

Question 2

$$(a) \quad P_m = \frac{2^2}{2} + \frac{4^2}{2} = 10$$

$$P_s = \frac{6^2}{2} \times P_m = 18 \times 10 = 180$$

$$(b) \quad M(f) = \delta(f-5) + \delta(f+5) \\ + 2\delta(f-7) + 2\delta(f+7)$$

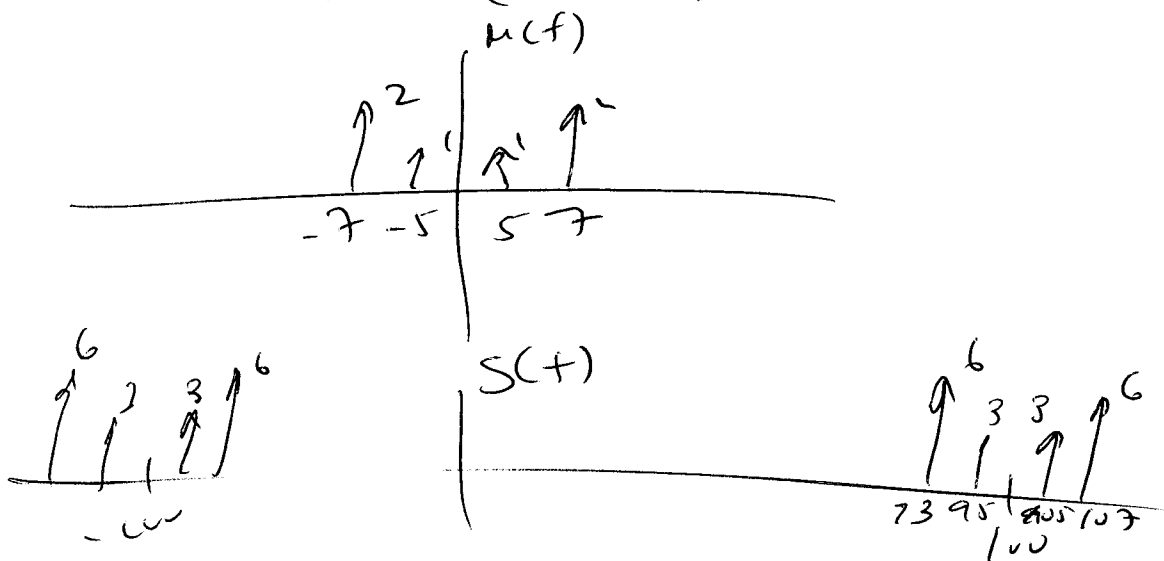
$$S(f) = 3M(f-100) + 3M(f+100)$$

$$= 3\delta(f-105) + 3\delta(f+105)$$

$$+ 3\delta(f-95) + 3\delta(f+95)$$

$$+ 6\delta(f-107) + 6\delta(f+107)$$

$$+ 6\delta(f-93) + 6\delta(f+93)$$



$$(c) \quad m_h(f) = -j\delta(f-5) + j\delta(f+5) \\ -j2\delta(f-7) + j2\delta(f+7)$$

$$m_h(t) = \cancel{2\cos(10\pi t)} + 4\sin(4\pi t)$$

$$S(f) = 3u(f-f_c) + 3u(f+f_c)$$

$$S_h(f) = -j3u(f-f_c) + j3u(f+f_c)$$

$$= \frac{3}{j}u(f-f_c) - \frac{3}{j}u(f+f_c)$$

$$S_h(t) = 6m(t)\sin 2\pi 100t$$

$$= 6(2\cos 10\pi t + 4\cos 14\pi t)\sin 2\pi 100t$$

$$(d) \quad m_+(t) = m(t) + jm_h(t)$$

$$= 2\cos 10\pi t + j2\sin 10\pi t$$

$$+ 4\cos 14\pi t + j4\sin 14\pi t$$

$$= 2e^{j10\pi t} + 4e^{j14\pi t}$$

$$S_+(t) = 6m(t)\cos 2\pi f_c t + j6m(t)\sin 2\pi f_c t$$

$$= 6m(t)e^{j2\pi f_c t}$$

$$= 6(2\cos 10\pi t + 4\cos 14\pi t)e^{j2\pi f_c t}$$

(can be found using F.T. as well)

Question 3

(a) $s(t) = 6 \cos(2\pi 2000t) + 6 \cos(2\pi 2500t)$

$$S(f) = 3\delta(f - 2000) + 3\delta(f + 2000) \\ + 3\delta(f - 2500) + 3\delta(f + 2500)$$

$$S_T(f) = 68(f - 2000) + 68(f - 2500)$$

$$S_+(t) = \mathcal{F}^{-1} \{ S_+(\omega) \} = 6e^{j2\pi 2000t} + 6e^{j2\pi 2500t}$$

$$\begin{aligned}\vec{s}(t) &= s_+(t) e^{-j2\pi f_c t} \\ &= s_+(t) e^{-j2\pi 250 t} \\ &= 6e^{-j2\pi 250 t} + 6e^{j2\pi 250 t} \\ &= 12 \cos 2\pi 250 t\end{aligned}$$

(b) $x_I(t) = \operatorname{Re}\{\tilde{s}(t)\} = (2\cos 20) \cos 250t$
 $x_Q(t) = -\operatorname{Im}\{\tilde{s}(t)\} = 0$

$$s(t) = 12 \cos(2\pi \cdot 250t) \cos(2\pi \cdot 2250t)$$

(C1)

$$S_+(t) = 6\delta(t-2000) + 6\delta(t-2500)$$

$$S_+(t) = \cancel{6e^{j2\pi 250t}} \\ 6e^{j2\pi 2000t} + 6e^{j2\pi 2500t}$$

(does not change with definition of A_c)

$$\begin{aligned}\tilde{S}(t) &= S_+(t) e^{-j2\pi f_c t} \\ &= (6e^{j2\pi 2000t} + 6e^{j2\pi 2500t}) e^{-j2\pi 2000t} \\ &= 6 + 6e^{j2\pi 500t}\end{aligned}$$

$$\cancel{= 6 + 6\cos}$$

$$\cancel{= 6 + 12\cos 2\pi 500t}$$

$$= 6 + 6\cos 2\pi 500t + j6\sin 2\pi 500t$$

$$x_I(t) = 6 + 6\cos 2\pi 500t$$

$$x_Q(t) = j6\sin 2\pi 500t$$

$$\begin{aligned}S(t) &= (6 + 6\cos 2\pi 500t) \cos 2\pi 2000t \\ &\quad - 6\sin 2\pi 500t \sin 2\pi 2000t\end{aligned}$$