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06EC65

Sixth Semester B.E. Degree Examination, June/July 2017
Information Theory and Coding

Time: 3 hrs. Max. Marks:100

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

PART – A

1 a. Show that the entropy of the following probability distribution is $\left[2-\left(\frac{1}{2}\right)^{n-2}\right]$ **(08 Marks)**

x	x_1	x_2	.....	x_i	.....	x_{n-1}	x_n
P(X-x)	$\frac{1}{2}$	$\frac{1}{4}$	.....	$\frac{1}{2^i}$	.....	$\frac{1}{2^{n-1}}$	$\frac{1}{2^{n-1}}$

b. Consider the first order Markov source of Fig. Q1 (b). For this source verify $G_1 > G_2 > G_3 > H(s)$ **(12 Marks)**

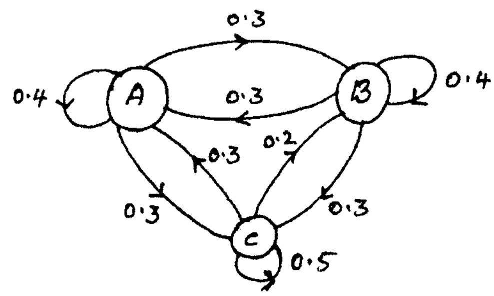

Fig. Q1 (b)

2 a. Suppose S_1 and S_2 are 2 zero memory sources with probabilities $P_1, P_2, \ldots P_n$ for source S_1 and $q_1, q_2, \ldots q_n$ for source S_2. Show that the entropy of source S_1.

$$H(S_1) \le \sum_{k=1}^{n} P_K \log \frac{1}{q_K}$$ **(10 Marks)**

b. A certain data source has 8 symbols that are produced in blocks of 4 at a rate of 500 blocks/sec. The first symbol in each block is always the same. The remaining three are filled by any of the 8 symbols with equal probability. What is the entropy rate of this source? **(05 Marks)**

c. Derive the relation between Hartley, rats and bits. **(05 Marks)**

3 a. Briefly explain the various channels available for communication system. **(04 Marks)**

b. A source having an alphabet $S = \{S_1\ S_2\ S_3\ S_4\ S_5\}$ produces symbols with probabilities $\frac{1}{2}, \frac{1}{6}, \frac{1}{6}, \frac{1}{9}, \frac{1}{18}$. Find code efficiency and redundancy when coded as code-T.

Code T
$l_1 = 1$
$l_2 = 2$
$l_3 = 3$
$l_4 = 4$
$l_5 = 4$

(06 Marks)

c. You are given 4 messages $x_1\ x_2\ x_3$ and x_4 with respective probabilities 0.1, 0.2, 0.3, 0.4 (i) device a code with prefix property and draw the code tree (ii) calculate efficiency and redundancy (iii) probability of 0's and 1's in the code. **(10 Marks)**

4 a. Define mutual information and prove that the average mutual information is always non negative. (08 Marks)

b. Compute the channel capacity of a channel whose noise characteristics is given below:

$$P\left[\frac{b_j}{a_i}\right] = \begin{bmatrix} \frac{1}{2} & \frac{1}{3} & \frac{1}{6} \\ \frac{1}{3} & \frac{1}{6} & \frac{1}{2} \\ \frac{1}{6} & \frac{1}{2} & \frac{1}{3} \end{bmatrix}.$$ (06 Marks)

c. A black and white television picture may be viewed as consisting of approximately 3×10^5 elements. Each one of which may occupy one of 10 distinct brightness levels with equal probabilities, assume rate of transmission is 30 picture frames per second and signal T_0 noise ratio is 30 dB. Calculate the minimum band width required to support the transmission of the resultant video signal. (06 Marks)

PART – B

5 a. List the properties of cyclic codes. (05 Marks)

b. For a (x, K) block code, if C is a valid code vector. Show that $CH^T = 0$, where H^T is the transpose of the parity check matrix H. (05 Marks)

c. The parity check bits of a (8, 4) linear block code are generated using the relations $C_5 = d_1 \oplus d_2 \oplus d_4$, $C_6 = d_1 \oplus d_2 \oplus d_3$, $C_7 = d_1 \oplus d_3 \oplus d_4$, $C_8 = d_2 \oplus d_3 \oplus d_4$, (i) Find the minimum weight of this code, (ii) Error correcting capabilities of this code (iii) The generator and parity check matrix (iv) Show that this code can detect three errors, with example. (10 Marks)

6 a. A (5, 1) repetition code has the generator matrix G = [1' 1 1 1 1], (i) Write its parity check matrix H (ii) Construct the standard array with a column for syndromes of the coset leaders. (06 Marks)

b. Explain the various methods for controlling error. (04 Marks)

c. A (15, 5) linear cyclic code has a generator polynomial $g(x) = 1 + x + x^2 + x^4 + x^5 + x^8 + x^{10}$ Draw the block diagram of a systematic encoder and explain its operation for a message polynomial $U(x) = 1 + x^2 + x^4$. Listing clearly contents of the registers at each step. (10 Marks)

7 a. Consider the convolutional encoder. The code is systematic draw the state diagram, draw the code tree. Find the encoder output produced by the message sequence 10111. Verify the output using time domain approach (matrix method). (10 Marks)

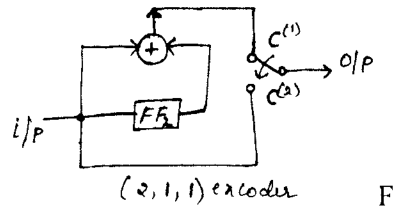

Fig. Q7 (a)

b. A triple error correcting (23, 12) golay code may be constructed with the generating polynomial $g(x) = x^{11} + x^9 + x^7 + x^6 + x^5 + x + 1$. Find the parity check polynomial h(x) Construct a decoder for the code. (10 Marks)

8 Briefly explain (i) Cascading of channels (ii) Standard array (iii) Shannon's Hartley law (iv) Rud Soloman code. (20 Marks)

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