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06EC65

Sixth Semester B.E. Degree Examination, May/June 2010
Information Theory and Coding

Time: 3 hrs. Max. Marks:100

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

PART – A

1 a. A binary source is emitting an independent sequence of 0's and 1's with the probabilities P and (1 – P) respectively. Plot the entropy of the source versus probability [0 < P < 1]. Write the conclusion. **(04 Marks)**

b. In a facsimile transmission of picture there are about 3.25×10^6 pixels per frame. For a good reproduction, 15 brightness levels are necessary. Assume all these levels are equally likely to occur. Find the rate of information transmission if one picture is to be transmitted every 3 minutes. **(05 Marks)**

c. The state diagram of the Mark off source is as shown in the Fig.Q1(c). P(state i) = $\frac{1}{3}$ for i = 1, 2, 3. Find : i) the entropy of each state Hi, ii) the entropy of source H, iii) G_1, G_2 and H. **(11 Marks)**

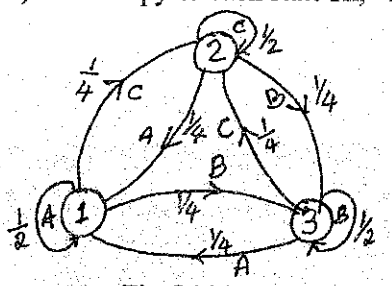

Fig.Q1(c)

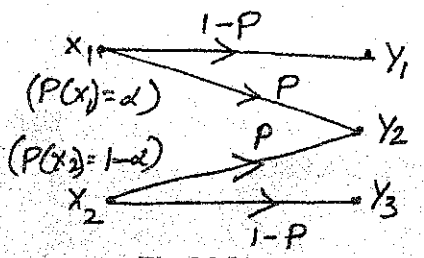

Fig.Q3(b)

2 a. What are the important properties of codes while encoding a source? **(05 Marks)**

b. A source emits an independent sequence of symbols from an alphabet consisting of five symbols A, B, C, D and E with probabilities of $\frac{1}{4}$, $\frac{1}{8}$, $\frac{1}{8}$, $\frac{3}{16}$ and $\frac{5}{16}$ respectively. Find the Shannon code for each symbol and efficiency and redundancy of the coding scheme. **(06 Marks)**

c. For a channel whose matrix is given below for which $P(x_1) = \frac{1}{2}$, $P(x_2) = P(x_3) = \frac{1}{4}$ and r_s = 10000/sec, find H(x), H(y), $H\left(\frac{y}{x}\right)$, H(x, y), I(x, y) and the capacity.

$$P\left[\frac{y}{x}\right] = \begin{bmatrix} 0.8 & 0.2 & 0 \\ 0.1 & 0.8 & 0.1 \\ 0 & 0.2 & 0.8 \end{bmatrix}$$ **(09 Marks)**

3 a. Design a quaternary and binary source code for the source shown, using Huffman's coding scheme. S = {S_1, S_2, S_3, S_4, S_5, S_6, S_7} ; P = $\left\{\frac{9}{32}, \frac{3}{32}, \frac{3}{32}, \frac{2}{32}, \frac{9}{32}, \frac{3}{32}, \frac{3}{32}\right\}$; X = {0, 1, 2, 3} and X = ||0, 1||. Find the coding efficiency. **(12 Marks)**

b. For a binary erasure channel shown in Fig.Q3(b), find the following:
i) Average mutual information
ii) Channel capacity
iii) Values of $P(x_1)$ and $P(x_2)$ for maximum mutual information. **(08 Marks)**

4 a. State and explain Shannon Hartley law. Derive the expression for the upper limit of the channel capacity. **(06 Marks)**

b. A voice grade channel of the telephone network has the bandwidth of 3.4 KHz. Calculate:
i) The channel capacity for a SNR of 30 dB
ii) The minimum SNR required to support information transmission at the rate of 4800 bits/sec. **(06 Marks)**

c. Show that : i) $I(x, y) \geq 0$; ii) $I(x, y) = (y, x)$; iii) $I(x, y) = H(x) + H(y) - H(x, y)$. **(08 Marks)**

PART – B

5 a. Consider the (7, 4) LBC whose generator matrix is given below. Find:
i) All code vectors ii) Parity check matrix, H
iii) The minimum weight and distance of this code.

$$[G] = \begin{bmatrix} 1000 & 101 \\ 0100 & 111 \\ 0010 & 110 \\ 0001 & 011 \end{bmatrix}$$ **(10 Marks)**

b. Prove that $CH^T = 0$. **(04 Marks)**

c. Why do we need error control coding? What are the types of errors and types of coding to combat them? **(06 Marks)**

6 a. A (15, 5) linear cyclic code has a generator polynomial, $g(x) = 1 \oplus x \oplus x^2 \oplus x^4 \oplus x^5 \oplus x^8 \oplus x^{10}$.
i) Draw block diagrams of an encoder and syndrome calculator circuit for this code.
ii) Find the code polynomial for the message polynomial $D(x) = 1 \oplus x^2 \oplus x^4$ (in a systematic form).
iii) Is $V(x) = 1 \oplus x^4 \oplus x^6 \oplus x^8 \oplus x^{14}$ a code polynomial? If not, find the syndrome of V(x). **(12 Marks)**

b. What is a binary cyclic code? Discuss the features of encoder and decoder used for cyclic codes using an (n – k) bit shift register. **(08 Marks)**

7 a. Explain briefly the following: **(09 Marks)**
i) Golay code ii) BCH code
iii) Shortened cyclic code iv) Reed Solomon code.

b. Consider a [15, 9] cyclic code generated by $g(x) = 1 \oplus x^3 \oplus x^4 \oplus x^5 \oplus x^6$. Find the burst error correcting efficiency of this code. **(06 Marks)**

c. List the advantages and disadvantages of cyclic codes. **(05 Marks)**

8 Fig.Q8 below shows the convolutional encoder:

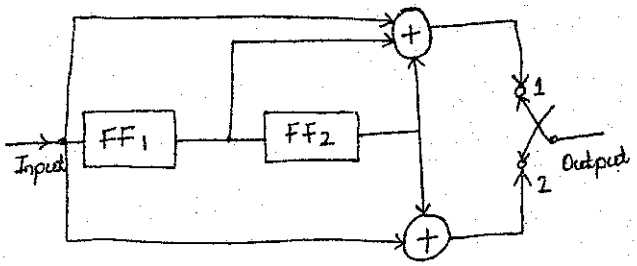

Fig.Q8

a. Write the impulse response of this encoder. **(03 Marks)**

b. Find the output for the message (10011) using time domain approach. **(05 Marks)**

c. Find the output for the message (10011) using transform domain approach. **(05 Marks)**

d. Draw the code tree for the encoder. **(07 Marks)**

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