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# Continuous-Time Signals and Systems

## EE 2353-003 – CRN -33879 – Summer

### 2018

### Syllabus

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## 1 General Information

- **Course ID:** Continuous-Time Signals and Systems, EE 2353-003, CRN 33879
- **Time:** MTWRF, 9:20 – 11:30 am



- Textbook: Signals, Systems & Transforms, Phillips, 5<sup>th</sup> Edition
- **Lecture Room:** LART 306
- **Prerequisites:** EE 2350, MATH 1312 and MATH 2326, each with a grade of C or better. EE 2350, MATH 1312 and MATH 2326 may NOT be taken concurrently with EE 2353.
- **Corequisites:** EE 2351
- **Instructor:** Ghassan Kachmar [gkachmar@utep.edu](mailto:gkachmar@utep.edu)
- **Office:** LIBRARY 514
- **Office Hours:** MTWRF 12:00 – 1:00

## 2 Catalog Description

Representation and analysis of continuous time signals; time and frequency analysis of linear time-invariant systems; convolution, differential equations, Laplace transform, Fourier series and transform, filters.

Prerequisites: EE 2350 Electric Circuits 1, MATH 1312 Calculus II, and MATH 2326 Differential Equations, each with a grade of C or better. EE 2350, MATH 1312 and MATH 2326 may NOT be taken concurrently with EE 2353.

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### 3 Textbook and Technical Computing Language

Continuous-Time Signals and Systems EE 2353 has two required resources: (1) the textbook *Signals, Systems, & Transforms* by Phillips et al., 5th edition [2, Textbook] (available at UTEP's bookstore); and (2) the software Matlab for numerical computation and visualization [4, Matlab on MathWorks]. The textbook is published by Pearson Higher Education and Matlab is developed by The MathWorks, Inc.

The Matlab software will be used by the students to solve homework problems, and by the instructor to explain concepts and find numerical solutions to problems. The Matlab software is available from the Engineering Technology Center (ETC) at the Engineering building E351D, College of Engineering, located between the Engineering and Classroom buildings on the 3rd floor, <http://etc.utep.edu>, e-mail: [etchelpdesk@utep.edu](mailto:etchelpdesk@utep.edu).

### 4 Learning Outcomes

1. Students will apply their now knowledge of mathematical concepts; algebra of complex numbers; basic signals: sinusoids, exponentials; basic signal manipulations: amplitude and time scaling, time shifting, time reversal; solution to linear constant-coefficient differential equations (Critical).
  2. Students will learn the concepts of linearity and time invariance (Critical).
  3. Students will learn (1) the convolution integral; understanding of convolution operation; unit step and unit impulse functions; properties: commutative, distributive, associative, shift, width; convolution with an impulse (Critical); (2) zero-state response and causality (Important). Students will apply the convolution integral to obtain the zero-state response of a LTI system to arbitrary inputs (Critical).
  4. Students will learn (1) Fourier series; periodic signals; orthogonality; effect of symmetry; trigonometric and exponential series, spectrum; LTI system response to periodic inputs (Critical); (2) Gibbs phenomenon; Parseval's theorem; generalized Fourier series: signals as vectors (Important). Students will apply the Fourier series to determine the LTI system response to a periodic input. (Critical).
  5. Students will learn (1) the Fourier transform: aperiodic signals; transform of useful functions; properties; LTI system response to aperiodic inputs (Critical); (2) ideal and practical filters; Parseval's theorem (Important). Students will apply the Fourier transform to explain the time-frequency relationship in signal transmission through a LTI system, amplitude modulation in communications, and sampling continuous-time signals in ideal analog-to-digital conversion (Critical).
  6. Students will learn (1) the Laplace transform; properties: linearity, shifts, time-differentiation, time-integration, time and frequency convolutions; solution of differential and integro-differential equations; inverse transform: partial fractions (Critical); (2) connection between the Laplace transform and the Fourier transform; Bode plots, poles and zeros (Important). Students will apply the Laplace transform to obtain the response of a LTI system with initial conditions to arbitrary inputs (Critical).
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Students will also become familiar with MATLAB for plotting functions, calculating mathematical operations, and solving systems of equations.

As a student, you will devote much of your attention and time to the discussion of problems already solved: problems solved in the classroom and problems solved in the textbook [2, Textbook]. You will only begin to develop the skills to successfully attack unsolved problems that you will face as a practicing engineer by reading and discussing the solutions to the problems presented in the classroom and in the textbook. You will need to discuss old and new problems with the instructor, teaching assistant and your colleagues, inside and outside the classroom, and during office hours. The homework and the quizzes will allow you and the instructor to assess your learning before the exams. By doing so, you will learn some general problem-solving procedures:

- Identify what's given and what's to be found;
- Sketch a solution **diagram**;
- Think of several solution **methods** and choose one among them;
- Calculate a solution;
- **Test** your solution; and
- Use creativity.

These procedures are discussed in the textbook for EE 2350 Electric Circuits 1 [1, Electric Circuits 1 Textbook].

## 5 Contents

Representation and analysis of continuous-time signals, time and frequency analysis of linear time-invariant systems, convolution, differential equations, Laplace transform, Fourier series and transform, filters. Background: complex numbers, sinusoids, sketching signals, partial fraction expansion, vectors and matrices, derivatives, integrals, Matlab [4, Matlab on MathWorks], [3, Matlab on Youtube].

- **Chapter 1** Introduction  
Modeling; continuous-time physical systems: electric circuits, operational amplifier, DC power supplies, analogous systems; numerical integration; Matlab [4, Matlab on MathWorks], [3, Matlab on Youtube].
  - **Chapter 2** Continuous-Time Signals and Systems  
Transformations of CT signals: time (reversal, scaling, shifting) and amplitude; signal characteristics: even and odd, periodic; common signals: exponential and sinusoidal (real-valued and complex-valued); singularity functions: unit step and unit impulse; mathematical functions for signals; CT systems: interconnection and feedback; properties of CT systems: memory, invertibility, causality, stability, time invariance and linearity.
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- **Chapter 3** Continuous-Time Linear Time-Invariant Systems  
Sifting property; convolution for CT LTI systems; properties of convolution; properties of CT LTI systems: memory, invertibility, causality, stability, unit step response; differential-equations: natural response and forced response.
- **Chapter 4** Fourier Series  
Approximating periodic functions; Fourier series; frequency spectra; properties; system analysis; amplitude transformations and time transformations.
- **Chapter 5** Fourier Transform  
Definition; properties: linearity, time scaling, time shifting, time reversal, duality, convolution, frequency shifting, time integration, time differentiation, frequency differentiation, symmetry; direct Fourier transform and inverse Fourier transform; application of the Fourier transform: frequency response of linear systems, frequency spectra of signals; energy and power density spectra.
- **Chapter 6** Applications of the Fourier transform  
Ideal filters; real filters; bandwidth relationships; sampling CT signals; reconstruction of signals from samples; sinusoidal amplitude modulation.
- **Chapter 7** Laplace Transform  
Definition; Laplace transform of functions; properties; response of LTI systems; LTI systems characteristics; relationship between the Laplace and Fourier transforms.

Wolfram Mathematica software is also going to be used by the instructor to illustrate concepts in continuous-time signals and systems.

## 6 Evaluation

Activity	%
Quizzes	12
Participation	8
Exam I	20
Exam II	20
Exam III	20
Comprehensive Final	20

Exams I, II, III and the Comprehensive Final will be taken in the classroom.

## 7 Grading

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

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## 8 Attendance

Class attendance is mandatory and will be monitored. Any student who has more than two unexcused absences will be dropped out of the EE 2353. It is student's responsibility to sign the attendance sheet provided by the instructor for each class.

## 9 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 2353 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.

## 10 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](mailto: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](http://www.sa.utep.edu/cass).

## 11 Academic Integrity

Please review the policy on academic integrity available at <http://sa.utep.edu/osccr/academic-integrity/>.

## References

- [1] J. W. Nilsson and S. A. Riedel. *Electric Circuits*. Always Learning. Pearson Education, Limited, Upper Saddle River, NJ, 2014.
  - [2] C. L. Phillips, J. Parr, and E. Riskin. *Signals, Systems, & Transforms*. Pearson Higher Education, 5th edition, 2013.
  - [3] <https://www.youtube.com/user/MATLAB?feature=watch>. MathWorks. Matlab videos. Introductory and advanced Matlab tutorials.
  - [4] <http://www.mathworks.com/access/helpdesk/help/techdoc/matlab.html>. MathWorks. Matlab documentation.
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