CBCS SCHEME

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15EC54

Fifth Semester B.E. Degree Examination, July/August 2022
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 (entropy) of long independent message. **(05 Marks)**

b. A source emits one of the four probable message S_1, S_2, S_3 and S_4 with probabilities of $\frac{7}{16}, \frac{5}{16}, \frac{1}{8}$, and $\frac{1}{8}$ respectively. Find the entropy of the source. List all the elements for the second extension of this source. Hence, show that $H(s^2) = 2H(s)$. **(05 Marks)**

c. For the first order Mark off source shown in Fig Q1(c)

i) Find the stationary distribution

ii) Find the entropy of each state and hence entropy of the source

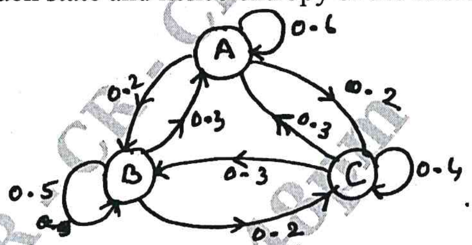

Fig Q1(c) **(06 Marks)**

OR

2 a. In a facsimile transmission of picture, there are about 2.25×10^6 pixel/frame. For a good reproduction 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 minutes. What is the sources efficiency of this facsimile transmitter? **(06 Marks)**

b. A binary source is emitting an independent sequence of '0' and '1' with probability P and 1-P respectively. Plot the entropy of source versus P. **(04 Marks)**

c. Show that $H(S^n) = n. H(s)$ where n is the n^{th} order extension of S. **(06 Marks)**

Module-2

3 a. Design an encoder using Shannon's encoding algorithm for a source having 5 symbols and probability $P = \frac{1}{4}, \frac{1}{8}, \frac{1}{8}, \frac{3}{16}, \frac{5}{16}$. Find the efficiency of the coding scheme. **(12 Marks)**

b. Write a note on Lempel – ZIV algorithm. **(04 Marks)**

OR

4 a. A source produces two symbols 'A' and 'B' with probability 0.05 and 0.95 respectively. Construct a suitable binary code such that the efficiency of a coding is at least 65%. Use Shannon Fano encoding. **(10 Marks)**

b. Design a Binary source code for the source shown Using Huffman's coding procedure.
$S = S_1, S_2, S_3, S_4, S_5, S_6, S_7$
$P = \frac{9}{32}, \frac{3}{32}, \frac{3}{32}, \frac{2}{32}, \frac{9}{32}, \frac{3}{32}, \frac{3}{32}$
Find coding efficiency. **(06 Marks)**

Module-3

5 a. Define Mutual information and list all the properties of mutual information. Prove any one of them. **(06 Marks)**

b. For the joint probability matrix. Compute individually H(X), H(Y), H(X, Y), H(X/Y), H(Y/X) and I(X, Y) verify the relationship among these entropies.

$$P(X,Y) = \begin{bmatrix} 0.05 & 0 & 0.20 & 0.05 \\ 0 & 0.10 & 0.10 & 0 \\ 0 & 0 & 0.20 & 0.10 \\ 0.05 & 0.05 & 0 & 0.10 \end{bmatrix}$$

(10 Marks)

OR

6 a. Show that H(X, Y) = H(X/Y) + H(Y) bits /sym. **(04 Marks)**

b. Find the mutual information and channel capacity using Muroga's method shown in Fig Q6(b), given $P(x_1) = 0.6$ and $P(x_2) = 0.4$

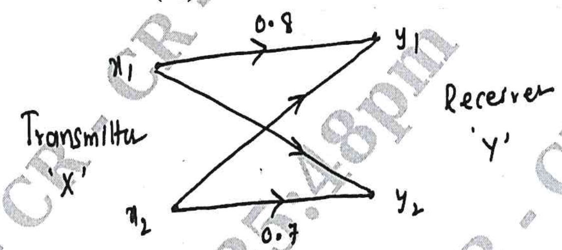

Fig Q6(b) **(12 Marks)**

Module-4

7 a. Design a single error correcting code with a message block size of 11 and show that by an example that it can correct single error. **(08 Marks)**

b. The parity check bits of a (8, 4) block code are generated by
$C_5 = d_1 + d_2 + d_4 \quad C_6 = d_1 + d_2 + d_3 \quad C_7 = d_1 + d_3 + d_4$
$C_8 = d_2 + d_3 + d_4$ where $d_1 d_2 d_3$ and d_4 are the message bits.

i) Find the generator matrix and parity check matrix for this code
ii) Find the minimum weight of this code.
iii) Show through this example that this code can detect and correct errors. **(08 Marks)**

OR

8 a. A(15, 5) Linear cyclic code has a generator polynomial $g(x) = 1 + x + x^2 + x^4 + x^5 + x^8 + x^{10}$
i) Draw the block diagram of an encoder and syndrome calculator for this code
ii) Find the code polynomial for the message polynomial
$D(x) = 1 + x^2 + x^4$ in systematic form
iii) Is $V(x) = 1 + x^4 + x^6 + x^8 = x^{14}$ is a code polynomial. **(10 Marks)**

b. A linear Hamming code is described by generator polynomial
$g(x) = 1 + x + x^3$
i) Determine the generator matrix G and parity check matrix H
ii) Design the encoder circuit. **(06 Marks)**

Module-5

9 Consider the (3, 1, 2) convolutional code with $g^{(1)} = 110$, $g^{(2)} = 101$ and $g^{(3)} = 111$.

i) Draw the encoder block diagram
ii) Find the generator matrix
iii) Find the codeword corresponding to the information source (11101) using the time domain approach and transform domain approach. **(16 Marks)**

OR

10 For a (2, 1, 2) convolutional encoder with $g^{(1)} = 111$ $g^{(2)} = 101$.

i) Draw the encoder diagram
ii) Write the state transition table and state diagram
iii) Draw the code tree
iv) Find the codeword for the message sequence 10111
v) Draw the Trellis diagram. **(16 Marks)**

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