Carleton University
Department of Systems and Computer Engineering
SYSC 5602F: Digital Signal Processing
Fall 2011
Course Syllabus

Instructor: Prof. Mohamed El-Tanany
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Office Hours: TBA

Course Description and Objectives
Overview of discrete time signals and systems, A/D and D/A conversions, representation in time, frequency, and z-domain, DFT/FFT transforms, FIR/IIR filter design, filter structures, quantization effects. Correlation functions. Multi-rate signal processing. Power spectrum estimation. Introduction to joint time & frequency analysis. DSP architecture: implementation approaches. Applications.

Prerequisites
A good knowledge of the continuous-time Fourier transform, Laplace transform, impulse response, frequency response, and probability and statistics, as well as a basic understanding of computer architecture. Understanding of discrete-time Fourier transforms, sampling, and basic digital signal processing an asset.

Textbook
J.G. Proakis and D.G. Manolakis, Digital signal processing, Prentice Hall, 4/e, 2007.
ISBN 0-13-187374-1

References
Mitra, Digital signal processing: A computer based approach, 2/e, McGraw-Hill, 2001.
ISBN 0-07-232105-9 (Excellent DSP textbook which includes many MATLAB examples.)

Oppenheim, Schafer, with Buck, Discrete-Time Signal Processing, 2/e, Prentice Hall, 1999.
ISBN 0-13-754920-2 (classic DSP textbook)

Lyons, Understanding signal processing, Addisson-Wesley, 1996. ISBN 0-201-63467-8
(not as complete but explains some DSP aspects in a clear manner)

Grading
Assignments & term papers: 20%
2 Midterm Tests (in-class): 25% (date to be determined)
Final Examination: 55%

To obtain a passing final grade, students must obtain a passing grade on the final exam.
Announcements, assignments, and additional material will be posted on the website:
http://www.sce.carleton.ca/courses/sysc-5602/

Midterm dates

Tuesday, October 11th, in-class
Tuesday, November 8th, in-class

Midterm Policy
The Midterm is to be written at the scheduled class time. A missed midterm will be recorded as a zero. If the midterm is missed for circumstances beyond your control, you should submit appropriate documentation within 5 business days for consideration.

Final Exam Policy
The final exam is for evaluation purposes only and will not be returned to the student

Plagiarism and Academic Honesty
Plagiarism (copying and handing in for credit someone else's work) is a serious instructional offence that will not be tolerated. Please refer to the section on instructional offences in the Calendar for additional information.

Students with disabilities:
Students with disabilities requiring academic accommodations in this course must register with the Paul Menton Centre for Students with Disabilities for a formal evaluation of disability-related needs. Registered PMC students are required to contact the Centre, 613-520-6608, every term to ensure that I receive your Letter of Accommodation, no later than two weeks before the first assignment is due or the first in-class test/midterm requiring accommodations. If you require accommodation for your formally scheduled exam(s) in this course, please submit your request for accommodation to PMC by November 11th 2011 for Fall term (December exams).

Academic Accommodation for Religious Obligations
Students who require accommodations due to religious obligations must follow the procedures described in Section 2.10 of the Academic Regulations of the University.

Course Content
Time permitting, the following topics will be covered:

Introduction to discrete-time signals and systems
Representation in time, frequency, and z-domains
Shannon sampling theorem, Nyquist rate
Analog to digital and digital to analog conversion

Discrete-Time Signals

Discrete-Time Systems
- Input-Output
- Block diagrams
- Classifications
- Interconnected systems

Analysis of Discrete-Time LTI systems
- Impulse response, frequency response
- Linear discrete-time convolution

Discrete-Time Systems described by difference equations
- Recursive and Non-recursive
- Systems Characterized by constant coefficient difference equations
- Solution of constant coefficient difference equations

The impulse response of systems described by constant coefficient difference equations

z-transform and applications to the analysis of LTI Systems

The direct z-transform and the inverse z-transform and properties
Pole-zero diagrams, stability, causality
The one-sided transform and solving difference equations

Frequency-Domain Analysis of LTI Systems

Frequency-Domain Characteristics of LTI systems
z-domain,frequency domain relationship
Generalized linear phase filters, group delay
Frequency selective filters, ideal filters, digital resonators, nulling filters, comb filters
All-pass, minimum-phase, and maximum-phase filters

FIR filter design

Gibbs' phenomenon
Windowing, Kaiser filter design
Equiripple FIR filers, Parks-McClellan filter design

IIR filter design

Impulse invariance
Bilinear transformation
Filter structures
Quantization effects

Discrete Fourier Transform (DFT) & Fast Fourier Transforms (FFT)

The direct and inverse transform and their properties
Picket fence effect, spectral leakage, frequency resolution
Circular convolution, linear filtering with DFT, overlap-add and overlap-save methods

Power spectrum estimation

Periodogram, Bartlett method, Welch method, Blackman-Tukey method

Random signals

Correlation functions
System identification

Multi-rate signal processing

Digital-to-digital rate conversion
Decimation
Interpolation
Polyphase realizations

Introduction to joint time-frequency analysis