Digital Signal Processing

EE 5371-001 – CRN 17229
EE 4383-001 – CRN 17228

Fall 2018 – Syllabus

Tuesday, September 4, 2018

R. von Borries
Department of Electrical & Computer Engineering
The University of Texas at El Paso, El Paso, Texas 79968, USA
rvonborries@utep.edu

1 General Information

- **Course ID:** Digital Signal Processing, EE 5371-001, CRN 17229
  Digital Signal Processing, EE 4383-001, CRN 17228
- **Time:** Monday and Wednesday, 6:00 pm – 7:20 pm
- **Textbook:** [OS11, Textbook] and [uM, Matlab].
- **Lecture Room:** Bell Hall 130A
- **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
- **Teaching Assistant:** –
- **TA Office Hours:** –
- **Version:** Tuesday, September 4, 2018

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 exams in the classroom. Exam and homework problems for EE 5371 and EE 4383 may differ.

5.1 EE 5371-001

Activity	**%**
Homework	30
Participation	10
Exam I	20
Exam II	20
Comprehensive Final	20

5.2 EE 4383-001

Activity	**%**
Homework	40
Participation	10
Exam I	15
Exam II	15
Comprehensive Final	20

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, 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		

2018

September

M	T	W	R	F	S	S
					1	2
	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

2018

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				

2018

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			24	25
26	27	28	29	30		

2018

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						

2018

Exam I: October 15
Material seen between 8/27 and 10/10

Exam II: December 5
Material seen between 10/17 and 12/3

Comprehensive Final: Wednesday, December 12
7:00 pm to 9:45 pm
All the material for Exams I and II

Labor Day – University Closed
September 3

Thanksgiving Holiday – University Closed
November 22 and 23

Course Drop/Withdrawal Deadline
November 2