Final Exam (Take home). Only lecture slides and textbooks, No Internet is allowed

Q1. Suppose you have a digital communication system with the following 8-QAM signal

$$s_m(t) = g_T(t)\cos\left(2\pi f_c t + \frac{2\pi m}{8}\right), \qquad m = 1,2,3,4,$$

and

$$s_m(t) = 2g_T(t)\cos\left(2\pi f_c t + \frac{2\pi m}{8}\right), \qquad m = 5,6,7,8,$$

where f_c is the carrier frequency and $g_T(t)$ is given by

$$g_T(t) = \frac{1}{4T}\left(1 - \cos\left(\frac{\pi t}{T}\right)\right), \qquad t \in [0,T],$$

Find the low pass representation of s(t)

Q2. Consider the output of the receiver of a DCS is

$$r_m = a_m + 2a_{m-1} + \nu_m,$$

Where a_m is the data having values +1 or -1. v_m is a Gaussian noise of zero mean and unit variance. If a_0=+1 and the detected outputs at the first three time instants are r_1=1, r_2=-1 and r_3=0. Use the Viterbi algorithm to find the optimal maximum likelihood sequence for a_1 based on r_1, r_2 and r_3. Draw the trellis and identify the Euclidian distance for each branch.

Q3. A convolutional encoder is sown in figure one:

a. What is the rate of this encoder? What is the constraint length of this encoder?
b. How many states the state diagram will have? How many transitions per state?
c. Draw the state diagram of the encoder.
d. Determine the encoder output produced by the message sequence 10111
e. Flip the third and eighth bit of the output of part d and show the process of decoding using the trellis diagram.
f. Find the transfer function of such encoder and the free distance

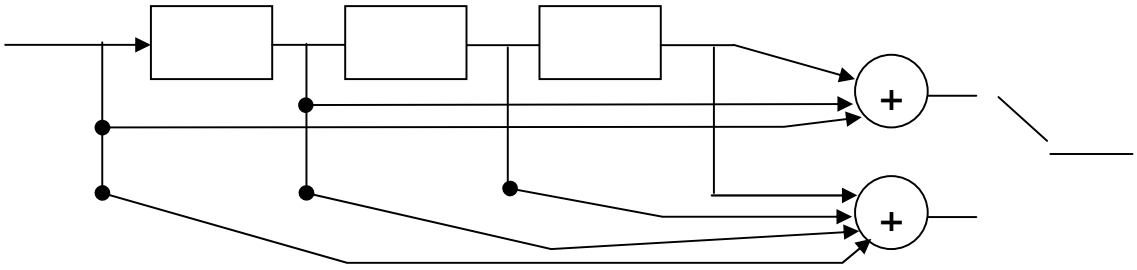

Figure one

Q4. A convolutional encoder having the rate R=1/5, constraint length K=4 and a generator matrix

G= [17 17 13 15 15].

a- How many shift registers are used in the encoder? Draw the encoder.
b- How many states the state diagram will have? Sketch the state diagram.
c- Draw one stage of the trellis diagram.

Q5. A linear block code has the following parity matrix

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

a- Express the generating matrix G in the form of [P:I] form.
b- Determine the parity check matrix H
c- Construct the table of syndromes
d- Determine the minimum distance of the code.
e- Show that the codeword corresponding to the information sequence 101 is perpendicular on H