

d-jcijc

(d-1-1)

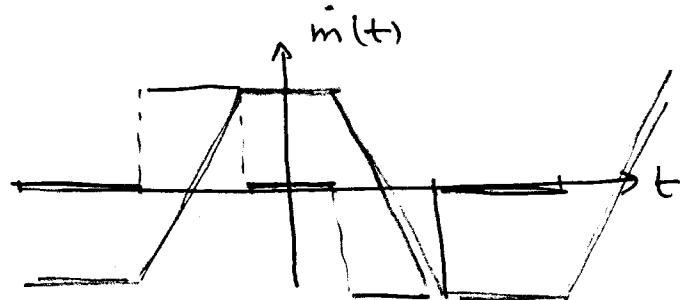
$$\omega_c = 10^8 \text{ rad/sec}$$

$$k_f = 10^5, k_p = 25$$

inf \rightarrow ω_i o dlsrsp φ_{PM} , $\dot{\varphi}_i \approx \omega_i m(t)$ of

$$\omega_i(t) = \omega_c + k_p m(t) \quad : PM$$

$$\omega_i(t) = \omega_c + k_f m(t) \quad : FM$$

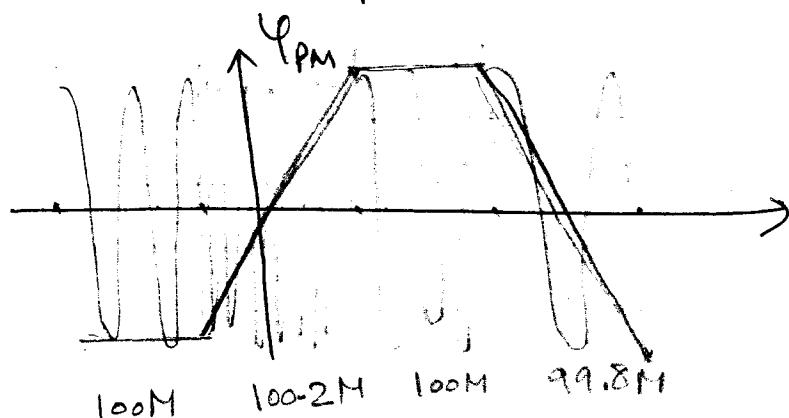


$$\frac{2}{\frac{1}{4} \times 10^{-3}} = 8 \times 10^3 \text{ 1/sec}$$

$$PM: \quad \omega_i(t) = \begin{cases} \omega_c + 0 & m(t) = -1 \\ \omega_c + 25 \times 8 \times 10^3 & m(t) \nearrow \\ \omega_c & m(t) = 1 \\ \omega_c - 25 \times 8 \times 10^3 & m(t) \searrow \end{cases}$$

$$= \begin{cases} 10^8 \\ 10^8 + 2 \times 10^5 = 1002 \times 10^6 = 100.2 \times 10^6 \text{ rad/sec} \\ 10^8 \end{cases}$$

$$= 99.8 \times 10^6 \text{ rad/sec}$$



$$FM: \omega_i(t) = \omega_c + k_f m(t)$$

$$m(t) = -1 : \quad \omega_i = 10^8 + 10^5 (-1) = (100 - 0.1) \times 10^6 \\ = 99.9 \text{ rad/sec}$$

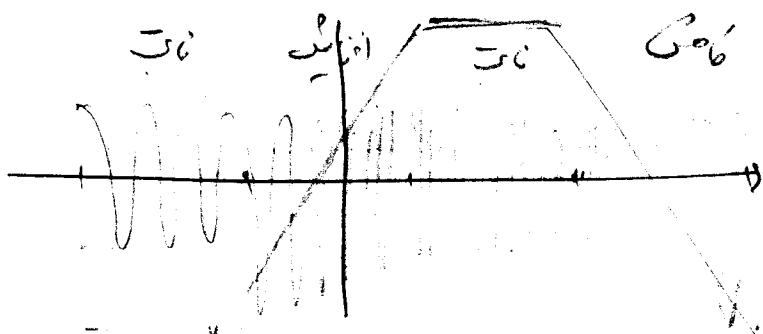
$$m(t) \uparrow \quad \omega_{i\max} = 99.9 \text{ rad/sec}$$

$$\omega_{i\max} = 10^8 + 0.1 \times 10^6 = 100.1 \text{ rad/sec}$$

$$m(t) = 1 \quad \omega_i = 100.1 \text{ rad/sec}$$

$$m(t) \downarrow \quad \omega_{i\max} = 100.1 \text{ rad/sec}$$

$$\omega_{i\min} = 99.9 \text{ rad/sec}$$

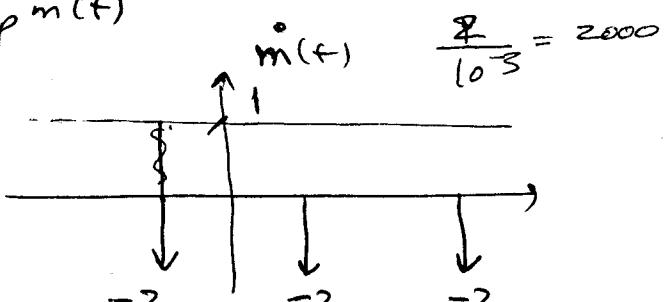
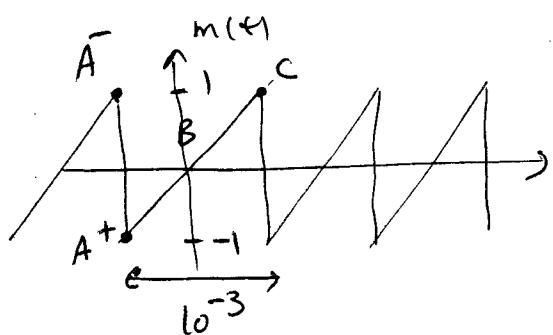


$$\omega_c f_c = 10^6 = 1 \text{ MHz}, \quad \frac{k_f}{\pi} = 1000, \quad k_p = \frac{\pi}{f_c} \quad \underline{\underline{\omega_c}}$$

$$k_p = 1000\pi, \quad k_p = \frac{\pi}{f_c}$$

PM: $\theta(t) = \omega_c t + k_p m(t)$

$$\omega_i(t) = \omega_c + k_p m(t)$$



$A_0 + A_1 \sin(\omega_c t + A_2 t^2 + A_3 t^4 + \dots) \neq A_0 \sin(\omega_c t) \rightarrow \text{WRF OK}$

$A_0 A_1 + A_0 A_2 \sin(\omega_c t + A_2 t^2) \neq A_0 \sin(\omega_c t) \rightarrow \text{WRF OK}$

$$\varphi_{PM}(t) = A \cos(\omega_c t + k_p m(t))$$

$$m(t) = k(t - t_0) = \gamma_{000}(t - t_0)$$

$$k = \gamma_{000}$$

$$\varphi_{PM}(t) = A \cos(\omega_c t + 1000\pi(t - t_0))$$

$$= A \cos((\omega_c + 1000\pi)t - 1000\pi t_0)$$

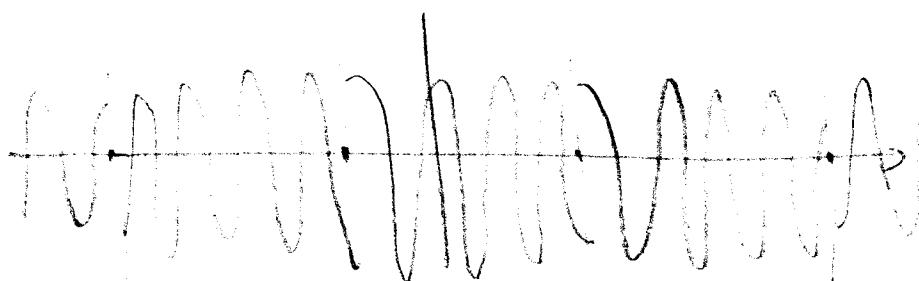
$$\omega_i = \omega_c + 1000\pi$$

$$\theta(t^-) = \omega_i t_0 + \pi_f(1)$$

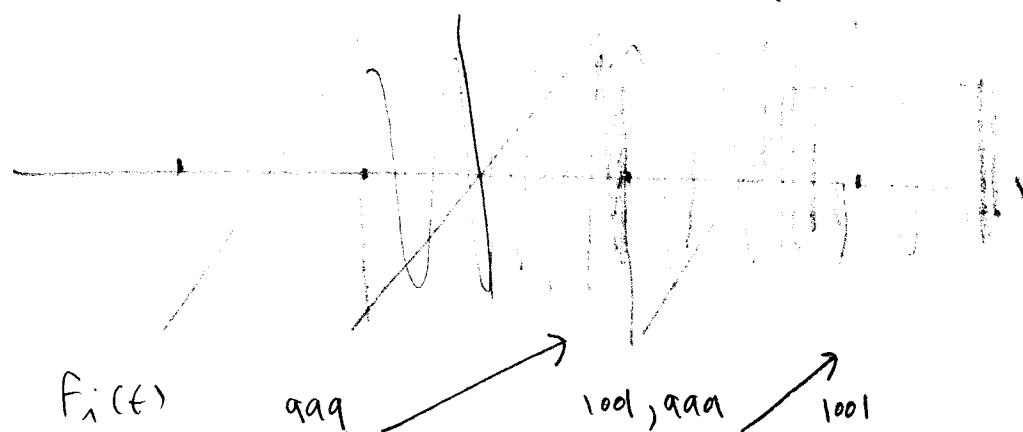
$$\theta(t^+) = \omega_i t_0 + \pi_f(-1)$$

$$\varphi_{PM}(t^-) = A \cos(\omega_i t_0 + \pi_f) = A \sin(\omega_i t_0)$$

$$\varphi_{PM}(t^+) = A \cos(\omega_i t_0 - \pi_f) = -A \sin(\omega_i t_0) = -\varphi_{PM}(t^-)$$



FM, $\omega_i(t) = \omega_c + k_f m(t) = \begin{cases} 10^6 + 1000 = 1001 \text{ kHz} + \delta \text{ m} \\ 10^6 - 1000 = 999 \text{ kHz} + \delta \text{ m} \end{cases}$

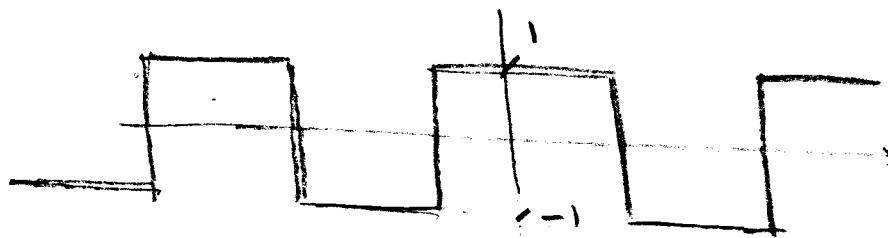


$$\varphi_{PM}(t) = A \sin(\omega_c t + k_p m(t))$$

$$\omega_c = 2\pi \times 10^6 + 1000\pi$$

$$f_c = 10^6 + 500 = 1000.5 \text{ kHz}$$

$\tilde{N}_0 - \gamma$ will be the carrier

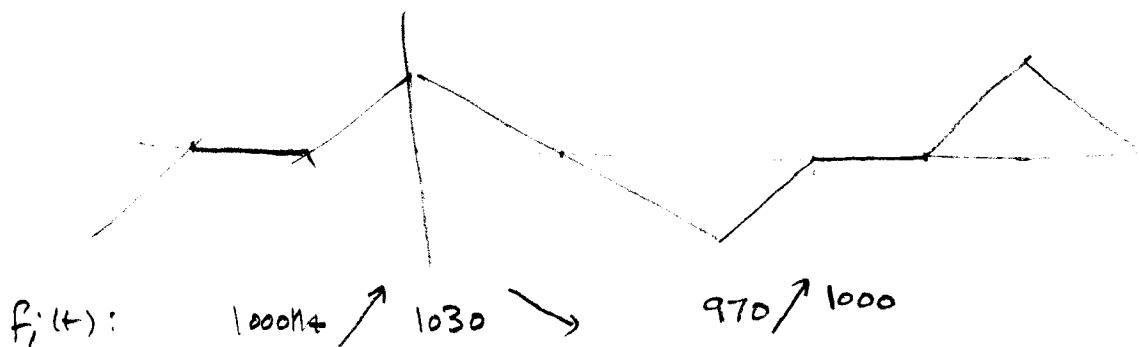


$$\omega_c = 2\pi \times 10^3 \text{ rad/sec} \rightarrow B = 35\omega_0$$

$$0-1-\frac{1}{10}$$

$$k_f = 20\pi$$

$$f_c = 10^3 + 10 m(t) = \begin{cases} 10^3 + 30 = 1030 \text{ Hz} & \text{max} \\ 10^3 - 30 = 970 \text{ Hz} & \text{min} \end{cases}$$



$$\frac{d\Delta \varphi}{d-1-r}$$

$$\Psi_{EM}(t) = 10 \sin(13,000\pi t), \quad \omega_c = 10,000\pi \quad |t| < 1$$

$$(a) \quad k_p = 1000$$

$$\Psi_{PM}(t) = 10 \sin(10000\pi t + 3000\pi t) \quad |t| < 1$$

$$= 10 \sin(10000\pi t + k_p m(t))$$

$$m(t) = 3\pi t \quad |t| < 1$$

$$(b) \quad k_f = 1000$$

$$\Psi_{FM}(t) = 10 \sin(10000\pi t + 3000\pi t)$$

$$= 10 \sin(10000\pi t + k_f a(t))$$

$$a(t) = 3\pi t \quad |t| < 1$$

$$d_0 + \int_{-1}^t m(\tau) d\tau = 3\pi t \Rightarrow m(t) = 3\pi$$

$\omega - \gamma - c$

$\delta - \gamma - I$

$$m(t) = V_0 S(100t) + 1A G_{1000\pi} t$$

$$\omega_c = 10^6, A = 10, k_f = 1000\pi, k_p = 1$$

a) $\varphi_{PM}(t) = 10 S (10^6 t + 2 S_1 100t + 18 S_2 2000\pi t) \checkmark$

$$\varphi_{FM}(t) = 10 S \left(10^6 t + (1000\pi) \int_{-\infty}^t m(\tau) d\tau \right)$$

$$(1000\pi) \int_{-\infty}^t (2 S_1 100t + 18 S_2 2000\pi t) =$$

$$(1000\pi) \left(\frac{2}{100} S_1 100t + \frac{18}{2000\pi} S_2 2000\pi t \right) + a_0$$

$$= 20\pi S_1 100t + 9 S_2 2000\pi t + a_0$$

$$\varphi_{FM}(t) = 10 S (10^6 t + 20\pi S_1 100t + 9 S_2 2000\pi t)$$

b) $\varphi_{PM}(t) = 10 S (10^6 t + 2 S_1 100t + 18 S_2 2000\pi t)$

$$\omega_i = \omega_c + (-200 S_1 100t - 18 \times 2000\pi S_2 2000\pi t)$$

$$\omega_{P_{max}} = 200 + 18 \times 2000\pi$$

$$\omega_{P_{min}} = - ()$$

$$\Delta f = \frac{200 + 18 \times 2000\pi}{2\pi} = 18.031 \text{ kHz}$$

$$B = 1000 \text{ Hz} = 1 \text{ kHz}$$

$$B_{PM} = 2 (18.031 \times 1) = 38.062 \text{ kHz}$$

$$\frac{500}{1000\pi \times 11} = 5.5 \text{ kHz}$$

$$\varphi_{FM}(t) = \dots$$

$$\omega_i(t) = \omega_c + 1000\pi (2S_{1000}t + 18S_{2000}\pi t)$$

$$m_p = 20 \Rightarrow \Delta f = \frac{1000\pi \times 20}{2\pi} = 10 \text{ kHz}$$

$$B_{FM} = 2(1+10) = 22 \text{ kHz}$$

$$\varphi_{EM}(t) = 10S(\omega_c t + 0.18 \cdot 1000\pi t)$$

$$\omega_c = 2\pi \times 10^6$$

$$\omega_0 = 2000\pi$$

$$f_0 = 1000 \text{ Hz}$$

$$(a) P = 50 \text{ Watt}$$

$$(b) \Delta f: \omega_i(t) = \omega_c + 2000\pi S 2000\pi t$$

$$\Delta f = \frac{2000\pi}{2\pi} = 100 \text{ Hz}$$

$$(c) \Delta\theta = 0.1 \text{ rad}$$

$$(d) B_{EM} = 2(1000 + 100) = 2.2 \text{ kHz}$$

$$\varphi_{EM}(t) = 5S(\omega_c t + 20S_{1000\pi t} + 10S_{2000\pi t})$$

$$\omega_0 = 2000\pi$$

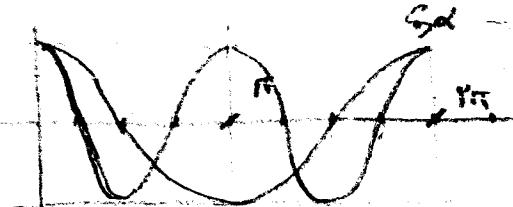
$$f_0 = 1 \text{ kHz}$$

$$(a) P = 12.5 \text{ Watt}$$

$$(b) \omega_i = \omega_c + 20000\pi S_{1000\pi t} + 2000\pi S_{2000\pi t} \\ = \omega_c + 20,000\pi(S_{4\alpha} + S_{5\alpha})$$

$$S_{4\alpha} + S_{5\alpha}$$

$$i\dot{\varphi} (e^{-i\dot{\varphi}}) \rho (\alpha e^{i\dot{\varphi}})$$



$$f(\alpha) = S\alpha + S2\alpha$$

$$f'(\alpha) = -2\alpha - 2S2\alpha = 0$$

$$4S2\alpha = -2\alpha \Rightarrow \begin{cases} 2\alpha = 0 \rightarrow 1.6 \text{ Max} \\ S_2\alpha = \frac{-1}{4} \Rightarrow \alpha = 104.48^\circ \\ \Rightarrow S_2\alpha = -0.875 \end{cases}$$

$$\Rightarrow \min f(\alpha) = -0.875 - 0.25 = -1.125$$

$$\max f(\alpha) = 2$$

$$(b) \Delta f = \frac{20,000\pi}{2\pi} \left(\frac{2+1.125}{2} \right) = 15.625 \text{ kHz}$$

$$(d) B_{EM} = 2(1k + 15.625k) = 33.25 \text{ kHz}$$

$$(c) f(\alpha) = 20(2\alpha + 0.5S2\alpha)$$

$$f'(\alpha) = 0 \Rightarrow S\alpha + S2\alpha = 0 \Rightarrow S_2\alpha + (2S^2\alpha - 1) = 0$$

$$2S^2\alpha + S\alpha - 1 = 0 \Rightarrow 2x^2 + x - 1 = 0$$

$$x = \frac{-1 \pm \sqrt{1+8}}{4} = \frac{1}{2}, -1 \Rightarrow \begin{cases} \alpha = 60^\circ, -60^\circ \\ \alpha = \pi \end{cases}$$

$$f(60^\circ) = 20(0.87 + 0.5 \times 0.87) = 20(1.3)$$

$$f(-60) = 20(-1.3)$$