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06EC65

Sixth Semester B.E. Degree Examination, Dec.2016/Jan.2017
Information Theory and Coding

Time: 3 hrs. Max. Marks:100

Note: *1. Answer any FIVE full questions, selecting atleast TWO questions from each part.*
2. Missing data, if any, may be suitably assumed.

PART – A

1 a. Define self, mutual and average information. Write a note on atleast 3 units of self information. Also show that 1 Hartley = 3.32 bits and 1 Nat = 1.44 bits. **(10 Marks)**

b. In a conventional telegraphic source, if you assume dash is 3 times as long as a dot and half as probable, calculate the self information in a dot and dash, entropy of the telegraphic source and also the average information rate if dot lasts for 3 ms. **(10 Marks)**

2 a. List necessary and sufficient conditions for maximization of entropy for a discrete memoryless information source. Also obtain an expression for maximum entropy of such a source. **(10 Marks)**

b. For the Markov's source illustrated in the state diagram shown in Fig.Q2(b), compute the following :

i) State probability ii) Entropy of each state iii) Entropy of the source. **(10 Marks)**

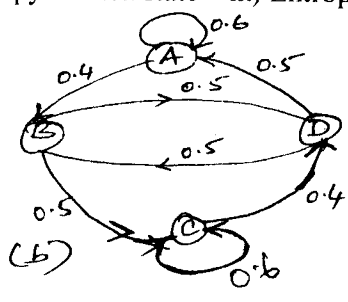

Fig.Q2(b)

3 a. Given a discrete source S_n emitting symbols S_1 , S_2 , S_3 and S_4 with respective probabilities 0.4, 0.3, 0.2 and 0.1 respectively. Encode the source using Shannon's binary encoding algorithm. Also perform the same for the 2[nd] extension of this source. In each case compute efficiency of the code and comment on the result. **(10 Marks)**

b. Given a discrete memoryless source x, comprising of symbols x_1 , x_2 , x_3 , x_4 , x_5 and x_6 receiving with probabilities 0.2, 0.1, 0.4, 0.15, 0.05 and 0.1 respectively. Obtain Huffman's minimum redundancy ternary codes for the same by

i) keeping the composite symbol as high as possible.

ii) keeping the composite symbol as high as possible.

In each case compute variance and also code efficiency. Compare and comment on the result. **(10 Marks)**

4 a. Channel matrix of a discrete communication channel is given below. Compute H(x), H(y), H(x/y), H(y/x), H(x, y) and I(x ; y) for the same.

$$P(y/x) = \begin{bmatrix} 0.4 & 0.3 & 0.3 \\ 0.1 & 0.7 & 0.2 \\ 0.2 & 0.2 & 0.6 \end{bmatrix}$$

Given $p(x_1) = p(x_2) = \frac{1}{4}$ and $p(x_3) = 1/2$ **(10 Marks)**

b. Two noisy channels are cascaded as shown below in Fig.Q4(b). Given $p(x_1) = p(x_2) = \frac{1}{2}$, find the overall mutual information I(x, z). **(10 Marks)**

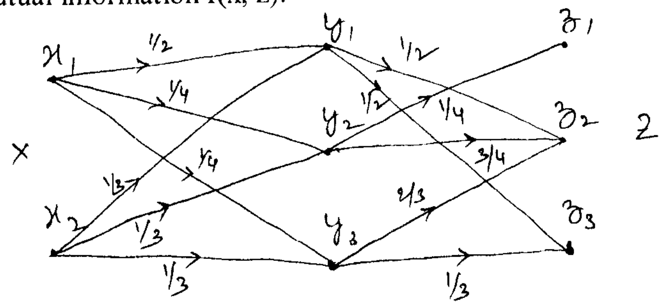

Fig.Q4(b)

PART – B

5 a. State and prove Shannon-Hartley theorem on channel capacity for continuous channel. Also show the C = 1.44 S/N if bandwidth tends to infinity, where C is the channel capacity, S is the symbol power and N is the noise power. **(10 Marks)**

b. A CRT terminal is used to inter alpha-numeric data into a computer through voice grade telephone line of bandwidth 3 kHz. If the output SNR = 10 db and the terminal has 128 characters, assume that the data sent from the terminal consists of sequences of equiprobable characters find the following :

i) Channel capacity

ii) Average information / character

iii) Maximum rate at which data can be transmitted from terminal to compute without errors. **(10 Marks)**

6 a. The generator matrix G for a (6, 3) linear block code is illustrated below. Find all valid code vectors of this code. Also if it is given that the received vector for this system is obtained as R_1 = 100000 and R_2 = 100111, using Syndrome method detect and correct errors, if any.

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

(10 Marks)

b. The Generator matrix for a (7, 4) linear block code is listed below. Construct a standard array for the same. Also illustrate how the following received vectors will be decoded using this method.

i) R_1 = 1100011 ii) R_2 = 1001100 iii) R_3 = 1000101

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

(10 Marks)

7 a. For a (15, 5) cyclic code, the generator polynomial is given as

$$g(x) = 1 + x + x^3 + x^4 + x^6 + x^8 + x^{10}$$

i) Draw the block diagram of an encoder and a decoder for the same.

ii) For a message polynomial $D(x) = 1 + x^2 + x^4$ find code polynomial in systematic form.

iii) Is $V(x) = 1 + x^5 + x^6 + x^8 + x^{14}$ a valid code polynomial? **(10 Marks)**

b. For the convolutional encoder shown in the Fig.Q7(b), if the information sequence is given as d = 10111, find the output sequence using both (i) Time domain approach as wells (ii) Transfer domain approach. **(10 Marks)**

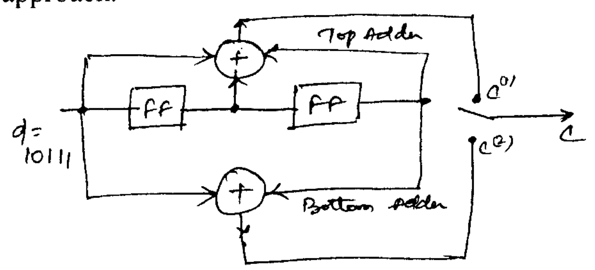

Fig.Q7(b)

8 Write short notes on :

a. BEC – Binary Erasure Channel
b. BCH Codes
c. Golay codes
d. RS codes
e. Shannon's limit with respect to Continuous channels. **(20 Marks)**

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