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A17KE4011 section: 05

Test 1 SKEE3143

Q1)

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

(II) $\theta_A = \dfrac{\text{Sum of finite poles} - \text{Sum of finite zeros}}{\#\text{poles} - \#\text{zeros}}$

$= \dfrac{(-4) + (2-j) + (-2+j) - 3}{3-1}$

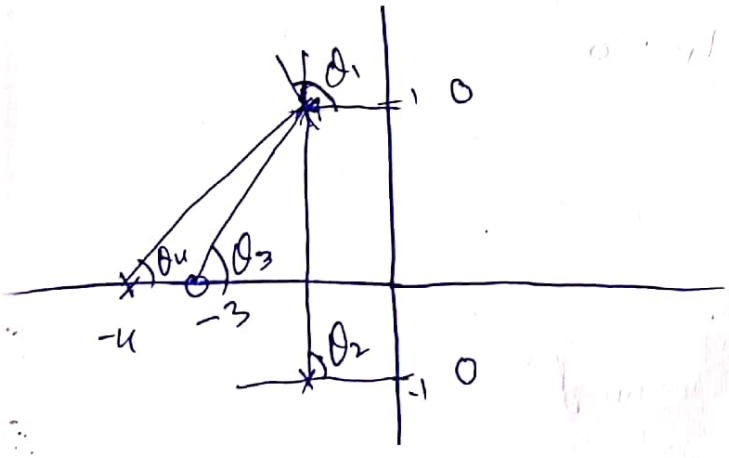
$= 2.5$

$\theta_A = \dfrac{(2k+1)\pi}{\text{Asymtote}} = \dfrac{\pi}{\frac{5}{2}} = \dfrac{2\pi}{5} = 75^\circ$ $\quad k = 0, 1, \ldots (A-1)$

$= \dfrac{2\pi}{\frac{2}{5}} = \dfrac{4\pi}{5} = 144^\circ$ $\quad = 1.5^\circ$

(III)

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



$\theta_1 = \text{Eq } \theta_{zeros} = \text{Eq } \theta_{poles} + 180$

$= \theta_3 - \theta_2 - \theta_4 + 180$

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

$= 45^\circ - 90 - 26.56 + 180^\circ$

$= 108.44$

b) $OS\% = 10\%$

$\zeta = 0.59$

$\omega = 4.08$ rad/sec

(I) $\theta = \cos^{-1}(0.59) = 53.8^\circ$

by using graph paper

$s_{1,2} = -2.4 + 3.28j$

(II) $K = \frac{1}{|G(s)|} = \frac{1}{\frac{(3.3)}{(3.3)(9.96)}} = 10.05$

(III) $CLTF = \frac{\frac{K(s+3)}{(s+4)(s^2+4s+5)}}{1+G(s)} = \frac{K(s+3)}{(s+4)(s^2+4s+5)+K(s+3)}$

Characteristic eq

$(s+4)(s^2+4s+5)+K(s+3)$

$s^3+4s^2+5s+4s^2+16s+20+Ks+K3=0$

$s^3+8s^2+31s+80=0$

$s\phi = -3.195$

60° This pole overlaps the zeros so it can be safely assumed

The system as second order.

$$G(s) = \frac{K(s^2-2s+8)}{(s+3)(s^2+4s+5)}$$

Zeros $= 1 \pm \sqrt{7}\,j$

Poles $= -3, -2 \pm j$

$$T_s = \frac{4}{\sigma} = \frac{4}{0.88} = 4.55\,s$$

$S = -0.88 \pm 1.72\,j$

$OS\% = 20\%$

$$T_{s(new)} = 4.55 \times \frac{3}{5} = 2.73\,s$$

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

$$\sigma = \frac{4}{2.73} = 1.47$$

$= 0.46$

$$\tan\theta = \frac{\omega_d}{\sigma} = \text{wdt}$$

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

$= 62.61^\circ$

$\omega_d = 1.47 \times \tan(62.61)$

$= 2.84$

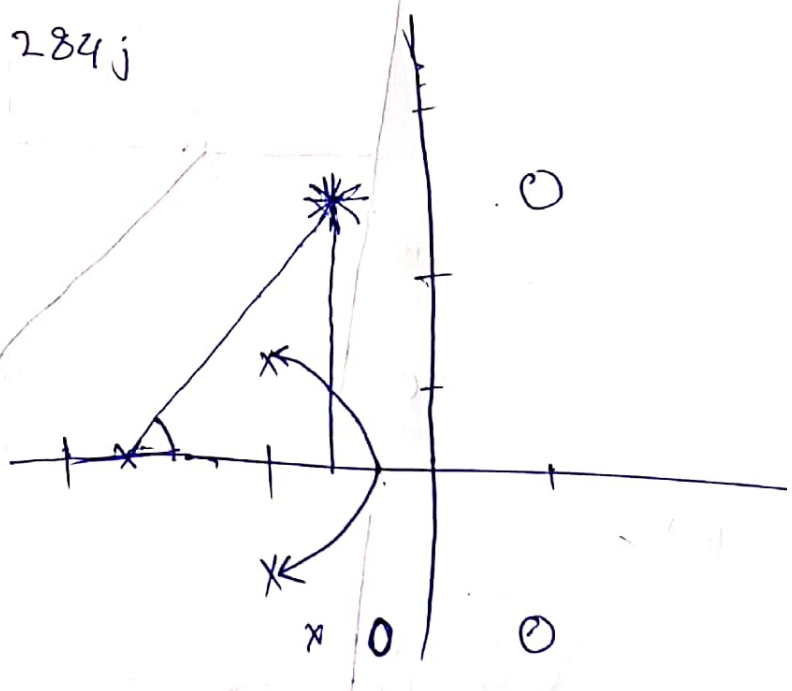
The new dominant pole $= -1.47 \pm 2.84\,j$

$\theta_{zeros} = \theta_{poles} - 180$

$= \tan^{-1}\left(\frac{2.84}{3-1.47}\right)$

$= 61.96^\circ - 180^\circ$

$= -119$



$$\tan(-119) = \frac{2.84}{z-1.47}$$

$$1.8 = \frac{2.84}{z-1.47} \qquad z = 3.05$$

$$|K\,G(s)\,H(s)| = 1 \qquad K = \left|\frac{(s+3)(s^2+4s+5)}{(s^2-2s+8)(s+3.05)}\right|$$

$$G_{PD}(s) = \frac{(s^2-2s+8)(s+3.05)}{(s+3)(s^2+4s+5)}$$

$K = 0.51$

$K_d = 2.27$

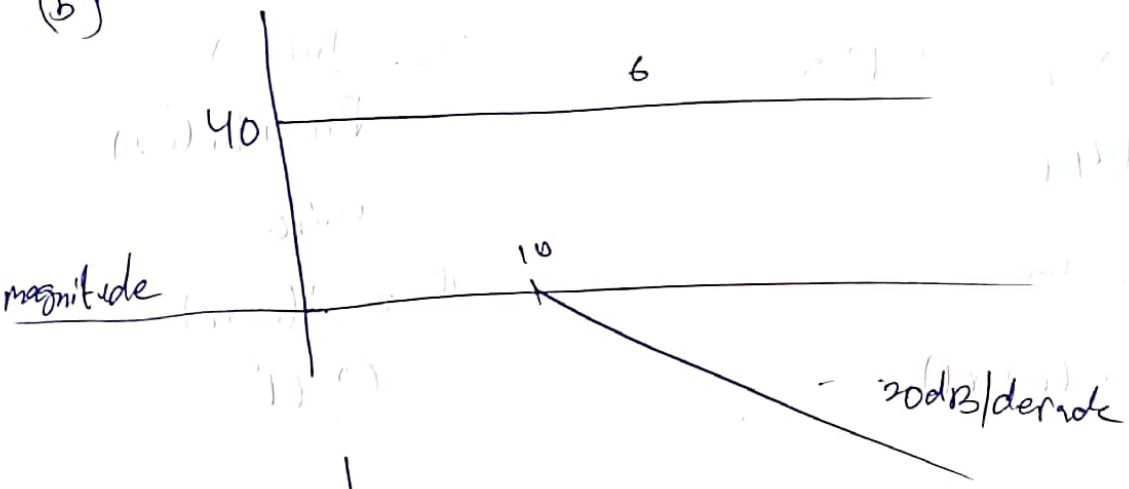
$K_p = K_d \times 3.05 = 1.55.$

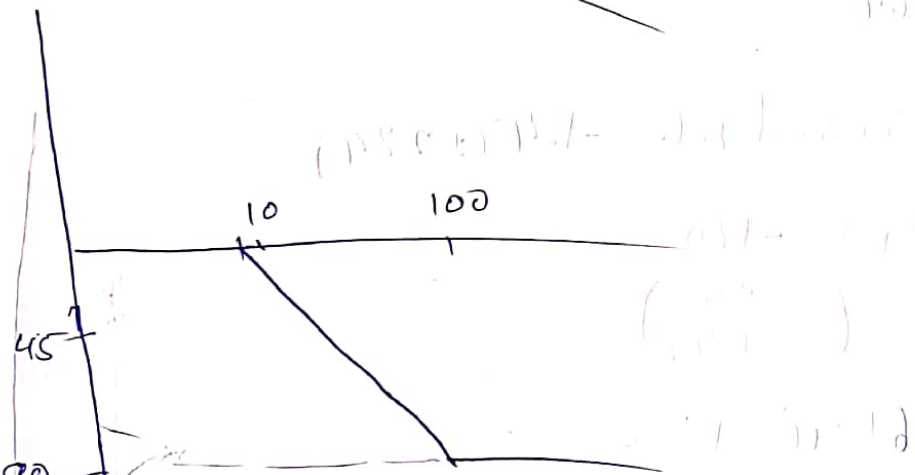
Q3)

a) $G(S) = \frac{12}{S+(S+6)} = \frac{12}{6(\frac{jw}{6}+1)}$

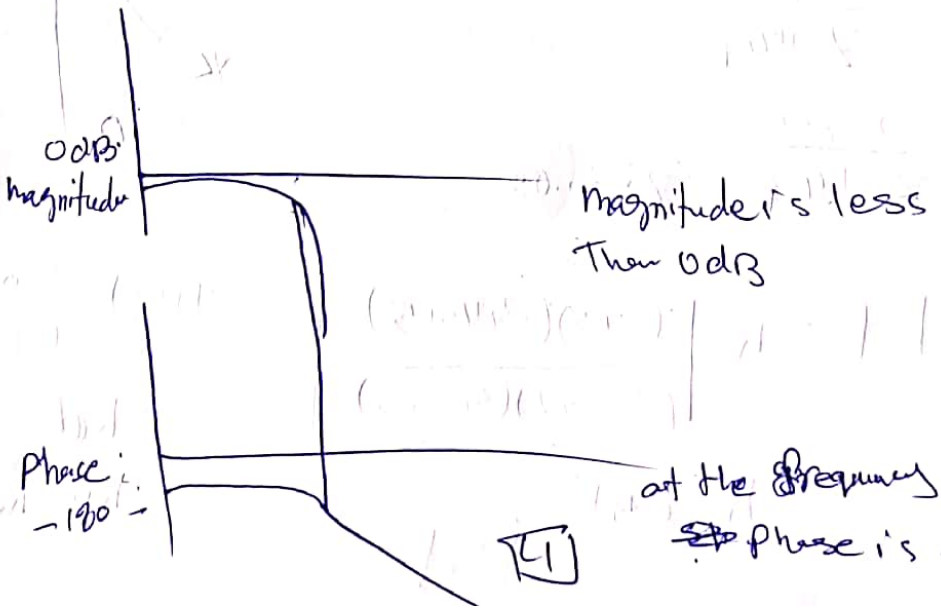
(I) $20\log_{10}|G(jw)| = 20\log(12) - 20\log(6(jw) - 20\log(\frac{w}{6}+1)$

(b)



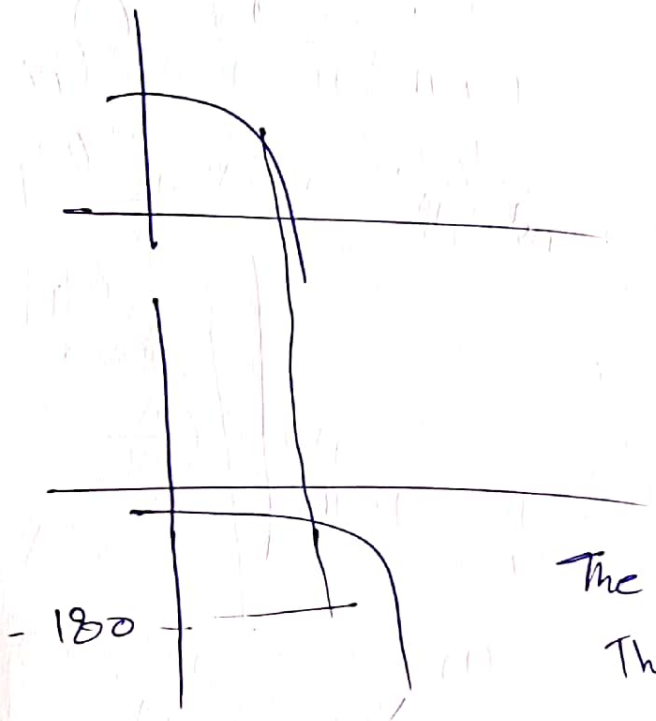


(c)



[4]

(II) unstable system



The magnitude is greater Than Zero phase ±180°