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

10TE65

Sixth Semester B.E. Degree Examination, June/July 2016
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. Discuss extremal property of entropy with examples. **(05 Marks)**

b. Suppose that s_1 and s_2 are two memory sources with probabilities $p_1, p_2, \ldots, p_n$ for source s_1 and $q_1, q_2, \ldots q_n$ for source s_2. Show that the entropy of source s_1.

$$H(s_1) \leq \sum_{k=1}^{n} P_k \log \frac{1}{q_k}.$$ **(05 Marks)**

c. Consider the state diagram of the Markov source of Fig.Q.1(c).
i) Compute the state probabilities; ii) Find the entropy of each state; iii) Find the entropy of the source. **(10 Marks)**

2 a. Construct binary code for the following source using Shannon's binary encoding procedure $S = \{s_1, s_2, s_3, s_4, s_5\}$ $P = \{0.4, 0.25, 0.15, 0.12, 0.08\}$. **(08 Marks)**

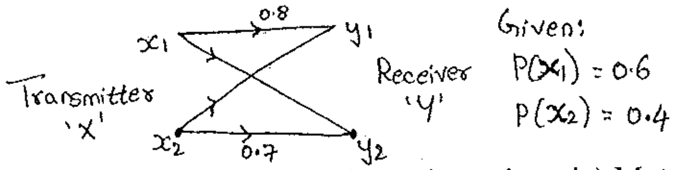
b. A source produces 5 symbols s_1, s_2, s_3, s_4 and s_5 with respective probabilities of 0.1, 0.3, 0.4, 0.12 and 0.08.
i) Construct Huffman binary code.
ii) Determine efficiency and redundancy of the code.
iii) Draw code tree. **(06 Marks)**

c. Discuss Shanon-Fano encoding algorithm with an example. **(06 Marks)**

3 a. Define binary erasure channel and obtain an expression for its channel capacity. **(06 Marks)**

b. Find the mutual information and the channel capacity of the channel shown in Fig.Q.3(b). **(06 Marks)**

Fig.Q.3(b)



c. Define: i) Priori entropy; ii) Posteriori entropy; iii) Equivocation; iv) Mutual information. **(08 Marks)**

4 a. State and prove Shanon-Hartley law. Derive an expression for upper limit on channel capacity as bandwidth tends to infinity. **(08 Marks)**

b. Consider a continuous random variable Y defined by Y = X + N where X and N are statistically independent. Show that the conditional differential entropy of Y, Given X is $H(y/x) = H(N)$ where H(N) is the differential entropy of N. **(06 Marks)**

c. Alpha numeric data are entered into a computer from a remote terminal through a Voice-grade telephone channel. The channel has a band width of 3.4 kHz and output signal to noise ratio of 20dB. The terminal has a total of 128 symbols. Assume that the symbols are equiprobable and the successive transmissions are statistically independent.
i) Calculate channel capacity
ii) Find the 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. What is error control coding? What are the different error controlling methods? **(05 Marks)**

b. Find the generator matrix G and parity check matrix H for a linear block code with minimum distance three and a message block size of eight bits. **(05 Marks)**

c. The generator matrix of a linear block code is given by $[G] = \begin{bmatrix} 1 & 0 & 0 & 1 & 1 & 1 & 0 \\ 0 & 1 & 0 & 0 & 1 & 1 & 1 \\ 0 & 0 & 1 & 1 & 1 & 0 & 1 \end{bmatrix}$.

i) Find all the possible valid code-vectors; ii) Find parity check matrix; iii) Find minimum distance; iv) Draw encoding circuit; v) Draw syndrome calculation circuit. **(10 Marks)**

6 a. Draw the general block diagram of syndrome calculation circuit for cyclic codes and explain its operation. **(06 Marks)**

b. A linear Hamming code is described by a generator polynomial $g(D) = 1 + D + D^3$.

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

ii) Design encoder circuit. **(06 Marks)**

c. Consider the (15, 11) cyclic code generated by $g(x) = 1 + x + x^4$.

i) Draw the feedback register encoding circuit for this cyclic code.

ii) Illustrate the encoding procedure with the vector 01101001011 by listing the states of the register with each input.

iii) Verify the code polynomial by using the division method. **(08 Marks)**

7 a. Discuss Reed-Solomon (RS) codes, and Golay codes. **(08 Marks)**

b. Determine the parameters of q-ary RS code over GF(16) for a $d_{min} = 9$. Also find the total number of code words in the code and also the nearest neighbours for any code-word at a distance of $d_{min} = 9$. **(09 Marks)**

c. Consider a (15, 9) cyclic code generated by $g(x) = 1 + x^3 + x^4 + x^5 + x^6$. This code has burst error correcting ability b = 3. Find the burst-error correcting efficiency of this code. **(03 Marks)**

8 a. Consider the (3, 1, 2) convolution 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 generator matrix.

iii) Find the codeword corresponding to the information sequence (1 1 1 0 1) using time domain and transform domain approach. **(12 Marks)**

b. For the convolution encoder shown in Fig.Q.8(b):

i) Find the impulse response and hence calculate the output produced by the information sequence 10111.

ii) Write the generator polynomial of the encoder. **(08 Marks)**

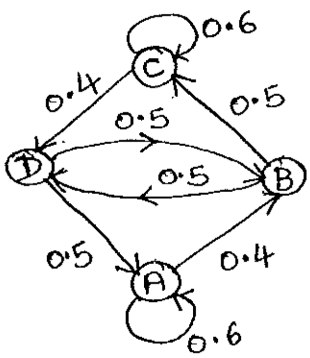


Fig.Q.1(c)

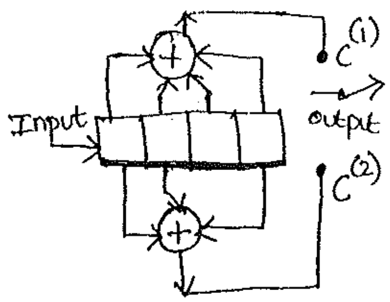


Fig.Q.8(b)

* * * * *