USN | | | | | | | | | |  **10EC55**

## Fifth Semester B.E. Degree Examination, June/July 2018
# Information Theory and Coding

Time: 3 hrs. Max. Marks:100

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

## PART – A

1 a. Define :
   i) Self information
   ii) Rate of source
   iii) Entropy of source. **(06 Marks)**

b. Output of an information source consists of 128 symbols 16 of which occur with a probability of 1/32 and the remaining occur with a probability of 1/224. The source emits 1000 symbols/sec. Assuming that the symbols are chosen independently. Find the average information rate of the source. **(04 Marks)**

c. The state diagram of Markov source is given in Fig.Q1(c) : $P_i = \frac{1}{3}$ ; for i = 1, 2, 3
   i) Find the entropy of each state $H_i$(i = 1, 2, 3)
   ii) Find entropy of the source H
   iii) Find $G_1$ and $G_2$ and show that $G_1 \geq G_2 \geq H$. **(10 Marks)**

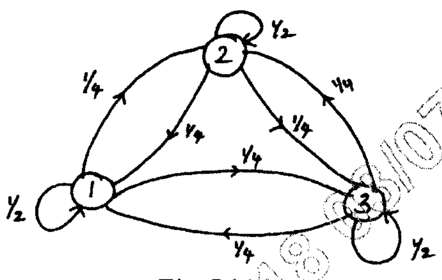

Fig.Q1(c)

2 a. Write Shannon's encoding algorithm. **(04 Marks)**

b. Apply Shannon's encoding algorithm to the following messages :

| $S_1$ | $S_2$ | $S_3$ |
|---|---|---|
| 0.5 | 0.3 | 0.2 |

   i) Find code efficiency and redundancy
   ii) If the same technique is applied to the 2nd order extension of this source, how much will the code efficiency be improved? **(08 Marks)**

c. An analog has 4KHz bandwidth. The signal is sampled at 2.5 times the Nyquist rate and each sample is quantized into 256 equally likely levels. Assume that the successive samples are stastically independent :
   i) Find the information rate of this source
   ii) Can output of this source be transmitted without errors over a Guassian channel for bandwidth 50Hz and S/N ratio of 26dB
   iii) If the output of this source is to be transmitted without errors over an analog channel having S/N ratio of 16dB, compute the bandwidth requirement of the channels. **(08 Marks)**

3 a. Write Huffman encoding procedure for obtaining compact code with least redundancy. **(04 Marks)**

b. Given 8 symbols source with probabilities
$P = \{0.25, 0.20, 0.15, 0.15, 0.10, 0.05, 0.05, 0.05\}$
Construct two binary Huffman coding as described below :
 i) Place the composite symbol as low as possible
 ii) Place the composite symbol as high as possible
In each case determine the code word and efficiency. **(08 Marks)**

c. The noise characteristics of a channel is as shown in Fig.Q3(c). Find the channel capacity (Using Muroga's method). **(08 Marks)**

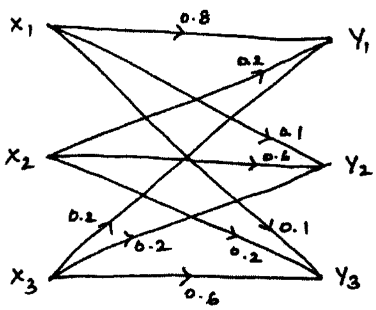


Fig.Q3(c)

4 a. List the properties of mutual information and prove the following :
 i) $I(X ; Y) = I(Y ; X)$
 ii) $I(X ; Y) \geq 0$. **(08 Marks)**

b. Two noisy channels are cascaded whose channel matrix are given by :

$$P\left(\frac{y}{x}\right) = \begin{bmatrix} 1/6 & 1/6 & 2/3 \\ 1/2 & 1/4 & 1/4 \end{bmatrix}, \quad P\left(\frac{z}{y}\right) = \begin{bmatrix} 1/2 & 1/2 & 0 \\ 1/3 & 2/3 & 0 \\ 0 & 1/3 & 2/3 \end{bmatrix}$$

With $P(x_1) = P(x_2) = \frac{1}{2}$. Find : i) $I(x ; y)$ ii) $I(x ; z)$. **(12 Marks)**

## PART – B

5 a. What are the methods of controlling errors? Explain. **(04 Marks)**

b. Mention types of errors and explain. **(04 Marks)**

c. The parity check bits of a (7, 4) Hamming code are generated by :

$C_5 = d_1 \oplus d_3 \oplus d_4$

$C_6 = d_1 \oplus d_2 \oplus d_3$

$C_7 = d_2 \oplus d_3 \oplus d_4$

Where $d_1$, $d_2$, $d_3$ and $d_4$ are message bits.
 i) Find generator matrix [G] and parity check matrix[H]
 ii) Prove that $GH^T = 0$
 iii) The (n, k) linear block code so obtained has a dual code. This dual code is a (n, n - k) code having a generator matrix H and parity check matrix G. Determine the eight code vectors of the dual code for (7, 4) Hamming code described above
 iv) Find the minimum distance of the dual code determined in part(iii). **(12 Marks)**

6 a. Explain the operation of an encoder using (n, k) bit shift register. **(04 Marks)**

b. Design the encoder for the (7, 4) cyclic code generated by generator polynomial $G(P) = P^3 + P + 1$ and verify this operation for message vector M = 1100. **(04 Marks)**

c. For a systematic (7, 4) linear block code the parity matrix P is given by

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

i) Find all Possible valid code vectors
ii) Draw the corresponding encoding circuit
iii) A single error has occurred in each of this received vectors. Detect and correct those errors.
$Y_A$ = 0111110
$Y_B$ = 1011100
$Y_C$ = 1010000
iv) Draw the syndrome calculation circuit. **(12 Marks)**

7 Write an explanatory note on following :
a. R.S codes
b. Golay codes
c. Shortened cyclic codes
d. Burst error correcting codes. **(20 Marks)**

8 Consider the (3, 1, 2) convolution code with impulse response $g^{(1)}$ = 110, $g^{(2)}$ = 101, $g^{(3)}$ = 111
a. Draw the encoder block diagram
b. Find generator matrix
c. Find the codeword corresponds to the message sequence 11101 using :
i) Time domain approach
ii) Transform domain approach. **(20 Marks)**

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