AMKAH ABBAS

Q1. a) i) $G(s) = \dfrac{(s+3)}{(s^2+4s+5)(s+4)}$

$(s-2-j1)(s-2+j1)$

$(s^2-2s+js-2s+4-2j-js+2j+1$

s^2+4s+5

ii) asymptote point $= \dfrac{-4-2-2-(-8)}{3-1}$

$= -2.5$

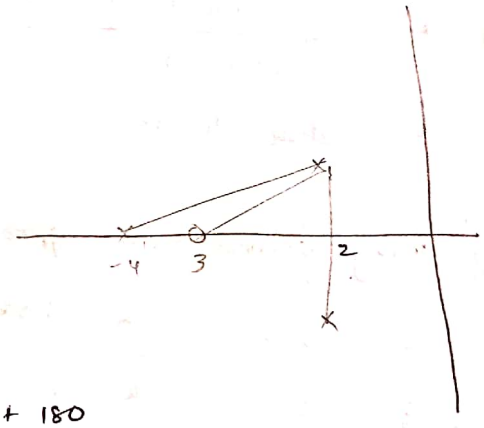
$\theta_a = \left(\dfrac{2k+1}{3}\right)\pi$

$= 60^\circ, 180^\circ, 300^\circ$

$= \dfrac{\pi}{3}, \pi, \dfrac{5\pi}{3}$

iii) Angle of departure:

$\theta_d - 90 + \tan\frac{1}{2} = -180$



$\theta_d = \angle$ angle zeros $- \angle$ angle pole $+ 180$

$= \tan^{-1}\left(\dfrac{1}{1}\right) - 90 - \tan^{-1}\dfrac{1}{2} + 180$

$= 45 - 90 - 26.56 + 180$

$= 108.44$

b) 10% overshop $\xi = 0.59$ $\omega_n = 4.08$ rad/s

i) Dominant closed loped.

$Real = -\xi\omega_n$

$= -0.59(4.08)$

$= -2.41$

$Img = j\omega_n\sqrt{1-\xi^2}$

$= j\,4.08\sqrt{1-0.59^2}$

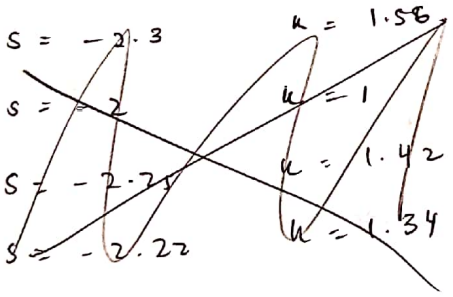
$= j\,3.29$

Dominant closed loop = $-2.41 \pm j3.29$

ii) $K = \dfrac{(s^2+4s+5)(s+4)}{(s+3)}$

$K = 10.96$

iii) verify second order approximation.



$S = -6 \quad K = 11.33$

ratio = $\dfrac{6}{2.41}$

$= 2.49 < 5$

$\therefore$ 2nd order app not valid.

~~ratio = $\dfrac{2.22}{2.41}$ = 0.92 < 5~~

iv) $T_s = \dfrac{4}{2.41} = 1.66\,s \qquad T_p = \dfrac{\pi}{3.29} = 0.95\,s$

$K_p = \lim_{s\to 0} \dfrac{10.96(s+3)}{(s^2+4s+5)(s+4)}$

$= 1.64$

$e_{ss} = \dfrac{1}{1+K_p} = \dfrac{1}{1+1.64}$

$= 0.38$

Q2. $G(s) = \dfrac{k(s^2-2s+8)}{(s+3)(s^2+4s+5)}$

$s_d = -0.88 \pm j1.72$, 20% OS

$\xi = \dfrac{-\ln 0.2}{\sqrt{\pi^2 + \ln(0.2)^2}} = 0.46$

$\theta = \cos^{-1} 0.46$

$= 62.61$

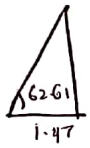
a) $T_s = \frac{3}{5}$ of uncompensated value.

$T_{s\,old} = \dfrac{4}{0.88} = 4.54s$ $\quad T_{s\,new} = \dfrac{4}{|Real|} = \frac{3}{5}(4.54)$

$= 1.47$

$T_{p\,new} = \tan 62.61 = \dfrac{T_{p\,new}}{1.47}$

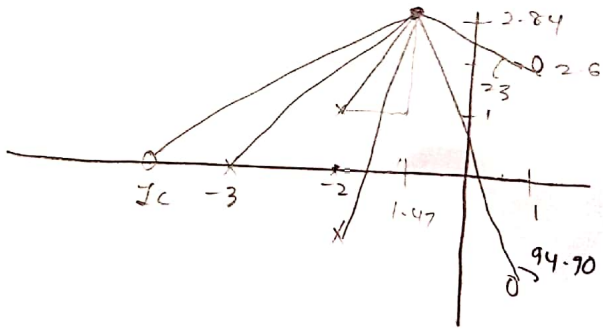
$T_{p\,new} = 2.84$



$s = -1.47 \pm j2.84$

$G_{po} = s+1$

$TF = \dfrac{k(s+1)(s^2-2s+8)}{(s+3)(s^2+4s+5)}$



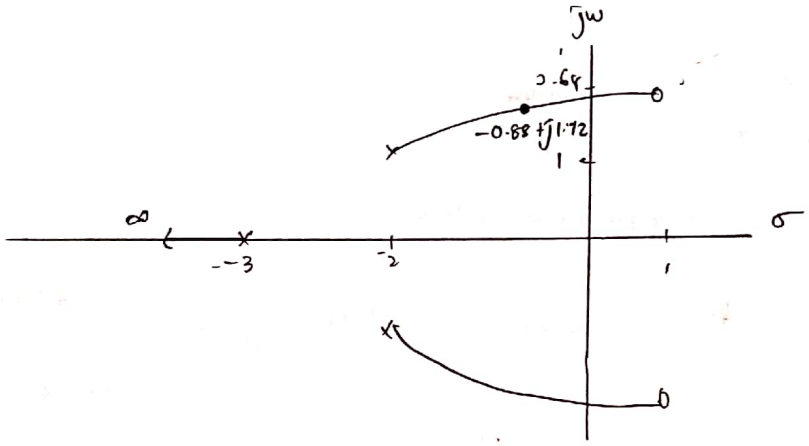
$\angle s+1 - \tan^{-1}\dfrac{1.84}{0.53} - \tan^{-1}\dfrac{4.31}{0.53} - \tan^{-1}\dfrac{2.84}{1.53} + 156.95 + 94.90 = -180$

$\angle s+1 = -213.24$

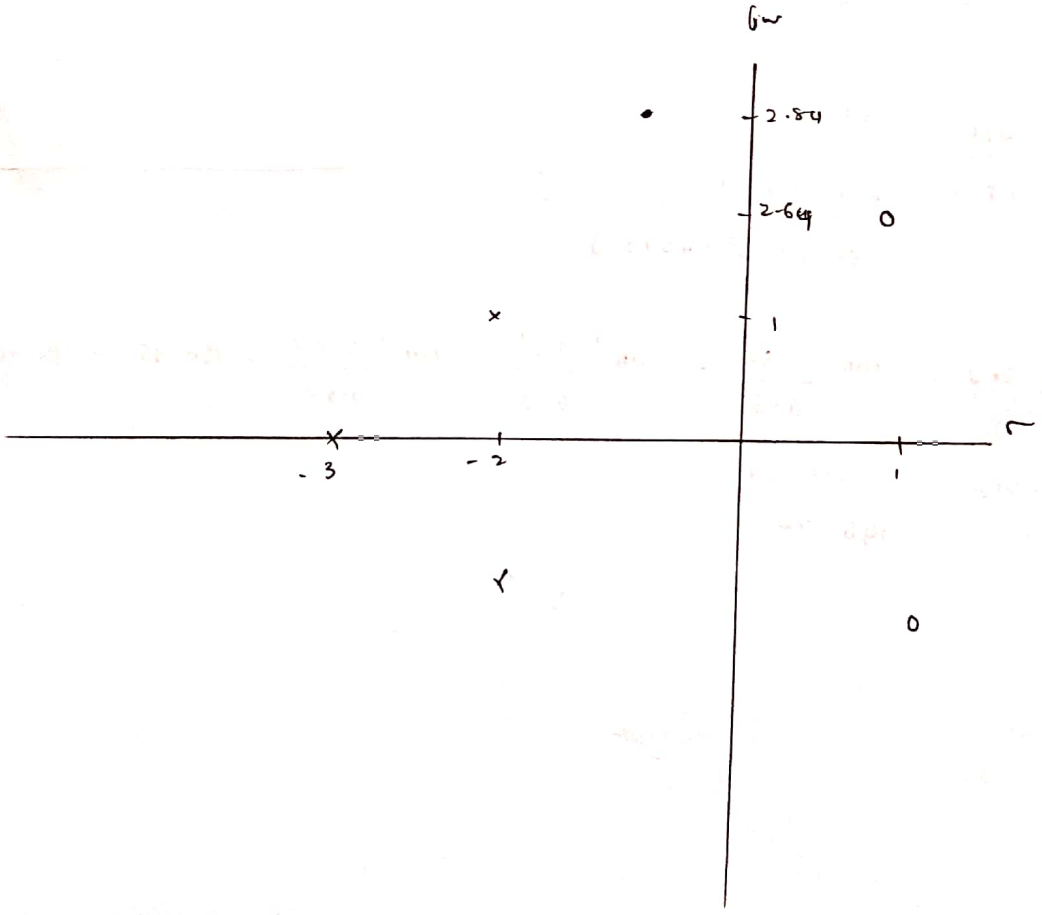
$= 146.76$

b) Sketch

Uncompensated.



Compensated



Q3. $G(s) = \frac{12}{s(s+6)} = \frac{12}{6s\left(\frac{s}{6}+1\right)}$

a)

i) magnitude

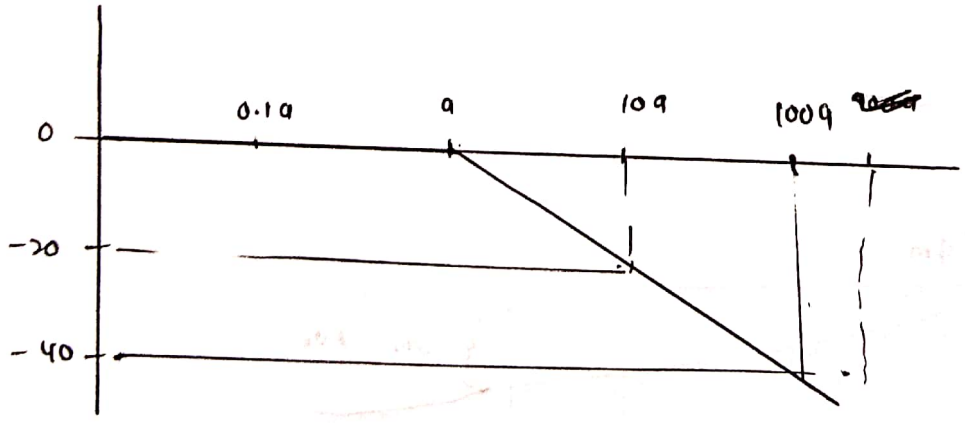
$|G\,jw| = \log\left(\frac{1}{w}\right)$

$= -20 \log w$

$|G\,jw| = \frac{1}{\sqrt{\left(\frac{w}{a}\right)^2 + 1}}$

$= 1$

b) sketch $G(s) = \frac{100}{(s+10)}$ $a = 10$



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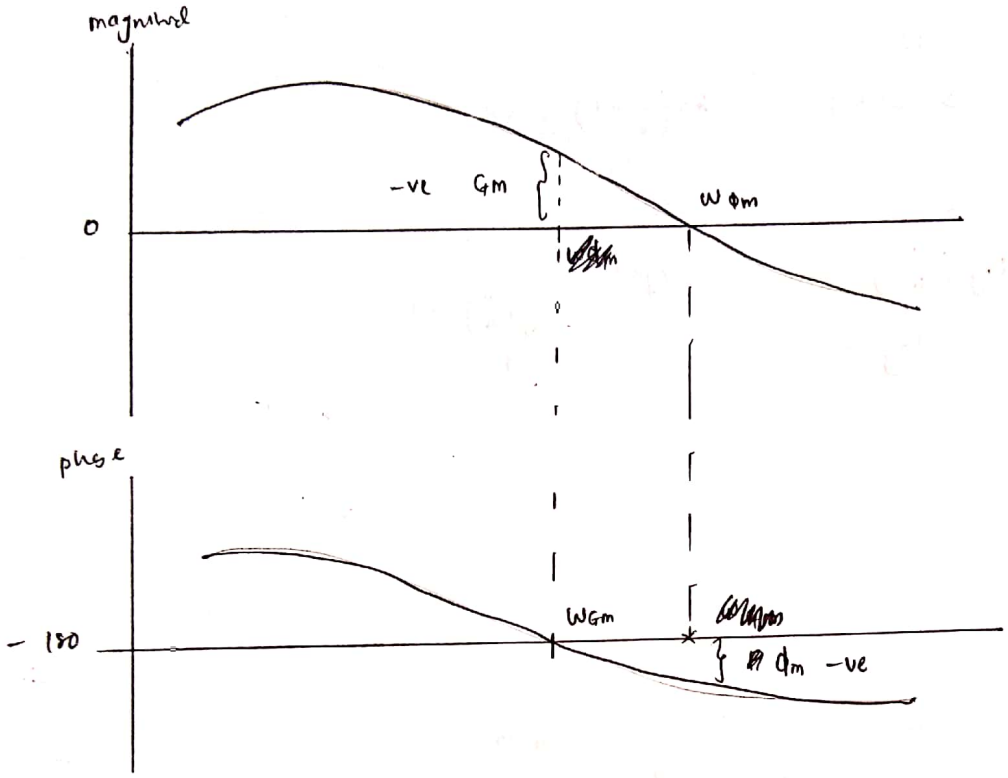

Unstable