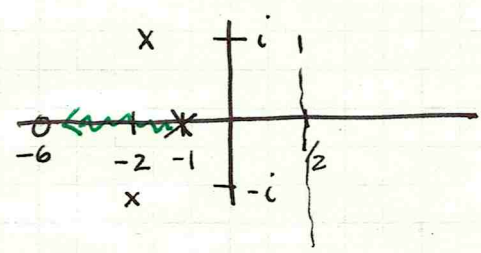


1.

poles: $s = -2 \pm i$
 $s = -1$
 zero $s = -6$



$$\sigma = \frac{-2+i - 2-i - 1 + 6}{3-1} = \frac{1}{2}$$

$$\phi = \pm \frac{(2n+1)\pi}{3-1} = \pm \frac{\pi}{2}$$

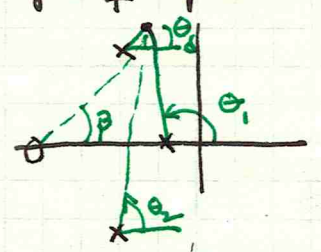
(b) jw-axis crossing

$$GH+1 = s^3 + 5s^2 + (9+k)s + 5+6k$$

$$\begin{array}{r|l} s^3 & 1 \quad 9+k \\ s^2 & 5 \quad 5+6k \\ s & 5(9+k)+5+6k \\ s^0 & 5+6k \end{array} \Rightarrow 5s^2 + 5 + 6k = 0 \Rightarrow s = \pm j7$$

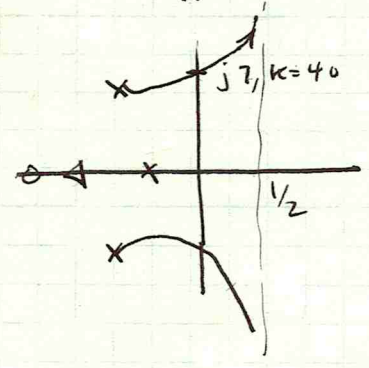
$$\Rightarrow k=40$$

no-breakaway pts
 angle of departure



$$\left. \begin{array}{l} \theta_1 = \pi - \tan^{-1}(1) \\ \theta_2 = \frac{\pi}{2} \\ \beta = \tan^{-1}(\frac{1}{4}) \end{array} \right\} -\theta_d - \theta_1 - \theta_2 + \beta = \pm (2n+1)\pi$$

$$\theta_d = -0.55 \text{ rad} = -31.22^\circ$$



$$2 \quad GH = \frac{4s+k}{s^2(s+2)}$$

$$GH+1 = 0 = s^3 + 2s^2 + 4s + k$$

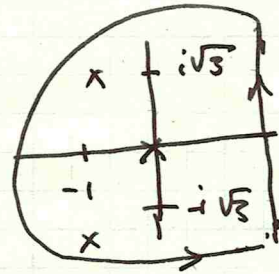
s^3	1	4	
s^2	2	k	
s^1	$\frac{8-k}{2}$		$k < 8$
s^0	k		$k > 0$

stable $0 < k < 8$

3.

$$\bar{Y} = \frac{4}{s(s^2 + 2s + 4)}$$

$$\frac{t > 0}{y(t)} = \frac{1}{2\pi i} \int_{-i\infty + c}^{i\infty + c} \bar{Y} e^{st} ds = \frac{1}{2\pi i} \oint_C \bar{Y} e^{st} ds$$



$$(a) y(t) = u(t) \left[1 - e^{-t} \left\{ \cos(\sqrt{3}t) + \frac{\sin(\sqrt{3}t)}{\sqrt{3}} \right\} \right]$$

$$\omega_d = \sqrt{3}$$

$$\left. \begin{array}{l} \xi \omega_n = 1 \\ \omega_n = 2 \end{array} \right\} \xi = \frac{1}{2} \quad (b) \hat{y}(t) = y(t) - y(t-A)$$

settling time

$$\frac{e^{-t_s}}{\sqrt{1 - \xi^2}} = 0.05 \Rightarrow t_s = -\ln(\sqrt{1 - \xi^2} \cdot 0.05) = \boxed{3.13 = t_s}$$

$$\sqrt{3} t_r = \pi - \tan^{-1}\left(\frac{\sqrt{1 - \xi^2}}{\xi}\right) = \pi - 1.04 = \cancel{t_r}$$

$$\boxed{t_r = 1.20}$$

