Digital Signal Processing
EE 5371-001 – CRN 16523
Fall 2019 – Syllabus

Monday, August 26, 2019

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1 General Information

- **Course ID:** Digital Signal Processing, EE 5371-001, CRN 16523
- **Time:** Monday and Wednesday, 6:00 pm – 7:20 pm
- **Textbook:** [OS11, Textbook] and [uM, Matlab].
- **Lecture Room:** Undergraduate Learning Center 336
- **Prerequisites:** EE 3353 Discrete-Time Signals and Systems with a grade "C" or better.
- **Instructor:** von Borries – rvonborries@utep.edu
- **Office:** Engineering Building 313
- **Office Hours:** TR from 1:30 pm to 3:00 pm, MW from 7:30 pm to 9:00 pm
- **Version:** Monday, September 2, 2019

2 Catalog Description

An introduction to basic one-dimensional processing methods including: sampling and quantization; discrete-time Fourier and z-domain LTI systems analysis, theory of operation and computational aspects of FIR and IIR digital filters; principles of filter design; the discrete Fourier transform and its application to spectral analysis.

3 Student Outcomes

- Describe and analyze the operations in the analog-to-digital conversion.
- Describe and analyze the operations in the digital-to-analog conversion.
- Describe and analyze discrete-time signals and linear time-invariant (LTI) discrete-time systems in the time domain: difference equation, convolution, correlation.
- Use the z-transform to analyze LTI systems.
- Describe LTI discrete-time systems in the frequency domain: FIR and IIR filters.
- Use the discrete Fourier transform (DFT) to perform analysis of signals.
- Understand basic algorithms for computing the DFT efficiently: fast Fourier transform (FFT).
- Implement FIR and IIR discrete-time systems in software.
- Design FIR and IIR systems using basic techniques.
- Implement sampling rate conversion.
- Analyze signals using multirate digital filter banks.
- Use `Matlab` to implement digital signal processing algorithms.

4 Syllabus

- **2. Discrete-Time Signals and Systems** – this chapter presents the basic definitions, notation, and develop and review the basic concepts associated with discrete-time signals and systems: classes of systems (memoryless, linear, time-invariant, causality, stability; LTI systems, convolution, properties), linear constant-coefficient difference equations, frequency-domain representation of discrete-time signals and systems, representation of sequences by Fourier transforms, symmetry properties of the Fourier transform, Fourier transform theorems (linearity, time shifting, frequency shifting, time reversal, differentiation, Parseval's theorem, convolution, windowing).

- **3. The z-Transform** – this chapter develops the z-transform representation of a sequence and study how the properties of a sequence are related to the properties of its z-transform: z-transform, region of convergence, inverse z-transform (inspection, partial fraction expansion), properties (linearity, time shifting, multiplication by exponential sequence, differentiation, conjugation, time reversal, convolution), z-transforms and LTI systems.

- **4. Sampling of Continuous-Time Signals** – this chapter reviews many of the basic issues of sampling continuous-time signals and their discrete-time processing: periodic sampling, frequency-domain representation of sampling, reconstruction of a bandlimited signal from its samples, changing the sampling rate using discrete-time processing (sampling rate reduction, increasing sampling rate, interpolation filters, changing the sampling rate by noninteger factor), multirate signal processing, interchange of filtering with compressor/expander, multistage decimation, polyphase decompositions, polyphase implementation of decimation filters, polyphase implementation of interpolation filters, multirate filter banks.

- **5. Transform Analysis of Linear Time-Invariant Systems** – this chapter develops the representation and analysis of LTI systems using the Fourier and z-transforms: frequency response of LTI systems, linear constant-coefficient difference equations, frequency response for rational system functions, relationship between magnitude and phase, all pass systems, minimum-phase systems.

- **7. Filter Design Techniques** – this chapter discusses different methods for designing both IIR and FIR filters: filter specifications, design of FIR filters by windowing, optimum approximations of FIR filters.

- **8. The Discrete Fourier Transform** – this chapter discusses the relationship between periodic sequences and finite-length sequences, Fourier series representation of periodic sequences and the DFT of the finite-length sequence: representation of periodic sequences, properties of the DFS, the Fourier transform of periodic signals, sampling the Fourier transform, Fourier representation of finite-duration sequences, properties of the DFT, circular convolution, linear convolution using the DFT.

- **9. Computation of the Discrete Fourier Transform** – this chapter discusses different methods for computing values of the DFT: direct computation of the discrete Fourier transform, decimation-in-time FFT algorithms, decimation-in-frequency FFT algorithms.

- **Applications**
  - Random signals and linear systems
  - Adaptive filters
  - Wavelet transform
  - Compressive sensing
  - Cepstrum and homomorphic deconvolution
  - Phase vocoder

5 Evaluation

All the exams in the classroom.

Activity	%
Homework	50
Participation	5
Exam I	20
Comprehensive Final	25

6 Grading

$A = 100 - 90\%$, $B = 90 - 80\%$, $C = 80 - 70\%$, $D = 70 - 60\%$ and $F = 60 - 0\%$.

7 Attendance

Class attendance is mandatory and will be monitored. Any student who has more than two unexcused absences will be dropped out of EE 5371/EE 4383. It is student's responsibility to sign the attendance sheet provided by the instructor for each class.

8 UTEP E-mail Account

Student's UTEP e-mail address is required for the instructor to communicate with the student and vice-versa. It is student's responsibility to have a UTEP e-mail account working properly. By the end of the first week of classes, every student should have received at least one e-mail message from the instructor. If an e-mail problem is detected (if no EE 5371/EE 4383 e-mail message is received by the end of the first week of classes), the student should request assistance from UTEP's help desk to fix the problem with the UTEP's e-mail account.

9 Accommodations and Support Services

If you have a disability and need classroom accommodations, please contact *The Center for Accommodations and Support Services (CASS)* at 747-5148, or by email at `cassutep.edu`, or visit their office located in UTEP Union East, Room 106. For additional information, please visit the CASS website at `www.sa.utep.edu/cass`.

10 Academic Integrity

Please review the policy on academic integrity available at https://www.utep.edu/student-affairs/osccr/student-conduct/academic-integrity.html.

References

[Mat12a] MathWorks. *Data Acquisition Toolbox User's Guide*. The MathWorks, Inc., 2012. http://www.mathworks.com/help/pdf_doc/allpdf.html#daq.

[Mat12b] MathWorks. *Signal Processing Toolbox User's Guide*. The MathWorks, Inc., 2012. http://www.mathworks.com/help/pdf_doc/allpdf.html#signal.

[Mol08] C. Moler. *Numerical Computing with MATLAB*. Society for Industrial and Applied Mathematics SIAM, second edition, 2008. http://www.mathworks.com/moler/chapters.html.

[OS11] A. V. Oppenheim and R. W. Schafer. *Discrete-Time Signal Processing*. Pearson Education, 3rd edition, 2011.

[uM] https://www.youtube.com/user/MATLAB?feature=watch. MathWorks. Matlab videos. Introductory and advanced Matlab tutorials.

11 Calendar

EE 5371 and EE 4383, MW 6:00 pm to 7:20 pm

August

M	T	W	R	F	S	S
			1	2	3	4
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	29	30	31	

2019

September

M	T	W	R	F	S	S
						1
	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	29
30						

2019

October

M	T	W	R	F	S	S
	1	2	3	4	5	6
7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29	30	31			

2019

November

M	T	W	R	F	S	S
				1	2	3
4	5	6	7	8	9	10
11	12	13	14	15	16	17
18	19	20	21	22	23	24
25	26	27			30	

2019

December

M	T	W	R	F	S	S
						1
2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	29
30	31					

2019

Exam I: October 14, Monday
Material seen between 8/26 and 10/9

Comprehensive Final: December 11, Wednesday
7:00 pm to 9:45 pm
All the material between 8/26 and 12/4

Labor Day – University Closed
September 2

Thanksgiving Holiday – University Closed
November 28 and 29

Course Drop/Withdrawal Deadline
November 1