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10TE65

Sixth Semester B.E. Degree Examination, June/July 2019
Information Theory and Coding

Time: 3 hrs. Max. Marks:100

Note: *Answer any FIVE full questions, selecting at least TWO full questions from each part.*

PART – A

1 a. Define Entropy and Information Rate. **(04 Marks)**

b. A black and white TV picture consists of 525 lines of picture information. Assume each line consists of 525 picture elements and that each element can have 256 brightness levels. Pictures are repeated at the rate of 30 frames/sec. Calculate the average rate of information conveyed by a TV set to a viewer. **(06 Marks)**

c. Consider an information source modeled by a discrete ergodic Markoff random process shown in Fig.Q.1(c). Find the source entropy H and the average information content per symbol in messages containing one, two and three symbols i.e. Find G_1, G_2 and G_3. **(10 Marks)**

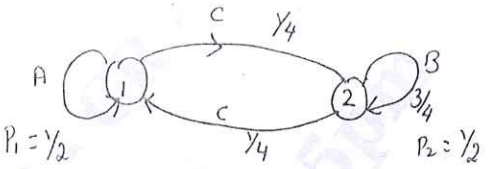

Fig.Q.1(c)

2 a. A source emits an independent sequence of symbols from an alphabet consisting of five symbols A, B, C, D and E with probabilities of 1/4, 1/8, 1/8, 3/16 and 5/16 respectively. Find the Shannon code for each symbol and efficiency of the coding scheme. **(08 Marks)**

b. For the channel matrix given in Q.2(b), find the channel capacity

$$P(b_j/a_i) = \begin{array}{c} \\ a_1 \\ a_2 \\ a_3 \end{array} \begin{array}{c} \begin{array}{ccc} b_1 & b_2 & b_3 \end{array} \\ \begin{bmatrix} 1/2 & 1/3 & 1/6 \\ 1/3 & 1/6 & 1/2 \\ 1/6 & 1/2 & 1/3 \end{bmatrix} \end{array}$$

Q.2(b) **(04 Marks)**

c. A transmitter has an alphabet consisting of 5 letters $\{a_1, a_2, a_3, a_4, a_5\}$ and the receiver has an alphabet of four letters $\{b_1, b_2, b_3, b_4\}$. The joint probabilities of the system are given below.

$$P(A,B) = \begin{array}{c} \\ a_1 \\ a_2 \\ a_3 \\ a_4 \\ a_5 \end{array} \begin{array}{c} \begin{array}{cccc} b_1 & b_2 & b_3 & b_4 \end{array} \\ \begin{bmatrix} 0.25 & 0 & 0 & 0 \\ 0.10 & 0.3 & 0 & 0 \\ 0 & 0.05 & 0.10 & 0 \\ 0 & 0 & 0.05 & 0.1 \\ 0 & 0 & 0.05 & 0 \end{bmatrix} \end{array}$$

Compute different entropies of this channel. **(08 Marks)**

3 a. Design a quarternary and 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 = {9/32, 3/32, 3/32, 2/32, 9/32, 3/32, 3/32} X = {0, 1, 2, 3} and X = {0, 1}. And find coding efficiency. **(14 Marks)**

b. Show that mutual information of a channel is symmetric. **(06 Marks)**

4 a. Consider a continuous random variable Y defined by Y = X + N where X and N are statistically independent. Show that the conditional differential entropy of Y, given X is H(Y/X) = H(N). Where H(N) is the differential entropy of N. (08 Marks)

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

i) Find the average information per character.
ii) Find capacity of the channel
iii) Find maximum rate at which data can be sent from terminal to the computer without error. (08 Marks)

c. State and explain Shannon Hartley law. (04 Marks)

PART – B

5 a. Explain matrix representation of linear block codes. (06 Marks)

b. Consider a (6,3) linear code whose generator matrix is

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

i) Find all code vectors
ii) Find all the Hamming weights and distances
iii) Find minimum weight purity check matrix
iv) Draw the encoder circuit for the above codes. (14 Marks)

6 a. List the properties of cyclic codes and explain each briefly. (04 Marks)

b. For the (7, 4) single error correcting cyclic code, $D(x) = d_0 + a_1x + d_2x^2 + d_3x^3$ and $x^n + 1 = x^7 + 1 = (1 + x + x^3)(1 + x + x^2 + x^4)$. Using the generator polynomial $g(x) = 1 + x + x^3$, Find all possible code vectors of the cyclic code in systematic form. (06 Marks)

c. The generator polynomial for a (15, 7) cyclic code is $g(x) = 1 + x^4 + x^6 + x^7 + x^8$

i) Find the code vector in systematic form for the message $D(x) = x^2 + x^3 + x^4$.
ii) Assume that the first and last hit of the code vector V(x) For $D(x) = x^2 + x^3 + x^4$ suffer transmission errors. Find the syndrome of V(x). (10 Marks)

7 Write short notes on:

a. Burst Error Correcting code
b. BCH code
c. Golay code
d. Shortened cyclic code. (20 Marks)

8 Consider the convolutional encoder shown in Fig.Q.8. The code is systematic.

i) Draw the state diagram
ii) Draw the code tree
iii) Find the encoder output produced by the message sequence 10111
iv) Verify the output using time domain approach.

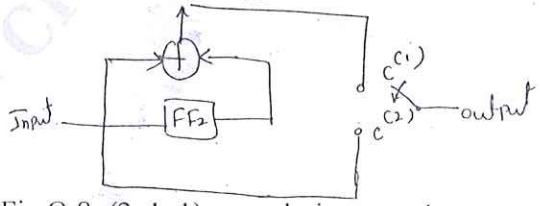

Fig.Q.8: (2, 1, 1) convolution encoder. (20 Marks)

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