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10EC55

Fifth 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 atleast TWO questions from each part.***

PART – A

1 a. A source emits one of the four probable messages m_1, m_2, m_3 and m_4 with probabilities 3/11, 2/11, 2/11 and 4/11 respectively. Find the entropy of the source and show that for the second order extension of the source $H(S^2) = 2\ H(S)$ by listing the symbols of second extended source along with their probabilities. **(10 Marks)**

b. A certain data source has 8 symbols that are produced in blocks of four at a rate of 500 blocks/sec. The first symbol in each block is always the same for synchronization. The remaining three symbols are filled by any of the 8 symbols with equal probability. Find entropy rate of this source. **(06 Marks)**

c. Explain the block diagram of an information system. **(04 Marks)**

2 a. Explain the steps in the Shannon's encoding algorithm for generating binary code. **(04 Marks)**

b. Show that $H(X, Y) = H(Y) + H(X/Y)$. **(04 Marks)**

c. The state diagram of the mark off source is as shown in the Fig.Q2(c).

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 $H(S) < H(\bar{S})$. **(12 Marks)**

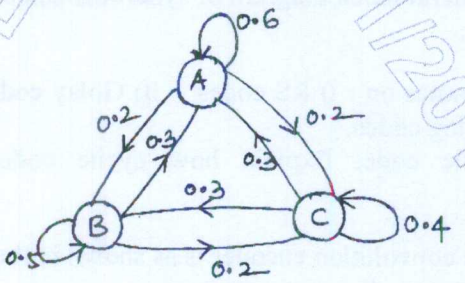

Fig.Q2(c)

3 a. A discrete memoryless source has an alphabet of seven symbols with probabilities for its output as $S = \{S_1, S_2, S_3, S_4, S_5, S_6, S_7\}$; $P = \{0.25, 0.25, 0.125, 0.125, 0.125, 0.0625, 0.0625\}$; $x = \{0, 1\}$, compute the Huffman code for this source, moving the composite symbol as high as possible. Explain why the computed source code has an efficiency of 100%. **(12 Marks)**

b. Prove that the mutual information of the channel is symmetric. **(04 Marks)**

c. Define priori entropy, posteriori entropy, equivocation and mutual information. **(04 Marks)**

4 a. Two noisy channels are cascaded whose channel matrices are given by :

$$P(Y/X) = \begin{bmatrix} 1/5 & 1/5 & 3/5 \\ 1/2 & 1/3 & 1/6 \end{bmatrix} \quad P(Z/Y) = \begin{bmatrix} 0 & 3/5 & 2/5 \\ 1/3 & 2/3 & 0 \end{bmatrix}$$

With $P(x_1) = P(x_2) = 1/2$. Find the overall mutual information I(X,Z) and show that I(X, Y) > I(X, Z). **(12 Marks)**

b. Alphanumeric data are entered into a computer from a remote terminal through a voice - grade telephone channel. The channel has a bandwidth of 3.2KHz and output signal to noise ratio of 20dB. The terminal has a total of 256 symbols. Assume that the symbols are equiprobable and the successive transmissions are statistically independent.

i) Calculate channel capacity
ii) Find the average information content per character
iii) Calculate the maximum symbol rate for which error free transmission over the channel is possible. **(08 Marks)**

PART – B

5 a. Design a systematic (4, 2) linear block code :

i) Find the generator matrix [G] and parity check matrix [H]
ii) Find all possible code vectors
iii) Write the standard array
iv) What are the error detecting and correcting capabilities of the code?
v) Draw the encoding circuit
vi) Draw the syndrome calculating circuit. **(14 Marks)**

b. Draw the general encoding circuit for (n, k) linear block code and explain its operation. **(06 Marks)**

6 a. Consider (15, 5) cyclic code generated by polynomial $g(x) = 1 + x + x^2 + x^4 + x^5 + x^8 + x^{10}$.

i) Draw the block diagram of an encoder and syndrome calculator for this code
ii) Find the code polynomial for the message polynomial $D(x) = 1 + x^2 + x^4$ in systematic form.
iii) Is $V(x) = 1 + x^4 + x^6 + x^8 + x^{14}$ a code polynomial? **(12 Marks)**

b. Draw the general block diagram of syndrome calculation circuit for cyclic codes and explain its operation. **(08 Marks)**

7 a. Write short notes on : i) RS codes ii) Golay codes iii) Shortened cyclic codes iv) Burst error correcting codes. **(15 Marks)**

b. Define cyclic code. Explain how cyclic codes are generated from the generating polynomials. **(05 Marks)**

8 a. Consider the convolution encoder is as shown in the Fig. Q8(a).

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 (matrix method). **(14 Marks)**

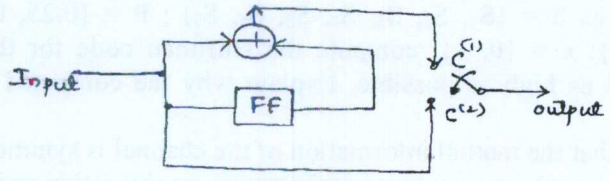

Fig.Q8(a)

b. Explain encoding of convolution codes using time domain approach with an example. **(06 Marks)**

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