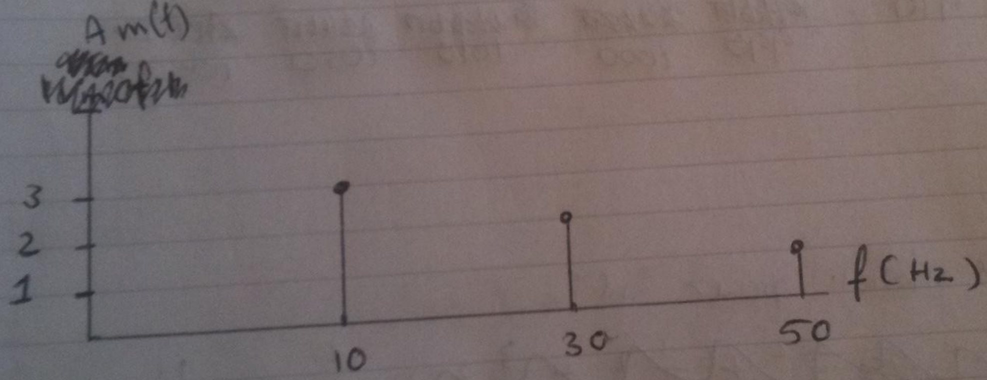
L3)

1)

$$V_m(t) = 3\cos\left(20\pi t + \frac{\pi}{4}\right) + 2\sin(60\pi t) - \cos(100\pi t)$$

$$V_m(t) = 3\cos\left(20\pi t + \frac{\pi}{4}\right) + 2\cos\left(60\pi t - \frac{\pi}{2}\right) - \cos(100\pi t)$$



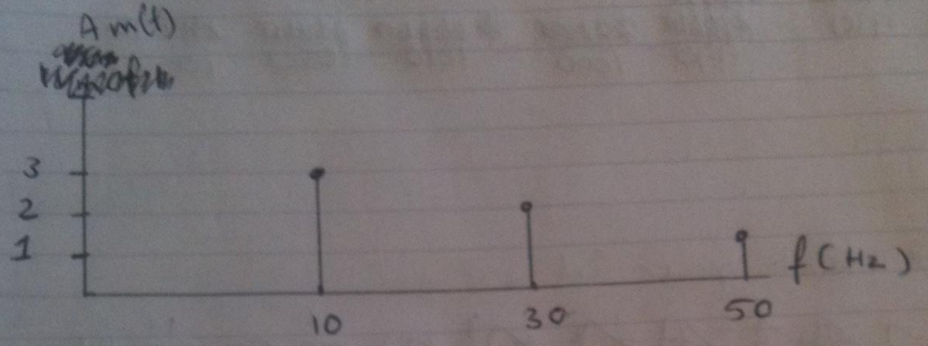
2)

$$V_{am}(t) = (V_c + \mu_{am} \cdot V_m(t)) \cos(2\pi f_c t)$$

$$V_{am}(t) = \cos(2\times10^3 \pi t) + 0.5\cos(2\times10^3 \pi t) V_m($$

$$V_{am}(t) = \cos(2\times10^3 \pi t) + \frac{3}{4}\cos\left(1980\pi t - \frac{\pi}{4}\right) + 3\cos\left(2020\pi t + \frac{\pi}{4}\right)$$

$$V_m(t) = 3\cos\left(20\pi t + \frac{\pi}{4}\right) + 2\cos\left(60\pi t - \frac{\pi}{2}\right) -$$
$$\cos(100\pi t)$$

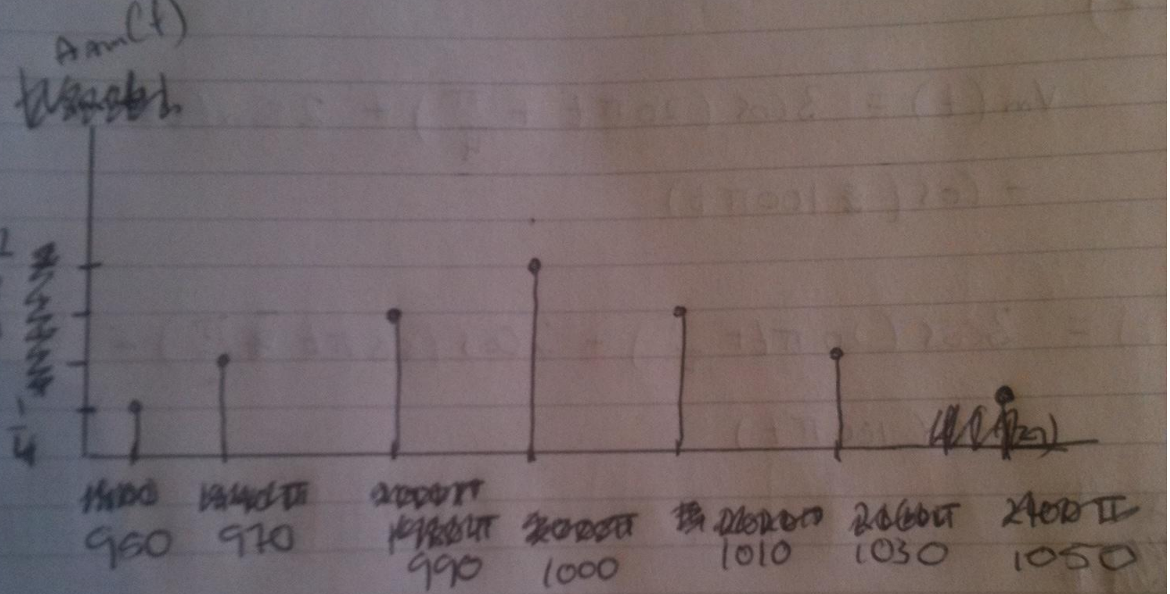


2)

$$V_{am}(t) = (V_c + k_{am} \cdot V_m(t)) \cos(2\pi f_c t)$$

$$V_{am}(t) = \cos(2\times10^3\pi t) + 0.5\cos(2\times10^3\pi t)V_m(t)$$

$$V_{am}(t) = \cos(2\times10^3\pi t)$$
$$+ \quad \frac{3}{4}\cos\left(1980\pi t - \frac{\pi}{4}\right)$$
$$+ \quad \frac{3}{4}\cos\left(2020\pi t + \frac{\pi}{4}\right)$$
$$+ \quad \frac{1}{2}\cos\left(1940\pi t + \frac{\pi}{2}\right)$$
$$\frac{1}{2}\cos\left(2060\pi t - \frac{\pi}{2}\right)$$
$$+ \quad -\frac{1}{4}\cos(1900\pi t)$$
$$-\frac{1}{4}\cos(2100\pi t)$$



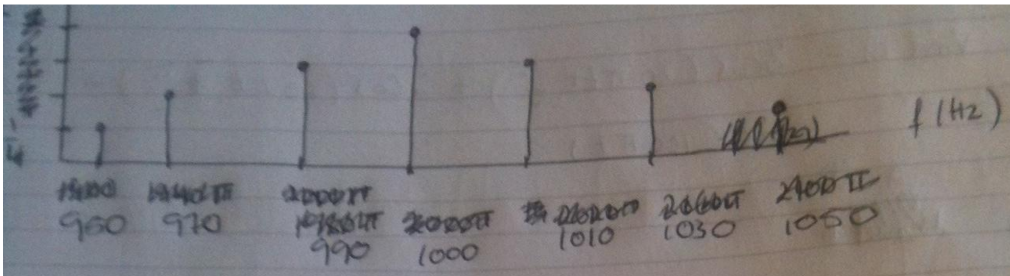
3)

The total power is:

$$\cancel{P_t = \frac{1}{4}^2 + \frac{1}{2}^2 + \frac{3}{4}^2 + \frac{1^2}{2} = \frac{11}{8}}$$

$$P_t = \frac{0.25^2}{2} + \frac{0.5^2}{2} + \frac{0.75^2}{2} + \frac{1^2}{2}$$

$$+ \frac{0.75^2}{} + \frac{0.5^2}{} + \frac{0.25^2}{}$$



)

The total power is:

$$\cancel{Pt = \frac{1}{4}^2 + \frac{1}{2}^2 + \frac{3}{4}^2 + \frac{1^2}{2} = \frac{11}{8}W}$$

$$Pt = \frac{0.25^2}{2} + \frac{0.5^2}{2} + \frac{0.75^2}{2} + \frac{1^2}{2} + \frac{0.75^2}{2} + \frac{0.5^2}{2} + \frac{0.25^2}{2}$$

$$Pt = \frac{43}{32} + \frac{0.25^2}{2} = \frac{11}{8} = 1.375\ Hz$$

power in side frequencies:

$$PSF = Pt - Pc = 1.375 - \frac{1^2}{2} = \underline{\underline{0.875\ Hz}}$$

4) Since the carrier has only 36.36% of the total power then we know that the message is over modulated and thus needs coherent detection.

Continued . . .

4) $V_o(t) = V_{am}(t) \cdot V_c(t)$

$$V_o(t) = (V_c + k_{am} \cdot V_m(t))\left[\frac{1}{2} + \frac{1}{2}\cos(4\pi f_c t)\right]$$

$$V_o(t) = (1 + 0.5\,v_m(t))\left[\frac{1}{2} + \frac{1}{2}\cos(4\times10^3 \pi t)\right)$$

$$V_o(t) = \frac{1}{2} + \frac{1}{2}\cos(4\times10^3\pi t) + \frac{1}{4}V_m(t) + \frac{1}{4}V_m(t)\cos(4\times10^3\pi t)$$

$V_o(t) =$

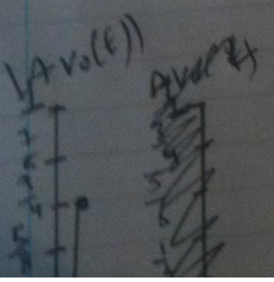
$$\frac{1}{2} + \frac{1}{2}\cos(4\times10^3\pi t) + \frac{3}{4}\cos\left(20\pi t + \frac{\pi}{4}\right)$$

$$+ \frac{1}{2}\cos\left(60\pi t - \frac{\pi}{2}\right) - \frac{1}{4}\cos(100\pi t)$$

$$+ \frac{3}{8}\cos\left(3980\pi t - \frac{\pi}{4}\right) + \frac{3}{8}\cos\left(4020\pi + \frac{\pi}{4}\right)$$

$$+ \frac{1}{4}\cos\left(3940\pi t + \frac{\pi}{2}\right) + \frac{1}{4}\cos\left(4060\pi t - \frac{\pi}{2}\right)$$

$$- \frac{1}{8}\cos(3900\pi) - \frac{1}{8}\cos(4100\pi)$$



$V_o(t) =$

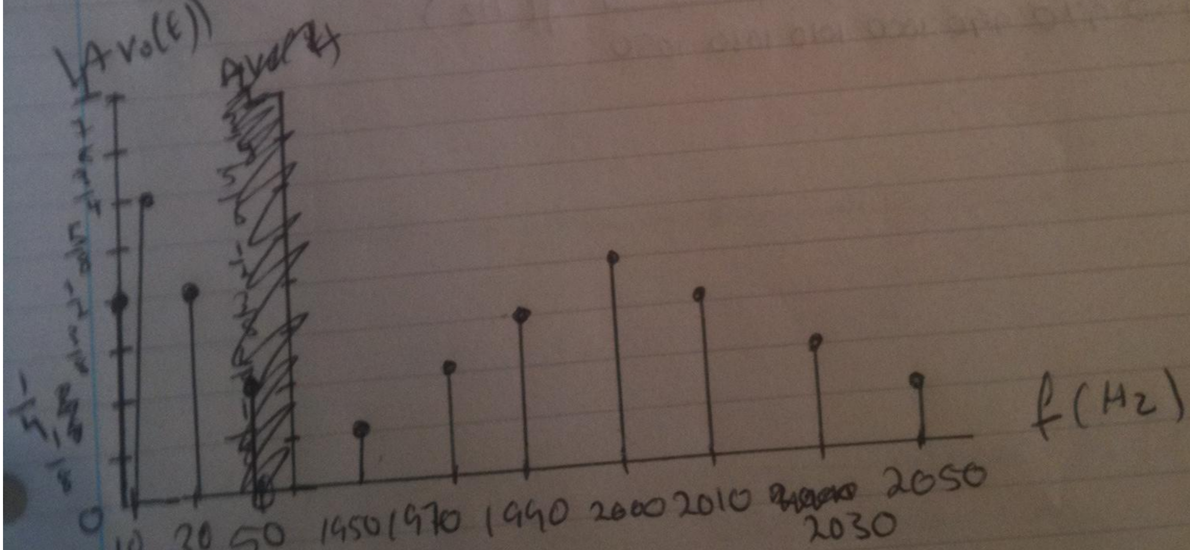
$$\frac{1}{2} + \frac{1}{2}\cos(4\times10^{3}\pi t) + \frac{3}{4}\cos\left(20\pi t + \frac{\pi}{4}\right)$$

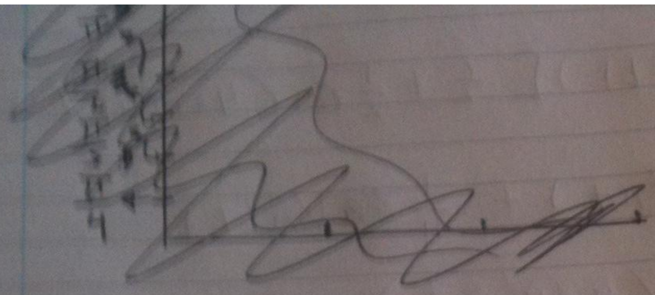
$$+ \frac{1}{2}\cos\left(60\pi t - \frac{\pi}{2}\right) - \frac{1}{4}\cos(100\pi t)$$

$$+ \frac{3}{8}\cos\left(3980\pi t - \frac{\pi}{4}\right) + \frac{3}{8}\cos(4020\pi$$

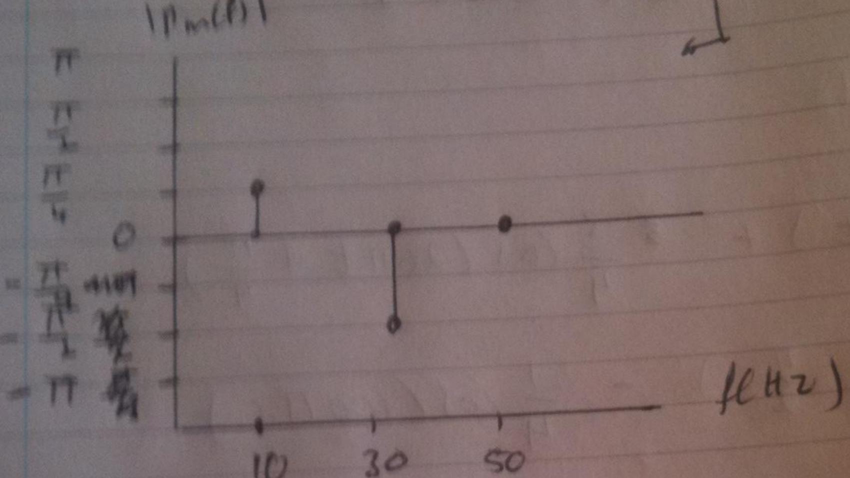
$$+ \frac{1}{4}\cos\left(3940\pi t + \frac{\pi}{2}\right) + \frac{1}{4}\cos(4060\pi t$$

$$+ - \frac{1}{8}\cos(3900\pi) - \frac{1}{8}\cos(4100\pi)$$



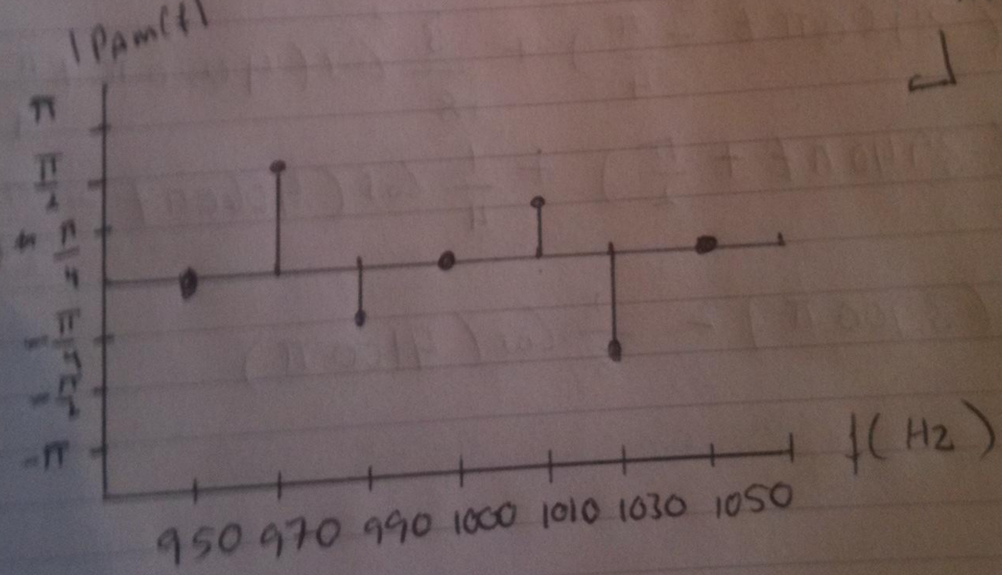


Vm(t)



|Pm(f)|
π
π/2
π/4
0
−π/4
−π/2
−π
f(Hz)
10
30
50

VAm(t



|PAm(f)|
π
π/2
π/4
−π/4
−π/2
−π
f(Hz)
950
970
990
1000
1010
1030
1050

L4)

1) $V_{m1}(t) = 2 + \sin(40\pi t) + 3\cos(60\pi t)$

$V_{m1}(t) = 2 + \cos(40\pi t + \frac{\pi}{2}) + 3\cos(60\pi t)$

$V_{dsb_1}(t) = V_{m_1}(t) \times V_c \cos(2\pi f_c t)$

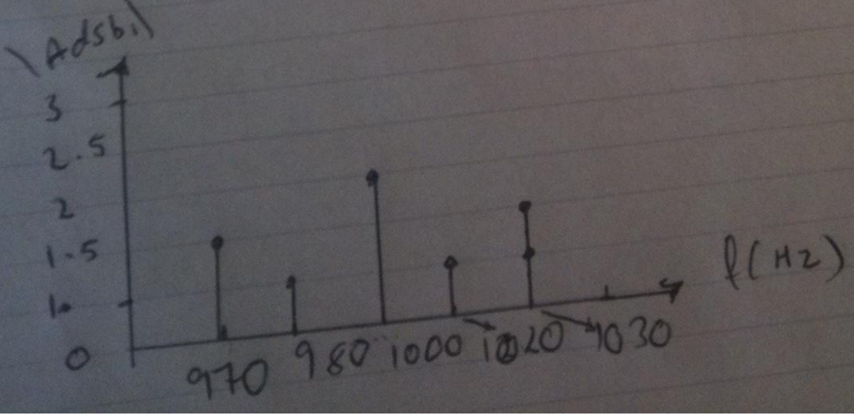
$V_{dsb}(t) = 2\cos(2\times10^3 \pi t) + \cos(40\pi - \frac{\pi}{2})\cos(2\times10^3 \pi t)$

$+ 3\cos(60\pi t)\cos(2\times10^3 \pi t)$

$V_{dsb_1}(t) = 2\cos(2\times10^3 \pi t) + \cos(1960\pi t + \frac{\pi}{2})$

$+ \cos(2040\pi t - \frac{\pi}{2})$

$+ \frac{3}{2}\cos(1940\pi t) + \frac{3}{2}\cos(2060\pi t)$



$$V_{dsb,}(t) = 2\cos(2\times10\ldots$$
$$+ \cos\left(2040\pi t - \frac{\pi}{2}\right)$$
$$+ \frac{3}{2}\cos(1940\pi t) + \frac{3}{2}\cos(2060\pi t)$$