Digital Communication

1.1 Course Number: ECE316

1.2 Contact Hours: 3-0-0 Credits: 9

1.3 Semester-offered: 3rd Year-Even

1.4 Prerequisite:

1.5 Syllabus Committee Member: Dr. Umakant Dhar Dwivedi, Dr. Shivanshu Shrivastava, Dr. Amarish Dubey, Dr. Sajal Agarwal, and Dr. Abhishek Kumar Singh.

2. **Objective:** To make students understand how to identify the functions of different components. Learn about theoretical bounds on the rates of digital communication system and represent a digital signal using several modulation methods. Draw signal space diagrams compute spectra of modulated signals and apply redundancy for reliable communication.

3. **Course Content:**

Unit-wise distribution of content and number of lectures

Unit	Topics	Sub-topic	Lectures
1	System Model	Digital communication system consisting of discrete source, source encoder-decoder pair, channel encoder-decoder pair, channel modulator-demodulator pair and waveform channel.	4
2	Source encoding decoding	Unique decodability and efficiency of source codes, prefixfree codes, kraft-mcmillan inequality, Discrete Memoryless Source, Shannon's noiseless source coding theorem, Source entropy, huffman coding procedure, Lempel-Ziv coding.	6
3	Waveform quantization	Sampling, quantization and reconstruction of waveform, SQNR, Optimum quantizers for speech signals, Companding of speech signals, A-law and μ-law of companding, PCM, DM, ADM, ADPCM.	5
4	Channel modulation demodulation	Channel modulation and optimum demodulation in AWGN channels with unlimited BW, Correlation Receiver, Matched filters, ASK, PSK, FSK and their optimum receivers, Modulation and demodulation in BW-limited channels, inter-symbol interference, Nyquist condition for zero inter-symbol interference, raised-cosine pulse spectrum and its properties.	5

5	Information theory	Entropy, mutual information and their relationships for discrete random variables and random vectors. Discrete memoryless channel(DMC), Binary Symmetric Channel (BSC), Channel capacity, Shannon's noisy channel coding theorem, Shannon's channel capacity theorem.	5
6	Channel Coding and Decoding	Transmission error due to channel noise, Notion of channel error detection and correction, ARQ and FEC schemes. Channel Coding: Memoryless channel coding, Channel coding with memory, linear and nonlinear coding, systematic and non-systematic coding, Optimum channel decoder for BSC, minimum distance decoding rule for arbitrary channel.	5
7	Channel coding without memory(linear systematic block code)	Generator and Parity check matrix of type (n,k) block code, syndrome decoding, hamming distance and guaranteed error detection and correction capability of block codes, cyclic codes, generator polynomial, coder and decoder circuits for cyclic codes and their applications.	5
8	Channel coding with memory (linear convolutional code)	Tree, trellis and state diagram, optimum decoding of convolutional code, viterbi decoding procedure, minimum free distance and error detection and correction capability, transfer function of convolutional code and its distance properties	5
		Total	**40**

4. **Readings**

4.1 Textbook:

1. Principles of communication, 4th ed., Simon Haykin
2. Digital Communications: Fundamentals & Applications, 2nd ed., B. Sklar

4.2 Reference Books:

1. Principles of Digital communication and coding, Viterbi and Omura
2. Information theory and reliable communication, Gallager

5. **Outcome of the Course:** After completing this course, Student will able to: Understand the basics of information theory, source coding techniques and calculate Entropy of source. Describe and determine the performance of line codes and methods to mitigate inter symbol interference. Learn the generation and detection of base band system. Understand the generation, detection signal space diagram, spectrum, bandwidth efficiency, and probability of error analysis of different band pass modulation techniques. Describe and determine the performance of different error control coding schemes for the reliable transmission of digital representation of signals and information over the channel.

Understand various spreading techniques and determine bit error performance of various digital communication systems.