ECE 410 "Introduction to Digital Signal Processing"

Instructor: Professor Alexandra Duel-Hallen. 2096 Engineering Building II, Telephone: (919) 515-7352
E-mail: sasha@ncsu.edu **Office hours:** after class or by appointment. Please send email to the instructor or the TA to ask your questions or set up a meeting.

Prerequisites: ECE 301, MATLAB experience.

Required Textbook: J. G. Proakis, D. G. Manolakis, "Digital Signal Processing: Principles, Algorithms and Applications," Pearson, Fourth or Fifth Edition. **Optional Texbooks**:(one of these is recommended to assist with Matlab assignments): J. G. Proakis, V. K. Ingle, "Student Manual for Digital Signal Processing with MATLAB," Prentice Hall; Vinay K. Ingle, John G. Proakis, "Digital Signal Processing Using Matlab," Cengage Learning. Additional resources will be provided.

Course Objectives: To provide students with understanding of discrete-time signals and systems and to develop digital signal processing design and analysis skills.

Course Description: This course is the senior-level course in digital signal processing. It develops essential tools required for a broad range of disciplines (e.g. communications, geophysics, medical image processing, etc.). ECE 410 is an introduction to graduate-level courses in communications and advanced signal processing. The course topics include properties and implementation of discrete-time signals and systems, analysis techniques using Z-Transform, Discrete-Time Fourier Transform, and Discrete Fourier Transform, sampling and reconstruction of signals, efficient computation methods using Fast Fourier Transform, and digital filter design.

Course Requirements:

Homework	17%, broken down as:	
Matlab/Problems		9% (drop the two lowest scores)
WebWork		8% (drop the two lowest scores)
Peer grading	5% (drop the two lowest scores; can *opt out* – see below)	
Matlab Project(s)	8% (one group project; one individual, optional project)	
WebWork Quizzes	10% (drop the two lowest scores)	
Midterm (in-class)	25%	
Final exam	35%	

+/- grading system will be used. **Audit policy** Students will receive AU grade if they receive a passing score on the homework assignments, or pass one exam, or pass one project.

Homework sets will be posted on the course website. They will include Matlab/problem sets (problems, some of which contain Matlab components) and separate WebWork assignments. Students will grade their peers' Matlab/problems homework using Moodle Workshop. Peer grading has been demonstrated to improve learning and retention of the material. TA should be contacted if students have questions on grading or prefer the homework regraded by the TA. Opting out of peer grading is discouraged but possible. This option will be discussed in the first lecture. You *must* email the instructor prior to the due date of the first homework if you would like to explore this option. Solutions and grading instructions will be provided. Additional posted handouts will be discussed in class and will provide guidance for homework completion as well as DSP examples and applications.

Quizzes Short WebWork quizzes will be given during scheduled class times weekly or biweekly. Students can use any course materials during the quizzes, but must work individually. Please bring laptops or other wireless devices to class but use these only during the quizzes or to access course materials. The quiz problems will be closely related to those in the homework, so please review the homework solutions and practice WebWorks problems before the quizzes. Please follow the *excuses and emergencies policy* below for missed quiz excuses.

Exams are closed-book. Tables of transforms and their properties will be provided. In addition, 3 pages of handwritten notes and calculators are allowed. Test samples will *not* be provided. Tests will be based on the

homework problems, class notes, and the textbook material in the sections listed in the posted Course Outline. Students should carefully compare posted homework solutions and grading guidelines with their work to determine the areas where additional practice/review is required. Such practice can include, but should not be limited to, working the assigned WebWork problems, which have randomized parameters. Please do not rely solely on peer or TA grading! Perform your own assessment. Mastery of all homework problems as well as examples and concepts in the class notes and the textbook is expected for successful exam completion. **Late or Missing Work** Late homework and peer grading submissions will not be accepted. Peer grading for each assignment will be available only to the students who turn in that assignment, so missing Matlab/problems homework will result in two zero scores (homework and peer grading). Missed quizzes will not be made up. The two lowest scores will be dropped as stated above, including zero scores for missing work. Moreover, please follow the *excuses and emergencies policy* below if you would like to be excused for missed homework or peer grading. Extension of project deadline will be granted once in rare cases. Please contact the instructor. **Excuses and Emergencies** If a student misses an exam and wishes to receive credit for that exam, do not contact the instructor or the TA. Similarly, please do not contact the instructor/TA for excuses, emergencies, make-up requests, etc. for any course assignments or quizzes. Please contact the Division of Academic and Student Affairs (DASA): https://dasa.ncsu.edu/students/absence-verification-process/ email: absence-verification@ncsu.edu They will examine your documentation and reasons and will contact the instructor as needed.
Students with Disabilities Reasonable accommodations will be made for students with verifiable disabilities. In order to take advantage of available accommodations, students must register with the Disability Resource Office at Holmes Hall, Suite 304, Campus Box 7509, 919-515-7653. For more information on NC State's policy on working with students with disabilities, please see the Academic Accommodations for Students with Disabilities Regulation (REG02.20.01)
https://policies.ncsu.edu/regulation/reg-02-20-01/ **Academic Integrity** All the provisions of the code of academic integrity apply to this course. In addition, it is my understanding and expectation that your signature on any test or assignment means that you neither gave nor received unauthorized aid. In an effort to affirm and respect the identities of **transgender students** in the classroom and beyond, please contact me if you wish to be referred to using a name and/or pronouns other than what is listed in the student directory.

Syllabus

Relevant chapters in the textbook are listed in parenthesis. Selected topics will be covered. The syllabus is tentative and is subject to change. In addition, please refer to the posted Course Outline.

1. Introduction and Review. Discrete-Time Signals and Systems and Z-Transform. (Chapters 1-3 (4^{th} edition) or 1-4 (5^{th} edition)) You will learn about the advantages and some applications of digital signal processing. You will review the properties of discrete-time signals and systems. Implementation techniques for discrete-time systems and the correlation of discrete-time signals will be introduced. You will review Z-Transform and will solve difference equations using One-Sided Z-Transform.

2. Frequency Analysis of Signals and Systems and Digital Filter Design (Chapters 4, 5, 10) You will compute Fourier Series and Fourier Transforms of discrete-time signals, analyze linear time-invariant systems in frequency domain, and design frequency-selective filters. You will investigate filter design using windows in the second, optional project.

3. Sampling and Reconstruction of Signals. (Chapter 6) You will review ideal sampling and reconstruction of continuous-time signals. You will be introduced to implementation of analog-to-digital and digital-to-analog converters.

4. Discrete Fourier Transform (DFT) and Fast Fourier Transform (FFT). (Chapters 7, 8) You will investigate DFT and its properties. You will compute circular convolution of discrete-time sequences and learn linear filtering methods and analysis of signals using DFT. Efficient computation of DFT using FFT will be introduced.