Cleveland State University
Department of Electrical Engineering and Computer Science

EEC 530 Digital Signal Processing

Catalog Data: EEC 530 Digital Signal Processing. (4 credits)
Prerequisites: Admission to the E&CE Graduate Program.
Modeling of DSP operations using discrete-time signals and systems: difference equations, Z-transforms, Fourier methods. Signal sampling (A/D) and reconstruction (D/A); digital filters; sample rate converters and oversampling; DFT and spectrum estimation; selected applications. Out-of-class projects completed on DSP equipment in lab.

Textbook: No formal textbook required.
Class notes will be made available.

Reference: Digital Signal Processing: A Computer-Based Approach, by Sanjit K. Mitra, Fourth Edition, McGraw-Hill, 2011.

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Hours: 12:30 – 2:30 M W

Grading:

Midterm I:	25-35%
Midterm II:	25-35%
Final:	30%
Selected HW:	10%

Class Hours: 4:00 pm - 5:50 pm M W FH 311

Final Exam: Monday, December 8, 2014 3:45-5:45 pm

Course Objectives: The objectives of this course are:

- To have students thoroughly understand the basic time, frequency, and transform domain methods of describing both the signals and the systems common to dsp applications. These methods of description form the language of dsp, and they involve topics such as difference equations, Fourier methods, the DTFT and DFT, and the Z-Transform.
- To have students thoroughly understand (i) how analog signals are transformed into digital form so that they can be processed using dsp techniques, and (ii) how digital signals are transformed back into analog form (after they have been processed in some way) so that the results of the processing can be used and applied outside the dsp hardware. Developing an understanding of these signal transformations involve mastering topics such as sampling, A/D and D/A conversion, antialiasing and anti-imaging filtering, oversampling, decimation (downsampling), and interpolation (upsampling).
- To have students understand the basics of designing IIR and FIR digital filters.
- To have students understand a dsp method for designing digital controllers for control applications.

- To have students understand the basics of the operation and use of adaptive filters.
- To have students understand the basics of estimating the spectrum of a signal from a finite record length.

Course Outline:

DATE	TOPIC	READING	HOMEWORK
Week #1 **Aug 25, 27**	• Overview of DSP (Chapt. 1).	1.1, 1.3, 1.4.1, 1.4.2, 1.4.4, 1.4.5, 1.5.	
	• **Discrete-time *signals*** described in the ***time domain***.	Pp. 41-44, 2.4, 2.4.1, 2.4.2, 2.4.3, 2.5.	2.3(d, e, f), 2.43, 2.38(a, b).
Week #2 **Sept 1, 3**	• **Discrete-time *signals*** described in the ***time domain***.	Pp. 41-44, 2.4, 2.4.1, 2.4.2, 2.4.3, 2.5.	**Handout**
(Sept 1 HOLIDAY)	• **Introduction to MATLAB and Simulink**.		
Week #3 **Sept 8, 10**	• Review of **continuous-time *signals*** described in the ***frequency domain*: Fourier methods** and **spectra**.	Class Notes.	**Handout**.
	• **Discrete-time *signals*** described in the ***frequency domain*: Fourier methods**, **spectra, DTFT** and **DFT**.	3.2, 3.2.1, 3.6, 5.2, 5.2.1, 5.2.4, 5.3, 5.3.1, 5.3.2.	3.48(a, b), 5.39(b), 5.61(a); **Handout**.
Week #4 **Sept 15, 17**	• **Signal sampling** and **reconstruction,** the **Nyquist Theorem**, and **aliasing.**	2.5, 3.8.	3.61, 62, 63, 65; **Handout**.
	• **Antialiasing** and **anti-imaging filters design.**	A.1, A.2(**skim**), A.3(**skim**), A.4 **(skim)**, A.6, B.2, A.9.	**Handout**.
	• **Oversampling** and **antialiasing filter design.**		
Week #5 **Sept 22, 24**	• **Signal sampling** and **reconstruction,** the **Nyquist Theorem**, and **aliasing.**	All same as week #4.	All same as week #4.
	• **Antialiasing** and **anti-imaging filters design.**		

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	• **Oversampling** and **antialiasing filter design.** • **DEMONSTRATION**		
<u>Week #6</u> **Sept 29, Oct 1**	**A/D conversion:** • **Sample/holds.** • **Quantization**, **dynamic range,** and **SQNR**. • **Practical converters.**	Class Notes.	
<u>Week #7</u> **Oct 6, 8**	• **Discrete-time *systems*** described in the ***time domain*: difference equations, impulse response, convolution, FIR, IIR**.	4.4, 4.4.1, pp. 150-151, 4.3, 4.4, 4.4.1, 4.6, 4.6.4, 4.6.5, 4.7, 4.7.1, 4.7.2.	2.38, 2.41(ignore time invariance), 2.49(a), 2.80, 24.55(find H only),
	• **Discrete-time *systems*** described in the ***frequency domain*: Fourier methods, frequency response**.	4.8, 4.8.1-8.5, 4.8.7.	4.63(find H only), 4.64, 4.66(find H only), 4.67, 4.69, 4.73(a), 4.74, 4.75, **Handout**..81, 2.86.
<u>Week #8</u> **Oct 13, 15** **(Oct 13 HOLIDAY)**	• **Oct 15: MIDTERM I**		
<u>Week #9</u> **Oct 20, 22**	• **Discrete-time *signals and systems*** described in the ***transform domain*.** • **Z-transform** of a discrete-time **signal**. • **Z-transfer function** of a discrete-time **system**.	**In all of this, ignore the region of convergence (ROC).** P. 277, Examples 6.1-3, Table 6.1, Sects. 6.2, 6.4.3-4.6.	**Ignore the ROC in all of these.** 6.39, 6.5(a), 6.34. 6.42, 6.44, 6.45(a), 6.66, 6.67, 6.80, 6.23; **Handout**.
<u>Week #10</u> **Oct 27, 29**	• **Digital Filter Design.**	7.1, 7.1.1, 9.1, 9.1.1, 9.1.2.	9.1, 9.2.
	• **IIR filter design; FIR filter design**	9.1.3-1.5, 9.2, 9.2.1, 9.2.2 (LP only), 9.6.	**Handout**.
<u>Week #11</u> **Nov 3, 5**	• **FIR filter design.**	10.1, 10.1.1, 10.2.1-2.4, 10.5, 10.5.1, 10.5.4.	10.7(a) (just find length for windows discussed in class);
	• **Signal reconstruction** and **D/A converters**.	Class Notes, A.10(**skim**).	**Handout**.
<u>Week #12</u> **Nov 10, 12**	• **Upsampling/Downsampling.**	Class Notes.	**Handout.**
	• **Digital Audio.**	Class Notes.	
	• **Nov 12: MIDTERM II**		
<u>Week #13</u>	• **Spectrum Estimation**	Class Notes.	**Handout.**

Dec 17, 19			
<u>Week #14</u> **Nov 24, 26**	• **Oversampling** and **bit reduction**, and **delta-sigma A/Ds**.	Class Notes.	**Handout.**
	• **Anti-imaging** and **equalization filters.**	Class Notes.	
<u>Week #15</u> **Dec 1, 3**	• **Adaptive filters** and their **applications.**	Class Notes.	**Handout.**