FACULTY OF ENGINEERING & TECHNOLOGY

Effective from Academic Batch: 2022-23

Programme: BACHELOR OF TECHNOLOGY (Electronics and Communication)

Semester: VI

Course Code: 202060602

Course Title: Information Theory and Coding

Course Group: Professional Core Course

Course Objectives: The aims of this course are to introduce the principles and applications of information theory and coding. It covers how information is measured in terms of probability and various entropies, and which used to calculate the capacity of communication channels, continuous or discrete, with or without noise. Coding schemes including error correcting codes are studied along with data compression, spectral analysis, and efficient coding using wavelets.

Teaching & Examination Scheme:

Contact hours per week			Course Credits	Examination Marks (Maximum / Passing)				
				Theory		J/V/P*		Total
Lecture	Tutorial	Practical		Internal	External	Internal	External	
3	0	2	4	50/18	50/17	25/9	25/9	150/53

* **J**: Jury; **V**: Viva; **P**: Practical

Detailed Syllabus:

Sr.	Contents	Hours
1	**Concept of Entropy and Coding:** Measure of information, Entropy of sources and their extension, Mutual information, Asymptotic Properties of Entropy and Problem Solving in Entropy, Unique decodable codes, Instantaneous Decodable Codes (IDC), Construction of IDC, Kraft's inequality and MC Millan's theorem, Huffman and Shannon-fano code.	10
2	**Arithmetic and Linear block codes:** Basic of channel coding, Hamming distances and bound condition, Channel capacity, Shannon's fundamental theorem, Systematic linear Block codes, optimum decoding for the binary symmetric channel, Generator and parity Check Matrices Syndrome decoding on symmetric channels; Hamming codes.	10

3	**Convolutional Coding and advance coding:** Convolutional Encoder Representation, Formulation of the Convolutional Decoding Problem, Properties of Convolutional Codes, Other Convolutional Decoding Algorithms, Interleaving and Concatenated Codes, Coding and Interleaving Applied to the Compact Disc Digital Audio System. Polar coding, LDPC coding.	**10**
4	**Cyclic Coding:** Algebraic Structure of Cyclic Codes, Binary Cyclic Code Properties, Encoding in Systematic Form, Circuit for Dividing Polynomials, Systematic Encoding with an (n – k)-Stage Shift Register, Error Detection with an (n – k)-Stage Shift Register, Burst errors, BCH Code, Reed Solomon Codes.	**10**
5	**Cryptography:** A Noisy Wiretap, Secret-Key Encryption, Public-Key Encryption, Encryption Based on Large Prime Numbers, Encryption Based on Knapsack Problems, Data Encryption Standard.	**5**
		45

List of Practicals / Tutorials:

1	A) Simulate binary Huffman code in MATLAB.
	B) Find average length, entropy and coding efficiency of the code.
2	Write a MATLAB program that takes in channel transition probability matrix and compute Mutual Information & channel capacity of the discrete memory-less channel.
3	Write a MATLAB program to encode messages for a forward error correction system with a given Linear block code.
4	Write a MATLAB program to decode the encoded word for a forward error correction system with a given Linear block code.
5	Write a MATLAB program to encode messages for a system with given Cyclic Polynomial code.
6	Decoding the messages for a system with a given cyclic polynomial code and verifying through simulation.
7	Understanding the concept of loss less data compression technique using Huffman coding.
8	Write a MATLAB program to perform BCH encoding and decoding.
9	Write a MATLAB program to perform Reed Solomon encoding and decoding.
10	Encoding the data bits using a Binary Cyclic block encoder in Simulink.
11	Decoding the code words using a Binary Cyclic block decoder in Simulink.
12	**Open Ended Problem:** Write a MATLAB program to encode and decode LDPC and Polar Code.

Reference Books:

1	Jiri Adamek, **Foundation of coding**, John Wiley and sons, 1991.
2	Ranjan Bose, **Information Theory, Coding and Cryptography**, Tata McGraw Hill, 2nd edition.
3	A. J. Viterbi and J. K. Ormura, **Principal of Digital Communication and Coding**, McGraw Hill.
4	Kennedy, **Electronic Communication Systems**, McGraw Hill, 4th Ed., 1999.

5	Andre Neabauer, **Coding Theory: Algorithms, Architectures & Applications**, Wiley Publications, 2010.

Supplementary learning Material:	
1	Error Correcting Codes, IISc Bangalore: https://nptel.ac.in/courses/117108044
2	Principles of Digital Communications, IIT Delhi: https://nptel.ac.in/courses/108102120
3	Information Theory, Coding and Cryptography : https://nptel.ac.in/courses/108102117
4	Video Lectures NPTEL and Coursera.

Pedagogy:
● Direct classroom teaching   ● Audio Visual presentations/demonstrations   ● Assignments/Quiz   ● Continuous assessment   ● Interactive methods   ● Seminar/Poster Presentation   ● Industrial/ Field visits   ● Course Projects

Internal Evaluation:

The internal evaluation comprised of written exam (40% weightage) along with combination of various components such as Certification courses, Assignments, Mini Project, Simulation, Model making, Case study, Group activity, Seminar, Poster Presentation, Unit test, Quiz, Class Participation, Attendance, Achievements etc. where individual component weightage should not exceed 20%.

Suggested Specification table with Marks (Theory) (Revised Bloom's Taxonomy):

Distribution of Theory Marks in %						R: Remembering; U: Understanding; A: Applying; N: Analyzing; E: Evaluating; C: Creating
R	U	A	N	E	C	
10	20	30	20	10	10	

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Course Outcomes (CO):

Sr.	Course Outcome Statements	%weightage
CO-1	To understand the basics of information theory.	**15**
CO-2	To have a deeper insight of the data communication applications, based on information theory	**25**

CO-3	To analyze various error correcting codes and their impact on communication systems.	**35**
CO-4	To compare encoded v/s uncoded communication system.	**25**

Curriculum Revision:	
Version:	2.0
Drafted on (Month-Year):	June -2022
Last Reviewed on (Month-Year):	-
Next Review on (Month-Year):	June-2025