2022

EECE 3204: Signals & Systems II (Syllabus)

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EECE 3204: Signals and Systems II
Lectures: ES 222, Monday, Wednesday and Friday, 10.20 am to 11.15 am

Instructor: Madhu Balasubramanian
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Office Telephone: (901) 678-1199
Email: mblsbrmn@memphis.edu (*more reliable*)
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 3203

Grades

- Six homework and programming assignments (for a total of 36%)
- Three exams (for a total of 48%) – the third exam will be on the finals day
- A final project presentation (for a total of 11%)
- Attendance / Quizzes (5%)
- 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 05, 8 am to 10 am

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://www.memphis.edu/um3d/canvas/index.php

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 eCourseware.

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 II

Catalog Description: Introduction to discrete-time signals and systems in time and frequency domains; frequency representation of signals using discrete Fourier series, discrete Fourier transforms and Z transforms.

PREREQUISITE: EECE 3203.

Course Objectives:

a. Mathematical modeling of discrete-time signals and systems.
b. Predicting system response by solving difference equation and by using impulse response of the system.
c. Discrete-time Fourier analysis of DT signals and systems
d. Determining system response using convolution theorem
e. Z-transform of DT signals and systems including region of convergence and pole-zero analysis
f. DT filtering system design.
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 discrete-time (DT) signals (Chapter 01, Sec. 4; ***5 classes***)
   a. Mathematical modeling of DT signals
      i. Sampling theory for constructing DT signals from continuous-time (CT) signals
      ii. Nyquist sampling criterion (Chapter 6, Sec. 2.I)

iii. *Special DT signals*: Impulse, unit step, pulse, ramp and sinusoidal signals
iv. Periodic DT signals and estimating their periodicity
v. Mixture signals and periodicity of mixture signals
vi. Real and complex DT signals; phasor plot; and special complex exponential DT signals
vii. Vector notation of DT signals
viii. Energy of DT signals

b. DT signal operations
   i. Sifting property of impulse function and impulse decomposition
   ii. Convolution and periodic convolution

c. Symmetric properties of real and complex DT signals
d. Odd-even decomposition of real and complex DT signals

3. Modeling and analysis of DT systems (Chapter 3; ***5 classes***)
   a. System modeling principles
   b. Building DT system from CT systems (using finite difference operators)
   c. Difference equations to model DT systems
   d. Superposition principle to test linearity of the system
   e. Determining if the system is time-invariant
   f. Impulse response of a linear time-invariant system
   g. Causality and stability of DT systems
4. Predicting response of DT system (Chapter 3; ***6 classes***)
   a. Solving difference 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. Discrete-time Fourier Analysis of DT signals (Chapter 05; ***6 classes***)
   a. Orthogonality of the DT complex exponential Fourier basis functions
   b. Analysis of periodic and non-periodic DT signals
   c. Characterizing spectral contents of DT signals
6. Discrete-time Fourier Analysis of DT systems (Chapter 05; ***4 classes***)
   a. Linearity and time-shifting properties of DT Fourier transform (DTFT)
   b. System or transfer function
   c. Convolution theorem
   d. Determining system response using convolution theorem
7. Z-transform for discrete-time signals (Chapter 08; ***3 classes***)
   a. Convergence characteristics of DTFT of a signal based on signal energy
   b. Z basis functions from Fourier basis functions
   c. Region of convergence

8. Z-transform for discrete-time systems (Chapter 08, Chapter 10, Sec. 5; ***6 classes***)
    a. Poles and zeros of a DT system
    b. Linearity, time-shifting and convolution properties
    c. Filter design using the manual pole-zero placement method
    d. Finite impulse response filter (moving average and moving difference)
    e. Infinite impulse response filter
    f. Filter bank design of bandpass filter
9. Optional / self-reading: State-space analysis of systems (Chapter 9, Sec. 3 and 4)
    a. State-Space Modeling of Discrete-Time Systems
        i. State-space models for DTLTI systems
        ii. Obtaining state-space model from difference equation
        iii. Obtaining state-space model from system function
        iv. Solution of state-space model
        v. Obtaining system function from state-space model
    b. Discretization of Continuous-Time State-Space Model
    c. MATLAB exercises
10. Individual project presentation and report (***3 classes***)
11. Tests (2 classes + 1 on final day)