ECE 366
Introduction to Signal Processing
Fall 2019

Instructor: Selin Aviyente, Ph.D.
Professor of Electrical & Computer Engineering
2210 Engineering Building
355-7649
aviyente@egr.msu.edu

Lectures: MWF, 3:00-3:50 p.m., A149 Plant & Soil Science Building

Office Hours: M 4:00-5:00 p.m., WF, 1:30-2:30 p.m. or by appointment

Textbook: Linear Systems and Signals, B. P. Lathi, Oxford Press, 2nd Edition.

Prerequisite: ECE 202 (Circuits and Systems II) or equivalent course and ECE 280.

Course Web Page: Please check the D2L website for the course. This website will serve as the main mechanism for information exchange in this course. All of the lecture notes, homework assignments, solutions and any other handouts will be posted on the web page. Please make sure to check the web page frequently.

Course Synopsis: This course provides a fundamental background in analog and digital signal and linear system theory that is prerequisite to many following courses in signals, systems, and control. The course will introduce tools for the analysis of signals and a special class of systems (linear, time-invariant systems) in both the time-domain and frequency-domain. The frequency-domain provides an alternative perspective of signals and systems and greatly simplifies their analysis. The course will present these analysis tools for both continuous-time and discrete-time signals and systems. In many instances, discrete-time signals and systems arise from the sampling of their continuous-time counterparts so as to facilitate the analysis with digital computers. The course will also provide an introduction to MATLAB software package to analyze signals and systems. The applications of the theory presented will also be discussed through various examples including biomedical signal processing and communication systems.

Requirements: There will be two midterm exams, weekly homework assignments, in class quizzes, one MATLAB project, and a final exam.

1. **Homework:** Homework assignments will be given every week and will constitute 10% of your final grade. The homework questions will be posted on the web with their due dates. Homework assignments will include some MATLAB problems. Posting of new assignments will be announced in class. You must submit your homework solutions during the class period on the due date unless prior permission has been granted to submit otherwise. *No* late homework assignments will be graded. The lowest homework score will be dropped when computing

your average homework grade. Homework solutions must be original copies in the student's own handwriting. No other submissions will be graded. Solutions must be clear and neatly written to receive credit. Solutions to homework assignments will be posted on the web. A subset of the homework problems will be graded each week.

2. **Quizzes:** There will be unannounced quizzes throughout the semester. The quizzes will be based on the homework problems. The quizzes will constitute 5% of your final grade. The lowest quiz score will be dropped when computing your average quiz grade.

3. **MATLAB Project:** There will be one final project that will require you to use MATLAB. The final project will be done in groups of two and will consist of a project report. This project will be worth 15% of your final grade. More details will be given later in the term.

4. **Exams:** There will be two midterm exams (one class period each). The exams will count 40 percent toward your final grade. A makeup exam, which will be *given only in legitimate cases of illness or personal emergency which is documented by a physician or other appropriate official*, will take place during the last week of the semester. This exam will take the place of any missed midterm and will be comprehensive. A student who finds it necessary to miss an exam should contact the professor before the exam to explain the circumstances.

   Midterm Exam 1- October 11th, 3:00-3:50 p.m. 20%
   Midterm Exam 2- November 15th, 3:00-3:50 p.m. 20%
   Homework- 10%
   Quizzes- 5%
   Final Project- Dec 4th, 15%
   Final Exam- Dec 9th, 3:00-5:00 p.m. 30%

Incomplete grades will be given only in unusual cases of illness or other personal emergency which causes the student to miss a significant amount of the course. This grade cannot be given for any other reason. A student who misses the final exam without satisfactory explanation will receive a failing grade in the course according to MSU policy.

Academic Honesty: Article 2.3.3 of the Academic Freedom Report states that "The student shares with the faculty the responsibility for maintaining the integrity of scholarship, grades, and professional standards." Therefore, unless authorized by your instructor, you are expected to complete all course assignments, including homework, projects and exams, without assistance from any source. You are expected to develop original work for this course; therefore, you may not submit course work you completed for another course to satisfy the requirements for this course. Also, you are not authorized to use the www.allmsu.com Web site to complete any course work in ECE 366. Students who violate MSU rules may receive a penalty grade, including--but not

limited to--a failing grade on the assignment or in the course. Contact your instructor if you are unsure about the appropriateness of your course work. (See also http://www.msu.edu/unit/ombud/honestylinks.html)

Accommodations for Students with Disabilities: Students with disabilities should contact the Resource Center for Persons with Disabilities to establish reasonable accommodations. For an appointment with a disability specialist, call 353-9642 (voice), 355-1293 (TTY), or visit MyProfile.rcpd.msu.edu.

Drops and Adds: The last day to add this course is the end of the first week of classes, 9/4/19. The last day to drop this course with a 100 percent refund and no grade reported is 9/23/19. The last day to drop this course with no refund and no grade reported is 10/16/19.

Course Outline:

PART 1: CONTINUOUS-TIME (CT) SIGNAL AND SYSTEM ANALYSIS

0. Introduction to the course

I. Basic CT Signal and System Concepts (Chapter 1)
   - A. Definition of a CT signal
   - B. CT signal properties and operations on signals
     1. Periodic vs. Aperiodic
     2. Even and Odd Signals
     3. Energy and Power Signals
     4. Operations on signals
   - C. Special signals
     1. Harmonic signals and sinusoids
     2. Singularity functions
   - D. Definition of a CT system
   - E. CT system properties

II. Time-domain analysis of LTI CT systems (Chapter 2)
   - A. Impulse response and the convolution integral
   - B. Properties of convolution
   - C. System properties in terms of the impulse response
   - D. System Response for Complex-Exponential Inputs

III. Frequency domain analysis of CT signals and LTI systems (Chapters 6 and 7)
   - A. Fourier Series (FS)
     1. Trigonometric FS
     2. Exponential FS
     3. Frequency Spectrum (Line Spectra)
     4. Properties of FS
     5. System Analysis
   - B. Fourier Transform (FT)
     1. Definition
     2. Relation to Laplace transform and FS
     3. Properties
     4. Examples
     5. Frequency Spectra
     6. Frequency Response of LTI systems
     7. Applications of the Fourier Transform (Ideal Filters, Amplitude Modulation)

PART 2: DISCRETE-TIME (DT) SIGNAL AND SYSTEM ANALYSIS

IV. Basic DT Signal and System Concepts (Chapters 8.1-8.2 and Chapters 3.1-3.4)

- A. Definition of a DT signal
- B. Sampling Theorem
- C. DT signal properties
  - 1. Energy vs. Power signals
  - 2. Periodic vs. Aperiodic
  - 3. Even and odd signals
  - 4. Operations on signals
- D. Special signals
  - 1. Harmonics
  - 2. Singularity signals
- E. Definition of a DT system
- F. DT system properties

V. Time domain analysis of LTI DT systems (Chapter 3.5-3.11)

- A. Difference equation representation of I/O relationship
- B. Impulse response and the convolution sum
- C. System properties in terms of the impulse response
- D. System response for complex-exponential inputs

VI. Frequency Domain Analysis of DT Signals and Systems (Chapters 5 and 9)

- A. Z-transform
  1. Definition, existence and motivation
  2. Evaluation of ZT
  3. Properties
  4. Inverse ZT
  5. LTI System Applications (transfer functions)
- B. Fourier transforms of discrete-time signals
  1. Discrete-Time Fourier Series
  2. Discrete-Time Fourier Transform
     a) Definition
     b) Relationship between DTFT and z-transform
     c) Relationship between DTFT and CTFT
     d) Properties
     e) Frequency response of DT LTI systems