ELEC 442: Digital Signal Processing (Fall 2019)

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This course focuses on fundamental concepts, algorithms, and applications of digital signal processing (DSP). The purpose is to enable you to apply DSP theory and methods to solve basic engineering problems.

Description: "Review of Z-transform; linear phase and non-linear phase systems; all-pass and minimum phase systems, recursive and non-recursive digital filters; common digital filter structures, common design approaches for digital filters; description of typical Digital Signal Processor chips; review of sampling, reconstruction, interpolation and decimation; changing the sampling rate by integer and non-integer factor; multirate signal processing, polyphase decomposition, multirate filter banks; digital processing of analog signals, A/D and D/A converters; discrete Fourier transform; random signals, Least-Mean-Square (LMS) filters. Lectures: three hours per week. Laboratory: 15 hours total. **Prerequisite**: ELEC 342 or 364; ENGR 371."

Text: A.V. Oppenheim and R.W. Schafer, *Discrete-Time Signal Processing*, Prentice-Hall, 3rd ed, 2010.

Grading:

Labs	20%
Assignments	10%
Midterm	20%
Final	50%

Exams: Exams are closed books but formulas sheets will be provided. If you miss the midterm exam (for a valid reason) or you do not do it as well, its weight will be added to final exam.

Assignments: We suggest a set of theoretical assignments based on the textbook. The suggested problems provide hands on experience with the theoretical concepts. They also are the best indicator of what you should expect on exams. There is no substitute for you sitting down and trying these on your own. Out of the suggested problems, there will be 4 assignments, to submit via ENCS e-submission. No make-up if you miss a deadline for any reason.

Labs: There are five labs, provided to help you get better understanding of the theoretical concepts and DSP methods learnt in class and gain hands-on experience of the application of signal processing algorithms. Your lab report will be due approximately two weeks after the Friday on which you are supposed to do the lab.

You need to submit **only one** signed "Expectations of originality form" for all the work.

Course Schedule (Tentative):

Topic	**Chapter/notes**	**Description**	**Suggested problems**	**Homework**
Discrete-Time (DT) Signals and Systems:	Chapter 2.0-2.9, Week 1 (2/9)	DT signals, linear time-invariant (LTI) systems, stability and causality, discrete convolution, linear constant coefficient difference equation (LCCDE), DT Fourier transform, frequency response of LTI systems.	2.1, 2.3, 2.6, 2.23, 2.24, 2.43, 2.50, 2.51, 2.52, 2.53, 2.54, , 2.55, 2.56	2.24, 2.43, 2.50, 2.52, 2.54, 2.56 **Due by: 16/09**

Z-Transform	Chapter 3.0-3.6, Week 2 (9/9)	Definition and properties of z-transform, region of convergence, inverse z-transform, system function of LTI systems.	3.4, 3.5, 3.8, 3.11, 3.23, 3.32, 3.34, 3.37, 3.39, 3.40, 3.41, 3.51, 3.54, 3.55, 3.57	3.8, 3.23, 3.34, 3.37, 3.41, 3.55 **Due by: 30/09**
Sampling of Continuous-Time (CT) Signals	Chapter 4.0-4.8, Weeks 3-4 (16&23/9)	Sampling of CT signals, effect of sampling in frequency domain, Nyquist theorem, reconstruction of CT signals, digital processing of CT signals, change of sampling rate, decimation and interpolation, A/D and D/A conversions.	4.2, 4.5, 4.20, 4.21, 4.22, 4.30, 4.26, 4.37, 4.38, 4.39, 4.58, 4.59	4.2, 4.20, 4.22, 4.26, 4.38, 4.58 **Due by: 14/10**
Transform Analysis of LTI Systems	Chapter 5.0-5.7, Weeks 5-7 (1 &7 & 14/10)	Frequency domain analysis of LTI systems, examination of rational system functions, pole/zero locations and frequency response, FIR, IIR, all-pass and minimum-phase systems.	5.3, 5.10, 5.11, 5.21, 5.35, 5.41, 5.48, 5.54	5.10, 5.11, 5.21, 5.35, 5.41, 5.48 **Due by: 28/10**
Midterm exam	Chapter 1-5 Week 8 (21/10)	October 23 during class		
Structures for DT Systems	Chapter 6.0-6.6, Week 9 (28/10)	Block diagram representation of LCCDE, signal flow graph representation, implementation structures for FIR and IIR systems.	6.1, 6.2, 6.3, 6.5, 6.6, 6.25, 6.37, 6.38, 6.52	
Filter Design Techniques	Chapter 7.0-7.4, Weeks 10 (4/11)	Specifications of digital filters, design of IIR filters, bilinear transform, typical analog filters, design of FIR filters using window functions and optimization.	7.5, 7.25, 7.26, 7.27, 7.29, 7.32, 7.44, 7.52	7.5, 7.26, 7.27, 7.29, 7.32, 7.52
The Discrete Fourier Transform (DFT) and Series (DFS)	Chapter 8.0-8.7, Week 11-12 (11 & 18/11)	Discrete Fourier series (DFS) of periodic signals, properties of DFS, FT of periodical signals, DFT and properties, Fast Fourier Transform, linear and circular convolutions of finite length sequences.	8.16, 8.19, 8.20, 8.21, 8.23, 8.29, 8.32, 8.50, 8.53	8.16, 8.20, 8.21, 8.29, 8.32, 8.53
Adaptive filters; Course review	Class notes, Week 13 (25/11)	Least Mean Squares algorithm.		