CONCORDIA UNIVERSITY

DEPARTMENT OF ELECTRICAL AND COMPUTER ENGINEERING

ELEC 6601 DIGITAL SIGNAL PROCESSING

Fall 2008

Lecture Information

Lecturer : Dr. William E. Lynch
Lectures: Tues & Thurs. 8:45-10:00, BE-245
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Office Hours: Tues. & Thurs 10-noon

Preface

Digital signal processing has become an area of major significance in the past three decades. With the increasing sophistication of digital computers and special purpose hardware, a variety of powerful signal processing techniques which had previously been impractical to implement are now commonly utilized. Applications of these techniques are prevalent in such diverse areas as biomedical engineering, acoustics, sonar, radar, seismology, communications, control, image processing, and audio recording. This course is intended to provide an understanding and working knowledge of the fundamentals of digital signal processing. Its purpose is to enable you to apply digital signal processing concepts to your own field of interest, to make it possible for you to read the technical literature on digital filtering, and to provide a basis for the study of more advanced topics and applications.

Course Objectives

At the end of this course you should:

- Understand the difference between a digital and an analog signal.
- Understand the notion of the frequency domain for digital signals.
- Know how to determine the output of a Linear Time Invariant digital system, given its input. (In the time domain using convolution and also using the Z-transform.)
- Know how to specify a digital filter.
- Know how to design FIR and IIR filters.

Textbook

Oppenheim and Schafer with Buck, Discrete-Time Signal Processing. 2nd Edition, Prentice-Hall, 1999.

Suggested Problems

The suggested problems provide hands on experience with the theoretical concepts. They also are the best indicator of what you should expect on exams. There is no substitute for you sitting down and trying these on your own.

Problems will not be handed in for grades. This is to encourage you to discuss the problems with your fellow students and learn from each other, which you could not legitimately do if the assignments were for grades. Try them on your own and then if there is one you do not get, talk to a friend. The discussion you have will generally be very useful if you have both thought about and tried the problem beforehand.

A list of suggested problems is given below. Solutions to the suggested problems will appear in the photocopy location.

Project

This year we will have a project. The purpose is for you to do some extensive self-study on amore advanced topic in Signal Processing and report your results back to the class. This project does not have to be an implementation project.

Procedure:

1. Projects will be individual projects.
2. Read a little on the topic(s) that you are interested in. Articles from the IEEE Signal processing Magazine or from the Proceedings of the IEEE are the best source.
3. Come to me with a written proposal that defines the scope of your project. **All projects must be approved.**
4. Do the work. I expect you to do about 40 hours (1 week) of work on the project after initial selection is done. Your goal is to understand your selected area and then present it so that the class can understand it.
5. You will have to hand in one report that is about 10 pages long. This report should explain your selected topic in language one of your classmates could understand. Report will be due on **Thursday, November 27**. You may get a one week extension without penalty but there will be no extensions past that date.
6. In the last week of classes we will schedule about two or three sessions where each group will present their project. Each person will have 8 minutes to do their presentation. These presentations will be outside class hours. You need only attend the session where you present.

Marking for the project: 75% for report, 25% for presentation.

Exams

There will be one midterm in addition to the final comprehensive examination. The midterm test will include the material covered in the lectures up to the exam date. There will be no make-up exams.

All exams will be closed book. However the students are permitted to bring in with them one 8.5*11 inch sheet of paper, written on both sides. Anything may be written on this paper. Students may photocopy things and tape/glue them to their crib sheet. However the taping/gluing must be on all 4 corners so that the attachment is not a "flap" that can be lifted up and more written underneath. The surface area available is only for the one 8.5*11inch piece of paper. Only the ENCS Faculty Calculators may be used on all exams and quizzes.

Grading

	Scheme A	Scheme B
Midterm	25%	0%
Project	25%	25%
Final	50%	75%

whichever is better.

Course Schedule (Tentative)

Date	Topic	Suggested Problems
Week 1 (Sept 2,4) Ch. 2.0-2.5	Discrete signals and systems, Linearity. Time Invariance. Stability. Causality. Memoryless. LTI systems. Discrete convolution. Linear Constant Coefficient Difference Equations	2.21,2.1 parts (d) through (h), 2.35, 2.36, 2.22 parts (b) and (d), 2.38, 2.39,2.3
Week 2 (Sept. 9,11) Ch. 2.6-2.9	Frequency Response. Fourier Transform for discrete time signals.	2.6, 2.40, 2.41, 2.42, 2.43, 2.44 (except b,e), 2.45
Week 3 (Sept. 16, 18) Class notes Ch. 3.0-3.4	MATLAB: Discrete Fourier Transform (DFT/FFT). Filter specification. Designing filters with MATLAB. Z-Transform: Definition, properties. Properties of Region of Convergence. Inverse Z transform, from tables.	3.4, 3.5,3.11, 3.48, 3,27, 3.29, 3.32, 3.21, 3.34, 3.36, 3.8, 3.52, 3.54, 3.37, 3.39(a)
Week 4 (Sept 23,25) 4.0-4.5	Periodic Sampling. Effect of sampling in frequency domain. Nyquist sampling theorem. Discrete Time processing of continuous time signals.	
Week 5 (Sept. 30, Oct 2) Class notes	Quantization and Quantizer Design.	
Week 6 (Oct 7)	Prepare for Midterm	
Week 7 (Oct. 14, 16) Ch 4.6	Change of Sampling rate using discrete time processing.	4.2, 4.21, 4.22, 4.24, 4.5, 4.20, 4.26, 4. 37, 4.38, 4.39, 4.52, 4.53
Week 8 (Oct. 21, 23) Ch 5.0-5.4	Examination of systems with rational system functions H(z). Relationship between pole-zero locations and Frequency response. Effect of one pole/zero.	5.21, 5.3, 5.11, 5.28, 5.10, 5.35, 5.39, 5.41

Week 9 (Oct 28, 30) Ch 6.0-6.5	Structures for discrete time systems. Block diagram for LCCDE. Signal flow diagrams. Direct Form I, Direct Form II. Cascade forms. Parallel forms. Transposed forms. FIR structures. Linear phase FIR structures	6.1, 6.2, 6.28, 6.3, 6.25, 6.5, 6.6, 6.29, 6.38
Week 10 (Nov 4,6) Ch 7.0-7.1	Filter Design Techniques. Filter Specifications. Design of discrete time filters from continuous time filters. Impulse invariance method. Bilinear transform. Design of Analog Butterworth filters. Properties of Chebychev and Elliptic filters.	
Week 11 (Nov 11, 13) Ch 7.3,7.4	Design of FIR filters using windowing. Properties of windows. Kaiser window method.	7.25, 7.26, 7.29, 7.46, 7.27, 7.32, 7.5, 7.35
Week 12 (Nov 18, 20) Class notes	Basics of Weiner filters.	
Week 13 (Nov 25, 27) Class notes	Least Mean Squares (LMS) algorithm.	
Final Exam		