Class Schedule: MW 1:30 - 2:45pm, Online

Instructor: Dr. Karl J. Molnar
Associate Adjunct Professor, ECE
Phone - (919) 349-8173

Office Hours - M 3:00-4:00pm, W 3:00-4:00pm, or by appointment (zoom)
Email - kjmolnar@ncsu.edu

Course Moodle Website:

PREREQUISITES

The prerequisites for this course are as follows:

1. An introductory level course in digital signal processing (ECE 421)
2. B average in ECE and Mathematics
1. Prerequisites by topic include:
   1. Concepts for the processing of continuous-time signals,
      (a) convolution (continuous-time and discrete-time).
      (b) sampling of continuous-time signal
      (c) correlation analysis
      (d) amplitude modulation
2. Fourier series,
3. Fourier transform,
COURSE DESCRIPTION

ECE 513 Digital Signal Processing 3(3-0-0) F

Preq: ECE 421, B average in ECE and MA or Consent of Instructor Digital processing of analog signals. Offline and real-time processing for spectrum estimation, filter design, and multirate signal processing. Analysis of FIR and IIR filter structures for efficient implementation. Advanced topics include design of quadrature mirror filter banks and discrete wavelet transforms. The following subjects are covered:

1. Review of Fundamental DSP Concepts
   (a) Discrete-Time Signals and Systems
   (b) Z-Transform and its Applications to the Analysis of LTI Systems
   (c) Frequency Analysis of Signals
   (d) Frequency Domain Analysis of LTI Systems
2. Sampling and Reconstruction of Signals
   (a) Ideal Sampling and Reconstruction
   (b) Sampling of Bandpass Signals
3. The Discrete-Time Fourier Transform: Its Properties and Applications
   (a) The Discrete Fourier Transform
   (b) Filtering Long Sequences
   (c) DFT Spectral Estimation
   (d) The Discrete Cosine Transform
4. Implementation of Discrete-Time Systems
   (a) FIR Filter Structures
   (b) IIR Filter Structures
5. Design of Digital Filters
   (a) FIR Filter Design
   (b) IIR Filter Design
6. Multirate Digital Signal Processing
   (a) Interpolation and Decimation
     i. Frequency Interpretation
     ii. Implementation using Polyphase Structures
     iii. Multistate Implementation
   (b) Multirate Filter Banks
     i. Uniform Filter Banks
     ii. Quadrature Mirror Filter Banks
     iii. Digital Wavelet Transform
7. Application Examples
GOALS AND EXPECTED OUTCOMES

The goals of this course are to provide graduate students with an understanding of discrete-time signals and the analytical tools to analyze and design digital signal processing systems. Upon completion of the course, the students will be able to:

1. design FIR and IIR digital filters to meet arbitrary specifications,
2. develop algorithms to implement digital filters using MATLAB or other high-level languages such as C++,
3. analyze tradeoffs associated with spectral estimation and filter design,
4. develop and analyze algorithms for multirate digital signal processing, and
5. design and implement digital signal processing algorithms for applications related to digital communications, data acquisition, spectrum analysis, etc.

TEXT AND REFERENCES

The optional texts for this course are


The following link is to the Mathworks page for books related to the use of Matlab http://www.mathworks.com/support/books/

COURSE REQUIREMENTS AND GRADING POLICY

The semester grade will be based upon:

1. two semester exams (20% each for a total of 40%),
2. homework and computer assignments, which will be a combination of Webworks assignments and “Turn-in” assignments (25%), and
3. a final exam (35%).
DISTANCE EDUCATION STUDENTS

Office Hours for Distance Education Students.

1. Email: kjmolnar@ncsu.edu
2. Phone: 919-349-8173
3. Course Message Board
4. Online Video Conference (e.g. Google Hangouts or Zoom)

DE HOMEWORK ASSIGNMENT SUBMISSION
Homework will be completed in Webworks and/or uploaded directly to the Moodle Course site in pdf form.

- Note: Due dates for homework assignments are the same as on campus due dates, which are listed on the course website.

DE MESSAGE BOARD
A message board will be created that accommodates both on campus and DE sections of the course on Moodle. All messages should be posted to the corresponding forum on Moodle.

FURTHER DE COMMENTS
All other sections of the syllabus, unless otherwise stated, pertain to both on campus and distance education students.

NOTE TO ON-CAMPUS STUDENTS
Captured Lectures: The zoom lectures may be captured and distributed via the Internet and/or electronic media as part of the Engineering Online (EOL) program for the distance students. These video recordings may contain an image of you asking questions or being a part of the class. Please notify Dr. Linda Krute, Director of EOL, in writing at ldkrute@ncsu.edu if you DO NOT want your image to be included in the lecture presentation. If we do not hear from you after the first week of the class, we will assume that you are in agreement with this procedure.
AUDITING POLICY

Students auditing this course must turn in all of the homework assignments. However, they are not required to take the two semester exams or the final exam.

STATEMENT ON LATE AND MISSED ASSIGNMENTS

All assignments (Webworks and/or Turn-in Assignment) must complete on the Webworks website or uploaded to the Moodle course website. Assignments must be turned in at by 11:59pm on the date they are due. Webworks: Problems completed by the due date will count for max credit if correct. A 24hr reduced scoring period will be assigned for each homework assignment. Problems completed/submitted during this time will incur a 30% reduction in credit (70% max credit) for that problem. Turn-in Assignments: A penalty of 10 points per day will be assessed for "Turn-in" homework assignments that are uploaded to Moodle after the due date. You are expected to turn your assignments in on time for any anticipated absences that you will have so please plan accordingly.

NOTE: Emergency or unanticipated absences will be handled on a case by case basis. There will be NO make-up exams. Missing grades for missed exams with valid excuses and documentation will be replaced by the final exam grade. Students who believe they have valid excuses to miss assignments or exams must comply with University Attendance Regulations, see

https://policies.ncsu.edu/regulation/reg-02-20-03-attendance-regulations/

A PC or any workstation may be used instead of the University computing system with appropriate software as follows:

1. Matlab (The student version of Matlab with the Signal Processing Tool Box is the minimum acceptable level)
2. Word Processor to prepare "Turn-in" homework assignments in a presentable manner.

Also, see https://oit.ncsu.edu/my-it/hardware-software/your-computer/
COURSE WEBSITE

The course Moodle site will be used to provide course notes, to provide additional information on the course, provide pdfs of homework assignments, to provide examples, etc. You can obtain access to the course website by using a Web browser such as Firefox or Internet Explorer. The URL for the locker is


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 Disability Services Office at Suite 1900, Student Health Center, Campus Box 7509, 515-7653. See

http://www.ncsu.edu/dso/

For more information on NC State's policy on working with students with disabilities, please see

https://dro.dasa.ncsu.edu/

ACADEMIC INTEGRITY

All the provisions of the code of student conduct apply to this course as appropriate. See

https://studentconduct.dasa.ncsu.edu/academic-integrity-overview/

COURSE EVALUATION

Students will receive an email message directing them to a website where they can login using their Unity ID and complete evaluations. All evaluations are confidential; instructors will never know how any one student responded to any question, and students will never know the ratings for any particular instructors. Schedule: Online class evaluations will be available for students to complete during the last week of class during the following dates and times:

- TBA

Students will receive an email message directing them to a website where they can login using their Unity ID and complete evaluations. All evaluations are confidential;
instructors will not know how any one student responded to any question, and students will not know the ratings for any instructors.

Evaluation website: https://classeval.ncsu.edu/
Student help desk: classeval@ncsu.edu