**EECE 4510: Digital Signal Processing**

**Credits/contact hours:** 3 credits, two 75 minute class periods per week

**Course Coordinator:** Henry Medeiros

**Text Book:** Discrete-Time Signal Processing, 3rd Ed., A. V. Oppenheim and R.W. Schafer, 2010.

**Course Information:**

Introduction to the theory and practice of discrete-time signals and systems. Concepts covered include: Fourier Transforms, Z-transforms, linear time invariant system analysis in the time and frequency domains, sampling theory and Discrete Fourier Transforms. Application of these concepts includes: digital filter design techniques and the use of Fast Fourier Transforms for efficient frequency domain analysis. Labs and design projects related to specific signal processing applications are used to illustrate the material, including topics such as audio and image processing. Design Elective.

**Prerequisites:** ELEN 3020 or BIEN 3300

**Selected Elective** in the "Signals, Systems, and Control" and "Electromagnetic Fields and Communication" areas, COEN Hardware area (depth only)

**Contribution to Professional Component:**

Engineering Science 50 %

Engineering Design 50%

**Course Goals**

The goal of the course is to teach students the tools needed to analyze, design, and implement discrete-time signals and systems.

**Course objectives:**

*By the end of this course, you should be able to ....*

1. define and identify the basic discrete-time system properties of memorylessness, stability, causality, linearity, and time-invariance.
2. calculate the Discrete Time Fourier Transform (DTFT) or inverse DTFT of a discrete-time signal or system, including magnitude response, phase response, and group delay.
3. calculate the Z-Transform (ZT) or inverse ZT of a discrete-time signal or system.
4. determine the convolution of two time-domain signals.
5. analyze Linear Time-Invariant (LTI) discrete-time systems and determine inputs, outputs, and system functions in the time domain (using impulse response, convolution and difference equations) or frequency domain (using the DTFT and ZT).
6. apply principles of sampling and quantization to implement conversion from analog to digital signal representations and identify possible aliasing affects based on the Nyquist sampling theorem.
7. implement a change of sampling rate by any integer factor.
8. identify discrete-time system characteristics such as infinite impulse response (IIR), finite impulse response (FIR), linear phase, generalized linear phase, all-pass, and minimum phase.
9. represent discrete-time systems using block diagrams or signal flow graphs, in direct, cascade, and parallel structures.
10. design IIR filters using impulse invariance and bilinear transforms.
11. design FIR filters using the windowing method
12. compute the Discrete Fourier Transform of a signal, and understand its relationship to the DTFT and Fourier Series.
13. compute the Fast Fourier Transform (FFT) implementation of the DFT,.
14. implement frequency-domain filtering operations using either overlap-add or overlap-save methods.
15. use Matlab to perform basic signal processing design tasks.

**Contribution to Student Outcomes:** Partial fulfillment of Criterion 3 outcomes A, C, E, G, K

**Course Topics: Chapter**

1. Introduction 1
2. Discrete-Time Signals and Systems 2
3. Discrete-Time Fourier Transforms 2
4. Z-Transforms 3
5. Sampling of Continuous-Time Signals 4
6. Analysis and Representation of Linear Time-Invariant Systems 5
7. Implementation Structures for Discrete-Time Systems 6
8. IIR and FIR Filter Design Techniques 7
9. Discrete Fourier Transforms 8
10. Implementing LTI Systems using the DFT 9
11. Computation of the Discrete Fourier Transform using the Fast Fourier Transform 10