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


2. References
   (a) B.P. Lathi, Modern Digital and Analog Communications Systems, Oxford University Press (1998)
   (b) Alan V. Oppenheim and Ronald W. Schafer, Discrete-Time signal processing, Prentice-Hall of India (1989)
   (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 transmitted 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 communication 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 Multiplexing
  – 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