

University of Waterloo
Department of Electrical and Computer Engineering
E&CE 413, Digital Signal Processing
Spring 2013
Course Information

Themes and objectives

Digital signal processing is employed throughout electrical and computer engineering – in video and audio engineering, in digital communications, data compression, medical imaging, automatic control and elsewhere. This course provides an introduction to the subject. It is organized in three main parts.

The course will first review some of the necessary background material. A cornerstone of signal processing is spectral analysis based on the Fourier transform. Sampling and reconstruction of analog signals is also essential background.

The Fourier transform of a discrete-time signal varies continuously with frequency. However, if a discrete-time signal is of finite duration – say, of n points – then it may be possible to reconstruct its Fourier transform from its value at n different frequencies, provided that those frequencies are appropriately chosen. This sampled version of the Fourier transform is called the *discrete Fourier transform* (DFT). Its practical application was made possible by the development of the *fast Fourier transform* (FFT) algorithm. The second part of the course will cover the DFT and the FFT algorithm, and their application in spectral analysis.

Such analysis is employed in many areas of the vast field that is digital signal processing. Another widely used technique is *digital filtering*, or the passage of a signal through a discrete-time system in order to select certain components of its frequency spectrum. The third main part of the course will review discrete-time linear systems and introduce methods for the modelling, design and implementation of linear digital filters.

While the course is introductory, it should bring the student to a level at which he or she can begin to explore advanced or specialized topics through other courses or via independent study.

Prerequisites

(Level at least 4A Computer Engineering or Electrical Engineering) or (MATH 213, STAT 206; Level at least 3B Software Engineering).

Course instructor

J.G. Thistle Department of Electrical and Computer Engineering, EIT 3113, tel. ext. 32910,
jthistle@uwaterloo.ca.

Laboratory instructor

TBA

Teaching assistants

TBA

Reference text

Porat, Boaz *A Course in Digital Signal Processing*. New York: Wiley, 1997. ISBN 0-471-149-616;
library call number TK5102.9.P66 1997.

Course outline

Chapter	Pertinent sections of reference
1 Introduction	1.1-1.3
2 Review of Frequency-Domain Analysis	2.1-2.4, 2.7-2.8
3 Sampling and Reconstruction	3.1-3.4, 3.8
4 Discrete Fourier Transform	4.1, 4.3-4.4, 4.6-4.8
5 Fast Fourier Transform Algorithm	5.1-5.3, 5.5-5.6, not 5.3.4
6 Practical Spectral Analysis	6.1-6.3
7 Review of Difference Equations and z-Transforms	7.1-7.6, not 7.4.5
8 Introduction to Digital Filters	8.1-8.5
9 Finite-Impulse-Response Filters	9.1, 9.2.1-9.2, 9.2.6-9.2.7, 9.3-9.4
10 Infinite-Impulse-Response Filters	10.1-10.3, 10.5-10.7, 10.9-10.10
11 Digital-Filter Realization and Implementation	11.1, 11.4
12 Multirate Signal Processing	12.1-12.3
13 Digital Signal Processing Applications	

Provisional grading scheme

Final examination	60%
Midterm examination	30%
Assignments	10%