Principles of Communications

Chapter V: Representation and Transmission of Baseband Digital Signal – Homework

December 6, 2013

1 If message symbol sequence is 1101001000001,write the corresponding sequence of AMI code and HDB3 code.

2 Assume 1 and 0 in a binary unipolar baseband signal sequence are respectively expressed by pulse $g(t)$ [see Fig.P5.1] and no pulse,as well as their occurring probability is equal,the duration of symbol is T.

(1) Find the expression for the power spectral density of the sequence,and draw its curve.

(2) Is there a discrete component with frequency $f = 1/T$ in the sequence?If yes,calculate its power.

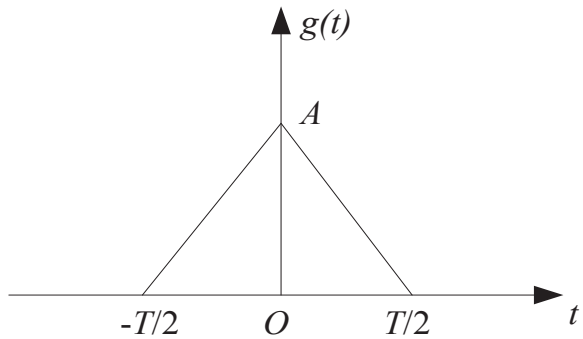


Figure P5.1 Waveform of $g(t)$

3 Assume symbol waveform $g(t)$ of a binary bipolar baseband symbol sequence is a rectangular pulse,as shown in Fig.P5.2,its height is 1 ,its duration equals $\tau = T/3$;and the occurring probability of the positive polarity pulse is $3/4$,the occurring probability of the negative polarity pulse is $1/4$.

(1) Write the expression for the power spectral density of the symbol sequence,and plot its curve.

(2) Is there a discrete component of $f = 1/T$ in the sequence? If yes,calculate its power.

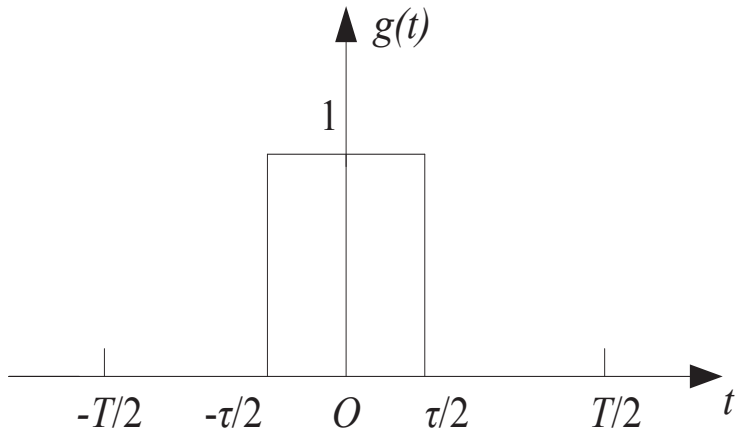


Figure P5.2 Rectangular pulse

4 Assume the output symbol waveform $h(t)$ of the receiving filter of a baseband transmission system is as shown in Fig. P5.3.

(1) Find transfer function $H(f)$ of the baseband transmission system.

(2) If its channel transfer function $c(f) = 1$,and the transfer functions of the transmitting filter and the receiving filter are equal,i.e.,$G_T(f) = G_R(f)$,find the expressions for $G_T(f)$ and $G_R(f)$.

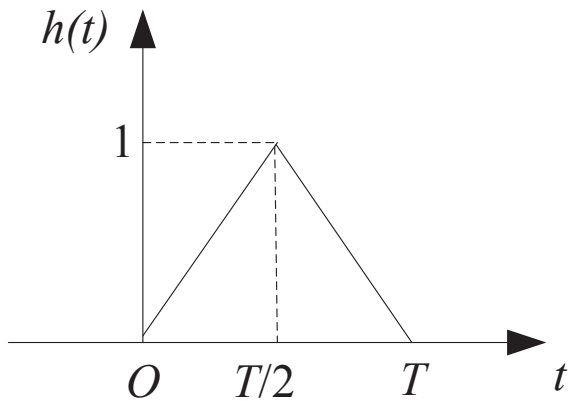


Figure P5.3 Waveform of h*(t)*

5 Assume transfer function $H(f)$ of a baseband transmission system is as shown in Fig.P5.4.

(1) Find the expression of the output symbol waveform of the receiving filter of the system.

(2) If symbol transmission rate of the baseband signal of the system is $R_B = 2f_0$,can the system guarantee the transmission without intersymbol interference,measured by the Nyquist cri-terion?

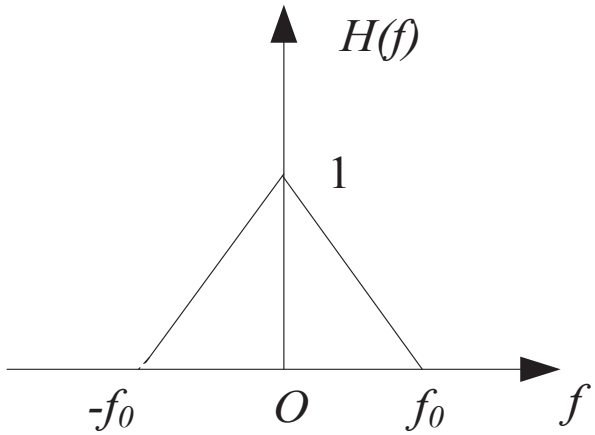


Figure P5.4 Waveform of H(*f*)

6 Assume the transfer function $H(f)$ of a binary baseband transmission system is

$$H(f)=\begin{cases}\tau_0(1+cos2\pi\tau_0) & |f|\leq\frac{1}{2\tau_0}\\ 0 & \text{else}\end{cases}$$

Determine the highest symbol transmission rate R_B and the symbol duration T of the system.

7 If transfer function $H(f)$ of a baseband transmisson system is as shown in the following equation where $W=W_1$,prove that its unit impulse response,i.e. the symbol wave-form of the receiving filter output,equals

$$h(t)=\frac{1}{T}\cdot\frac{\frac{sin\pi t}{T}}{\frac{\pi f}{T}}\cdot\frac{\frac{cos\pi t}{T}}{1-\frac{4t^2}{T^2}}$$

If a symbol with Baud rate $\frac{1}{T}$ is transmitted in the system;then does intersymbol interference exist at the sampling instant?

$$H_0(f)=\begin{cases}1 & |f|<W-W_1\\ \frac{1}{2}+\frac{1}{2}cos[\frac{\pi}{2W_1}(|f|-W+W_1)] & W-W_1<|f|<W+W_1\\ 0 & W+W_1<|f|\end{cases}$$

8 Assume the structure of a transversal equalizer is shown in the following figure;its 3 tap gain coefficients are respectively $C_{-1}=-\frac{1}{3},C_0=1,C_1=-\frac{1}{4}$.If samples of $x(t)$ at each point in turn are $x_{-2}=\frac{1}{8},x_{-1}=\frac{1}{3},x_0=1,x_1=\frac{1}{4},x_2=\frac{1}{16}$,and samples at other points are all zeros. Calculate distortion of the peak of $x(t)$ and find the distortion of the peak of the equalizer output $y(t)$.

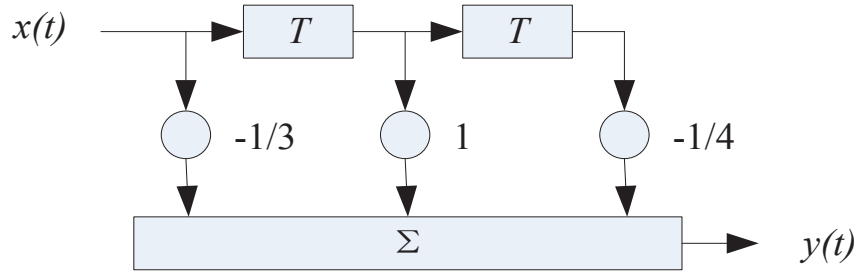


Figure P5.5 Transversal equalizer with 3 taps

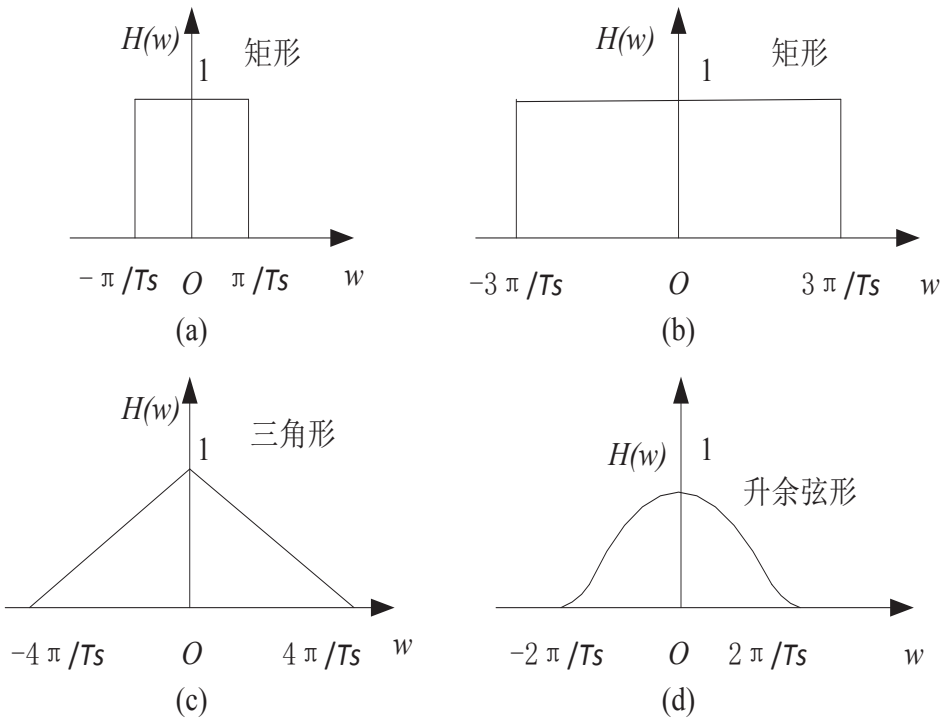
9 Assume there is a 3 tap equalizer. The sample sequence of input unit impulse response is known as 0.1, 0.2 ,-0.2, 1.0, 0.4, -0.1, 0.1.Design gain coefficients C_n of its 3 taps by using the zero-forcing method. Calculate the output values at the instants $k = 0, \pm 1, \pm 2, \pm 3$ and the peak intersymbol interference after equalization.

10 设二进制符号序列为101110010001110, 画出与它相对应的单极性、双极性、单极性归零、双极性归零、二进制差分及八电平的波形。

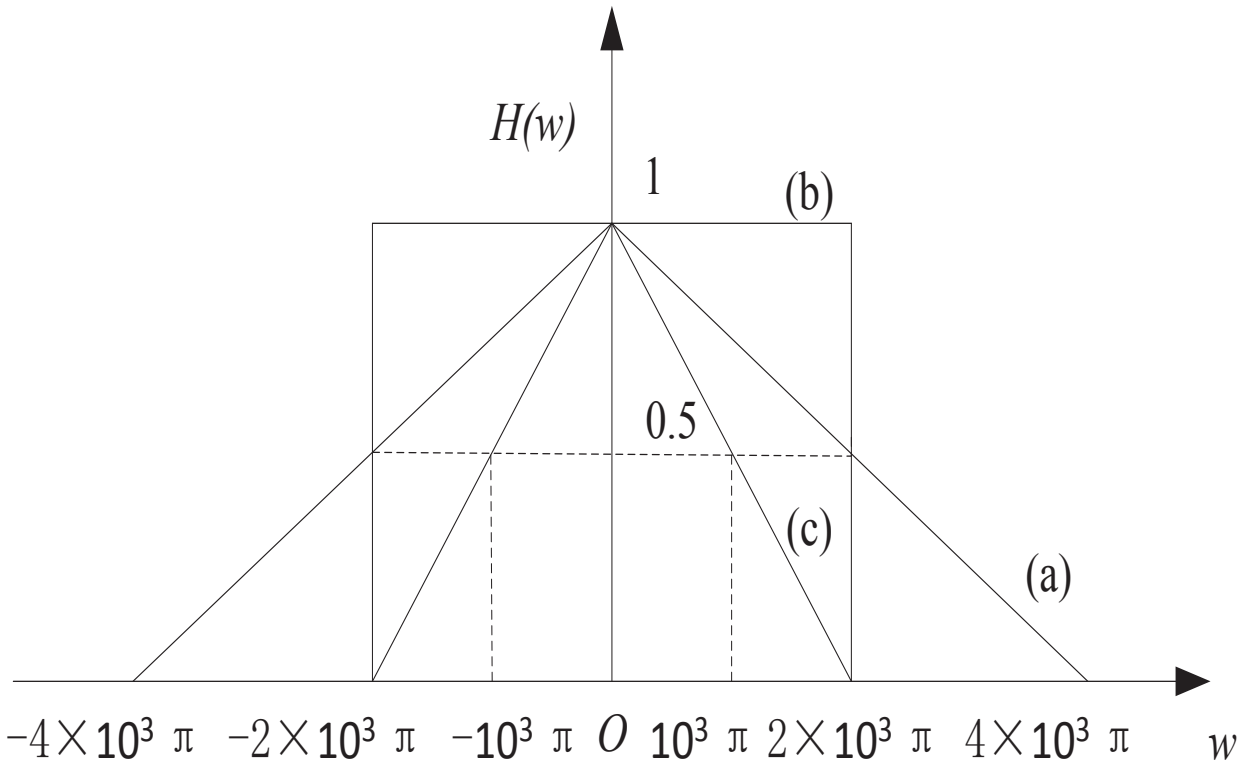
11 已知信息代码为1011000000000101，试确定相应的AMI码和HDB3码，并分别画出它们的波形图。

12 已知HDB3码为+10-1000-1+1000+1-1+1-100-1+10-1，试译出原信息代码。

13 设基带传输系统的发送滤波器、信道及接收滤波器组成总特性为$H(w)$，若要求以$\frac{2}{T_s}$波特的速率进行数据传输，试验证下图所示的各种$H(w)$能否满足抽样点上无码间串扰的条件。



14 为了传送码元速率$R_B = 10^3 B$ 的数字基带信号，试问：系统采用下图所画的哪一种传输特性较好？并简要说明其理由。



15 二进制数字基带传输系统如下所示，设$C(\omega)=1$, $G_T(\omega)=G_R(\omega)=\sqrt{H(\omega)}$。现已知

$$H(w)=\begin{cases}\tau_0(1+cos\omega\tau_0) & |\omega|\le\frac{\pi}{\tau_0}\\ 0 & \text{其它}\end{cases}$$

(1) 若$n(t)$ 的双边功率谱密度为$n_0/2(W/Hz)$,试确定$G_R(\omega)$的输出噪声功率。

(2) 若在抽样时刻kT（k为任意正整数）上，接收滤波器的输出信号以相同概率取0、A电平，而输出噪声取值V服从下述概率密度分布的随机变量

$$f(V)=\frac{1}{2\lambda}e^{-\frac{|V|}{\lambda}},\lambda>0$$

试求系统最小的误码率P_e。

16 一随机二进制序列101100100,"1"码用脉冲$g(t)$表示,"0"码用$-g(t)$表示，$g(t)=\frac{1}{2}(1+cos\frac{2\pi t}{T_s})$,码元持续时间为T_s。

(1) 当示波器扫描周期$T_0=T_s$时，试画出眼图。

(2) 当$T_0=2T_s$时，试画出眼图。

(3) 比较以上两种眼图的最佳抽样判决时刻、判决门限电平及噪声容限值。