ECE 551: (Advanced) Digital Signal Processing, II
Fall 2017
https://courses.engr.illinois.edu/ece551/

Official Description:
Basic concept review of digital signals and systems; computer-aided digital filter design, quantization effects, decimation and interpolation, and fast algorithms for convolution and the DFT; introduction to adaptive signal processing.
Pre-requisites: ECE 310 and ECE 313.

Instructor: Prof. Ivan Dokmanić (313 CSL, dokmanic@illinois.edu, 300-1442)
- Lectures: Monday and Wednesdays, 10:00 – 11:20am, 2013 ECEB
- Office hour: Tuesdays 3 – 4pm, 313 CSL

Teaching Assistant: Elad J. Yarkony (yarkony2@illinois.edu)
- Office hour: Fridays, 1 – 3pm, 5034 ECEB

Textbook:
- M. Vetterli, J. Kovačević, and V. K. Goyal, "*Foundation of Signal Processing*", Cambridge University Press, 2014. Available in open access at http://www.fourierandwavelets.org

Course Plan

Week	Topic	Reading*	Note
#1 (Aug 28)	Introduction; signals as vectors; vector spaces	1; 2.1; 2.2; 2.B	
#2 (Sep 4)	Hilbert spaces; approximation and projections; bases and frames	2.3; 2.4; 2.5	HW #1
#3 (Sep 11)	Discrete-domain signals and systems; DTFT	3.1; 3.2; 3.3; 3.4	HW #2
#4 (Sep 18)	z-transform; DFT; multirate systems	3.5; 3.6; 3.7; 3.9	HW #3
#5 (Sep 25)	Continuous-domain signals and systems; FT	4.1; 4.2; 4.3; 4.4	HW #4
#6 (Oct 2)	Application I: spectral analysis; filter design; filter banks; beamforming; source localization		Midterm #1
#7 (Oct 9)	Sampling and interpolation	5.1; 5.2; 5.3; 5.4	Project proposal
#8 (Oct 16)	Approximation; splines; multiresolution	6.1; 6.2; 6.3	HW #5
#9 (Oct 23)	Stochastic processes and systems; MMSE and Wiener filters	3.8; 4.6	HW #6
#10 (Oct 30)	Adaptive filters; LMS algorithm	Papers; Notes	HW #7
#11 (Nov 6)	Quantization; compression; transform coding	6.4; 6.5; 6.6	HW #8
#12 (Nov 13)	Application II: audio, image, and video compression; inverse rendering		Midterm #2
Nov 18-26	*Thanksgiving break*		
#13 (Nov 27)	Convolutional neural networks; deep learning	Papers; Notes	
#14 (Dec 4)	Application III: presented by students in class	Papers	Project final presentation
#15 (Dec 11)	Review		Project report

*Note 1: Reading x.y denotes Chapter x, Section y of the textbook.
*Note 2: The homework schedule is subject to change.

Grading:

- Homework: 30% (using the best 7 out of 8 homework scores)
- First midterm: 25% (Monday Oct 2, 6:00pm–7:30pm)
- Second midterm: 25% (Wednesday Nov 15, 10:00am–11:20am; regular class time)
- Final project: 20% (3% proposal; 7% presentation; 10% final report)

Grade cutoffs: A+: 95%; A: 90%; A-: 85%; B+: 80%; B: 75%; B-: 70%; C+: 65%; C: 60%; C-: 55%; D: 50%

Course objectives:

By the end of this course you should:

1. Master modern signal processing tools including vector spaces, bases and frames, operators, signal expansions and approximation, as well as classical signal processing tools including Fourier and *z*-transforms, filtering, and sampling.
2. Apply the above tools to real-world problems including spectral analysis, filter design, noise cancellation, signal compression, rate conversion, feature extraction, inverse problems, machine learning and justify why these are appropriate tools.
3. Learn how to think critically, ask questions, and apply problem-solving techniques to homework and midterm exams.
4. Research, present, and report on a selected topic that is of current interest within a specified time.

Course guidelines:

- We will only cover topics that have significant practical impacts, though often “nothing is more practical than a good theory” (Vapnik)
- “It is with logic that one proves; it is with intuition that one invents.” (Poincaré). As is often done in engineering disciplines, we will aim to invent first and prove later.
- As computation and simulation are essential in applying the signal processing theory to practical problems, all homework and projects will have a significant computer assignment (in Python!).