NIRMA UNIVERSITY

Institute:	Institute of Technology
Name of Programme:	B.Tech. Electronics & Communication Engineering
Course Code:	3EC301CC24
Course Title:	Digital Communication
Course Type:	Core
Year of Introduction:	2024-25

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Course Learning Outcomes (CLOs):

At the end of the course, students will be able to

1. comprehend the fundamentals of digital communication with wireless channel. BL-2
2. compute bit error rate of digital modulation techniques in the presence of additive white gaussian noise. BL-4
3. apply information theory for determining the capacity of binary symmetric channel. BL-3
4. evaluate the performance of digital communication system with error control coding and spread spectrum modulation. BL-5

Unit No.	Contents	Teaching hours (Total 45)
I	**Signal Space Analysis:** signal space representation of energy signals, grand-smith orthogonalisation procedure, conversion of the continuous additive white gaussian noise (AWGN) channel into a vector channel, detection of known signals in AWGN, maximum likelihood detection and correlation receiver, matched filter	06
II	**Passband Digital Transmission:** passband transmission model, coherent phase shift keying, hybrid amplitude/phase modulation schemes, QAM, coherent frequency shift keying, detection of signals with unknown phase, non-coherent binary frequency shift keying, differential phase-shift keying, comparison of digital modulation schemes, multichannel modulation and OFDM, synchronisation, carrier recovery and symbol timing	10
III	**Spread-Spectrum Modulation:** Pseudo-noise sequences, a notion of spread spectrum, direct-sequence spread spectrum with coherent binary phase-shift keying, signal-space dimensionality and processing gain, probability of error, frequency hop spread spectrum, scrambler	06
IV	**Information Theory:** Uncertainty, information and entropy, source coding theorem, channel capacity, channel coding theorem, channel capacity of various channel, Shannon's theorem of error-free communication	08
V	**Error-Control Coding:** Introduction, discrete memoryless channels, linear block codes, error correcting capabilities of the codes, hamming bound, cyclic codes, polynomial representation, convolutional codes, trellis structure, maximum likelihood decoding of convolutional codes, Viterbi algorithm, design numerical	10
VI	**Fundamentals of Wireless Communication:** Wireless channel characterisation, multipath propagation, types of the fading channel, cellular concepts- frequency reuse, handoff, channel assignment, multiple-access techniques – FDMA, TDMA & CDMA	05

Self-Study:
The self-study contents will be declared at the commencement of the semester. Around 10% of the questions will be asked from self-study content.

Laboratory Work: Laboratory work will be based on the above syllabus with a minimum of

Sr. No.	Title of the experiments	Hours
1.	Analyse BER versus SNR performance of Coherent Binary detection in AWGN channel using simulations	02
2.	Analyse BER versus SNR performance of binary Differential Phase Shift Keying in AWGN channel using simulations	02
3.	Analyse BER versus SNR performance of Coherent detection of Frequency Shift Keying (FSK) in AWGN channel using simulations	02
4.	Analyse BER versus SNR performance of Non-Coherent detection of Frequency Shift Keying (FSK) in AWGN channel using simulations	02
5.	Analyse BER versus SNR performance of coherent detection of M-PSK in AWGN channel using simulations	02
6.	Analyse Mean Square Error (MSE) versus SNR for speech using coherent detection of MQAM in AWGN channel using simulations	02
7.	Generate BPSK, FSK and ASK waveforms using simulations	02
8.	Analyse Mean Square Error (MSE) versus SNR for image using Coherent BPSK with Linear Block codes in AWGN channel using simulations	02
9.	Analyse BER versus SNR performance of Coherent BPSK with Convolutional codes in AWGN channel using simulations	02
10.	Analyse Mean Square Error (MSE) versus SNR for speech transmission with AWGN channel	02
11.	Analyse channel capacity for channels such as Binary Symmetric, Binary Asymmetric and AWGN	02
12.	Analyse Mean Square Error (MSE) versus SNR for video transmission with AWGN channel	02
13.	Analyse Mean Square Error (MSE) versus SNR for image transmission with AWGN channel	02
14.	Analyse the performance of scrambler and descrambler	02
15.	Realise the effect of AWGN on the received image with different modulation schemes	02

10 experiments to be incorporated.

Suggest List of Experiments (not restricted to the following):
(Only for information)

Suggested Readings:

1. S. Haykin, Communication Systems, John Wiley publication
2. B. P. Lathi, Modern Digital and Analog Communications Systems, Oxford University Press
3. T. Rappaport, Wireless Communication- Principles and Practices, Pearson Education
4. B. Sklar, Digital Communication Fundamentals and Applications, Pearson Education
5. J. Proakis, Digital Communications, Tata McGraw-Hill