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B.M.S. College of Engineering, Bengaluru-560019

Autonomous Institute Affiliated to VTU

September / October 2023 Supplementary Examinations

Programme: B.E. **Semester: V**
Branch: Electronics and Telecommunication Engineering **Duration: 3 hrs.**
Course Code: 19ET5PCITC **Max Marks: 100**
Course: INFORMATION THEORY AND CODING **Date: 19.09.2023**

Instructions: 1. Answer any FIVE full questions, choosing one full question from each unit.
2. Missing data, if any, may suitably assumed.

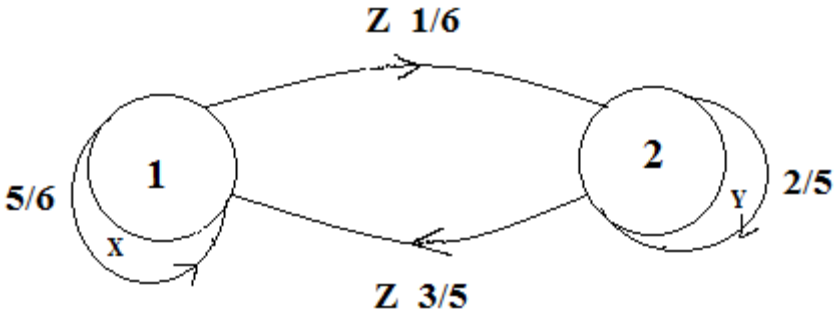
UNIT - I

1 a) Find the relation between Hartley, Nats and Bits. **04**

b) For the First order Markov Source, as shown **08**

i) Find the entropy of each state and entropy of the source.

ii) Find G_1, G_2 and Show that $G_1 > G_2 > H$.



c) The Joint probability P (X, Y) for a channel is given below. Compute individually H(X), H(Y), H (X, Y), H(Y/X), H(X/Y) and I (X, Y). Verify the relationship among these entropies. **08**

$$\begin{bmatrix} 0.05 & 0 & 0.20 & 0.05 \\ 0 & 0.10 & 0.10 & 0 \\ 0 & 0 & 0.20 & 0.10 \\ 0.05 & 0.05 & 0 & 0.10 \end{bmatrix}$$

UNIT - II

2 a) A source emits 7 symbols A to G with respective probabilities of 9/32, 3/32, 1/16, 3/32, 3/32, 3/32 and 9/32. Design a source encoder using Shannon's encoding algorithm and determine the code efficiency. **07**

b) Consider a source with 8 alphabets A to H with respective probabilities of 0.22, 0.20, 0.18, 0.15, 0.10, 0.08, 0.05 and 0.02. Construct a ternary Huffman code and determine the efficiency of the code. **07**

c) State and Prove Shannon's First Theorem. **06**

UNIT - III

3 a) Derive an expression for channel capacity of the Symmetric/Uniform Channel. **06**

b) A non-symmetric binary channel has the following noise characteristics **08**

$P(Y1/X1) = \alpha$, $P(Y1/X2) = (1-\beta)$, $P(Y2/X1) = (1-\alpha)$ and $P(Y2/X2) = \beta$.

Find H(X), H(Y), H(X/Y) and H(Y/X) given P(X=0)= ¼, P(X=1) = ¾, $\alpha = 0.75$ and $\beta = 0.9$.

c) Two binary symmetric channels are connected in cascade. Find the overall channel capacity of the cascaded connection assuming that both the channels have the same channel diagram. **06**

OR

4 a) Prove that I (X, Y) = H(X) - H(X/Y) for continuous channel. **06**

b) A CRT terminal is used to enter alphanumeric data into a computer. The CRT is connected through a voice grade telephone line having usable bandwidth of 3 KHz and an output (S/N) of 10dB. Assume that the terminal has 128 characters and data is sent in an independent manner with equal probability **06**

i) Find the average information per character.

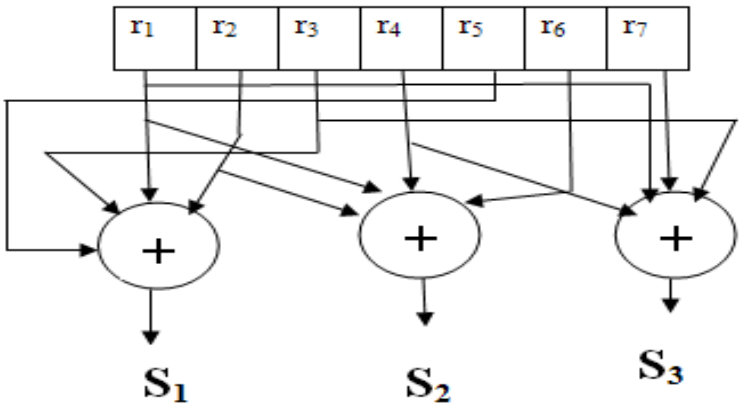
ii) Find the capacity of the channel.

iii) Find maximum rate at which data can be sent from terminal to the computer without error.

c) State and prove Shannon Hartley Law. **08**

UNIT - IV

5 a) Design an encoder for the given syndrome calculation circuit and obtain its Parity matrix, Parity check matrix and the Generator matrix. Determine the 'n' and 'k' values of the linear block code. Obtain the code vectors. Construct the standard array for the code and obtain the decoding circuit. **10**



b) Prove that the minimum distance of a Linear Block code is equal to the minimum Hamming weight of a non-zero cod vector. **05**

c) A linear hamming code is described by the generator polynomial g (D) = 1+D+D3. Determine the Generator and the Parity check matrix. **05**

OR

6 a) A (15, 7) linear cyclic code has a generator polynomial $g(x) = 1 + x^4+x^6+x^7+x^8$. **10**

(i) Find the code polynomial for the message $D(x) = x^2+x^3+x^4$ in systematic form.

(ii) Assume the first and the last bit of the code vector suffer transmission errors. Find the Syndrome of the code vector.

b) Design an encoder for (n, k) binary cyclic code generated by $g(x) = 1+ X^4+X^6+X^7+X^8$. Identify 'n' for 7 message bits. Compute the input message for the encoder by considering the content of the shift register given below. Verify your answer by direct hand calculation. **10**

No of Shifts	Input	Shift Register Contents							
		R_0	R_1	R_2	R_3	R_4	R_5	R_6	R_7
Initialization		0	0	0	0	0	0	0	0
1	?	0	0	0	0	0	0	0	0
2	?	1	0	0	0	1	0	1	1
3	?	1	1	0	0	1	1	1	0
4	?	1	1	1	0	1	1	0	0
5	?	0	1	1	1	0	1	1	0
6	?	1	0	1	1	0	0	0	0
7	?	0	1	0	1	1	0	0	0

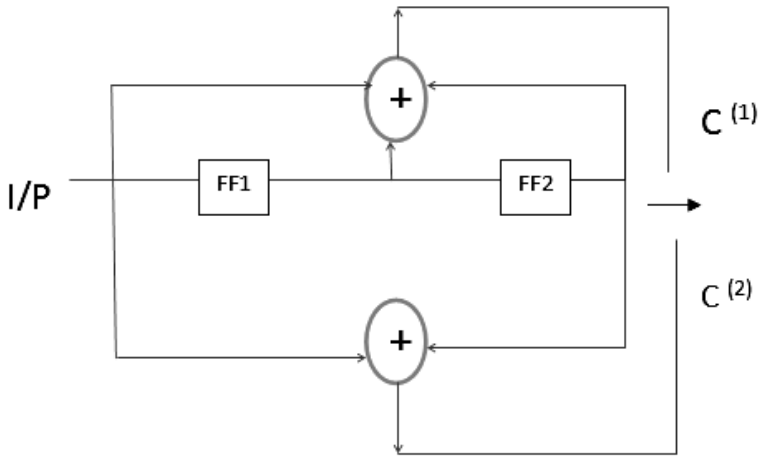
UNIT - V

7 a) For the given Generator matrix, obtain n, k, m values of the convolutional encoder and draw the encoder diagram. **04**

$$G= \begin{bmatrix} 111\ 101\ 011\ 000\ 000\ 000\ 000 \\ 000\ 111\ 101\ 011\ 000\ 000\ 000 \\ 000\ 000\ 111\ 101\ 011\ 000\ 000 \\ 000\ 000\ 000\ 111\ 101\ 011\ 000 \\ 000\ 000\ 000\ 000\ 111\ 101\ 011 \end{bmatrix}$$

b) Describe RS Codes with applications. **04**

c) For the binary convolutional encoder (2, 1, 2) given below. Draw the state transition table, trellis diagram. Using the trellis structure. If the received vector is [11 11 10 01 10 01 11] decode the input sequence using Viterbi Decoding. **12**



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