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10TE65

Sixth Semester B.E. Degree Examination, Dec.2019/Jan.2020
Information Theory & Coding

Time: 3 hrs. Max. Marks:100

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

PART – A

1 a. An analog signal is bandlimited to 4 kHz. It is sampled at 2.5 times an Nyquist rate and each sample is quantized at 256 levels. These levels are equally likely to occur. The samples are assumed to be statistically independent. Find information rate of the sampled signal. **(06 Marks)**

b. Derive an expression for average information content of long independent message. **(04 Marks)**

c. Given the model of a Mark off source as shown in Fig. Q1 (c). Calculate (i) state probability (ii) Entropy of first order and second order source (iii) G_1 and G_2 (iv) Efficiency and redundancy of first order. **(10 Marks)**

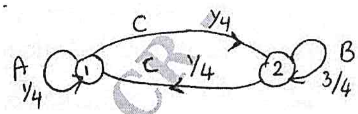

Fig. Q1 (c)

2 a. Explain the important properties of codes while encoding a source. **(06 Marks)**

b. Consider the following discrete source $S = \{S_1, S_2, S_3, S_4, S_5\}$, $P = \{0.4, X, 0.15, 0.12, 0.08\}$
(i) Determine X (ii) Using Shannon's binary encoding procedure construct the code. **(08 Marks)**

c. Show that $H(X,Y) = H(X/Y) + H(Y)$. **(06 Marks)**

3 a. Design a quarternary and binary source code for the source shown using Huffman's coding procedure. $S = \{S_1, S_2, S_3, S_4, S_5, S_6, S_7\}$, $P = \left\{\frac{9}{32}, \frac{3}{32}, \frac{3}{32}, \frac{2}{32}, \frac{9}{32}, \frac{3}{32}, \frac{3}{32}\right\}$, $X = \{0, 1, 2, 3\}$ and $X = \{0, 1\}$. Find code efficiency. **(10 Marks)**

b. The input to the channel consists of 5 letters $X = \{X_1, X_2, X_3, X_4, X_5\}$ and output consists four letters $Y = \{Y_1, Y_2, Y_3, Y_4\}$. The JPM of this channel is given. Compute

- (i) H(X) (ii) H(Y) (iii) H(X,Y) (iv) $H(X/Y)$ (v) $H(Y/X)$ (vi) I(X, Y)
- Rate of data transmission given $r_s = 1000$ symbols/sec and channel capacity. **(10 Marks)**

4 a. Derive an expression for channel capacity of a binary erasure channel. **(06 Marks)**

b. State Shannon-Hartley law for channel capacity and illustrate the implications. **(08 Marks)**

c. Alphanumeric data are entered into a computer from a remote terminal through a voice grade telephone channel. The channel has a bandwidth of 3.4 kHz and output SNR of 20 dB. The terminal has a total of 128 symbols. Assume that the symbol are equiprobable and the successive transmissions are statistically independent.
(i) Calculate channel capacity.
(ii) Find average information content per character.
(iii) Calculate the maximum symbol rate for which error free transmission over the channel is possible. **(06 Marks)**

Important Note : 1. On completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages.
2. Any revealing of identification, appeal to evaluator and /or equations written eg, 42+8 = 50, will be treated as malpractice.

PART – B

5 a. Explain the matrix representation of linear block codes. **(04 Marks)**

b. Consider the systematic (7, 4) linear block code, the parity check matrix is given,

$$P = \begin{bmatrix} 1 & 1 & 1 \\ 1 & 1 & 0 \\ 1 & 0 & 1 \\ 1 & 1 & 1 \end{bmatrix}.$$

(i) Find all possible code vectors.

(ii) Draw encoding circuit.

(iii) A single bit error has occurred in each of the following code words given $R_A = [0111110]$, $R_B = [1011100]$ detect and correct these errors.

(iv) Draw syndrome computation circuit. **(12 Marks)**

c. Test hamming bound of (7, 4) hamming code and show that it is perfect code. **(04 Marks)**

6 a. For a (7, 4) cyclic code the received vector $Z(x) = 1110101$ and the generator polynomial is $g(x) = 1 + x + x^3$. Draw the syndrome calculation circuit and correct the signal error in the received vector. **(10 Marks)**

b. The generator polynomial of a (15, 7) cyclic code is $g(x) = 1 + x^4 + x^6 + x^7 + x^8$. Find the code word in systematic form for the message (0 1 0 1 0 1 0). Explain the steps and list the states of registers in each step of code. Verify the answer by direct hand calculation. **(10 Marks)**

7 Write short notes on :

a. Shortened cyclic codes.

b. Golay codes.

c. BCH codes.

d. RS codes. **(20 Marks)**

8 For a (2, 1, 3) convolution encoder with $g^{(1)} = [1101]$, $g^{(2)} = [1011]$.

a. Draw the convolutional encoder block diagram.

b. Write down the state transition table.

c. Draw the code tree.

d. Find the encoder output produced by message sequence "11101" by traversing through the code tree. **(20 Marks)**

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