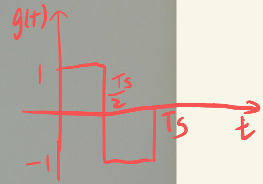
随堂测试9

设有双极性NRZ信号$s_1(t)=\sum_{n=-\infty}^{\infty} a_n g(t-nT_s)$, 其中

$$g(t)=\begin{cases}1, t\in[0,T_s/2]\\ -1, t\in[\frac{T_s}{2},T_s]\end{cases}, \quad a_n\text{独立等概取值于}\pm 1.$$



令$s_2(t)=s_1^2(t), s_3(t)=s_1(t)+s_1(t-T_s)$,

求：$s_1(t), s_2(t), s_3(t)$的功率谱密度表达式与主瓣带宽

$$g(t)=\mathrm{Rect}\left(\frac{t-\frac{T_s}{4}}{\frac{T_s}{2}}\right)-\mathrm{Rect}\left(\frac{t-\frac{3}{4}T_s}{\frac{T_s}{2}}\right)$$

※ sinc函数 窗函数转化 一定要会

$$G(f)=\frac{T_s}{2}\,\mathrm{sinc}\left(\frac{T_s}{2}f\right)e^{j2\pi f\frac{T_s}{4}}-\frac{T_s}{2}\,\mathrm{sinc}\left(\frac{T_s}{2}f\right)e^{j2\pi f\frac{3}{4}T_s}$$

$$=\frac{T_s}{2}\,\mathrm{sinc}\left(\frac{T_s}{2}f\right)\left[e^{j2\pi f\frac{T_s}{4}}-e^{j2\pi f\frac{3}{4}T_s}\right]$$

$$=e^{j2\pi f\frac{T_s}{2}}\left(e^{-j2\pi f\frac{T_s}{4}}-e^{j2\pi f\frac{T_s}{4}}\right)=2\sin(\pi f T_s)$$

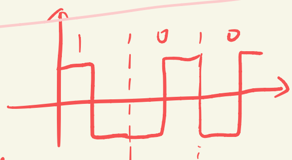
$$\therefore |G(f)|^2=\frac{T_s^2}{4}\,\mathrm{sinc}^2\left(\frac{T_s}{2}f\right)4\sin^2(\pi f T_s)$$

$$\frac{2\pi}{\frac{\pi T_s}{2}}\times\frac{1}{2}=\frac{2}{T_s}$$

$$BW_1=\frac{2}{T_s}.$$

$$P_{s_1}(f)=\frac{1}{T_s}|G(f)|^2=T_s\,\mathrm{sinc}^2\left(\frac{fT_s}{2}\right)\sin^2\left(\frac{\pi f T_s}{2}\right)$$

对于 $s_2(t)=s_1^2(t)$ $\quad\because s_1(t)=\sum a_n g(t-nT_s)$



$\therefore s_1^2(t)=1.$ $\quad P_2(f)=\delta(f).$ $\quad BW_2=0.$

而对于 $s_3(t)=s_1(t)\otimes h(t).$ $\quad h(t)=\delta(t)+\delta(t-T_s).$

$P_3(f)=P_1(f)|H(f)|^2$ $\quad H(f)=1+e^{-j2\pi f T_s}$

$=4T_s\,\mathrm{sinc}^2\left(\frac{fT_s}{2}\right)\sin^2\left(\frac{\pi f T_s}{2}\right)\cos^2(\pi f T_s)$ $\quad |H(f)|^2=|1+e^{-j2\pi f T_s}|^2=|2\cos\pi f T_s|^2$

$=|e^{-j\pi f T_s}|^2\,|e^{j\pi f T_s}+e^{-j\pi f T_s}|^2=1\cdot|2\cos\pi f T_s|^2$

$BW_3=\frac{1}{2T_s}$ $\quad \frac{2\pi}{\pi T_s}\times\frac{1}{4}$