USN | | | | | | | | | | |

10TE65

Sixth Semester B.E. Degree Examination, Dec.2016/Jan.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. Justify that the information content of a message is a logarithmic function of its probability. **(06 Marks)**

b. A card is drawn from a deck of playing cards.
   i) You are informed that the card you draw is a spade. How much information did you received in bits?
   ii) How much information do you receive if you are told that the card that you drew is an ace?
   iii) How much information do you receive if you are told that the card you drew is an "ace of spades"?
   Is the information content of the message "ace of spades" the sum of the information contents of the messages "spade" and "ace"? What do you conclude? **(04 Marks)**

c. For the given first order Markov source in Fig.Q.1(c). Find: i) Entropy of each state; ii) Entropy of source; iii) G_1 and G_2 and verify $G_1 \geq G_2 \geq H$. **(10 Marks)**

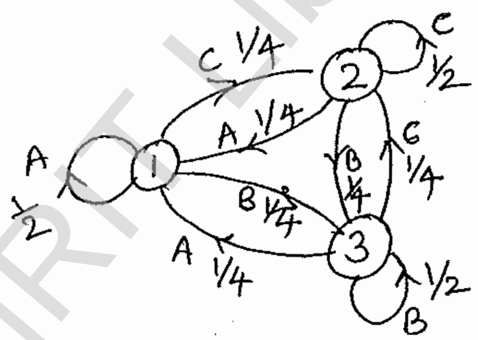

Fig.Q1(c)

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

b. State and explain Kraft inequality. **(04 Marks)**

c. Explain Shannon encoding algorithm. Design an encoder using Shannon encoding algorithm for a source having 5 symbols and probability statistics $P = \left\{\frac{1}{8}, \frac{1}{16}, \frac{3}{16}, \frac{1}{4}, \frac{3}{8}\right\}$. Find coding efficiency and redundancy. **(10 Marks)**

3 a. Consider a source $S = \{S_1, S_2, S_3\}$ with $P = \left\{\frac{1}{2}, \frac{1}{3}, \frac{1}{6}\right\}$.
   i) Determine the binary codewords using Huffman's encoding procedure.
   ii) If the same technique is applied to the 2^{nd} order extension of the source how much will the code efficiency be improved.
   iii) Comment on the result. **(10 Marks)**

b. A BSC channel has the following noise matrix with source probabilities:

$$P(x_1) = \frac{3}{4} \quad \text{and} \quad P(x_2) = \frac{1}{4} \qquad P(Y/X) = \begin{bmatrix} 2/3 & 1/3 \\ 1/3 & 2/3 \end{bmatrix}$$

Determine: i) H(x), H(y), H(x, y), H(x/y), H(y/x) and I(x, y); ii) Capacity, efficiency and redundancy of the channel. **(10 Marks)**

4 a. State and explain the Shannon-Hartley law. Obtain an expression for the maximum capacity of a continuous channel. **(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 levels with equal probability. Assume the rate of transmission to be 30 picture frames per second, and the signal to noise power ratio is 30 dB. Using the channel capacity theorem, calculate the minimum bandwidth required to support the transmission of the resultant video signal. **(05 Marks)**

c. A voice grade channel of the telephone network has a bandwidth of 3.4 kHz.
   - i) Calculate channel capacity of the telephone channel for a signal to noise ratio of 30dB.
   - ii) Calculate the minimum signal to noise ratio required to support information transmission through the telephone channel at the rate of 4800 bits/sec. **(05 Marks)**

PART – B

5 a. For a systematic (6, 3) linear block code

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

   - i) Find all the code vectors.
   - ii) Error detecting and error correcting capabilities.
   - iii) Draw encoder circuit.
   - iv) If the received vector R = 010110. Detect and correct the single error present in it. **(10 Marks)**

b. Prove that $CH^T = 0$. **(04 Marks)**

c. Why do we need error control coding? What are the types of errors and types of coding to combat them? **(06 Marks)**

6 a. The generator polynomial of a (7, 4) cyclic code is $g(x) = 1 + x + x^3$.
   - i) Find the code words for messages 1010 and 1101 both in systematic and non-systematic form.
   - ii) Find generator and parity check matrices.
   - iii) Draw the encoder diagram. **(10 Marks)**

b. 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 block diagram of syndrome calculator circuit.
   - ii) Is $V(x) = 1 + x^4 + x^6 + x^8 + x^{14}$ a code polynomial? If not, find the syndrome of V(x).
   - iii) Find the code polynomial $D(x) = 1 + x^2 + x^4$ in systematic form. **(10 Marks)**

7 Write short notes on:
a. RS codes
b. BCH codes
c. Golay codes
d. Burst and random error correcting codes. **(20 Marks)**

8 a. Consider the (3, 1, 2) convolutional code with $g^{(1)} = (1, 1, 0)$, $g^{(2)} = (1, 0, 1)$ and $g^{(3)} = (1, 1, 1)$.
i) Draw the encoder block diagram.
ii) Find the codeword corresponding to the message sequence [1 1 1 0 1] using time domain and transform domain approach. **(10 Marks)**

b. Consider the convolutional encoder shown:

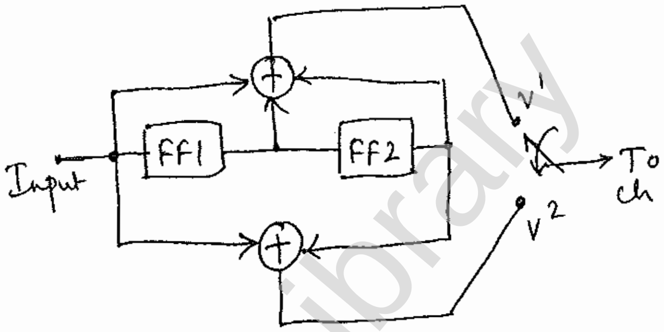

Fig.Q.8(b)

i) State transition table
ii) Code tree for 3 intervals
iii) Using code tree find the codeword corresponding to the message (1 0 1 1 1). **(10 Marks)**

* * * * *