![CBCS SCHEME]

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18EC54

Fifth Semester B.E. Degree Examination, July/August 2022
Information Theory and Coding

Time: 3 hrs. Max. Marks: 100

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

Module-1

1 a. Choose a facsimile transmission of a picture, which 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 source efficiency. **(08 Marks)**

b. State and prove External property of Entropy. **(06 Marks)**

c. A zero memory source has alphabet $S = \{S_1\ \ S_2\ \ S_3\}$ with $P = \left\{\frac{1}{2}, \frac{1}{4}, \frac{1}{4}\right\}$. Find the entropy of this source. Also determine the entropy of its 2^{nd} extension and verify that $H(s^2) = 2H(s)$. **(06 Marks)**

OR

2 a. State and prove Extension of zero-memory source. **(08 Marks)**

b. For the first order Markoff source shown in Fig.Q2(b).
(i) Find the stationary distribution (ii) Find the entropy of each state and hence the entropy of the source (iii) Find the entropy of the adjoint source and verify that $H(s) < H(\overline{s})$.

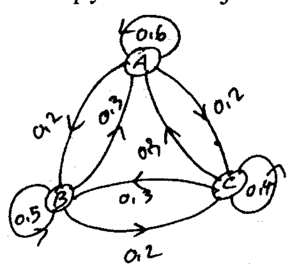

Fig.Q2(b) **(12 Marks)**

Module-2

3 a. Select a source $S = \{S_1, S_2\}$ with probabilities ¾ and ¼ respectively. Obtain Shannon Fano code for source S and its 2^{nd} extension. Calculate efficiencies for each case. **(10 Marks)**

b. Construct Huffman Binary Code and determine its efficiency for a source with 8 alphabets A to H with probabilities of
0.22, 0.20, 0.18, 0.15, 0.10, 0.08, 0.05, 0.02. **(10 Marks)**

OR

4 a. Apply Shannon encoding algorithm for the following message and obtain efficiency, redundancy and draw code tree.
$S = \{S_1\ \ S_2\ \ S_3\ \ S_4\}$
$P = \{0.4,\ 0.3,\ 0.2,\ 0.1\}$ **(10 Marks)**

b. Explain with examples Prefix Codes. (min 4 examples two not prefix and two prefix.) **(06 Marks)**

c. State and explain Kraft's inequality. **(04 Marks)**

Module-3

5 a. What is Mutual information? Mention its properties. **(04 Marks)**

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

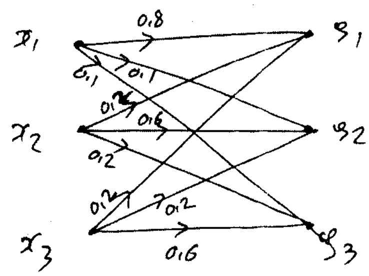

Fig.Q5(b) **(08 Marks)**

c. Explain Binary Symmetric and Binary Erroneous channel, with neat figure and JPM. **(08 Marks)**

OR

6 a. A binary symmetric channel has the following noise matrix

$$P(Y/X) = \begin{matrix} & y_1 & y_2 \\ x_1 & 3/4 & 1/4 \\ x_2 & 1/4 & 3/4 \end{matrix}$$

The source probabilities are $P(x_1) = 2/3$, $P(x_2) = 1/3$.

i) Determine H(x), H(y), H(x, y), H(y/x), H(x/y) and I(x,y)

ii) Find the channel capacity C

iii) Find channel η. **(08 Marks)**

b. What is Joint Probability matrix? Explain their properties. **(08 Marks)**

c. For the given channel matrix P(B/A), find H(B) by find P(A, B)

$$P(B/A) = \begin{bmatrix} 1 & 0 & 0 & 0 \\ 1/4 & 3/4 & 0 & 0 \\ 0 & 1/3 & 2/3 & 0 \\ 0 & 0 & 1/3 & 2/3 \\ 0 & 0 & 1 & 0 \end{bmatrix}$$

The symbol probabilities are 0.2, 0.3, 0.2, 0.1 and 0.2. **(04 Marks)**

Module-4

7 a. Consider a (6, 3) linear block code whose generator matrix is given by

$$\begin{bmatrix} 1 & 0 & 0 & 1 & 0 & 1 \\ 0 & 1 & 0 & 1 & 1 & 0 \\ 0 & 0 & 1 & 0 & 1 & 1 \end{bmatrix}$$

(i) Find all codewords.

(ii) Draw encoder circuit

(iii) Find minimum weight parity check matrix

(iv) Draw syndrome computation circuit. **(12 Marks)**

b. What is Syndrome Decoding Standard Array? Mention steps to decode using Syndrome Standard Array. **(08 Marks)**

OR

8 a. The generator polynomial of a (7, 4) cyclic code is $g(x) = 1 + x + x^3$, find the 16 code words of this code by forming the code polynomials $V(x)$ using $V(x) = D(x)\,g(x)$, where $D(x)$ is message polynomial. **(10 Marks)**

b. For a (7, 4) cyclic code, the received vector $Z(x)$ is 1110101 and the generator polynomial is $g(x) = 1 + x + x^3$. Draw the syndrome calculation circuit and correct the single error in the received vector. **(10 Marks)**

Module-5

9 a. Consider a (3, 1, 2) convolution encoder with g(1) = 110, g(2) = 101 and g(3) = 111
(i) Draw encoder diagram
(ii) Find the code word for the message sequence (11101) using (a) Generator Matrix / time Domain approach and (b) Transformation approach. **(15 Marks)**

b. Explain Viterbi decoding Algorithm. **(05 Marks)**

OR

10 a. Explain importance of Convolution Code. **(05 Marks)**

b. Construct (2, 1, 3) convolution encoder circuit with $g^1 = 1011$ and $g^2 = 1101$ and obtain
(i) State diagram
(ii) Code tree
(iii) The encoder output produced by the message sequence 11101 by traversing the code tree. **(15 Marks)**

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