**Department of Electrical and Computer Engineering**
**University of Massachusetts Amherst**

**ECE 564/645: Communication Systems/Digital Communications**
**Spring 2019**

**Catalog Data**
ECE 564: Waveform coding, source coding and data compression. Pulse modulation systems: signal spaces, optimal receivers, probability of error. Baseband and bandpass data transmission. Introduction to channel coding. Prerequisite: ECE 563.
ECE 645: Introduction to digital communications at the graduate level. Signaling formats, optimal receivers, and error probability calculations. Introduction to error control coding, source coding, and information theory. Prerequisite: undergraduate probability.

**Objectives**
Students completing this course will know:
1.  How to measure information in a digital signal and represent that information efficiently through source coding.
2.  How to use digital information to modulate continuous-time signals for transmission across channels.
3.  How to represent a set of transmitted signals geometrically using a signal space.
4.  How to implement optimal (minimum probability of error) receivers for communication across additive white Gaussian noise channels.
5.  How to calculate key system parameters (probability of error, bandwidth efficiency) for characterizing and comparing different systems.
6.  Sources of intersymbol interference (ISI) and methods for reducing its effects.
7.  How to reduce transmission errors through the use of channel coding (linear block codes and convolutional codes).

**Prerequisite**
ECE 563 (Introduction to Communications and Signal Processing) or graduate standing.

**Instructor**
Patrick A. Kelly, Marcus 215B, email: kelly@ecs.umass.edu
Office hours: Monday, 3 – 4 PM; Thursday, 2:30 – 3:30 PM.

**Lectures**
Tuesday, Thursday 1 – 2:15 PM, Marston 211.

**Web Site**
All course material (announcements, handouts, assignments and solutions, grade records) will be available on Moodle: moodle.umass.edu (*Note:* You must be registered in either ECE 564 or ECE 645 to have Moodle access.)

**Textbook**
There is no required textbook for this course – all of the course material will be covered in the lectures. Lecture notes will be posted on Moodle after each class. If you would like to use a supplemental textbook, the following are good choices:
Proakis and Salehi, *Digital Communications, 5th ed.*, McGraw-Hill, 2007.
Madhow, *Introduction to Communication Systems*, Cambridge University Press, 2014.
Proakis and Salehi, *Fundamentals of Communication Systems*, Prentice Hall, 2004.

**Grading policy**
Homework: 15%
Exam 1 (Tuesday, March 5, in class): 25%
Exam 2 (Tuesday, April 9, in class): 25%
Final Exam (Friday, May 3, 10:30AM – 12:30 PM, Marston 211): 35%
(Exams will be open book and notes. Some homework problems 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: |
| --- | --- |
| 88-100 | A |
| 84-87 | A- |
| 80-83 | B+ |
| 76-79 | B |
| 72-75 | B- |
| 68-71 | C+ |
| 64-67 | C |
| 60-63 | C- (undergraduate) |
| 55-59 | D (undergraduate) |

**Difference Between ECE 564 and ECE 645**
The courses will have the same lectures and mostly the same assignments and exams. Students in ECE 645 will be assigned approximately one extra problem on each homework set and exam. The extra problems will often involve more math and go a little deeper into course topics than the common problems.

**Course Topics**
**I. Introduction**
    1.     General overview of digital communication systems
    2.     Review of probability and random processes
**II. Source Coding and Information Theory**
    1.     Quantization and waveform coding
    2.     Information and entropy
    3.     Source coding and data compression
    4.     Channel capacity

**III. Digital Modulation and Optimal Receivers for AWGN Channels**
    1.        Signal spaces
    2.        Optimal (minimum probability of error) receivers
    3.        Performance calculations and bounds
    4.        Sample modulation formats (PSK, QAM, FSK)

**IV. Signaling for Bandwidth-Limited Channels**
    1.        Signal design for zero intersymbol interference (ISI)
    2.        Optimal receiver in the presence of ISI
    3.        Channel equalization

**V. Error Control Coding**
    1.        Minimum distance and error correction capability
    2.        Linear block codes
    3.        Convolutional codes and the Viterbi algorithm

**VI. Topics in Wireless Communication (as time permits)**


**Academic Honesty**
It is expected that all students will abide by the Academic Honesty Policy, available at the Academic Honesty Office (Ombud's Office), or online at http://www.umass.edu/dean_students/codeofconduct/acadhonesty/. Acts of academic dishonesty (such as taking or giving answers in an exam, use of extra crib sheets, submitting another person's work as your own, etc.) will result in a grade of F in the course, and possibly additional sanctions including 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 Board.


**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 the instructors within the first two weeks of the semester so that we may make appropriate arrangements.


**Inclusivity and Diversity**
The diversity of the participants in this course is a valuable source of ideas, problem solving strategies, and engineering creativity. If you feel that your contribution is not being valued or respected for any reason, please speak with me privately. If you wish to communicate anonymously, you may do so in writing, speak with Assistant Dean Paula Rees (rees@umass.edu 413.545.6324, Marston 128), or submit your concern through the College or Engineering Climate Concerns and Suggestions on-line form (tinyurl.com/UMassEngineerClimate). We are all members of an academic community with a shared responsibility to cultivate a climate where all students/individuals are valued and where both they and their ideas are treated with respect.