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06EC65

Sixth Semester B.E. Degree Examination, Dec.2017/Jan.2018

Information Theory and Coding

Time: 3 hrs. Max. Marks:100

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

PART – A

1 a. Define the following terms with respect to information theory:
i) Symbol rate ii) Self information iii) Source efficiency **(06 Marks)**

b. Consider a discrete memoryless source with source alphabets S = {s_0, s_1, s_2} with source probabilities {0.5, 0.3, 0.2}. Calculate:
i) Entropy of the source (bits/symbol)
ii) Entropy of the second order extension of the source
iii) List all the elements for second extension of this source. **(06 Marks)**

c. For the first order Markov source shown in Fig.Q1(c), calculate the state probabilities, the entropy of the states A, B, and C and the entropy of the source.

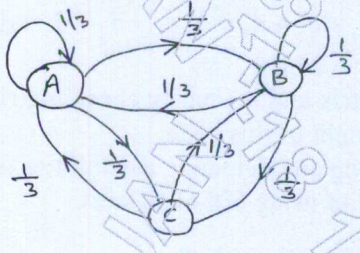
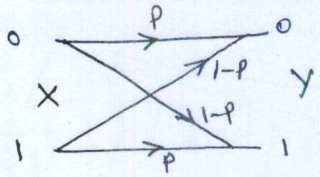


Fig.Q1(c) **(08 Marks)**

2 a. Explain the following terms with respect to source coding: (i) Non-singular code; (ii) Optimal code; (iii) Uniquely decodable codes. **(06 Marks)**

b. The technique used in constructing a source encoder consists of arranging the messages in decreasing order of probability and dividing the messages into two almost equally probable groups. The messages in the first group are given the bit 0 and the messages in the second group are given the bit 1. The procedure is now applied again for each group separately, and continued untill no further division is possible. Using this algorithm, find the code words for six messages occurring with probabilities $\frac{1}{3}, \frac{1}{3}, \frac{1}{6}, \frac{1}{12}, \frac{1}{24}, \frac{1}{24}$. **(06 Marks)**

c. A binary symmetric channel is shown in Fig.Q2(c), find the rate of information transmission over this channel when P = 0.9 and 0.6. Assume γ_s = 2000/sec. **(08 Marks)**



$P(X = 0) = \frac{1}{2}$

$P(X = 1) = \frac{1}{2}$

Fig.Q2(c)

3 a. Prove that I(A, B) = H(A) – H(A/B). **(06 Marks)**

b. A discrete source (memory less) with S ={s_1, s_2, s_3, s_4, s_5}, P = {0.55, 0.15, 0.15, 0.10, 0.05}. Construct Huffman binary code by placing the composite symbol as low as possible.
i) Repeat (i) by moving the composite symbol as high as possible.
ii) In each of the cases (i) and (ii) above compute the variance of the word length and comment on the result. **(08 Marks)**

c. For the channel matrix shown, find the channel capacity. Assume $\gamma_s = 2000$ bits/sec.

$$P(Y/X) = \begin{bmatrix} 0.5 & 0.2 & 0.3 \\ 0.2 & 0.3 & 0.5 \\ 0.3 & 0.5 & 0.2 \end{bmatrix}$$ **(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. **(06 Marks)**

b. A CRT terminal is used to enter alphanumeric data into a computer. The CRT is connected to the computer through a voice grade telephone line having a usable bandwidth of 3000 Hz and an output S/N of 10 dB. Assume that the terminal has 128 characters and that the data sent from the terminal consists of independent sequence of equiprobable characters.

i) Find the capacity of the channel.

ii) Find the maximum rate at which data can be transmitted from the terminal to the computer without errors. **(06 Marks)**

c. State Shannon-Hartley law and discuss the implications of its. **(08 Marks)**

PART – B

5 a. What are the advantages and disadvantages of error control coding? **(04 Marks)**

b. What is the use of generator matrix (G) and parity check matrix (H)? **(04 Marks)**

c. The parity check bits of a (8, 4) block code are generated by $c_5 = d_1 + d_2 + d_4$; $c_6 = d_1 + d_2 + d_3$; $c_7 = d_1 + d_3 + d_4$; $c_8 = d_2 + d_3 + d_4$ where d_1, d_2, d_3 and d_4 are the message bits.

i) Find the generator matrix and the parity check matrix for this code.

ii) Find the minimum weight of this code.

iii) Find the error correcting and detecting capabilities of this code.

iv) Draw the encoder circuit using EX-OR Gates. **(12 Marks)**

6 a. What are the advantages of cyclic codes? **(02 Marks)**

b. Explain the operation of a syndrome calculation circuit for a (n, k) cyclic code using shift register. **(06 Marks)**

c. A (15, 5) linear cyclic code has a generator polynominal

$$g(x) = 1 + x + x^2 + x^4 + x^5 + x^8 + x^{10}$$

i) Draw block diagrams of an encoder and syndrome calculator for this code.

ii) Is $V(x) = 1 + x^4 + x^6 + x^8 + x^{14}$ a code polynominal? If not find the syndrome of V(x). **(12 Marks)**

7 a. What are the applications of RS codes? **(05 Marks)**

b. Explain the following codes: (i) Golay codes; (ii) Shortened codes; (iii) Burst error correcting codes. **(15 Marks)**

8 a. How convolutional codes are different from block codes? **(04 Marks)**

b. Consider the (2, 1, 2) convolution encoder shown in Fig.Q8(b).

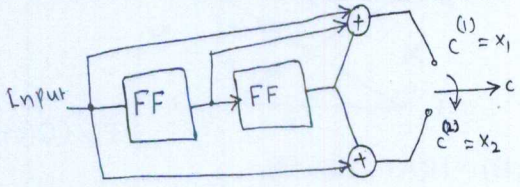


Fig.Q8(b)

i) Write the impulse response of the system.

ii) Find the o/p corresponding to input message (10111) using time domain approach.

iii) Write the code tree to calculate the response for the input (1011). **(16 Marks)**

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