**5-5.** (a.) $50{,}000 = \dfrac{A_c^2}{2(50)} \Rightarrow A_c = 2236\text{ V}$

$g(t) = A_c\{1 + m(t)\}$

$= \underline{\underline{2236\left[1 + A_1(\cos\omega_1 t + \cos 2\omega_1 t)\right]}}$

(b.) to find $m(t)_{MIN}$: $x(\theta) = \cos\theta + \cos 2\theta$

$0 = \dfrac{dx(\theta)}{d\theta} = -\sin\theta - 2\sin 2\theta$

$\sin 2\theta = 2\sin\theta\cos\theta \Rightarrow -\sin\theta = 4\sin\theta\cos\theta$

$\underline{\theta = 104.5^\circ}$

$A_{max} = 2236\{1 + 2A_1\}$ $\qquad x(104.5^\circ) = -1.125$

$A_{MIN} = 2236\{1 - 1.125A_1\}$

$90 = \dfrac{A_{max} - A_{min}}{2A_c} = \dfrac{3.125}{2}A_1 \Rightarrow \underline{\underline{A_1 = .576}}$

(c.) $A_{max} = 2236\{1 + 2(.576)\} = 4811.9$ volts

$I_{max} = \dfrac{A_{max}}{50} = \underline{\underline{96.238\text{ Amps}}}$

$\langle s(t)\rangle = \left\langle 2236\left[1 + .576(\cos\omega_1 t + \cos 2\omega_1 t)\right] \cdot \cos\omega_c t \right\rangle$

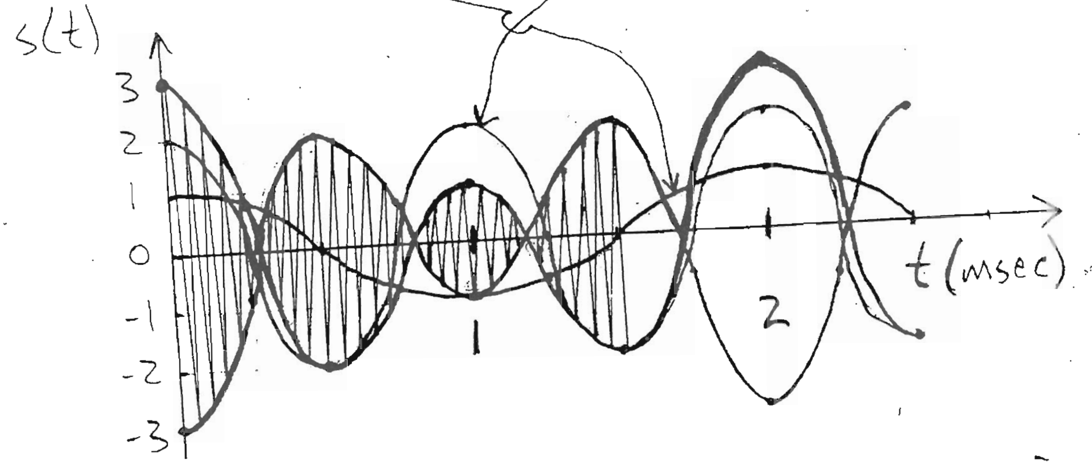
$= 0$ for $\omega_c \gg \omega_1$

$\therefore I_{AV} = \underline{\underline{0}}$ Amps

5-7. (a.) DSB-SC $m(t) = \cos\omega_1 t + 2\cos 2\omega_1 t$

$$\underline{\underline{s(t) = [\cos\omega_1 t + 2\cos 2\omega_1 t]\cos\omega_c t}}$$

where $\omega_1 = 1000\pi$

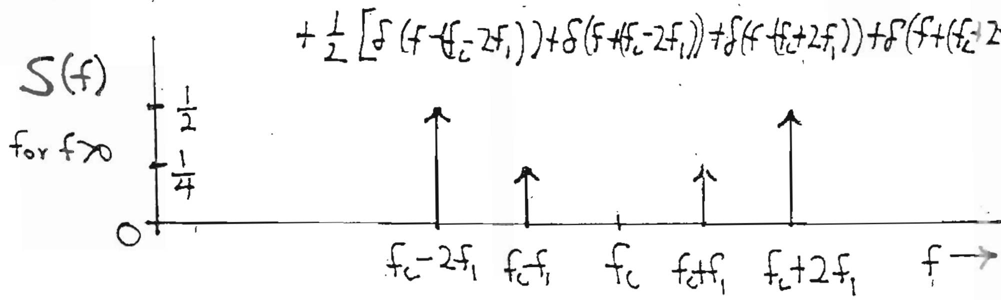



(b.) $s(t) = \frac{1}{2}\left[\cos(\omega_c-\omega_1)t + \cos(\omega_c+\omega_1)t\right]$

$+ \cos(\omega_c-2\omega_1)t + \cos(\omega_c+2\omega_1)t$

5-7 (b.) Cont'd

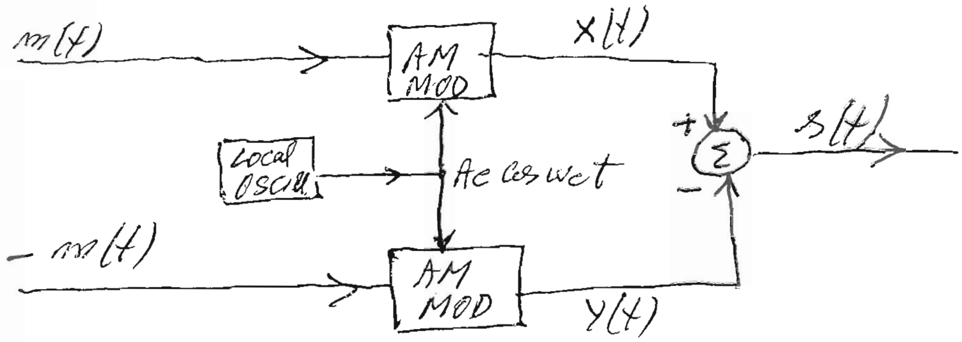
$$S(f) = \mathcal{F}[s(t)] = \frac{1}{4}[\delta(f-(f_c-f_1)) + \delta(f+(f_c-f_1)) + \delta(f-(f_c+f_1)) + \delta(f+(f_c+f_1))]$$
$$+ \frac{1}{2}[\delta(f-(f_c-2f_1)) + \delta(f+(f_c-2f_1)) + \delta(f-(f_c+2f_1)) + \delta(f+(f_c+2f_1))]$$




(c.) $P_{AV_{norm}} = \frac{1}{2}\left[(\frac{1}{2})^2+(\frac{1}{2})^2+(1)^2+(1)^2\right] = \underline{\underline{1.25\ W}}$

(d.) $A_{max} = 3 \Rightarrow PEP_{norm} = \frac{(3)^2}{2} = \underline{\underline{4.5\ W}}$

Prob. 5.9 ✓




where:

$$x(t) = A_c[1 + K_a m(t)]\cos w_c t$$

$$y(t) = A_c[1 - K_a m(t)]\cos w_c t$$

$$s(t) = x(t) - y(t) = 2A_c K_a m(t) \cos w_c t$$

$s(t)$ is a DSBSC signal.

Prob. # 5.13

$$s(t) = \frac{A_c}{2} m(t)\cos 2\pi f_c t + \frac{A_c}{2}\hat{m}(t)\sin 2\pi f_c t$$

Assume $A_c = 1$, $m(t) = 5\cos 2\pi f_1 t$

$f_1 = 500\,Hz$.

a) $\hat{m}(t) = H \cdot T[m(t)]$

$$\hat{M}(f) = -j\,sgn(f)M(f) = -j\,sgn f\left\{\frac{5}{2}[\delta(f-f_1) + \delta(f+f_1)]\right\}$$

$$= \frac{-5j}{2}[\delta(f-f_1) - \delta(f+f_1)]$$

$$= \frac{5}{2j}[\delta(f-f_1) - \delta(f+f_1)]$$

$$\hat{m}(t) = F^{-1}T[\hat{M}(f)] = 5\sin 2\pi f_1 t$$

prob # 5.13 cont'd)

b) $s_L(t) = \frac{5}{2} \cos\omega_1 t \cos\omega_c t + \frac{5}{2} \sin\omega_1 t \sin\omega_c t$ (1)

using $\cos(\alpha - \beta) = \cos\alpha \cos\beta + \sin\alpha \sin\beta$
we have

$$s_L(t) = \frac{5}{2} \cos[(\omega_c - \omega_1)t] \quad (2)$$

c) $S_{rms} = \frac{S_{peak}}{\sqrt{2}} = \frac{5/2}{\sqrt{2}} = \frac{5}{2\sqrt{2}}$ volts

d) $S_{peak} = 5/2$ volts

e) $P_{av} = \frac{S_{peak}^2}{2} = \frac{(5/2)^2}{2} = \frac{25}{8}$ watts

f) PEP = ?
using eq. (1) find the envelope

$$a(t) = \sqrt{S_I^2(t) + S_Q^2(t)} = \sqrt{\left(\frac{5}{2}\right)^2 \cos^2\omega_1 t + \left(\frac{5}{2}\right)^2 \sin^2\omega_1 t}$$

$$a(t) = 5/2$$

$$PEP = \frac{1}{2}[\text{Max } a(t)]^2 = \frac{(5/2)^2}{2} = \frac{25}{8} \text{ watt}$$

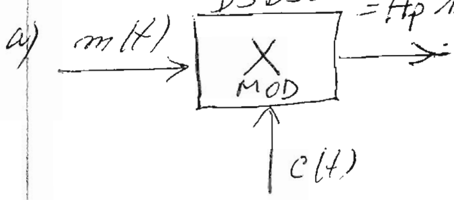
Note: $S_{rms}$ can be obtained from:

$$S_{rms}^2 = P_{av} = \frac{(5/2)^2}{2} = \frac{25}{8}$$

$$S_{rms} = \sqrt{P_{av}} = \frac{5}{2\sqrt{2}}$$

5.8)

a) DSBSC $s(t) = A_p\, m(t) \cos w_c t$

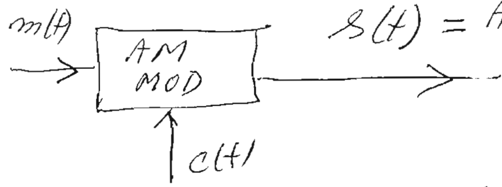



$P_{DSBSC} =$

$$P_{DSBSC} = \langle A_p^2\, m^2(t) \cos^2 w_c t \rangle = \langle A_p^2 \cos^2 w_c t \rangle \langle m^2(t) \rangle$$

$$= \frac{A_p^2}{2} \langle m^2(t) \rangle \qquad (1)$$

b) $s(t) = A_c[1 + k\, m(t)] \cos w_c t$




Assume $\text{Max}[m(t)] = 1$ ← To avoide envelope distortion $|m(t)| \le 1$

The problem stated that:

$$s_{AM\,(peak)}(t) = A_c[1 + \max(m(t))] = 2A_c \triangleq A_p$$

$$\Rightarrow A_c = \frac{A_p}{2}$$

Thus:

$$s_{AM}(t) = \frac{A_p}{2}[1 + m(t)] \cos w_c t$$

$$= \underbrace{\frac{A_p}{2} \cos w_c t}_{\text{Carrier}} + \underbrace{\frac{A_p}{2} m(t) \cos w_c t}_{\text{Sideband}}$$

$$P_{AM\,(SB)} = \left\langle \frac{A_p^2}{4} m^2(t) \cos^2 w_c t \right\rangle$$

$$= \frac{A_p^2}{4} \underbrace{\langle \cos^2 w_c t \rangle}_{1/2} \cdot \langle m^2(t) \rangle = \frac{A_p^2}{4 \times 2} \langle m^2(t) \rangle \qquad (2)$$

Thus.. $$\frac{P_{DSBSC}}{P_{AM\,(SB)}} = \frac{\frac{A_p^2}{2} \langle m^2(t) \rangle}{\frac{A_p^2}{8} \langle m^2(t) \rangle} = 4 = 6\,dB$$