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10TE65

Sixth Semester B.E. Degree Examination, Jan./Feb. 2021
Information Theory and Coding

Time: 3 hrs. Max. Marks:100

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

PART – A

1 a. Define the following terminologies :
   i) Information content of a message
   ii) Average information content of symbols
   iii) Average source information rate. **(03 Marks)**

   b. A code is composed of dots and dashes. Assuming that a dash is 3 times long as a dot and one third the probability of occurrence. Calculate :
   i) Information in Dot and Dash
   ii) Entropy of dot – dash code
   iii) Average rate of information if a dot lasts for 10msec and this time is allowed between symbols. **(07 Marks)**

   c. For the Markoff source shown in Fig.Q1(c) calculate :
   i) Entropy of source
   ii) Draw tree diagram for 2 symbol sequences
   iii) Find G_1 and G_2 and G_2 and show that $G_1 > G_2 > H$.

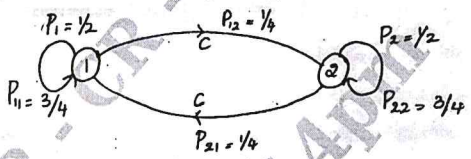


Fig.Q1(c) **(10 Marks)**

2 a. Explain the steps involved in generating binary code using Shannon's encoding algorithm. **(04 Marks)**

   b. The source emits messages consisting of 2 symbols each as per table given below. Design a source encoder using Shannon's encoding algorithm and also find encoder efficiency and code redundancy. **(06 Marks)**

Message Mi	AA	AB	AC	CC	BC	CA	BB
Probability	9/32	3/32	3/32	1/16	3/32	3/32	9/32

   c. Apply Shannon's encoding algorithm to the following messages

S_1	S_2	S_3
0.5	0.3	0.2

   i) Find code efficiency and redundancy
   ii) If the same technique is applied to the 2nd order extension of this source. How much will the code efficiency be improved? **(10 Marks)**

3 a. Define Mutual Information. List all the properties of mutual information. **(04 Marks)**

   b. Consider a discrete memoryless source with alphabets (S_0, S_1, S_2) and probabilities [0.75, 0.15, 0.15] for its output.
   i) Apply Huffman coding procedure for the source and find the average length of the code word
   ii) Consider the 2nd extension of this source apply Huffman encoding procedure and find the average length of the codeword
   iii) Find the coding efficiency in both cases. **(10 Marks)**

   c. Prove the following :
   i) Mutual information of the channel is symmetric
   ii) Mutual information is always positive. **(06 Marks)**

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

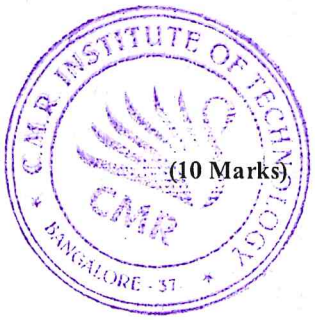
b. State and prove Shannon Hartley law. Derive an expression for the upper limit on channel capacity as bandwidth tends to ∞. **(06 Marks)**

c. A binary symmetric channel has the following noise matrix with source probabilities of

$$P(x_1) = \frac{2}{3} \text{ and } P(x_2) = \frac{1}{3}$$

$$P\left(\frac{Y}{X}\right) = \begin{matrix} \\ X_1 \\ X_2 \end{matrix} \begin{matrix} Y_1 & Y_2 \\ \end{matrix} \begin{bmatrix} 3/4 & 1/4 \\ 1/4 & 3/4 \end{bmatrix}$$

i) Determine H(X), H(Y), H(X, Y), H(Y/X), H(X/Y) and I(X, Y)
ii) Find the channel capacity C
iii) Find channel efficiency and redundancy. **(10 Marks)**



PART – B

5 a. Consider a (6, 3) linear code whose 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 all code vectors
ii) Find all the Hamming weights and distances
iii) Find minimum parity check matrix
iv) Draw the encoder circuit for the above codes. **(12 Marks)**

b. What is error control coding? What are the methods employed in detecting and correcting errors? **(08 Marks)**

6 a. With neat block diagram explain the operation of encoding using (n – k) bit shift register. **(08 Marks)**

b. Consider the (15, 11) cyclic code generated by $g(x) = 1 + x + x^4$.
i) Device a feedback register encoder for this code
ii) Illustrate the encoder procedure with the message vector 1 1 0 0 1 1 0 1 0 1 1 by listing the states of register. **(12 Marks)**

7 Consider the (3, 1, 2) convolution code with $g^{(1)} = (1\ 1\ 0)$, $g^{(2)} = (1\ 0\ 1)$, $g^{(3)} = (1\ 1\ 1)$
i) Draw the encoder block diagram
ii) Find the generator matrix
iii) Find the code word corresponding to the information sequence [1 1 1 0 1] using time domain and transform domain approach. **(20 Marks)**

8 Write short notes on :
a. Shortened cyclic codes
b. Golay codes
c. Burst error correcting codes
d. Reed Solomon codes. **(20 Marks)**

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