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10TE65

Sixth Semester B.E. Degree Examination, June/July 2017
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. Explain why logarithmic expression is chosen for measuring information. **(04 Marks)**

b. Shortly before a horse–race, a book-maker believes that several horses entered in the race have the following probability of winning :

Horse	A	B	C	D	E
P(winning)	0.04	0.42	0.31	0.12	0.11

He, then receives a message that owing to a minor injury. One of the horses is not participating in the race. Explain how would you access from an information theory point of view, the information value of this message.

i) If the horse in question is known ii) if it is not known. **(07 Marks)**

c. Consider the state diagram of the Markov source as shown in Fig.Q1(c),

i) compute the state probabilities

ii) find the entropy of each state

iii) find the entropy of the source. **(09 Marks)**

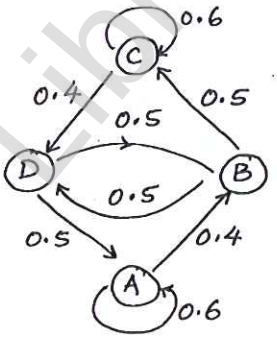

Fig.Q1(c)

2 a. Find the smallest number of letters in the code alphabet for devising a code with prefix property such that [W] = [0, 3, 0, 5] where W is the set of number of words with word lengths 1, 2, 3 - - -. **(04 Marks)**

b. The source emits the messages consisting of 2 symbols each. These messages and their probabilities are given as shown in Table.Q2(b). Design the source encoder using Shannon's encoding algorithm and also find encoder efficiency. **(09 Marks)**

TableQ2(b)

Messge (M_i)	Probability (P_i)
AA	9/32
AC	3/32
CC	1/16
CB	3/32
CA	3/32
BC	3/32
BB	9/32

c. Consider 4 messages x1, x2, x3 and x4 with probabilities 0.1, 0.2, 0.3, 0.4.

i) Device a code with prefix property [Shannon–fano code) for these messages and draw the code tree

ii) Calculate the efficiency and redundancy of the code

iii) Calculate the probabilities of 0's and 1's in the code. **(07 Marks)**

3 a. Consider a source with 8 alphabets A to H with respective probabilities 0.22, 0.20, 0.18, 0.15, 0.10, 0.08, 0.05, 0.02.
i) Construct a binary compact code and find the code efficiency
ii) Construct a ternary compact code and find efficiency of the code. **(12 Marks)**

b. Define the following terms :
i) Priori entropy ii) posteriori entropy iii) equivocation iv) mutual information. **(08 Marks)**

4 a. Define symmetric/uniform channel and obtain an expression for its channel capacity. **(08 Marks)**

b. Consider a BSC whose channel matrix is given as :

$$P(Y/X) = \begin{bmatrix} 3/4 & 1/4 \\ 1/4 & 3/4 \end{bmatrix}.$$

Find the channel capacity using Muroga's method. **(04 Marks)**

c. Consider a continuous random variable having a distribution as given below :

$$f_X(x) = \frac{1}{a}, \quad 0 \le x \le a$$
$$0, \quad \text{otherwise}$$

Find the differential entropy H(x). **(04 Marks)**

d. A Gaussian channel has a bandwidth of 4KHz and a 2 sided noise power spectral density $\eta/2$ of 10^{-14} watts/Hz. Signal power at the receiver has to be maintained at a level less than or equal to 0.1 milliwatt. Calculate the capacity of the channel. **(04 Marks)**

PART – B

5 a. 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) Draw the corresponding encoding circuit
ii) Draw the syndrome calculation circuit
iii) A single error has occurred in each of these received vectors. Detect and correct those errors.
i) $R_A = [0111110]$ ii) $R_B = [1011100]$ iii) $R_c = [1010000]$. **(10 Marks)**

b. Design a (4, 2) linear block code :
i) find the generator and parity check matrix of the code
ii) find all possible code vectors
iii) construct a standard array for the code
iv) What are the error–detecting and error correcting capabilities of the code? Explain with an example. **(10 Marks)**

6 a. For a (7, 4) single error correcting cyclic code find the generator and parity check matrix using the generator polynomial $g(x) = 1 + x + x^3$. **(08 Marks)**

b. 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 transmission errors. Find the syndrome of V(x)
iii) Design an encoder circuit
iv) Devise a syndrome calculation circuit. **(12 Marks)**

7 a. Determine the parameters of a 9-ary RS code over GF(256) for a $d_{min} = 33$. **(05 Marks)**

b. Consider a (15, 7) BCC code generated by a $g(x) = x^8 + x^4 + x^2 + x + 1$ with $d_{min} = 5$ and double error correcting capability. Construct a (75, 35) interleaved code with $\lambda = 5$. Explain and illustrate the burst and random error correcting capability of this code. **(09 Marks)**

c. Mention the parameters of BCH code for a (15, 5) BCH code the generator polynomial is given as $g(x) = 1 + x + x^2 + x^4 + x^5 + x^8 + x^{10}$. Find :

i) Number of check bits

ii) Minimum distance

iii) Error correcting capability of the code. **(06 Marks)**

8 a. For a convolutional encoder shown in Fig.Q8(a), :

i) obtain dimension of the code

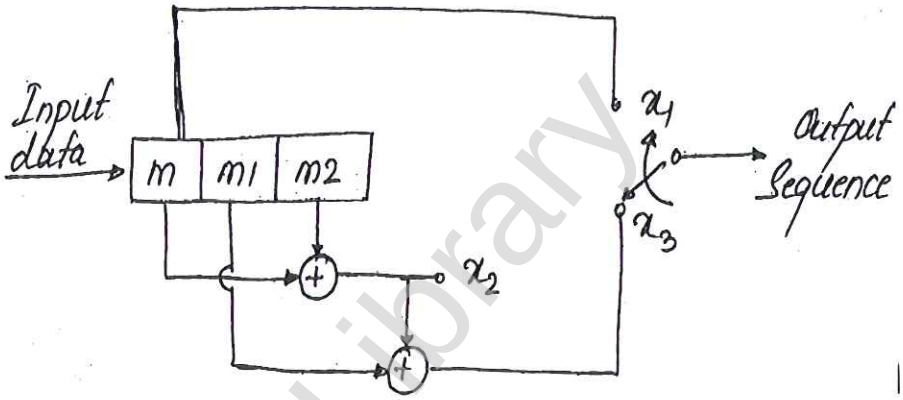

Fig.Q8(a)

ii) Construct state transition table

iii) Sketch the state diagram

iv) Determine the output data sequence for the input data sequence 10110. **(12 Marks)**

b. Bring out the differences between the linear block codes and convolutional codes. **(08 Marks)**

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