Sheet 9

Communication Theory II, Third Year
Electronics and Communication Department

1. Given the data stream 1110010100, sketch the transmitted sequence of pulses for each of the following line codes:
(a) unipolar NRZ
(b) polar NRZ
(c) unipolar RZ
(d) bipolar RZ
(e) Manchester code (split-phase)

2. Figure 1 shows an *N*-order linear predictor
(a) Determine the relation of the output $\hat{m}[k]$
(b) Estimate the prediction coefficients for a second-order predictor
(c) If the difference signal $\Delta[k]=m[k]-\hat{m}[k]$ is used as the transmitted signal of a modulator, list an advantage of using a good predictor. How it can be achieved in terms of the predictor order?

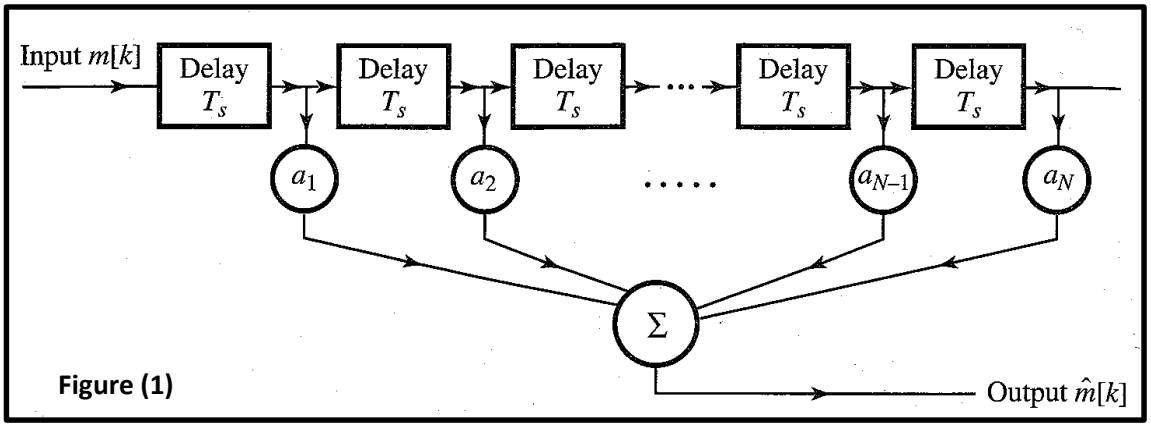

Figure (1)

3. If the predictor in Figure 1 has been used in the modulator and demodulator as shown in Figure 2.
(a) Mention the name of the modulation used. What is its disadvantage over PCM?
(b) Show that using this scheme, we are able to receive the desired signal plus a quantization error
(c) In comparable to PCM, show how to use this scheme to increase the SNR
(d) In comparable to PCM, show how to use this scheme to increase the transmission bandwidth

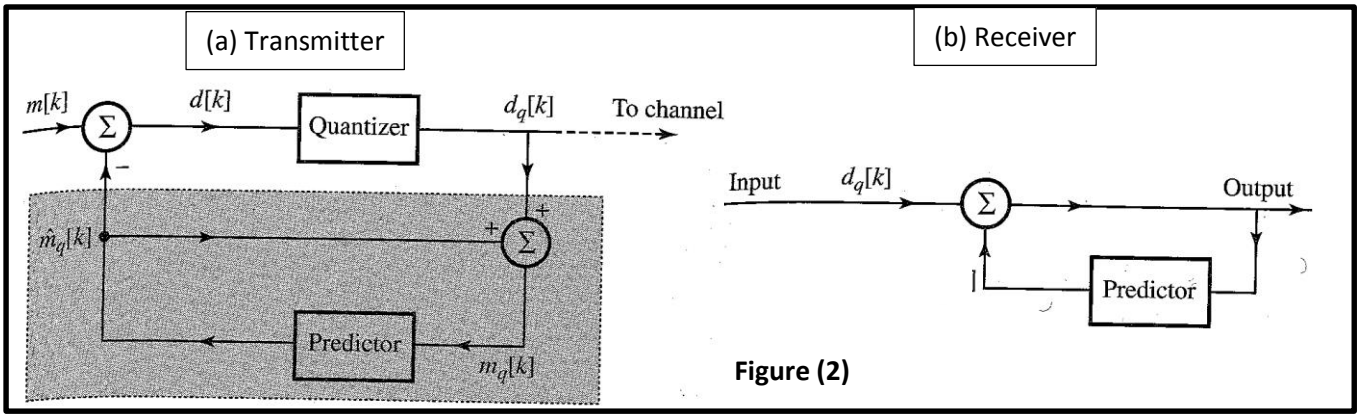

Figure (2)

4. In problem 3, if we choose to design a modulator using a first order-predictor with two-level quantization

(a) Mention the name of the modulation used

(b) Using this scheme, is the prediction error larger or less than that of higher-order predictors? How to reduce this error in term of the sampling rate?

(c) A schematic diagram for realizing the modulator and the demodulator is given in Figure 3. Show that integrating of the delta-modulated signal (difference signal) is an approximation of m(t).

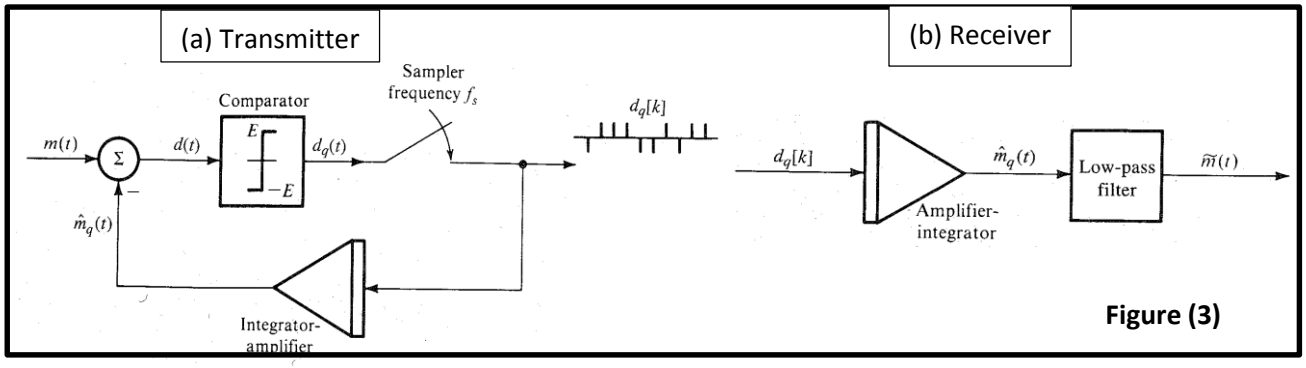

Figure (3)

(d) Using Figure 4, derive a relation between the maximum allowable slope of the input signal for overcoming the slope-overload noise as a function of the step size Δ and the sampling interval T_s

(e) What is the range of the granular noise error in terms of the step size Δ?

(f) Derive a relation for the power of the granular noise (mean square value) assuming uniform noise distribution.

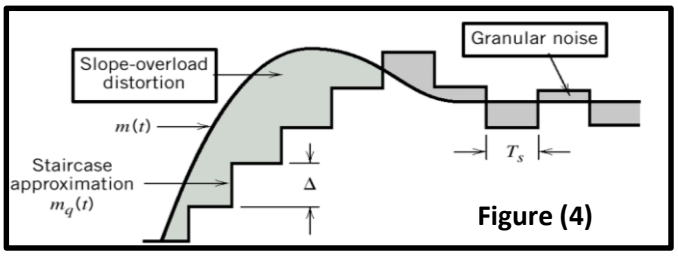

Figure (4)

(g) For a linear delta modulator is designed to operate on speech signals limited to 3.4 kHz. The specifications of the modulator are as follows:

- Sampling rate = 10 $f_{Nyquist}$, where $f_{Nyquist}$ is the Nyquist rate of the speech signal.
- Step size = 100 mV.

The modulator is tested with a 1kHz sinusoidal signal. Determine the maximum amplitude of this test signal required to avoid slope-overload distortion using the relation in (d).

(h) Suggest a solution to overcome the two sources of noise of this scheme, the granular noise and the slope overload noise