Homework 7

Reading

- Chapter 2 in the Anderson text

Problems

1. Suppose you wish to transmit 21000 bits per second over a channel with one-sided bandwidth $\sqrt{2} \cdot 1000$ Hertz.
   (a) What is the maximum symbol rate that avoids ISI?
   (b) What is the fewest number of bits per symbol that avoids ISI? Let this number be denoted k_{min}.
   (c) Design a raised-cosine (RC) pulse that occupies the full channel bandwidth. What is the excess bandwidth α when there are k_{min} bits per symbol?
   (d) Design a raised-cosine (RC) pulse that occupies the full channel bandwidth. What is the excess bandwidth α when there are $k_{\text{min}} + 1$ bits per symbol?
   (e) Design a raised-cosine (RC) pulse that occupies the full channel bandwidth. What is the excess bandwidth α when there are $k_{\text{min}} + 2$ bits per symbol?
   (f) Show graphically (via a sketch in the frequency domain) that the $k_{\text{min}} + 2$ case avoids ISI.

2. Using a $\alpha = 1/\sqrt{2}$ RC pulse to transmit 2400 bits/second with 3 bits/symbol, what is the minimum channel bandwidth needed for zero ISI in the samples taken by the sampling receiver?

3. Let the transmitter pulse be given by

$$v(t) = \begin{cases} \frac{1}{T}t + 1 & -T \le t \le 0 \\ -\frac{1}{T}t + 1 & 0 \le t \le T \\ 0 & |t| > T \end{cases}$$

   Suppose that the symbol set is $\{+3, +1, -1, -3\}$. Sketch the eye diagram. Be sure to show all possible transitions between symbols.

4. Let the transmitter pulse be given by

$$v(t) = \begin{cases} \frac{9}{10T}t + 1 & -\frac{10T}{9} \le t \le 0 \\ -\frac{9}{10T}t + 1 & 0 \le t \le \frac{10T}{9} \\ 0 & |t| > \frac{10T}{9} \end{cases}$$

   Suppose that the symbol set is $\{+1, -1\}$. Sketch the eye diagram. Be sure to show all possible transitions.

5. Prove that the NRZ pulse defined by

$$v(t) = \begin{cases} 1 & -\frac{T}{2} \le t < \frac{T}{2} \\ 0 & \text{otherwise} \end{cases}$$

   is a Nyquist and a root-Nyquist pulse. Do this in the time domain.

6. Prove that the sinc pulse defined by

$$v(t) = \text{sinc}\left(\frac{t}{T}\right) = \frac{\sin(\pi t/T)}{\pi t/T}$$

   is a Nyquist pulse and a root-Nyquist pulse. Do this in the frequency domain.