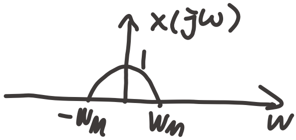
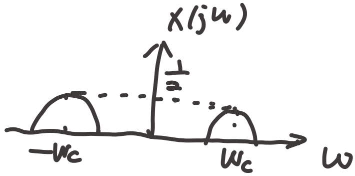
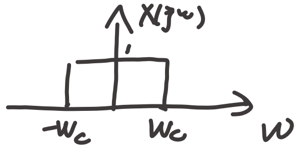
8 6 对 $x(t)$ 是个带限信号



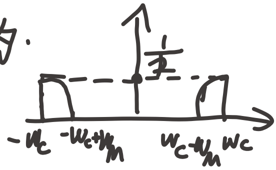
调制 $\longrightarrow$



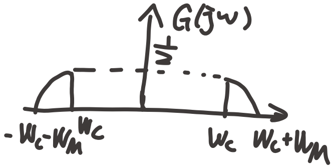
$$\frac{\sin\omega_c t}{\pi t} \xrightarrow{\mathcal{F}} \begin{cases} 1 & |\omega| \le \omega_c \\ 0 & |\omega| > \omega_c \end{cases}$$



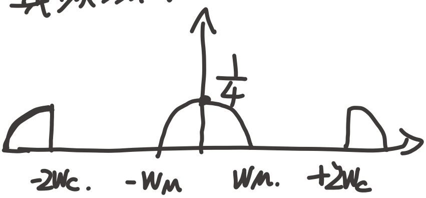
∴ $x(t)\cos\omega_c t * \frac{\sin\omega_c t}{\pi t}$ 的频谱为.



∴ $g(t) \to G(j\omega)$ 的频谱为.



$g(t)\cos(\omega_c t)$ 经对 $g(t)$ 调制
其频域为



$x(t) = g(t)\cos\omega_c t * \frac{A\sin\omega_m t}{\pi t}$ 相当于 $g(t)\cos\omega_c t$ 过一个带宽 $2\omega_m$ 滤波(低通)，其中保留部分幅度最大本

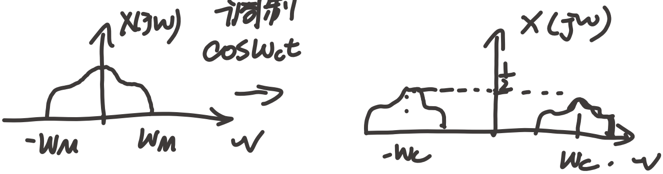
则 $A=4$.

8.9 (a) $y_1(t) = x_1(t)\cdot\cos w_c t + [x_1(t) * h(t)]\cdot\sin w_c t$

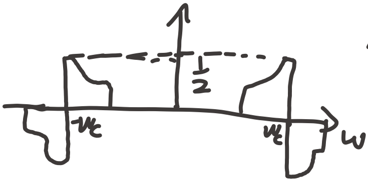
$y_2(t) = x_2(t)\cos 2w_c t + [x_2(t) * h(t)]\sin 2w_c t$

$\because y(t) = y_1(t) + y_2(t)$

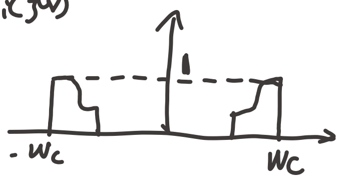
记 $X_1(jw)$



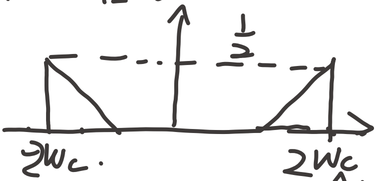
$X_1(jw)\,H(jw)$ 后调制



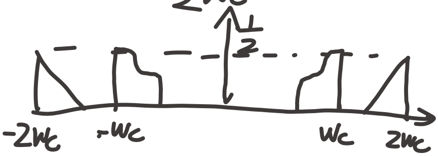
$\therefore$ $Y_1(jw)$



同理 $Y_2(jw)$

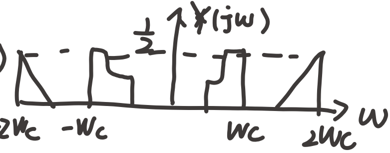


$Y(jw)$ 为



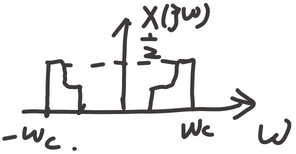
要求 $|w| \geq 2w_c$

(b) 对于 $Y(jw)$

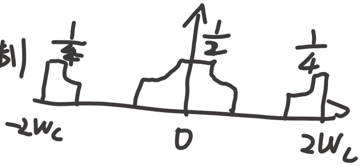


要分离出 $x_1(t)$ 则过LPF时 截止频率 $w_0 = w_c$

得到

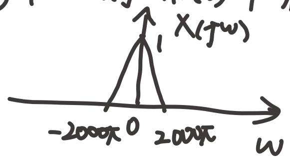


后调制



再使用截止频率 w_c 的 LPF 保留原点处附近频谱.
恢复得到 $\frac{1}{2}$ 幅度频谱 . $A=2$ 补偿可得到 $X_1(jw)$
进而还原 $x_1(t)$

8.12 对 $x_i(t)$ 中某信号 $x(t)$ 其FT的频谱为



对 $c(t)=\sum_{-\infty}^{+\infty}\delta(t-nT)$ 不忽略其宽度

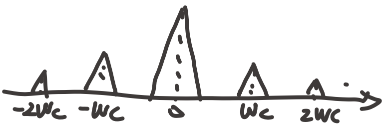
其 $C(jw) = 2\pi\sum_{n=-\infty}^{+\infty} a_k\delta(w-kw_c)$

$$a_k = \frac{1}{T}\int_T \Delta\, e^{-jwt}dt = \frac{1}{T}\int_{-\frac{\Delta}{2}+kT}^{\frac{\Delta}{2}+kT} e^{-jkw_0 t}dt$$

$$= \frac{1}{T}\frac{e^{-jkw_0 t}\Big|_{-\frac{\Delta}{2}}^{\frac{\Delta}{2}}}{-jkw_0} = \frac{\sin(kw_c\Delta/2)}{\pi k}$$

$$Y(jw) = \sum_{n=-\infty}^{+\infty}\frac{\sin(kw_c\Delta/2)}{\pi k}X(j(w-kw_c))$$

只需 $w_c > 2w_m$ 便不混叠, 只有幅度变化



$T = \frac{2\pi}{\omega_s}$ $\omega_s = \omega_{s\min} = 2\omega_m = 4000\pi$.

$\therefore T = \frac{1}{2000}s$

每个信号占用间隔 Δ 满足 $T = 10\Delta$

$\therefore \Delta = \frac{T}{10} = \frac{1}{20000}s$

8.2(a) 调制系统中

$$w(t) = x(t)\cos^2 w_c t$$

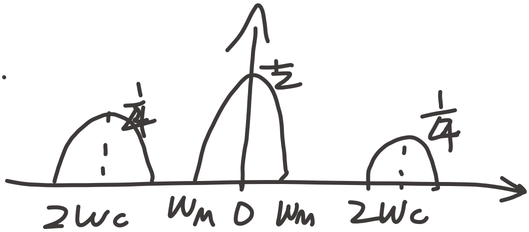
$$= x(t)\,\frac{1+\cos 2w_c t}{2}$$

当有相位 w_c

$$w(t) = \frac{1}{2}x(t) + \frac{1}{2}x(t)\cos(2w_c t + 2\theta_c)$$

得证

(b) 调制后.

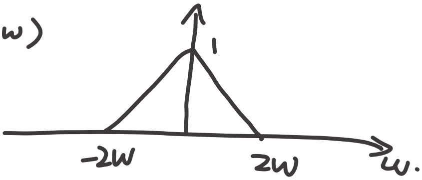


$\therefore$ $w_{co} \geq w_m$ (x 的截止)

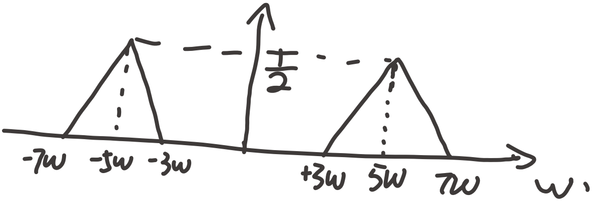
$$w_{co} \leq 2w_c - w_m$$

与 θ_c 无关.

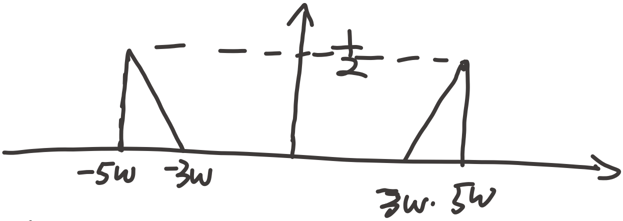
题 8.22 $x(t) \to X(jw)$



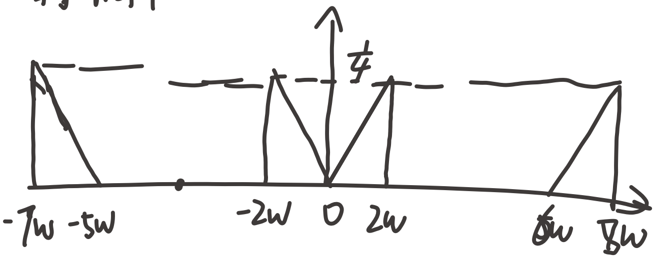
① 调制 cos5wt后



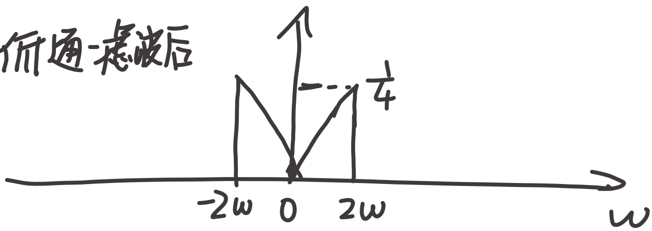
② 带通滤波后



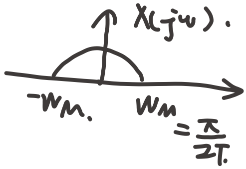
③ 再调制



④ 低通滤波后



8 24 (a) $x(t)$ 带限于 w_M

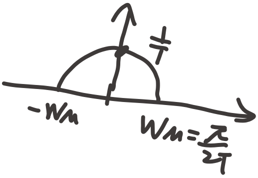


调制：记 $z(t)=x(t)\sum_{n=-\infty}^{\infty}\delta(t-nT)$.

$$Z(jw)=\frac{1}{2\pi}X(jw)*\sum_{n=-\infty}^{\infty}\delta(w-n\frac{2\pi}{T})\cdot\frac{2\pi}{T}=\frac{1}{T}\sum_{n=-\infty}^{\infty}X(j(w-n\frac{2\pi}{T}))$$

① $n=0$. $Z(jw)=\frac{1}{T}X(jw)$

该频段被滤除



② $n=\pm1$ $Z(jw)=\frac{1}{T}X(j(w\pm\frac{2\pi}{T}))$

$\because$ $\frac{2\pi}{T}-\frac{\pi}{2T}=\frac{3\pi}{2T}>w_L$

$\frac{2\pi}{T}+\frac{\pi}{2T}=\frac{5\pi}{2T}<w_h$

$\therefore$ 该频段保留，乘权重

③ $n=\pm2$ $Z(jw)=\frac{1}{T}X(j(w\pm\frac{4\pi}{T}))$

该频段被滤除 $|n|\geq2$. 被滤除

$$\therefore\quad Y(jw)=\frac{A}{T}\left[X(j(w+\frac{2\pi}{T}))+X(j(w-\frac{2\pi}{T}))\right]$$

$$y(t)=\frac{A}{T}\left(x(t)e^{j\frac{2\pi}{T}t}+x(t)e^{-j\frac{2\pi}{T}t}\right)$$

$$=\frac{2A}{T}x(t)\cos(w_ct)\ \propto\ x(t)\cos w_ct$$

得证.

(b) 对 $s(t)=\sum_{n=-\infty}^{+\infty}\delta(t-\Delta-nT)$

$$S(j\omega)=\sum_{n=-\infty}^{+\infty}\frac{2\pi}{T}\cdot e^{-j\omega\Delta}\,\delta(\omega-n\frac{2\pi}{T})$$

$$\therefore \mathcal{F}[x(t)\ s(t)]=\frac{1}{2\pi}\left[X(j\omega)*\sum_{n=-\infty}^{+\infty}\frac{2\pi}{T}e^{-j\omega\Delta}\delta(\omega-n\frac{2\pi}{T})\right]$$

$$=\frac{1}{T}\sum_{n=-\infty}^{+\infty}e^{-j\omega\Delta}X(j(\omega-n\frac{2\pi}{T}))$$

实际上只是结果中多了$e^{-j\omega\Delta}$系数，并不影响带通滤波器保留频段. $y(t)$ 正比于 $x(t)\cos(\omega_c t+\theta_c)$

$$\therefore Y(j\omega)=\frac{A}{T}\cdot\left(e^{-j\omega_c\Delta}X[j(\omega-\omega_c)]+e^{+j\omega_c\Delta}\cdot X(j(\omega+\omega_c))\right)$$

$$\therefore y(t)=\frac{A}{T}x(t)\left(e^{j\omega_c(t-\Delta)}+e^{-j\omega_c(t-\Delta)}\right)$$

$$=\frac{2A}{T}x(t)\cos(\omega_c(t-\Delta))$$

$$\therefore \theta_c=-\omega_c\Delta \quad \omega_c=\frac{2\pi}{T}$$

$$=-\frac{2\pi}{T}\Delta.$$

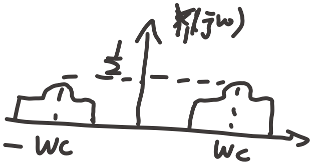
(c). 要求经过带通可全部保留 ω_c 段 $\quad \frac{2\pi}{T}+\omega_m\le\frac{3\pi}{T}$

$\therefore \omega_m\le\frac{\pi}{T}$

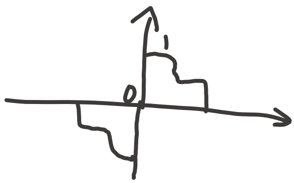
最大容许值为$\frac{\pi}{T}$

8.28 (a) $X(j\omega)$

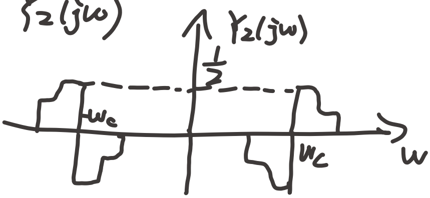
$Y_1(j\omega)$



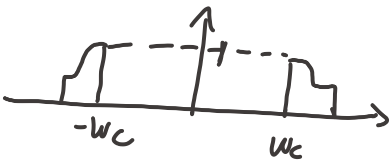
对 $X(j\omega)H(j\omega)$



$Y_2(j\omega)$

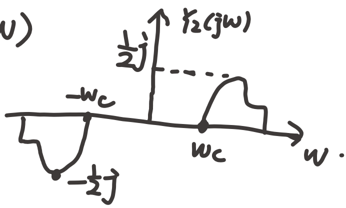


$Y(j\omega)$ 为

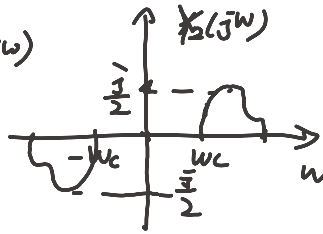


(b). $X(j\omega)$ 纯虚，则 $x(t)$ 为奇函数 且 $X(j\omega)$ 是奇函数

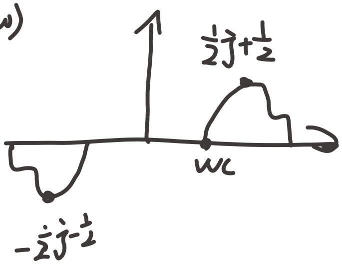
$Y_1(j\omega)$



$Y_2(j\omega)$

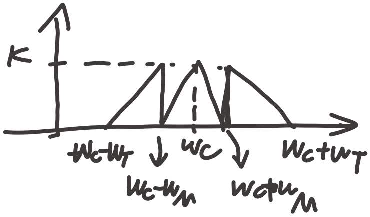


$Y(j\omega)$



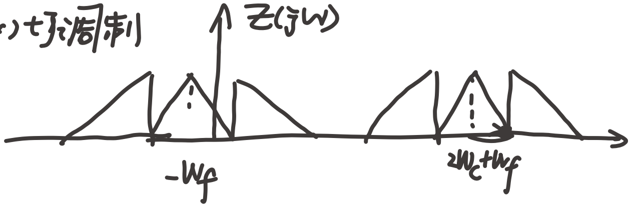
8.36 (a) $Y(j\omega)$

进入粗调谐滤波



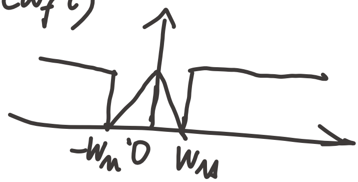
再与 $\cos[(\omega_c+\omega_f)t]$ 调制

得 $Z(j\omega)$



(b) 希望输出为 $r(t) = x_1(t)\cos(\omega_f t)$

$\because$ $x_1(t)\cos\omega_c t$ 频谱为



要不失真频谱集中 $\omega=\omega_f$

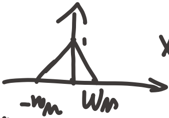
$\omega_T \geq 2\omega_M$，否则混叠

(c). 为保证不失真 $G=1$

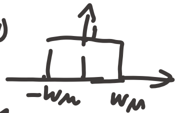
$\alpha = \omega_f - \omega_M$ $\beta = \omega_f + \omega_M$.

$H_2(j\omega)$ 才可完整包含 $x_1(t)$ 调制至 ω_f 的频谱

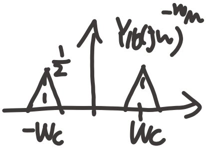
8.40 对 P8.40(a) 记 $X_1(j\omega)$



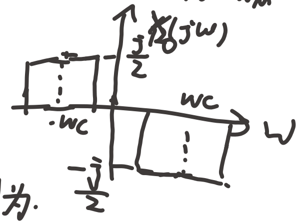
$X_2(j\omega)$



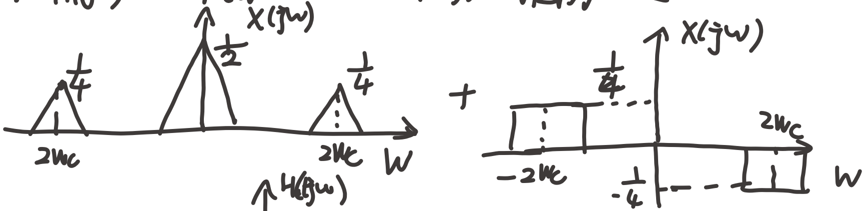
$x_1(t)$路上得到 $Y_{10}(j\omega)$



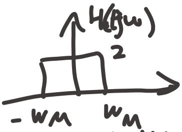
$x_2(t)$路上得到 $Y_{20}(j\omega)$



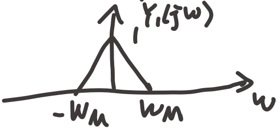
① 求 $Y_1(j\omega)$：$r(t)\cos\omega_c t$ 的频域图为



通过滤波器



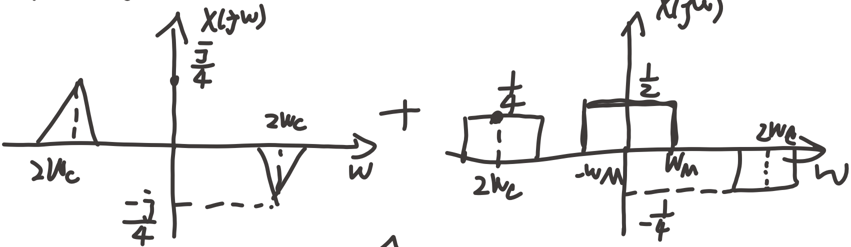
$Y_1(j\omega)$ 为



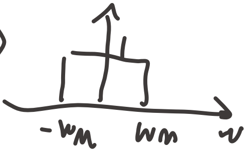
$= \mathcal{F}[x_1(t)]$

$\therefore y_1(t) = x_1(t)$

② 求 $Y_2(j\omega)$ $r(t)\sin\omega_c t$ 频域为



过滤波器 $Y_2(j\omega)$



则 $y_2(t) = x_2(t)$ 得证