COURSE TITLE	**INFORMATION THEORY AND CODING**
COURSE CODE	**01CT0702**
COURSE CREDITS	**4**

Objective:

1 The objective of the course is to define and apply basic concepts of information theory, learn principles and applications of information theory in communication systems, how information is measured in terms of probability and entropy, information coding techniques including error-correcting codes and various data compression methods

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Course Outcomes: After completion of this course, student will be able to:

1 Understand information channels and explain the working of various source and channel coding algorithms. [Understand]

2 Calculate information measures for various discrete channels and coding schemes. [Apply]

3 Design codewords for given probability distributions using various source and channel coding algorithms. [Apply]

4 Distinguish the relationship between information parameters and analyze statistics for various coding algorithms. [Analyze]

5 Construct coding algorithms, related matrices, polynomials, encoding, and decoding diagrams. [Create]

Pre-requisite of course: Linear Algebra, Probability Theory

Teaching and Examination Scheme

Theory Hours	Tutorial Hours	Practical Hours	ESE	IA	CSE	Viva	Term Work
3	0	2	50	30	20	25	25

Contents : Unit	Topics	Contact Hours
1	**Introduction to Information Theory** Concept of amount of information, Entropy, Mutual Information, Conditional and Joint Entropy, Measures for Continuous Random Variable, Relative Entropy, Information Rate, Channel Capacity, Redundancy and Efficiency of channels, Binary Symmetric Channel, Binary Erasure Channel, Noiseless and Deterministic Channels,, Cascaded Channels, Binary Asymmetric Channel, Shannon Theorem	8

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Contents : Unit	Topics	Contact Hours
2	**Source Coding** Encoding techniques, Purpose of encoding, Instantaneous Codes, Kraft Inequality, Coding efficiency and Redundancy,Shannon-Fano- Elias coding, Huffman Coding, Run Length Coding, Arithmetic Coding, LZW coding	8
3	**Chanel Coding-I** Parity check coding, Linear block codes, Generator and Parity check matrices, Error detecting and correcting capabilities, Standard array and Syndrome decoding, Hamming codes, Cyclic codes – Generator polynomial, Generator and Parity check matrices, Encoding of cyclic codes, Syndrome computation, and error detection, Decoding of cyclic codes, BCH codes, RS codes, Burst error correction	9
4	**Channel Coding-II:** Convolutional codes – Encoding, State and Tree diagrams, Maximum likelihood decoding of convolutional codes -Viterbi algorithm, Sequential decoding -Stack algorithm, Interleaving techniques – Block and convolutional interleaving, Coding, and interleaving applied to CD digital audio system - CIRC encoding and decoding, Coding, and interleaving applied to CD digital audio system - CIRC decoding, interpolation, and muting, ARQ – Types of ARQ, Performance of ARQ, Probability of error and throughput, Trellis diagrams	10
5	**Rate-Distortion Theory** Rate distortion function, random source codes, joint source-channel coding , Lossy compression techniques: JPEG for images, MPEG for video, LPC for speech, the separation theorem	7
Total Hours		**42**

Suggested List of Experiments:

Contents : Unit	Topics	Contact Hours
1	**Lab1** Write a program to determine entropy and mutual information of given channels: (a) Noise-free the channel, (b) Binary symmetric channel.	2
2	**Lab2** Write a program to implement encoding and decoding using Huffman codes.	2
3	**Lab3** Write a program to implement arithmetic codes.	2
4	**Lab4** Write a program to implement Run-length coding.	2
5	**Lab5** Write a program to implement LZW codes.	2

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Suggested List of Experiments:

Contents : Unit	Topics	Contact Hours
6	**Lab6** Write a program for coding and decoding for Linear Block Codes.	2
7	**Lab7** Write a program for coding and decoding for Cyclic codes.	2
8	**Lab8** Write a program for encoding Convolution codes. (a) use a time-domain approach (b) use transform domain approach	2
9	**Lab9** Write a program for coding and decoding for the BCH code.	2
10	**Lab10** Write a program for coding and decoding for the RS code.	2
11	**Lab11** Write a program to decode the convolution code with the Viterbi algorithm.	2
Total Hours		**22**

Textbook :

1 Elements of Information Theory, T. M. Cover, J. A. Thomas, Wiley, 1991

2 Fundamentals of Information Theory and Coding Design, R. Togneri, C. J. S. DeSilva, Taylor and Francis, 2002

3 Fundamentals of Information Theory and Coding, M. Borda, Springer, 2011

4 The Theory of Information and Coding, R. J. McEliece, Cambridge University Press, 1977

References:

1 Information Theory Coding and Cryptography, Information Theory Coding and Cryptography, R Bose, Tata McGraw Hill, 2002

Suggested Theory Distribution:

The suggested theory distribution as per Bloom's taxonomy is as follows. This distribution serves as guidelines for teachers and students to achieve effective teaching-learning process

Distribution of Theory for course delivery					
Remember / Knowledge	**Understand**	**Apply**	**Analyze**	**Evaluate**	**Higher order Thinking / Creative**
5.00	25.00	30.00	20.00	10.00	10.00

Instructional Method:

1 The course delivery method will depend upon the requirement of content and need of the students. The teacher in addition to conventional teaching method (Chalk and Talk) may use any of the tools such as demonstration, role play, Quiz, brainstorming, MOOCs etc. for effective teaching.

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Instructional Method:

2 The internal evaluation will be done on the basis of continuous evaluation of students in the laboratory and class-room.

3 Students may use supplementary resources such as online videos, NPTEL videos, e-courses, Virtual Laboratory, etc.

Supplementary Resources:

1 https://nptel.ac.in/courses/117/101/117101053/

2 https://www.coursera.org/learn/information-theory

3 https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-441-information-theory-spring-2016/syllabus/