CBCS SCHEME

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17EC54

Fifth Semester B.E. Degree Examination, Dec.2023/Jan.2024
Information Theory and Coding

Time: 3 hrs. Max. Marks: 100

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

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.

Module-1

1 a. A black and white TV picture consists of 525 lines of picture information. Assume that each line consists of 525 picture elements (pixels) and that each can have 255 brightness levels. Picture is repeated at the rate of 30 frame/sec. calculate average rate of information conveyed by TV set to a viewer. **(06 Marks)**

b. A zero memory source has a sources alphabet $S = \{S_1, S_2, S_3\}$ with $P = \left\{\frac{1}{2}, \frac{1}{4}, \frac{1}{4}\right\}$. Find entropy of this source. Also determine entropy of its 2[nd] extension and verify $H(s^2) = 2H(s)$. **(07 Marks)**

c. With neat sketch explain block diagram of information system. Also state any two properties of entropy. **(07 Marks)**

OR

2 a. Derive an expression for entropy of symbols in a long independent sequence. **(06 Marks)**

b. For the first order Mark off source shown in Fig Q2(b), i) find stationary distribution ii) Find entropy of each state and hence entropy of the source iii) Find entropy of adjoint source and verify $H(s) < G_1$.

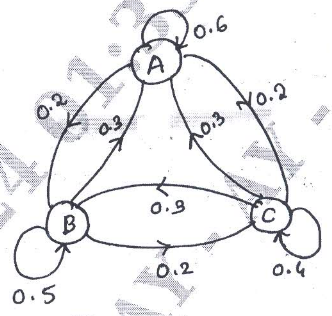

Fig Q2(b) **(14 Marks)**

Module-2

3 a. Apply Shannon's encoding algorithm to following set of message (m_1, m_2, m_3, m_4, m_5) and their corresponding probabilities are $\left(\frac{1}{8}, \frac{1}{16}, \frac{3}{16}, \frac{1}{4}, \frac{3}{8}\right)$. Determine code efficiency and redundancy. **(10 Marks)**

b. A source produces two symbols S_1 and S_2 with probabilities $\frac{7}{8}$ and $\frac{1}{8}$ respectively. Device a coding scheme using Shannon-Fanθ encoding procedure to get coding efficiency atleast 75%. **(10 Marks)**

OR

4 a. Consider a 8 source $\{S_1, S_2, S_3, S_4, S_5, S_6, S_7, S_8\}$ with respective probabilities of {0.22, 0.20, 0.18, 0.15, 0.10, 0.08, 0.05, 0.02}
  i) Construct binary code and determine code efficiency using Huffman coding technique
  ii) Construct ternary code using Huffman coding and determine efficiency. **(10 Marks)**

b. Given 4 messages x_1, x_2, x_3 and x_4 with respective probabilities 0.1, 0.2, 0.3, 0.4.
  i) Device a code with prefix properties for message and draw code tree
  ii) Calculate efficiency and redundancy of code
  iii) Calculate probabilities of 0's and 1's in code. **(10 Marks)**

Module-3

5 a. For the joint probability matrix given below, compute individually H(X), H(Y), H(X, Y), H(X/Y), H(Y/X) and I(X, V). Verify the relationship among the entropies.

$$P(X, V) = \begin{bmatrix} 0.05 & 0 & 0.20 & 0.05 \\ 0 & 0.10 & 0.10 & 0 \\ 0 & 0 & 0.20 & 0.10 \\ 0.05 & 0.05 & 0 & 0.10 \end{bmatrix}$$ **(12 Marks)**

b. A binary channel has following characteristics $P\left(\frac{Y}{X}\right) = \begin{bmatrix} 2/3 & 1/3 \\ 1/3 & 2/3 \end{bmatrix}$ input probabilities are $3/4$ and $1/4$ respectively. Find H(X), H(X, Y) and H(Y/X). **(08 Marks)**

OR

6 a. The noise characteristics of a channel is given in matrix. Find channel capacity. If it were a symmetric channel recomputed the channel capacity using Muroga's method.

$$P\left(Y/X\right) = \begin{bmatrix} 0.8 & 0.1 & 0.1 \\ 0.2 & 0.6 & 0.2 \\ 0.2 & 0.2 & 0.6 \end{bmatrix}$$ **(10 Marks)**

b. A message source produces two independent symbols A and B with probabilities P(A) = 0.4 P(B) = 0.6. Calculate the efficiency of source and hence its redundancy. If symbols are received in average with 4 in every 100 symbols in error, calculate transmission rate of system. **(10 Marks)**

Module-4

7 a. In a 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 parity check matrix [H]
  ii) Draw encoder circuit
  iii) Find codeword for all input sequences
  iv) How many errors it can detect and correct
  v) What is the syndrome for received data 1011011? **(10 Marks)**

b. Design a single error correcting Hamming code for a message length of 4. Given t = 1. **(10 Marks)**

OR

8 a. The parity check bits of (7, 4) Hamming code generated
$C_5 = d_1 + d_3 + d_4$, $C_6 = d_1 + d_2 + d_3$, $C_7 = d_2 + d_3 + d_4$
i) Find generator matrix [G] and parity check matrix [H]
ii) Prove that $GH^T = 0$
iii) The (n, k) linear block code is a dual code (n, n – k) having H matrix and G matrix. Determine 8 code vectors for (7, 4) Hamming code.
iv) Find minimum distance of dual code determined in part© **(10 Marks)**

b. The generator polynomial for (15, 7) cyclic code is $g(x) = 1 + x^4 + x^6 + x^7 + x^8$
i) Find code vector in systematic form for the message $D(x) = x^2 + x^3 + x^4$
ii) Assume that first and last bit of code vector V(x) for $D(x) = x^2 + x^3 + x^4$ suffer transmission errors. Find the syndrome of V(x). **10 Marks)**

Module-5

9 a. For convolution encoder shown in Fig Q9(a), the information sequence is d = 10011. Find the output sequence using following two approaches.
i) Time – domain approach ii) Transform – domain approach.

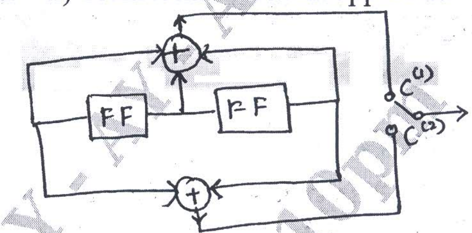

Fig Q9(a) **(10 Marks)**

b. Write explanatory note on following :
i) R S codes ii) Golay codes **(10 Marks)**

OR

10 a. Consider convolution encoder shown in Fig Q10(a)
i) Draw state diagram
ii) Draw code tree
iii) Find encoder output for message 10111
iv) Verify output using time domain approach.

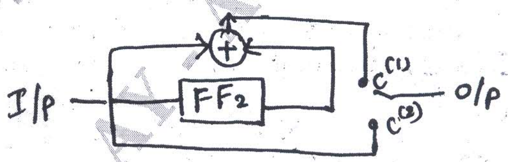

Fig Q10(a) **(16 Marks)**

b. Write a short note on BCH code. **(04 Marks)**

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