CBCS Scheme

USN | | | | | | | | | | 15EC54

Fifth Semester B.E. Degree Examination, Dec.2017/Jan.2018
Information Theory and Coding

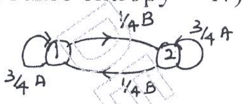
Time: 3 hrs. Max. Marks: 80

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

Module-1

1 a. Derive an expression for average information content of symbols in long independent sequence. (03 Marks)

b. For the Markov source shown below, find i) The stationary distribution ii) State entropies iii) Source entropy iv) G_1 G_2 and show that $G_1 \geq G_2 \geq H(s)$. (10 Marks)



c. Define Self Information, Entropy and Information rate. (03 Marks)

OR

2 a. Mention different properties of entropy and prove external property. (07 Marks)

b. A source emits one of the four symbols S_1 S_2 S_3 and S_4 with probabilities of $\frac{7}{16}$, $\frac{5}{16}$, $\frac{1}{8}$ & $\frac{1}{8}$. Show that $H(S^2) = 2H(S)$. (04 Marks)

c. In a facsimile transmission of a picture, there are about 2.25×10^6 pixels/frame. For a good reproduction at the receiver 12 brightness levels are necessary. Assume all these levels are equally likely to occur. Find the rate of information if one picture is to be transmitted every 3 min. Also compute the source efficiency. (05 Marks)

Module-2

3 a. A discrete memory less source has an alphabet of five symbols with their probabilities as given below : (10 Marks)

Symbol	S_0	S_1	S_2	S_3	S_4
Probabilities	0.55	0.15	0.15	0.1	0.05

Compute Huffman code by placing composite symbol as high as possible and by placing composite symbol as low as possible. Also find i) The average codeword length ii) The variance of the average code word for both the cases.

b. Using Shannon Fano – coding, find code words for the probability distribution $P = \left\{\frac{1}{2}, \frac{1}{4}, \frac{1}{8}, \frac{1}{8}\right\}$. Find average code word length and efficiency. (06 Marks)

OR

4 a. Write a short note on Lempel Ziv algorithm. (05 Marks)

b. Derive Source coding theorem. (05 Marks)

c. Apply Shannon's encoding algorithm and generate binary codes for the set of messages given below. Also find variance, code efficiency and redundancy. (06 Marks)

M_1	M_2	M_3	M_4	M_5
1/8	1/16	3/16	1/4	3/8

Module-3

5 a. Find the capacity of the discrete channel whose noise matrix is (04 Marks)

$$P\left(\frac{y}{x}\right) = \begin{bmatrix} 0.8 & 0.2 & 0 \\ 0.1 & 0.8 & 0.1 \\ 0 & 0.2 & 0.8 \end{bmatrix}$$

b. Define Mutual Information. List the properties of Mutual information and prove that $I(x ; y) = H(x) + H(y) - H(xy)$ bits/system. **(06 Marks)**

c. A channel has the following characteristics :

$$P\left(\frac{y}{x}\right) = \begin{bmatrix} \frac{1}{3} & \frac{1}{3} & \frac{1}{6} & \frac{1}{6} \\ \frac{1}{6} & \frac{1}{6} & \frac{1}{3} & \frac{1}{3} \end{bmatrix} \text{ \& } P(x_1) = p(x_2) = \frac{1}{2}$$

. Find H(x) , H(y) , H(x, y) and Channel capacity if r = 1000 symbols/sec. **(06 Marks)**

OR

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

$$P(x_1) = \frac{2}{3} \text{ and } P(x_2) = \frac{1}{3} \text{ and } P\left(\frac{y}{x}\right) = \begin{bmatrix} \frac{3}{4} & \frac{1}{4} \\ \frac{1}{4} & \frac{3}{4} \end{bmatrix}.$$ **(08 Marks)**

i) Determine H(x) , H(y) , H(x, y) , H(y/x) , H(x/y) and I(x, y).
ii) Find channel capacity C. iii) Find channel efficiency and redundancy.

b. Derive an expression for channel efficiency for a Binary Erasure channel. **(05 Marks)**

c. Write a note on Differential Entropy. **(03 Marks)**

Module-4

7 a. For a systematic (6.3) linear block code generated by $C_4 = d_1 \oplus d_3$, $C_5 = d_2 \oplus d_3$, $C_6 = d_1 \oplus d_2$.

i) Find all possible code vectors ii) Draw encoder circuit and syndrome circuit
iii) Detect and correct the code word if the received code word is 110010.
iv) Hamming weight for all code vector, min hamming distance. Error detecting and correcting capability. **(14 Marks)**

b. Define the following : i) Block code and Convolutional code ii) Systematic and non – systematic code. **(02 Marks)**

OR

8 a. A linear Hamming code for (7, 4) is described by a generator polynomial $g(x) = 1 + x + x^3$. Determine Generator Matrix and Parity check matrix. **(03 Marks)**

b. A 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 for the message $D(x) = x^2 + x^3 + x^4$. Using cyclic encoder circuit.
ii) Draw syndrome calculation circuit and find the syndrome of the received polynomial $Z(x) = 1 + x + x^3 + x^6 + x^8 + x^9 + x^{11} + x^{14}$. **(13 Marks)**

Module-5

9 a. Consider the (3, 1, 2) convolutional code with $g_1 = 110$, $g_2 = 101$, $g_3 = 111$. **(12 Marks)**

i) Draw the encoder block diagram ii) Find the generator matrix
iii) Find the code word corresponding to the information sequence 11101 using time domain and transform Domain approach.

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

OR

10 For a (2,1, 3) convolutional encoder with $g_1 = 1011$, $g_2 = 1101$. **(16 Marks)**

a. Draw the state diagram b. Draw the code tree.
c. Draw trellis diagram and code word for the message 1 1 1 0 1.
d. Using Viterbi decoding algorithm decode the obtained code word if first bit is erroneous.

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