DCS Sample Question Bank-2

- Define i) Mutual Information ii) Channel Capacity.
- A binary symmetric channel has the following noise matrix with source probabilities $P(x_1) = 2/3$, $P(x_2) = 1/3$. Evaluate H(x), H(y), H(x,y), H(x/y), H(y/x), I(x, y), C, η_{ch}

$$P\left(\frac{y}{x}\right) = \begin{bmatrix} \frac{3}{4} & \frac{1}{4} \\ \frac{1}{4} & \frac{3}{4} \end{bmatrix}$$

- Analyze binary symmetric channel. Develop an expression for channel capacity

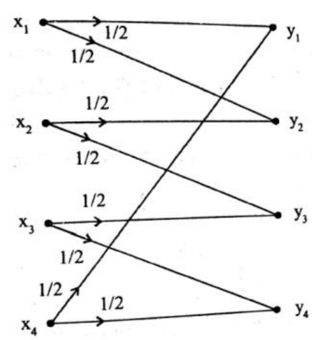
- For the channel matrix shown below, estimate the Capacity of the channel if rs =1000 symbols/sec

$$P\left(\frac{y}{x}\right) = \begin{bmatrix} 0.4 & 0.3 & 0.2 & 0.1 \\ 0.4 & 0.1 & 0.3 & 0.2 \\ 0.1 & 0.2 & 0.4 & 0.3 \end{bmatrix}$$

- A transmitter transmits 5 symbols with probabilities with probabilities 0.2, 0.3, 0.2, 0.1, 0.2. Determine H(X), H(Y), H(X, Y), H (Y/X) for the Channel matrix P(Y/X) as shown below.

$$\begin{bmatrix} 1 & 0 & 0 & 0 \\ 1/4 & 3/4 & 0 & 0 \\ 0 & 1/3 & 2/3 & 0 \\ 0 & 0 & 1/3 & 2/3 \\ 0 & 0 & 1 & 0 \end{bmatrix}$$

- Determine the Channel capacity shown in fig



- For the channel matrix shown, evaluate the channel capacity

$$P(b_j/a_i) = \begin{array}{c} \\ a_1 \\ a_2 \\ a_3 \end{array} \begin{array}{c} \begin{array}{ccc} b_1 & b_2 & b_3 \end{array} \\ \begin{bmatrix} 1/2 & 1/3 & 1/6 \\ 1/3 & 1/6 & 1/2 \\ 1/6 & 1/2 & 1/3 \end{bmatrix} \end{array}$$

- For the JPM given below, compute H(X), H(Y), H(X,Y), H(X/Y), H(Y/X) and I(X,Y).

$$P(X, Y) = \begin{matrix} 0.05 & 0 & 0.20 & 0.05 \\ 0 & 0.10 & 0.10 & 0 \\ 0 & 0 & 0.20 & 0.10 \\ 0.05 & 0.05 & 0 & 0.10 \end{matrix}$$

- State Shannon- Hartley law. Derive an expression for the upper limit on Channel capacity as bandwidth tends to ∞.
  - State Shannon-Hartley law for channel capacity and illustrate its implication.
- A B/W TV picture may be viewed as consisting of approximately 3 x10^5 elements, each one of which may occupy 10 distinct brightness levels with equal probability. Assuming the rate of transmission as 30 picture frames/sec and an SNR of 30dB, estimate minimum bandwidth required to support the transmission of the resultant video signal.
- 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 3KHz 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 probability.
  i. Check the average information per character.
  ii. Determine capacity of the channel.
  iii. Check the maximum rate at which data can be sent from terminal to the computer without error.
- What is Shannon's limit? Derive expression for Shannon's limit for (E_b/n_0) parameter illustrating with Bandwidth – efficiency diagram.
- An analog signal having bandwidth of 5 KHz is sampled at twice the Nyquist rate with each sample quantized into one of 128 equally likely levels.
  a. Assess the information rate of this source.
  b. Is it possible for this source to transmit without error over an AWGN Channel with Bandwidth of 12 KHz and SNR of 22dB?
  c. Estimate the SNR required for error free transmission for part (a)
  d. Determine the Bandwidth required for AWGN channel for error free transmission of this source if SNR happens to be 22dB.

Module-2:

- For the given (6, 3) systematic linear block code, the parity matrix P is given by

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

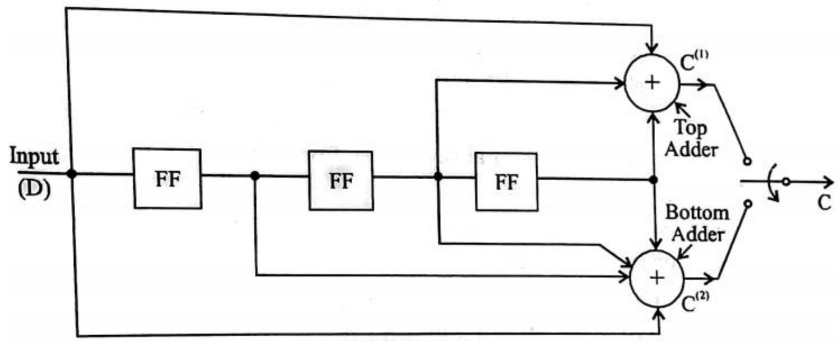
  i] Generate all possible code words and construct the encoding circuit.
  ii] If the received code vector is R=[110010]. Detect and correct the single error that has occurred due to noise.
- In a linear block code (6,3) the syndrome is given by
  S1=r1+r3+r4 S2=r2+r3+r5 S3=r1+r2+r6
  a**]** If the received code vector is R = [110010], Detect and correct the single error that has occurred due to noise.
  b] Construct G and H Matrices.
- In a linear block code (7,4) the syndrome is given by
  S1=r1+r2+r3+r5 S2=r1+r2+r4+r6 S3=r1+r3+r4+r7
  a**]** Construct G and H Matrices.
  b] A single error has occurred in the received vector R= [1011100].Detect and correct error.

- A (6,3)linear block code has the following check bits, $C_4=d_1+d_2$, $C_5=d_1+d_3$, $C_6=d_2+d_3$
  i) Construct G & H matrices
- For a systematic (7,4) linear block code, the parity matrix is given by

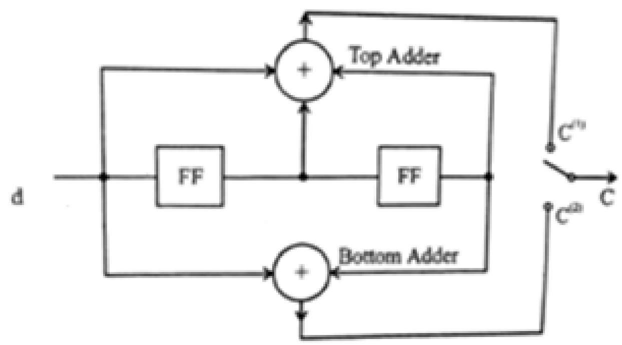
$$P=\begin{bmatrix}1 & 1 & 1\\ 1 & 1 & 0\\ 1 & 0 & 1\\ 0 & 1 & 1\end{bmatrix}$$

  a) Generate all possible valid code vectors
  b) A single error has occurred in the received vector **R=[1010000].** Detect and correct error.
- The generator polynomial for a (7, 4) binary cyclic code is $\mathbf{g(x) = 1 + x + x^3}$. Find the code vector in Non-systematic and Systematic form for the following messages (i) 1011 (ii) 1001
- The generator polynomial for (15,7) cyclic code is $g(x)=1+x^4+x^6+x^7+x^8$. Find the code vector in systematic form of message $D(x) = x^2+x^3+x^4$ suffer transmission error. Find the syndrome of V(x).
- Design an encoder for the (7,4) binary cyclic code generated by g(x) = 1 + x + x3 and check its operation using the message vectors 1001 and 1011
- Consider a (15,11) Cyclic code generated using $\mathbf{g(x) = 1 + x + x^4}$
  i. Design a feedback register Encoder for the same.
  ii. Generate a code vector for the message **[11001101011]** by listing the status of shift register.
- For a **(7,4)** cyclic code, the $\mathbf{g(x) = 1 + x + x^3}$,
  i. Build the syndrome calculation circuit
  ii. Determine the syndrome for the following received vector with single error **[1110101]**
- Consider a (15,11) Cyclic code generated using $\mathbf{g(x) = 1 + x + x^4}$
  i. Device a feedback register Encoder for the same.
  ii. Illustrate the encoding procedure with the message vector **[10010110111]** by listing the status of shift registers.
- A (**15, 5)** linear cyclic code has generator polynomial $\mathbf{g(x) = 1 + x + x^2 + x^4 + x^5 + x^8 + x^{10}}$
  i. Construct the block diagram of Encoder.
  ii. Determine the code polynomial for message polynomial $\mathbf{D(x) = 1 + x^2 + x^4}$ using encoder diagram
- For a **(7,4)** cyclic code, the received vector is **[1110101]** and the $\mathbf{g(x) = 1 + x + x^3}$. Build the syndrome calculation circuit and correct the single error in the received vector **.**

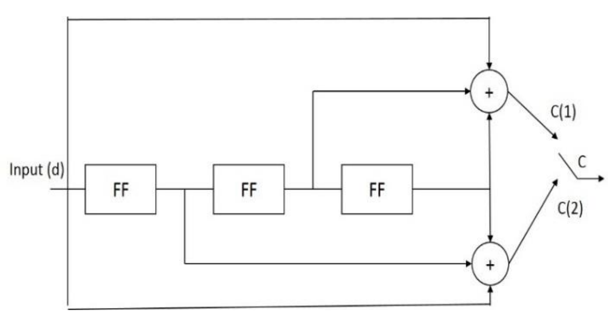
- The generator polynomial for a (15,7) cyclic code is g(x) = 1+x4+x6+x7+x8
  (a) Find the code vector in the systematic form for the message D(x) = x2+x3+x4.
  (b) Assume the first and last bit of the code vector V(x) for D(x) = x2+x3+x4 suffer the transmission errors. Find the syndrome of V(x).
- Consider a (3, 1, 2) Convolution Encoder with $g^{(1)}=110$, $g^{(2)}=101$ and $g^{(3)}=111$.
  Build the Encoder Block diagram, Construct the Generator Matrix and find code vector Corresponding to information sequence D=111101 using time domain approach**.**
- Consider a (n, k, m) = (2, 1, 3) convolutional encoder as shown in the fig. Generate the codes using time domain and transfer domain approach.



- 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) Determine the constraint length, rate efficiency.
  ii) Construct the generator matrix.
  iii) Generate the codeword for the message sequence (1 1 1 0 1) using time domain approach.
- 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) Construct the generator matrix.
  ii) Generate the code word for the message sequence (1 1 1 0 1) using time domain and Transfer domain approach.
- For the convolution encoder shown in fig , draw the state table, state transition table, State diagram and corresponding code tree. Using the code tree, assess the encoded sequence for the message d= 10111.

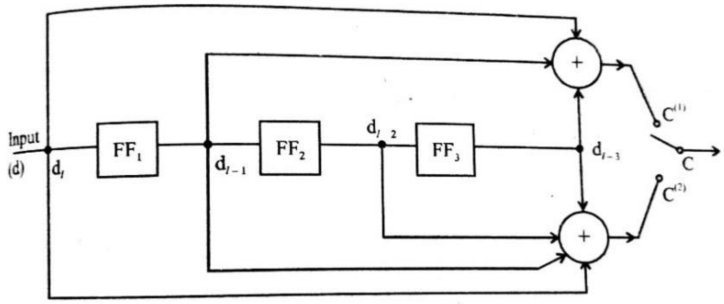


- Figure shows a (2,1,3) convolutional encoder
  (a) Draw the state diagram
  (b) Draw the code tree
  (c) Find the encoder output produced by the message sequence 11101 by traversing through code tree.



- For the convolutional encoder shown in the figure
  (a) Draw state table
  (b) Draw state transition table

(c) Draw state diagram
(d) Find encoder output for the message sequence 10011 by traversing through the state diagram



Module-3:

- Model DCS
- Determine basis functions for a given set of signals using Gram Schmidt orthogonalization procedure.