5.2-4:

* Since third harmonic is included, bandwidth of $m(t)$ is

$B = 3 \times f_0$, f_0 is the fundamental frequency.

$f_0 = 1000\,Hz \Rightarrow B = 3 \times 1000 = 3\,KHz$

* For FM: $\Delta f = \frac{k_f m_p}{2\pi} = \frac{10^5 \times 1}{2\pi} = 15.951\,KHz$

$BW_{FM} = 2(\Delta f + B) = 2(15.951\,KHz + 3\,KHz) = 37.831\,KHz$

For PM: $\Delta f = \frac{k_p m'_p}{2\pi} = \frac{25 \times 8000}{2\pi} = 31.831\,KHz$

$BW_{PM} = 2(\Delta f + B) = 66.662\,KHz$

5.2-5: signal bandwidth $B = 5 \times 1000 = 5\,KHz$

for FM: $\Delta f = \frac{k_f m_p}{2\pi} = \frac{2000\pi \times 1}{2\pi} = 1\,KHz$

$BW_{FM} = 2(\Delta f + B) = 2(1+5) = 12\,KHz$

for PM: $\Delta f = \frac{k_p m'_p}{2\pi} = \frac{(\frac{\pi}{2})(2 \times 10^3)}{2\pi} = 500\,Hz$

$BW_{PM} = 2(500 + 5000) = 11\,KHz$

5.2-6: $m(t) = \sin 2000\pi t$, $k_f = 2\pi \times 10^5$, $k_p = 10$

a) For FM: $\Delta f = \frac{k_f m_p}{2\pi} = \frac{(2\pi \times 10^5)(1)}{2\pi} = 100\,KHz$

BW of $m(t) = B = \frac{2000\pi}{2\pi} = 1000\,Hz$

$BW_{FM} = 2(\Delta f + B) = 202\,KHz$

for PM: $\Delta f = \frac{k_p m'_p}{2\pi}$, $\dot{m}(t) = 2000\pi \cos 2000\pi t$

$= \frac{(10)(2000\pi)}{2\pi} = 10\,KHz$

$BW_{PM} = 2(\Delta f + B) = 2(10+1) = 22\,KHz$

b) $m(t) = 2 \sin 2000\pi t$

$$\Rightarrow m_p = 2 \quad , \quad m_p' = 2(2000\pi) = 4000\pi$$

For FM:

$$\Delta f = \frac{(2\pi \times 10^5)(2)}{2\pi} = 200\,KHz$$

$$BW_{FM} = 2(200+1) = 402\,KHz$$

For PM:

$$\Delta f = \frac{(10)(4000\pi)}{2\pi} = 20\,KHz$$

$$BW_{PM} = 2(20+1) = 42\,KHz$$

c) $m(t) = \sin 4000\pi t \quad \Rightarrow B = \frac{4000\pi}{2\pi} = 2\,KHz$

For FM: $\Delta f = 100\,KHz$ (same as part a)

$$BW_{FM} = 2(\Delta f + B) = 2(100+2) = 204\,KHz$$

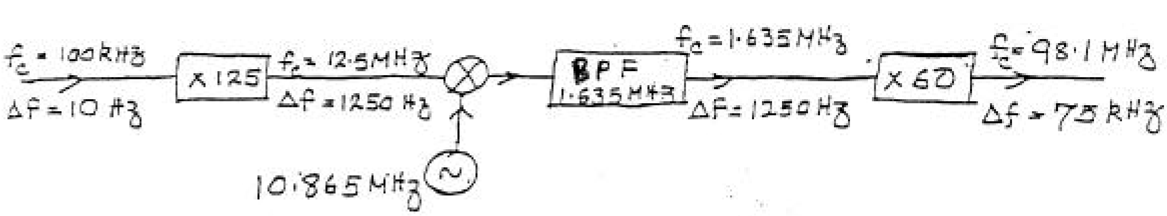
For PM: $m_p' = 4000\pi$

$$\Delta f = \frac{k_p m_p'}{2\pi} = \frac{(10)(4000\pi)}{2\pi} = 20\,KHz$$

$$BW_{PM} = 2(\Delta f + B) = 2(20+2) = 44\,KHz$$

d) From part (c), we see that BW_{FM} does not vary significantly with varying signal bandwidth. However, BW_{PM} has almost doubled by doubling the signal bandwidth. This is because Δf in PM signals is a function of the rate of change in m(t), whereas it is not in FM signals.

5.3-1: The block diagram of the design is shown below.



5.4_2