2022

EECE 3203: Signals & Systems I (Syllabus)

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EECE 3203: Signals and Systems I
Lectures: ES 218, Monday, Wednesday and Friday, 11.30 am to 12.25 pm

Instructor: Madhu Balasubramanian
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Office hours: By appointment (flexible; email for appointment)

Textbook and Other Required Materials:

a. Alkin, Oktay. *Signals and Systems: A MATLAB® Integrated Approach*. CRC Press, 2015. ISBN: 9781138075474
   - e-copy available in our library: https://sierra.memphis.edu/record=b3344399~S16
   - Supplementary software / materials: http://www.signalsandsystems.org/home

b. Lecture slides, and notes.

Additional References

i. Vaseghi, Saeed V. *Multimedia signal processing: theory and applications in speech, music and communications*. John Wiley & Sons, 2007.
ii. Wang, Ruye. *Introduction to orthogonal transforms: with applications in data processing and analysis*. Cambridge University Press, 2012.
iii. Yarlagadda, RK Rao. *Analog and digital signals and systems*. Vol. 1. New York (NY): Springer, 2010.

Website: https://elearn.memphis.edu

Prerequisites: EECE 2201, EECE 2207 or BIOM 1720; MATH 2120 or MATH 3402

Grades

- Six to eight homework and programming assignments (for a total of 40%)
- Three exams (for a total of 45%) –
- Final exam (comprehensive; for a total of 15%)
- Letter grade assignment (may change to match class average)

A+: 98 to 100;	**A**: 92.5 to 97.9;	**A-**: 90.0 to 92.4
B+: 87.5 to 89.9;	**B**: 82.5 to 87.4;	**B-**: 80.0 to 82.4
C+: 77.5 to 79.9;	**C**: 72.5 to 77.4;	**C-**: 70.0 to 72.4
D+: 67.5 to 69.9;	**D**: 62.5 to 67.4;	**D-**: 60.0 to 62.4
F: 0.0 to 59.5		

University Guidelines for Covid-19:

https://www.memphis.edu/coronavirusupdates/

Important Dates:

https://www.memphis.edu/registrar/calendars/academic/ay2223.php

- *First Day of Classes: August 22, 2022 / Monday*
- *Labor Day: September 5, 2022 / Monday*
- *Fall Break: October 8-11, 2022/ Saturday-Tuesday*
- *Thanksgiving Holidays: November 23-27, 2022 / Wednesday-Sunday*
- *Last Day of Classes: November 30, 2022 / Wednesday*
- *Study Day: December 1, 2022 / Thursday*
- *Exams: December 2-8, 2022 / Friday-Thursday*

https://www.memphis.edu/registrar/calendars/exams/22f-final-exams.php

Final Exam: Monday, Dec 5, 10.30 am to 12.30 pm

Class Participation:

a. I expect the students to fully engage in the learning activities and participate in class discussion.

b. Students should feel at ease to seek clarification at any stage in this course during lecture, and after lecture through individual appointment (seek appointment by email).

I encourage students to utilize the class discussion forum setup in Canvas to seek additional clarification regarding lectures and course materials, share your thoughts on questions from other students in class. While using the group discussion forum, please following the following etiquette:

- Please use the discussion tool to seek clarification.
- Feel free to participate in discussion, and answer questions.
- Be respectful to others during discussion.
- For each topical question, open a new thread
- Answer any questions by responding to the question within the thread.

Academic Integrity:

Plagiarism, cheating and other forms of academic dishonesty are prohibited. Students guilty of academic misconduct, either directly or indirectly, through participation or assistance, are immediately responsible to the instructor of the class in addition to other possible disciplinary sanctions which may be imposed through the regular institutional disciplinary procedures. Expectations for academic integrity and student conduct are described in detail on the website of the Office of Student Accountability. Please read in particular, the section about "Academic Misconduct". Also refer to https://www.memphis.edu/osa/pdfs/csrr.pdf

Software Requirements:

a. ***Canvas*** (learning management system) will be used to distribute lecture materials (slides, videos, notes), quizzes, and homework problems; submit assignments, and exam solutions; and for offline discussion including for seeking clarification and sharing your thoughts:

https://memphis.instructure.com/

b. Learning to use Canvas: https://www.memphis.edu/um3d/canvas/index.php

c. Your assignments include writing Matlab programming scripts. You can use one of the following possibilities to access ***Matlab software***:

   i. Citrix has a comprehensive collection of engineering software such as Matlab and commonly used software such as Photoshop. You can access Citrix online with the following URL: https://citrix.memphis.edu/vpn/index.html

   ii. Herff College of Engineering students are eligible to download and install Matlab software in your personal computer for free. Follow instructions from the following URL to install Matlab in your personal computer: https://www.mathworks.com/academia/tah-portal/university-of-memphis-40714972.html

Syllabus Changes

The instructor reserves the right to make changes as necessary to this syllabus. If changes are necessitated during the term of the course, the instructor will immediately notify students of such changes both in class and in Canvas.

Students with Disabilities

Qualified students with disabilities will be provided reasonable and necessary academic accommodations if determined eligible by disability services staff at the University of Memphis. Prior to granting disability accommodations in this course, the instructor must receive written verification of a student's eligibility for specific accommodations from the disability services staff. It is the student's responsibility to initiate contact with Disability Resources for Students (DRS) and to follow the established procedures for having the accommodation notice sent to the instructor.

Sexual Misconduct and Domestic Violence Policy

This policy specifically addresses sexual misconduct which includes dating violence, domestic violence, sexual assault, and stalking. The policy establishes procedures for responding to Title IX-related allegations of sexual misconduct. Complaints can be reported to the Office for Institutional Equity (OIE). You may contact OIE by phone at 901.678.2713 or by email at oie@memphis.edu. Complaints can be submitted online at File a Complaint. OIE's office is located at 156 Administration Building.

Non-Discrimination and Anti-Harassment Policy

University policy prohibiting discrimination and harassment based on protected characteristics and classes. Complaints of discrimination and harassment can be reported to the Office for Institutional Equity (OIE). You may contact OIE by phone at 901.678.2713 or by email at oie@memphis.edu. The full text of the policy can be found at GE2030 - Non-Discrimination and Antiharassment.

Catalog Title Abbreviation: Signals and Systems I

Catalog Description: Introduction to continuous-time signals and systems in time and frequency domains; system analysis of linear, time-invariant systems using Laplace and Fourier transforms and Fourier series.

PREREQUISITE: EECE 2201, EECE 2207 or BIOM 1720; MATH 2120 or MATH 3402.

Course Objectives:

a. Mathematical modeling of continuous-time (CT) signals and systems.
b. Predicting system response by solving differential equations and by using impulse response of the system.
c. Continuous-time Fourier analysis of CT signals and systems
d. Determining system response using convolution theorem
e. Laplace transform of CT signals and systems including region of convergence and pole-zero analysis
f. Design and analysis of filters.
g. To lay foundation for further studies in signal / data analysis, signal / data processing, and statistical learning; and research work

My Teaching Philosophy:

- I believe that motivation in a course is an important factor in learning. A significant part of the initial motivation in a topic often comes from gaining a comprehensive view of the subject as well as its uses. Further, it is essential to preserve or further enhance the initial motivation when complex topics are introduced as the course progresses. I will remind the class how each of my lectures fit into the course, the overall subject matter and when applicable, how the lecture is relevant to areas that the students are majoring in and in their professional career.
- I will review relevant and necessary background materials (e.g. linear algebra concepts related to Fourier expansion) that may engage the learners and encourage them to further strengthen their foundational knowledge through self and assisted learning. Further, it may lay a coherent and stronger foundation for learning newer and advanced concepts.
- I encourage students to develop perseverance to learn and master newer concepts i.e. keep practicing and don’t give up.

Course Outline:

1. Number of classes: 40
2. Representation and modeling of continuous-time (CT) signals (Chapter 01, Sec. 1.1 to 1.3; ***5 classes***)
   a. Mathematical modeling of CT signals
      i. *Special CT signals*: Impulse, step, pulse, ramp, triangle, and sinusoidal signals
      ii. Periodic CT signals and their period
      iii. Mixture signals and periodicity of mixture signals
      iv. Real and complex CT signals; phasor plot; and special complex exponential CT signals
      v. Power, energy and RMS value of CT signals
   b. CT signal operations
      i. Arithmetic, time shifting, time scaling, time reversal, integration and differentiation, time averaging operator
      ii. Sampling and sifting property of impulse function
      iii. Impulse decomposition
      iv. Convolution
   c. Symmetric properties of real and complex CT signals
   d. Odd-even decomposition of real and complex CT signals
3. Modeling and analysis of CT systems (Chapter 2; ***5 classes***)
   a. System modeling principles
   b. Differential equations to model CT systems
   c. Superposition principle to test linearity of the system
   d. Determining if the system is time-invariant
   e. Block diagram representation of CT systems
   f. Impulse response of a linear time-invariant system
   g. Causality and stability of CT systems
4. Predicting response of CT system (Chapter 2; ***6 classes***)
   a. Solving differential equations using the auxiliary equation method and the method of undetermined coefficients
   b. Convolution of input signal and the system impulse response of a linear time-invariant system
5. Fourier Analysis of CT signals (Chapter 04; ***6 classes***)
   a. Orthogonality of the CT complex exponential Fourier basis functions
   b. Analysis of periodic and non-periodic CT signals
   c. Characterizing spectral contents of CT signals
   d. Existence of Fourier series / transform and Gibbs phenomenon
   e. Energy and power in the frequency domain, Parseval's theorem

f. Energy and power spectral densities (spectral contents continued)

6. Fourier Analysis of CT systems (Chapter 04; ***4 classes***)
   a. Linearity, symmetry, duality, time-shifting, frequency shifting, modulation, time and frequency scaling, differentiation, and integration properties of Fourier transform
   b. System or transfer function
   c. Convolution theorem
   d. Determining system response using convolution theorem
7. Laplace transform for continuous-time signals (Chapter 07; ***3 classes***)
   a. Convergence characteristics of FT of a signal and limitations of FT
   b. Laplace basis functions from Fourier basis functions
   c. Complex *s*-plane and region of convergence
8. Laplace transform of continuous-time systems (Chapter 07, Chapter 10, Sec. 5; ***6 classes***)
   a. Poles and zeros of a CT system
   b. Shifting in the *s*-domain
   c. Scaling and differentiation in time and *s*-domain
   d. Linearity, time-shifting and convolution properties
   e. Inverse Laplace transform
   f. Bode plot
   g. Filter design using the manual pole-zero placement method
   h. Analog filter design
   i. Butterworth and Chebyshev low-pass filter design
   j. Transforming low-pass filters to high-pass, band-pass or band-reject filters using analog filter transforms
   k. Filter bank design of bandpass filter