Sub Code: R2331042 **R23** **Set No. 1**

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY-GURUJADA VIZINAGARAM
III B. Tech I Semester Regular Examinations November -2025
INFORMATION THEORY AND ERROR CONTROL CODING
(ECE)

Time: 3 hours **Max. Marks: 70**

The Question paper consists of Part A & Part B.
Part A is compulsory, Answer all questions. Part B Answers any one question from each unit.
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1		PART-A	(20Marks)
	a)	Write any two differences between *Shannon–Fano* and *Huffman* coding.	[2]
	b)	Define *Binary Symmetric Channel (BSC)* and its crossover probability.	[2]
	c)	What are *systematic* and *non-systematic* codes?	[2]
	d)	Write the condition satisfied by *Generator matrix (G)* and *Parity-check matrix (H)*.	[2]
	e)	Differentiate between *block* and *convolutional* codes.	[2]
	f)	What is *Concatenated coding*?	[2]
	g)	Define *Iterative decoding*.	[2]
	h)	What is the purpose of *Soft-Input Soft-Output (SISO)* decoding?	[2]
	i)	What is *soft decision decoding*?	[2]
	j)	What is the purpose of *edge connections* in Tanner graphs?	[2]
		PART-B	(50Marks)
		Unit - I	
2	a)	State and prove *Kraft's Inequality* for any instantaneous code. How does it determine the existence of a prefix-free code for a given set of codeword lengths?	[5]
	b)	For a Binary Symmetric Channel (BSC) with error probability $p = 0.1$, derive the channel capacity. Compare it with that of a Binary Erasure Channel (BEC) with erasure probability $p = 0.1$.	[5]
		(OR)	
3	a)	Construct the *Huffman code* for a source with symbols {A, B, C, D, E} having probabilities {0.3, 0.25, 0.2, 0.15, 0.1}. Compute the average code length, entropy, and coding efficiency.	[5]
	b)	State and explain *Shannon's Source Coding Theorem*. Derive the limits on the average code length for any lossless source coding scheme.	[5]
		Unit - II	
4	a)	Explain the *Standard Array Decoding* method for linear block codes. Illustrate with an example for a (6,3) code	[5]
	b)	Define a *Linear Block Code (n, k)*. Derive the relation between *Generator Matrix (G)* and *Parity Check Matrix (H)* and show that $GH^T = 0$.	[5]
		(OR)	
5	a)	For the (7,4) *Hamming Code*, construct the *Generator Matrix* and *Parity Check Matrix*. Encode the message 1011 and find the syndrome if an error occurs in the 5th bit.	[5]
	b)	Describe the encoding process of *Cyclic Codes* using	[5]

		Generator Polynomial. For $g(x) = 1 + x + x^3$, encode the message 1011.	
		Unit - III	
6	a)	Draw the *State Diagram* and *Trellis Diagram* for a rate ½, constraint length 3 convolutional encoder with generator sequences $G_1 = [1,1,1]$and $G_2 = [1,0,1]$. Encode the sequence 1101.	[5]
	b)	Explain the *Viterbi Algorithm* for decoding convolutional codes. Show step-by-step decoding for a simple 3-bit input sequence using path metric calculation.	[5]
		(OR)	
7	a)	Discuss the types of *ARQ protocols* (Stop-and-Wait, Go-Back-N, Selective Repeat). Derive an expression for throughput efficiency for Stop-and-Wait ARQ.	[5]
	b)	Explain the concept of *Concatenated Coding*. How are convolutional and block codes combined in practice (e.g., in space communication systems)?	[5]
		Unit - IV	
8	a)	Explain the *structure* and *encoding* process of a *Parallel Concatenated Turbo Code*. Illustrate with a block diagram showing two RSC encoders and interleaver.	[5]
	b)	Describe the *Iterative Decoding Process* of Turbo Codes using the *Soft-Input Soft-Output (SISO)* approach. Discuss how extrinsic information improves performance.	[5]
		(OR)	
9	a)	Differentiate between *Serial* and *Parallel Concatenated Turbo Codes*. Explain their respective advantages.	[5]
	b)	Explain the role of *Interleaver Design* in Turbo Codes. What parameters affect the performance of the Turbo Decoder?	[5]
		Unit - V	
10	a)	What are *Low-Density Parity-Check (LDPC) Codes*? Describe their *Tanner Graph* representation and explain how sparsity affects decoding complexity.	[5]
	b)	Explain the *Belief Propagation (Sum-Product)* decoding algorithm for LDPC codes. Illustrate one iteration of message passing on a simple 4-bit parity-check graph.	[5]
		(OR)	
11	a)	Discuss the *construction and encoding* of LDPC codes using a *Parity Check Matrix* with column and row weights (3,6).	[5]
	b)	Write short notes on *Spatially Coupled LDPC Codes*. How do they improve decoding threshold compared to regular LDPC codes?	[5]

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