CBCS SCHEME

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17EC54

# Fifth Semester B.E. Degree Examination, Dec.2019/Jan.2020
## Information Theory and Coding

Time: 3 hrs. Max. Marks: 100

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



### Module-1

1 a. Suppose you are planning a trip to Miami, Florida from Minneapolis in the winter time. You are receiving the following information from Miami Weather bureau:
(i) Mild and Sunny day (ii) Cold day (iii) Possible snow flurries
Explain the amount of information content in each statement. **(06 Marks)**

b. The output of an information source consists of 128 symbols, 16 of which occurs with probability of $\frac{1}{32}$ and the remaining 112 occurs with probability of $\frac{1}{224}$. The source emits 1000 symbols/sec. Assuming that the symbols are chosen independently. Find the Average Information Rate of this source. **(06 Marks)**

c. The state diagram of a stationary Mark off Source is shown in Fig.Q1(c):
(i) Find the entropy of each state
(ii) Find the entropy of the source
(iii) Find $G_1$ and $G_2$ and verify that $G_1 \geq G_2 \geq H$.
Assume $P(1) = P(2) = P(3) = \frac{1}{3}$

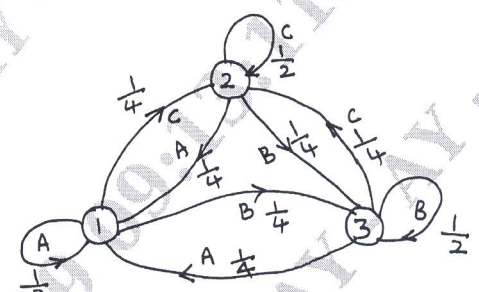


Fig.Q1(c) **(08 Marks)**

**OR**

2 a. What is self information? Mentions its various measuring units and also mentions the reasons for choosing logarithmic function. **(06 Marks)**

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

c. For the first order Markov statistical model as shown in Fig.Q2(c).
(i) Find the probability of each state (ii) Find H(s) and $H(s^{-2})$

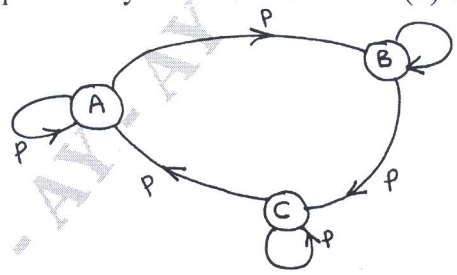


Fig.Q2(c) where A, B, and C are the states. **(08 Marks)**

## Module-2

3 a. Identify whether the codes shown in Table.Q3(a) are instantaneous. Justify your answer.

| Symbols | Code A | Code B | Code C |
|---|---|---|---|
| $S_1$ | 00 | 1 | 0 |
| $S_2$ | 01 | 01 | 100 |
| $S_3$ | 10 | 001 | 101 |
| $S_4$ | 11 | 00 | 111 |

Table.Q3(a) **(06 Marks)**

b. Consider a Discrete Memory Source (DMS) with S = {X, Y, Z} with P = {0.6, 0.2, 0.2}. Find the code word for the message "YXZXY" using Arithmetic code. **(06 Marks)**

c. An information source produces a sequence of independent symbols having the following probabilities. More composite symbol as slow as possible.

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

Construct Binary Huffman encoding and find its efficiency. **(08 Marks)**

**OR**

4 a. Write the Shannon's Encoding Algorithms. **(06 Marks)**

b. Consider the following source with probabilities:

S = {A, B, C, D, E, F} P = {0.4, 0.2, 0.2, 0.1, 0.08, 0.02}

Find the code words using Shannon-Fano algorithm and also find its efficiency. **(06 Marks)**

c. Consider the following discrete memoryless source:

$S = \{S_0, S_1, S_2, S_3, S_4\}$ P = {0.55, 0.15, 0.15, 0.1, 0.05}

Compute Huffman code by placing composite symbol as high as possible. Also find average code word length and variance of the code word. **(08 Marks)**

## Module-3

5 a. What is Joint Probability Matrix? How it is obtained from Channel Matrix and also mention properties of JPM. **(06 Marks)**

b. For the communication channel shown in Fig.Q5(b), determine Mutual Information and Information Rate if $r_s$ = 1000 symbols/sec. Assume $P(X_1) = 0.6$ and $P(X_2) = 0.4$.

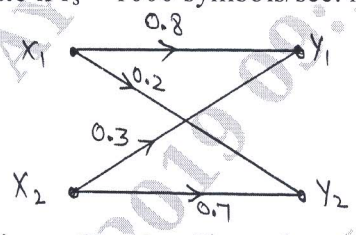


Fig.Q5(b)

**(06 Marks)**

c. Discuss the Binary Erasure Channel and also prove that the capacity a Binary Erasure Channel is $C = \overline{P} \cdot r_s$ bits/sec. **(08 Marks)**

**OR**

6 a. What is Mutual Information? Mention its properties. **(06 Marks)**

b. The noise characteristics of a channel shown in Fig.Q6(b). Find the capacity of a channel if $r_s$ = 2000 symbols/sec using Muroga's method.

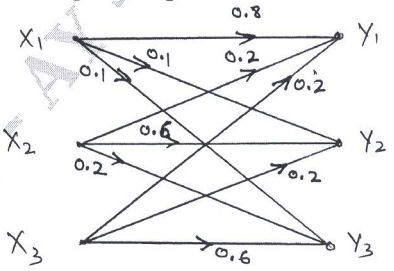


Fig.Q6(b)

**(06 Marks)**

c. State and prove the Shannon-Hartley Law. **(08 Marks)**

## Module-4

7 a. What are the advantages and disadvantages of Error Control Coding? Discuss the methods of controlling Errors. **(06 Marks)**

b. The parity check bits of a (7, 4) Hamming code are generated by

$C_5 = d_1 + d_3 + d_4$

$C_6 = d_1 + d_2 + d_3$

$C_7 = d_2 + d_3 + d_4$

where $d_1$, $d_2$, $d_3$ and $d_4$ are the message bits.

(i) Find G and H for this code.

(ii) Prove that $GH^T = 0$. **(06 Marks)**

c. Design a syndrome calculating circuit for a (7, 4) cyclic code with $g(X) = 1 + X + X^3$ and also calculate the syndrome of the received vector R = 1110101. **(08 Marks)**

**OR**

8 a. For a systematic (6, 3) linear block code, the Parity Matrix P is given by

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

(i) Find all possible code words.

(ii) Find error detecting and correcting capability. **(06 Marks)**

b. A (7, 4) cyclic code has the generator polynomial $g(X) = 1 + X + X^3$. Find the code vector both in systematic and non-systematic form for the message bits (1101). **(06 Marks)**

c. Draw the Encoder circuit of a cyclic code using (n – K) bit shift Registers and explain it. **(08 Marks)**

## Module-5

9 a. Consider (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 and Transform domain approach. **(16 Marks)**

b. Discuss the BCH codes. **(04 Marks)**

**OR**

10 a. Consider the convolution encoder shown in Fig.Q10(a).

(i) Write the impulse response and its polynomial.

(ii) Find the output corresponding to input message (10111) using time and transform domain approach.

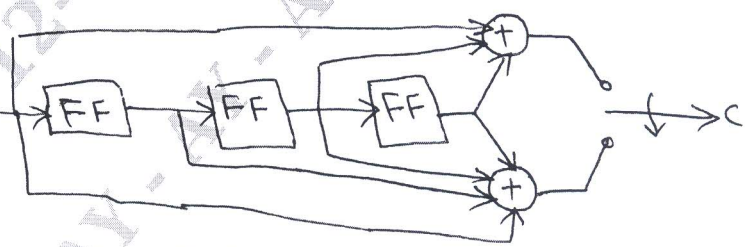


Fig.Q10(a) **(16 Marks)**

b. Write a note on Golay codes. **(04 Marks)**

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