CBCS SCHEME

USN

17EC54

Fifth Semester B.E. Degree Examination, Feb./Mar. 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. Define :
i) Self information
ii) Entropy of source
iii) Rate of source information. **(06 Marks)**

b. Explain the properties of entropy. Derive entropy expression for extended source. **(06 Marks)**

c. A binary source is emitting independent sequence of 0's and 1's with probability p and $1-p$ respectively plot the entropy of this source vs probability $(0 < p < 1)$ write the conclusion. **(08 Marks)**

OR

2 a. Explain the extremal properties of entropy. **(10 Marks)**

b. The state probability of a stationary Markov sources is given below the probabilities of state $i = \frac{1}{2}$, $i = 1, 2$
i) Find the entropy of each state
ii) Find the entropy of source
iii) Find G_1, G_2 and show that $G_1 > G > H[s]$.

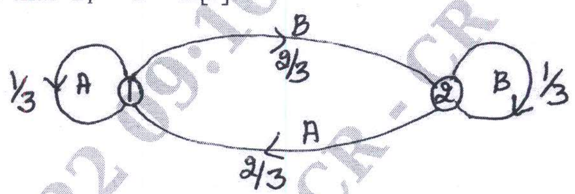

Fig.Q2(b) **(10 Marks)**

Module-2

3 a. Explain the important properties of codes to be considered while encoding a source. **(07 Marks)**

b. Explain how do you test for instantaneous property. **(03 Marks)**

c. Construct binary code for the following source using Shannon's binary encoding procedure $S = \{S_1, S_2, S_3, S_4, S_5\}$, $P = \{0.4, 0.25, 0.15, 0.12, 0.08\}$. Find the coding efficiency. **(10 Marks)**

OR

4 a. Using Shannon Fano – coding, find code words for the probability distribution $[P = \frac{1}{4}, \frac{1}{4}, \frac{1}{8}, \frac{1}{8}, \frac{1}{16}, \frac{1}{16}, \frac{1}{16}]$ code word length efficiency. **(10 Marks)**

b. A discrete memory less source has an alphabet of seven symbols with probabilities as given in the table below :

Symbols	S_1	S_2	S_3	S_4	S_5	S_6	S_7
Prob	0.25	0.25	0.125	0.125	0.125	0.0625	0.0625

Compute Huffman code for this source by moving combined symbols as high as possible. Find efficiency of this code. **(10 Marks)**

Module-3

5 a. List the properties of mutual information. Prove that mutual information.

$$I[A,B] = H[A] - H\left[\frac{A}{B}\right] = H[B] - H\left[\frac{B}{A}\right]$$

$$I[A,B] = H[A] + H[B] - H\left[\frac{A}{B}\right].$$ **(10 Marks)**

b. Find H[A], H[B], H[A, B], $H\left[\frac{A}{B}\right]$ and $H\left[\frac{B}{A}\right]$ for the channel shown below :

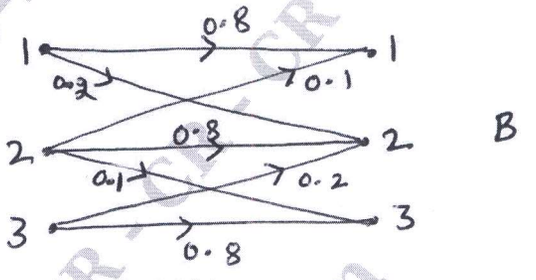

Fig.Q5(b)

$P[A_1] = \frac{1}{3}$, $P[A_2] = \frac{1}{3}$, $P[A_3] = \frac{1}{3}$. **(10 Marks)**

OR

6 a. State and explain Shannon Hartley law and its implications. **(08 Marks)**

b. An analog single has a 4 KHz band width. The signal is sampled at 2.5 times the Nyquist rate and each sample quantized into 256 equally likely levels. Assume that the successive samples are statistically independent.

i) Find the information rate of this source

ii) Can the output of this source be transmitted without errors over, a Gaussian channel of bandwidth 50KHz and S/N ratio of 20dB

iii) If the output of this source is to be transmitted without errors over an analog channel having S/N of 10dB compute the bandwidth requirement of the channel. **(12 Marks)**

Module-4

7 a. For A (6, 3) code find all the code vectors if the co-efficient matrix P is given by

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

i) Find code vector

ii) Implement the encoder

iii) Find the syndrome vector [S]

iv) Implement the syndrome circuit. **(10 Marks)**

b. Obtain the generator and parity check matrices for an (n, k) cyclic with $g(x) = 1 + x + x^3$. **(10 Marks)**

OR

8 a. For a (15, 5) binary cyclic code, generator polynomial is $g(x) = 1 + x + x^2 + x^4 + x^5 + x^8 + x^{10}$. Draw the encoder diagram and find the encoded output for a message $D[X] = 1 + X^2 + X^4$. **(12 Marks)**

b. If C is a valid code vector then prove that $CH^T = 0$ where H^T is transpose of check matrix H. **(08 Marks)**

Module-5

9 For a (3, 1, 2) convolutional encoder with generator sequences :

$g^{(1)} = 110, \quad g^{(2)} = 101, \quad g^{(3)} = 111.$

a. Find encoder block diagram
b. Find generator matrix and output for 11101
c. Find code word for 11101 using time domain method
d. Draw the state diagram and tree diagram. **(20 Marks)**

OR

10 Write short notes on :
a. Golay codes
b. Shortened cyclic
c. Burst error correcting codes
d. Burst and random error correcting codes. **(20 Marks)**

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