Roll No.												

PRESIDENCY UNIVERSITY

BENGALURU

End - Term Examinations – MAY 2025

Date: 20-05-2025 **Time:** 09:30 am – 12:30 pm

School: SOCSE	**Program:** B. Tech-ISE	
Course Code : CSE3086	**Course Name :** Information Theory & Coding	
Semester: VI	**Max Marks**: 100	**Weightage**: 50%

CO - Levels	**CO1**	**CO2**	**CO3**	**CO4**	**CO5**
Marks	**24**	**24**	**26**	**26**	

Instructions:

(i) Read all questions carefully and answer accordingly.

(ii) Do not write anything on the question paper other than roll number.

Part A

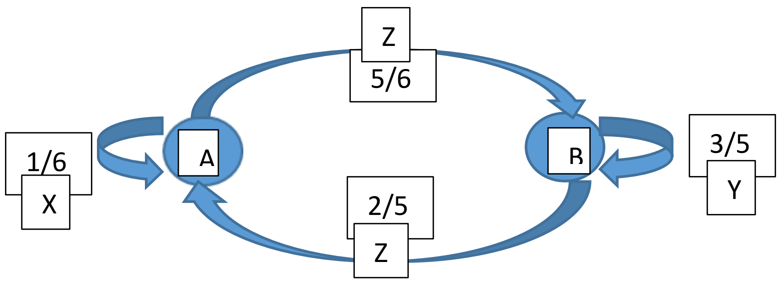
Answer ALL the Questions. Each question carries 2marks. **10Q x 2M=20M**

1	Define entropy, symbol rate, and information rate with their units.	**2 Marks**	**L1**	**CO1**
2	Clarify the statement having more information between “Dog bites a man” or “man bites a dog”.	**2 Marks**	**L1**	**CO1**
3	Correlate two principles of Shannon-Fano Coding and Huffman coding theorem in brief.	**2 Marks**	**L2**	**CO2**
4	State purpose of coding. What is a uniquely decodable code?	**2 Marks**	**L2**	**CO2**
5	State Shannon’s channel capacity theorem.	**2 Marks**	**L1**	**CO3**
6	State Muroga’s method for channel capacity?	**2 Marks**	**L2**	**CO3**
7	Write down any two properties of mutual information.	**2 Marks**	**L1**	**CO3**
8	Correlate E_b/N_o with error probability in X-Y plot.	**2 Marks**	**L2**	**CO4**

9	Define Hamming weight, Hamming distance and minimum distance with an example.	2 Marks	L2	CO4
10	What is error control coding?	2 Marks	L1	CO4

Part B

Answer the Questions **Total 80 Marks**

11.	**a.**	Distinguish between long dependent memory sequence and long independent memory sequence with examples. Define and explain the properties of entropy. A source emits five symbols with probabilities {0.4, 0.2, 0.2, 0.1, 0.1}. Compute the entropy and comment on the source's uncertainty.	**10 Marks**	**L1**	**CO1**
	b.	For the given state diagram: Find entropy of each state and total entropy. Find G_1, G_2 and H and show that $G_1>G_2>H$. 	**10 Marks**	**L2**	

or

12.	**a.**	Define average information content of symbols for a dependent sequence. Consider a two-symbol Markov source with transition probabilities: $P = \begin{bmatrix} 0.7 & 0.3 \\ 0.4 & 0.6 \end{bmatrix}$. Find the stationary distribution and entropy rate.	**10 Marks**	**L1**	**CO1**
	b.	Define entropy for a discrete memory-less source. Derive an expression for the average information content of symbols in long independent sequences. A source emits symbols A, B, C with probabilities 0.6, 0.3, 0.1 respectively. Compute the entropy of the source. All the symbols and their corresponding probabilities for second extension of the entropy. Prove that $H(S^2) = 2H(S)$.	**10 Marks**	**L2**	

13.	**a.**	Discuss any five optimal source encoding techniques for discrete memoryless source with examples. Elaborate lossy and lossless compression techniques in brief with examples. Prove that Kraft Mcmillan Inequality (KMI) equation $$\sum_{i=1}^{n} r^{-l_i} \leq 1$$	**10 Marks**	**L1**	**CO2**
	b.	Consider the following uniquely decodable codewords assigned to symbols A, B, C, D: CA = 00 CB = 01 CC = 10 CD = 11 (i) Prove whether this code is uniquely decodable. Provide justification. (ii) If the code is not uniquely decodable, provide a method to adjust the codewords to ensure unique decodability. (iii) Calculate the average code length for the current set of code words. (iv) Determine the redundancy of the code if the source emits symbols according to the following probabilities: P(A) = 0.5, P(B) = 0.2, P(C) = 0.2, P(D) = 0.1.	**10 Marks**	**L2**	

or

14.	**a.**	Consider a discrete memoryless source with S= {X, Y, Z} with respective probabilities P= {0.5, 0.3, 0.2}.Find the code-words for symbols using Shannon's first algorithm and find source efficiency and redundancy.	**10 Marks**	**L1**	**CO2**
	b.	For the problem (a) mentioned above, Consider the second extension of the source so find the code-word, source efficiency and redundancy.	**10 Marks**	**L2**	

15.	**a.**	Formulate the probability transition matrix and probability joint matrix in terms of information channel. Using Muroga's method, find out the capacity of the channels.	**10 Marks**	**L1**	**CO3**
	b.	A channel matrix is given by P (Y/X) = $$\begin{matrix} 0.4 & 0.3 & 0.3 \\ 0.3 & 0.2 & 0.5 \\ 0.1 & 0.4 & 0.5 \end{matrix}$$	**10 Marks**	**L2**	

		and P(X) = [1/2 ¼ 1/4] Find H(X), H(Y), H (X,Y), H (X/Y) and H (Y/X)			

Or

16.	**a.** **b.**	State and prove Shannon's Channel capacity for discrete information channel. Elaborate positive and negative impact of the Shannon capacity theorem. Using Graphical representation of mutual information, show that I (X; Y) = I (Y;X) . Write down the different properties of mutual information.	**10 Marks** **10 Marks**	**L1** **L2**	**CO3**

17.	**a.** **b.**	For a systematic (6,3) linear block code P= $\begin{bmatrix} 1 & 0 & 1 \\ 0 & 1 & 1 \\ 1 & 1 & 0 \end{bmatrix}$. Draw the corresponding encoding circuit (n,k)= (6,3). Prove that $C * H^T = 0$.	**10 Marks** **10 Marks**	**L1** **L2**	**CO4**

Or

18.	**a.** **b.**	Explain error detection and correction using Hamming code. Design (n, k) Hamming code with minimum distance $d_{min} = 3$ and message length of 4 bits. Generate all possible code words and check for 1-bit error correction. Define and explain cyclic codes. Given a (7,4) cyclic code with generator polynomial $g(x) = x^3 + x + 1$, encode the message [1 1 0 1]. Show the polynomial and shift register representation.	**10 Marks** **10 Marks**	**L1** **L2**	**CO4**

***** BEST WISHES *****