

University of Waterloo
Department of Electrical and Computer Engineering
ECE-710: Special Topics in Communications and Information Theory
Topic 16: Digital Signal Processing
Fall 2021

Web

<https://learn.uwaterloo.ca>

Instructor

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Teaching Assistant

TBA

Schedule

This will be a fully online course. Follow announcements and instructions posted at LEARN.

Course Description

This course covers the concepts, theories and methodologies of digital signal processing. Topics include discrete signals and systems, Z-transform, discrete Fourier analysis; digital filter design; digital processing of analog signals; multi-rate digital signal processing; multi-dimensional digital signal processing; and digital signal processing and machine learning.

Course Outline

1) Discrete Signals and Systems, Z-transform, and Discrete Fourier Analysis

Discrete signals and systems; Z-transform; discrete-time Fourier transform (DTFT); transform domain analysis of signals and systems; discrete Fourier series (DFS) and transform (DFT); fast Fourier transform (FFT).

2) Digital Filter Design

Finite impulse response (FIR) filter design; infinite impulse response (IIR) filter design.

3) Digital Processing of Analog Signals

Bandlimited signals and Shannon's sampling theorem; reconstruction from sampling.

4) Multi-Rate Digital Signal Processing

Discrete sampling rate conversion; narrowband and short time Fourier transform and analysis; spectrogram; analysis-synthesis filter banks and multi-resolution analysis.

5) Multi-Dimensional Digital Signal Processing

Multi-dimensional DFT and FFT; multi-dimensional filter design; multi-dimensional general sampling lattice.

6) Digital Signal Processing and Machine Learning

Neural networks; convolutional neural networks; machine learning for digital signal processing.

Textbooks and References

No required textbook. Lecture notes and study materials will be posted at LEARN. Additional reference books and materials include (but not required)

- 1) *Discrete-Time Signal Processing*, Oppenheim, Schaffer and Buck, 2nd edition, Prentice-Hall, 1998.
- 2) *Digital Signal Processing*, Proakis and Manolakis, 3rd edition, Prentice-Hall, 1996.
- 3) *Multidimensional Digital Signal Processing*, Dudgeon and Mersereau, Prentice-Hall, 1983.

Homework

Both paper and computer homework assignments/solutions will be posted at LEARN. Homework assignments are not graded but are important to after-exam happiness. Computer homework uses MATLAB as an analysis, design and visualization tool.

Exam and Grading

There will be one midterm exam and one final exam.

Mark1 = 0.3 (midterm exam grade) + 0.7 (final exam grade)

Mark2 = 0.5 (midterm exam grade) + 0.5 (final exam grade)

Overall grade = $\max\{\text{Mark1}, \text{Mark2}\}$