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

Fifth Semester B.E. Degree Examination, June/July 2015
Information Theory and Coding

Time: 3 hrs. Max. Marks: 100

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

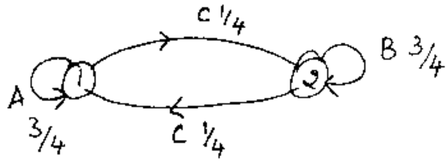
PART – A

1 a. Derive an expression for average information content (entropy) of long independent messages. **(05 Marks)**

b. Define information [I], average information, information rate, symbol rate and mutual information. **(05 Marks)**

c. For the Markov source model shown below compute initial probabilities, state entropy source entropy and show that $G_1 > G_2 > H(s)$. **(10 Marks)**

Fig.Q.1(c)



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

b. Using Shannon's binary encoding algorithm, find all the code words for the symbols given below also find its efficiency and redundancy. Given: **(08 Marks)**

S_0	S_1	S_2	S_3	S_4
0.55	0.15	0.15	0.1	0.05

c. State all the properties of entropy and prove the external property. **(08 Marks)**

3 a. For a channel whose matrix is as given below for which $P(x_1) = 1/2$; $P(x_2) = P(x_3) = 1/4$ and r_s = 10,000 sym/sec. Find H(x), A(y), H(x, y), H(x/y), H(y/x), I(x,y). Also find information rate at transmitter (R_{in}) and information rate at receiver (R_t), capacity, efficiency and redundancy.

$$P(y/x)=\begin{bmatrix}0.8 & 0.2 & 0\\ 0.1 & 0.8 & 0.1\\ 0 & 0.2 & 0.8\end{bmatrix}.$$ **(10 Marks)**

b. A source produces 9 symbols with probabilities {0.36, 0.24, 0.12, 0.08, 0.08, 0.07, 0.03, 0.02}.

i) Construct Huffman binary code and determine its efficiency (η) and redundancy (R).

ii) Construct Huffman ternary code and find its efficiency (η) and redundancy (R). **(10 Marks)**

4 a. State and explain Shannon Hartley law. Derive an expression for the upper limit of the channel capacity. **(07 Marks)**

b. Define mutual information and explain all the properties of mutual information. **(06 Marks)**

c. Two noisy channels are cascaded whose channel matrices are given by

$$P(y/x)=\begin{bmatrix}1/5 & 1/5 & 3/5\\ 1/2 & 1/3 & 1/6\end{bmatrix} \qquad P(z/y)=\begin{bmatrix}0 & 3/5 & 2/5\\ 1/3 & 2/3 & 0\\ 1/2 & 0 & 1/2\end{bmatrix}$$ with $P(x_1) = P(x_2) = 1/2$, find

the over all mutual information I(x,z) and I(x,y). **(07 Marks)**

PART – B

5 a. Draw the block diagram of a digital communication system and explain the function of each block. **(06 Marks)**

b. The parity check bits of a (7, 4) Hamming codes are generated by

$c_5 = d_1 + d_3 + d_4$

$c_6 = d_1 + d_2 + d_3$

$c_7 = d_2 + d_3 + d_4$

where d_1, d_2, d_3 and d_4 are message bits

i) Find generator matrix (G) and parity check matrix [H] for this code.
ii) Prove that $GH^T = 0$.
iii) Find the minimum weight of this code.
iv) Find error detecting and correcting capability.
v) Draw encoder circuit and syndrome circuit for the same. **(12 Marks)**

c. Compare fixed length code and variable length code. **(02 Marks)**

6 a. A (15, 5) linear cyclic code has a generator polynomial $g(x) = 1 + x + x^2 + x^4 + x^5 + x^8 + x^{10}$.

i) Draw the cyclic encoder and find codeword for the message polynomial. $D(x) = 1 + x^2 + x^4$ in systematic form by listing the states of the shift register.
ii) Draw the syndrome calculator circuit for given g(x). **(12 Marks)**

b. For the given generator polynomial find generator matrix and parity check matrix and find codeword for (7, 3) Hamming code and its hamming weight $g(x) = 1 + x + x^2 + x^4$. **(08 Marks)**

7 Write short notes on:

a. BCH codes
b. Shortened cyclic code
c. RS code
d. Golay code
e. Burst error correcting code. **(20 Marks)**

8 a. Consider the convolutional encoder shown below:

i) Draw the state diagram
ii) Draw code tree
iii) Find the codeword for the message sequence 10111. **(10 Marks)**

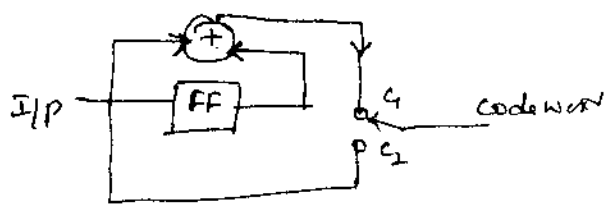


Fig.Q.8(a)

b. For a (2, 1, 2) convolutional encoder with generator sequence $g^1 = 111$ and $g^{(2)} = 101$.

i) Draw convolutional encoder circuit.
ii) Find the codeword for the message sequence 10111 using time domain approach and transfer domain approach. **(10 Marks)**

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