Master Course Description for EE-342 (ABET sheet)

Title: Signal Processing II

Credits: 4

UW Course Catalog Description

Review of basic signal processing concepts. Two-sided Laplace and *z*-transforms and connection to Fourier transforms. Modulation, sampling and the FFT. Short-time Fourier transform. Multi-rate signal processing. Applications including inference and machine learning. Computer laboratory. Prerequisite: EE242. Offered WSp

Coordinator: Les Atlas

Goals: To provide students with advanced signal processing theory and applications. To further build proficiency in design and software implementation of signal processing systems.

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

1. *Describe* signals and systems in different domains (time, frequency, and Laplace/*z*-transforms) and *map* characteristics in one domain to those in another (e.g. distinguish between high and low frequency components of time signals);
2. *Use* transfer functions in analysis of filters;
3. *Design and implement* filters and *analyze* frequency content of signals and responses of systems using Python tools*;*
4. *Understand* how modulation and sampling affect the frequency components of a signal; and
5. *Apply* signal processing methods using machine learning.

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

Reference Texts:
Sanjit K Mitra, *Signals and Systems 1st Ed.,* Oxford University Press, 2015.
C. Phillips, J. Parr and E. Riskin, *Signals, Systems and Transforms,* Prentice Hall, 2003.
Oppenheim and Verghese, Signals, Systems and Inference, Pearson, 2016.

Prerequisites by Topic: Introductory signal processing tools, including signals and systems properties, convolution and Fourier transforms

Topics:

1. Review and expand on theory of introductory signal processing concepts (2 weeks)

2. Modulation, sampling, windowing & the FFT (1.5 weeks)
3. Laplace and *z*-transforms & relation to Fourier (2 weeks)
4. Using transforms for analysis of LTI filters and systems with feedback (1 week)
5. Short-time FT and multi-rate signal processing (1 week)
6. Applications including machine learning and inference (2 weeks)

Course Structure: The class meets 3 times a week for a 50-minute lecture and each student participates in one laboratory session that meets for 2 hours a week. There is weekly homework and several laboratory exercises that must be done in Python. There are midterms and a final exam.

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.

Laboratory Resources: Lab sections are scheduled in a classroom that supports collaborative student work with laptop computers.

ABET Student Outcome Coverage: This course addresses the following outcomes:

H = high relevance, M = medium relevance, L = low relevance to course.

(1) *An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics.* **(H)** The majority of the lectures and homework deal with the derivations and application of linear mathematics theory for system analysis.

(2) *An ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors.* **(L)** The labs include open-ended assignments in signal synthesis, digital filter design, and signal classification, with constraints on performance and computation.

(5) *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 20% of their grade, depending on the instructor.

(6) *An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions.* **(M)** The labs include assignments where students experiment with different signals and explore different system configurations and parameters.

(7) *An ability to acquire and apply new knowledge as needed, using appropriate learning strategies.* **(H)** Students use Python and associated data acquisition/display tools to solve homework problems on signal analysis and filter design.

Prepared By: Mari Ostendorf with added input from Les Atlas