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10EC55

Fifth Semester B.E. Degree Examination, December 2012
Information Theory and Coding

Time: 3 hrs. Max. Marks:100

Note: ***Answer FIVE full questions, selecting at least TWO questions from each part.***

PART – A

1 a. Define the following with respect to information theory: i) Self information ii) Entropy iii) Rate of information iv) Mutual information. **(04 Marks)**

b. Prove that the entropy of the following probability distribution function is $2-\left(\frac{1}{2}\right)^{n-2}$. **(08 Marks)**

Symbols:	x_1	x_2	x_3	....	x_{n-1}	x_n
Probability of $(x = x_i)$:	$\frac{1}{2}$	$\frac{1}{4}$	$\frac{1}{8}$	....	$\frac{1}{2^{n-1}}$	$\frac{1}{2^{n-1}}$

c. A sample space of events is shown in the diagram below with probability $P=\left\{\frac{1}{5},\frac{4}{15},\frac{8}{15}\right\}$,

i) Evaluate average uncertainity associated with the scheme.

ii) Average uncirtainity pertaining to the following probability scheme:

$P[A/M = B\cup C]$, $P\left[{}^{B}\!/_{M}, {}^{C}\!/_{M}\right]$

iii) Verify additive rule. **(08 Marks)**

2 a. Given the model of a Markoff source in Fig. Q2 (a)

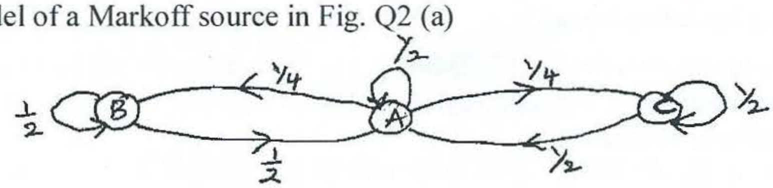

Fig. Q2 (a)

Find i) State probability ii) Entropy of first order and second order source

iii) Efficiency and redundancy of first order source

iv) Find rate of information if $r_s = 1$ sym/sec. **(10 Marks)**

b. Design an encoder using Shannons encoding algorithm for a source having six symbols and probability statistics $P=\left\{\frac{1}{2},\frac{1}{4},\frac{1}{8},\frac{1}{16},\frac{1}{32},\frac{1}{32}\right\}$. **(10 Marks)**

3 a. Consider a source with 8 alphabets A to H with respective probabilities of 0.22, 0.20, 0.18, 0.15, 0.10, 0.08, 0.05, 0.02

i) Construct a binary compact code and determine coding efficiency using Huffman coding algorithm.

ii) Construct ternary Huffman code and determine efficiency of the code. **(10 Marks)**

b. Prove that $H(X/Y) = p.H(X)$ for a binary erasure channel. **(05 Marks)**

c. Given the following channel matrix find the channel capacity:

$$P\left({}^{Y}\!/_{X}\right)= \begin{array}{c} \\ x_1 \\ x_2 \\ x_3 \end{array} \begin{array}{c} \begin{array}{ccc} y_1 & y_2 & y_3 \end{array} \\ \begin{bmatrix} 0.8 & 0.2 & 0 \\ 0.1 & 0.8 & 0.1 \\ 0 & 0.2 & 0.8 \end{bmatrix} \end{array}$$

(05 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.

4 a. Define i) Differential entropy ii) Shannon's limit **(02 Marks)**

b. Prove that for an infinite bandwidth signal energy to noise ratio $\frac{E}{\eta}$ approaches a limiting value. **(06 Marks)**

c. A black and white TV picture may be viewed as consisting of 3×10^5 elements, each of which occupies 10 distinct brightness levels with equal probability. Assume rate of transmission as 30 picture frames per sec and SNR = 30 dB. Using channel capacity theorem compute minimum bandwidth to error free transmission of video signal. **(06 Marks)**

d. Prove that $\lim_{B \to \infty} C = 1.44 \frac{S}{\eta}$. **(06 Marks)**

PART – B

5 a. Consider a systematic (7, 4) linear block code, the parity check matrix,

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

i) Find all possible code words.

ii) Draw encoding circuit.

iii) A single bit error has occurred in each of the following code words given:

$R_A = [0\ 1\ 1\ 1\ 1\ 1\ 0]$, $R_B = [1\ 0\ 1\ 1\ 1\ 0\ 0]$

Detect and correct these errors

iv) Draw syndrome computation circuit. **(12 Marks)**

b. Find generator matrix G and H-matrix for a linear block code with $d_{min} = 3$ and message block size of 8 bits. **(04 Marks)**

c. Test hamming bound of (7, 4) hamming code and show that it is a perfect code. **(04 Marks)**

6 a. Design an encoder for (7, 4) binary cyclic code generated by $G(x) = 1 + x + x^3$ and verify its operation using message vectors (1 0 0 1) and (1 0 1 1). Also verify the code obtained using polynomial arithmetic. **(10 Marks)**

b. For a (7, 4) cyclic code with received vector Z is 1 1 1 0 1 0 1, with the generator polynomial $G(x) = 1 + x + x^3$. Draw the syndrome computation circuit and correct, the error in the received vector. **(10 Marks)**

7 Write short notes on: a. Shortened cyclic codes b. Golay codes. c. BCH codes. d. RS codes. **(20 Marks)**

8 a. For the convolution encoder shown in Fig. Q8 (a).

i) Find impulse response and hence calculate the output produced by the information sequence (1 0 1 1 1).

ii) Write the generator polynomials of the encoder and recompute the output of the input of (i) and compare with that of (ii). **(08 Marks)**

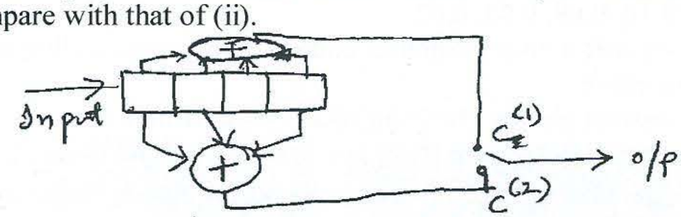

Fig. Q8 (a)

b. Consider a (3, 1, 2) convolution encoder with $g^{(1)} = 1\ 1\ 0$ and $g^{(2)} = 1\ 0\ 1$, $g^{(3)} = 1\ 1\ 1$. Draw encoder block diagram, find generator matrix. Find code vector corresponding to information sequence D = 1 1 1 0 0 0 using time and frequency domain approach. Draw state diagram and code tree. **(12 Marks)**

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