CBCS SCHEME

USN

18EC54

Fifth Semester B.E. Degree Examination, Jan./Feb. 2023
Information Theory & 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 the followings:
   (i) Entropy
   (ii) Information rate.
   (iii) Self information. **(06 Marks)**

b. A binary source is emitting an independent sequence of 0's and 1's with probability of P and 1-P respectively. Plot the Entropy of this source versus P ($0<P<1$). **(06 Marks)**

c. For the first order Markov statistical model shown in Fig. Q1 (c). Compute
   (i) Probabilities of each state.
   (ii) H(s) and $H(s^{-2})$

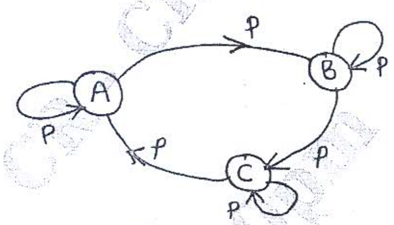

Fig. Q1 (c) **(08 Marks)**

OR

2 a. For the first order Markoff model shown in Fig. Q2 (a). Find
   (i) Entropy of each state.
   (ii) Entropy of the source.
   (iii) Prove that $G_1 \geq G_2 \geq H$

Assume $P(1) = P(2) = P(3) = \frac{1}{3}$

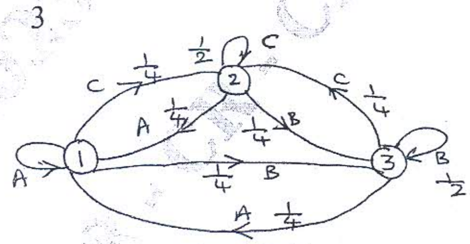

Fig. Q2 (a) **(12 Marks)**

b. The international Morse code uses a sequence of dots and dashes to transmit letters of the English alphabets. The dash represented by a current pulse that has a durationof 3 units and the dot has a duration of 1 unit. The probability of a dash is $\frac{1}{3}$ of the probability of occurrence of a dot.
   (i) Calculate the information content of a dot and a dash.
   (ii) Calculate H(s) in the dot-dash code.
   (iii) Assume that the dot lasts 1 msec.
   Which is the same time interval as the pause between symbols? Find the average rate of information transmission. **(08 Marks)**

Module-2

3 a. Construct a binary Shannon encoding algorithm for the following source with probabilities:
S = {A, B, C, D, E}
P = {0.4, 0.25, 0.15, 0.12, 0.08}
Also compute the code Efficiency. **(08 Marks)**

b. What is prefix of a code and explain with example. **(04 Marks)**

c. Construct a Ternary code using Huffman Encoding algorithm for the source given with probabilities and move the composite symbol as low as possible.

Symbol :	A	B	C	D	E	F	G
Probabilities :	$\frac{1}{3}$	$\frac{1}{27}$	$\frac{1}{3}$	$\frac{1}{9}$	$\frac{1}{9}$	$\frac{1}{27}$	$\frac{1}{27}$

Also find the code efficiency. **(08 Marks)**

OR

4 a. Check the following codes given in Table (1) are instantaneous or not with the help of KMI.

Symbols	Code A	Code B	Code C
A	0	0	00
B	10	11	01
C	110	100	10
D	1110	110	111
E	1111	1011	0110

Table (1) **(09 Marks)**

b. Design a source Encoder using Shannon encoding algorithm for the information source shown in Fig.Q4 (b). Compute the average output bit rate and efficiency of the code for N = 1. Assume $P_1 = P_2 = \frac{1}{2}$.

Fig. Q4 (b) **(11 Marks)**

Module-3

5 a. Define the followings:
(i) Channel matrix.
(ii) Joint probability matrix.
(iii) Input entropy.
(iv) Output entropy. **(08 Marks)**

b. What is mutual information? Prove that $I(X,Y) \geq 0$. **(08 Marks)**

c. Determine the capacity of the channel shown in Fig. Q5 (c).

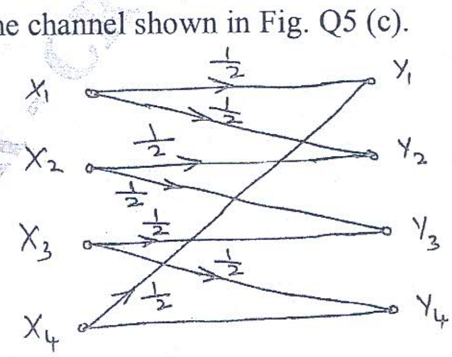

Fig. Q5 (c) **(04 Marks)**

OR

6 a. Consider a channel matrix, $P\left(\frac{Y}{X}\right) = \begin{bmatrix} 0.6 & 0.2 & 0.2 \\ 0.2 & 0.6 & 0.2 \\ 0.2 & 0.2 & 0.6 \end{bmatrix}$

with $P(X_1) = P(X_2) = P(X_3) = \frac{1}{3}$

Find H(X), H(Y), H(X,Y), $H\left(\frac{Y}{X}\right)$ and $H\left(\frac{X}{Y}\right)$. **(08 Marks)**

b. The noise characteristic of a channel as shown in Fig. Q6 (b). Find the capacity of a channel using Muruga's method. Assume $r_s = 1500$ symbols/sec.

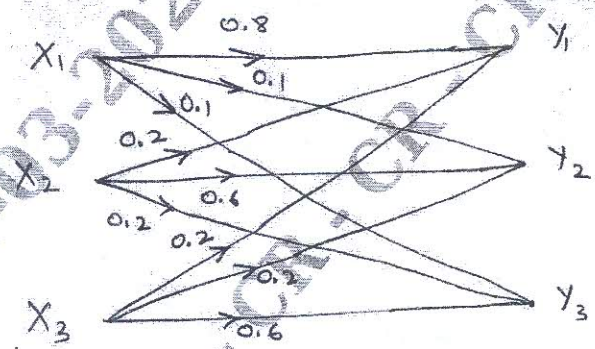

Fig. Q6 (b) **(08 Marks)**

c. Explain Binary Erasure channel. **(04 Marks)**

Module-4

7 a. Define the following:

(i) Hamming weight.
(ii) Hamming distance.
(iii) Minimum distance. **(06 Marks)**

b. For a (6, 3) linear block code, the parity matrix is,

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

(i) Obtain the generator matrix.
(ii) Write all possible code words.
(iii) If the received code vector R = 1 1 1 0 1 0, detect and correct the single error.
(iv) Draw the encoder and syndrome calculation block diagram. **(14 Marks)**

OR

8 a. 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 encoder circuit.
(ii) Draw the syndrome calculation circuit and find the syndrome of the received polynomial.
$z(x) = 1 + x + x^3 + x^6 + x^8 + x^9 + x^{11} + x^{14}$ **(16 Marks)**

b. Mention the advantages and disadvantages of error control coding. **(04 Marks)**

Module-5

9 a. Consider the (3, 1, 2) convolution encoder with $g_{(1)} = 110$, $g_{(2)} = 101$ and $g_{(3)} = 111$
 (i) Draw the encoder diagram.
 (ii) Find the code word for the message sequence (11101) using generator matrix/matrix method.
 (iii) Find the code word for the message sequence (11101) using transform domain approach. **(16 Marks)**

b. What are convolution codes? How it is different from block codes. **(04 Marks)**

OR

10 The (2, 1, 2) convolution encoder shown in Fig. Q10.
 (i) Draw state transition table.
 (ii) State diagram.
 (iii) Draw the code tree and find the encoder output produced by the message (110)
 (iv) Construct a Trellis diagram and find the encoder output produced by the message (110)

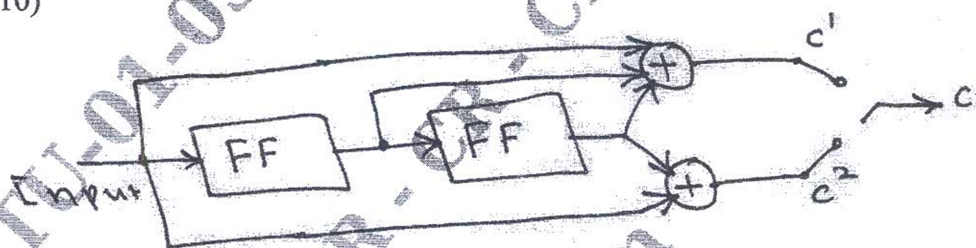

Fig. Q10 **(20 Marks)**

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