CBCS SCHEME

USN

18EC54

Fifth Semester B.E. Degree Examination, June/July 2024
Information Theory and Coding

Time: 3 hrs. Max. Marks: 100

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

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-1

1 a. With relevant equations and units define
i) Self information
ii) Entropy of source
iii) Information rate. **(06 Marks)**

b. For the Markov source shown in Fig.Q.1(b). Find:
i) State entropies
ii) Source entropy
iii) G_1 and G_2. Also show that $G_1 \geq G_2 \geq H(S)$ **(10 Marks)**

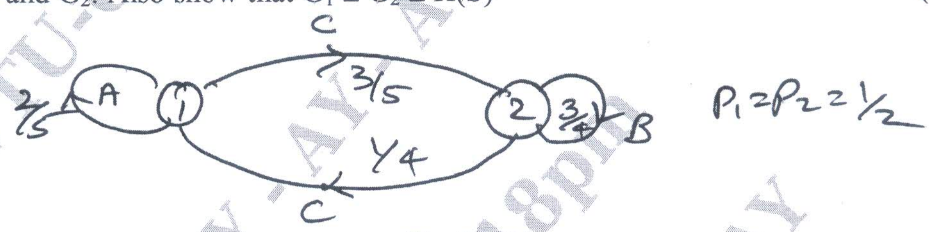

Fig.Q.1(b)

c. List any 4 properties of entropy with relevant equations. **(04 Marks)**

OR

2 a. Consider a discrete memoryless source with source alphabet $S = \{S_0, S_1, S_2, S_3\}$ with source statics $\left\{\frac{7}{16}, \frac{5}{16}, \frac{1}{8}, \frac{1}{8}\right\}$
i) Calculate source entropy
ii) Find all the symbols and probabilities of 2^{nd} extension. Also find its entropy.
iii) Show that $H(S^2) = 2H(S)$. **(08 Marks)**

b. The international Morse code uses a sequence of dots and dashes to transmit letters of English alphabet. The dash is represented by a current pulse of duration 3 times as long as dot and has half the probability of a occurrence of dot. Consider 0.2 sec duration of gap is given in between the symbols, which is same as dot duration. Calculate self-information of a dot and dash, average information content of a dot dash code and average information rate of transmission. **(08 Marks)**

c. Show that the source entropy is $\log_2 M$, when M symbols emitted from source are equiprobable. **(04 Marks)**

Module-2

3 a. State and prove the source encoding theorem. **(10 Marks)**

b. Differentiate between fixed length and variable length source coding. **(04 Marks)**

c. Define the following codes with example:

i) Prefix codes

ii) Uniquely decodable codes

iii) Instantaneous codes. **(06 Marks)**

OR

4 a. Apply Shannon encoding algorithm to the following set of messages and obtain code efficiency and redundancy.

$S = \{S_1, S_2, S_3, S_4, S_5\} = \left\{\frac{1}{8}, \frac{1}{16}, \frac{3}{16}, \frac{1}{4}, \frac{3}{8}\right\}$. **(10 Marks)**

b. The five symbols of the alphabet of a discrete memory less source are given as $S = \{S_1, S_2, S_3, S_4, S_5\} = \{0.4, 0.2, 0.2, 0.1, 0.1\}$. Find the Huffman code by

i) Moving combined symbol as high as possible.

ii) Moving combined symbol as low as possible.

Also find variance in both the cases and inference the results. **(10 Marks)**

Module-3

5 a. For joint probability matrix shown below find H(x, y), H(x), H(y), H(x/y), H(y/z) and I(x, y).

$$P(x,y) = \begin{bmatrix} 0.2 & 0 & 0.2 & 0 \\ 0.1 & 0.01 & 0.01 & 0.01 \\ 0 & 0.02 & 0.02 & 0 \\ 0.04 & 0.04 & 0.01 & 0.06 \\ 0 & 0.06 & 0.02 & 0.2 \end{bmatrix}$$ **(10 Marks)**

b. Prove the following equations:

i) I(x, y) = I(y, x)

ii) I(x, y) = H(x) – H(x/y)

iii) I(x, y) = H(y) – H(y/x) **(10 Marks)**

OR

6 a. For a given channel matrix. Find the channel capacity by using Muroga method. If it were a symmetric channel recomputed the channel capacity.

$$P(y/x) = \begin{bmatrix} 0.8 & 0.1 & 0.1 \\ 0.2 & 0.6 & 0.2 \\ 0.2 & 0.2 & 0.6 \end{bmatrix}$$ **(10 Marks)**

b. What is Binary Erasure Channel (BEC)? Derive the equation for channel capacity of a BEC. **(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 below

$c_4 = d_1 \oplus d_3$

$c_5 = d_1 \oplus d_2$

$c_6 = d_2 \oplus d_3$

i) Find the generator matrix G and H.

ii) Find all code words and weights of the code

iii) Find error correcting and detecting capabilities of the code. **(10 Marks)**

b. The generator polynomials of a (7, 4) cyclic code is $g(x) = 1 + x + x^3$. Find the 16 code words of this code by forming the code polynomial $V(x) = D(x)\,g(x)$ where $D(x)$ is the message polynomial. **(10 Marks)**

OR

8 a. For a given generator matrix below for (6, 3) linear block code

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

i) Draw the encoder circuit diagram.
ii) Draw the syndrome circuit diagram. **(10 Marks)**

b. In a (15, 5) cyclic code the generator polynomial is given by $g(x) = 1 + x + x^2 + x^4 + x^5 + x^8 + x^{10}$.
i) Draw the encoder and syndrome calculator.
ii) Find whether $r(x) = 1 + x^4 + x^6 + x^8 + x^{14}$ a valid code word or not. **(10 Marks)**

Module-5

9 a. For the convolutional encoder shown in Fig.Q.9(a) find the encoder output for the message sequence m = {1, 1, 0, 1} by

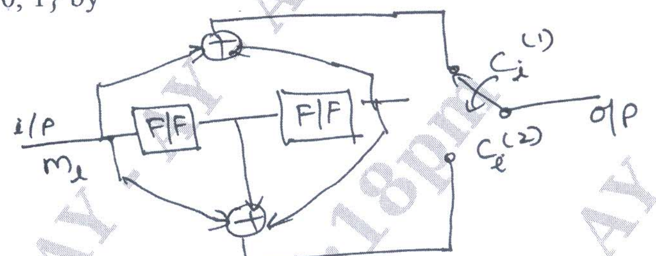

Fig.Q.9(a)

Using Time-domain and transfer domain approach. **(10 Marks)**

b. For encoder in Fig.Q.9(a) construct state diagram and code tree. **(10 Marks)**

OR

10 a. Consider a(3, 1, 2) convolution encoder with $g^{(1)} = 110$ $g^{(2)} = 101$ and $g^{(3)} = 111$.
i) Draw encoder diagram
ii) Find the code word for the message (11101) using generator matrix and transform domain approach. **(10 Marks)**

b. Write a note on:
i) Trellis diagram
ii) Viterbi decoding algorithm. **(10 Marks)**

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