Department of Electronics & Communication Engineering.
Bundelkhand Institute of Engineering & Technology, Jhansi.

Assignment Sheet 6

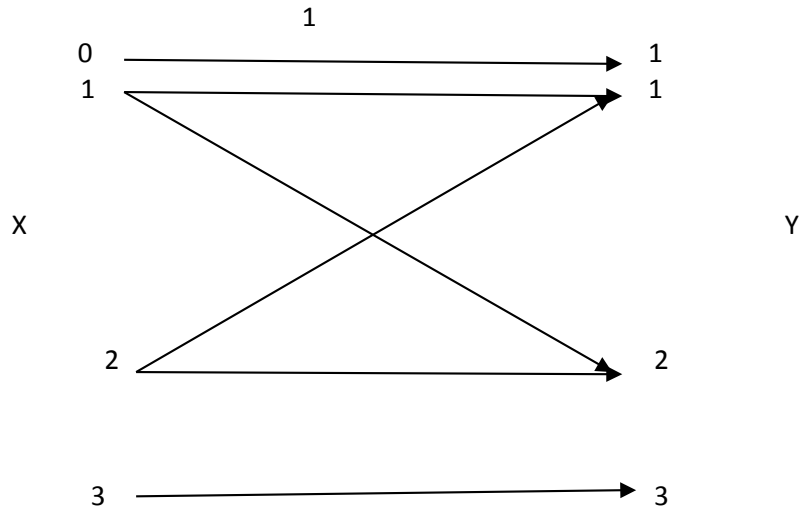
Information Theory and Coding (DC 13)

Instructor: Yogendra Kumar Prajapati
Due Date :
Problems : 10

1. A CRT terminal is used to enter alphanumeric data into a computer. The CRT is connected to the computer through a voice grade telephone line having a usable bandwidth of 3000 Hz and an output S/N of 10 db. Assume that terminal has 128 characters and that the data sent from the terminal consist of independent sequence of equiprobable characters. Find the following :
   (A) Capacity of channel.
   (B) Maximum data transfer rate which data can transmitted from one end to other without any error.

2. Find out the capacity of the channel with the usable bandwidth of 3000 Hz and S/N of 1000 at the channel output. Assume the channel noise is Gaussian.

3. Calculate the capacity of the channel given below. Data transfer rate is 1symbole/sec .

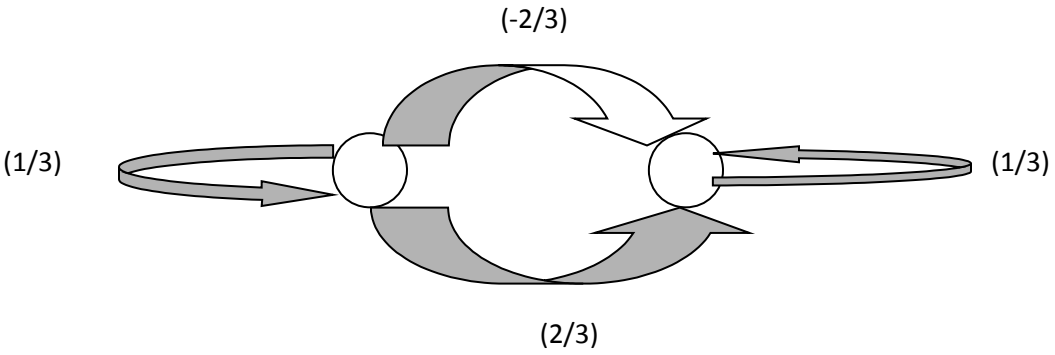


Probabilities of the channel are
$P(X_0) = P$, $P(X_1) = Q$, $P(X_2) = Q$ & $P(X_3) = P$.
$P(Y_0/X_0) = P(Y_3/X_3) = 1$
$P(Y_1/X_1) = P(Y_2/X_2) = p$
$P(Y_1/X_2) = P(Y_2/X_1) = (1-p)$
Also explain why this is symmetric channel or non symmetric channel with proper reasons.

4. Consider a discrete channel with two inputs and three outputs.
   Input probabilities are given by $P(X_1) = P(X_2) = ½$
   Conditional probabilities are given by $P(Y_1/X_1) = ¾$, $P(Y_2/X_1) = ¼$, $P(Y_3/X_1) = 0$, $P(Y_1/X_2) = 0$, $P(Y_2/X_2) = ½$ & $P(Y_3/X_2) = ½$.
   Find out
   (A) I(X ;Y)
   (B) Is this channel is symmetric or non symmetric channel.

5. Consider two source S_1 & S_2 each emit three messages X_1 , X_2 & X_3 and Y_1, Y_2 & Y_3. Their joint probabilities is given by
   $P(X_1, Y_1) = 3/40$, $P(X_1, Y_2) = 1/40$, $P(X_1, Y_3) = 1/40$, $P(X_2, Y_1) = 1/20$, $P(X_2, Y_2) = 3/20$, $P(X_2, Y_3) = 1/20$, $P(X_3, Y_1) = 1/8$, $P(X_3, Y_2) = 1/8$ & $P(X_3, Y_3) = 1/8$.
   Probabilities of the inputs given by $P(X_1) = 1/8$, $P(X_2) = 2/8$, $P(X_1) = 5/8$, $P(Y_1) = ¼$, $P(Y_2) = 3/10$ & $P(Y_3) = 9/20$.
   Calculate the value of H(X), H(Y), H(X/Y) & H(Y/X).

6. Consider a first order markov process



   First box represents the symbol A and other one B.
   Calculate
   (A) State probabilities P(A) & P(B) .
   (B) Entropy of the system.
   (C) Also calculate $H(S^2_1)$ & $H(S^3_1)$ of the system.

7. Consider a three source with the respective probabilities P(A) = 0.4, P(B) = 0.3 & P(C) = 0.3. Design the best code for the source and calculate the code efficiency.

8. Consider the problem 7 for the extended source S^2 with nine alphabets. Design the new code for `these alphabets and calculate the source efficiency.

9. Consider a source is emitting four alphabet X_1 , X_2 , X_3 & X_4 with the probability matrix $P(X_i)$ is given by {0.5, 0.25, 0.125, 0.125}.
   Find out
   (A) Entropy of the source.
   (B) Entropy of the extended source S^2 with sixteen alphabets.

10. Consider the third extension of the binary source having the priori probability P(0) = 0.25 & P(1) = 0.75. Calculate
    (A) Entropy of the source.
    (B) Number of alphabet(number) in the extended source S^3
    (C) Entropy of the extended source S^2
    (D) Entropy of the extended source S^3