CBCS SCHEME

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15EC54

Fifth Semester B.E. Degree Examination, Feb./Mar. 2022
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. For the rolling of two dices, obtain the probability of obtaining the sum 10 and also the probability of obtaining a sum greater than or equal to 10. **(04 Marks)**

b. The output of an information source contains 160 symbols, 128 of which occur with a probability of 1/256 and remaining with a probability of 1/64 each. Find the average information rate of source if source emits 10,000 symbols/sec. **(04 Marks)**

c. Consider Markoff source shown in Fig. Q1(c). Find
i) State probabilities ii) State entropies iii) Source entropy. **(08 Marks)**

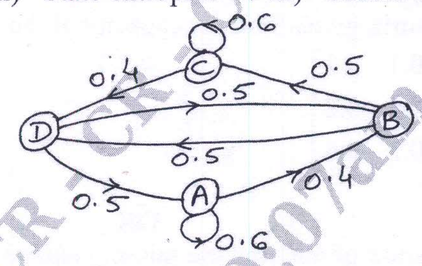

Fig. Q1(c)

OR

2 a. Derive an expression for average information content (entropy) of long independent messages. **(04 Marks)**

b. For the source model shown in Fig. Q2(b), find the source entropy and the average information content per symbol in messages containing one, two and three symbols. **(12 Marks)**

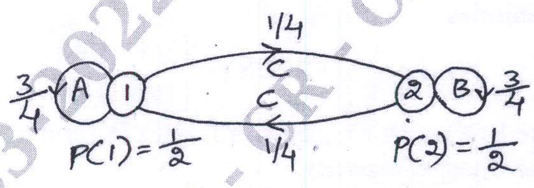

Fig. Q2(b)

Module-2

3 a. Consider a source with source alphabets S = (A, B, C, D) with corresponding probability P = (0.1, 0.2, 0.3, 0.4). Find the code words for symbol using Shannon's algorithm. Also find the source efficiency and redundancy. **(08 Marks)**

b. Consider a system emitting one of the three symbols A, B, and C with respective probabilities 0.7, 0.15 and 0.15. Calculate its efficiency and redundancy. **(04 Marks)**

c. Write note on Kraft Mc. Millan inequality. **(04 Marks)**

OR

4 a. Find the codewords for the source using Shannon Fano algorithm. Also find source efficiency and redundancy. S = (A, B, C, D, E, F) P = (0.10, 0.15, 0.25, 0.35, 0.08, 0.07). **(05 Marks)**

b. Construct a quaternary Huffman code for the following set of message symbols with respective probabilities :

A	B	C	D	E	F	G	H
0.22	0.2	0.18	0.15	0.1	0.08	0.05	0.02

Also find efficiency and redundancy. **(06 Marks)**

c. Explain steps in Shannon's encoding algorithm for generating Binary codes. **(05 Marks)**

Module-3

5 a. For the JPM given, find all the entropies.

$$P(x, y) = \begin{bmatrix} 0.05 & 0 & 0.20 & 0.05 \\ 0 & 0.10 & 0.10 & 0 \\ 0 & 0 & 0.20 & 0.10 \\ 0.05 & 0.05 & 0 & 0.10 \end{bmatrix}.$$

(06 Marks)

b. Show that H(X, Y) = H(X/Y) + H(Y). **(04 Marks)**

c. For the channel matrix given, find the capacity of the channel.

$$P(Y/X) = \begin{bmatrix} 0.8 & 0.1 & 0.1 \\ 0.2 & 0.6 & 0.2 \\ 0.2 & 0.2 & 0.6 \end{bmatrix}.$$

(06 Marks)

OR

6 a. For the channel matrix given, find the missing entries. Also draw the corresponding channel diagram.

$$P(Y/X) = \begin{bmatrix} 0.8 & * & 0.2 \\ * & 0.6 & 0.2 \\ 0.2 & 0.3 & * \end{bmatrix}.$$

(04 Marks)

b. Noise matrix of a binary symmetric channel is illustrated below which has following source symbol probabilities :

$$P(x_1) = \frac{2}{3}, \quad P(x_2) = \frac{1}{3} \quad P(Y/X) = \begin{bmatrix} 3/4 & 1/4 \\ 1/4 & 3/4 \end{bmatrix}$$

i) Determine H(X) , H(Y) , H(X, Y) , H(Y/X) and I(X, Y). **(08 Marks)**

ii) Determine Channel capacity.

c. Show that H(X, Y) = H(Y/X) + H(X). **(04 Marks)**

Module-4

7 For the following (6, 3) systematic LBC.

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

i) Find all code vectors.
ii) Draw encoder circuit for above code.
iii) Find minimum Hamming weight.
iv) Find error detecting and error correcting capability.
v) Draw syndrome calculation circuit.
vi) Find syndrome of received vector (101111) and correct error if any. **(16 Marks)**

OR

8 a. For a systematic (7, 4) LBC, parity matrix is

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

i) Find all possible code vectors.
ii) Draw corresponding encoder and syndrome calculation circuit.
iii) Detect and correct the single bit error in following received vectors :
$R_A = [0\ 1\ 1\ 1\ 1\ 1\ 0]$; $R_B = [1\ 0\ 1\ 1\ 1\ 0\ 0]$; $R_C = [1\ 0\ 1\ 0\ 0\ 0\ 0]$. **(12 Marks)**

b. Define Hamming weight , Hamming distance and Minimum distance of LBC with examples. **(04 Marks)**

Module-5

9 Consider (3, 1, 2) convolution code with $g^{(1)} = (110)$, $g^{(2)} = (101)$, $g^{(3)} = (111)$.
i) Find constraint length.
ii) Find the rate.
iii) Draw encoder block diagram.
iv) Find generator matrix.
v) Find codeword for message sequence (11101) using time domain approach.
vi) Repeat (v) using transfer domain approach. **(16 Marks)**

OR

10 a. Write short notes on Golay codes and BCH codes. **(08 Marks)**

b. Consider a (2, 1, 2) convolution code with generator polynomial $g_1(101)$ and $g_2(011)$. Draw encoder diagram. Find encoded sequence for input (101101) using time domain and transfer domain approach. **(08 Marks)**

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