CBCS SCHEME

USN | | | | | | | | | | | 17EC54

Fifth Semester B.E. Degree Examination, July/August 2022
Information Theory and Coding

Time: 3 hrs. Max. Marks: 100

Note: ***Answer any FIVE full questions, choosing ONE full question from each module.***

Module-1

1 a. Define: i) Self information ii) Entropy of the long independent messages iii) Rate of information iv) Average symbol duration. **(04 Marks)**

b. A card is drawn from deck,
  i) You are told that it is spade, how much information did your receive?
  ii) How much information did you receiver if the card is drawn as an Ace?
  iii) How much information did you receive if the card is drawn as an Ace of spade?
  iv) Is the information content of the message Ace of spade is the sum of the information content of the message Ace is spade? **(06 Marks)**

c. Consider the following Markov source, write two level tree diagrams shown in Fig Q1(c). Compute state probability, message probabilities of message length 1, 2. Compute H(s) G1, G2 and hence prove that $G1 \geq G2 \geq H(s)$

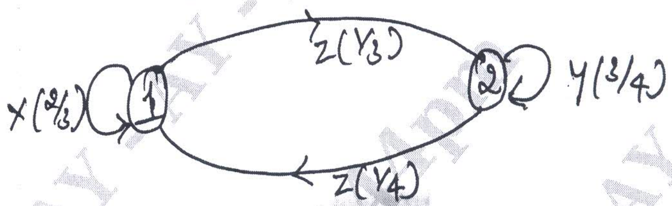

Fig Q1(c) **(10 Marks)**

OR

2 a. Prove Maximal property using total derivative method. **(06 Marks)**

b. A code is compound of dash and dot, assuming that dash is 3 time long as dot and has one third of the probability of the occurrence. Calculate the i) information in dot and dash ii) entropy of dash dot code iii) the average rate of information if the dot last for 10ms and same time is allowed between the symbols. **(08 Marks)**

c. A zero memory source has source alphabet $S = \{S_1, S_2, S_3\}$, $P = \left\{\frac{1}{2}, \frac{1}{4}, \frac{1}{4}\right\}$ find the entropy of the source and also determine entropy of the second order extension and verify $H(S^2) = 2H(S)$. **(06 Marks)**

Module-2

3 a. Consider a statistically independent source whose source alphabet $S = \{S_0, S_1, S_2, S_3, S_4, S_5\}$ with P = {0.5, 0.125, 0.25, 0.03125, 0.03125, 0.0625} using source Shannon encoding algorithm, find code words for all the symbols of first order source and compute minimum average length, efficiency, variance. **(06 Marks)**

b. With an illustrative example, explain the arithmetic coding technique. **(06 Marks)**

c. A DMS emits 8 symbols with probabilities P = {0.3, 0.1, 0.1, 0.1, 0.05, 0.05, 0.05, 0.25} construct Huffman code with X = {0, 1, 2} compute efficiency, also write decision tree illustrate the decoding process using an example. **(08 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.

OR

4 a. Define and prove sources code theorem. **(06 Marks)**

b. Output of DMS consists of 3 letters S_1, S_2, S_3 with probability statistics 0.45, 0.35, 0.2

i) Construct Huffman code and compute efficiency and variance by moving the combined symbols as high as possible.

ii) Construct second order source and construct Huffman code by moving combined symbols as low as possible

iii) Comment on the result based on variance

iv) Write decision trees and illustrate the decoding process using an example. **(10 Marks)**

c. List out the properties of source encoding algorithm and explain any two. **(04 Marks)**

Module-3

5 a. What is mutual information; prove that $I(X, Y) \geq 0$. **(05 Marks)**

b. Compute H(X), H(Y), H(X,Y), H(X/Y), H(Y/X) data transmission rate, channel capacity and channel efficiency with the following parameters

$$P(Y/X) = \begin{bmatrix} 0.4 & 0.3 & 0.3 \\ 0.3 & 0.2 & 0.5 \\ 0.1 & 0.4 & 0.5 \end{bmatrix} \quad P(X) = \left[\tfrac{1}{2}, \tfrac{1}{4}, \tfrac{1}{4} \right] \quad r_s = 100 \text{ sym/sec.}$$ **(10 Marks)**

c. Compute the channel capacity of the channel matrix $\begin{bmatrix} 0.2 & 0.8 \\ 0.8 & 0.2 \end{bmatrix}$ T = 1Sec/sym. **(05 Marks)**

OR

6 a. Prove that H(X, Y) = H(X) + H (Y/X) bits/sym. **(06 Marks)**

b. A analog channel having 4KHz bandwidth is sampled 1.25 times the Nyquist rate each sample is quantized into 256 equally likely probable assuming that samples are statistically independent. Calculate information rate of the source. Can the output of the source be transmitted without error over AWGN channel if the bandwidth is 10KHz and S/N is 20db. Find the SNR for the error free transmission if B = 10KHz, find bandwidth for error free transmission if SNR is 20db. **(08 Marks)**

c. Find the missing terms in the following matrix

$$P(XY) = \begin{bmatrix} 0.1 & a & 0.2 \\ 0.125 & 0.1 & 0.05 \\ a & 0.2 & c \end{bmatrix} \quad P(Y) = \left\{ \tfrac{1}{3}, \tfrac{2}{3}, b \right\}$$ compute H(X) and H(Y/X). **(06 Marks)**

Module-4

7 a. Prove that $CH^T = 0$ there by show that $S = EH^T$. **(05 Marks)**

b. For a (7, 4) linear block code the syndrome is given by $S_1 = r_1 + r_2 + r_3 + r_5$, $S_2 = r_1 + r_2 + r_4 + r_6$, $S_3 = r_1 + r_3 + r_4 + r_7$

i) Find generator matrix ii) find parity check matrix iii) Draw the encoder is syndrome detection circuit iii) How many errors can be detected and corrected iv) Demonstrate the error detection and correction for R = 1011011. **(10 Marks)**

c. The parity check bits of a (8, 4) block codes are generated by $C_5 = D_1 + D_2 + D_4$, $C_6 = D_1 + D_2 + D_3$, $C_7 = D_1 + D_3 + D_4$, $C_8 = D_2 + D_3 + D_4$ where D_1, D_2 D_3, D_4 are message bits. Find the generate matrix and parity matrix for this code. **(05 Marks)**

OR

8 a. A(15, 11) cyclic code is generated using $g(x) = 1 + x + x^4$, Design an encodes and illustrate the encoding procedure with the message vector [11001101011] by listing the state of the register assuming the right most bits as the earliest bit. **(08 Marks)**

b. A(7, 4) cyclic code has the generate polynomial $g(x) = 1 + x + x^4$ write the syndrome calculation circuit and verify the circuit for the message polynomial $d(x) = 1 + x^3$. **(07 Marks)**

c. Explain the standard array decoding procedure. **(05 Marks)**

Module-5

9 a. Write a note on Golay codes. **(05 Marks)**

b. For a (2, 1, 3) convolution encodes with g(1) = (1101), g(2) = (1011)

i) Find constraint length
ii) Find rate efficiency
iii) Draw the encodes diagram
iv) Find the generate matrix
v) Find the code word for the message sequence (11101) using matrix approach and frequency domain approach. **(10 Marks)**

c. For the state diagram, shown below Fig Q9(c), with $S_0 = 00$, $S_1 = 10$, $S_2 = 01$, $S_3 = 11$, draw the Trellis diagram. For the input sequence m (1, 0, 1) tree the output.

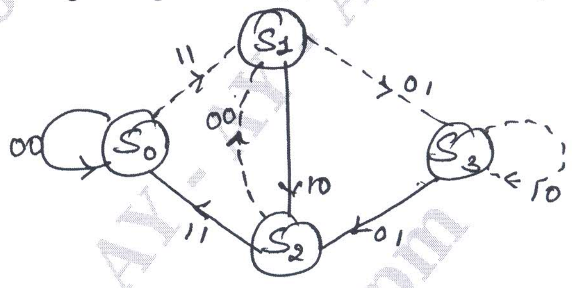

Fig Q9(c) **(05 Marks)**

OR

10 a. Consider the (3, 1, 2) convolution encodes with g(1) = (110), g(2) = (101), g(3) = (111)

i) Write the encodes circuit
ii) Write the state transition table
iii) Write the state diagram
iv) Draw the code tree **(10 Marks)**

Find the encoded output for the message (11101) by traversing the code tree. **(05 Marks)**

b. Write a note on BCH code

c. Describe the Viterbi decoding algorithm. **(05 Marks)**

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