EE 121:
Introduction to Digital Communication Systems

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Description:

Digital communication systems are basic workhorses behind the information age. Examples include high-speed digital communication networks, wireless and wireline telephone transmission systems, modems, compact discs, etc. This course is an introduction to the basic principles underlying the design and analysis of digital communication systems. In this semester, particular focus will be placed on wireless communication systems. Their design and modeling will serve to illustrate the basic concepts of the course.

Prerequisite:

The basic prerequisites for this course are familiarity with EE 120 (Signals and Systems) and EE 126 (Probability and Random Processes). Come and talk to me if you lack these prerequisites.

Requirements:

There will be weekly problem sets (25 % of the grade), a midterm (30 %) and a final (45 %). The problem sets include Matlab exercises and a small MATLAB project on implementing a wireless communication system.

Required Text:

The book *Communication Systems Engineering* by J. Proakis and M. Salehi is the text for the course.

Course Outline:

0. **Overview** (1 lecture)

   Digital vs analog communication. Block diagram of a digital communication system. Source-channel separation as a layering technique.

1. **Source Coding and Compression** (8 lectures)

   Huffman and Lempel-Ziv compression algorithms. Source entropy. Quantization. Speech and waveform coding. Sampling theorem revisited. Examples: digital audio in telephone networks and compact disks.

2. **Signal Space Framework for Modulation and Demodulation** (6 lectures)

   Signal space framework as a geometric approach to waveform modulation and demodulation. Gaussian noise models. Optimal detection under Gaussian noise. Error probability performance analysis.

3. **Baseband and Passband Transmission in Bandlimited Channels** (6 lectures)

   Baseband pulse amplitude modulation (PAM). Nyquist criterion. Pulse design for bandlimited channels. Passband communication. Quadrature amplitude modulation (QAM). Passband to baseband conversion. Carrier and phase recovery. Simple coding techniques. Power and bandwidth as fundamental resources for communication. Channel capacity.

4. **Wireless Communication** (8 lectures)

   Modeling of multipath wireless channels. Key parameters: delay spread, coherence bandwidth, coherence time, Doppler spread. Channel fading. Noncoherent and coherent detection in flat fading channels. Diversity techniques. Diversity and inter-symbol interference mitigation in frequency-selective fading channels. Direct sequence spread spectrum and OFDM modulation. Channel measurement. Case studies on wireless system design.