CBCS SCHEME

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15EC54

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

Time: 3 hrs. Max. Marks: 80

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

Module-1

1 a. Define entropy and list the properties of entropy. **(04 Marks)**

b. Consider a zero memory source emitting three symbols s_1, s_2 and s_3 with respective probabilities 0.5, 0.3 and 0.2. Calculate: i) Entropy of the source ii) All symbols and the corresponding probabilities of the second order extension. Also, find entropy of extended source iii) Show that $H(s^2) = 2H(s)$. **(08 Marks)**

c. Show that 1 Nat = 1.443 bits. **(04 Marks)**

OR

2 a. Define Markoff source. Explain with typical transition state diagram. **(06 Marks)**

b. For the Markoff source shown in Fig.Q.2(b), find

i) State probabilities
ii) State entropies
iii) Source entropy.

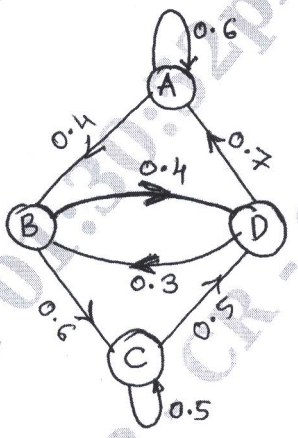

Fig.Q.2(b) **(10 Marks)**

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. What is a discrete communication channel? Illustrate the model of a discrete channel. Obtain the equation for P(error) for such a channel. **(08 Marks)**

b. State and discuss Shannon's theorem on channel capacity. **(04 Marks)**

c. For the channel matrix shown below, find the channel capacity,

$$P\left(\frac{b_j}{a_i}\right) = \begin{array}{c} \\ a_1 \\ a_2 \\ a_3 \end{array} \begin{array}{c} \begin{array}{ccc} b_1 & b_2 & b_3 \end{array} \\ \begin{bmatrix} \frac{1}{2} & \frac{1}{3} & \frac{1}{6} \\ \frac{1}{3} & \frac{1}{6} & \frac{1}{2} \\ \frac{1}{6} & \frac{1}{2} & \frac{1}{3} \end{bmatrix} \end{array}$$

(04 Marks)

OR

6 a. State and prove Shannon-Hartley law. **(08 Marks)**

b. Discuss Muroga's method for estimating the channel capacity. **(08 Marks)**

Module-4

7 a. Briefly explain the need of parity/redundant bits in the data transmission. Also, explain how errors can be tackled using,
i) FEC (Forward Error Correction) ii) ARQ codes (Automatic Repeat Request Codes). **(06 Marks)**

b. Consider a (6, 3) Linear Block Code (LBC) with generator matrix

$$G = \begin{bmatrix} 1 & 0 & 0 & 1 & 1 & 1 \\ 0 & 1 & 0 & 1 & 1 & 0 \\ 0 & 0 & 1 & 1 & 0 & 1 \end{bmatrix}$$

Find:
i) All codewords
ii) All Hamming weights
iii) Minimum Hamming weight and distance
iv) Parity Check Matrix (PCM)
v) Draw the encoder circuit. **(10 Marks)**

OR

8 a. Explain the syndrome calculation and error detection with the help of neat circuit diagram for cyclic codes. **(06 Marks)**

b. Consider a (15, 7) binary cyclic code with $g(x) = 1 + x^4 + x^6 + x^7 + x^8$
i) Draw the encoder circuit
ii) Obtain the codeword for the input (00111)
iii) Draw the syndrome calculating circuit. **(10 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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