Homework Solution

(4.4-1) $x_1(t) = [m_1(t)\cos\omega_c t + m_2(t)\sin\omega_c t]\cdot 2\cos[(\omega_c+\Delta\omega)t+\delta]$

From p. 773:
$$2\sin x \sin y = \cos(x-y) - \cos(x+y)$$
$$2\cos x \cos y = \cos(x-y) + \cos(x+y)$$
$$2\sin x \cos y = \sin(x-y) + \sin(x+y)$$

$$x_1(t) = m_1(t)\cos[\Delta\omega t+\delta] + m_1(t)\cos[2\omega_c t + \Delta\omega t + \delta]$$
$$- m_2(t)\sin[\Delta\omega t+\delta] + m_2(t)\sin[2\omega_c t + \Delta\omega t + \delta]$$

After LPF: $\hat{m}_1(t) = m_1(t)\cos(\Delta\omega t+\delta) - m_2(t)\sin(\Delta\omega t+\delta)$

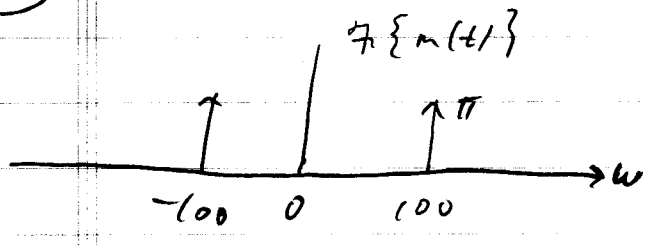
$$x_2(t) = [m_1(t)\cos\omega_c t + m_2(t)\sin\omega_c t]\cdot 2\sin[(\omega_c+\Delta\omega)t+\delta]$$
$$= m_1(t)\sin(\Delta\omega t+\delta) + m_1(t)\sin(2\omega_c t + \Delta\omega t+\delta)$$
$$+ m_2(t)\cos(\Delta\omega t+\delta) - m_2(t)\cos(2\omega_c t + \Delta\omega t+\delta)$$

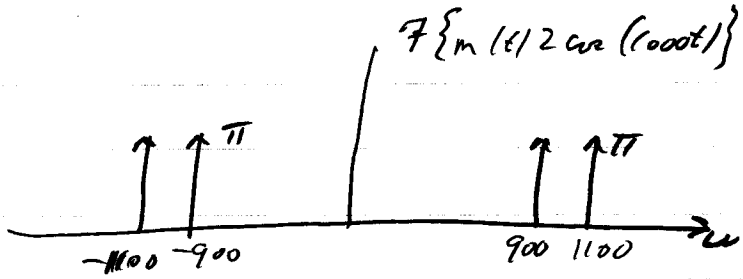
After LPF: $\hat{m}_2(t) = m_1(t)\sin(\Delta\omega t+\delta) + m_2(t)\cos(\Delta\omega t+\delta)$

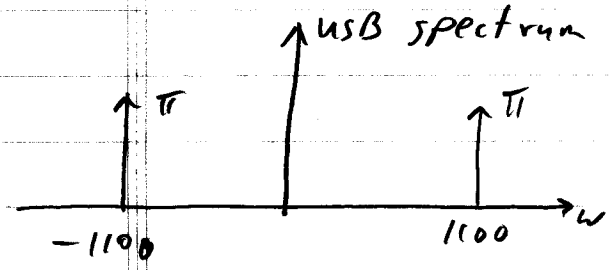
If $\delta \neq 0$: "crosstalk" in estimates of $m_1(t)$ and $m_2(t)$.

$\Delta\omega \neq 0$: "modulation" of message by frequency $\Delta\omega$.

(4.5-1) $m(t) = \cos 100t$







$$\varphi_{USB}(t) = \cos(1100t)$$

Similar for LSB: $\varphi_{LSB}(t) = \cos(900t)$

(4.5-2) Hilbert transform:

$$m_h(t) = \cos\left(100t - \frac{\pi}{2}\right) = \sin(100t)$$

$$\varphi_{USB}(t) = m(t)\cos 1000t - m_h(t)\sin 1000t$$

$$= \cos 100t \cos 1000t - \sin 100t \sin 1000t$$

$$= \left[\cos 900t + \cos 1100t\right]\cdot\frac{1}{2} - \left[\cos 900t - \cos 1100t\right]\cdot\frac{1}{2}$$

$$= \cos 1100t$$

$$\varphi_{LSB}(t) = m(t)\cos 1000t + m_h(t)\sin 1000t$$

$$= \cos 900t$$