III B.Tech – I Semester
(20EC5636) CODING TECHNIQUES
(Honors)

Int. Marks	Ext. Marks	Total Marks	L	T	P	C
30	70	100	3	1	-	4

Pre-Requisites: Probability Theory and Stochastic Processes, Analog & Digital Communications

Course Objectives:

- To understand the concept of Information and various theorems proposed by Shannon for efficient data compression and reliable transmission over a noisy channel
- To study Block codes and understand their error detection and correction capabilities
- To understand Cyclic codes and BCH codes
- To study Convolution and Turbo codes
- To familiarize with Space Time codes

UNIT-I: Introduction to Information Theory

Introduction to Information Theory: Information, Average Information, Mutual Information, Entropy, Marginal, Conditional and Joint Entropies, Relation among Entropies, Information Rate.

Source Coding: Differential Entropy, Gaussian channels, Shannon – Hartley theorem, Shanon-Fano Coding, Huffman Coding, Efficiency Calculations and redundancy, Kraft‘s inequality.

Channel Capacity: Binary symmetric channel (BSC), Binary erasure channel (BEC), capacity of band limited Gaussian channels, capacity of a channel of infinite bandwidth, Bandwidth –S/N Trade off, Shannon‘s limit.

UNIT-II: Linear Block Codes

Linear Block Codes: Introduction, Codes for Error Detection and Correction – Linear Block Codes, Matrix Description of Linear Block Codes, Syndrome and error detection, Minimum Distance of A Block Code, Error Detection and Error Correction Capabilities of Linear Block Codes, Probability of an Undetected Error for Linear Codes over a BSC, Parity Check Coding, Generator and Parity Check Matrices, Standard Array and Syndrome Decoding, Hamming Codes.

UNIT-III: Cyclic and BCH Codes

Cyclic Codes: Perfect codes, polynomial and matrix descriptions, generation of cyclic codes, Generator and Parity-check Matrices, Encoding, Syndrome Computation and Error Detection, decoding of cyclic codes, Binary Cyclic Codes, Algebraic Structure, Encoding, Cyclic Hamming Codes, Shortened cyclic codes, Error-trapping decoding for cyclic codes, Majority logic decoding for cyclic codes.

BCH Codes: Minimum distance and BCH bounds, Construction and decoding of BCH codes, Reed Solomon codes, Syndrome Calculation.

UNIT-IV: Convolution and Turbo Codes

Convolution Codes: Introduction, Encoding of Convolution Codes, Structural and Distance Properties, Time Domain Approach, Transform Domain Approach. Graphical Approach: State, Tree and Trellis Diagram, Maximum likelihood decoding of convolutional codes, The Viterbi Algorithm, Sequential decoding, Applications of Convolutional codes in ARQ system, Concatenated convolutional codes-Parallel concatenation.

Turbo Codes: LDPC Codes- Codes based on sparse graphs, Decoding for binary erasure channel, Log-likelihood algebra, Product codes, Iterative decoding of product codes, The UMTS Turbo code, Serial concatenation, Parallel concatenation, Turbo decoding.

UNIT-V: Space-Time Codes

Space-Time Codes: Introduction, Digital modulation schemes, Diversity, Orthogonal space- Time Block codes, Alamouti's schemes, Extension to more than Two Transmit Antennas, Simulation Results, Spatial Multiplexing : General Concept, Iterative APP Preprocessing and Per-layer Decoding, Linear Multilayer Detection, Original BLAST Detection, QL Decomposition and Interface Cancellation, Performance of Multi – Layer Detection Schemes, Unified Description by Linear Dispersion Codes.

Course Outcomes:

After successful completion of the course, the students can be able to

S.No	Course Outcome	BTL
1.	Apply the knowledge of Shannon's Source coding theorem and Channel coding theorem for designing an efficient and error free communication link	L3
2.	Design encoders and decoders for Block codes	L3
3.	Compute and analyze Cyclic codes and BCH codes.	L3
4.	Obtain knowledge in designing Convolution and Turbo codes	L2
5.	Understand the concept of Diversity and Space Time codes	L2

Correlation of Cos with Pos & PSOs:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO 1	3	3	3	-	-	-	-	-	-	-	-	-	3	-
CO 2	3	3	3	-	-	-	-	-	-	-	-	-	3	-
CO 3	3	3	3	-	-	-	-	-	-	-	-	-	3	-
CO 4	2	2	1	-	-	-	-	-	-	-	-	-	2	-
CO 5	2	2	1	-	-	-	-	-	-	-	-	-	2	-

Text Books:

1. Simon Haykin: Digital Communication Systems, Wiley India, 2013.
2. P S Sathya Narayana, Concepts of Information Theory & Coding, Dynaram Publications, 2005.
3. Error Control Coding- Fundamentals and Applications –Shu Lin, Daniel J.Costello, Jr, Prentice Hall, Inc 2014.
4. Error Correcting Coding Theory-Man Young Rhee, McGraw – Hill Publishing 1989.

Reference Books:

1. Principles of Communication Systems – H. Taub and D. Schilling, TMH, 2003.
2. Digital Communications – John Proakis, TMH, 1983.
3. Bose, Information theory coding and cryptography, 3/e McGraw Hill Edu. India, 2016.
4. Kelbert & Suhov, Information theory and coding by examples, Cambridge University Press, 2013.
5. Digital Communications- Fundamentals and Application, BernardSklar, PE.
6. Introduction to Error Control Codes-Salvatore Gravano-oxford.