Course Name : Communication Theory
Course Number: EE - 304
Credits: 3-0-2-4
Prerequisites: IC260, IC252
Intended for: B.Tech.
Distribution: Core for EE; elective for CSE
Semester: 4th

Preamble:

To obtain a comprehensive view of communication theory and its applications, undergraduate students should not only learn the principles of modern digital communications, they should also be aware of the historical developments in the analog communications that led us to this digital communication era and are still relevant. Considering the breadth of the topics that need to be covered to provide such a comprehensive view, it is understandable that all these topics cannot be accommodated in a single course. Therefore, two courses namely Communication Theory and Advanced Communication Theory are proposed, by grouping the topics based on their prerequisites, difficulty level and coherency over the topics.

Communication theory, the first course in this two-course sequence, introduces the students to the different signals and systems pertaining to communication engineering by tracing the route of development of analog broadcasting technologies, e.g., AM and FM. Upon familiarizing students with different performance metrics, this course also highlights the benefits of digital communication over its analog counterpart. Finally, this course briefly introduces some of the digital modulation schemes, e.g., ASK, FSK, QAM, BPSK. The theory sessions are accompanied by the corresponding lab sessions whose details are provided separately.

Learning outcomes: After taking this course, students will be

1. familiar with different types of communication systems. They will also gain familiarization with various types of signals and systems that are commonly used in modelling various communication systems.

2. able to identify different design criteria (power budget, bandwidth, SNR, BER etc.) associated with communication systems.

3. able to compare the performance of different communication schemes/systems in terms of widely used metrics, e.g., SNR and BER.

4. able to understand different tradeoffs associated with different communications systems, e.g., noise immunity and bandwidth etc.

5. able to comprehend limitations of different models and the associated analyses.

6. familiar with several prototyping systems, e.g., USRP, LabVIEW and GNURadio. Additionally, they will also gain hands-on experience in developing simple communication systems.

Course modules:

1. **Signals in communication systems and their representations:** (15 contact hours)
Time and frequency domain representations of signals, vector representation of signals, Constellation diagram, Baseband and bandpass signals, Amplitude and angle modulated signals (AM, FM, PM, ASK, FSK, PSK, PAM etc.), random processes and their analysis, Energy and Power spectral densities,

2. **Systems in communication system and their analysis:** (15 contact hours)
Modulators and demodulators (coherent and noncoherent; envelope detectors, PLLs, balanced discriminators etc.), Pre-emphasis and de-emphasis, Sampler, Quantizer, Equalizers, Encoders (PCM), Line coders (On-off, Polar, Bipolar, NRZ, RZ etc.), Pulse shapers, Bandlimited and distortion-less channels, LTI systems and random processes, Matched filter, Correlation receiver

3. **Performance analysis of analog and digital communication systems:** (8 contact hours)
Signal-to-Noise Ratio (SNR) calculation for different analog communication systems, SNR analysis for PCM, Bit Error Rate (BER) calculations for different digital communication systems

4. **Case studies:** (4 contact hours)
A brief overview of modern communication/broadcast technologies, e.g., Digital Radio Mondiale (DRM), WiFi, Cellular communication etc.

Text Books:

1. B. P. Lathi and Z. Ding, Modern Digital and Analog Communication Systems, Oxford Univ. Press, January 2009, 4/e.

2. J. G. Proakis and M. Salehi, Fundamentals of Communication Systems, Prentice Hall, December 2004

Reference Books:

1. S. Haykin and M. Moher, An Introduction to Analog and Digital Communications, Wiley, January 2006, 2/e.

2. R. G. Gallager, Principles of Digital Communication, Cambridge Univ. Press, March 2008.

3. A. Lapidoth, A Foundation in Digital Communication, Cambridge Univ. Press, August 2009