

# ECE 3500: Fundamentals of Signals and Systems

**Credits and Contact Hours:** 4.0 Credit Hours

15 weeks: Two 80-minute lectures + one 3-hour lab per week

**Instructor's Name:** Joel Harley

## **Text Book(s) and/or Required Material:**

- B.P. Lathi, *Signal Processing and Linear Systems*, First Edition, Oxford University Press, 2000

**Catalog Description:** Transform domain analysis of passive circuits. Linear and time invariant systems in continuous-time and discrete-time domains. System representations using impulse-response functions, frequency responses and transfer functions. Realizations of linear time-invariant systems. Fourier analysis of continuous and discrete-time signals. Sampling theorem. Filter design from specifications.

**Prerequisites:** C- or better in:

- ECE 2240: Introduction to Electric Circuits; **and**
- Math 2210: Calculus III; or
- Math 1320: Eng. Calculus I **and** Math 2250: Diff. Equations and Linear Algebra; **and**
- Full major status in Computer Engineering

**Designation:** Required

**Contribution of Course to Meeting the Requirements of ABET Criterion 5:** This course teaches electrical engineering science and some electrical engineering design.

**Specific Outcomes of Instruction:** At the completion of this course, students should be able to:

1. Understand the language of signals and systems.
2. Apply convolution to continuous-time and discrete-time systems.
3. Analyze a system's input-output relationship using Fourier theory.
4. Design and implement simple systems for practical applications in MATLAB.
5. Discuss the use of signals and systems for advanced applications.
6. Communicate signals and systems concepts through a technical report.

## **Relationship of the Course to the Program Outcomes:**

- (a) *An ability to apply knowledge of mathematics, science, and engineering.* Students apply fundamental concepts learned earlier, including electronic circuit design techniques, calculus, complex analysis, and programming. Students apply this background knowledge and the material learned in the course in solving homework problems and completing their laboratory assignments.
- (b) *An ability to design and conduct experiments, to analyze and interpret data, and to debug and analyze software.* The three lab experiments designed for this course involve (1) signal analysis and synthesis using Fourier techniques; (2) design of analog filters for audio music

denoising through pole-zero placement of transfer functions; and (3) design of a digital binary phase shift keying communication system in MATLAB.

- (c) *An ability to design a system, component, process or software package to meet desired needs.* Each lab involves designing systems that satisfy certain requirements. The first lab involves designing a digital system to analyze and synthesize sounds. The second lab involves designing an analog system to remove noise from music. The third lab involves designing a digital system to communicate information.
- (d) *An ability to function on multidisciplinary teams.* While each student's work is submitted independently, students share their knowledge and collaborate in labs and on practice problems in class.
- (e) *An ability to identify, formulate, and solve engineering problems.* In each lab, the students must identify problems encountered and develop solutions for them. Many homework problems also ask students to reflect on the applications and purposes of systems they analyze.
- (g) *An ability to communicate effectively.* The results of the labs are submitted in written reports. The lab report guidelines and rubrics are designed to emphasize concise, clear writing.
- (h) *The broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context.* The foundations mathematics presented in class often related to recent significant advancements in technology that are now widespread in society.
- (k) *An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.* Students use the software package MATLAB extensively in the labs. Through MATLAB, the students design tools for digital signal processing and digital communications. In one lab, students design, assemble, and test analog circuits with signal generators and oscilloscopes.

### Topics Covered in the Course:

- Continuous-time signals
- Continuous-time systems
- Applications of continuous-time signals and systems
- Theory of sampling
- Discrete-time signals
- Discrete-time systems
- Applications of discrete-time signals and systems