Q.1 Consider a (6,3) linear block code with the generater matrix G in systematic form given by:

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

(a) Determine the code words, what is the $d_{\min}$ for this code?

(b) Determine the syndromes of this linear block code and list them.

(c) fill in the standard array (for syndrom decoding) clearly filling inthe code-word (i.e., top row), and the coset leaders (i.e., first colomn). Assing the coset leaders to the appropriate syndromes.

Q.2 A rate 1/3 conventional encoder with L=3 has the following structure.

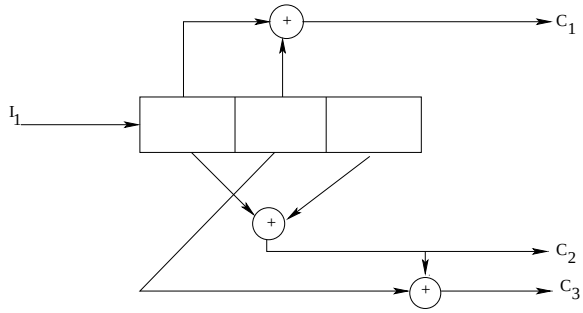

Figure-1

Find the transfer function $T(D, N, J)$ for the code, where the D is the hamming distance, N is the number of "1's" which caused the transition, and J is the hop count. Hint: Drawing the state diagram first would be good idea.

Q.3 Using the same trellis encoder as in Figure-1 answer the following questions:

(a) Assume that 6 bit message bits, namely $\{I_1, I_2, I_3, I_4\}$followed by zero bits, has been encoded by this code and sent over a BSC with an error probability of p=0.1. If the received sequence $r = (111, 111, 111, 111, 111, 111, 111)$, find the transmitted bit sequence using the Viterbi algorithm.

(b) Find the lowe-bound on bit error probabilty of the code when above binary-symmetric channel is employed. Use only the d_{free} (the minimum distance of the code) from Q.2 to get this lower-bound.

Q.4 A trellis coded modulation scheme uses a rate 1/2 convolutional coder as well as 2 uncoded bits, as shown below in Figure-2. Bandwidth expansion (compared to uncoded 8-PSK to send the 3 bits across) is avoided by using 16-QAM modulation.

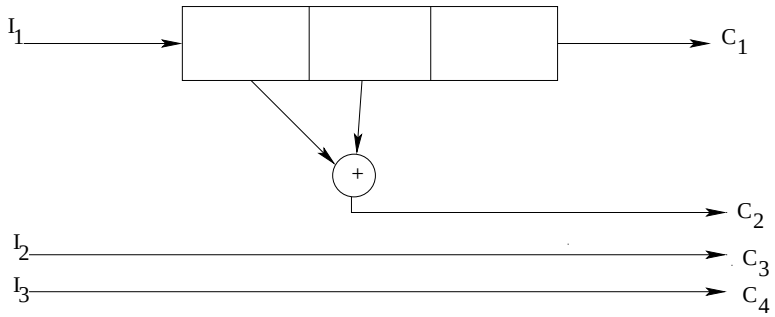

Figure-2

(a) Plot the trellis up to appropriate number of stages of the above TCM scheme. Label the all zero path, and the path with least number of hope away from this, using the 3 code bits C_1 and C_2.

(b) Perform set-partitioning on the 16-QAM alphabet. Observe your result in part (a) in order to assign appropriately the code bits C_3 and C_4 now, label parallel transitions in the trellis, if any, with the assigned 16-QAM symbols.

(c) What is the d_{free} of this TCM scheme?

(d) What is the coding gain when compared with un-coded 8-PSK for the same average transmit power.

Q.5 Consider the (5,2) Golay code with generator matrix G in systematic form given as below:

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

(a) Determine the syndromes of this linear block and list them.

(b) Fill in the standard array (for syndrome decoding) clearly filling in the code-word (i.e., top row) and the coset leaders (i.e., first column). Assign the coset leaders to the appropriate syndromes.

Q.6 Repeat Q.4 for the figure given below:

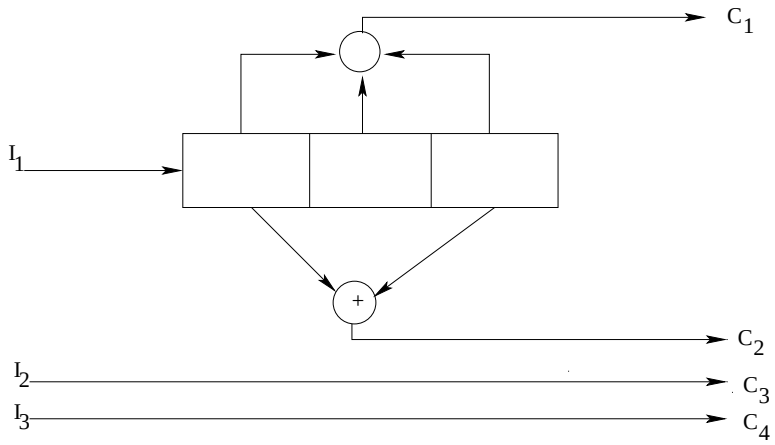

Figure-3

From the text book following problems:

Chapter 13:

Problems: 16, 17, 18, 20, 21, 23, 27