CBCS SCHEME

USN | | | | | | | | | | | **15EC54**

Fifth Semester B.E. Degree Examination, Jan./Feb.2021

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. Define self-information and obtain an expression for entropy of a zero-memory information source emitting independent sequences of symbols. **(08 Marks)**

b. An analog signal is band limited to B Hz and sampled at Nyquist rate. The samples are quantized into 4 levels. Each level represents one message. Thus there are 4 messages. The probability of occurrence of these 4 levels (messages) are $P_1 = P_4 = \frac{1}{8}$ and $P_2 = P_3 = \frac{3}{8}$. Find out information rate of the source. **(08 Marks)**

OR

2 a. Explain Markoff model for information source. **(04 Marks)**

b. Obtain an expression for entropy of Markoff's source. **(04 Marks)**

c. For the first order Markov source with a source alphabet $S = \{A, B, C\}$ shown in Fig. Q2 (c) below. Compute the probabilities of state and entropy of source. **(08 Marks)**

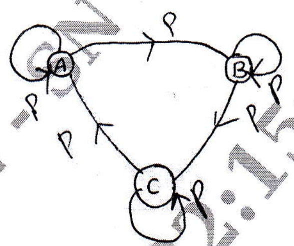


Fig. Q2 (c)

Module-2

3 a. Discuss the various properties of codes. **(04 Marks)**

b. What is Kraft Inequality? Clearly explain with suitable examples. **(06 Marks)**

c. Construct binary code for the following source using Shannon's binary encoding procedure, $S = \{S_1, S_2, S_3, S_4, S_5\}$, $P = \{0.4, 0.25, 0.15, 0.12, 0.08\}$ **(06 Marks)**

OR

4 a. Consider a zero-memory source with,
$S = \{S_1, S_2, S_3, S_4, S_5, S_6, S_7\}$, $P = \{0.4, 0.2, 0.1, 0.1, 0.1, 0.05, 0.05\}$

(i) Construct a binary Huffman code by placing the composite symbol as low as you can.

(ii) Repeat (i) By moving the composite symbol 'as high as possible'.

In each of the cases (i) and (ii) above. Compute the variances of the word-lengths and comment on the result. **(10 Marks)**

b. Compare Huffman coding and Arithmetic coding. **(04 Marks)**

c. State Shannon's first theorem (Noiseless coding theorem). **(02 Marks)**

Module-3

5 a. What is a discrete communication channel? Illustrate the model of a discrete channel. Obtain the equation for P(error) for such a channel. **(08 Marks)**

b. State and discuss Shannon's theorem on channel capacity. **(04 Marks)**

c. For the channel matrix shown below, find the channel capacity, **(04 Marks)**

$$P\left(\frac{b_j}{a_i}\right) = \begin{matrix} a_1 \\ a_2 \\ a_3 \end{matrix}\overset{\begin{matrix} b_1 & b_2 & b_3 \end{matrix}}{\begin{bmatrix} \frac{1}{2} & \frac{1}{3} & \frac{1}{6} \\ \frac{1}{3} & \frac{1}{6} & \frac{1}{2} \\ \frac{1}{6} & \frac{1}{2} & \frac{1}{3} \end{bmatrix}}$$

OR

6 a. State and prove Shannon-Hartley law. **(08 Marks)**

b. Discuss Muroga's method for estimating the channel capacity. **(08 Marks)**

Module-4

7 a. Illustrate the following terms used in error control coding with examples, (i) Block length (ii) Code rate (iii) Hamming weight (iv) Hamming distance (v) Minimum distance. **(10 Marks)**

b. What is the use of syndromes? Explain syndrome decoding. **(06 Marks)**

OR

8 a. The parity check matrix of a particular (7, 4) linear block code is given by,

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

(i) Find the generator matrix (G).
(ii) List all the code vectors.
(iii) What is the minimum distance between code vectors.
(iv) How many errors can be detected? How many errors can be corrected? **(10 Marks)**

b. For a systematic linear block code, the three parity check digits, C_4, C_5 and C_6 are given by

$C_4 = d_1 \oplus d_2 \oplus d_3$, $C_5 = d_1 \oplus d_2$; $C_6 = d_1 \oplus d_3$

(i) Construct the generator matrix.
(ii) Construct the code generated by this matrix. **(06 Marks)**

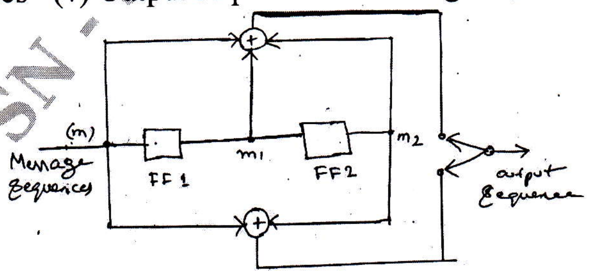
Module-5

9 a. Briefly explain the following codes:
(i) BCH codes (ii) Reed-Soloman codes. (iii) Golay codes. **(08 Marks)**

b. What are convolutional codes? With block diagram explain the operation of convolutional encoder. **(08 Marks)**

OR

10 For the convolutional encoder shown below in Fig.Q10, determine the following:
(i) Dimension of code. (ii) Code rate (iii) Constraint length
(iv) Generating sequences (v) Output sequence for message of, m = {1 0 0 1 1}. **(16 Marks)**



Convolutional encoder Fig. Q10

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