to use MatLab.

Instructional Mode: In person class. Location: LEEP2 2420. Time: TuTh 02:00 PM - 03:15 PM

Optional Discussion Sessions:

Usually scheduled for Wednesday 5:00-6:50 PM in Room TBD. These sessions will be used for test reviews, make-up classes, and as needed homework reviews. These sessions will not meet every week; check the class web site to find out if discussion session is meeting. Use of the discussion session will be announced in class and on the class web site.

Required Textbook:

zyBooks: NI Engineering Signals and Systems (2e) - Interactive Edition, zyBook ISBN: 979-8-203-34293-5 (The zyBook is based on: Signals and Systems: Theory and Applications, Ulaby and Yagle, Michigan Publishing, 2018, available for free at https://ss2-2e.eecs.umich.edu/)

Obtain **required** zyBooks by:

1. Sign in or create an account at learn.zybooks.com
2. You **must** use your "official" KU e-mail address, NOT a Gmail or other e-mail address.
3. Enter zyBook code: KUEECS361FrostFall2025
4. Subscribe

Required Software: MATLAB and Wolfram CDF Player available at http://www.wolfram.com/products/player/,

Class web page: http://www.ittc.ku.edu/~frost/EECS_360/index_EECS_361_Fall_2025.html

Course Objectives: Students will be able to:

1. Describe continuous and discrete signals and systems in the time and frequency domains.
2. Understand how to classify signals as periodic or aperiodic and power or energy signals,
3. Understand how to classify systems as linear/non-linear, time-invariant/time-varying, causal/non-causal, and BIBO stable/unstable.
4. Understand and be able to use the special functions, including impulse, step, and pulse functions.
5. Perform continuous and discrete time convolution.
6. Determine the time and frequency characteristics of continuous and discrete time systems.
7. Represent periodic signals using Fourier series and construct spectral plots.
8. Represent aperiodic signals using the Fourier transform.
9. Understand the properties of the Fourier transform.
10. Use Parsaval's theorem for periodic and aperiodic signals to determine signal power and energy.
11. Determine the output of linear time-invariant systems with a periodic and aperiodic inputs.
12. Understand the concept of bandwidth and the signal duration/bandwidth relationship.
13. Understand the characteristics of ideal filters.
14. Understand the criteria for distortionless transmission.

15. Understand the Sampling Theorem and its application.
16. Understand how to apply the z-transform to discrete time signals and systems.
17. Understand digital filters, transfer functions for discrete systems, and digital filter design.
18. Understand the Discrete Fourier Transform (DFT), its parameters and properties, including spectral leakage and windowing.
19. Understand how to use the DFT to perform linear convolution.
20. Analyze a basic feedback control system for stability and how to design for stability.
21. Determine appropriate tools to apply to signals and systems problems.

Outcomes: Students should be capable of:

1. Performing continuous and discrete time convolution
2. Determining properties of time linear time invariant systems and performing linear system analysis
3. Using Fourier transforms of signals and impulses responses for linear system analysis.
4. Forming discrete time Fourier transforms of signals for linear system analysis.
5. Forming z-transforms and application to discrete time linear system analysis
6. Discrete time filter design.

Instructor: Victor S. Frost

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vsfrost@ku.edu (e-mail is the best ways to contact me)
More information about me can be found at http://www.ittc.ku.edu/~frost/

Office Hours: 8:30 - 10:30 TR
3:30 - 4:30 TR
I am available outside of office hours: e-mail to confirm my availability at specific day/time.

Computer Usage:

Plotting with MATLAB. For plotting in MATLAB see Plotting Functions using fplot see: https://www.youtube.com/watch?v=Xaos1ALprCQ and for creating stem plots in MATLAB see:https://www.youtube.com/watch?v=bWIzuYwwAbk

Interacting with Wolfram Computable Document Format (CDF) files for interactive content. Wolfram CDF Player is installed on all EECS Windows computers, and a free download is available at http://www.wolfram.com/products/player/

Grading: The following percentages will be used to arrive at the final grade:

Test 1	24% (Some formulas and tables will be provided)
Test 2	24% (Some formulas and tables will be provided)
Final Exam	30% (Some formulas and tables will be provided)
Participation Activities	7.5% (Process to check on # points/PA)
Homework	12%
Attendance	2.5%

Tests and the final exam will be closed book/closed notes.

Final letter grades are determined from the final grade scores using

90 – 100%	A
80 – 89%	B
70 – 79%	C
60 - 69 %	D
0 – 59%	F

Lower limit on these ranges may be reduced as a function of the distribution of the final scores. This class will **not** use +/- grading.

Homework:

1. Homework problems are designed to illustrate and reinforce concepts covered in class. Each homework problem is explicitly associated with a signals and systems concept.
2. There is a strong correlation between the course grade and understanding concepts demonstrated in homework problems.
3. Assigned participation activities and homework problems are posted on the class web site.
4. There will be approximately one homework assignment per week.
5. Collaboration with classmates is permitted. Copying is not permitted.
6. Each homework problem is counted as 10 points, e.g., an assignment with 6 homework problems will be 60 points
7. Participation activities are auto-graded by the zybooks app. Participation activities are different from homework problems. (Process to check on # points/PA)
8. Plots and graphs on homework **must** be generated by a computer tool, e.g., MATLAB.
9. Solutions will not be posted; upon request any problem will be worked in class, in review sessions or during office hours.
10. Homework must be submitted in the specified format given at Homework Format.
11. Your solution to the assigned problems must be submitted via e-mail as a PDF file using this subject line and file name format:
    LastName_361_Homework#.pdf, e.g., Frost_361_Homework5.pdf .
    The subject line in the e-mail must be LastName_361_Homework#, e.g., Frost_361_Homework5
12. Homework must be submitted by email to the grader TBD
13. Homework is due at 5:00 pm on the due date.

Quizzes: Quizzes maybe given at random and unannounced. Quiz scores will be counted as homework.

Make-ups: Make-up exams are given rarely, and only if:

1. I am informed IN ADVANCE, and
2. I deem the reason to be sufficiently meritorious (job interviews and pleasure trips are not). If the reason is illness, I REQUIRE documentation of the illness from a health-care professional.

Class decorum: The School of Engineering is a professional school, and the decorum in this class will reflect that. You are expected to arrive on time, leave on time, and act professionally in class. This includes being intellectually and physically involved in the class. Cell phones are **not** to be used in class. Use of tablets, and laptops during class is discouraged; tablets, and laptops may **only** be used in direct support of class activities, e.g., following along in the zybook. Texting, general web browsing, checking of e-mail is **NOT** permitted during class. Video and audio recording of the EECS 361 class lectures is **strictly prohibited**.

Attendance Policy: Attendance at all class meetings is expected. All topics discussed in class are considered required material. There is a strong correlation between attendance and the course grade.

Academic Misconduct: Instances of cheating will be referral to the Dean. Cheating includes, but is not limited to: copying another exam, copying of hardcopy or online solutions or previously worked homework or exam solutions, having another person do your work, use of "tutoring" websites like chegg.com.

Course Evaluation: A course evaluation will be available to students at the end of the semester.

Special Needs: Any student who has a disability that demands special accommodations should contact the Student Access Center at https://access.ku.edu/ in order to make arrangements. Also, members of KU sanctioned organizations (band, athletic teams, etc.) that have special needs should also contact the instructor as the need arises.

Course Schedule (subject to change)

No class September 23, 2025
No class October 2, 2025
Make class dates TBD
Test 1: Tentatively October 9, 2025
Test 2: Tentatively November 18, 2025
Comprehensive Final Exam: Thursday, December 11 from 1:30-4:00 PM

Topic/Chapter/Section

1. Class introduction and discussion of class syllabus.
2. Signals (~2 weeks)
   - 2.1. Types of signals
   - 2.2. Review of complex numbers
   - 2.3. Signal transformations
   - 2.4. Waveform properties
   - 2.5. Nonperiodic waveforms
   - 2.6. Signal power and energy
3. Linear Time-Invariant Systems - Continuous Time (~2 week)
   - 3.1. Linear time-invariant systems
   - 3.2. Impulse response
   - 3.3. Convolution
   - 3.4. Graphical convolution
   - 3.5. Convolution properties
   - 3.6. Causality and BIBO stability
   - 3.7. LTI sinusoidal response
   - 3.8. Impulse response of second-order systems
4. Fourier Analysis Techniques (~5 weeks)
   - 4.1. Phasor-domain technique
   - 4.2. Fourier series analysis technique
   - 4.3. Fourier series representations
   - 4.4. Sine/Cosine representation of Fourier series
   - 4.5. Amplitude/phase representation of Fourier series
   - 4.6. Exponential representation of Fourier series
   - 4.7. Fourier series symmetry considerations

     -------- Likely time for Test 1
   - 4.8. Circuit analysis with Fourier series
   - 4.9. Parseval's theorem for periodic waveforms
   - 4.10. Fourier transform
   - 4.11. Fourier transform properties
   - 4.12. Fourier transform pairs
   - 4.13. Parseval's theorem for Fourier transforms
   - 4.14. Additional attributes of the Fourier transform
   - 4.15. Phasor vs. Laplace vs. Fourier
   - 4.16. Circuit analysis with the Fourier transform
   - 4.17. The importance of frequency domain phase information
5. Applications of the Fourier Transform (~1.5 Weeks)
   - 5.1 Filtering a 2-D image
   - 5.2 Filter types
   - 5.6 Bandpass filters
   - 5.7 RLC highpass, lowpass and bandreject filters

5.8 Filter order and second order filters
5.9 Ideal brick-wall filters
5.10 Signal bandwidth
5.12 Double-sideband amplitude modulation (DSB-AM)
5.13 Mixing, frequency division multiplexing (FDM)
5.14 Sampling analog signals
5.15 Shannon's sampling theorem
5.16 Aliasing

6. Discrete-Time Signals and Systems with Applications (~5 weeks)
   6.1 Discrete signal notation and properties
   6.2 Discrete-time signal functions
   6.3 Discrete-time LTI systems
   6.4 Properties of discrete-time LTI systems
   6.5 Discrete-time convolution
   ------- Likely time for Test 2
   6.6 The z-transform
   6.7 Properties of the z-transform
   6.8 Inverse z-transform
   6.9 Partial fractions method for inverse z-transform
   6.10 System transfer function H(z)
   6.11 BIBO stability of H(z)
   6.12 System frequency response
   6.13 Discrete-time filters, and role of poles and zeros
   6.14 Discrete-time filter types
   6.15 Notch filters
   6.16 Comb filters
   6.17 Discrete-time Fourier series (DTFS)
   6.18 Discrete-time Fourier transform (DTFT)
   6.19 Discrete Fourier transform (DFT)
   6.20 Windowing in DFT
   6.21 DFT and convolution
   6.22 Data windows
   6.23 Deconvolution and filtering using the DFT
   6.24 Finite impulse response (FIR) filters, and FIR design by windowing
   6.25 FIR filter design methods
   6.26 Infinite impulse response (IIR) filters
   6.27 IIR bilinear transform filter design
   6.28 Spectrograms

7. Basic Control Theory (~0.5 weeks)

Comprehensive Final Exam: Thursday, December 11 from 1:30-4:00 PM

Late work: Assignments should be submitted on the indicated due date/time. I acknowledge that life happens, and sometimes a deadline cannot be met because of illness, caregiving responsibilities, work demands, mental health struggles, and emergencies. In these cases, I request that you contact me via email as soon as possible to arrange an alternative due date. I believe the material covered this course is valuable, and I want to work with you so you can successfully complete the assignments. If I do not receive any communication from you before the assignment is due, you will receive a 0 for late assignments.

Changes: Changes announced in class and/or on the class web page will supersede these written instructions.

IEEE Code of Ethics

We, the members of the IEEE, in recognition of the importance of our technologies in affecting the quality of life throughout the world, and in accepting a personal obligation to our profession, its members and the communities we serve, do hereby commit ourselves to the highest ethical and professional conduct and agree:

I. To uphold the highest standards of integrity, responsible behavior, and ethical conduct in professional activities.

1. to hold paramount the safety, health, and welfare of the public, to strive to comply with ethical design and sustainable development practices, to protect the privacy of others, and to disclose promptly factors that might endanger the public or the environment;

2. to improve the understanding by individuals and society of the capabilities and societal implications of conventional and emerging technologies, including intelligent systems;

3. to avoid real or perceived conflicts of interest whenever possible, and to disclose them to affected parties when they do exist;

4. to avoid unlawful conduct in professional activities, and to reject bribery in all its forms;

5. to seek, accept, and offer honest criticism of technical work, to acknowledge and correct errors, to be honest and realistic in stating claims or estimates based on available data, and to credit properly the contributions of others;

6. to maintain and improve our technical competence and to undertake technological tasks for others only if qualified by training or experience, or after full disclosure of pertinent limitations;

II. To treat all persons fairly and with respect, to not engage in harassment or discrimination, and to avoid injuring others.

7. to treat all persons fairly and with respect, and to not engage in discrimination based on characteristics such as race, religion, gender, disability, age, national origin, sexual orientation, gender identity, or gender expression;

8. to not engage in harassment of any kind, including sexual harassment or bullying behavior;

9. to avoid injuring others, their property, reputation, or employment by false or malicious actions, rumors or any other verbal or physical abuses;

III. To strive to ensure this code is upheld by colleagues and co-workers.

10. to support colleagues and co-workers in following this code of ethics, to strive to ensure the code is upheld, and to not retaliate against individuals reporting a violation.

Important Resource and Policy Information

- Explanation of instructional time expected for out-of-class student work per credit:

  see https://policy.ku.edu/registrar/credit-hour .

- Accommodations and/or information for students with disabilities:

  see https://access.ku.edu/syllabus-statement .

- Sexual Harrassment Policy:

  see https://policy.ku.edu/civil-rights/sexual-harassment .

- Nondiscrimination, Equal Opportunity, and Affirmative Action Policy:

  see https://policy.ku.edu/IOA/nondiscrimination .

- KU Statement on Diversity and Inclusion: see https://policy.ku.edu/provost/diversity-inclusion .

- Academic Misconduct (USRR 2.7.1):

  see https://policy.ku.edu/governance/USRR#art2sect6 .

- Change of Grade:

  see https://policy.ku.edu/registrar/grade-change and

  https://policy.ku.edu/governance/USRR#art2sect3 .

- Code of Student Rights and Responsibilities:

  see https://policy.ku.edu/student-affairs/student-code .

- Commercial Note-Taking:

  see https://policy.ku.edu/provost/commercial-note-taking .

- Mandatory Reporting:

  see https://policy.ku.edu/civil-rights/mandatory-reporting .

- Racial and Ethnic Harassment Policy:

  see https://policy.ku.edu/civil-rights/racial-ethnic-harassment-policy .