Spring 2014
ECEN 314-300 Signals and Systems

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Lecture: MWF 01:50 pm-02:40 pm, ZACH 223B
Recitation: T 05:30 pm-06:30 pm, ZACH 203

TEXTBOOK
Haykin and Van Veen, Signals and Systems, Wiley, 2005

Lecture Videos (by Dr. Krishna Narayanan)
http://signalsandsystems.wikidot.com

Class Quiz: **nearpod** (get from Apple iTunes or Google Play)

OTHER REFERENCES

Class Notes
Oppenheim, Wilsky and Young, "Signals and Systems", Second Edition, Prentice-Hall
Hwei Hsu, Schaum's Outline of Signals and Systems, Second Edition (Schaum's Outline Series) : contains many solved problems.
Stormy Attaway, *MATLAB: A Practical Introduction to Programming and Problem Solving*

Course Description

This course will introduce students to mathematical descriptions of signals & systems, and mathematical tools for analyzing and designing systems that can operate on signals to achieve a desired effect. The focus of the class will be on the class of systems called linear time invariant systems. Significant emphasis will be place both on time domain analysis of systems through the operation of convolution and on frequency domain analysis of systems using the Fourier and Laplace transforms. Both continuous-time and discrete-time signals will be considered. Several examples from engineering practice will be used throughout the course.

Prerequisites

ECEN 214, knowledge of calculus, complex variables, differential equations

Major Goals

1. Describe signals mathematically and understand how to perform mathematical operations on signals. Be familiar with commonly used signals such as the unit step, ramp, impulse function, sinusoidal signals and complex exponentials

2. Classification of signals (continuous-time vs. discrete-time, periodic vs. non-periodic, energy signal vs. power signal, odd vs. even)

3. Be able to describe systems either using linear constant coefficient differential equations or using their impulse response.

4. Understand various system properties such as linearity, time invariance, presence or absence of memory, causality, bounded-input bounded-output stability and invertibility. Be able to identify whether a given system exhibits these properties and its implication for practical systems.

5. Understand the process of convolution between signals and its implication for analysis of linear time invariant systems. Understand the notion of an impulse response.

6. Be able to solve a linear constant coefficient differential equation using Laplace transform techniques.

7. Understand the intuitive meaning of frequency domain and the importance of analyzing and processing signals in the frequency domain.

8. Be able to compute the Fourier series or Fourier transform of a set of well-defined signals from first principles. Further, be able to use the properties of the Fourier transform to compute the Fourier transform (and its inverse) for a broader class of signals.

9. Understand the application of Fourier analysis to ideal filtering, amplitude modulation and sampling.

10. Be able to process continuous-time signals by first sampling and then processing the sampled signal in discrete-time.

11. Develop basic problem solving skills and become familiar with formulating a mathematical problem from a general problem statement.

12. Use basic mathematics including calculus, complex variables and algebra for the analysis and design of linear time invariant systems used in engineering.

13. Develop a facility with MATLAB programming to solve basic signal problems.

BRIEF COURSE OUTLINE

Mathematical concepts, signals and systems, operations (6 hours)
Description and Classification of signals (2 lectures)
Signal properties – (1 lecture)
Linear systems, linearity, time-invariance, causality, signal properties (6 hours)
Impulse response, convolution (6 hours)
Tentative date for Midterm 1
Fourier series and the Fourier transform (9 hours)
Signal representations in the Fourier space (xxx)
Frequency-domain analysis of systems (6 hours)
Tentative date for Midterm 2
Differential equations and Laplace transforms (6 hours)
The sampling theorem, discrete time systems (6 hours)
Application to Communications (2 hours)
Review of course (3)
Final Exam

GRADING POLICY

MATLAB & Computer Projects	**20%**
Periodic quizzes	**25%**
Midterm exam	**30%**
Final exam	**25%**

Homework will be handed out weekly but it will not be graded. Solutions will be provided at recitation time. Please note that no late submission of assigned projects will be accepted unless arrangements are made and approved in advance or for reasons that allowed by university policy.

CLASS POLICY

- Class notices and course related information will be posted periodically on the e-campus at http://ecampus.tamu.edu. Please check regularly for important information.
- Homework will not be collected but solutions will be discussed at recitation time.

Recommendations for Studying

1) Read and review the lecture notes; watch short videos provided
2) Locate and read the relevant sections in the textbook (including examples presented)
3) Work on the assigned homework (if you have trouble solving it, go back to 1 and repeat the process)
4) Attend the recitations!

Americans with Disabilities Act (ADA) Policy Statement

The Americans with Disabilities Act (ADA) is a federal anti-discrimination statute that provides comprehensive civil rights protection for persons with disabilities. Among other things, this legislation requires that all students with disabilities be guaranteed a learning environment that provides for reasonable accommodation of their disabilities. If you believe you have a disability requiring an accommodation, please contact the Department of Student Life, Services for Students with Disabilities, in Cain Hall or call 845-1637.

Academic Integrity Statements
AGGIE HONOR CODE

"An Aggie does not lie, cheat, or steal or tolerate those who do."

Upon accepting admission to Texas A&M University, a student immediately assumes a commitment to uphold the Honor Code, to accept responsibility for learning, and to follow the philosophy and rules of the Honor System. Students will be required to state their commitment on examinations, research papers, and other academic work. Ignorance of the rules does not exclude any member of the TAMU community from the requirements or the processes of the Honor System.

Course Review

Theme: understand the concepts, know the definitions, and perform the basic procedures that involve LTI systems and its characterization in both time domain and frequency domain.

Basic signals and systems

- From block diagrams to difference equation (DT),
- From circuits to differential equation (CT)
- In time domain, output signal of a LTI system is the convolution between the input signal and its impulse response
- In frequency (or Laplace) domain, the output of a LTI system is the product of the input and the transfer function

One theorem: Sampling Theorem

- Nyquist rate
- Mapping from CT frequency to DT frequency
- Aliasing due to periodicity of DT frequency

Two transforms: Fourier transform and Laplace transform

- Definitions
- Connections and relations between the transforms

Three key concepts:

- LTI Systems
- Convolution and convolution theorem
- Frequency Response

Four procedures:

- Test properties of a LTI System
- Compute the fwd/bwd Fourier Series and Fourier Transform

- Compute the convolution of two signals
- Analyze signal spectrum using FFT
- Obtain frequency response from system differential equations

Other key concepts/procedures

- Signals and systems
- Complex number and it's vector presentation in the complex plane
- Impulse response
- Linearity
- Time-invariance
- Causality
- BIBO stability
- Gibb's phenomenon
- Magnitude and phase spectrum
- Magnitude and phase frequency response
- Odd/even functions
- Signal energy
- Period
- Frequency
- Band-limitedness
- Filter types: Low-pass, high-pass, band-pass, band-stop, comb
- A/D and D/A conversion
- Continuous-time and discrete-time signals/systems
- Group delay and linear phase frequency response
- Zeros and poles of the Laplace transform
- Transfer function of a system (Frequency response, or Laplace transform of the impulse response)