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10EC55

Fifth Semester B.E. Degree Examination, Dec.2018/Jan.2019
Information Theory and Coding

Time: 3 hrs. Max. Marks:100

Note: ***Answer any FIVE full questions, selecting atleast TWO questions from each part.***

PART – A

1 a. Discuss the reasons for using logarithmic measure for measuring information. **(03 Marks)**

b. Derive an expression for the entropy of symbols in long independent sequence. find the entropy of a source in Nats/symbol of a source that emits one out of four symbols A, B, C and D in a statically independent sequence with probabilities $\frac{1}{2}$, $\frac{1}{4}$, $\frac{1}{8}$ and $\frac{1}{8}$. **(07 Marks)**

c. For the first order Markoff model as shown below Fig.Q1(c), find the state probabilities, entropy of each state, entropy of the source and show that $G_1 > H(s)$. **(10 Marks)**

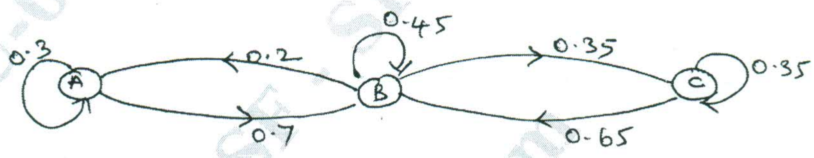

Fig.Q1(c)

2 a. A source emits an independent sequence of symbols from an alphabet consisting of five symbols A, B, C, D, E with probabilities $\frac{1}{4}, \frac{1}{8}, \frac{1}{8}, \frac{3}{16}$ and $\frac{5}{16}$ respectively. Find the binary code using Shannon's binary algorithm. Also find coding efficiency. **(10 Marks)**

b. For the channel matrix shown below for which $P(x_1) = \frac{1}{2}$, $P(x_2) = P(x_3) = \frac{1}{4}$ and $r_s = 10{,}000$/sec. Find H(x), H(y), H(y/x), H(x,y), I(x,y) and channel capacity.

$$P(y/x) = \begin{bmatrix} 0.8 & 0.2 & 0 \\ 0.1 & 0.8 & 0.1 \\ 0 & 0.2 & 0.8 \end{bmatrix}.$$ **(10 Marks)**

3 a. For the following source,

$S = \{s_1, s_2, s_3, s_4, s_5, s_6, s_7\}$ with probabilities

$P = \left\{\frac{1}{3}, \frac{1}{3}, \frac{1}{9}, \frac{1}{9}, \frac{1}{27}, \frac{1}{27}, \frac{1}{27}\right\}$

i) Find the compact Huffman code when X = {0, 1} and X = {0, 1, 2}

ii) Find the coding efficiency for the above codes. **(10 Marks)**

b. Two noisy channels are cascaded whose channel matrices are given by

$$P(y/x) = \begin{bmatrix} \frac{1}{4} & \frac{1}{2} & \frac{1}{4} \\ \frac{1}{2} & \frac{1}{4} & \frac{1}{4} \end{bmatrix}, \quad P(z/y) = \begin{bmatrix} \frac{1}{3} & \frac{2}{3} & 0 \\ \frac{2}{3} & 0 & \frac{1}{3} \\ 0 & \frac{1}{3} & \frac{2}{3} \end{bmatrix}$$

With $P(x_1) = P(x_2) = 0.5$, show that $I(x,y) > I(x, z)$. **(10 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.

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4 a. For the channel matrix shown below, find channel capacity and derive the expression for same.

$$P(b/a) = \begin{bmatrix} 0.4 & 0.3 & 0.2 & 0.1 \\ 0.4 & 0.1 & 0.3 & 0.2 \\ 0.1 & 0.2 & 0.4 & 0.3 \end{bmatrix}.$$ **(06 Marks)**

b. State and prove Shannon's Hartley law. Derive the expression for the upper limit of channel capacity. **(06 Marks)**

c. An analog signal has 4KHz bandwidth. The signal is sampled at 2.5 times the Nyquist rate and each sample is quantized to 256 equally likely levels. All samples are statistically independent.

i) What is information rate of the signal

ii) Can the output of this source be transmitted without errors over a Gaussian channel with a band width of 50KHz and S/N ratio of 23dB?

iii) What will be the bandwidth required for transmitting the o/p of the signal without errors, if S/N ratio is 10dB. **(08 Marks)**

PART – B

5 a. Prove that $C.\, H^T = 0$. **(04 Marks)**

b. The parity check bits of a (8, 4) linear block code is given by,

$C_5 = d_1 + d_2 + d_4, \quad C_6 = d_1 + d_2 + d_3,$

$C_7 = d_1 + d_3 + d_4, \quad C_8 = d_2 + d_3 + d_4,$

where d_1 d_2 d_3 and d_4 are databits.

i) Find generator and parity check matrix of this code

ii) Find all the code vectors

iii) Draw the encoding and syndrome calculation circuit. **(08 Marks)**

c. Design a linear block code with a minimum distance of three and message block size of eight bits. **(08 Marks)**

6 a. Given the generator polynomial of (7, 4) cyclic code $g(x) = 1 + x^2 + x^3$,

i) Find the code vector of messages 0101, 0111, 1010 and 1100 in systematic form

ii) Draw the syndrome calculation circuit. **(12 Marks)**

b. Consider a (15, 11) cyclic code generated by $g(x) = 1 + x^3 + x^4$. Derive a feedback shift register encoder circuit. Illustrate the encoding procedure with the message 11101000111 by listing the state of registers. **(08 Marks)**

7 Write a short note on:

a. Golay codes

b. Shortened cyclic code

c. Rs codes

d. Burst error correcting codes. **(20 Marks)**

8 Consider the (3, 1, 2) convolution code with impulse response $g^{(1)} = 110$, $g^{(2)} = 101$, $g^{(3)} = 111$.

a. Draw the endoder block diagram

b. Find generator matrix

c. Find the codeword corresponds to the message sequence 11101 using :

i) Time domain approach

ii) Transform domain approach. **(20 Marks)**

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