Department of Electrical and Computer Engineering
University of Massachusetts/Amherst

ECE 697K: Special Topics - Signal Processing
Fall 2015

Description: A graduate-level introduction to signal processing, covering fundamentals of discrete-time signals and systems, design and implementation of signal processing systems, discrete-time random processes and applications, and adaptive signal processing. Prerequisites: undergraduate-level courses in signals and systems (equivalent to ECE 313) and probability (equivalent to ECE 314). (3 credits)

Objectives: Students completing this course will know:

1. Time-domain and transform-domain techniques for representing and analyzing discrete-time signals and systems.
2. How to use discrete-time systems to process continuous-time signals.
3. How to design and implement discrete-time filters.
4. How to analyze and reduce the effects of error in filter implementations.
5. How to design optimal filters for estimating discrete-time random processes.
6. How to develop adaptive filters capable of responding to varying processing requirements.

Prerequisites: ECE 313 (Signals and Systems), ECE 314 (Introduction to Probability and Random Processes) or equivalents.

Web Site: All course material (homework assignments and solutions, announcements, handouts, grade records) will be posted on Moodle (moodle.umass.edu). Note that you must be enrolled in ECE 697K to have access to the Moodle site.

Instructor: Patrick A. Kelly
phone: (413) 545-3637; email: kelly@ecs.umass.edu

Lectures: Tues., Thurs., 10 – 11:15 AM, ELab 327

Office Hours: Tuesday, 1 – 2 PM; Friday, 11 AM – noon

Textbook: No textbook is required – all of the course material will be covered in the lectures, and some lecture notes will be posted on Moodle. Two recommended books for reference are:

Proakis and Manolakis, *Digital Signal Processing – Principles, Algorithms and Applications (4th ed.)*, Prentice Hall, 2007. (This is a comprehensive book covering fundamentals of digital signal processing. The lecture contents will roughly follow this book.)

Hayes, *Schaum's Outline of Digital Signal Processing, 2nd ed*. McGraw-Hill, 2012. (This is a very inexpensive book that gives a concise treatment of most important topics, with lots of examples and worked out problems.)

Grading policy: Homework: 15%
Midterm Exam (Wed., Nov. 4, 7 – 9 PM): 40%
Final Exam (Mon, Dec. 14, 10:30 AM – 12:30 PM): 45%
Exams will be open book. Some homework assignments will require the use of MATLAB.

Course Grade Scale:

If your overall course grade is in the range:	You will receive a course letter grade of at least:
86-100	A
80-85	A-
74-79	B+
68-73	B
62-67	B-
56-61	C+
50-55	C

Topics covered:
(Italics refer to sections in the book by Proakis and Manolakis)

I. Fundamentals of discrete-time signals and systems

a) Discrete-time signals; linear, time-invariant (LTI) discrete-time systems; finite impulse response (FIR) and infinite impulse response (IIR) systems. *(Secs. 2.1-2.5)*
b) z-transforms for analysis of discrete-time systems: poles and zeros, causality and stability, system response. *(Secs. 3.1-3.5)*
c) Fourier transforms for analysis of discrete-time systems: discrete-time Fourier Transforms, system frequency responses, frequency selective filters. *(Chs. 4, 5)*
d) Discrete-time processing of continuous-time signals: sampling, processing and reconstruction. *(Secs. 6.1-6.4)*
e) Discrete Fourier transforms (DFTs) and applications; Fast Fourier Transforms (FFTs). *(Secs. 7.1-7.4, 8.1)*

II. Design and implementation of signal processing systems

a) Structures for implementing IIR and FIR filters; effects of quantization and finite wordlength. *(Ch. 9)*
b) Digital filter design techniques: windowing and frequency sampling for FIR filter design, bilinear transformation for IIR filter design. *(Ch. 10)*
c) Multirate signal processing: interpolation, decimation, polyphase filters. *(Secs. 11.1-11.9)*

III. Discrete-time random processes and applications

a) Discrete-time random processes: wide-sense stationarity, autocorrelation functions and power spectral densities, autoregressive (AR) and moving average (MA) processes, LTI filtering of random processes. *(Sec. 12.1)*
b) Optimum linear filters for estimating random processes: linear predictors, FIR and IIR Wiener filters, Kalman filters. *(Secs. 12.2, 12.7)*
c) Adaptive filters: LMS and RLS algorithms. *(Secs. 13.1-13.3)*

Accommodation Policy: The University of Massachusetts Amherst is committed to providing an equal educational opportunity for all students. If you have a documented physical, psychological or

learning disability on file with Disability Services (DS), Learning Disability Support Services (LDSS) or Psychological Disabilities Services (PDS), you may be eligible for reasonable academic accommodations to help you succeed in this course. If you have a documented disability that requires an accommodation, please notify me within the first two weeks of the semester so that we may make appropriate arrangements.

Academic Honesty: It is expected that all graduate students will abide by the Graduate Student Honor Code and the Academic Honesty Policy (available at the Graduate Dean's Office, the Academic Honesty Office (Omduds Office), or online at http://www.umass.edu/ombuds/honesty.php/). Acts of academic dishonesty will result in a grade of F in the course, and possibly additional sanctions including loss of funding, being placed on probation or suspension for a period of time, or being dismissed from the University. All students have the right of appeal through the Academic Honesty Office.