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06EC65

Sixth Semester B.E. Degree Examination, June/July 2011

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. Justify that the information content of a message is a logarithmic function of its probability of emission. **(06 Marks)**

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

c. Given is the model of a Markoff source in Fig.Q1(c).

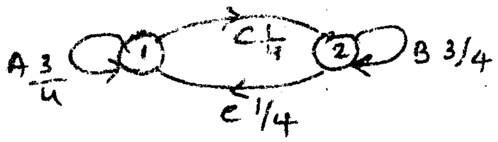

Fig.Q1(c)

Find, i) State probability ii) Entropy of first order source and second order source H(s) and $H(s^2)$ iii) G_1, G_2 iv) Efficiency and redundancy of first order source. **(10 Marks)**

2 a. Explain Shannon encoding algorithm. Design an encoder using Shannon encoding algorithm for a source having 5 symbols and probability statistics P = { 1/8, 1/16, 3/16, 1/4, 3/8 }. Find coding efficiency and redundancy. **(10 Marks)**

b. Explain with a neat block diagram, the digital communication system indicating the various types of communication channels. Also, define the various probabilities and their relationship with respect to coding channel. **(10 Marks)**

3 a. A source emits an independent sequence of symbols from an alphabet consisting of 5 symbols A, B, C, D and E with probabilities P = { 0.4, 0.2, 0.2, 0.1, 0.1 }. Determine Huffman code by, i) Shifting the combined symbols as high as possible. ii) Shifting the combined symbol as low as possible. iii) Find coding efficiency and variance of both the codes. **(10 Marks)**

b. The input to the channel consists of 5 letters X = { x_1, x_2, x_3, x_4, x_5 } and output consists of four letters Y = { y_1, y_2, y_3, y_4 }. The JPM of this channel is given in Fig.Q3(b).

	y_1	y_2	y_3	y_4
x_1	0.25	0	0	0
x_2	0.1	0.3	0	0
x_3	0	0.05	0.1	0
x_4	0	0	0.05	0.1
x_5	0	0	0.05	0

Fig.Q3(b)

i) Compute H(x), H(y), H(xy), H(y/x) and H(x/y)
ii) Rate of data transmission and mutual information.
iii) Channel capacity, channel efficiency and redundancy. **(10 Marks)**

4 a. Derive an expression for channel capacity of a binary Erasure Channel. **(06 Marks)**

b. Explain the Shannon Hartley theorem and that $\lim_{B \to \infty} C = 1.44 \frac{S}{\eta}$ **(08 Marks)**

c. A CRT terminal is used to enter alphanumeric data into a computer. The CRT is connected through a voice grade telephone line having usable bandwidth of 3 kHz and an output S/N of 10 dB. Assume that the terminal has 128 characters and data is sent in an independent manner with equal probabilities.
   i) Find the average information per character.
   ii) Find the channel capacity
   iii) Find the maximum rate at which the data can be sent from terminal to computer without error. **(06 Marks)**

PART – B

5 a. Explain the matrix representation of linear block codes. **(06 Marks)**

b. Consider a (6, 3) linear block code whose generator matrix is given below.

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

Find, i) All code words ii) All naming weights and distances iii) Minimum weight and minimum distance iv) Parity check matrix v) Draw the encoder circuit. **(14 Marks)**

6 a. A (7, 4) binary cyclic code has a generator polynomial $g(x) = 1 + x + x^3$
   i) Write the syndrome circuit ii) Verify the circuit for the message polynomial $d(x) = 1 + x^3$. **(08 Marks)**

b. A (15, 5) binary cyclic code has a generator polynomial $g(x) = 1 + x + x^2 + x^4 + x^5 + x^8 + x^{10}$
   i) Draw encoder block diagram
   ii) Find code polynomial for message polynomial $d(x) = 1 + x^2 + x^4$ in systematic form
   iii) Is $v(x) = 1 + x^4 + x^6 + x^8 + x^{14}$ a code polynomial? If not, find the syndrome of v(x). **(12 Marks)**

7 Explain the following error control codes:
   i) Golay codes
   ii) Shortened cyclic codes
   iii) RS codes
   iv) Burst and random error correcting codes. **(20 Marks)**

8 Consider the (3, 1, 2) convolutional code with $g^{(1)} = (1\ 1\ 0)$, $g^{(2)} = (1\ 0\ 1)$ and $g^{(3)} = (1\ 1\ 1)$.
   i) Find constraint length
   ii) Find rate efficiency
   iii) Draw the encoder block diagram
   iv) Find the generator matrix
   v) Find the codeword for the message sequence (1 1 1 0 1) using time-domain and transfer domain approach. **(20 Marks)**

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