USN | | | | | | | | | | | **06EC65**

Sixth Semester B.E. Degree Examination, June / July 2013

Information Theory and Coding

Time: 3 hrs. Max. Marks:100

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

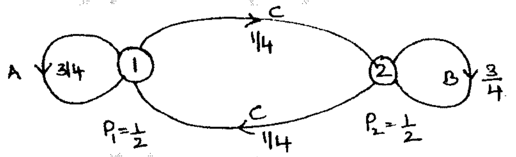
PART - A

1 a. Discuss the reasons for using logarithmic function for measuring the amount of information. **(04 Marks)**

b. The International Morse code uses a sequence of dots and dashes to transmit letters of English alphabet. The dash is represented by a current pulse that has a duration of 3 units and the dot has a duration of 1 unit. The probability of occurrence of a dash is 1/3 of the probability of occurrence of a dot. i) calculate the information content of a dot and a dash. ii) Calculate the average information in the dot – dash code iii) Assume that the dot lasts for 1 msec, which is the same time interval as the pause between symbols. Find the average rate of information transmission. **(06 Marks)**

c. For the Markoff source shown in fig. Q1(c), find i) Source Entropy ii) G_1 , G_2 and G_3. **(10 Marks)**

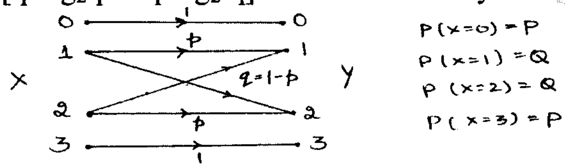
Fig.Q1(c)



2 a. Explain the steps in the Shannon's encoding algorithm for generating binary code. Design an encoder using Shannon encoding algorithm for a source having 5 symbols and probability statistics $P = \left\{\frac{1}{8}, \frac{1}{16}, \frac{3}{16}, \frac{1}{4}, \frac{3}{8}\right\}$. Find the coding efficiency and redundancy. **(10 Marks)**

b. Show that the capacity of a discrete channel shown in fig. Q2(b) is $C = \log_2\left[\frac{2(\beta+1)}{\beta}\right]$ bits/sec, where $\beta = 2^{\alpha}$ and $\alpha = -[\, p\log_2 p + q \log_2 q]$. Assume rs = 1 symbol / sec. **(10 Marks)**

Fig.Q2(b)



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 symbol 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. A binary symmetric channel has the following noise matrix with source probabilities of $P(X_1) = \frac{2}{3}$ and $P(X_2) = \frac{1}{3}$.

$P(Y/X) = \begin{bmatrix} \frac{3}{4} & \frac{1}{4} \\ \frac{1}{4} & \frac{3}{4} \end{bmatrix}$. i) Determine H(X), H(Y) , H(X, Y) , H(Y/X) and H(X/Y) ii) Find the channel capacity. **(10 Marks)**

4 a. Define mutual information. Describe the four properties of mutual information. **(10 Marks)**
b. State Shannon – Hartley law. Derive an expression for the upper limit of the channel capacity. **(06 Marks)**
c. A Voice – grade channel of the telephone network has a bandwidth of 3.4 kHz.
i) Calculate the channel capacity of the telephone network for a signal – to – noise ratio of 30dB.
ii) Calculate the minimum signal – to – noise ratio required to support information transmission through the telephone channel at the rate of 4800 bits/sec. **(04 Marks)**

PART - B

5 a. What is error control coding? Explain the functional blocks that accomplish error control coding. **(06 Marks)**
b. For a (6, 3) systematic linear block code the parity check bits are generated by $C_4 = d_1 + d_3$, $C_5 = d_1 + d_2 + d_3$, $C_6 = d_1 + d_2$. i) Write the generator matrix ii) Construct all possible code vectors iii) Suppose the received code word is 010111, decode this word by computing the syndrome vector. **(14 Marks)**

6 a. What is a binary cyclic code? Explain with neat diagrams, the implementation of encoding and decoding operations of a binary cyclic code. **(10 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 the block diagram of encoder and syndrome calculator.
ii) Find the code polynomial for message $D(x) = 1 + x^2 + x^4$ in systematic form.
iii) Is $V(x) = 1 + x^4 + x^6 + x^8 + x^{14}$ a code polynomial? **(10 Marks)**

7 Explain the following error control codes :
a. RS codes.
b. Golay codes.
c. Shortened cyclic codes.
d. Burst and random error correcting codes. **(20 Marks)**

8 a. For a (3, 1, 2) convolutional code with impulse responses $g^{(1)} = 110$, $g^{(2)} = 101$, $g^{(3)} = 111$.
i) Draw the encoder block diagram.
ii) Find the generator matrix and the convolutional code for the message sequence 11101 using time domain approach.
iii) Verify code vector found in ii) using transfer domain approach. **(12 Marks)**
b. For a (2, 1, 1) convolutional code with impulse responses $g^{(1)} = 11$, $g^{(2)}$ 10.
i) Draw the block diagram of the encoder.
ii) Find the constraint length and rate efficiency of the encoder.
iii) Find the generator matrix and the convolutional code for the message sequence 1101. **(08 Marks)**

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