Chapter 3 Part 2

Activities

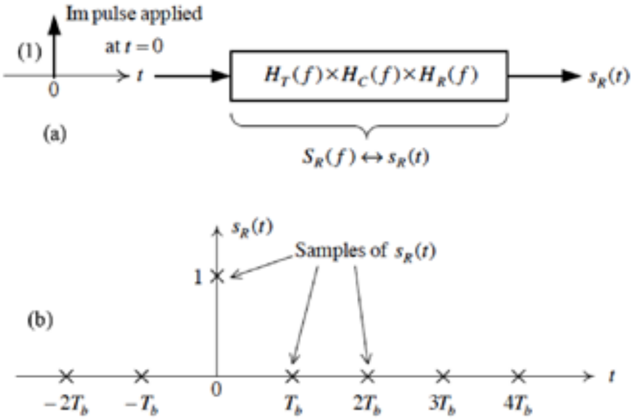
Activity 1

Under what conditions the Nyquist Criterion for zero ISI holds?

Activity 1

Under what conditions the Nyquist Criterion for zero ISI holds?

The samples of $s_R(t)$ due to an impulse should be 1 at t=0 and zero at all other sampling times kT ($k \neq 0$)

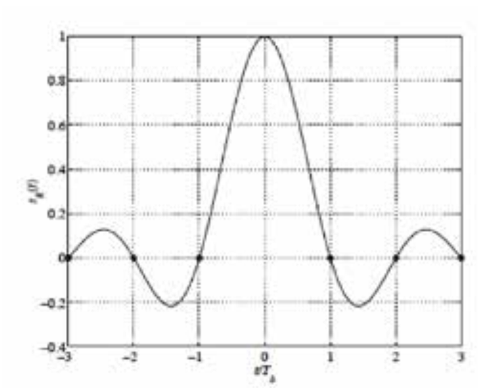


3

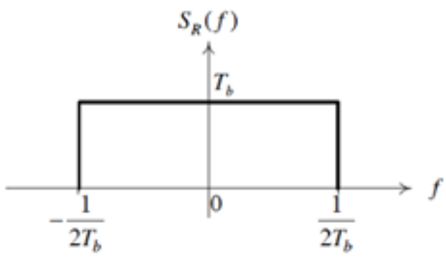
Activity 1

Under what conditions the Nyquist Criterion for zero ISI holds?

The samples of $s_R(t)$ due to an impulse should be 1 at t=0 and zero at all other sampling times kT ($k \neq 0$).



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

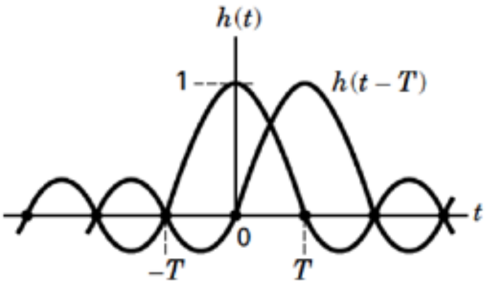


4

Activity 1

Under what conditions the Nyquist Criterion for zero ISI holds?

The samples of $s_R(t)$ due to an impulse should be 1 at t=0 and zero at all other sampling times kT ($k \neq 0$).



Note: if the samples are not taken at t=T, then considerable ISI can be encountered.

5

Activity 2

Find the minimum required bandwidth for the baseband transmission of a 4-level PAM pulse sequence having a date rate of R = 2400 bit/s if the system transmission characteristic consist of a raised cosine spectrum with 100% excess bandwidth (r = 1).

6

Activity 2

Find the minimum required bandwidth for the baseband transmission of a 4-level PAM pulse sequence having a date rate of R = 2400 bit/s if the system transmission characteristic consist of a raised cosine spectrum with 100% excess bandwidth (r = 1).

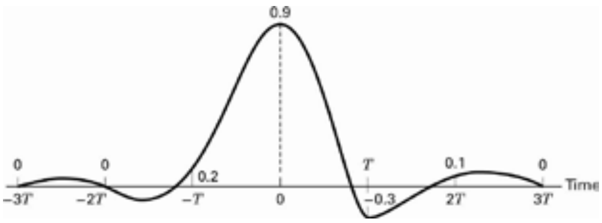
$$M = 2^k, \text{ since M=4 levels}, k = 2$$

$$\text{Symbol or pulse rate } R_s = \frac{R}{k} = \frac{2400}{2} = 1200 \text{ sybmols/s},$$

$$\text{Minimum bandwidth } W = \frac{1}{2}(1+r)R_s = \frac{1}{2} \times 2 \times 1200 = 1200 \text{ Hz}$$

7

Activity 3



1. A single impulse is transmitted through a digital communication system with the above waveform received, i.e. [$x(k)$]=[0.0, 0.0, 0.2, 0.9,-0.3, 0.1,0.0]. Use a zero-forcing solution to find the weights $\{c_k\}$ (k=-1,0.1) of a 3-tap transversal equalizer that reduce the ISI so that the equalized pulse samples $z(k)$ have the values [$z(-1)$=0, $z(0)$=1, $z(1)$=0].
2. Using the weights obtained in (1), determine the ISI values of the equalized pulse at sample times $k = \pm1, \pm2$, and ±3.
3. What is the largest magnitude sample contributing to the ISI and what is the sum of all of the ISI magnitudes?

8

Activity 3

1. A single impulse is transmitted through a digital communication system with the above waveform received, i.e. $[x(k)]$ (k=-2, …, 2) are [0.0, 0.2, 0.9,-0.3, 0.1]. Use a zero-forcing solution to find the weights $\{c_k\}$ (k=-1,0.1) of a 3-tap transversal equalizer that reduce the ISI so that the equalized pulse samples $z(k)$ have the values [$z(-1)=0$, $z(0)=1$, $z(1)=0$].

Given the channel impulse response, we have

$$\begin{bmatrix} 0 \\ 1 \\ 0 \end{bmatrix} = \begin{bmatrix} x(0) & x(-1) & x(-2) \\ x(1) & x(0) & x(-1) \\ x(2) & x(1) & x(0) \end{bmatrix} \begin{bmatrix} c_{-1} \\ c_0 \\ c_1 \end{bmatrix} = \begin{bmatrix} 0.9 & 0.2 & 0 \\ -0.3 & 0.9 & 0.2 \\ 0.1 & -0.3 & 0.9 \end{bmatrix} \begin{bmatrix} c_{-1} \\ c_0 \\ c_1 \end{bmatrix}$$

Solving these 3 simulataneous equations results in the following weights:

$$\begin{bmatrix} c_{-1} \\ c_0 \\ c_1 \end{bmatrix} = \begin{bmatrix} -0.2140 \\ 0.9631 \\ 0.3448 \end{bmatrix}$$

Activity 3

2. Using the weights obtained in (1), determine the ISI values of the equalized pulse at sample times k = ±1, ±2, and ±3.

The values of the equalized pulse samples $[z(k)]$ corresponding to sample times k=-3,-2,-1,0,1,2,3 are computed by using weights c_{-1}=-0.2140, c_0=0.9631, and c_1=0.3448.

$$z[k] = \sum_{n=-N}^{N} x[k-n]c_n$$

$$k = -3,\ z(-3) = x(-2)c_{-1} + x(-3)c_0 + x(-4)c_1 = 0.0000$$
$$k = -2,\ z(-2) = x(-1)c_{-1} + x(-2)c_0 + x(-3)c_1 = -0.0428$$
$$k = -1,\ z(-1) = x(0)c_{-1} + x(-1)c_0 + x(-2)c_1 = 0.0000$$
$$k = 0,\ z(0) = x(1)c_{-1} + x(0)c_0 + x(-1)c_1 = 1.0000$$
$$k = 1,\ z(1) = x(2)c_{-1} + x(1)c_0 + x(0)c_1 = 0.0000$$
$$k = 2,\ z(2) = x(3)c_{-1} + x(2)c_0 + x(1)c_1 = -0.0071$$
$$k = 3,\ z(3) = x(4)c_{-1} + x(3)c_0 + x(2)c_1 = 0.0345$$

Activity 3

3. What is the largest magnitude sample contributing to the ISI and what is the sum of all of the ISI magnitudes?

The sample of largest magnitude contributing to ISI is 0.0428.
The sum of all of the ISI magnitudes is: 0.0428+0.0071+0.0345=0.0844