

① - $\phi(\omega) = \frac{2e^{-6\omega}}{s+1}$

$\phi(\omega) = -\omega\delta - \sigma \tan \omega$

$\gamma = -\omega\delta - \sigma \tan \omega$

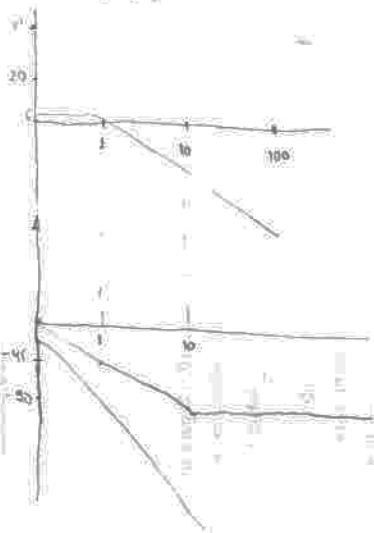
$\sigma \tan \omega = \gamma - \omega\delta$

$\omega = 1$

$0.78 = \gamma - \delta \Rightarrow \delta = \gamma - 0.78$

$\omega = \sqrt{3}$

$\sigma \tan \sqrt{3} = \gamma - \sqrt{3}\delta \Rightarrow \gamma = 1.20$



$\frac{2}{\sqrt{\omega^2+1}} = 1 \Rightarrow 4 = \omega^2+1 \Rightarrow \omega^2=3 \Rightarrow \omega=\sqrt{3}$

② - $1 + K \frac{1}{(s+1)(s^2+4s+1)}$ $p_1 = -1+j$ $p_2 = -1-j$ $m=3$ $m=0$ $\phi_{asm} = +60, -60, 180$

$D(s) = s^3 + 4s^2 + 25s + 17$ $N(s) = 1$

$\tilde{D}(s) = 3s^2 + 18s + 25$ $\tilde{N}(s) = 0$

$\sigma_a = \frac{-8}{3} = -2.66$

$\tilde{D}' - \tilde{D}\tilde{N}' = 0 \Rightarrow 3s^2 + 18s + 25 = 0$

$s_1 = -3.81$

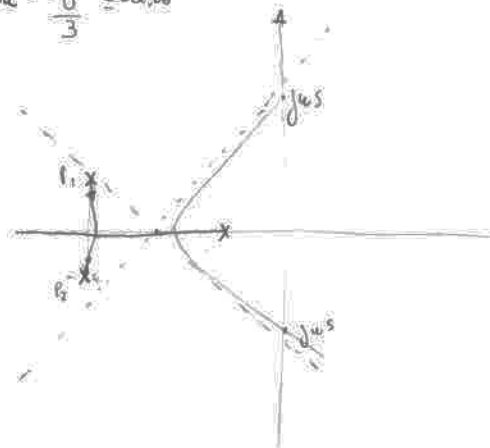
$s_2 = -2.18$

$\phi_{p_1} = 0^\circ - \phi_{p_2} - \phi_{p_3} + 180$

$= 0 - 90 - 161.5^\circ + 180 = -71.56$

$\phi_{p_2} = 0 - \phi_{p_1} - \phi_{p_3} + 180$

$= +90 + 161.5 + 180 = 71.56$



$\tilde{D}(j\omega) + K\tilde{N}(j\omega) = -j\omega^3 + 9\omega^2 + 25j\omega + 17 + K = 0$

$(K+17-9\omega^2) = 0 \Rightarrow K = -17+9.5^2 = 208$

$25\omega - \omega^3 = 0 \Rightarrow \omega^2 = 25 \Rightarrow \omega = 5$

③ - $\phi(s) = \frac{1}{s(s+2)(s+4)}$

$p_1 = 0$

$n=3$

$m=3$

$\phi_{asm} = 60, -60, 180$

$p_2 = -2$

$m=0$

$\sigma_a = \frac{-6}{3} = -2$

$D = s^3 + 6s^2 + 8s$

$N=1$

$\tilde{D}(j\omega) + K\tilde{N}(j\omega) = 0$

$-j\omega^3 - 6\omega^2 + 8j\omega + K = 0$

$K - 6\omega^2 \Rightarrow K = 48$

$\omega^3 = 8\omega \Rightarrow \omega = \sqrt{8} \text{ rad/s}$

$\omega = 2\pi f \Rightarrow f = \frac{\sqrt{8}}{2\pi} \Rightarrow T = \frac{2\pi}{\sqrt{8}}$

$K_p = 0.6.48 = 28.8$

$T_1 = \frac{2\pi}{\sqrt{8}} = 1.11$

$T_2 = \frac{2\pi}{\frac{\sqrt{8}}{8}} = 0.27$

