HW ch3.

解調 → 基頻

#1. $V_1(t)$ → [平方律元件] → $V_2(t)$ → [Filter $H(f)$] → $y(t)$ → C → $Y(t) \sim k m(t)$

(a) : AM signal

$V_1(t) = A_c[1+k_a m(t)]\cos(2\pi f_c t)$

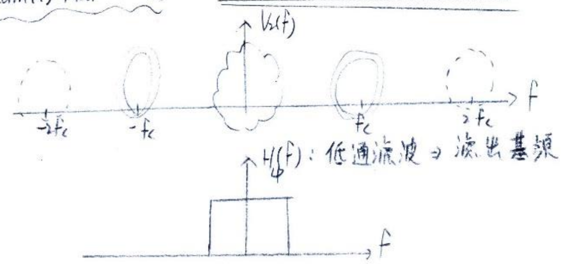
$V_2(t) = a_1 V_1(t) + a_2 V_1^2(t)$

$= a_1(A_c[1+k_a m(t)]\cos(2\pi f_c t)) + a_2(A_c^2[1+2k_a m(t) + k_a^2 m^2(t)])(\frac{1}{2}+\frac{1}{2}\cos(4\pi f_c t))$ #   ($\cos^2(2\pi f_c t)$)

$= a_1(A_c[1+k_a m(t)]\cos(2\pi f_c t)) + a_2(A_c^2[1+2k_a m(t)+k_a^2 m^2(t)])\cos(4\pi f_c t)$ ⟶ 畫頻率圖

⇒ 將相同載波訊號放一起

$= (\frac{1}{2}a_2 A_c^2[1+2k_a m(t)+k_a^2 m^2(t)]) + (a_1 A_c(1+k_a m(t)))\cos(2\pi f_c t) + (\frac{1}{2}a_2 A_c^2[1+2k_a m(t)+k_a^2 m^2(t)])\cos(4\pi f_c t)$




⇒ $y(t) = \frac{a_2 A_c^2}{2}[1+2k_a m(t)+k_a^2 m^2(t)]$

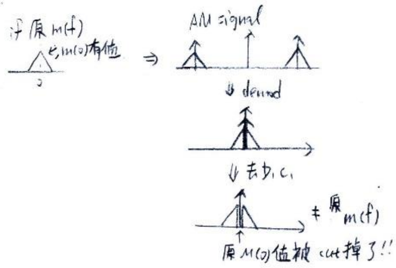
討論 $\frac{a_2 A_c^2}{2} + a_2 A_c^2 k_a m(t) + \frac{a_2 A_c^2}{2}k_a^2 m^2(t)$ vs. $m(t)$: 所要訊息.

條件 ⇒

(1) $m(t)$ 不得具 D.C. (∵低通 $H(f)$ 會濾 $m(t)$ 的直流部份) ⇒

(2) $|k_a \min\{m(t)\}| << 1$ ⇒ $k_a m^2(t) << 1$
⇒ $\mu << 1$

(3) $f_c >> W$ (避免頻譜重疊)




(b)

⇒ $Y(t) = a_2 A_c^2 k_a m(t)$

$\approx k' m(t)$ # ⇒ 還原訊息 #

#2. from 1. 的 $Y(t)$ 等效於 Fig3. 的 $V_3(t)$

⇒ $V_3(t) = \frac{a_2 A_c^2}{2}[1+2k_a m(t)+k_a^2 m^2(t)]$

$= \frac{a_2 A_c^2}{2}(1+k_a m(t))^2$

$\sqrt{V_3(t)}$

⇒ $V_3(t) = \sqrt{\frac{a_2 A_c^2}{2}(1+k_a m(t))^2}$

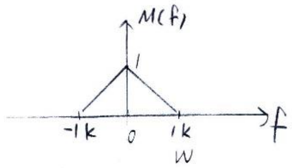
令 $a_2=1$

$= \frac{A_c}{\sqrt{2}}(1+k_a m(t))$ #



#3.

(a)

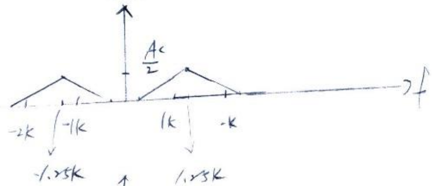



(a) $f_c = 1.25$ kHz

DSB-SC ⇒ $c(t) = A_c\cos(2\pi f_c t)$

$\xrightarrow{F} \frac{A_c}{2}[\delta(f-f_c)+\delta(f+f_c)]$

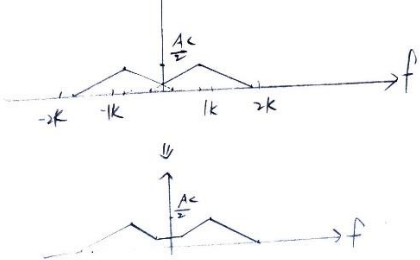
$S(f) = M(f) * C(f)$




可完整解回 $M(f)$

(b) $f_c = 0.75$ kHz

∵ $f_c$ > 1 B.W. 才可還原 $m(t)$ #




無法完整解回 $M(f)$ ⇒ $f_c$ 取值太小可能造成 aliasing.

#4. DSB-SC MOD. (Balanced Modulator)

$s_1(t) = A_c[1+k_a m(t)]\cos(2\pi f_c t)$

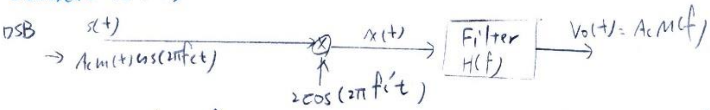
$s_2(t) = A_c[1-k_a m(t)]\cos(2\pi f_c t)$

$s(t) = s_1(t) - s_2(t)$ ← 去掉載波,只留 $m(t)$ part

$= 2k_a m(t) A_c \cos(2\pi f_c t)$

$= A_c' m(t)\cos(2\pi f_c t)$ ⇒ DSB-SC #

#5 DSB解調 Coherent 接收器, Coherent (de-mod) receiver




當 $f_c' = f_c + \Delta f$

$\cos(a)\cdot\cos(b) = \frac{1}{2}[\cos(a+b) + \cos(a-b)]$

$x(t) = 2s(t)\cos(2\pi(f_c+\Delta f)t)$

$= 2A_c m(t)\cos(2\pi f_c t)\cos(2\pi(f_c+\Delta f)t)$

$= A_c m(t)\cos(2\pi\Delta f t) + A_c m(t)\cos(2\pi(2f_c+\Delta f)t)$   ($\frac{1}{2}\cos(2\pi\Delta f t) + \frac{1}{2}\cos(2\pi(2f_c+\Delta f)t)$)

低 f     高 f

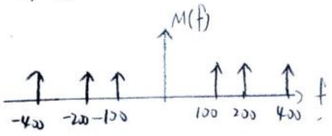
$\xrightarrow{LPF}$ $V_o(t) = A_c m(t)\cos(2\pi\Delta f t)$ →失真因子

∴ 節拍效應 (Beating effect)

↑ 聲音會忽大忽小,但有節奏(頻率)

# 8.

m(t) 具 100, 200, 400 Hz 的訊號




$f_c = 100\,kHz$

r(t) ⇓ carrier 100 kHz ⇒ $m(t)\cdot\cos(2\pi\, 100k\, t)$

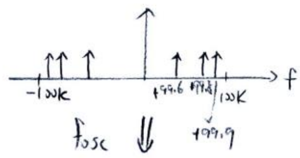

⇓

(a) $H_{USB}(f)$


(b) $H_{LSB}(f)$


(a) $R_{USB}(f)$

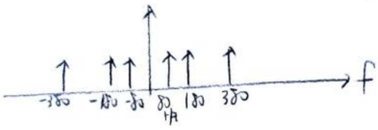

(b) $R_{LSB}(f)$

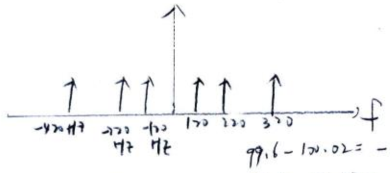



⇓ 經本地振盪器 $f_0 = 100.02\,kHz$

$r_{USB}(t)\cdot\cos(2\pi f_0 t)$

$f_{osc}$ ⇓




$-100.1 + 100.02 = -0.08$

$100.1 - 100.02 = 0.08\,kHz = 80\,Hz$

$100.2 - 100.02 = 0.18\,kHz = 180\,Hz$

$100.4 - 100.02 = 0.38\,kHz = 380\,Hz$

$-99.9 + 100.02 = 120\,Hz$

$99.6 - 100.02 = -0.42 = -420\,Hz$

$99.8 - 100.02 = -220\,Hz$

$99.9 - 100.02 = -120\,Hz$

⇓

USB後，剩下有 {80 Hz, 180 Hz, 380 Hz} #

LSB後剩下有 {120 Hz, 220 Hz, 420 Hz} #