CMPE-242
Applied Feedback Control

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Winter 2016

Office Hours

CMPE. 242 controls

20/JAN/2016

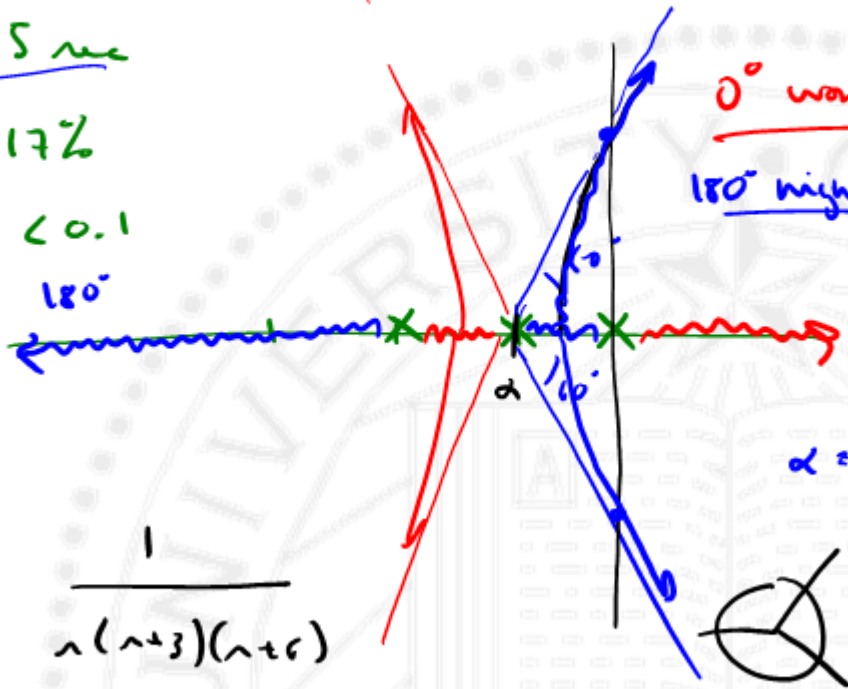
$T_s < 5$ sec

$M_p < 17\%$

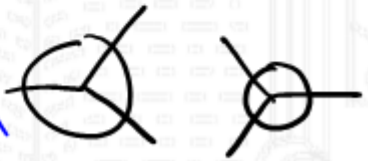
$e_{ss} < 0.1$

180° would work

180° might work



$$\alpha = \frac{\Sigma p - \Sigma z}{n - m}$$

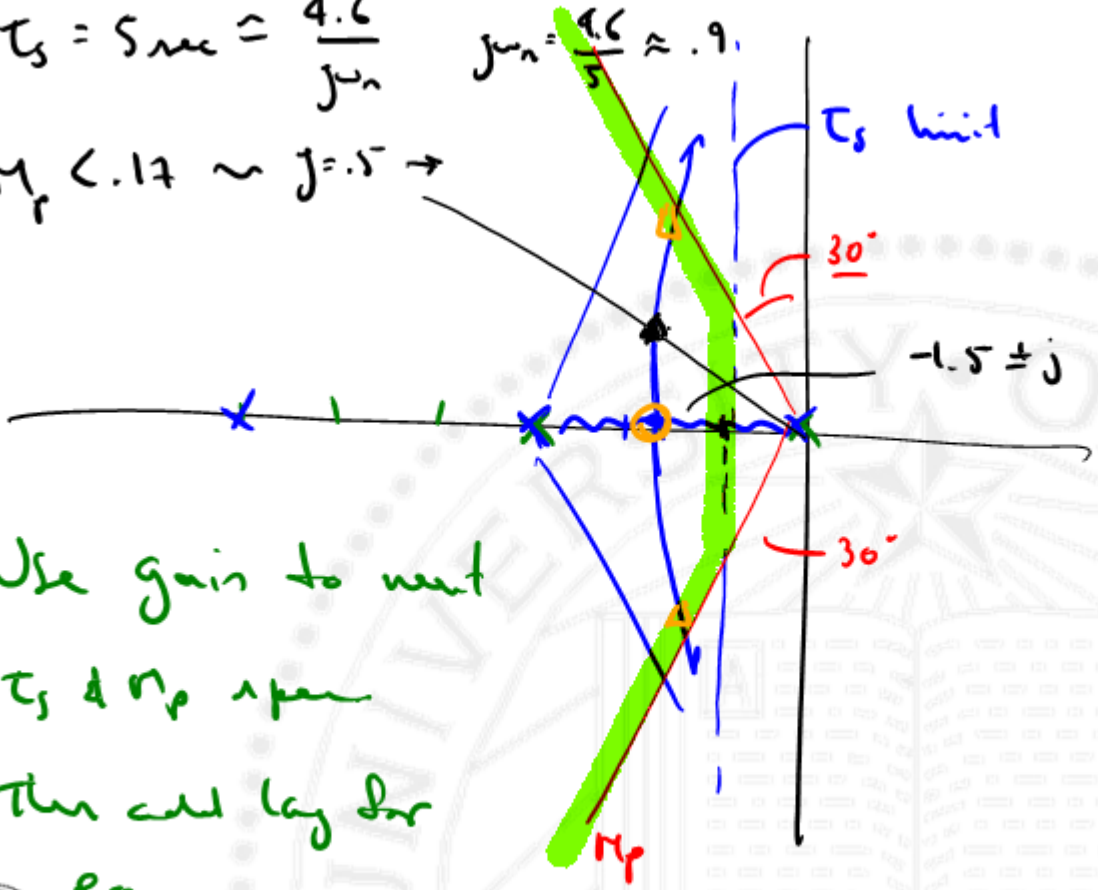


$$= \frac{1}{s(s+3)(s+6)}$$

$\tau_s = 5\tau_{max} \cong \frac{4.6}{\omega_n}$

$\omega_n = \frac{4.6}{5} \approx .9$

$M_p < .17 \sim \zeta = .5 \rightarrow$

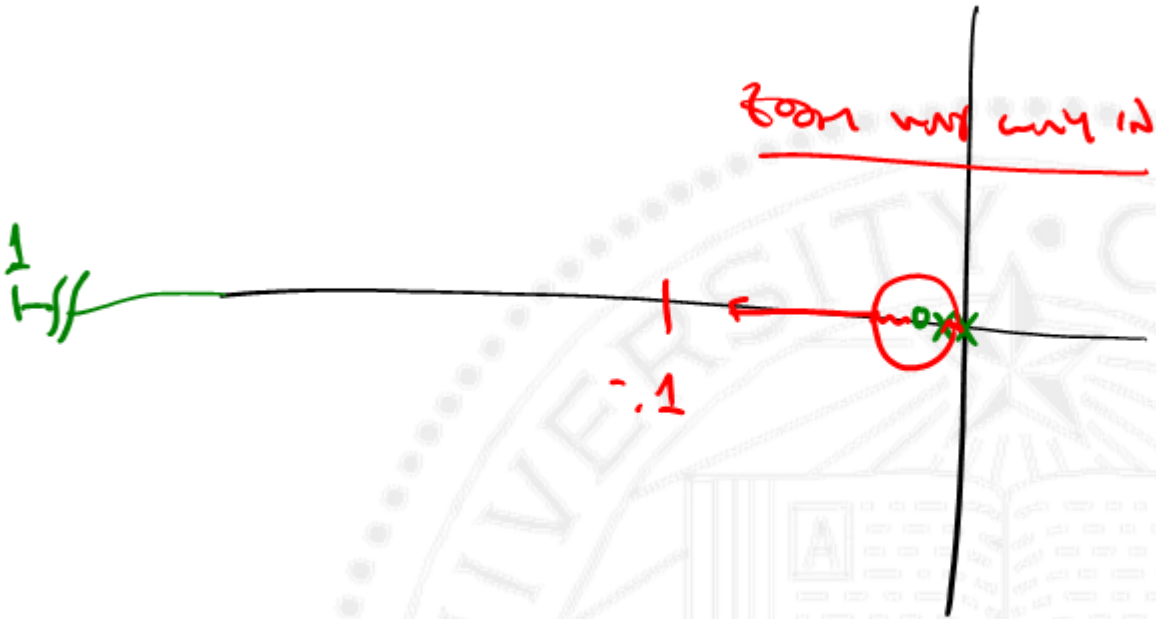


Use gain to meet

τ_s & M_p specs

Then add lag for

e_{ss}.


1
-.1

$$|F(s)|_{\Delta} = \frac{1}{\ell_1 \ell_2 \ell_3}$$

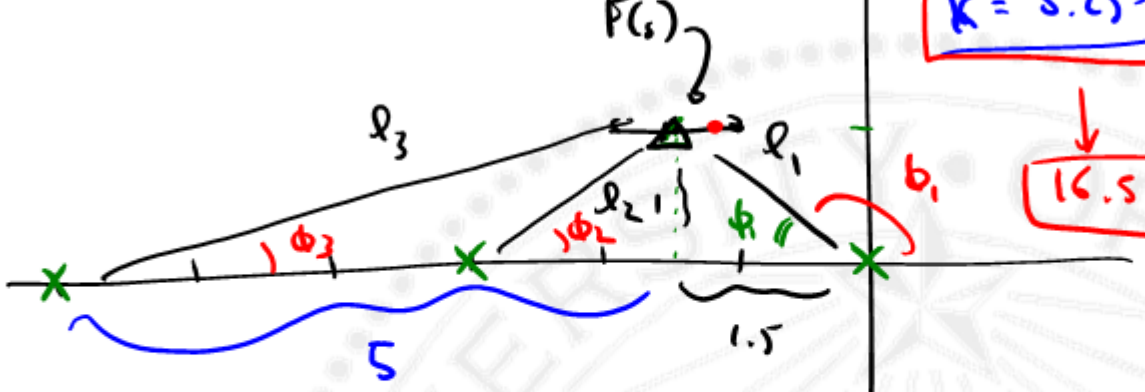
$$\ell_1 = \ell_2 = \sqrt{1^2 + (1.5)^2} = \sqrt{3.25}$$

$$\ell_3 = \sqrt{1^2 + 5^2} = \sqrt{26}$$

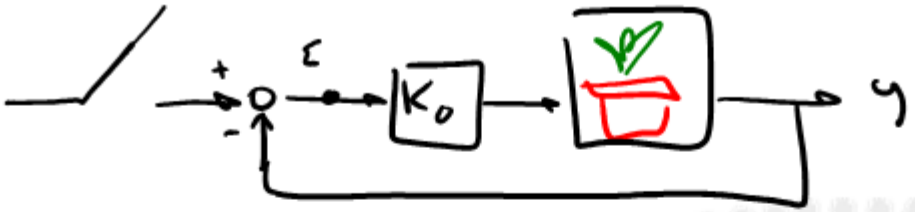
$$K = 3.25\sqrt{26}$$

$$\downarrow$$

$$16.57$$



$$\phi = -180 - \phi_3 = -180 - \tan^{-1}\left(\frac{1}{5}\right)$$



$\left[\frac{P}{\delta}\right]$

$\frac{Y}{R} = \frac{K_0 G(s)}{1 + K_0 G(s)}$ $\qquad \frac{Y}{\varepsilon}$

$$\lim_{s \to 0} s\left[\frac{\varepsilon}{R} \cdot R\right] = e_{ss} = \lim_{s \to 0} s\left(\frac{\varepsilon}{R}\right) \cdot \frac{1}{s^2} = \lim_{s \to 0} \frac{1}{s}\left(\frac{1}{1 + K_0 G(s)}\right)$$

$$\lim_{s \to 0} \frac{1}{s}\left[\frac{1}{1 + \frac{K_0}{s(s+3)(s+1)}}\right] = \lim_{s \to 0} \frac{1}{s}\left[\frac{s(s+3)(s+1)}{s(s+3)(s+1) + K_0}\right]$$

$$= \left.\frac{(s+3)(s+1)}{K_0}\right|_{s=0} = \frac{3}{K_0} = \boxed{\quad}$$

$$K(s) = K_0 \frac{s+z}{s+p} \qquad \frac{z}{p} = 15$$

$$z = 15p$$

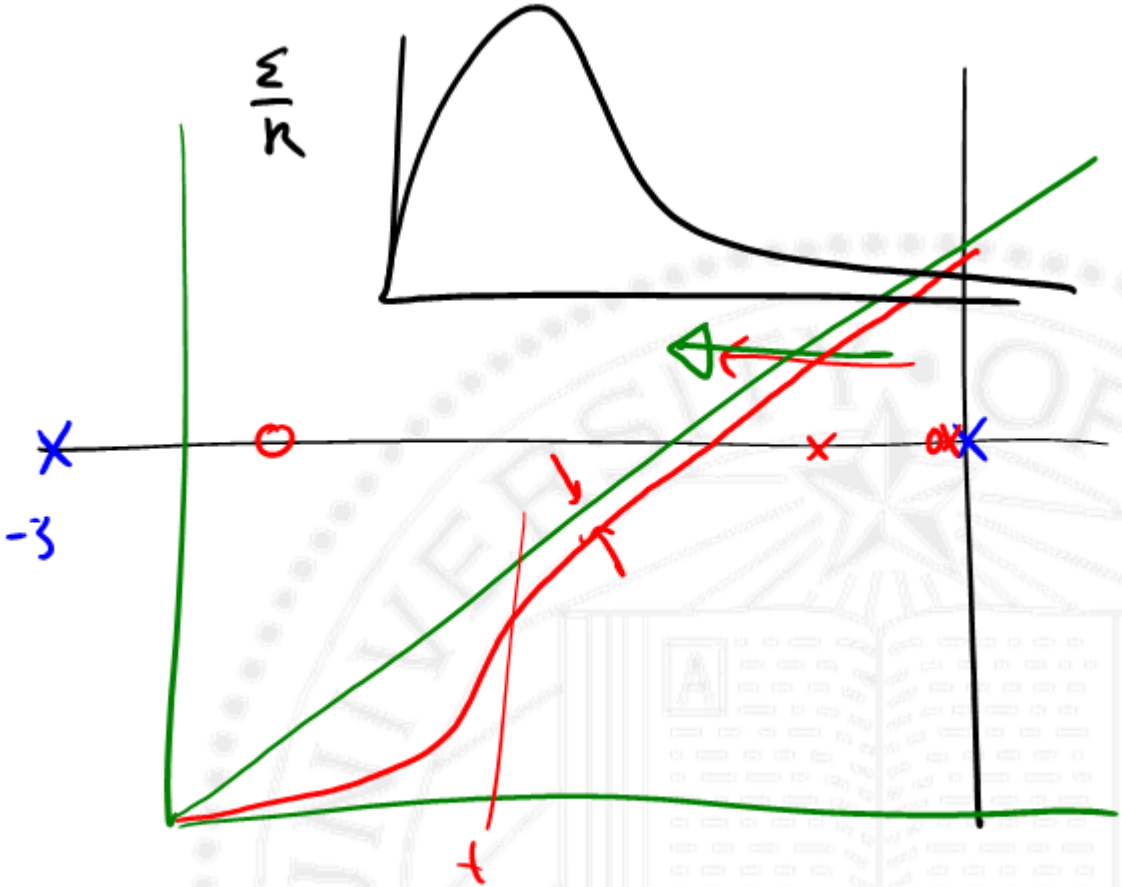
$$K(s) = K_0 \frac{s+15p}{s+p} \qquad \text{choose "p"} \qquad p = 0.01$$

$$z = 15(.01) = .15$$

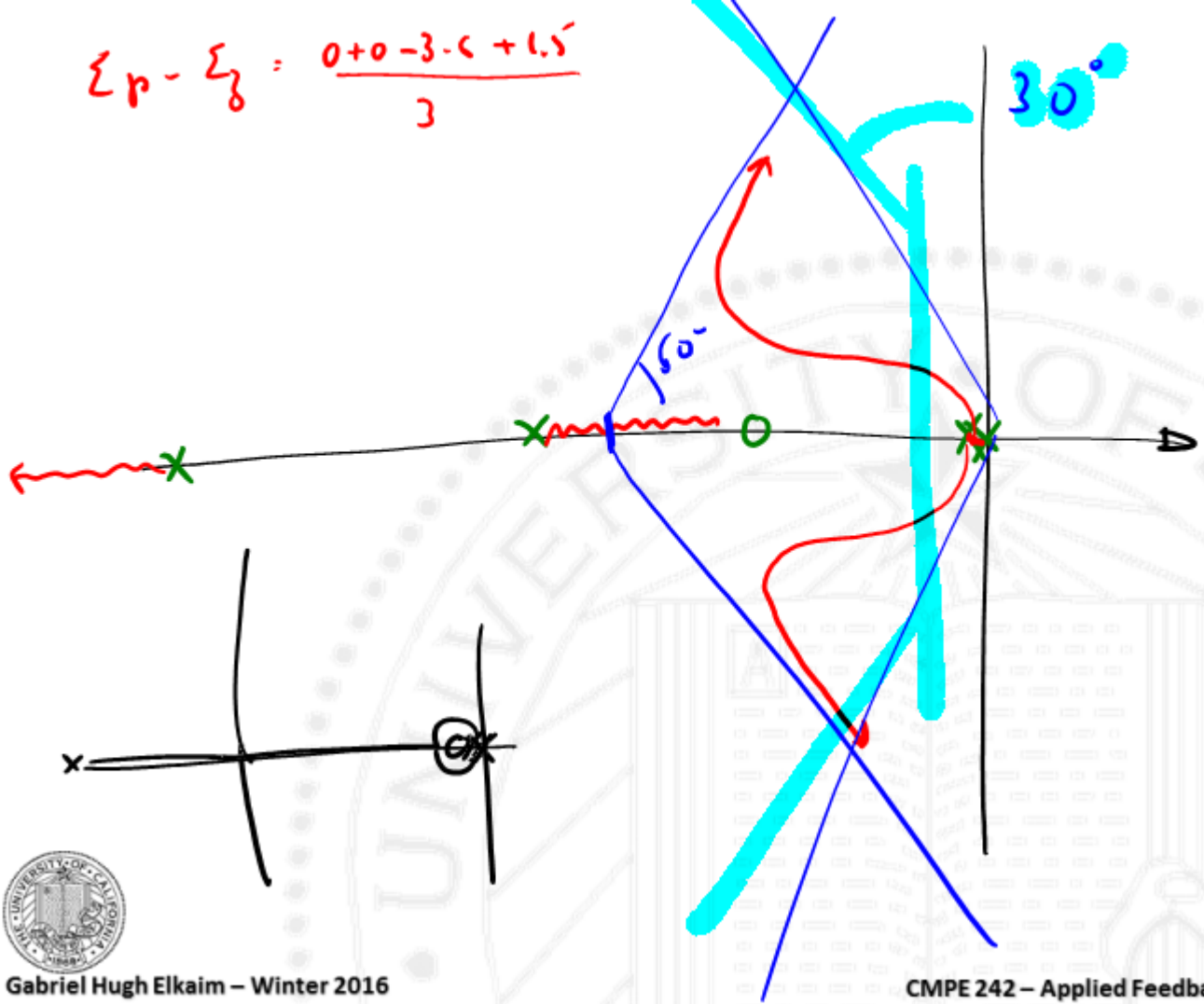
$$K(s) = K_0 \frac{s+.15}{s+0.01} \qquad KG(s) = \frac{K_0(s+.15)}{s(s+.01)(s+3)(s+6)}$$

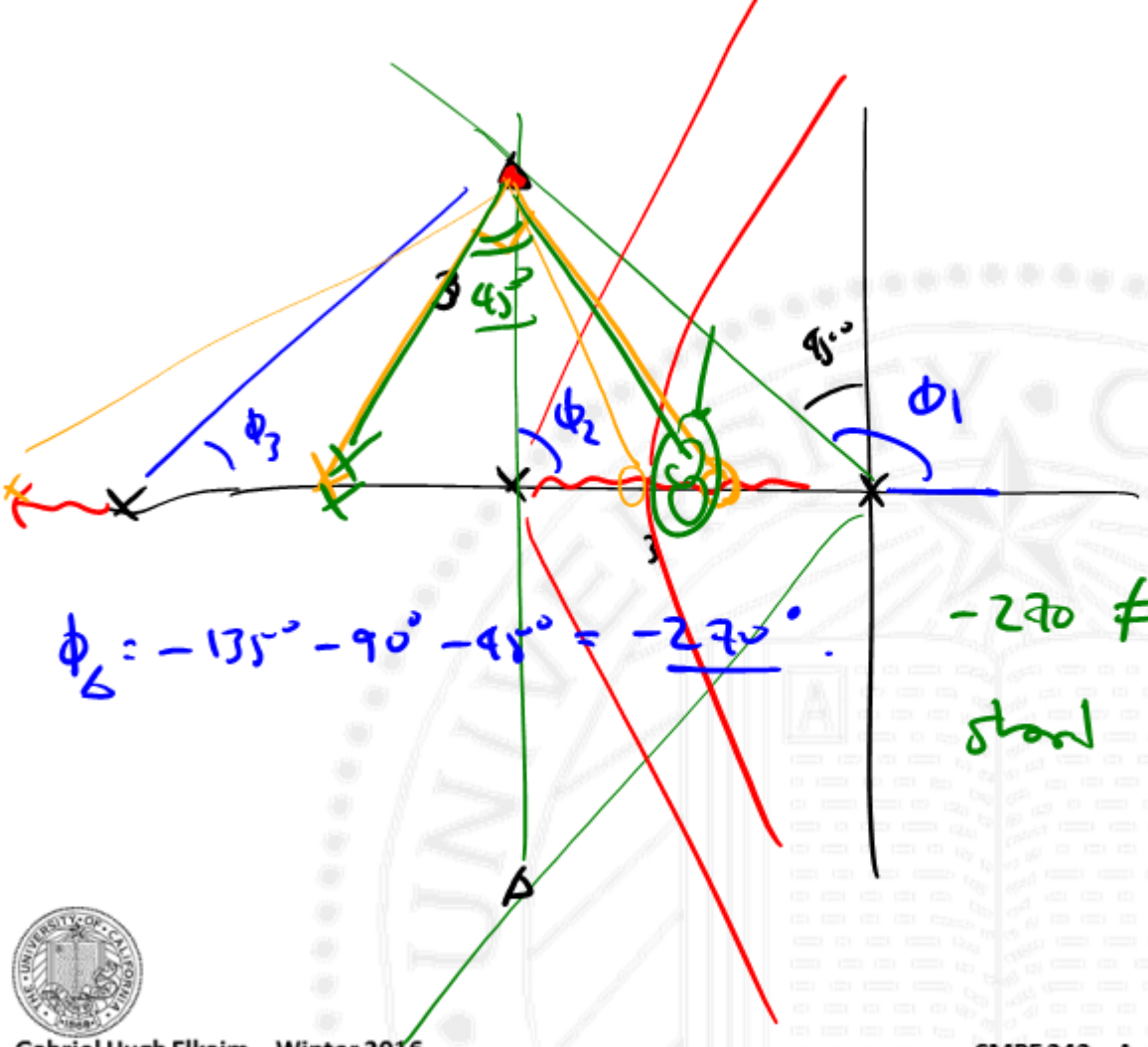
$$\frac{1}{1+KG(s)} = \frac{s(s+.01)(s+3)(s+6)}{s(s+.01)(s+3)(s+6) + K_0(s+.15)}$$

$$\frac{(.01)\,1P}{K_0(.15)} \rightarrow \frac{1.2}{15} \checkmark$$


ε/n
-3

$\zeta_p - \zeta_0 = \frac{0+0-3\cdot\zeta+1.5}{3}$



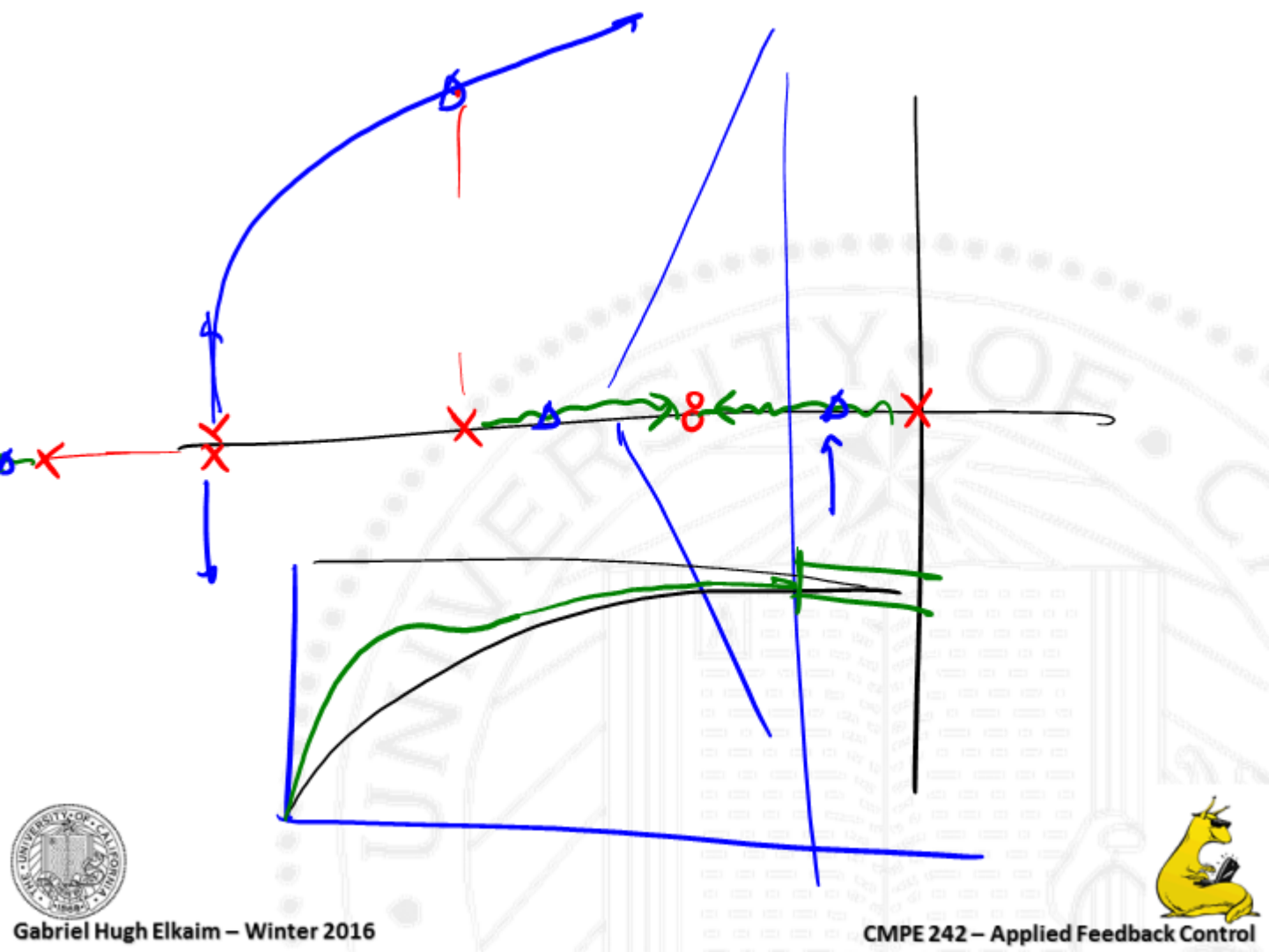

ϕ_3
ϕ_2
ϕ_1
90°
45°
45°
$\phi_6 = -135° - 90° - 45° = -270°$.
$-270 \neq -180°$
$\phi_6 = 90°$.

Cookbook

K ← gain when ($\pm 180°$ M / $0°$ M)

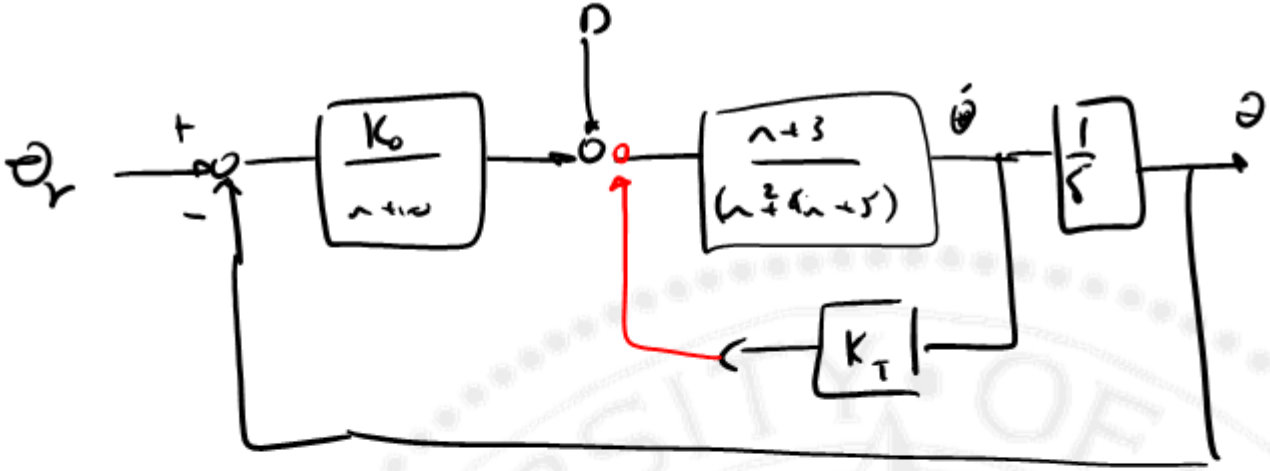
pick a point in s-plane that meets spec's

add <u>lead</u> to bring that point.



servo : $\boxed{\frac{10}{s+10}}$ gain $\left(\frac{K_0}{10}\right)$

$\left(\frac{K_0}{s+10}\right)$



$$\frac{\theta}{D}\Big|_{D(1)=\frac{0.5}{s}}$$

FVT < 1 degree → RMS

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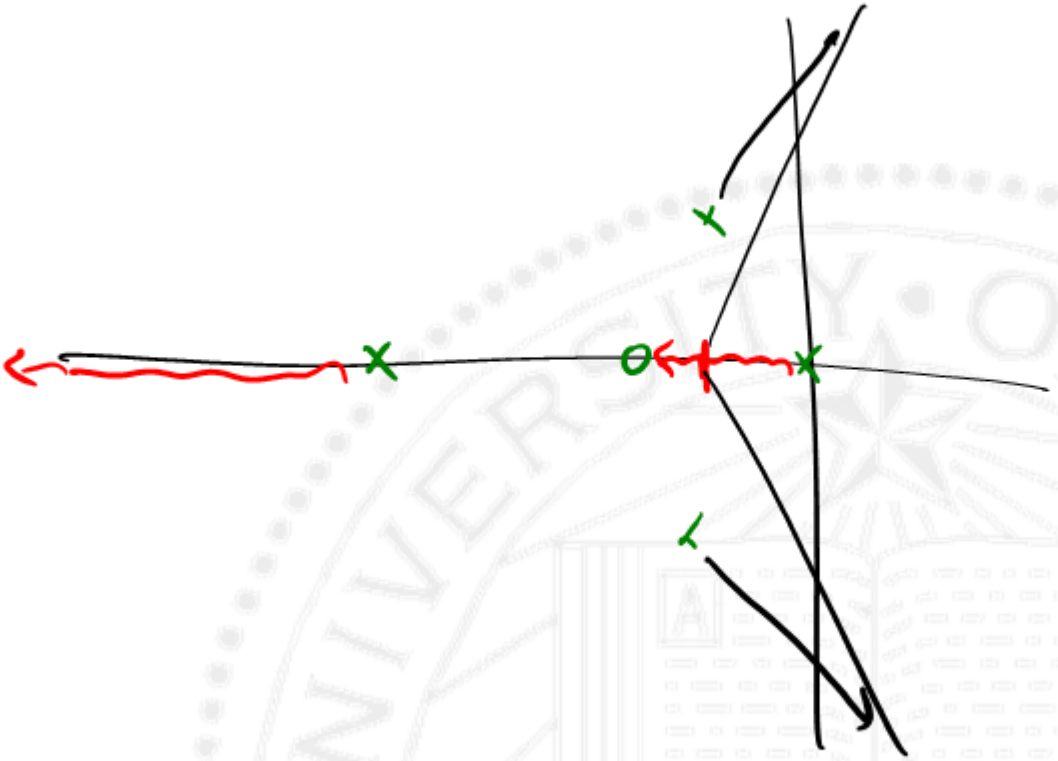
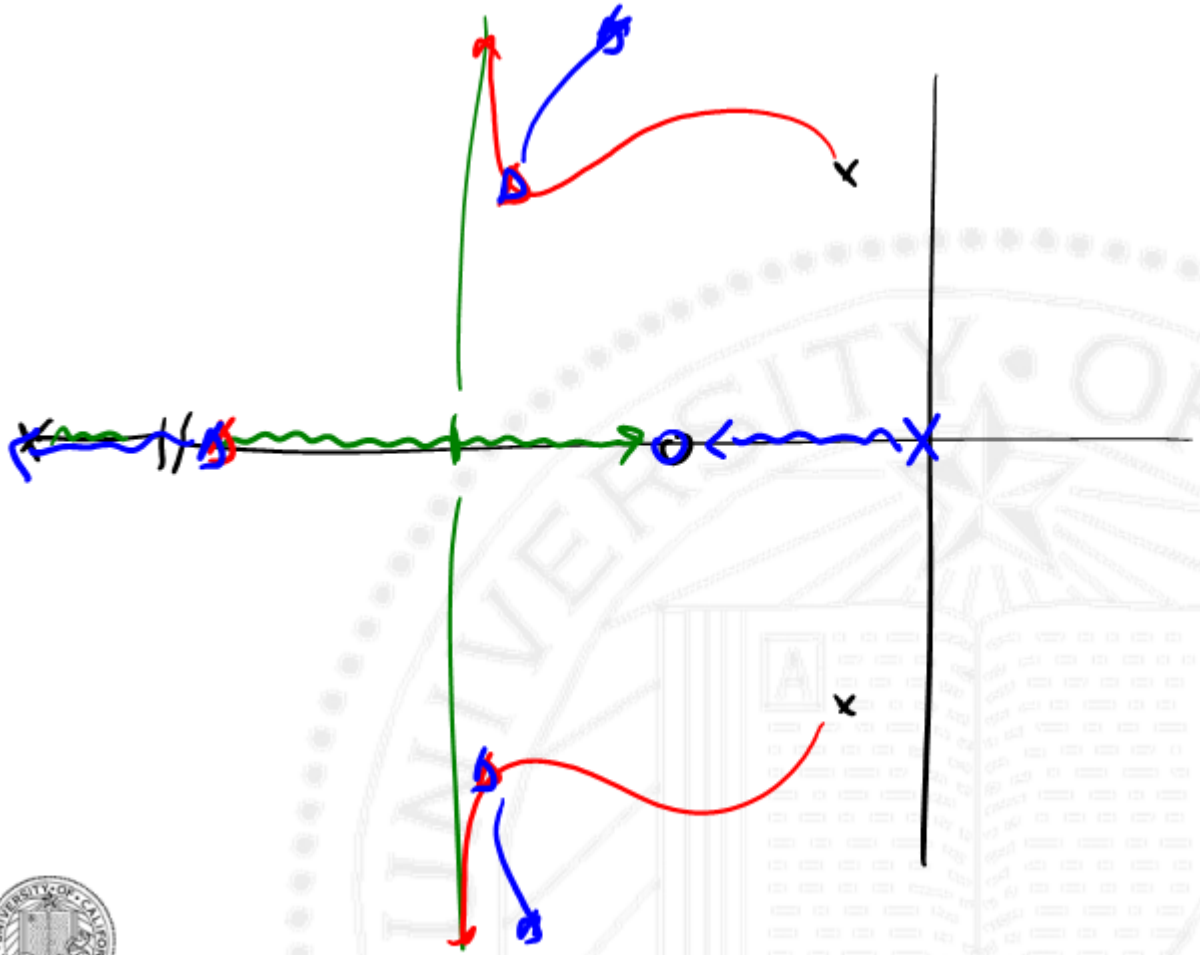
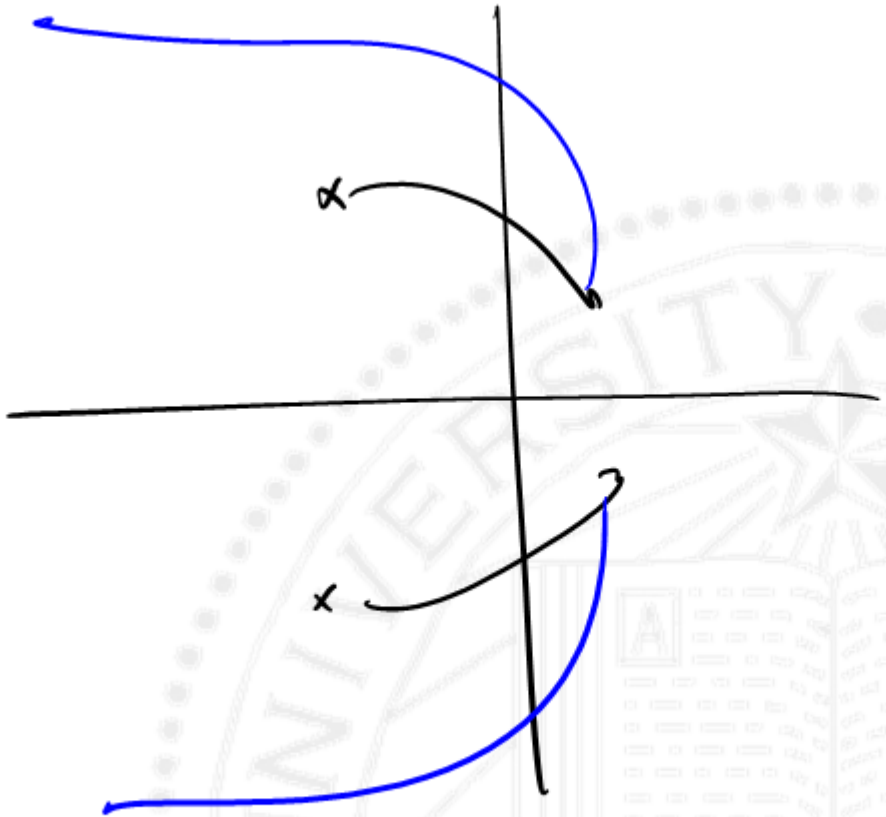
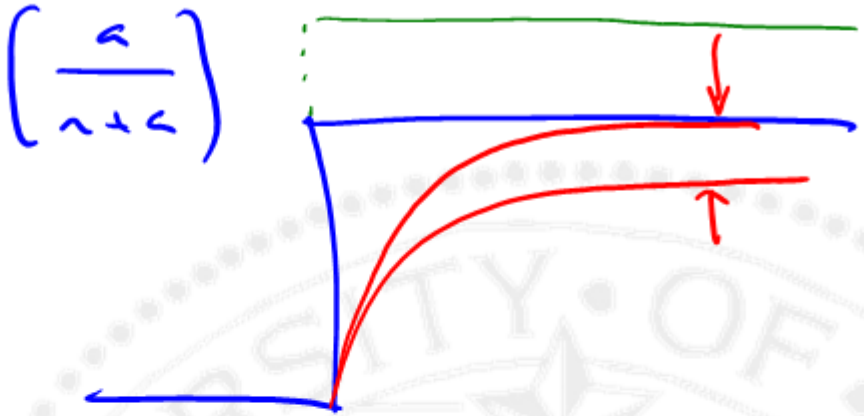
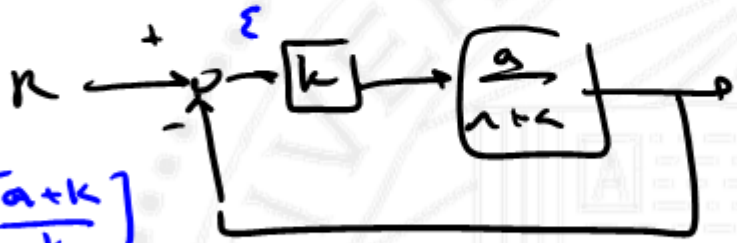




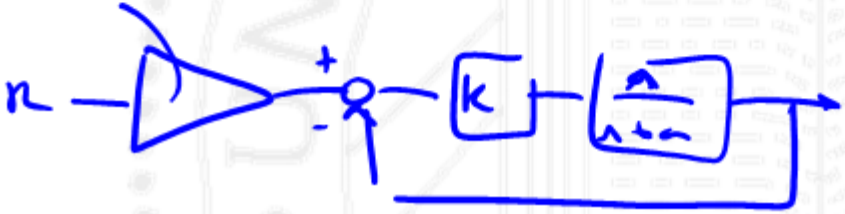


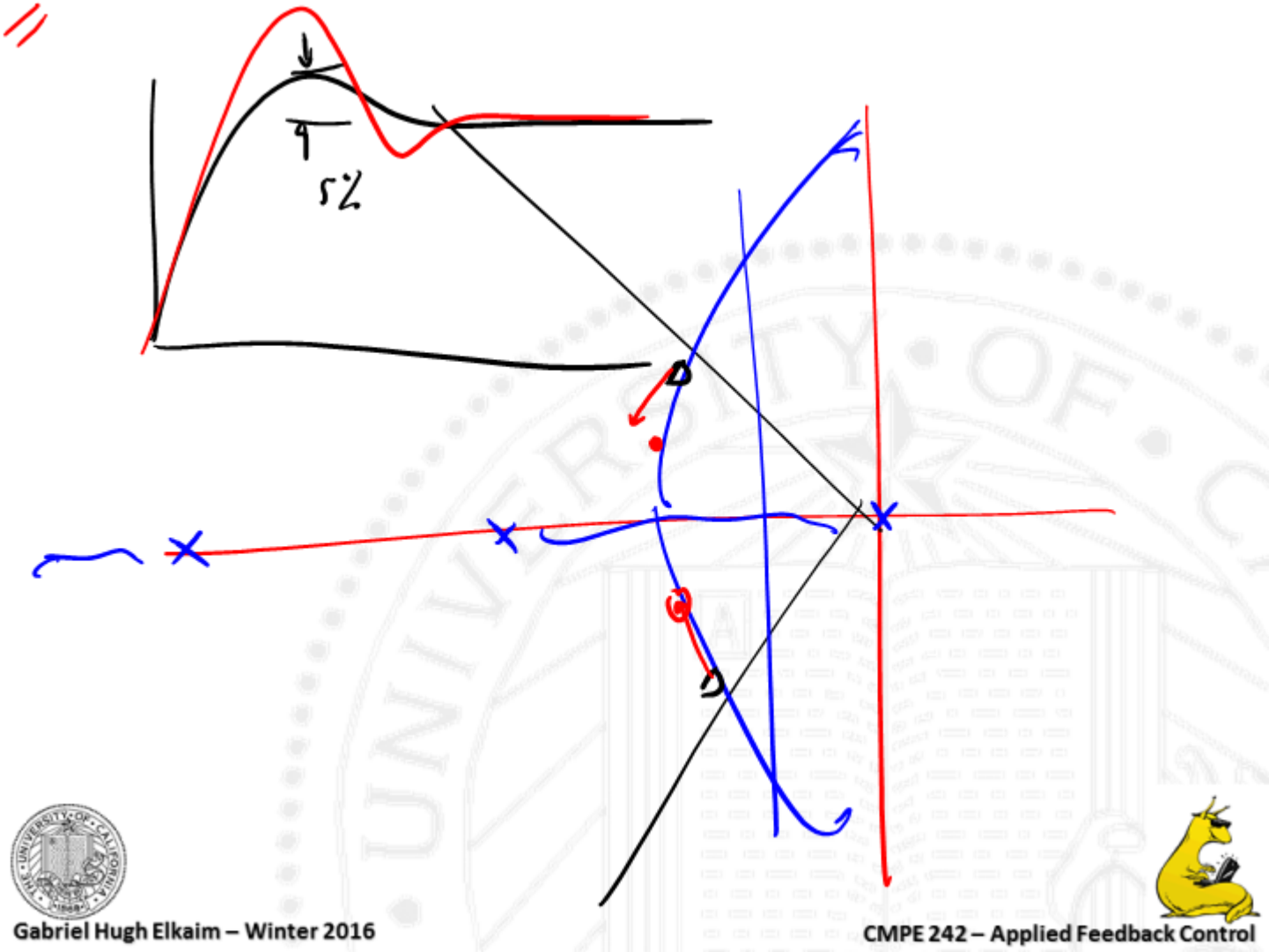




$\left[\frac{K}{K+a}\right] < 1.$

$\left[\frac{a+K}{K}\right]$

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