Principles of Communication Systems

1.1 Course Number: ECE311

1.2 Contact Hours: 3-1-0 Credits: 9

1.3 Semester-offered: 3rd Year-Odd

1.4 Prerequisite: Signals & Systems

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 understand the fundamentals of basic communication system, types of noise affecting communication system and noise parameters. Need of modulation, modulation processes and different amplitude modulation schemes. Different angle modulation schemes with different generation and detection methods. Various radio receivers with their parameters. Need of sampling and different sampling techniques. Generation and detection of pulse modulation techniques and multiplexing.

3. Course Content:

Unit-wise distribution of content and number of lectures

Unit	Topics	Sub-topic	Lectures
1	Introduction	Basic elements of an analog communication system, analog modulations and their need for communication, types of analog modulations.	2
2	Amplitude Modulation (AM) and Demodulation	Time domain representation and spectral analysis of amplitude modulated (AM) signals, transmission bandwidth, transmission efficiency, single-tone and multi-tone AM signals, generation and demodulation techniques of AM signals, virtues, limitations and modification of the AM systems, time-domain representation, spectral analysis, generation and demodulation of double-side band suppressed carrier (DSB-SC), single side band (SSB) and vestigial side band (VSB) modulated signals; Costas receiver, quadrature carrier multiplexing, frequency translation, frequency division multiplexing system.	9

3	Angle Modulation and Demodulation	Basic definitions of frequency modulation (FM) and phase modulation (PM), basic relation between FM and PM Signals, time-domain description, and spectral analysis of narrow band FM (NBFM) and wide band FM (WBFM), bandwidth of FM signals: universal graph, Generation of FM using Armstrong modulators, voltage-controlled oscillators etc., demodulation of FM signals using frequency discriminator, phase lock loop (PLL) etc., FM stereo multiplexing systems; nonlinear effects on FM systems, Superheterodyne receiver for both AM and FM systems	10
4	Random Variables and Random Processes	Basic definition of random variables (RVs), definition and properties of cumulative distribution function (CDF) and probability density function (PDF) of RVs, normal or Gaussian, Poisson, Binomial, Uniform, Rayleigh and Exponentially distributed RVs, transformation of RVs, functions of single and bivariate RVs, mean, variance, central mean, absolute mean, correlation, covariance, and characteristic function of RVs, central limit theorem, introduction to random processes, wide sense stationary (WSS) and strict sense stationary (SSS), properties of WSS random processes; auto- and cross correlation functions, transmission of WSS random processes through linear time-invariant (LTI) systems, definition and properties of Gaussian random process Noise: shot, thermal and white noise processes, equivalent noise temperature and bandwidth of the LTI systems, narrowband noise and its properties	10
5	Noise Performance Analysis in Analog Receiver Systems	Receiver Model assuming additive white Gaussian noise (AWGN) in the channel, definitions of input, output and channel signal-to-noise ratios of the receiver, figure-of-merit (FOM) of a receiver, determination of FOM of AM, DSBSC, SSB and FM receivers, threshold effects in AM and FM systems, pre-emphasis and de-emphasis in FM systems	9
		Total	**40**

4. Readings

4.1 Textbook:

1. Communication Systems (3/e), Simon Haykin; John Wiley & Sons (Asia) Pte Ltd.
2. Modern Digital and Analog Communication Systems (4/e), B. P. Lathi and Zhi Ding; Oxford University Press, Oxford
3. Probability, Random Variables and Stochastic Processes; A. Papulis, McGraw-Hill International, New York

4.2 Reference Books:

1. Principles of Communication Systems (2/e); H. Taub and D. L. Schilling, Tata McGrawHill, New Delhi
2. Communication System Engineering (2/e); J. G. Proakis and M. Salehi; Pearson Education (Singapore) Pte Ltd.

Outcome of the Course: After successful completion of the course students will able to understand different blocks in communication system and how noise affects communication using different parameters. Distinguish between different amplitude modulation schemes with their advantages, disadvantages and applications. Analyze generation and detection of FM signal and comparison between amplitude and angle modulation schemes. Identify different radio receiver circuits and role of AGC. Sample analog signal and recover original.