ECE 313 – Signals and Systems

Department of Electrical and Computer Engineering
University of Massachusetts at Amherst

Fall 2006

Lecture	Sect 1	TuTh	9:30-10:45 AM	ECSCII 119
Discussion	Sect D01	W	10:10-11:00 AM	ELAB 304
	Sect D02	W	1:25-2:15 PM	ELAB 323
Instructors	Prof. Dev Gupta		Marcus 215G	dgupta@newlans.com
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Course Description

This course focuses on the study of signals and linear systems. It constitutes the basic theory behind a further study of communication theory and systems, control theory and systems, signal processing, microwave and radar systems, networking and almost all disciplines of electrical engineering.

Course Outline

1. Math Review (2 Lectures)
   - Linear Algebra, vector spaces
   - Differential Equations
   - Complex Numbers, complex variables

2. Signals (2 Lectures)
   - Types of signals
   - Unit step, delta functions
   - Signal spaces, basic idea of metric, normed spaces, L2
   - Gram Schmidt Procedure

3. Systems (2 Lectures)
   - Linear System
   - Systems as Diff. Eqns.
   - Impulse Response
   - Convolution
   - Signal system interchange

4. Laplace Transform (4 Lectures)
    - Single sided Laplace transform
    - Inverse Laplace transform
    - LT of common signals
    - Inverse LT of common transforms
    - Properties of LT
    - Solving Diff. Eqns. using LTs
    - Transfer Fuction representation of systems
    - Poles and Zeros, Amplitude Response, Phase Response Group Delay Response

5. Fourier Series/Transform (3 Lectures)
    - Periodic Functions, sin and cosine of multiples of fundamental frequency as a complete basis
    - Fourier Transform Pair, Exp(2*pi*f*t) as a complete basis for L2
    - FT of common signals
    - Inverse FT of common transforms
    - Properties of FT
    - Solving Diff. Eqns. using FTs
    - Relationship between LT and FT

6. State Variable Techniques (3 Lectures)
    - The concept of State of a System
    - Diff. Eqns. revisited
    - State Variable formulation of Diff. Eqns., Companion Matrix
    - State Transition Matrix
    - Eigenvalues, eigenvectors
    - Solution of State Variable Eqns.
    - Relationship between LT and SV formulations of systems

7. Analog Filters (3 Lectures)
    - For frequency domain applications
        - Low Pass
        - High Pass
        - Bandpass
    - For the Time Domain
        - All Pass
        - Equalization
    - Major families
    - Tables, Frequency scaling and Impedance scaling

8. Discrete Time Signals (2 Lectures)
    - Sampling Theorem
    - The D operator
    - Difference Equations

- The z-transform
- Solving Difference Eqns. using the z-transform
- Relationship between ZT, LT, FT

9. Discrete Time Systems (2 Lectures)
    - A DTS as a Difference Equation
    - Impulse Response of a DTS
    - Digital Convolution
    - Transfer Function
    - Spectrum of a DTS
    - State Variable formulation of a DTS
    - Its solution

10. DFT/FFT Algorithms (1.5 Lectures)

11. Digital Filters (1 Lectures)
    - FIR/IIR Filters

12. Communication and Signal Processing Applications (2.5 Lectures)
    - Data Transmission
        - ISI, Nyquist Pulses, PAM
        - Partial Response Coding
        - Channel Dispersion
        - Equalization
    - Prony's Method to Synthesize an Impulse Response

Required Texts

Signals and Systems by Steven T. Karris, Second Edition (Orchard Publications).

Getting Started with MATLAB 7: A Quick Introduction for Scientists and Engineers by Rudra Pratap (Oxford).

Grading

Projects – 40%
Midterm Exam – 20%
Final Exam – 20%
Homework – 20%

Office Hours

Professor Gupta	Tuesday 1:00-3:00, Friday 2:00-4:00 (or by appointment)
Professor Anderson	Monday and Thursday, 1:00-3:00 (or by appointment)

Honors Colloquium

A one-credit honors colloquium (E&C-ENG HO1, Sec. 1) is available for this course, which is a requirement for Commonwealth College students in the EE or CSE Department Honors track. The meeting times will be announced in lecture.