

**ECE Department
University of Arizona**

ECE 340: Engineering Systems Analysis

Fall 2011

Course Description

Basic concepts in the modeling and analysis of engineering systems and fundamental topics in communications, controls, and signal processing. Includes classification of systems; signal characterization in frequency domain, Fourier and Laplace transforms; state variable models; stability analysis and Bode plots; feedback system characteristics; discrete-time systems; and digital signal processing.

Goals

The goal of this course is to provide students with the basic mathematical techniques and tools needed for the analysis of linear continuous- and discrete-time engineering systems. Application areas include: electrical circuits, communication systems, control systems, signal processing systems, mechanical systems, and simple thermodynamic phenomena.

Educational Objectives

The successful student will be able to understand and compute input-output relationships for linear systems, in both the time and the frequency domain. Both continuous- and discrete-time systems will be covered, but the bulk of the course will be on continuous-time systems as discrete-time signals and systems is covered in more depth in ECE 429.

Prerequisites

ECE 320a and Math 322

Instructor

Nathan A. Goodman, Associate Professor
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Time and Place

Tuesdays and Thursdays 12:30 – 1:45 PM; Harvill 302

Office Hours

Tentative: 1:45 – 3:00 Tuesdays and 11:30 – 12:30 Thursdays

Textbook

B.P. Lathi, Linear Systems and Signals, 2nd Ed., Oxford University Press, 2005.

Homework

Homework will be assigned approximately every week and will be due one week after it is assigned at the beginning of class. Some homework assignments may include short Matlab problems.

Exams

No makeup exams will be offered. If you miss an exam (due to legitimate, unavoidable circumstances), the score for that exam will be 90% of the average of your other two exams. Exam dates are somewhat flexible, and we will try to avoid any major conflicts.

Final Exam

Scheduled for Tuesday, December 13, 10:30 AM – 12:30 PM.

Grading

Homework	10%
Matlab Assignments	20%
Exam #1	20%
Exam #2	25%
Final Exam	25%

Class Web Page

The course web page will often be the best way to convey announcements and assignments. The web page will have administrative announcements, homework assignments, and test solutions. I will usually email the class when new assignments are posted. The web page is:

<http://www.ece.arizona.edu/~ece340>

Accommodations

The ECE department is committed to meeting the needs of students with disabilities. Students requiring accommodation should discuss their needs with the instructor.

Academic Integrity

The University's Code of Academic Integrity (Section 2.1a) is based on the guiding principle that a student's submitted work must be the student's own. This policy will be applied to all work submitted for a grade, including exams, projects, and homework. Copying previously posted solutions or solution manuals is strictly forbidden; anyone violating this policy will receive zero credit for homework for the entire semester. All work must be original. The minimum penalty for submitting work that is not your own is an E grade. Repeated violations may result in expulsion from the university.

Study Groups

Working in study groups can be beneficial if everyone participates. Therefore, while working in study groups is allowed and even encouraged, all work submitted for a grade must be your own. When this rule is violated, the guilty student will receive a grade of zero on the offending item. Cheating will not be tolerated.

Course Outline

Background (Review on your own) (Chapter B)

Signals and Systems (Chapter 1)

Signals: Continuous-time, discrete-time, periodic, aperiodic, phasors
Energy signals, power signals, special signal forms
Systems: Time-invariant, time-varying, causal, noncausal
Linear systems, nonlinear systems

Time-Domain Analysis of Continuous-Time Systems (Chapter 2)

Unit impulse response, convolution integral for LTI systems,
System response, stability

Fourier Series (Chapter 6)

Representation for periodic signals
Trigonometric and exponential Fourier series
Parseval's theorem, Generalized Fourier Series

Fourier Transform (Chapter 7)

Aperiodic signal representation, the Fourier integral
Fourier Transform pairs, theorems, and properties
LTI system analysis with the Fourier Transform
Filtering

Laplace Transform (Chapter 4)

Review of definitions, theorems, inversions
Stability
Transfer functions and frequency response
Block diagrams
Bode plots

Sampling (Chapter 8)

Sampling and signal reconstruction, A/D conversion

Discrete-Time Signals and Systems (Chapters 3 & 5)

Difference equations and unit impulse response
The convolution sum
Z-transform definition and properties
Stability

State Space Analysis (Chapter 10) (*time permitting*)

Formulation of the (A, B, C, D) matrices
Solution
State transition matrix

Course Outcomes:

By the end of this course, the student will be able to:

1. Identify the characteristics of a given signal (continuous or discrete, periodic, finite energy/power, etc.).
2. Find the energy or power in a signal using time domain or frequency domain descriptions.
3. Plot continuous-time and discrete-time signals in the time and frequency domains.
4. Identify the characteristics of a given system, e.g., linear, time-invariant, causal, dynamic, and a system's order.
5. Perform a convolution.
6. Find the output of a system given the input and the impulse response.
7. Write an input-output relationship (transfer function) from a system block diagram.
8. Perform block diagram algebra/analysis and/or use Mason's gain to determine a system's transfer function from its block diagram description.
9. Find the Fourier series of a signal.
10. Find the Fourier transform of a signal.
11. Find the Laplace transform of a signal.
12. Find the transfer function of a system.
13. Determine system stability from the poles of the transfer function or a pole-zero plot.
14. Solve differential equations using Laplace transforms.
15. Determine the Nyquist frequency of a signal.
16. Find a state space representation of a system from its differential equations, transfer function, or block diagram.
17. Explain aliasing.
18. Find the z-transform of a signal.
19. Sketch the Bode plot of a system from its transfer function.
20. Determine the transfer function of a minimum-phase system given its magnitude response or phase response.
21. Find the sinusoidal, steady-state output of a linear, time-invariant system from its transfer function and sinusoidal input.
22. Obtain $y(n)$ from $x(n)$ and a system description, where the system description might be in the form of a difference equation or a transfer function of a discrete-time system.
23. Transform a difference equation into a transfer function and vice versa.
24. Apply Fourier Transform Theorems to obtain the Fourier Transform of particular signals.
25. Understand the Fast Fourier Transform (FFT).
26. Write a sequence of basic Matlab commands to analyze a system or signal.
27. Create a Matlab M-file to execute a sequence of commands.
28. Plot basic waveforms using Matlab.
29. Create exponentially damped sinusoids in Matlab.
30. Debug and verify the accuracy of Matlab commands.