NIRMA UNIVERSITY

Institute:	Institute of Technology
Name of Programme:	BTech CSE, Integrated BTech (CSE)-MBA
Course Code:	XXXX
Course Title:	Information Theory and Coding
Course Type:	Department Elective–I
Year of Introduction:	2024-25

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Course Learning Outcomes (CLO):

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

1. explain the fundamental concepts of information theory, such as entropy, mutual information, and channel capacity (BL2)
2. experiment with channel coding, flow control, and error control techniques (BL3)
3. compare the channel coding techniques for noisy channels and their implications (BL4)
4. solve problems related to different channel coding techniques. (BL6)

Unit	Contents	Teaching Hours (Total 45)
Unit-I	**Information theory:** Concept of amount of information, information units Entropy: marginal, conditional, joint and relative entropies, relation among entropies Mutual information, information rate, channel capacity, redundancy and efficiency of channels Discrete channels – Symmetric channels, Binary Symmetric Channel, Binary Erasure Channel, Noise-Free Channel, Channel with independent I/O, Cascaded channels, Binary asymmetric channel, Shannon theorem.	12
Unit-II	**Linear Block Codes:** Introduction to Linear Block Codes, Syndrome and Error Detection, Minimum Distance of a Block code, Error-Detecting and Error-correcting Capabilities of a Block code, Standard array and Syndrome Decoding, Probability of an undetected error for Linear Codes over a BSC, Hamming Codes, Applications of Block codes.	10
Unit-III	**Cyclic Codes:** Description, Generator and Parity-check Matrices, Encoding, Syndrome Computation and Error Detection, Decoding, Cyclic Hamming Codes, shortened cyclic codes, Error-trapping decoding for cyclic codes, Majority logic decoding for cyclic codes.	08
Unit-IV	**Convolutional Codes:** Encoding of Convolutional Codes- Structural and Distance Properties, State, Tree, Trellis Diagrams, Maximum Likelihood Decoding, Sequential Decoding, Majority- Logic Decoding of Convolution Codes.	08
Unit-V	**Network Coding:** Fundamentals of Network Coding, Butterfly Networks, Max-Flow Min-Cut Theorem, Multi-Source Multicast Problem, Deterministic Code Design for Network Coding, Randomized Network Coding Application of Network Coding	07

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

Suggested Readings/ References:

1. Richard B. Wells, Applied Coding and Information Theory for Engineers, India Pearson Education Asia Pte. Ltd
2. Gareth A Jones, J. Mery Jones, Information and Coding Theory, New Delhi Springer (India) Pvt. Ltd.
3. K. N. Hari Bhat, D. Ganesh Rao, Information Theory and Coding, Cengage Learning India Pvt. Ltd.
4. Ranjan Bose, Information Theory, Coding and Cryptography, McGraw-Hill Education (India) Private Limited
5. Shu Lin, Daniel J. Costello, Jr, Error Control Coding- Fundamentals and Applications, Prentice Hall, Inc.
6. C. Fragouli and E. Soljanin: Network Coding Fundamentals, Now Publisher.

Laboratory Work:
Laboratory work will be based on the above syllabus with a minimum of 10 experiments to be incorporated. The students in a suitable group size will design and perform one experiment as a part of Laboratory work.

Sr. No.	List of Experiments/Exercises	Hours
1	Write a program for the determination of various entropies and mutual information of a given channel. Test various types of channels such as a) Noise-free channel, b) Error-free channel, c) Binary symmetric channel. Compare the channel capacity of above channels	04
2	Determination of various entropies and mutual information of the given Binary symmetric channel.	04
3	Write a program for generation and evaluation of variable length source coding using Huffman Coding and decoding. Calculate the entropy, average length, and efficiency of Huffman Coding.	04
4	Write a Program for coding of Linear block codes for error detection and correction.	02
5	Write a Program for coding & decoding of Cyclic codes for error detection and correction.	02
6	Write a program for coding and decoding of convolutional codes for error detection and correction.	04
7	Write a program to find minimum s-t cut in a flow network.	02
8	Write a program to implement the Maximum likelihood decoding for convolution code to determine the most likely transmitted message in a digital communication system.	04
9	Write a program to implement the Majority logic decoding for cyclic codes.	02
10	Write a program to implement the Majority logic decoding for convolution codes.	02