San José State University
Department of Electrical Engineering
EE 253, Digital Signal Processing, Spring 2018

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Office Hours:	TR 15:00-16:00
Class Days/Time:	Tuesdays and Thursdays 18:00 – 19:15
Classroom:	Sweeney Hall 315 (room to be changed later)
Prerequisites:	EE 102

Course Description

DSP systems analysis and design. Spectral analysis and spectrograms. FIR and IIR digital filters. Quantization effects. Decimation, interpolation, and sample rate conversion. Perfect reconstruction filter banks. The discrete wavelet transform and applications. Computer implementations.

Course Goals and Student Learning Objectives

The course offers an introduction to the principles and applications of digital signal processing. After a short review of discrete-time signals and systems, the course begins with an introduction to applications of the discrete-time Fourier transform, including fast computation of convolution and correlation as well as spectral analysis of signals. This is followed by a treatment of the design and implementation of various types of filter of both finite (FIR) and infinite impulse response (IIR) types. Quantization effects are discussed. The last part of the course includes multirate signal processing (decimation and interpolation), multistage and polyphase implementations of filters, filter banks and wavelet analysis.

Course Content Learning Outcomes

Upon successful completion of this course, students will be able to:

LO1: Apply the FFT to reliably move signals between time and frequency domains. Analytically characterize achieved spectral resolution and leakage performance.

LO2: Use frequency domain algorithms to compute convolution and correlation

LO3: Analyze digital filter specified using polynomial coefficients or poles/zeros . Design simple filters based on direct pole/zero placement in the z-plane.
LO4: Understand basic algorithms for digital filter design. Effectively use computer-aided design tools (Matlab) to design most filter types.
LO5: Analyze sensitivity of digital filters realization choices to quantization effects
LO6: Analyze simple multirate signal processing systems.
LO7: Understand utility of perfect reconstruction filter banks and the associated discrete wavelet transform as an alternative approach to frequency analysis using the DFT.
LO8: Apply filter banks to signal denoising and signal compression.
LO9: Relate studied algorithms to real-life signal processing applications.

Required Texts/Readings

Textbook and Software

1. *Discrete-Time Signal Processing*, 3rd Ed., A. V. Oppenheim & R.W. Schafer, Pearson, 2010. The main text for the course. Required
2. *Introduction to Digital Signal Processing*, D. Blandford and J. Parr, Pearson, 2013. Source of Matlab implementations, examples and problems, applications. Recommended
3. The *Student Version of Matlab* (including the Signal Processing Toolbox among other Toolboxes). Matlab is published by the Mathworks Inc. It's the computational tool for this course. Recommended

Other Readings

1. *Digital Signal Processing: A Computer-Based Approach*, 4th Ed., S. K. Mitra, McGraw-Hill, 2011. (A previous textbook for EE253.)
2. *Digital Signal Processing Using Matlab*, V. K. Ingle and J.G. Proakis, 3nd ed., Cengage, 2012 (the 2nd Ed, 2007, should also be OK) . Many Matlab examples and problems.
3. Digital Signal Processing, M H. Hayes, Schaum's Outline Series, McGraw-Hill, 1999. A moderately priced source of additional solved and unsolved problems.
4. Digital Signal Processing: Principles, Algorithms, and Applications, R. A. Proakis and D. G. Manolakis, 4th Ed., Prentice-Hall, 2007. Another standard textbook for EE253-like courses.
5. Digital Signal Processing: System Analysis and Design, 2nd Ed., P.S.R. Diniz, E. A. B. da Silva, and S. L. Netto, Cambridge University Press, 2010. A very good comprehensive book.
6. *DSP First*, J.H. McCleallan, R.W. Schafer and M.A. Yoder, 2nd ed., Pearson, 2016. Great review of sinusoidals and complex exponentials, and basic concepts.

Software: Matlab & the Signal Processing Toolbox

Matlab is used as the computational platform for class examples and homework problems. Matlab and many of its Toolboxes are available on the PCs in room ENG 387. The lab operates on an open door policy. Check availability times posted on the lab door. You may also consider purchasing the Student Version of Matlab ($100) for private use at school and home. This is perhaps the most time flexible way to do the computational assignments and project. The Student Version Release R2007a and later includes the Signal Processing Toolbox. Check the web site http://www.mathworks.com/academia/ for more information.
Source code for the m-files in the Blandford and Parr textbook is available from the publisher's website (copy and paste the link below in your browser) http://www.pearsonhighered.com/parr/

If you are not familiar with Matlab, an introduction can be found at http://www.mathworks.com/access/helpdesk/help/techdoc/matlab.html and a DSP introduction at http://www.mathworks.com/access/helpdesk/help/toolbox/signal/ See also the Student Version Manual.
Several good Matlab tutorials are also available on various websites (Google 'Matlab tutorial'). A short course is available on the MIT OCW at http://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-094-introduction-to-matlab-january-iap-2010/index.htm
Electronic versions (html and pdf) of Matlab and all Toolboxes manuals can be accessed at the Mathworks website above. Matlab has very good 'help' facility that you should invoke to learn more about specific commands and functions.
You will need to learn and use Matlab successfully complete this course.

Classroom Protocol

Students are expected to participate actively in class. Students will turn their cell phones off or put them on vibrate mode while in class. They will not answer their phones in class.

Dropping and Adding

Students are responsible for understanding the policies and procedures about add/drops, academic renewal, etc. Information on add/drops are available at http://info.sjsu.edu/web-dbgen/narr/soc-fall/rec-298.html. Information about late drop is available at http://www.sjsu.edu/sac/advising/latedrops/policy/ **.** Students should be aware of the current deadlines and penalties for adding and dropping classes.

Assignments and Grading Policy

There are two midterm exams and a final exam. Exams cover the assigned reading materials and class lecture notes. There will be no make-up exams (only in very special circumstances, both written excuse and official proofs are required for extraordinary exams). Exam solutions will be posted in the web site of the course.

Grading:	Homework	5%
	Midterm Exam #1: (1st Monday of March, Tentative)	30%
	Midterm Exam #2: (3rd Wednesday of April, Tentative)	30%
	Optional Term Project (replaces the worst midterm)	30%
	Final Exam: (Wed 05/22/18, Firm; 17:15- 19:30)	35%

Exams & Optional Term Project:

All exams are in-class. Two 8.5x11 front & back summary sheets in your own handwriting are allowed. No other photocopied problem solutions or any other course material is allowed. A term project that deals with an in depth study of a relevant application, including computer simulations or DSP board implementation, is optional. The optional project grade could replace the worst of the two midterms. More details regarding the term project will be handed out in class later.

Homework:

Homework is crucial for the understanding of the course material. Homework will be assigned regularly. Part will be fully graded and the rest will be checked for completeness. Solutions for only the analytical part of the problems will be provided. *Part of the homework will require using Matlab*.

Please try to solve the homework problems on your own. This is critical if you are to understand the course material and to do well in the exams. Please note that the 5% for the homework can move your grade across grade boundaries (from B to B+ or A- to A, … etc).

Grading Percentage Breakdown

90% and above	A
80% - 89%	B
70% - 79%	C
60% - 69%	D
Below 60%	F

University Policies

Academic integrity

Instances of academic dishonesty will not be tolerated. Cheating on exams or plagiarism (presenting the work of another as your own, or the use of another person's ideas without giving proper credit) will result in a failing grade and sanctions by the University. For this class, all assignments are to be completed by the individual student unless otherwise specified.

Campus Policy in Compliance with the American Disabilities Act

If you need course adaptations or accommodations because of a disability, or if you need to make special arrangements in case the building must be evacuated, please make an appointment with me as soon as possible, or see me during office hours. Presidential Directive 97-03 requires that students with disabilities requesting accommodations must register with the DRC (Disability Resource Center) to establish a record of their disability.

EE Department honor code

The Electrical Engineering Department will enforce the following Honor Code that must be read and accepted by all students.

"I have read the Honor Code and agree with its provisions. My continued enrollment in this course constitutes full acceptance of this code. I will NOT:

- Take an exam in place of someone else, or have someone take an exam in my place
- Give information or receive information from another person during an exam
- Use more reference material during an exam than is allowed by the instructor
- Obtain a copy of an exam prior to the time it is given
- Alter an exam after it has been graded and then return it to the instructor for re-grading
- Leave the exam room without returning the exam to the instructor."

EE 253 / Digital Signal Processing I, Spring 2018, Course Schedule

Table 1 Course Schedule (Subject to change with fair notice)

Week	Topics
1	Introduction. MATLAB. DTFT and DFT Review
2	Spectra of sinusoids; resolution and leakage. The STFT and spectrograms
3	IIR and FIR Filter Analysis
4	FIR Filter Design 1: Windows method.
5	FIR Filter Design 2: Sampling and optimal methods
6	FIR Filter Design 3: Optimal method (cont.). IIR Filter Design
7	**Midterm exam 1** IIR Filter Design (cont.)
8	Implementation. Quantization effects
9	Quantization effects (cont.)
10	Audio signal processing 1
11	Audio signal processing 2
12	Decimation and Interpolation 1
13	**Midterm exam 2** Decimation and Interpolation 2
14	Multi-stage and polyphase implementations. Two-channel perfect reconstruction filter banks
15	The discrete wavelet transform (DWT). Signal compression and denoising using the DWT
	Final Exam, Thursday May 22 17:15-19:30