CBCS SCHEME

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Fifth Semester B.E. Degree Examination, June/July 2025

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.

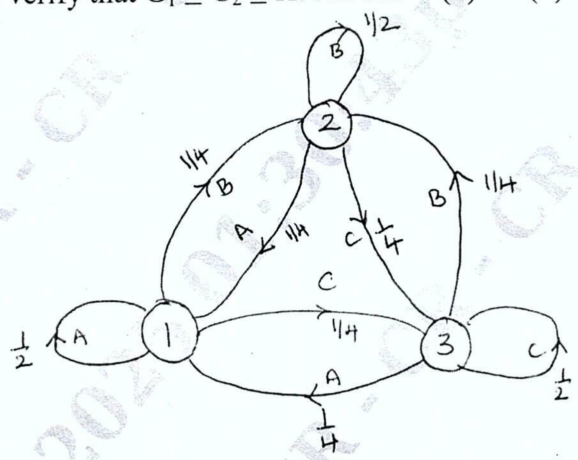
Module-1

1 a. Discuss the reasons for using Logarithmic measure for measuring the amount of information and mention the different measuring units. **(06 Marks)**

b. The output of an information source consists of 128 symbols, 16 of which occur with a probability of $\frac{1}{32}$ and the remaining 112 occur with a 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. **(04 Marks)**

c. The state diagram of a stationary Markoff 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, G_2 and verify that $G_1 \geq G_2 \geq H$. Assume P(1) = P(2) = P(3) = 1/3. **(10 Marks)**

Fig. Q1(c)



OR

2 a. Derive an expression for average information content of symbols in long independent sequence. **(04 Marks)**

b. The international Morse code uses a sequence of dots and dashes to transmit letters of the English alphabet. The dash is represented by a current pulse that has a duration of 3 units and the dot has a duration of 1 unit. The Probability of occurrence 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 the average information in the dot – dash code.
   iii) Assume that the dot lasts 1 m sec, which is the same time interval as the pause between symbols. Find the average rate of information transmission. **(06 Marks)**

c. For the Markoft source shown in Fig. Q2(c), find the i) Source Entropy ii) G_1 and G_2. **(10 Marks)**

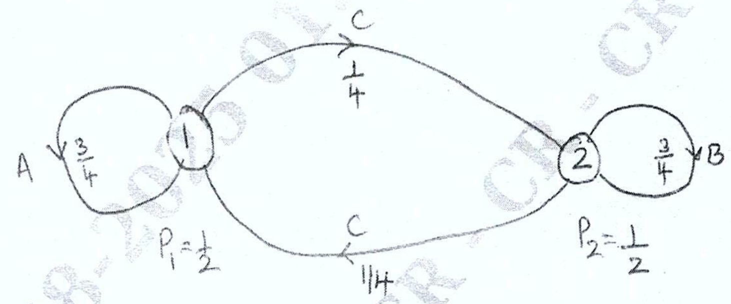


Fig. Q2(c)

Module-2

3 a. State Shannon's first theorem and Kraft – McMilan inequality. **(04 Marks)**

b. Consider a discrete memory less source having symbols S_1, S_2, S_3, S_4, S_5, S_6, S_7 and S_8 with the corresponding probabilities $\frac{1}{4}, \frac{1}{4}, \frac{1}{8}, \frac{1}{8}, \frac{1}{16}, \frac{1}{16}, \frac{1}{16}$ and $\frac{1}{16}$. Find the code words for the symbols using Shannon's and Shannon - Fano algorithms. Also find the efficiency and redundancy. **(16 Marks)**

OR

4 a. What are Prefix codes? Identify the prefix codes in the four codes listed below :. **(06 Marks)**

Symbol	Code I	Code II	Code III	Code IV
S_0	0	0	0	00
S_1	10	01	01	01
S_2	110	001	011	10
S_3	1110	0010	110	110
S_4	1111	0011	111	111

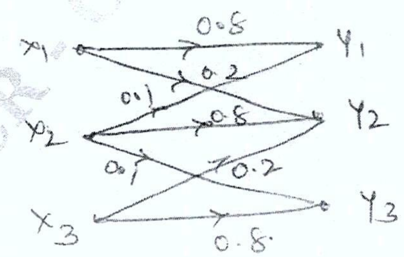
b. A discrete memory less source has a alphabet of five symbols with probabilities 0.4, 0.2, 0.2, 0.1 and 0.1. Construct two different binary Huffman codes. Find the efficiency and variance. **(14 Marks)**

Module-3

5 a. What is Mutual information? Mention its properties. Prove that I(x ; y) = I (y ; x). **(12 Marks)**

b. Find the capacity of the discrete channel shown in Fig. Q5(b), if r_s = 10000 symbols/sec. **(08 Marks)**

Fig. Q5(b)



OR

6 a. Derive an expression for the channel capacity of a binary symmetric channel. **(06 Marks)**

b. For the communication channel shown in Fig. Q6(b), determine mutual information and information rate if $r_s = 1000$ symbols/sec. Assume $P(x_1) = P(x_2) = 1/2$. **(06 Marks)**

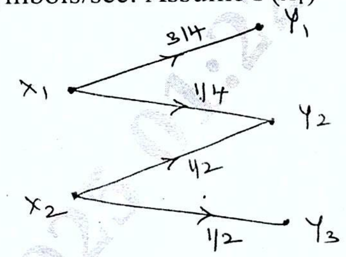


Fig. Q6(b)

c. For joint probability matrix shown in Fig. Q6(c). Find H(x), H(y), H(x, y), H(y/x)

$$P(X, Y) = \begin{bmatrix} 0.05 & 0 & 0.20 & 0.05 \\ 0 & 0.10 & 0.10 & 0 \\ 0 & 0 & 0.20 & 0.10 \\ 0.05 & 0.05 & 0 & 0.10 \end{bmatrix}$$

(08 Marks)

Module-4

7 a. Consider a (7, 4) linear block code whose generator matrix is

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

i) Find all the code vectors of this code ii) Find the parity check matrix for this code
iii) Find the minimum weight of this code. **(06 Marks)**

b. A (15.5) linear cyclic code has a generator polynomial $g(x) = 1 + x + x^2 + x^4 + x^5 + x^8 + x^{10}$.
i) Draw the block diagrams of an encoder and syndrome calculator for this code.
ii) Find the code polynomial for the message polynomial $D(x) = 1 + x^2 + x^4$ (in a systematic form).
iii) Is $V(x) = 1 + x^4 + x^6 + x^8 + x^{14}$ a code polynomial? If not, find the syndrome V(x). **(14 Marks)**

OR

8 a. Design a linear block code with a minimum distance of three and a message block size of eight bits. **(10 Marks)**

b. Design an encoder for the (7, 4) binary cyclic code generated by $g(x) = 1 + x + x^3$. **(10 Marks)**

Module-5

9 a. Consider a (3, 1, 2) convolution code with $g(1) = (110)$ $g^{(2)} = (101)$ and $g^{(3)} = (111)$.
i) Draw the encoder block diagram ii) Find the generator matrix
iii) Find the code word corresponding to the information sequence (11101) using time domain and transfer domain approach. **(16 Marks)**

b. Write a short note on code tree. **(04 Marks)**

OR

10 a. Consider a (2, 1, 3) convolution encoder, find the output sequence for the input message d = 10111 using time domain and transfer domain approach for $g^{(1)} = 1011$ and $g^{(2)} = 1111$. **(16 Marks)**

b. Write a short note on : i) Trellis and ii) State diagram. **(04 Marks)**