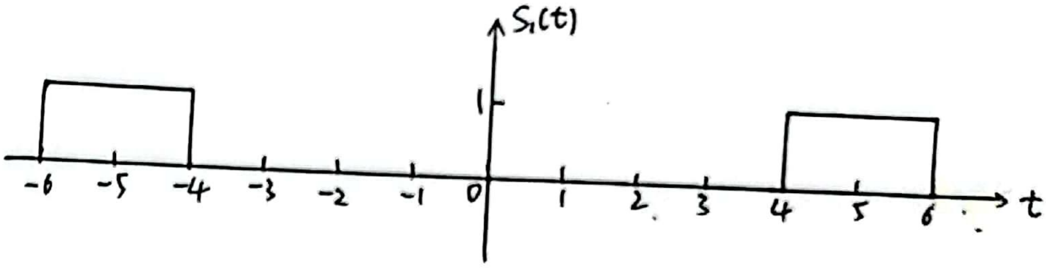
信号分析与处理 HW-2 190410102 方尧 自动化1班

2-15

(1) $s_1(t)=f_1(t)*f_2(t)=[u(t+1)-u(t-1)]*[\delta(t+5)+\delta(t-5)]$

$=u(t+1)*\delta(t+5)+u(t+1)*\delta(t-5)-u(t-1)\delta(t+5)-u(t-1)\delta(t-5)$

$=u(t+6)+u(t-4)-u(t+4)-u(t-6)$



(3) $s_3(t)=\{[f_1(t)*f_1(t)][u(t+5)-u(t-5)]\}*f_2(t)$

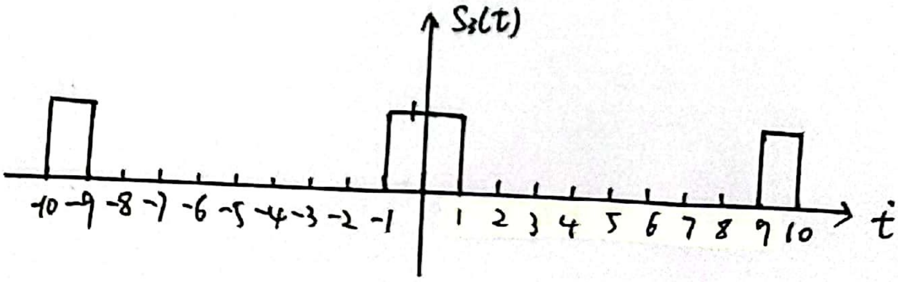
$[f_1(t)*f_2(t)][u(t+5)-u(t-5)]$

$=[u(t+6)+u(t-4)-u(t+4)-u(t-6)][u(t+5)-u(t-5)]$

$=u(t+5)+u(t-4)-u(t+4)-u(t-5)$

$s_3(t)=\{u(t+5)+u(t-4)-u(t+4)-u(t-5)\}*[\delta(t+5)+\delta(t-5)]$

$=u(t+10)+u(t+1)-u(t+9)-u(t)\quad +u(t)+u(t-9)-u(t-1)-u(t-10)$



3-3

(1) 周期矩形波的傅里叶级数 $f(t)=\frac{E\tau}{T_1}+\sum_{n=1}^{\infty}\frac{2E}{n\pi}\sin(\frac{n\pi\tau}{T_1})\cos(n\omega_1 t)$

$f_1(t)=\frac{1}{2}+\sum_{n=1,3,\dots}^{\infty}\frac{2}{n\pi}(-1)^{\frac{n-1}{2}}\cos(n\omega_1 t)$

不考虑直流分量，谱线间隔为 $\frac{2}{T}=2000kHz$，考虑直流分量，间隔为 $\frac{1}{T}=1000kHz$

$n=2$ 时，出现第1个零点，带宽 $\frac{2}{T}=2000kHz$

(2) 同(1) $f_2(t)=\frac{3}{2}+\sum_{n=1,2,\dots}^{\infty}\frac{6}{n\pi}(-1)^{\frac{n-1}{2}}\cos(n\omega_1 t)$

不考虑直流信号，谱线间隔为 $\frac{2}{T}=\frac{2000}{3}kHz$；考虑直流分量，间隔为 $\frac{1}{T}=\frac{1000}{3}kHz$

带宽为 $\frac{2000}{3}kHz$

(3) 基波幅度之比 $=\frac{2}{\pi}:\frac{6}{\pi}=1:3$.

(4) $f_1(t)$基波与$f_2(t)$三次谐波之比 $=\frac{2}{\pi}:\frac{6}{3\pi}=1:1$

3-5

$T=\frac{1}{f}=0.1ms$，$\omega_1=\frac{2\pi}{T}=2\times10^4\pi$，$f(t)=E\cos(2\pi f t)$ $(-\frac{T}{4}<t<\frac{T}{4})$

$$a_0=\frac{1}{T}\int_{-\frac{T}{2}}^{\frac{T}{2}}f(t)dt=\frac{1}{T}\int_{-\frac{T}{4}}^{\frac{T}{4}}f(t)dt=\frac{1}{T}\cdot\frac{E}{2\pi f}\cdot\sin(\omega_1 t)\Big|_{-\frac{T}{4}}^{\frac{T}{4}}=\frac{E}{\pi}$$

$$a_n=\frac{2}{T}\int_{-\frac{T}{2}}^{\frac{T}{2}}f(t)\cdot\cos n\omega_1 t\,dt=\frac{2}{T}\int_{-\frac{T}{4}}^{\frac{T}{4}}E\cos(\omega_1 t)\cdot\cos(n\omega_1 t)dt$$

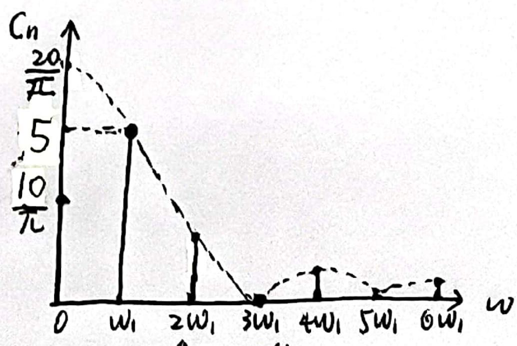
① 当$n=1$时，$a_n=\frac{2E}{T}\int_{-\frac{T}{4}}^{\frac{T}{4}}\frac{1}{2}[\cos(2\omega_1 t)+1]dt=\frac{E}{2}$

② $n\neq1$时，$a_n=\frac{2E}{T\omega_1}\left\{\frac{\sin[(n+1)\omega_1 t]}{n+1}+\frac{\sin[(n-1)\omega_1 t]}{n-1}\right\}\Big|_0^{\frac{T}{4}}=\frac{2E}{(1-n^2)\pi}\cos\frac{n\pi}{2}$

$$=\begin{cases}0, & n为奇, n>1\\ (-1)^{\frac{n}{2}}\frac{2E}{(1-n^2)\pi}, & n为偶\end{cases}$$

$$f(t)=\frac{E}{\pi}+\frac{E}{2}\cos(\omega_1 t)+\sum_{n=2,4,\dots}^{\infty}(-1)^{\frac{n}{2}}\cdot\frac{2E}{(1-n^2)\pi}\cdot\cos(n\omega_1 t)$$

$C_n=\sqrt{a_n^2+b_n^2}=|a_n|$



$\omega_1=2\times10^4\pi$ rad/s