Roll No .....

EC-7005 (1) (CBGS)

B.E. VII Semester

Examination, November 2019

Choice Based Grading System (CBGS)

Information Theory and Coding

Time : Three Hours

Maximum Marks : 70

Note: i) Attempt any five questions out of eight.
ii) All questions carry equal marks.
iii) Make suitable assumptions wherever necessary.

1. a) Define uncertainty, information and entropy. State the various units of information and find relation between them. Show that entropy of a binary system (two events) is maximum when both events are equiprobable.

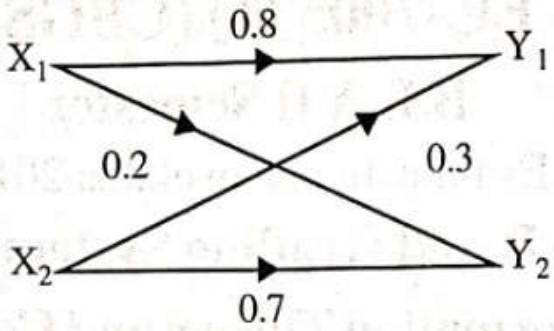
   b) Consider that two sources S_1 and S_2 emit message x_1, x_2, x_3 and y_1, y_2, y_3 with the joint probability p(X, Y) as shown in the matrix form. Calculate H(X), H(Y), H(X/Y) and H(Y/X). Given that:

$$p(Y/X) = \begin{array}{c|ccc} & y_1 & y_2 & y_3 \\ \hline x_1 & 3/40 & 1/40 & 1/40 \\ x_2 & 1/20 & 3/20 & 1/20 \\ x_3 & 1/8 & 1/8 & 3/8 \end{array}$$

2. a) What is mutual information? Prove that the mutual information of a channel is related to the joint entropy of the channel input and channel output is by

$$I(x : y) = H(x) + H(y) - H(x, y)$$

b) Consider a channel given in figure given below:



Given $P(X_1) = 0.6$ and $P(X_2) = 0.4$

Find mutual information and channel capacity.

3. a) Apply the Huffman encoding procedure for the following message ensembles:

$[X] = [X_1 \quad X_2 \quad X_3 \quad X_4 \quad X_5 \quad X_6 \quad X_7]$

$[P] = [0.4 \quad 0.04 \quad 0.08 \quad 0.12 \quad 0.08 \quad 0.08 \quad 0.2]$

Find the codewords for every message and calculate the efficiency of the coding method. The number of symbol used for coding M = 3.

b) Explain the Shannon-Fano coding method with the help of a suitable example.

4. a) Consider a (7, 4) code whose generator matrix is as given below:

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

i) Find all the Code-words of the code.

ii) Find H, Parity check matrix of code.

b) Discuss in detail about Linear Block Codes and relation between message block, codeword block and parity bit block.

5. a) State Source Coding theorem and Channel Coding Theorem. Discuss in detail the implications of these two theorems in information theory.

b) The generator polynomial of a (7, 4) cyclic code is $g(x) = 1 + x + x^2$. Find the code-words of this code.

6. a) Given that Message (D) = 1010001101 and Pattern (P) = 110101, calculate the FCS (R) and the message which is actually transmitted (T) using Cyclic Redundancy Check method. Also check it for correctness at receiver end that received message is correct or not. Do all calculations in clear manner.

b) Explain Viterbi algorithm for maximum likelihood decoding.

7. A convolution encoder is defined by the following generator polynomials:

$g_0(x) = 1 + x + x^2 + x^3 + x^4$

$g_1(x) = 1 + x + x^3 + x^4$

$g_2(x) = 1 + x^2 + x^4$

a) What is the constraint length of this code?

b) How many states are in the trellis diagram of this code.

c) What is the code rate of this code?

8. Write short notes on any three of the following:

i) Hamming Code

ii) Binary Symmetric Channel

iii) Trellis Code

iv) Error Correction and detection

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