Indian Institute of Technology Kanpur

EE390: Digital Communication Systems-I

First Course Handout

Instructor:

Name: Adrish Banerjee

E-mail: adrish@iitk.ac.in (preferred mode of communication)

Phone: 0512-259-7991

Teaching Assistants:

1. Tamoghno Nath
   tamoghno@iitk.ac.in
2. Kalyan Paul
   kalyanpaul21@iitk.ac.in

Course Description: This course will cover the fundamentals of digital communication systems, emphasizing the physical layer aspects of communications. In the first part of the course, we will discuss, among other topics, modulation techniques and optimum receivers for the AWGN channel. The course will give tools to analyze and characterize the performance of digital communication systems.

Course Plan:

Week 1: Introduction

Lecture 1A: An introduction to digital communications

Lecture 1B: Communication channels and models

Lecture 2A: Review of signals

Lecture 2B: Representation of lowpass and bandpass signals

Posting of Assignment #1

Discussion Hour

Week 2: Mathematical preliminaries

Lecture 2C: Signal space representation of waveforms

Lecture 2D: Some useful random variables

Lecture 2E: Complex random variables

Lecture 2F: A brief introduction to random processes

Posting of Assignment #2

Discussion Hour

Week 3: Memoryless modulation

Lecture 3A: Digital Modulation: An Introduction

Lecture 3B: Pulse Amplitude Modulation, Phase Shift Keying, and Quadrature Amplitude Modulation

Lecture 3C: Orthogonal, bi-orthogonal, and simplex signaling

Posting of Assignment #3

Discussion Hour

Week 4: Modulation with memory

Lecture 4A: Continuous Phase Frequency Shift Keying

Lecture 4B: Continuous Phase Modulation

Posting of Assignment #4

Discussion Hour

Week 5: Optimum receivers for AWGN channels

Lecture 5A: Optimal Detection for a vector AWGN channel

Lecture 5B: Waveform and vector AWGN channels

Lecture 5C: Optimal Detection for Binary Antipodal Signaling

Lecture 5D: Correlation Receiver and Matched Filter

Posting of Assignment #5

Discussion Hour

Week 6: Probability of error computation for coherent detection

Lecture 6A: Optimal detection and error probability for ASK or PAM, and PSK signalling.

Lecture 6B: Optimal detection and error probability for QAM signalling.

Lecture 6C: Optimal detection and error probability for Orthogonal, Bi-Orthogonal and Simplex Signalling

Posting of Assignment #6

Discussion Hour

Week 7: Noncoherent detection

Lecture 7A: Noncoherent detection of carrier modulated signals

Lecture 7B: Error probability of orthogonal signaling with noncoherent detection

Lecture 7C: Differential Phase Shift Keying

Posting of Assignment #7

Discussion Hour

Week 8: Detection of signals with memory

Lecture 8A: Maximum likelihood sequence estimator: Viterbi Algorithm

Lecture 8B: Optimum receivers for CPM signals

Posting of Assignment #8

Discussion Hour

Course Evaluation:

Components:

- **Class Participation in live sessions:** You are expected to participate in discussions in the weekly live sessions actively.
- **Assignments:** Weekly assignments will be given. Assignments will be based on multiple-choice questions. You will have to submit the assignments before the due date. Your scores on the best six assignments will be considered for the final grade. There will be no negative markings in the assignments.
- **Quizzes:** Four quizzes will be conducted. The first one will be on Sunday 16th October 2022 from 5.00 pm-6.00 pm, the second one will be on Sunday 30th October 2022 from 5.00 pm-6.00 pm, third one will be on Sunday 13th November 2022 from 5.00 pm-6.00 pm, and four one will be on Sunday 20th November 2022 from 5.00 pm-6.00 pm. Quiz-1 will cover topics covered from Week-1 to Week-2, Quiz-2 will cover topics from Week-3 to Week-4, Quiz-3 will cover topics from Week-5 to Week-6, and Quiz-4 will cover topics from Week-7 to Week-8. Your best two scores out of four quizzes will be considered for the final grade. Each quiz will be of one-hour duration based on multiple-choice questions. There will be no negative marking in the quizzes.
- **End-semester examination:** The end-semester examination will be of three hours duration based on multiple-choice questions. There will be negative marking.

S.No	Component	Marks
1.	Class Participation in live sessions	10
2.	Assignments (best six out of eight)	30
3.	Quizzes (best two out of four)	20
4.	End-semester examination	40

References:

1. Proakis & Salehi, ``Digital Communications", McGraw Hill Education; Fifth edition, 5th edition.
2. Sklar & Ray, ``Digital Communications: Fundamentals & Applications", Pearson Education India; 2nd edition.
3. Barry & Lee & Messerschmitt, ``Digital Communication", Springer, 3rd Edition.