15EC54

Fifth Semester B.E. Degree Examination, Dec.2018/Jan.2019
Information Theory and Coding

Time: 3 hrs. Max. Marks: 80

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

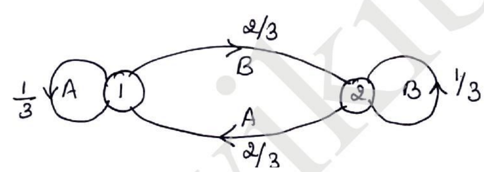
Module-1

1 a. The output of an information source contains 160 symbols, 128 of which occur with a probability of $\frac{1}{256}$ and remaining with a probability of $\frac{1}{64}$ each. Find the average information rate of the source if the source emits 10,000 sym/s. **(02 Marks)**

b. In a facsimile transmission of a picture, there are 4×10^6 pixels/frame. For a good reconstruction of the image atleast eight brightness levels are necessary. Assuming all these levels are equally likely to occur. Find the average information rate if one picture is transmitted every 4s. **(04 Marks)**

c. Consider the following Markov source shown in fig. Q1(c). Find i) State probabilities ii) State entropies iii) Source entropy iv) G_1, G_2 v) Show that $G_1 > G_2 > H$. **(10 Marks)**

Fig.Q1(c)



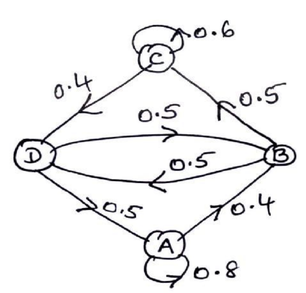
OR

2 a. The international Morse code uses a sequence of symbols of dots and dashes to transmit letters of English alphabet. The dash is represented by a current pulse of duration 2ms and dot of 1ms. The probability of dash is half as that of dot. Consider 1ms duration of gap is given in between the symbols. Calculate i) Self – information of a dot and a dash ii) Average information content of a dot – dash code iii) Average rate of information. **(06 Marks)**

b. State the properties of Entropy. **(04 Marks)**

c. Consider the Markov source shown in fig. Q2(c). find i) State probabilities ii) State entropies iii) Source entropy. **(06 Marks)**

Fig.Q2(c)



Module-2

3 a. With an example, explain Prefix codes. **(04 Marks)**

b. Consider the following source S = {A, B, C, D, E} with probabilities P = {0.5, 0.25, 0.125, 0.0625, 0.0625}. Find the code words for the symbols using Shannon's encoding algorithm. Also, find the source efficiency and redundancy. **(06 Marks)**

c. An information source produces a sequence of independent symbols having the following probabilities. Construct binary code using Huffman encoding and find its efficiency. **(06 Marks)**

A	B	C	D	E	F	G
1/3	1/27	1/3	1/9	1/9	1/27	1/27

OR

4 a. State Kraft McMillan Inequality property. **(04 Marks)**

b. Consider a discrete memory less source with S = (X, Y, Z) with the corresponding probabilities P = (0.5, 0.3, 0.2). Find the code words for the symbols using Shannon's algorithm. Also, find the source efficiency and redundancy. **(06 Marks)**

c. Consider a discrete memory less source with S = (X, Y, Z) with respective probabilities P = (0.6, 0.2, 0.2). Find the codeword for the message 'YXZXY' using arithmetic coding. **(06 Marks)**

Module-3

5 a. A binary channel has the following characteristics

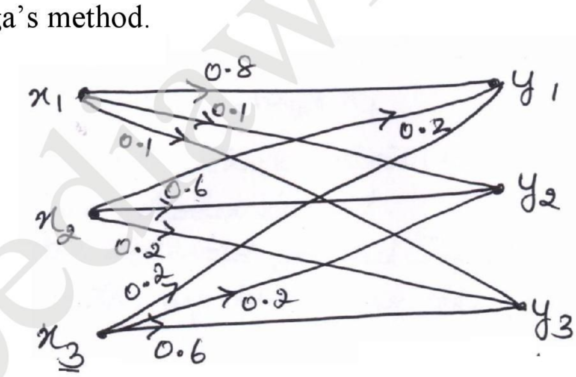
$$P(Y/X) = \begin{bmatrix} 2/3 & 1/3 \\ 1/3 & 2/3 \end{bmatrix}$$. If input symbols are transmitted with probabilities ¾ and ¼

respectively. Find entropies, H(X), H(X, Y) and H(Y/X). **(03 Marks)**

b. Prove that the mutual information is always a non - negative entity $I(X ; Y) \geq 0$. **(06 Marks)**

c. The noise characteristics of a channel are as shown in fig.Q5(c). Find the capacity of the channel using Muroga's method. **(07 Marks)**

Fig.Q5(c)

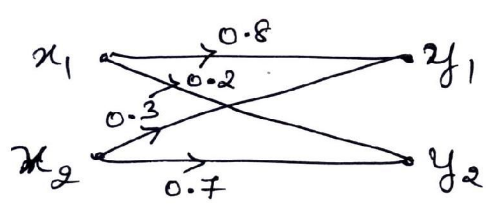


OR

6 a. State the properties of Joint Probability Matrix. **(04 Marks)**

b. Find the mutual information for the channel shown in fig.6(b). Let $P(x_1) = 0.6$ and $P(x_2) = 0.4$. **(06 Marks)**

Fig.Q6(b)



c. Derive the expression for the channel capacity of a Binary Symmetric Channel. **(06 Marks)**

Module-4

7 a. For a (6, 3) code find all the code vectors if the co-efficient matrix P is given by

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

i) Find code vector ii) Implement the encoder iii) Find the syndrome vector (S).
iv) Implement the syndrome circuit. **(08 Marks)**

b. Obtain the generator and parity check matrices for an (n, k) cyclic code with $g(x) = 1+x+x^3$. **(08 Marks)**

OR

8 a. In an LBC, 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 the parity check matrix (H) ii) Draw the encoder circuit
iii) Find the code word for all input sequences.
iv) What is the syndrome for the received data 1011011? **(08 Marks)**

b. In a (15,5) cyclic code, the generator polynomial is given by $g(x) = 1+x+ x^2+x^4+x^5+ x^8+ x^{10}$. Draw the block diagram of an encoder and syndrome calculator for this code. Find whether $r(x) = 1+ x^4 + x^6 + x^8 + x^{14}$ a valid code word. **(08 Marks)**

Module-5

9 a. Design a (15,7) binary BCH code with r = 2. **(06 Marks)**

b. Consider the (3, 1, 2) convolution code with $g^{(1)} = (1\ 1\ 0)$, $g^{(2)} = (1\ 0\ 1)$, $g^{(3)} = (1\ 1\ 1)$.
i) Find the constraint length ii) Find the rate iii) Draw the encoder block diagram
iv) Find the generator matrix v) Find the code word for the message sequence (1 1 1 0 1) using time – domain and transfer – domain approach. **(10 Marks)**

OR

10 a. Explain why (23, 12) Golay code is called as perfect code. **(04 Marks)**

b. Consider the convolution encoder shown in fig. Q10(b).
i) Write the impulse response of the encoder.
ii) Find the output for the message (1 0 0 1 1) using time – domain approach.
iii) Find the output for the message (1 0 0 1 1) using transfer – domain approach. **(12 Marks)**

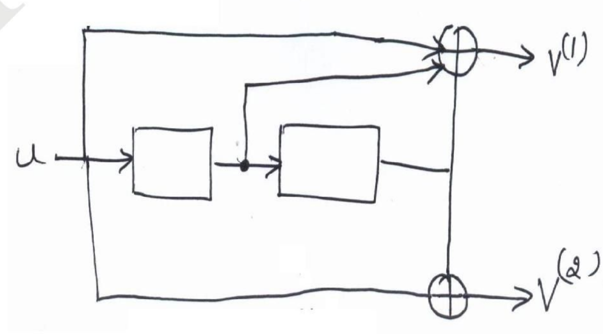


Fig.Q10(b)