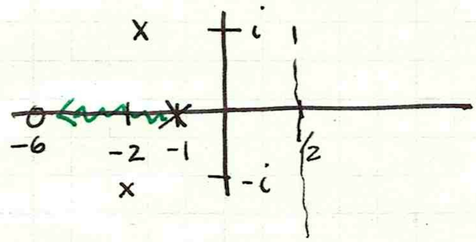
1.

poles: $s = -2 \pm i$

$s = -1$

zero $s = -6$



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

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

(b) jw-axis crossing

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

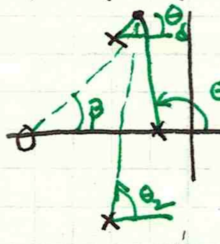
s^3	1	$9+k$
s^2	5	$5+6k$
s	$\frac{5(9+k)+5+6k}{5}$	
s^0	$5+6k$	

$\Rightarrow 5s^2 + 5+6k = 0 \Rightarrow s = \pm j7$

$\Rightarrow k = 40$

no - breakaway pts

angle of departure



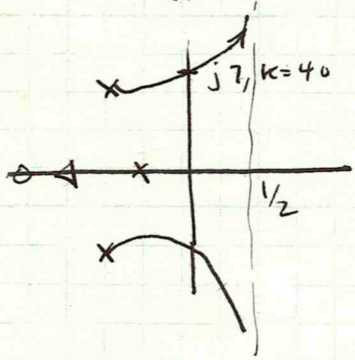
$\theta_1 = \pi - \tan^{-1}(1)$

$\theta_2 = \frac{\pi}{2}$

$\beta = \tan^{-1}\left(\frac{1}{4}\right)$

$-\theta_d - \theta_1 - \theta_2 + \beta = \pm(2n+1)\pi$

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



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

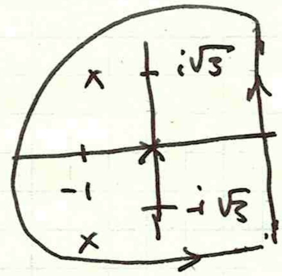
$GH+1 = 0 = s^3+2s^2+4s+k$

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.

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



$\underline{t>0}$

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

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

$\omega_d = \sqrt{3}$

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

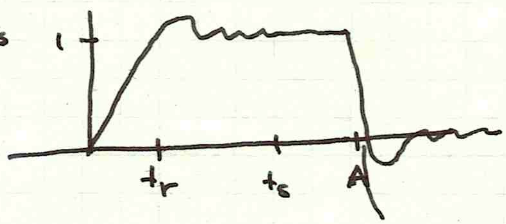
$\underline{\text{settling time}}$

$$\frac{e^{-t_s}}{\sqrt{1-1/4}} = 0.05 \Rightarrow t_s = -\ln\left(\sqrt{1-1/4}\,(0.05)\right) = \boxed{3.13 = t_s}$$

$$\sqrt{3}\,t_r = \pi - \tan^{-1}\left(\frac{\sqrt{1-1/4}}{1/2}\right) = \pi - 1.04 = \cancel{\pi}$$

$$\boxed{t_r = 1.20}$$

(c) $A >> t_s$



(d) $A << t_s$