CBCS SCHEME

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15EC54

Fifth Semester B.E. Degree Examination, Jan./Feb. 2023
Information Theory and Coding

Time: 3 hrs. Max. Marks: 80

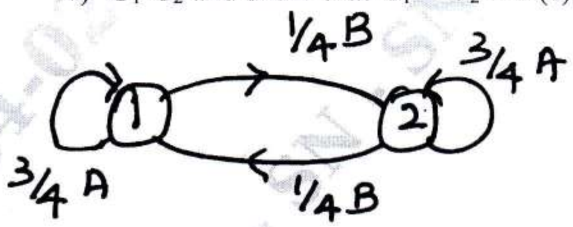
Note: Answer any FIVE full questions, choosing ONE full question from each module.

Important Note : 1. On completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages.
2. Any revealing of identification, appeal to evaluator and /or equations written eg, 42+8 = 50, will be treated as malpractice.

Module-1

1 a. Derive an expression for average information content of symbols in long independent sequence. **(03 Marks)**

b. For the Markov source shown below, find i) The stationary distribution ii) State entropies iii) Source entropy iv) G_1 G_2 and show that $G_1 \geq G_2 \geq H(s)$. **(10 Marks)**



c. Define Self Information, Entropy and Information rate. **(03 Marks)**

OR

2 a. Mention different properties of entropy and prove external property. **(07 Marks)**

b. A source emits one of the four symbols S_1 S_2 S_3 and S_4 with probabilities of $\frac{7}{16}$, $\frac{5}{16}$, $\frac{1}{8}$ and $\frac{1}{8}$. Show that $H(S^2) = 2H(S)$. **(04 Marks)**

c. In a facsimile transmission of a picture, there are about 2.25×10^6 pixels/frame. For a good reproduction at the receiver 12 brightness levels are necessary. Assume all these levels are equally likely to occur. Find the rate of information if one picture is to be transmitted every 3 min. Also compute the source efficiency. **(05 Marks)**

Module-2

3 a. Apply Shannon's binary encoding algorithm to the following set of symbols given in table below. Also obtain code efficiency. **(08 Marks)**

Symbols	A	B	C	D	E
P	1/8	1/16	3/16	1/4	3/8

b. Consider a source S = {s_1, s_2} with probabilities 3/4 and 1/4 respectively. Obtain Shannon-Fano code for source S and its 2[nd] extension. Calculate efficiencies for each case. Comment on the result. **(08 Marks)**

OR

4 a. Consider a source with 8 alphabets A to H with respective probabilities of 0.22, 020, 018, 015, 0.10, 0.08, 0.05 and 0.02. Construct Huffman's code and determine its efficiency. **(10 Marks)**

b. With an illustrative example, explain arithmetic coding technique. **(06 Marks)**

Module-3

5 a. A binary channel has the following characteristics $P\left(\frac{Y}{X}\right) = \begin{bmatrix} \frac{2}{3} & \frac{1}{3} \\ \frac{1}{3} & \frac{2}{3} \end{bmatrix}$. If input symbols are transmitted with probabilities $\frac{3}{4}$ and $\frac{1}{4}$ respectively. Find entropies, H(X), H(X, Y) and $H(Y/X)$. **(03 Marks)**

b. Prove that the mutual information is always a non-negative entity $I(X\,;Y) \geq 0$. **(06 Marks)**

c. The noise characteristics of a channel are as shown in Fig. Q5 (c). Find the capacity of the channel using Muroga's method.

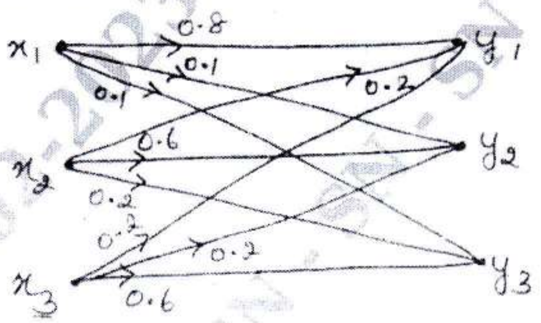


Fig. Q5 (c) **(07 Marks)**

OR

6 a. State the properties of Joint Probability Matrix. **(04 Marks)**

b. Find the mutual information for the channel shown in Fig. Q6 (b). Let $P(x_1) = 0.6$ and $P(x_2) = 0.4$. **(06 Marks)**

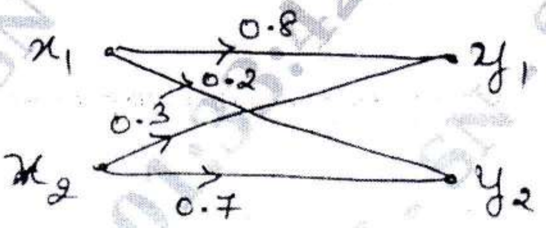


Fig. Q6 (b)

c. Derive the expression for the channel capacity of a Binary Symmetric Channel. **(06 Marks)**

Module-4

7 a. Distinguish between "block codes" and "convolution codes". **(02 Marks)**

b. For a systematic (6, 3) linear block code, the parity matrix is $P = \begin{vmatrix} 1 & 0 & 1 \\ 0 & 1 & 1 \\ 1 & 1 & 0 \end{vmatrix}$. Find all possible code vectors. **(08 Marks)**

c. The parity check bits of a (8, 4) block code are generated by $c_5 = d_1 + d_2 + d_4$, $c_6 = d_1 + d_2 + d_3$, $c_7 = d_1 + d_3 + d_4$ and $c_8 = d_2 + d_3 + d_4$ where d_1, d_2, d_3 and d_4 are message bits. Find the generator matrix and parity check matrix for this code. **(06 Marks)**

OR

8 a. A (7, 4) cyclic code has the generator polynomial $g(x) = 1 + x + x^3$. Find the code vectors both in systematic and nonsystematic form for the message bits (1001) and (1101). **(12 Marks)**

b. Consider a (15, 11) cyclic code generated by $g(x) = 1 + x + x^4$. Device a feed back shift register encoder circuit. **(04 Marks)**

Module-5

9 a. Consider the (3, 1, 2) convolutional code with $g_1 = 110$, $g_2 = 101$, $g_3 = 111$. **(12 Marks)**

i) Draw the encoder block diagram

ii) Find the generator matrix

iii) Find the code word corresponding to the information sequence 11101 using time domain and transform Domain approach.

b. Write short note on BCH code. **(04 Marks)**

OR

10 For a (2,1, 3) convolutional encoder with $g_1 = 1011$, $g_2 = 1101$.

a. Draw the state diagram

b. Draw the code tree.

c. Draw trellis diagram and code word for the message 1 1 1 0 1.

d. Using Viterbi decoding algorithm decode the obtained code word if first bit is erroneous. **(16 Marks)**

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