

### Assignment 5

- 1) The generator polynomial of a (7, 4) code is give as,

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

- a) List all the codewords of this code.
  - b) Show that this code is cyclic.
  - c) Find the parity check matrix of the code.
- 2) A convolutional code with constraint length  $K = 3$  has generator polynomials  $g_1(D) = D^2 + 1$  and  $g_2(D) = D^2 + D + 1$ .
- a) Draw the encoder of this code.
  - b) Draw the state diagram of the code.
  - c) Find the output of the encoder if the input is 0010100.
- 3) For  $m = 6$ , determine the Reed Solomon code that can correct 6 errors. What is the rate of the code? (1 Mark). What is the length of each codeword in bits.
- 4) An  $(n,k) = (8,5)$  linear block code with a generator polynomial of  $g(x) = 1 + x + x^2 + x^3$  is considered.
- a) Prove that this code is cyclic and non-perfect.
  - b) Evaluate the error correction and detection capability of the code.
  - c) Calculate the probability of undetected error if the uncoded bit error probability is  $10^{-2}$ .
- 5) A stream of digital data with data rate of 4 Mb/s is to be transmitted using non-coherent orthogonal 4-level FSK system. The received signal power to noise density ratio  $P_r/N_0$  is 76 dB-Hz. The required performance of the system is a bit error rate of  $10^{-9}$ .
- a) Evaluate the bit error rate of the system without coding and calculate the required coding gain to achieve the system performance.
  - b) Use BCH(127, 106) code which has capability of correcting 3 errors in a block of 127 bits. Evaluate the bit error rate of the system.
  - c) Using the BCH code of part b, can we achieve the required system performance? If not what should be done? If we can achieve the performance, do you think this code is an overkill? Do you have a suggestion?

- 6) For  $m = 5$  determine the Reed-Solomon code that can correct 3 erroneous symbols, i.e., find the block length  $N$  and the number of information symbols  $K$  (3 Marks). Find the rate of the code  $(N, K)$ . What is the block length in bits
- 7) Consider the convolutional code with the encoder shown in Figure 2.
- What is the constraint length of this code?
  - What are the generator polynomials of this code?
  - Assume that the encoder is in state 0 (all flip-flops contain 0), find the output for the input ....00001101. Note: Bit 1 enters the encoder first.

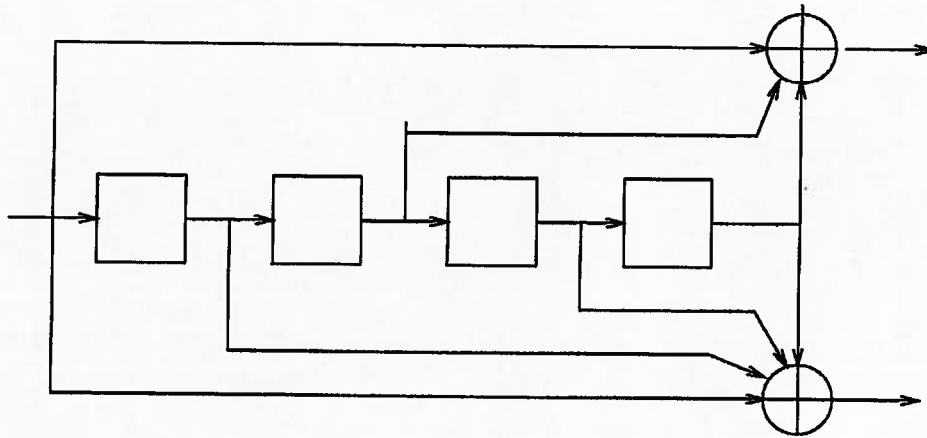


Figure 3: The encoder for convolutional code of problem 7

- 8) The generator polynomial of the (15,11) Hamming code is  $g(X) = X^4 + X + 1$ . Draw the block diagram of the encoder for this code in the systematic form.