Electrical Engineering 121
Introduction to Digital Communication Systems

Logistics

- Time and Location: TuTh 12:30-2pm, 293 Cory
- Instructor: Professor Kannan Ramchandran
  Email: kannanr@eecs
  Office hours: Tu 2-3pm, 258 Cory. Or by appointment.
- GSI: Venkatesan Ekambaram
  Email: venkyne@eecs
  Discussion hours: Tu 5-6pm, 299 Cory
  Office hours: Venky: Wed 10-11am, 258 Cory
- Course Admin Assistant: Lea Barker
  Email: leab@eecs
  Phone: (510) 642-2384
- Prerequisites: EECS 120, 126.
- Requirements: Homework 15%, Midterm 1 40%, Midterm 2 45%
  Midterm 1 - Oct 14th 2011: 6-8pm, 521 Cory
  Midterm 2 - Dec 2nd 2011: 6-8pm, 521 Cory
- Website: resources, homework, and solutions will be posted on bspace.

Course Description

Introduction to the basic principles of the design and analysis of modern digital communication systems. Topics include source coding, channel coding, baseband and passband modulation techniques, receiver design, and channel equalization. Applications to the design of digital of digital telephone modems, compact disks, and digital wireless communication systems.

Course Outline

1. Overview of digital communications. Basics of source and channel coding. (Gallager chapter 1).

2. Overview of source coding, quantization and compression, LZ77 (Gallager chapter 2).

3. Signal space concepts with application to modulation. Complex discrete-time baseband representation. (Madhow chapter 3.3) (Proakis chapter 2.2)

4. Communication over Gaussian channels.

   Gaussian noise model. Optimal maximum likelihood detection under Gaussian noise. Error probability performance analysis. Modulation schemes: PAM, QAM, PSK, PPM. Signal space framework. (Proakis chapter 4.)

5. Communication over bandlimited channels.

   Baseband pulse amplitude modulation (PAM). Nyquist criterion. Pulse design for bandlimited channels. Power and bandwidth as fundamental resources for communication. Channel capacity. Linear block and convolutional codes. Soft and hard decision decoding. Inter-symbol interference. Equalization: Linear and maximum likelihood sequence detection. Viterbi algorithm. (Proakis chapters 7 and 9)

6. Codes for communication and storage.

   MDS codes, Reed Solomon codes, codes on graphs, digital fountain codes, Low Density Parity Check codes (McKay section VI).

7. System level concepts

   Orthogonal frequency division multiplexing (OFDM). Code Division Multiple Access (CDMA). Synchronization (Proakis chapters 12 and 13).

References

1. Principles of Digital Communication, Robert. G .Gallager. (chap 1-3 pdf in bspace)

2. Digital Communications, John Proakis, 5th Edition.

3. Fundamentals of Digital Communication, Upamanyu Madhow. (pdf in bspace)

4. Information theory, inference and learning algorithms, David J C MacKay. (pdf in bspace)

Homework Policy

- **General**: Solutions will be posted on the course webpage in the evening of the due date. Therefore no late homework will be accepted. Please make a photocopy of your homework (including code for MATLAB problems) and hand in one copy. Please staple your homework and mark on the first page how many pages total are submitted. One lowest homework score will be dropped.

- **Collaboration**: Discussions about homework are allowed and encouraged but each student is expected to writer his/her own solutions.

- **Self-Grading and Score Submission**: Students will grade their own homework and submit the score to the TA no later than 10 PM on the following Monday. Graders will grade the copy of the homework submitted. Your scores and the graders' scores will be cross-checked. If there are inconsistencies, the instructor will be notified, and will take actions accordingly. Please note the department policy on academic dishonesty:
  http://www.eecs.berkeley.edu/Policies/acad.dis.shtml

  You can get 3 possible scores for a problem, 0, 0.5 and 1. If your solution is entirely correct, you get 1 point. If your solution is more than 50% correct on a single-part problem or you solve at least half the parts entirely correctly for a multi-part problem, you get 0.5 point. Otherwise you get 0 for the problem.

  In the email to the TA to report the score, the title should be of the following format: `EE121HomeworkX` (where `X` is the homework assignment number). The content of the email should include name, student ID number, and a row of scores (the number of scores should be equal to the number of problems). Please only put spaces between the scores for each problem, i.e. no commas, no semi-colons, no new-lines.

  Example of a student submitting self-graded score for Homework 1, in which there are 6 problems.

  Title of email: `EE121Homework1`

  Content of email:

  ```
  Name:  First Last
  SID: 10001000
  1 0.5 1 0 1 1
  ```