14:332:421  Communications Engineering Notes  
Date:  September 7, 2000  
Lecture:  1  
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General Announcements:

Professors Office:  Winlab 120  
Professors Email Address:  ryates@winlab.rutgers.edu  
Course Textbook:  Communications Systems 4th edition, Haykin  
Course Website:  www.winlab.rutgers.edu/~ryates/rut/421

Course Overview:  
• Emphasis on digital communication  
• Review Chapter 1  
• Focus on Chapters 5, 6, 7, 8 and possibly 9

Grading and Percentage Breakdown:  

<table>
<thead>
<tr>
<th></th>
<th>Date</th>
<th>Percentage of Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exam 1</td>
<td>October 5</td>
<td>20%</td>
</tr>
<tr>
<td>Exam 2</td>
<td>November 13</td>
<td>20%</td>
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<tr>
<td>Final Exam</td>
<td></td>
<td>40%</td>
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<tr>
<td>Random Quizzes (6)</td>
<td></td>
<td>10%</td>
</tr>
<tr>
<td>Homework</td>
<td></td>
<td>10%</td>
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</tbody>
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*NOTE:  The lowest quiz grade will be dropped and homework will be collected.

Recording Notes for the Website:  

When a student volunteers to take notes during lecture and reproduce these notes for posting on the course website, the notes will be graded and serve to replace either one quiz grade or one homework credit will be given.
Analog and Digital Signals

Why is everything digital?
- Provides a universal description of all content
  Ex. Internet—delivers audio, video, text and images
- Reliable signal regeneration

Communication Model

Definition of Communication Model Components

1. Digital Source: Sequence of characters from an alphabet \( \{ a_0, \ldots, a_{k-1} \} \)
2. Source: Produces a random sequence. The most common random sequence is an independent and identically distributed stream of bits, each bit is equiprobably 0 or 1.
3. Source Encoder: removes redundancy
   ex. CD contains 600 Mbytes for an hour of music, MP3 contains 30-60 Mbytes for an hour of music. This is done by source encoding. A MP3 is the compression of music that sounds pretty good.
   - Lossless compression: exact recreation (every bit)
     Ex. Zip file
   - Lossy compression: can not recreate exactly
     Ex. MP3—can not create a CD from an MP3 exactly.
4. **Channel Encoder:** Adds redundancy; adds extra bits to allow error detection and correction.
5. **Modulator:** Encodes data symbols to waveforms

6. **Channel:** Looks like a linear system typically. Put a signal waveform in and signal waveforms come out.

   - Telephone line—can send Kbps
   - Coax Cable—can send Mbps
   - Optical Fiber—can send Gbps
   - Microwave Radio—transmit to another microwave radio tower; can send Mbps
   - Satellite
   - Cell Phone

**Data packet**  |  **CRC**  

**CRC** = Cyclic Redundancy Check; Checks to see if bits in data packet have been changed.

A Device on the base station checks to see if data packets are in error; sends a message to the phone to send original message again but if it’s a voice message it throws it away.
Analog Phone/North American-TDMA (AT&T or Comcast)

- 30KHz
- Roughly 3 users on one channel band
- 850 MHZ

CDMA phone (Verizon)

- 1.2M Hz
- Approximately 10-40 users can share one channel band
- 850 MHZ

Homework Assignment: Read Background & Preview; Read Stochastic Process Review in Chapter 1