ECE 5000, Introduction to Analog and Digital Communication — Aug. 21, 2013
OSU, Autumn 2013

Course Syllabus

Time and venue: MWF 8–8:55 am, Caldwell 0120

Instructor: C. Emre Koksal, Dreese 712, koksal@ece.osu.edu

Web page: Class material will be posted on Carmen

Office Hours: Wed. 9–10 am, Tuesday 9:30–10:30 am or by appointment

Content: A thorough introduction to the basic theories behind digital communication systems. The concepts covered in this class include source coding/data compression, modulation of signals, signal spaces, detection, and coding. It is critical to try to reason about how/why systems work, rather than learning to pattern match and manipulate equations. To that end, this course will favor providing intuition over giving implementation details of existing systems.

Prerequisites: Linear algebra and basic signals and systems (ECE 3050 (352), or equivalent). Basic statistics and probability (Stat 3470 (427) or Phy 3700 (416) or equivalent). Some exposure to MATLAB. Mathematical maturity.

Homework assignments: Approximately once every two weeks. Some questions will require the use of MATLAB. Since the primary purpose of the homeworks is to help you solidify your understanding of course material, discussions on assigned problems are encouraged. However, all written work turned in must be your own.

References: Copies of related parts from various references will be provided on Carmen.

- *Principles of Digital Communication*, Robert G. Gallager, Cambridge University Press, 2008.
- *Introduction to Wireless Digital Communication: A Signal Processing Perspective*, Robert W. Heath Jr., 2012 (on Carmen).
- *Communication Systems Engineering*, John G. Proakis and Masoud Salehi, Prentice Hall, 1994.
- *Principles of Communication Engineering*, John M. Wozencraft and Irwin M. Jacobs, Wiley, 1965.

Grading (*tentative*):

Homework	15%
Midterm 1	25%
Midterm 2	25%
Final	35%

Attendance: Attendance is not mandatory. However the student is responsible for all assignments, changes of assignments, announcements, lecture notes, etc. I will also be posting the assignments, main announcements, and my lecture notes on Carmen.

Topical Outline of the Course

1. Discrete source coding (6–7 lectures)
   - Fixed-length codes for discrete sources
   - Variable-length codes for discrete sources
   - Probability models for discrete sources
   - Minimum average length for prefix-free codes and Huffman coding
   - Entropy and fixed-to-variable length codes
   - The Lempel-Ziv universal data compression algorithm
2. Quantization (6–7 lectures)
   - Continuous random variables, pdfs, expectations, and variance
   - Scalar quantization and Lloyd-Max algorithm
   - Vector quantization
   - Entropy-coded quantization
   - High-rate entropy rated quantization
3. Source and channel waveforms (7–8 lectures)
   - Signals and systems, continuous-time and discrete-time Fourier transforms, and sampling
   - Sources to signals: samples to signals, Nyquist criterion
   - Signals through channels: modulation and demodulation
   - Bandwidth, baseband and passband signals, PAM and QAM
   - Imperfections: Intersymbol interference, phase tracking
4. Signal spaces (6–7 lectures)
   - Energy signals and power signals, L2 signals
   - Geometric representation of signals
   - Cholesky factorization
   - Signal constellations
   - Dimension vs. bandwidth
5. Noise and detection (5–6 lectures)
   - Noisy communication
   - Additive Gaussian noise and its representation in signal spaces
   - Received noisy signal in a simple detector
   - Probability of error
   - Optimal detector
   - Discussion: PPM vs. PAM - error performance and bandwidth
6. Channel capacity and coding (6–7 lectures)
   - Controlling errors
   - Capacity of Gaussian channels
   - Power penalty
   - Block codes and performance
   - Convolutional codes and the Viterbi algorithm (time permitting)
   - Bandwidth constrained channels (time permitting)