Communication Systems

Code	Credit Hours
EE-351	3-1

Course Description

This course familiarizes the students with the principles of communication systems and their applications in telephone, radio, and television and computer communications. The course primarily consists of Analog Communication Systems and is supplemented with introduction to Digital Communication Systems. We start with a brief review of Fourier analysis and random processes. Basic analog communication systems, including AM and FM systems are covered next. Signal-to-noise-ratio in (SNR), in AM and FM systems, is also covered. Then, transition towards digital communication systems is made gradually with A/D conversion process, pulse modulation schemes and finally PCM. At each level, system design is given primary importance by using examples from practical systems. Digital Transmission and Reception including line codes, timing/synchronization and matched filter detection are covered next.

Text Book:

1. Communication Systems, 5th edition, by Simon Haykin and Michael Moher, John Wiley and Sons

2. B. P. Lathi, “Modern Digital and Analog Communication Systems,” 4th Edition, Adapted by Hari M. Gupta, 2017, Oxford University Press

Reference Book:

1. An Introduction to Analog and Digital Communications, 2nd Edition by Simon Haykin and Michael Moher
2. Introduction to Communication Systems by Ferral G. Stremler
3. Analog and Digital Communication Systems by Martin S. Roden
4. Communication System by John G. Proakis and Masoud Salehi

Prerequisites

EE-232

ASSESSMENT SYSTEM FOR THEORY

Quizzes	10%
Assignments	10%
Mid Terms	30%
ESE	50%

ASSESSMENT SYSTEM FOR LAB

Quizzes	10%-15%

Assignments	5% - 10%
Lab Work and Report	70-80%
Lab ESE/Viva	20-30%

Teaching Plan

Week No	Topics	Learning Outcomes
1-2	Introduction to Communication Systems and Review of Fourier Series	- Understand the basic concepts and components of communication systems. - Explain the significance and applications of Fourier Series in signal analysis. - Analyze periodic signals using Fourier Series to determine their frequency components. - Apply Fourier Series to decompose complex signals into simpler sinusoidal components.
3-4	Review of Fourier Transform and Distortion less communication systems	- Grasp the principles of Fourier Transform and its role in communication systems. - Differentiate between Fourier Series and Fourier Transform. - Analyze signals in the frequency domain using Fourier Transform. - Introduction to Frequency and Phase response for distortion less communication systems, ensuring signal integrity over transmission channels.
5-7	Amplitude Modulation	- Comprehend the theory and principles of amplitude modulation (AM). - Analyze and design AM systems, including Double Sideband (DSB), Single Sideband (SSB), and Vestigial Sideband (VSB) modulation. - Evaluate the performance of AM systems in terms of bandwidth, power efficiency, and noise immunity. - Implement practical AM modulation and demodulation techniques.
8	Angle Modulation	- Understand the fundamental concepts of angle modulation, including frequency modulation (FM) and phase modulation (PM).
9	**MID TERM EXAM**	
10-12	Angle Modulation	- Analyze the spectral characteristics of FM and PM signals. - Design and evaluate angle modulation and demodulation schemes. - Compare the performance of angle modulation systems with amplitude modulation systems in terms of bandwidth, noise resilience, and efficiency.

13-16	Random processes, Noise in communication systems, SNR calculation	1. Introduction to Probability and Random Variables, Statistical Averages. 2. Random Processes, Transmission of random process through a Linear Filter, Power Spectral Density, Gaussian Process, Analytics of Noise, Narrowband Noise, Noise in Analogue Modulation. 3. Receiver Model for Analog Link, Noise in DSB-SC Receivers, Noise in AM Receivers, Noise in FM Receivers.
17	Additional topics	Introduction to Digital Communication Systems, Difference between Analogue and Digital Communication Systems.
18	**END SEMESTER EXAM**	

Practical

Exp. No.	Experiment Title
1	Fourier Series and Fourier Transform Analysis
2	Distortionless Transmission and System Response
3	Amplitude Modulation (DSB-SC and DSB-AM)
4	Single Sideband (SSB) and Vestigial Sideband (VSB) Modulation
5	COASTAS Receiver
6	Frequency and Phase Modulation (FM & PM) Generation
7	FM Demodulation
8	Phase-Locked Loop (PLL)
9	Introduction to GNU Radio and SDR Reception
10	USRP Transmit-Receive
11	Generation and Statistical Analysis of received Signal using USRP
12	Power Spectral Density and Filtering of Random Processes
13	Noise Modeling and Performance in AM and FM Systems
14	Introduction to Digital Communication (Sampling and Quantization)

Commented [D1]:

Practical:

Experiment No	Description
1	Introduction to Analog Communication System.
2	AM transmission.
3	AM reception.
4	AM transmitter and receiver (envelope detector).
5	SSB transmission.
6	SSB reception.
7	SSB and Frequency Division Multiplexing.
8	COSTAS Receiver.
9	Angle modulation and demodulation.
10	Phase locked loop (MatLab).
11	Phase locked loop (LabVolt Kit).
12	Frequency discriminator.
13	Stochastic model of systems.
14	Noise performance of modulation schemes.