

CBCS SCHEME

18EC54

Fifth Semester B.E. Degree Examination, Jan./Feb. 2021 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. Derive the expression for average information contents of symbols in long independent sequence. (06 Marks)
- b. Find the relationship between Hartley's, nats and bits. (06 Marks)
- c. A code is composed of dots and dashes. Assuming that a dash is 3 times as long as a dot and has one-third the probability of occurrence. Calculate:
 - (i) The information in a dot and dash
 - (ii) The entropy of dot-dash code
 - (iii) The entropy rate of information, if a dot lasts for 10 ms and this time is allowed between symbols. (08 Marks)

OR

- 2 a. Consider a second order mark-off source as shown in Fig.Q2(a). Here $s = \{0, 1\}$ and states are $A = \{0, 0\}$, $B = \{0, 1\}$, $C = \{1, 0\}$ and $D = \{1, 1\}$.
 - (i) Compute the probability of states
 - (ii) Compute the entropy of the source

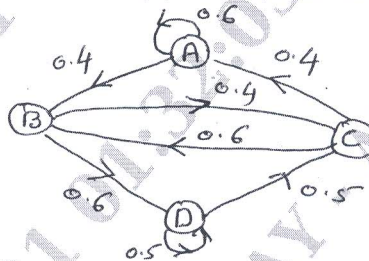


Fig.Q2(a)

- b. Prove that entropy of zero memory extension source is given by $H(s^n) = nH(s)$. (10 Marks)

Module-2

- 3 a. A Discrete Memory Source (DMS) has an alphabet $X = \{x_1, x_2, x_3, x_4, x_5, x_6\}$ and source statistics. $P = \{0.3, 0.25, 0.20, 0.12, 0.08, 0.05\}$. Construct binary Huffman code. Also find the efficiency and redundancy of coding. (10 Marks)
- b. Apply Shannon encoding algorithm to the following set of messages and obtain code efficiency and redundancy. (10 Marks)

m_1	m_2	m_3	m_4	m_5
1/8	1/16	3/16	1/4	3/8

OR

- 4 a. A source having alphabet $s = \{s_1, s_2, s_3, s_4, s_5\}$ produces a symbols with respective probabilities $1/2, 1/6, 1/6, 1/9, 1/18$.
 - (i) When the symbols are coded as shown 0, 10, 110, 1110, 1111 respectively.
 - (ii) When the code is as 00, 01, 10, 110, 111
 Find code efficiency and redundancy (12 Marks)
- b. State and prove Kraft McMillan inequality. (08 Marks)

Important Note : 1. On completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages.
2. Any revealing of identification, appeal to evaluator and/or equations written eg. 42+8 = 50, will be treated as malpractice.

Module-3

- 5 a. Discuss the binary Erasure Channel (BEC) and also derive channel capacity equation for BEC. (08 Marks)
- b. A channel has the following characteristics

$$P\left[\begin{array}{c} Y \\ X \end{array}\right] = \begin{array}{c} X_1 \begin{bmatrix} \frac{1}{3} & \frac{1}{3} & \frac{1}{6} & \frac{1}{6} \end{bmatrix} \\ X_2 \begin{bmatrix} \frac{1}{6} & \frac{1}{6} & \frac{1}{3} & \frac{1}{3} \end{bmatrix} \end{array}$$

Find $H(X)$, $H(Y)$, $H(X, Y)$ and channel capacity if $r = 1000$ symbols/sec.

(12 Marks)

OR

- 6 a. Determine the rate of transmission of information through a channel whose noise characteristics is as shown in Fig.Q6(a).

Given $P(X_1) = P(X_2) = \frac{1}{2}$. Assume $r_s = 10,000$ symbols/sec.

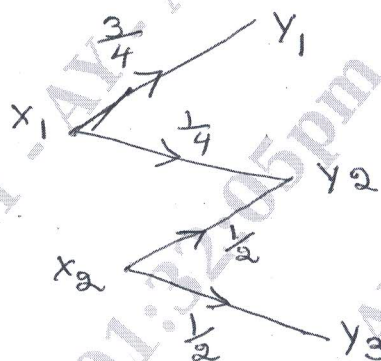


Fig.Q6(a)

(10 Marks)

- b. What is mutual information? Mention its properties and prove that $I(X:Y) = H(X) - H\left(\frac{X}{Y}\right)$; $I(X:Y) = H(Y) - H\left(\frac{Y}{X}\right)$. (10 Marks)

Module-4

- 7 a. For a (6, 3) linear block code the check bits are related to the message bits as per the equations given below:

$$c_1 = d_1 \oplus d_2$$

$$c_2 = d_1 \oplus d_2 \oplus d_3$$

$$c_3 = d_2 \oplus d_3$$

i) Find the generator matrix G

ii) Find all possible code words

iii) Find error detecting and error correcting capabilities of the code. (12 Marks)

- b. The generator polynomial of a (7, 4) cyclic code is $g(x) = 1 + x + x^2$. Find the 16 code words of this code by forming the code polynomial $v(x)$ using $V(X) = D(X)G(X)$ where $D(X)$ is the message polynomial. (08 Marks)

OR

- 8 a. Design a linear block code with a minimum distance of 3 and a message block size of 8 bits. (08 Marks)
- b. For a (6, 3) cyclic code, find the following: (12 Marks)
- $G(x)$
 - G in systematic form
 - All possible code words
 - Show that every code polynomial is multiple of $g(x)$.

Module-5

- 9 a. For the convolution encoder shown in Fig.Q9(a) the information sequence is $d = 10011$. Find the output sequence using the following two approaches. (10 Marks)
- Time domain approach
 - Transfer domain approach

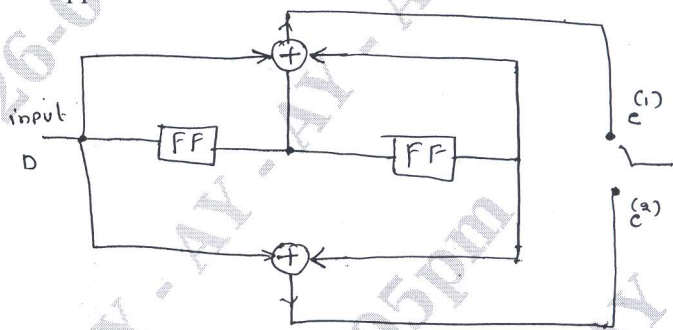


Fig.Q9(a) (10 Marks)

- b. Consider a (3, 1, 2) convolution encoder with $g^{(1)} = 110$, $g^{(2)} = 101$ and $g^{(3)} = 111$. (10 Marks)
- Draw the encoder diagram
 - Find the code word for message sequence (11101) using Generator matrix and Transfer domain approach.

OR

- 10 a. Consider the rate $r = \frac{1}{2}$ and constraint length $K = 2$ convolution encoder shown in Fig.Q10(a). (14 Marks)
- Draw the state diagram.
 - Draw the code tree
 - Draw Trellis diagram,
 - Trace the path through the tree that corresponds to the message sequence $\{1, 0, 1\}$.

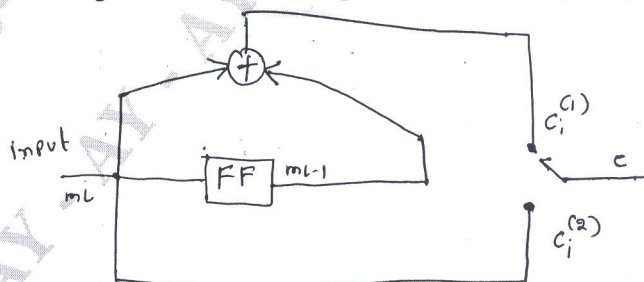


Fig.Q10(a) (14 Marks)

- b. Explain Viterbi decoding. (06 Marks)
