Principles of Communication

- The communication process:

  Sources of information, communication channels, modulation process, and communication networks

- Representation of signals and systems:

  Signals, Continuous Fourier transform, Sampling theorem, sequences, z-transform, convolution and correlation.

- Stochastic processes:

  Probability theory, random processes, power spectral density, Gaussian process.

- Modulation and encoding:

Basic modulation techniques and binary data transmission:AM, FM, Pulse Modulation, PCM, DPCM, Delta Modulation

- Information theory:

  Information, entropy, source coding theorem, mutual information, channel coding theorem, channel capacity, rate-distortion theory.

- Error control coding:

  linear bloc codes, cyclic codes, convolution codes

Course Material

1. Text: Simon Haykin, Communication systems, 4th edition, John Wiley & Sons, Inc (2001)
2. References
   (a) B.P. Lathi, Modern Digital and Analog Communcations Systems, Oxford University Press (1998)
   (b) Alan V. Oppenheim and Ronald W. Schafer, Discrete-Time signal processing, Prentice-Hall of India (1989)
   (c) Andrew Tanenbaum, Computer Networks, 3rd edition, Prentice Hall(1998).
   (d) Simon Haykin, "Digital Communication Systems," John Wiley & Sons, Inc.

Course Schedule

Duration: 14 Weeks

- Week 1:* Source of information; communication channels, modulation process and Communication Networks
- Week 2-3:* Signals, Continuous Fourier transform, Sampling theorem
- Week 4-5:* sequences, z-transform, convolution, correlation
- Week 6:* Probability theory - basics of probability theory, random processes
- Week 7:* Power spectral density, Gaussian process
- Week 8:* Modulation: amplitude, phase and frequency
- Week 9:* Encoding of binary data, NRZ, NRZI, Manchester, 4B/5B

- Week 10:* Characteristics of a link, half-duplex, full-duplex, Time division multiplexing, frequency division multiplexing
- Week 11:* Information, entropy, source coding theorem, mutual information
- Week 12:* channel coding theorem, channel capacity, rate-distortion theory
- Week 13:* Coding: linear block codes, cyclic codes, convolution codes
- Week 14:* Revision

Overview of the Course

Target Audience: Computer Science Undergraduates who have not taken any course on Communication

- Communication between a source and a destination requires a channel.
- A signal (voice/video/facsimile) is transmitted on a channel: Basics of Signals and Systems
  - This requires a basic understanding of signals
    - Representation of signals
  - Each signal transmitted is characterised by power.
  - The power required by a signal is best understood by frequency characteristics or bandwidth of the signal:
    - Representation of the signal in the frequency domain - Continuous Fourier transform

  - A signal trasmitted can be either analog or digital
    * A signal is converted to a digital signal by first discretising the signal - Sampling theorem - Discrete-time Fourier transform
    * Frequency domain interpretation of the signal is easier in terms of the Z-transform
    * Signals are modified by Communication media, the communication media are characterised as Systems
    * The output to input relationship is characterised by a Transfer Function

- Signal in communcation are characterised by Random variables
  - Basics of Probability
  - Random Variables and Random Processes
  - Expectation, Autocorrelation, Autocovariance, Power Spectral Density

- Analog Modulation Schemes
  - AM, DSB-SC, SSB-SC, VSB-SC, SSB+C, VSB+C
  - Frequency Division Muliplexing
  - Power required in each of the above
- Digital Modulation Schemes
  - PAM, PPM, PDM (just mention last two)
  - Quantisation
  - PCM, DPCM, DM
  - Encoding of bits: NRZ, NRZI, Manchester
  - Power required for each of the encoding schemes
- Information Theory
  - Uncertainty, Entropy, Information
  - Mutual information, Differential entropy
  - Shannon's source and channel coding theorems

  - Shannon's information capacity theorem - Analysis of Gaussian channels

- Coding
  - Repetition code
  - Hamming codes
  - Error detection codes: CRC