Master Course Description

No: EE 242

Title: SIGNAL PROCESSING I

Credits: 5

UW Course Catalog Description

Introduction to signal processing, including both continuous- and discrete-time signals and systems. Basic signals including impulses, unit steps, periodic signals and complex exponentials. Convolution of signals. Fourier series and transforms. Linear, time-invariant filters. Computer laboratory. Prerequisite: either MATH 136, MATH 207 (or AMATH 351), any of which may be taken concurrently; EE 241 (may be taken concurrently) or CSE 163. Offered: AWSp.

Coordinator: Mari Ostendorf

Goals: To study analysis of signals and linear systems in the time and frequency domains. To begin using Python for signal analysis and linear system implementation.

Learning Objectives:

At the end of this course, students will be able to:

- *Describe* signals in time and frequency domains using Fourier transforms, and *map* characteristics in one domain to those in another;
- *Understand* the differences between discrete-time and continuous-time signals and the connections between digital and analog domains;
- *Understand* the implications of different system properties and how to test for them;
- *Perform* convolutions for arbitrary and closed-form signals;
- *Analyze* Linear, Time-Invariant (LTI) systems given different system representations (including input-output equations, impulse response, frequency response), and *translate* between these different representations;
- *Use and understand* standard ECE terminology associated with filtering and LTI systems (e.g. LPF, HPF, impulse response, step response, etc.); and
- *Implement* simple programs in Python to *synthesize, plot, play, analyze and filter* time functions.

Textbook: A. Oppenheim, A. Willsky and S. H. Nawab, *Signals and Systems,*Prentice Hall, 1996.

Reference Texts:
S. K. Mitra, *Signals and Systems,* Oxford University Press, 2015.
C. Phillips, J. Parr and E. Riskin, *Signals, Systems and Transforms,* Prentice Hall, 2003.

Prerequisites by Topic: Calculus, complex numbers, computer programming

Topics:

1. Introduction, analog vs. digital, discrete-time and continuous-time signals and signal transformations (1.5 week)
2. Systems and their properties (1 week)
3. Linear time-invariant systems analysis in the time domain: convolution (2 weeks)
4. Fourier series representations of periodic signals (series and transforms) (1.5 weeks)
5. Fourier transforms (CTFT, DTFT, DFT) (2.5 weeks)
6. Filtering applications, time vs. frequency domain (1.5 weeks)

Course Structure: The class meets for four lectures a week for a 50-min lecture and also has a weekly 2-hour computer lab section with a Teaching Assistant. There are weekly homework assignments and several laboratory exercises that must be done in Python. Most instructors also offer an optional 1-hour problem solving discussion session weekly to provide opportunity for students to work through additional examples.

Computer Resources: The course uses Python for the laboratory exercises and optionally for checking homework problems. Students are expected to use their personal computers in the labs. Outside of the two-hour lab section, students spend an additional hour per week on average to complete the labs, including prelab assignments and lab reports.

Laboratory Resources: (see Computer Resources)

Outcome Coverage:

(1) **Problems:** *An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics.* (H) The course introduces fundamental mathematical principles used for analysis of continuous-time signals and systems. Students routinely solve problems in systems analysis using mathematical tools of convolution and transforms. They are introduced to computer analysis methods via Python-based computer lab assignments.

(3) **Communication:** *An ability to communicate effectively with a range of audiences.* (M) Students are expected to provide clear, concise answers to questions in exams that include only information relevant to the question. In addition, they answer questions about lab assignments orally during laboratory sections and provide written lab reports in electronic notebook format. Some instructors include a brief writing assignment where students are asked to pick an example of modern technology and explain how some aspect of signal processing plays a role in this technology.

(5) **Teams:** *An ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives.* (M) The computer labs are conducted in teams. Labs constitute about 10-20% of their grade (depending on the instructor).

(7) **Learning:** *An ability to acquire and apply new knowledge as needed, using appropriate learning strategies.* (M) Students are expected to use online documentation to learn the Python programming language for use in lab exercises, building on their knowledge of programming in other languages.

Prepared By: Mari Ostendorf