USN | | | | | | | | | | 10TE65

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. Derive the expression for the average information content (entropy) of symbols in long independent sequences. **(05 Marks)**

b. A zero memory source has a source alphabet $S = \{s_1, s_2, s_3\}$ with $P = \left\{\frac{1}{2}, \frac{1}{4}, \frac{1}{4}\right\}$. Find the entropy of the source. Also determine the entropy of its 2[nd] extension and verify $H(S^2) = 2H(S)$. **(07 Marks)**

c. For the mark off source shown in Fig.Q1(c), find the entropy H_A, H_B, H_C and source entropy H.

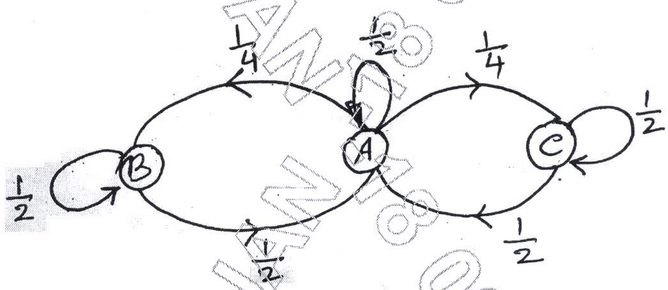

Fig.Q1(c) **(08 Marks)**

2 a. For the Fig.Q2(a) shown below, find the entropy of each state and hence the entropy of the source.

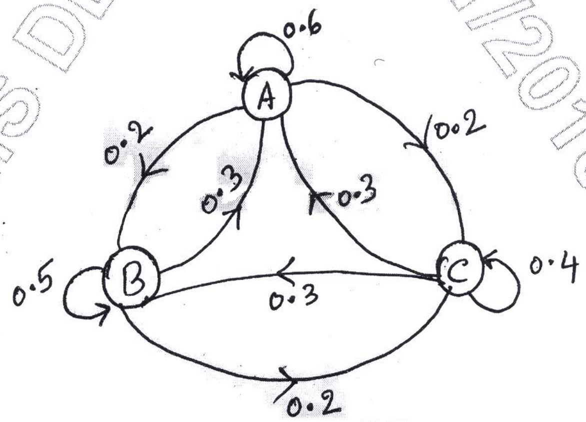

Fig.Q2(a) **(10 Marks)**

b. Write the steps involved in Shannon's encoding algorithm. **(04 Marks)**

c. Apply Shannon's binary encoding algorithm for the following messages, find the efficiency and redundancy of the code. **(06 Marks)**

s_1	s_2	s_3
0.5	0.3	0.2

3 a. Construct a Shannon fano ternary code for the following ensemble and find code efficiency and redundancy. Also draw the corresponding code tree.
$S = \{s_1, s_2, s_3, s_4, s_5, s_6, s_7\}$
$P = \{0.3, 0.3, 0.12, 0.12, 0.06, 0.06, 0.04\}$ with $X\{0, 1, 2\}$ **(10 Marks)**

b. Show that $H(X,Y) = H\left(\frac{X}{Y}\right) + H(Y)$. **(04 Marks)**

c. For the joint probability matrix shown below, compute H(X), H(Y) and H(X, Y).

$$P(X,Y) = \begin{bmatrix} 0.05 & 0 & 0.2 & 0.05 \\ 0 & 0.1 & 0.1 & 0 \\ 0 & 0 & 0.2 & 0.1 \\ 0.05 & 0.05 & 0 & 0.1 \end{bmatrix}$$

(06 Marks)

4 a. Find the capacity of the discrete channel shown in Fig.Q4(a) using Muroga's method.

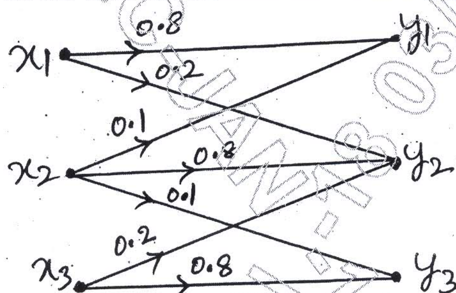

Fig.Q4(a) **(10 Marks)**

b. 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 level with equal probability. Assume the rate of transmission is 30 picture frames per second and the SNR is 30 dB. Using Shannon Hartley law, calculate the minimum bandwidth required to support the transmission of the resultant video signal. **(10 Marks)**

PART – B

5 a. Define hamming weight, hamming distance and minimum distance with respect to the code vector. **(03 Marks)**

b. For a (6, 3) linear code the generator matrix is

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

i) Find the code vector for the message (110).
ii) Find the minimum weight parity check matrix.
iii) Draw the encoder circuit. **(10 Marks)**

c. For the (6, 3) code, the parity matrix is given by

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

The received code vector is R = [110010]. Detect and correct the single error that has occurred due to noise. **(07 Marks)**

6 a. The generator polynomial for a (15, 7) cyclic code is $g(x) = 1 + x^4 + x^6 + x^7 + x^8$.

i) Find the code vector in systematic form for the message $D(x) = x^2 + x^3 + x^4$.

ii) Assume that the first and last bit of the code vector V(x) for $D(x) = x^2 + x^3 + x^4$ suffer from transmission errors. Find the syndrome of V(x). **(10 Marks)**

b. A (7, 4) linear hamming code is described by a generator polynomial $g(x) = 1 + x + x^3$.

i) Determine the generator matrix G and the parity check matrix H.

ii) Design an encoder circuit. **(10 Marks)**

7 a. Determine the parameters of a q-ary RS code over GF(256) for $d_{min} = 33$. **(08 Marks)**

b. Write a note on:

i) BCH codes

ii) RS codes

iii) Burst error correcting codes. **(12 Marks)**

8 a. Consider the convolution encoder shown in Fig.Q8(a). The code is systematic:

i) Draw the state diagram and state transition table.

ii) Draw the code tree.

iii) Find the encoder o/p produced by the message sequence 10111.

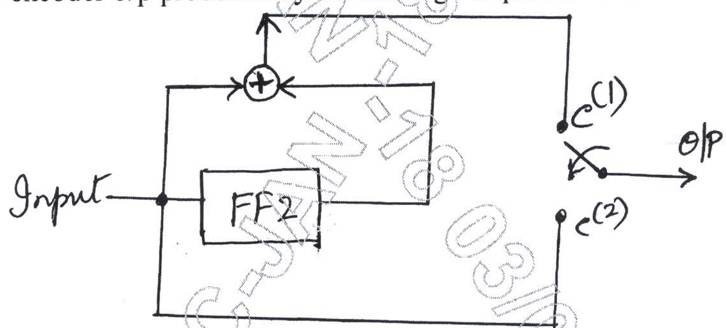

Fig.Q8(a) **(10 Marks)**

b. Consider the (3, 1, 2) convolution code with $g^{(1)} = 110$, $g^{(2)} = 101$ and $g^{(3)} = 111$.

i) Draw the encoder block diagram.

ii) Find the generator matrix.

iii) Find the code word corresponding to the information sequence (11101) using time domain approach. **(10 Marks)**

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