ELC 423 (1 .0 CU)
DIGITAL SIGNAL PROCESSING

Course Information **Professor: Orlando Hernandez**
Fall 2012: R 12:30PM–3:20PM/AR148

Course Description:
Sampling data systems, z-transform, DFT, FFT, and digital filter design with applications to digital signal processing.

Instructor Information:
Office Location: AR 147A
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Office Hours:
Tuesday 4:00 PM - 5:20 PM
Thursdays 10:00 AM - 11:20 AM
By appointment (send me email)
And whenever my office door is open

Textbook:
DIGITAL SIGNAL PROCESSING, A Computer-Based Approach by Sanjit K. Mitra, 2011.

Prerequisite:
Digital Circuits and Microprocessors (ENG 312)
Signals and Systems (ELC321)

Corequisite:
None

Grading Policy:
Homework 15%
Homework will be announced for each chapter after the chapter has been covered.
Mid-Term Exam 35%
Final Exam 35%
Miscellaneous 15%

Tips for Success:
Read the book sections prior to their discussion in class.
Do as much homework as possible. Attempt to do all the problems, even the ones that have not been assigned.
Do not be shy about asking questions, either during class or outside of the class.

College Level Policies:
Attendance Policy: http://www.tcnj.edu/~recreg/policies/attendance.html

Academic Integrity Policy: http://www.tcnj.edu/~academic/policy/integrity.html

Americans with Disabilities Act (ADA) Policy: http://www.tcnj.edu/~affirm/ada.html

Languages Across the Curriculum:
A quarter unit (one credit) Languages Across the Curriculum independent study may be added to this course for those students who have intermediate level proficiency in another language and who wish to complement the work in this course by utilizing their language skills. Please visit the LAC website at http://internationalstudies.pages.tcnj.edu/student-resources/languages/ or contact Dr. Deborah Compte at dcompte@tcnj.edu for more information. Students must meet with Dr. Compte to enroll in the LAC independent study by Wednesday, Sept 5.

Tentative Agenda:

Week	Topics	Reading
1 Monday 8/27	**SIGNALS AND SIGNAL PROCESSING** Overview of Methods	CHAPTER 1
2, 3 Monday 9/3 Monday 9/10	**DISCRETE-TIME SIGNALS AND SYSTEMS** Sampling LTI Systems Correlation of Signals	CHAPTER 2.1-2.9
4, 5 Monday 9/17 Monday 9/24	**DISCRETE-TIME FOURIER TRANSFORM** Discrete Fourier Transform DFT Properties Linear Convolution	CHAPTER 3
6 Monday 10/1	**DISCRETE-TIME SIGNALS** Analog Filter Design Sample-and-Hold Circuits A/D and D/A Converts	CHAPTER 4.1-4.4
7 Monday 10/8	**REVIEW** **TEST #1 (MIDTERM)**	
8, 9, 10 Monday 10/15 Monday 10/22 Monday 10/29	**FINITE-LENGTH DISCRETE TRANSFORMS** Discrete Fourier Transform DFT Symmetry Relations Linear Convolution	CHAPTER 5.1-5.10
11, 12 Monday 11/5 Monday 11/12	**Z-TRANSFORM** Convergence Inverse z-Transform z-Transform Properties	CHAPTER 6
13 Monday 11/19	**LTI DISCRETE-TIME SYSTEMS** Magnitude Characteristics Phase Characteristics Simple Digital Filters	CHAPTER 7.1-7.4
14 Monday 11/26	**DIGITAL FILTER STRUCTURE** Block Diagrams Basic FIR Digital Filter Structures Basic IIR Digital Filter Structures	CHAPTER 8.1-8.5
15 Monday 12/3	**IIR DIGITAL FILTER DESIGN** Bilinear Transformation Design of IIT Digital Filters Spectral Transformations	CHAPTER 9.1-9.4
16, 17 Monday 12/10 Monday 12/17	**REVIEW** **TEST #2 (FINAL)**	

Educational Objectives

(What TCNJ engineers should be able to accomplish during the first few years after graduation)

The School of Engineering at the College of New Jersey seeks to prepare its graduates:

- To contribute to the economic development of New Jersey and the nation through the ethical practice of engineering;
- To become successful in their chosen career path, whether it is in the practice of engineering, in advanced studies in engineering or science, or in other complementary disciplines;
- To assume leadership roles in industry or public service through engineering ability, communication skills, teamwork, understanding of contemporary global and socio-economic issues, and use of modern engineering tools;
- To maintain career skills through life-long learning and be on the way towards achieving professional licensure.

Electrical and Computer Engineering Student Outcomes

(What TCNJ Electrical and Computer Engineering students are expected to know and be able to do at graduation. What knowledge, abilities, tools and skills the program gives the graduates to enable them to accomplish the Educational Objectives)

The Program Outcomes listed below are expected of all graduates of the Electrical or Computer Engineering Program.

ECE graduates will have:

a. an ability to apply knowledge of mathematics, science and engineering;
Laplace transforms Z-transforms, Discrete-Time Fourier Transforms, Discrete Fourier Transform, and Sampling

b. an ability to design and conduct experiments, as well as to analyze and interpret data;

c. an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability;
Analog-to-Digital and Digital-to-Analog Converters, Basic FIR and IIR Digital Filter Structures

d. an ability to function in multidisciplinary teams;

e. an ability to identify, formulate and solve engineering problems;
Analog Filter Design, FIR and IIR Digital Filter Design

f. an understanding of professional and ethical responsibility;

g. an ability to communicate effectively;
Students do presentations and write reports.

h. the broad education necessary to understand the impact of engineering solutions in a global and societal context;

i. a recognition of the need for and an ability to engage in life-long learning;

j. a knowledge of contemporary issues;

k. an ability to use the techniques, skills and modern engineering tools necessary for engineering practice;
Analog and Digital Filter Design using MATLAB

l. an ability to analyze and design complex electrical and electronic devices;

m. an ability to analyze and design software and systems containing hardware and software components.
Students apply software to microprocessor design in homework problems, presentations, reports, and tests.

Course Objectives*

Objective 1 To be able to explain and apply sampling theory, analog to digital conversion, digital to analog conversion and to understand ideal and non-ideal sampling and reconstruction. [a,c,e]

Objective 2 To introduce the student to the tools and mathematical techniques necessary for understanding and analyzing both continuous-time and discrete-time systems. [a,k]

Objective 3 To describe and design lowpass, highpass, or bandpass FIR and IIR filters to meet specific design specifications. [a,c,e,k]

Topics Covered

1. Linear Time-Invariant systems (Continuous and Discrete)
2. Fourier Analysis (Continuous-time and Discrete-time signals)
3. Sampling
4. Z-transforms and Transfer Functions
5. Analog Filter design methods
6. FIR and IIR filter design methods

Evaluation:

A. Examinations
B. Homework (Written and Oral)
C. Design Project

Performance Criteria**

Objective 1
- 1.1 The student will be able to evaluate the frequency response of a discrete-time (DT), linear time-invariant (LTI) system from its impulse response. [A,B,]
- 1.2 The student will be able to explain and apply sampling theory, analog to digital conversion, digital to analog conversion and understand ideal and non-ideal sampling and reconstruction. [A,B,]

Objective 2
- 2.1 The student will be able to design DSP systems for processing continuous-time signals, transfer continuous-time specifications to discrete-time implementation and understand the definition, properties and applications of the Discrete Fourier Transform.
- 2.2 The student will be able to use DTFT, DFT, and FFT to analyze DT signals and systems. [A,B,C,]
- 2.2 The student will be able to implement complex arithmetic functions using MATLAB functions in the analysis of FIR and IIR filtering. [C]

Objective 3
- 3.1 The student will be able to design lowpass, highpass or bandpass FIR filters to meet frequency domain specifications using windowing methods. [C]
- 3.2 The student will be able to design lowpass, highpass or bandpass IIR filters to meet frequency domain specifications from analog prototype filters using Bilinear Transformation methods. [C]

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*Lower case letters in brackets refer to the program outcomes of the Electrical/Computer Engineering Program

**Upper case letters in brackets refer to the evaluation methods used to assess student performance

ELC 423: ADDITIONAL INFORMATION

1. DESCRIPTION OF DESIGN ACTIVITY

Design of Butterworth, elliptic, and Chebyshev analog filters using MATLAB.

Example: Design Type 1 Chebyshev lowpass filter and an elliptic lowpass filter with a 1-dB cutoff frequency at 1 KHz and minimum attenuation of 40 dB at 5 kHz. Compare the performance of each.

Design of infinite impulse response (IIR) LTI and finite impulse response (FIR) LTI filters using MATLAB.

Example: Design a Type 1 Chebyshev IIR digital highpass filter with a passband edge of 700 Hz, stopband edge of 500 Hz, passband ripple of 1 dB, minimum stopband attenuation of 32 dB and sampling frequency of 2kHz.

2. ENGINEERING STANDARDS

N/A

3. REALISTIC CONSTRAINTS

Economic: Discuss product time to market and product price.

4. MODERN AND PROFESSIONAL ENGINEERING TOOLS USAGE

MATLAB is widely used in industry for signal processing and DSP analysis and design.

5. COMPUTER USAGE

Students use computers during to prepare reports on reading assignments.

Twenty percent of the homework problems involve the use of a computer.

6. FEEDBACK MECHANISMS

Examinations: Students are given a mid-term examination and a final one.
Reports: Students are graded on reports, which include not only the technical aspects, but also the level of communication skills. There are at least three assignments.
Homework: Homework problems are assigned and graded. Not all the problems are graded. These are selected randomly, but students do not know in advanced which problems are going to be graded, so they are behooved to do all assigned problems. These problems are a mixture of analysis and design problems.

There are a number of design problems and one design project. The problems are each presented in class in a Power Point presentation and discussed.