CMPE-242
Applied Feedback Control

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Office Hours

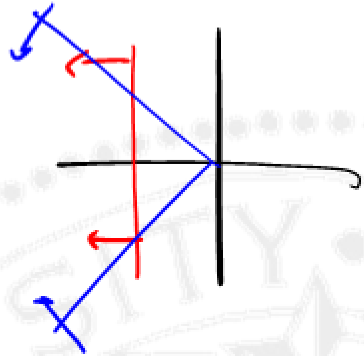
20/JAN/2017

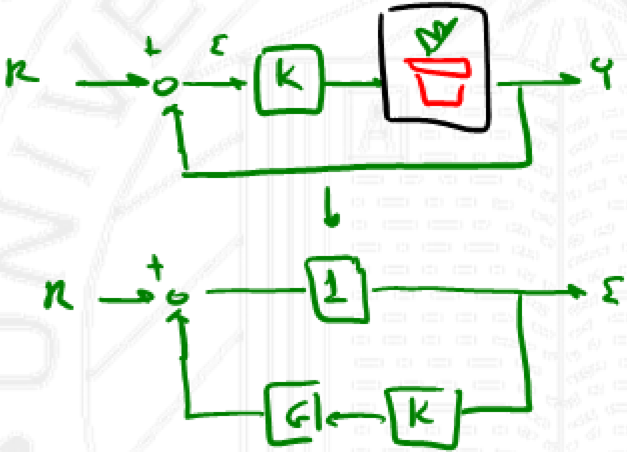
$T_s \rightarrow \frac{4.6}{\zeta\omega_n}$

$M_p \rightarrow e^{-\pi\zeta/\sqrt{1-\zeta^2}}$

e_{ss}

e_{ss}





$\frac{Y}{R} = \frac{GK}{1+GK}$

$\frac{E}{R} = \frac{1}{1+GK}$

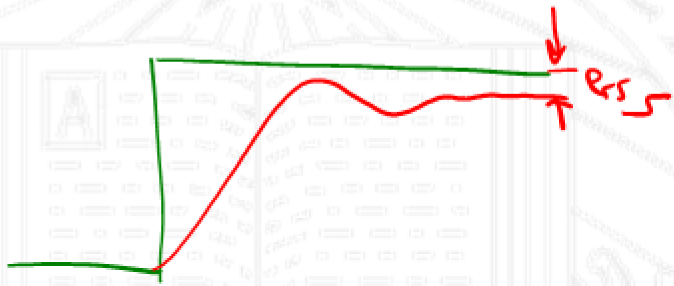
e_{ss} (step) $\Rightarrow$ FVT

$$e_{ss}(\infty) = \lim_{s\to 0} sE(s) = \lim_{s\to 0} s\,\frac{E}{R}(s)\cdot\frac{1}{s}$$

$\uparrow$ $R(s)$

$$\frac{E}{R} = \frac{1}{1+GK} \qquad R = \text{(step)} = \frac{1}{s}$$

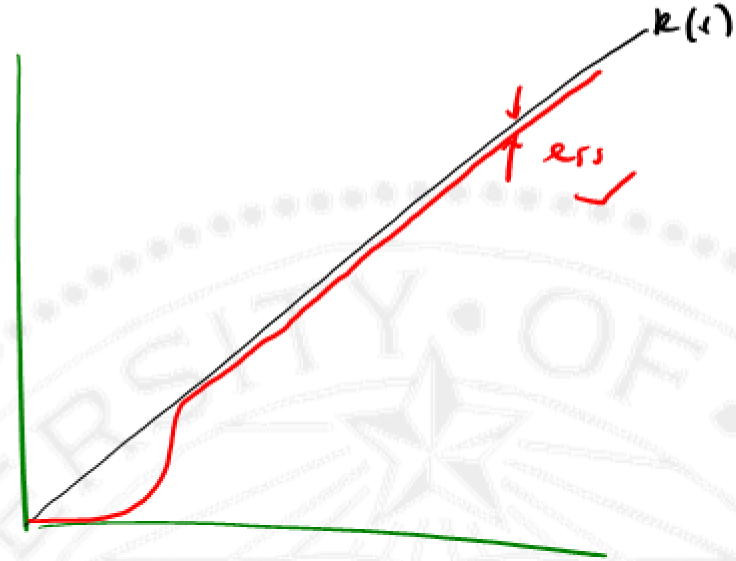
$$E_{ss}\text{(step)} = \lim_{s\to 0}\frac{1}{1+GK} < \underline{0.1}$$



e_{ss} (ramp) $\qquad R(s) = \frac{1}{s^2}$

$y \to \infty$ as $t \to \infty$

$\varepsilon \not\to \infty$ as $t \to \infty$



FVT $\to$ $y(\infty) = \lim_{s \to 0} sY(s)$

$E(\infty) \to \frac{E}{R}(s) \cdot R(s)$

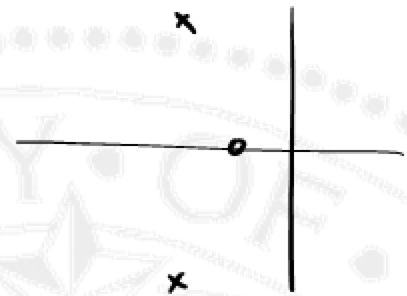
($R(s) = 1/s^2$)

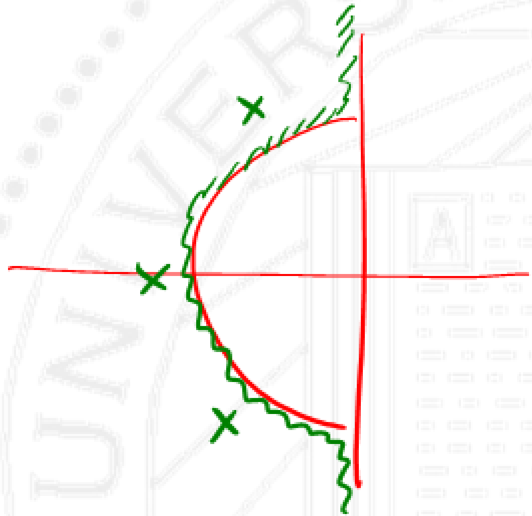
```
sys = tf([1 1],[1 3 5]);
rlocus(sys);
k = rlocfind(sys);
sysCL = feedback(k*sys,1);
step(sysCL);

sgrid(z,wn);
```

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

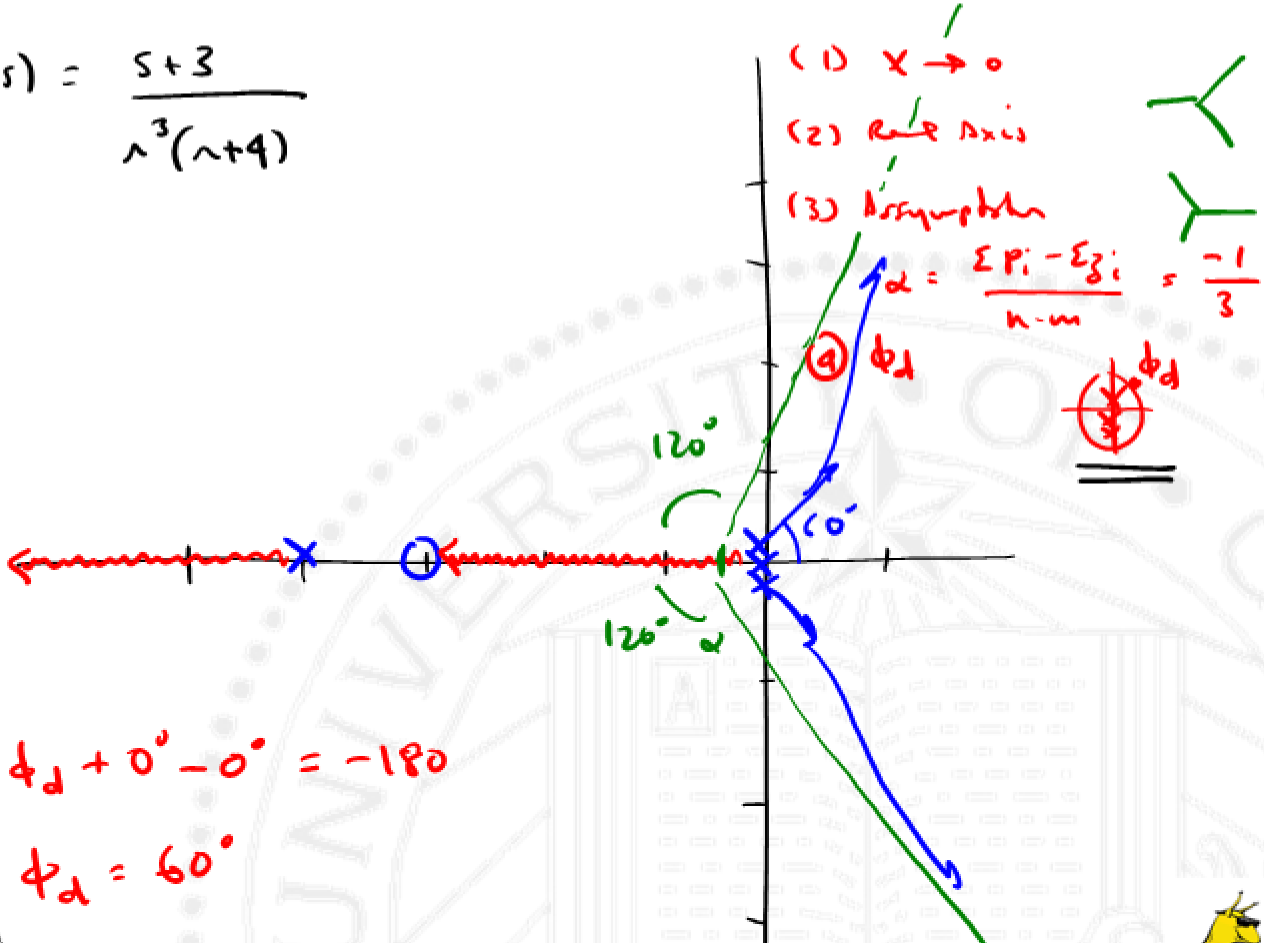
1 1

1 3 5





$$G(s) = \frac{s+3}{s^3(s+4)}$$



$$-3\phi_d + 0^\circ - 0^\circ = -180$$

$$\phi_d = 60^\circ$$

0° root locus

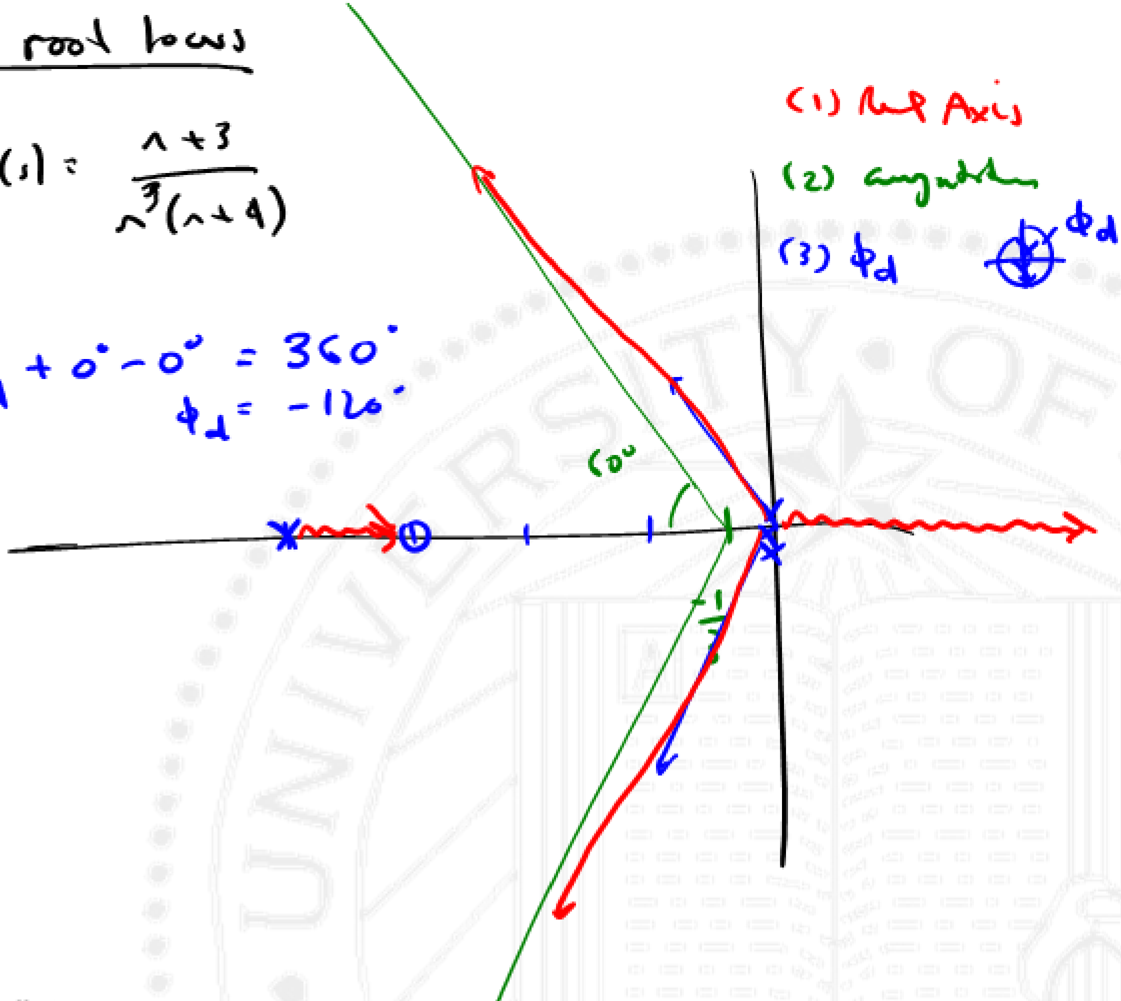
$$G(s) = \frac{s+3}{s^3(s+4)}$$

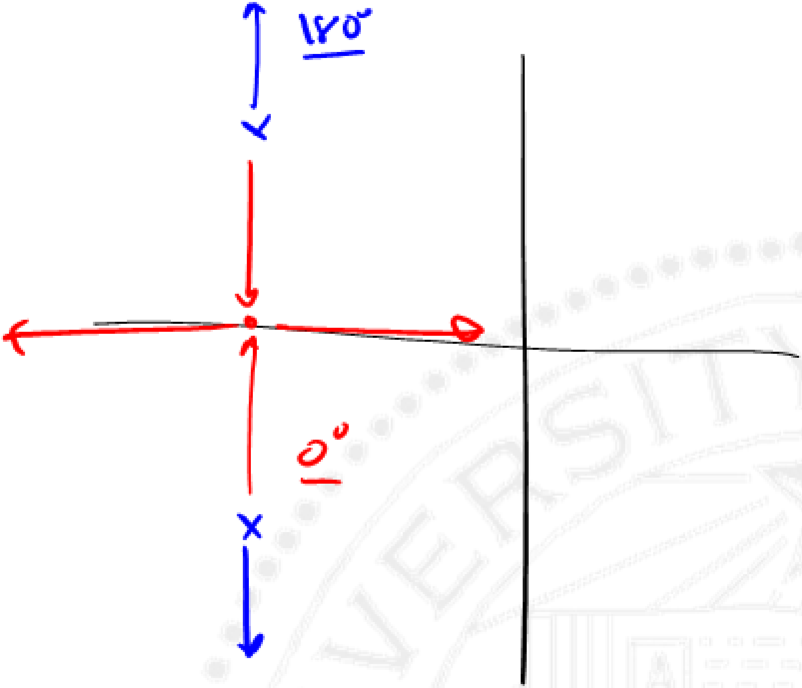
(1) Real Axis

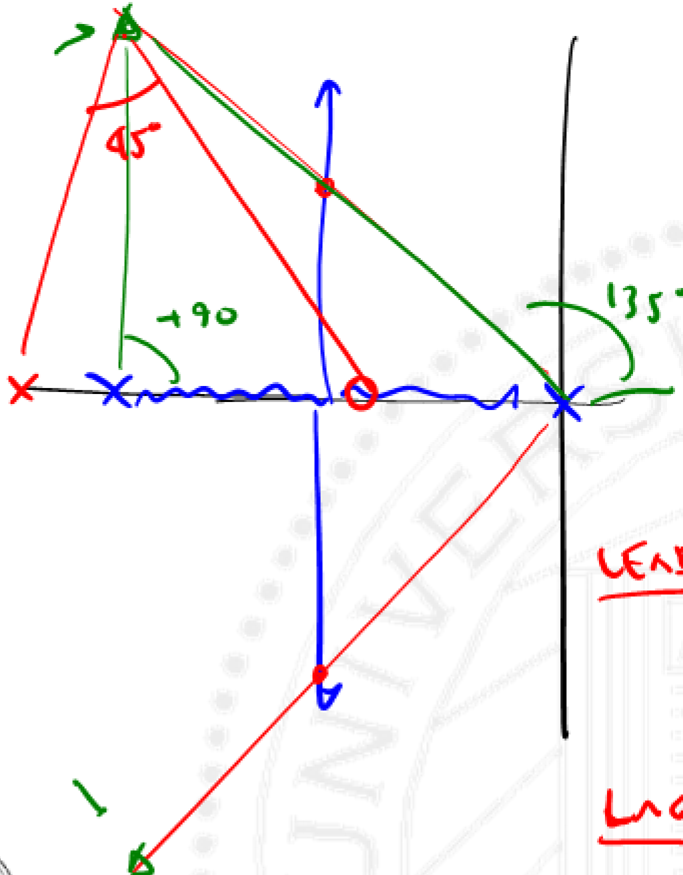
(2) asymptotes

(3) ϕ_d

$$-3\phi_d + 0° - 0° = 360°$$
$$\phi_d = -120°$$

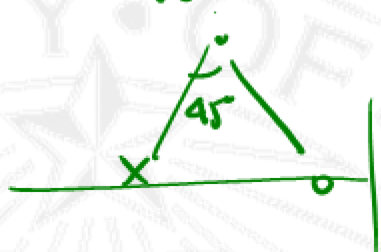



180°
0°



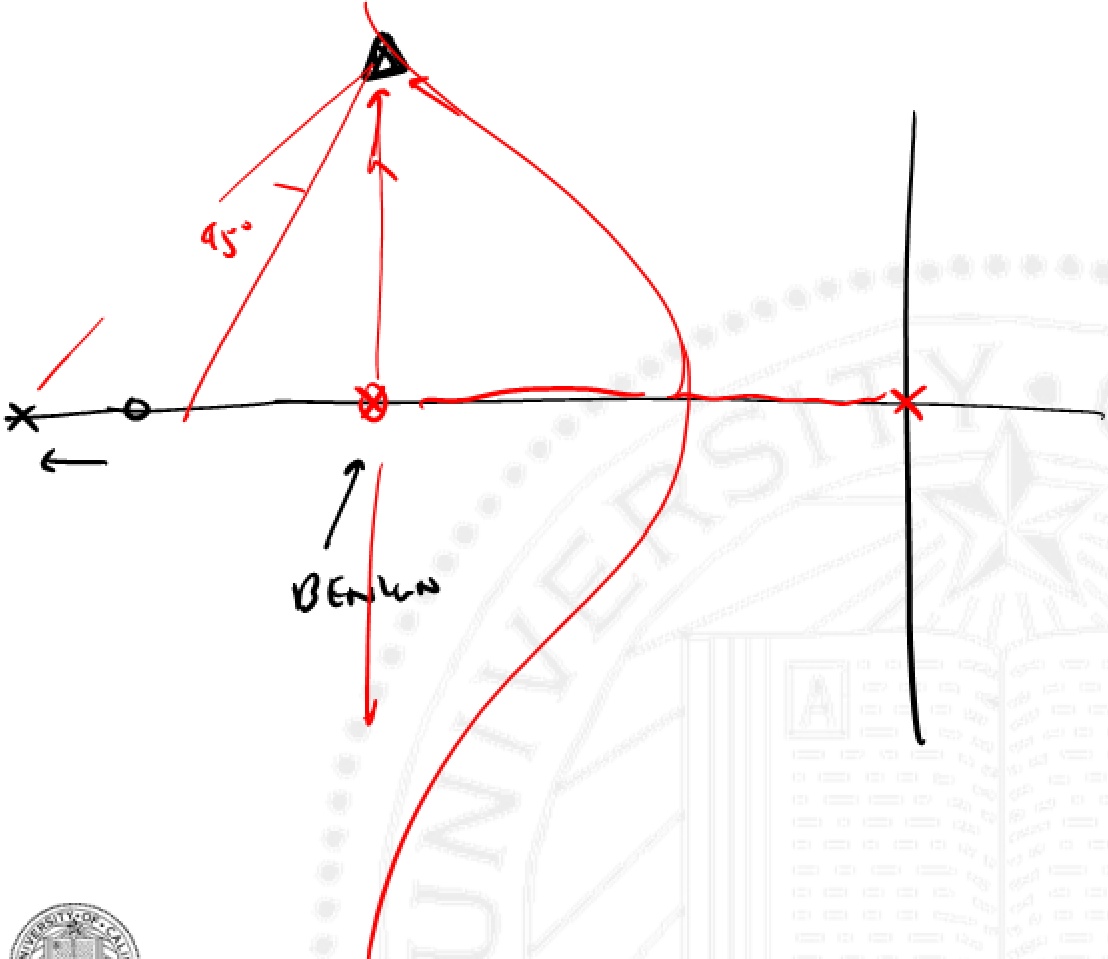
$\Phi_D = -90 - 135 = -225 \pm 180$

$$\begin{array}{r} 225 \\ -180 \\ \hline 45° \end{array}$$

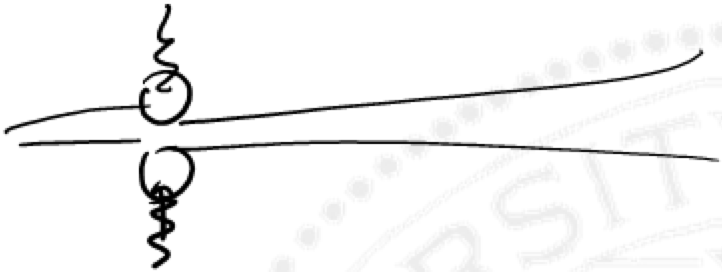


LEAD zero closer to origin & adds phase

LAG pole closer to the origin subtracts phase.


45°

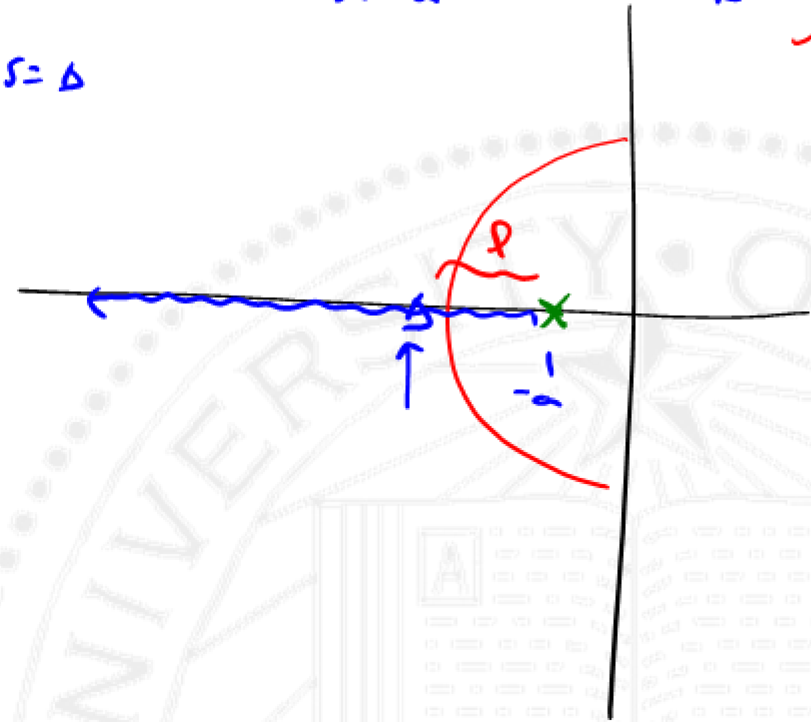
PLANT → PAPER MILLS / PROCESS CONTROL.

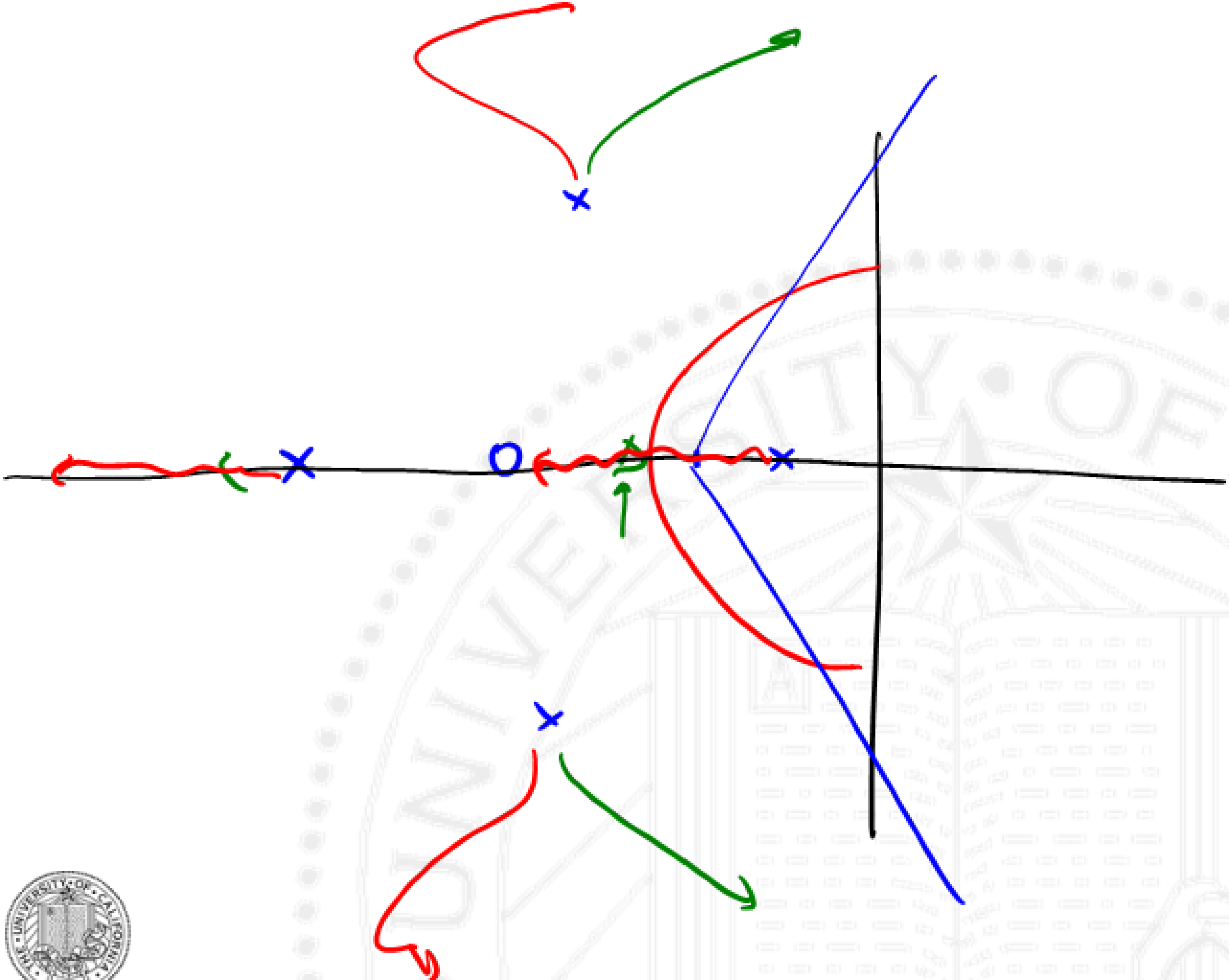


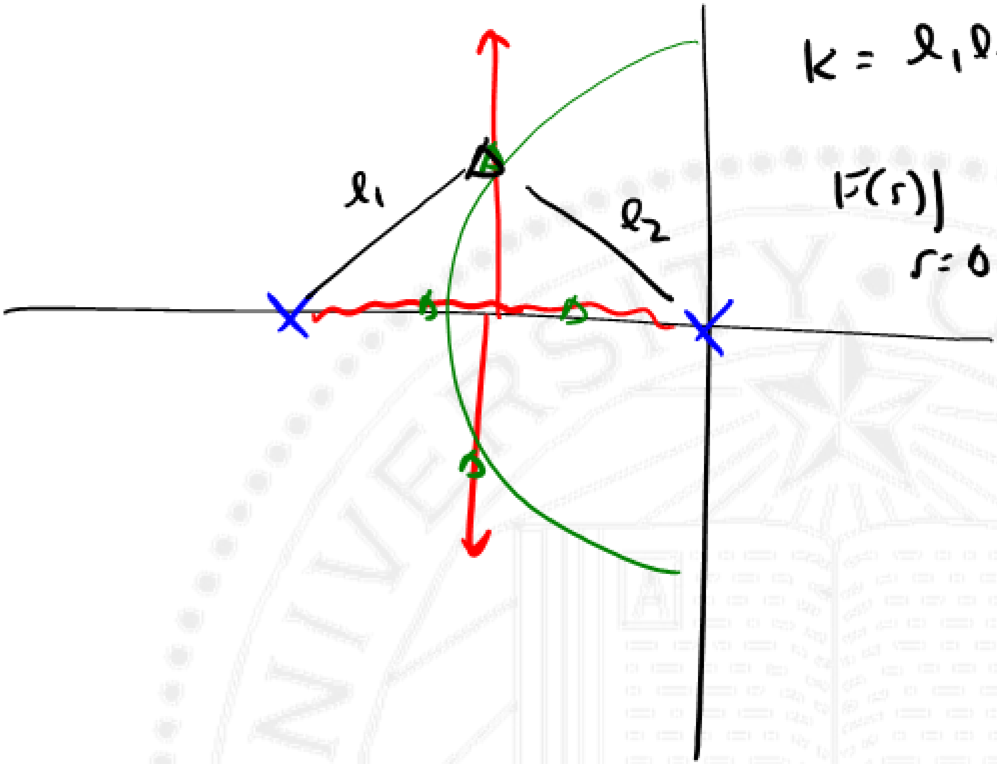
$$K = \frac{1}{|F(s)|_{s=\Delta}}$$

$$F(s) = \frac{1}{s+a}$$

$$K = \frac{1}{\ell}$$

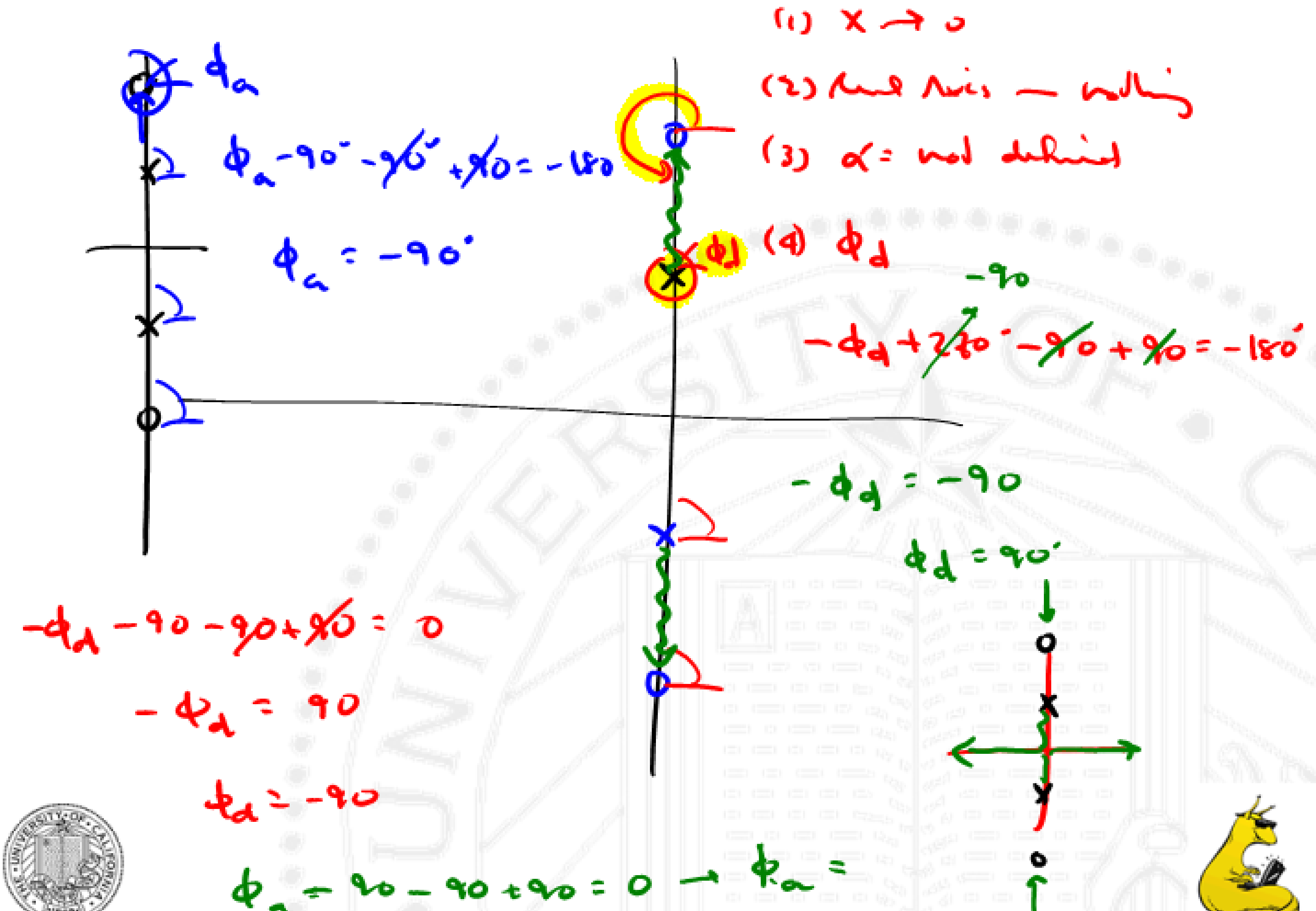






$$K = \ell_1 \ell_2$$

$$\left| F(s) \right|_{s=0} = \frac{1}{\ell_1 \ell_2}$$


(1) X → 0
(2) Real Axis — nothing
(3) α = not defined
(4) φd
φa − 90° − 90° + 90 = −180
φa = −90°
−90
−φd + 270° − 90 + 90 = −180°
−φd = −90
φd = 90°
−φd − 90 − 90 + 90 = 0
−φd = 90
φd = −90
φa = 90 − 90 + 90 = 0 → φa =