ELEC1200 – Midterm Exam

Part II: Canvas Assignment

Q1: [15] Consider data transmission according to the following protocol.

The data to be transmitted is divided into 4-bits blocks. If not enough bits are available to fill a complete block, zero padding is applied.

The communication channel is asynchronous so that one start bit (value 1) and one stop bit (value 0) is added to each data block to make a complete frame.

A bit stream is converted into a bit waveform by holding each bit for SPB = 3 samples per bit.

a) Assume that the sampling rate is 1MHz and that we need to transmit 50 data bits using this protocol. Also assume that the frames are transmitted one after the other without any delay between them.

   i. [2] What is the number of frames needed to transmit the 50 data bits?

   ii. [2] What is the total time required to transmit the 50 data bits?

b) [6] Assume that a random time delay may exist between frames. Suppose that we receive the following sample sequence. What is the original bit data assuming the above communication protocol is used?

   00000000001111110001110000000000111000111111000000001110001111111111000000000

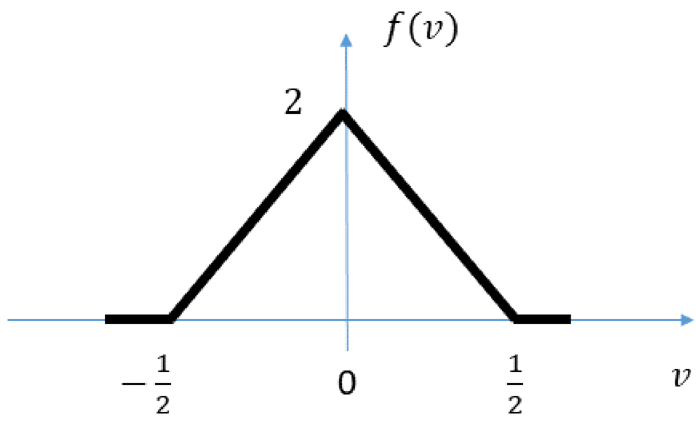
c) The channel's step response is measured, and is found to have the following form

$$s(n) = k(1 - 0.92^{n+1})u(n)$$

   i. [3] In order to help identify a suitable threshold for data detection, a training sequence consisting of a pulse of P samples of 1's is transmitted. Find the minimum value of P such that the maximum value of the response to the training sequence is $0.95k$.

   ii. [2] To try to improve the bit rate, we decide to apply an equalizer to the channel output. Assume that the channel output is denoted by $y(n)$, and let $e(n)$ be the output of the equalizer. Find the input-output equation for the equalizer such that $e(n)$ is the best estimate of the input $x(n)$. Assume no noise is present in the channel.

Q2: [15] A binary communication channel has noise ***v*** with the following PDF (probability density function).



The response to a bit is the sum of the response to the input and noise. Without noise, the responses *r* to bit “0” and bit “1” are *r* = 0 volts and *r* = 0.5 volt, respectively.

Decoding the channel output is done by comparing the channel output, $y = r + v$, to a threshold *T*. The decoded bit is “1” if the channel voltage is greater than *T* and “0” otherwise.

a) [2] What is the probability that the noise is greater than 0.15?

b) [2] Draw the PDF of the received signal if the input bit is “0”.

c) [2] Draw the PDF of the received signal if the input bit is “1”.

d) [2] What is the optimal threshold T if the inputs bits “0” and “1” are equally likely?

e) [2] Calculate the BER (bit error rate) if we use the optimal threshold *T* assuming that the input bits “0” and “1” are equally likely.

f) Suppose that the input bits are *three times as likely* to be 1 as they are to be 0.

   i. [3] What is the new optimal threshold?

   ii. [2] What is the new BER?

--- End of part II ---