CMPE-242
Applied Feedback Control

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$$G(s) = \frac{K}{s\left(\frac{s}{5}+1\right)\left(\frac{s}{50}+1\right)} = \frac{250K}{s(s+5)(s+50)}$$

$PM \geq 40^\circ$

$e_{ss} < 0.01$

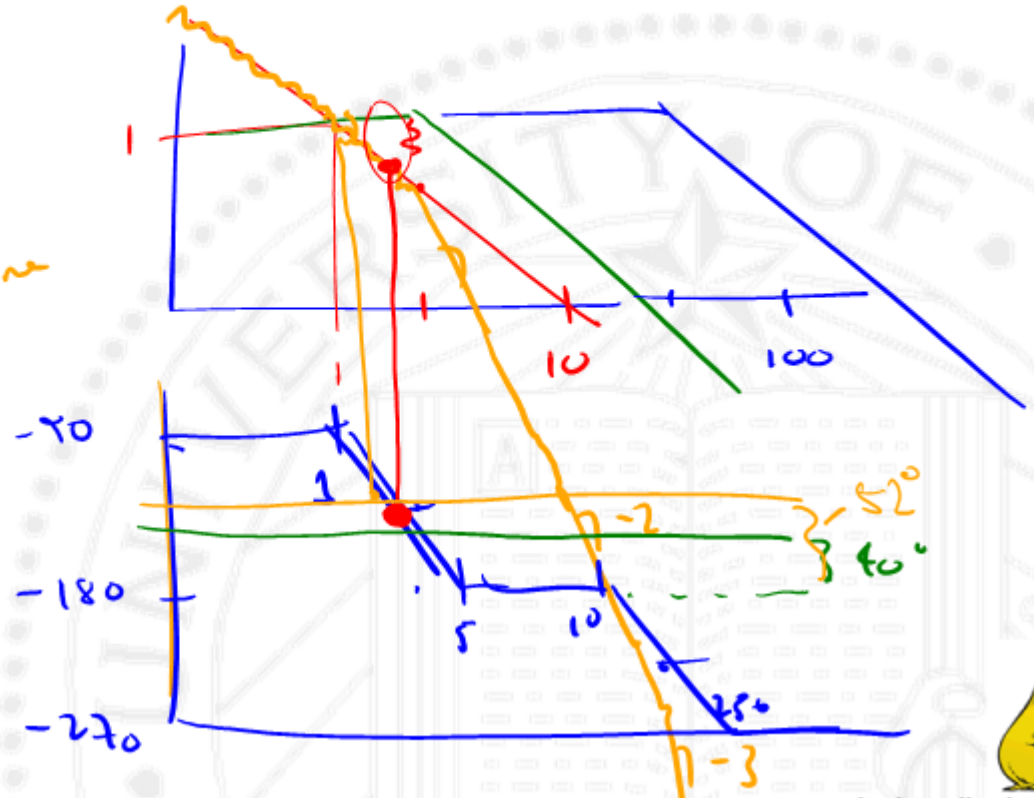
K, ω_c

$\omega = 1.3$ rad/sec

@ 52° pm

$\omega_c = 30$

$\frac{s+30a}{s+a}$



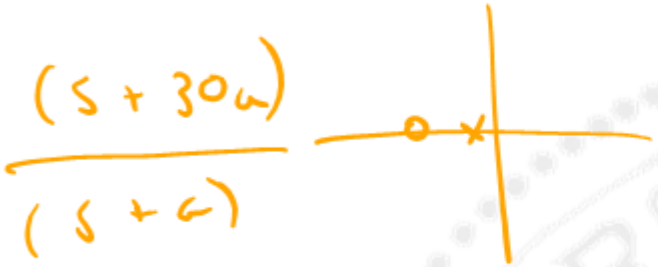
$\varepsilon_{ss} \Rightarrow$ FVT — $\varepsilon_{ss}(\infty) = \lim_{s \to 0} s \left(\frac{1}{R}\right) R(s)$

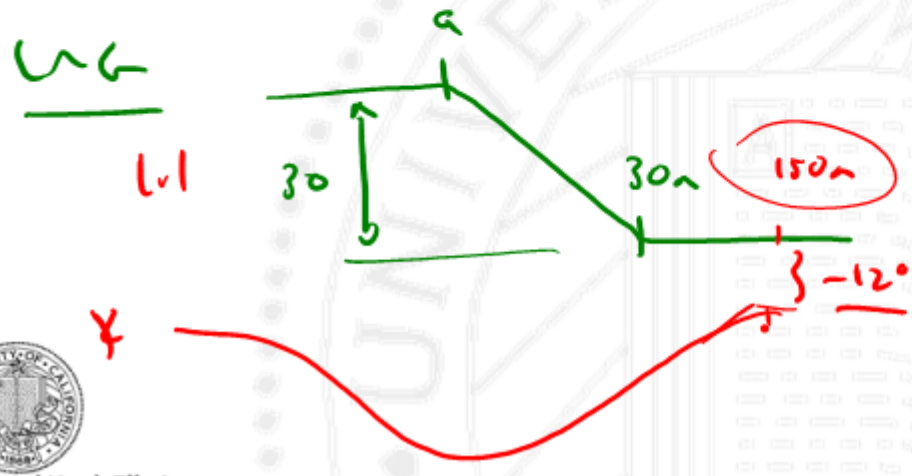
$\frac{1}{s^2}$

$\frac{(s + 30\omega)}{(s + \omega)}$

$\frac{1}{1 + GK}$

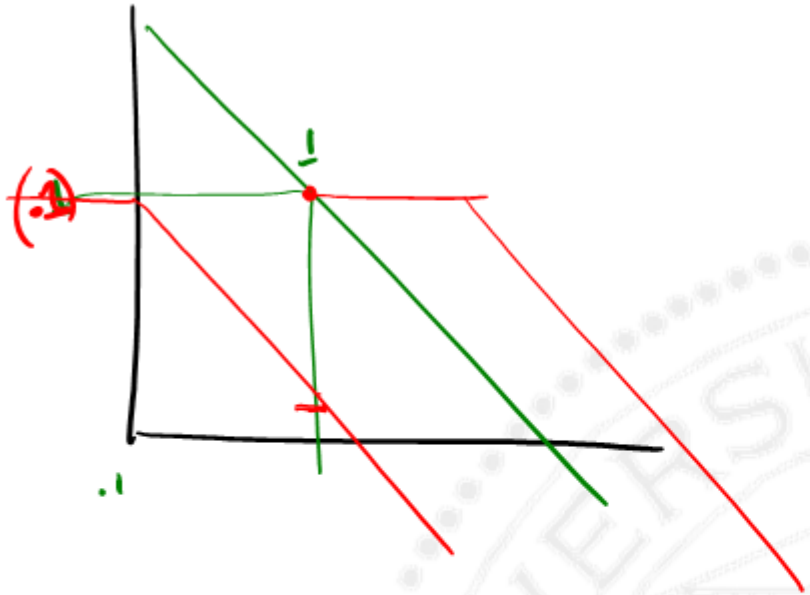
$P(K)$

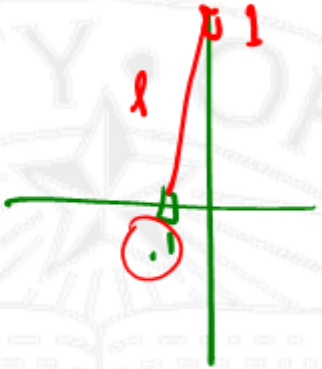




$150a = 1.3$

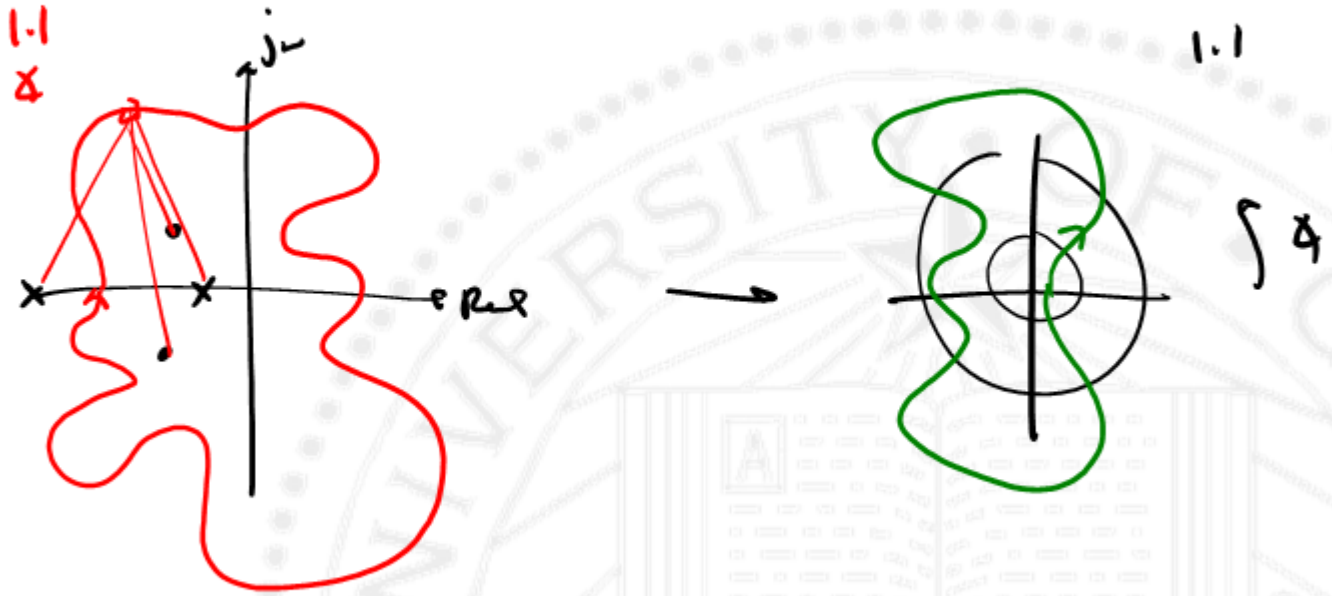
$\therefore a = \frac{1.3}{150}$

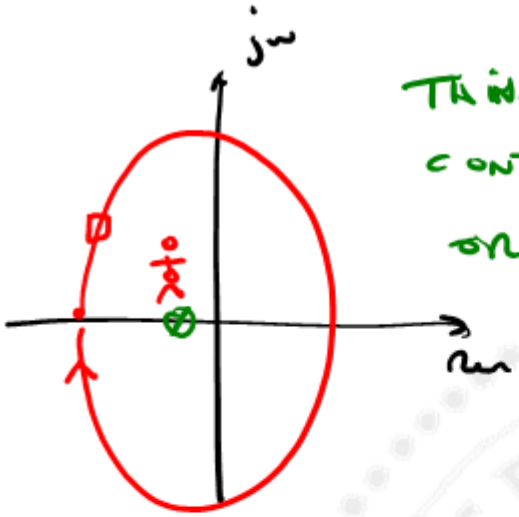




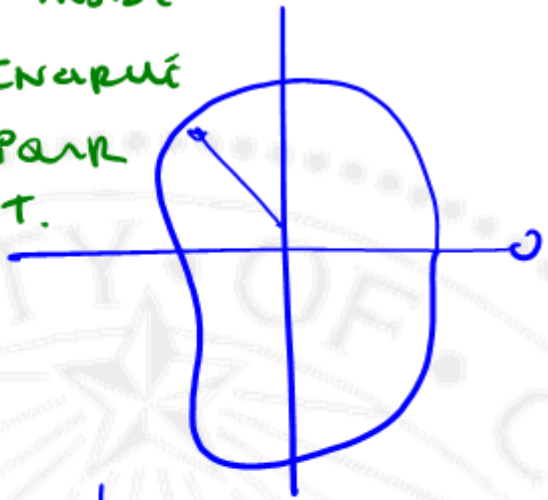
Nyquist

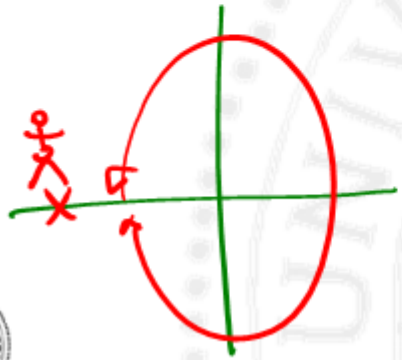
Cauchy's Principle of the Argument





THINGS (Y,0) INSIDE CONTOUR → ENCIRCLE ORIGIN IN POLAR PLOT.



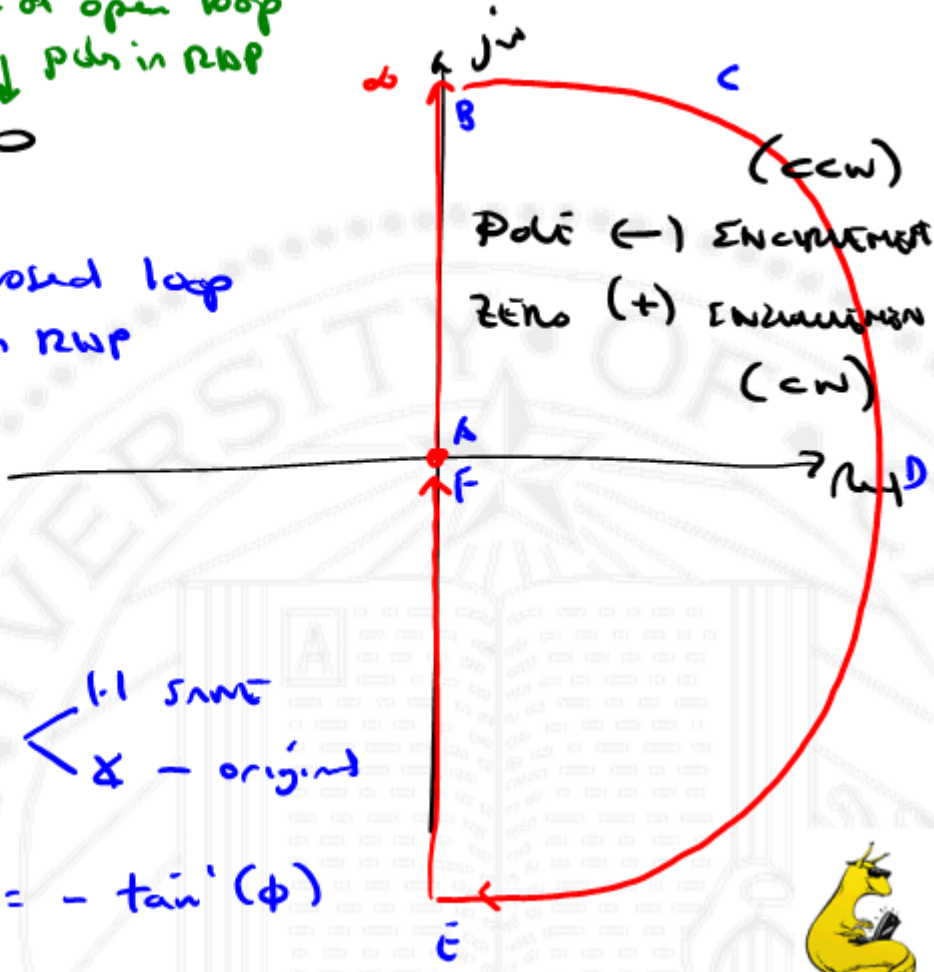


NYQUIST

of open loop poles in RHP

$$N = Z - P$$

# of closed loop poles in RHP



A → B "BODE"

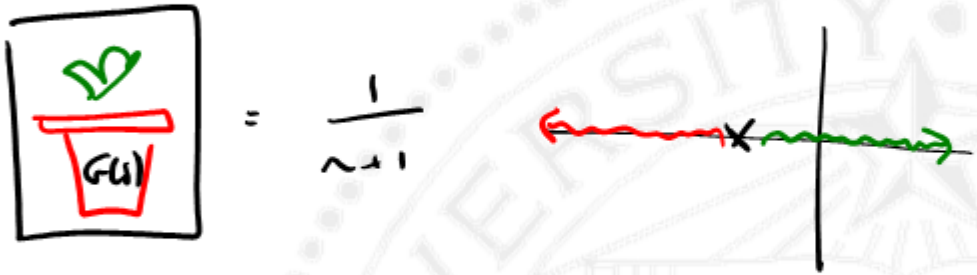
C, D, E → @ ∞.

E → F → BODE < 1:1 same
α − original

$$\tan^{-1}(-\phi) = -\tan^{-1}(\phi)$$

$$\frac{Y}{R} = \frac{GK}{1+GK} = \phi \quad \text{closed loop poles} \quad \therefore \quad GK = -1$$

$$1 + K\frac{N}{D} = 0 \quad \therefore \quad D + KN = \phi .$$

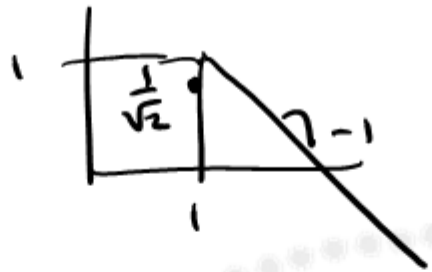


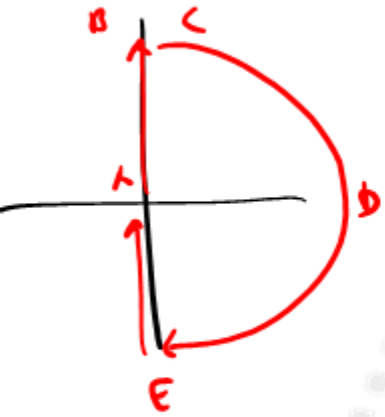
open loop poles

$$Z = N + P$$

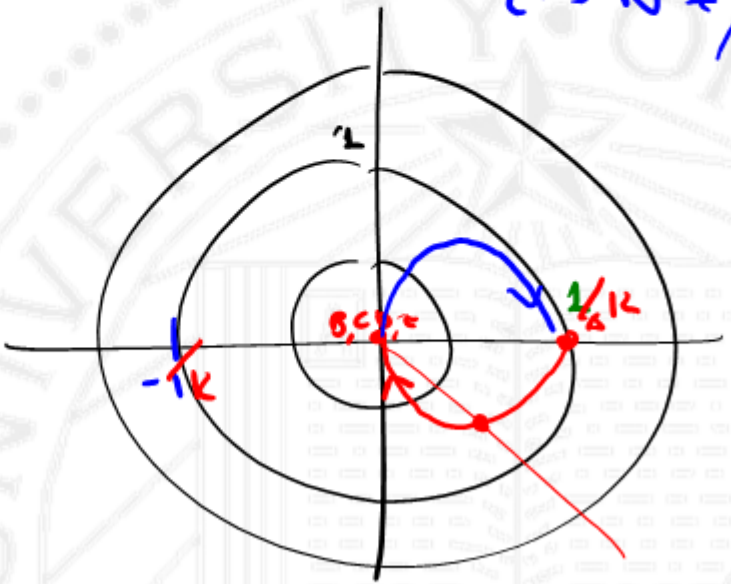
Z = # of CW encirclements

$\frac{K}{s+1}$ BODE

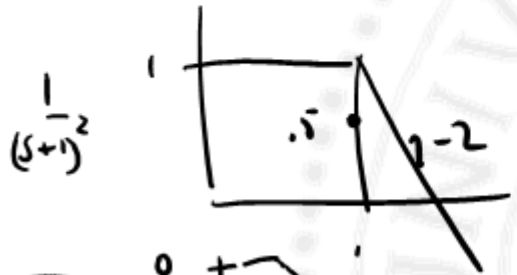


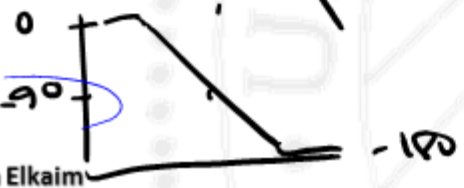


$Z = N + P$

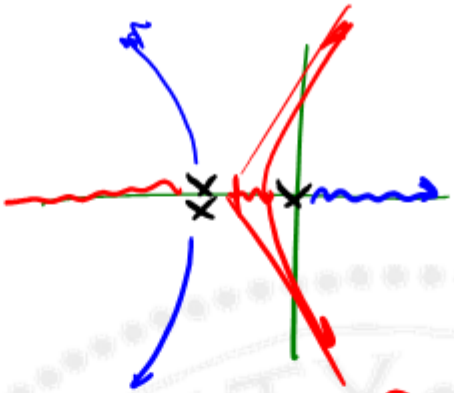


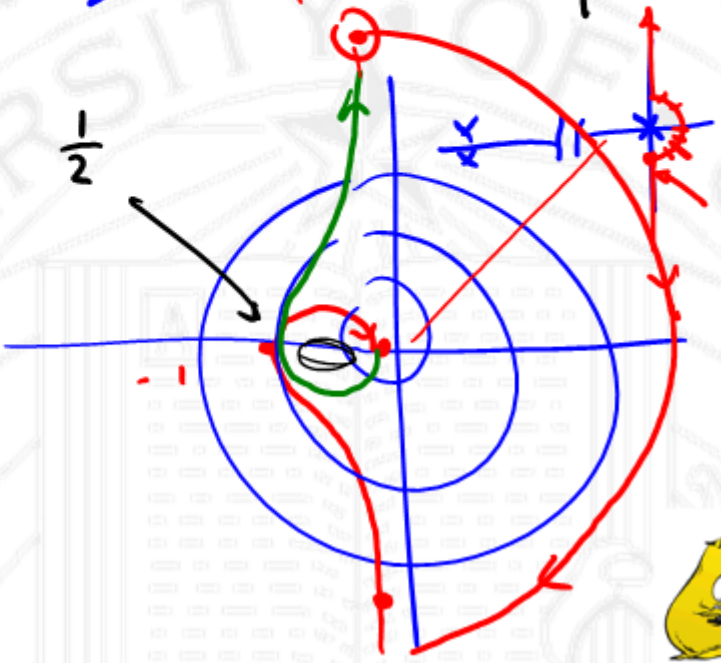
$$KG = \frac{K_0}{s(s+1)^2}$$

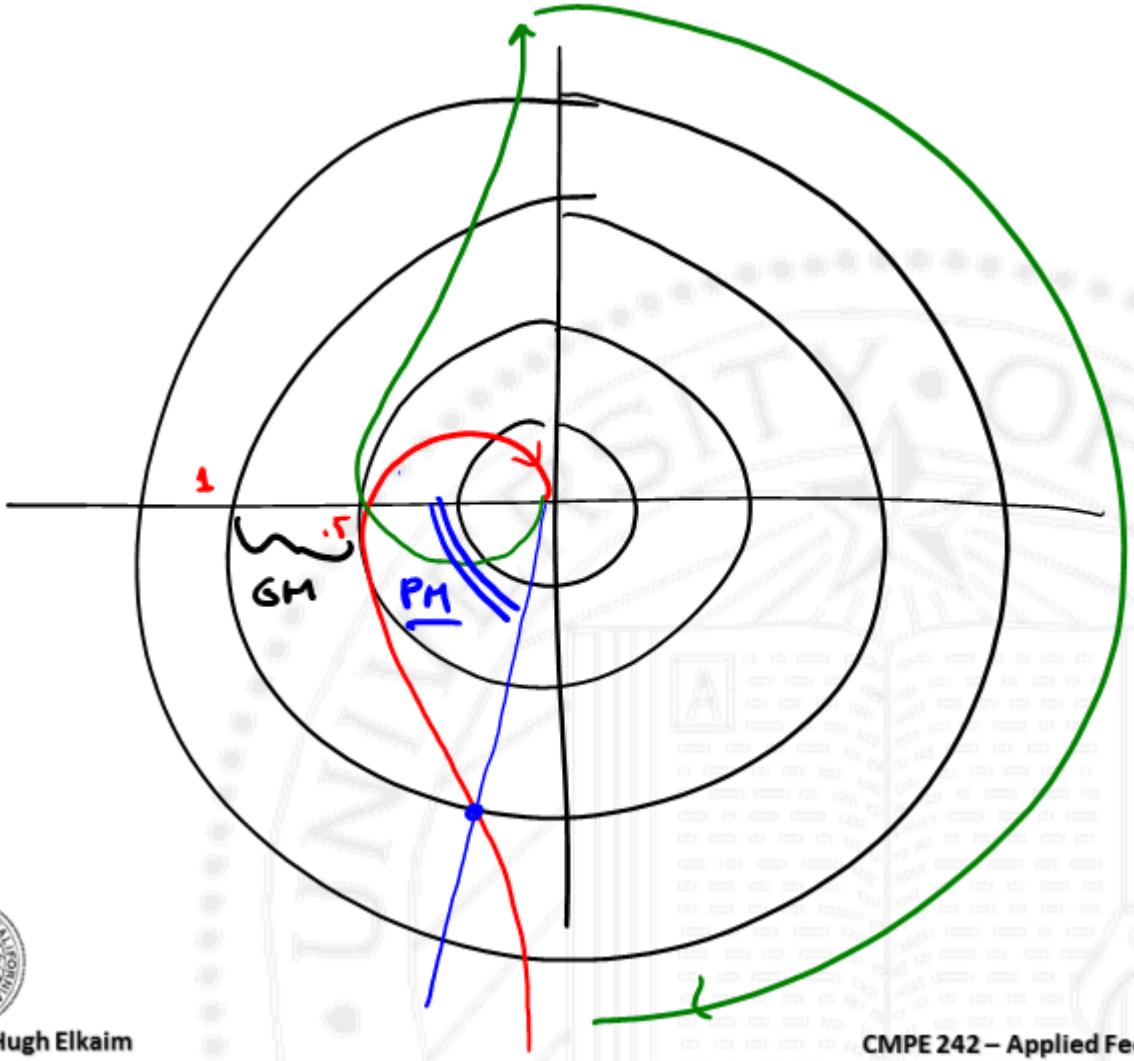


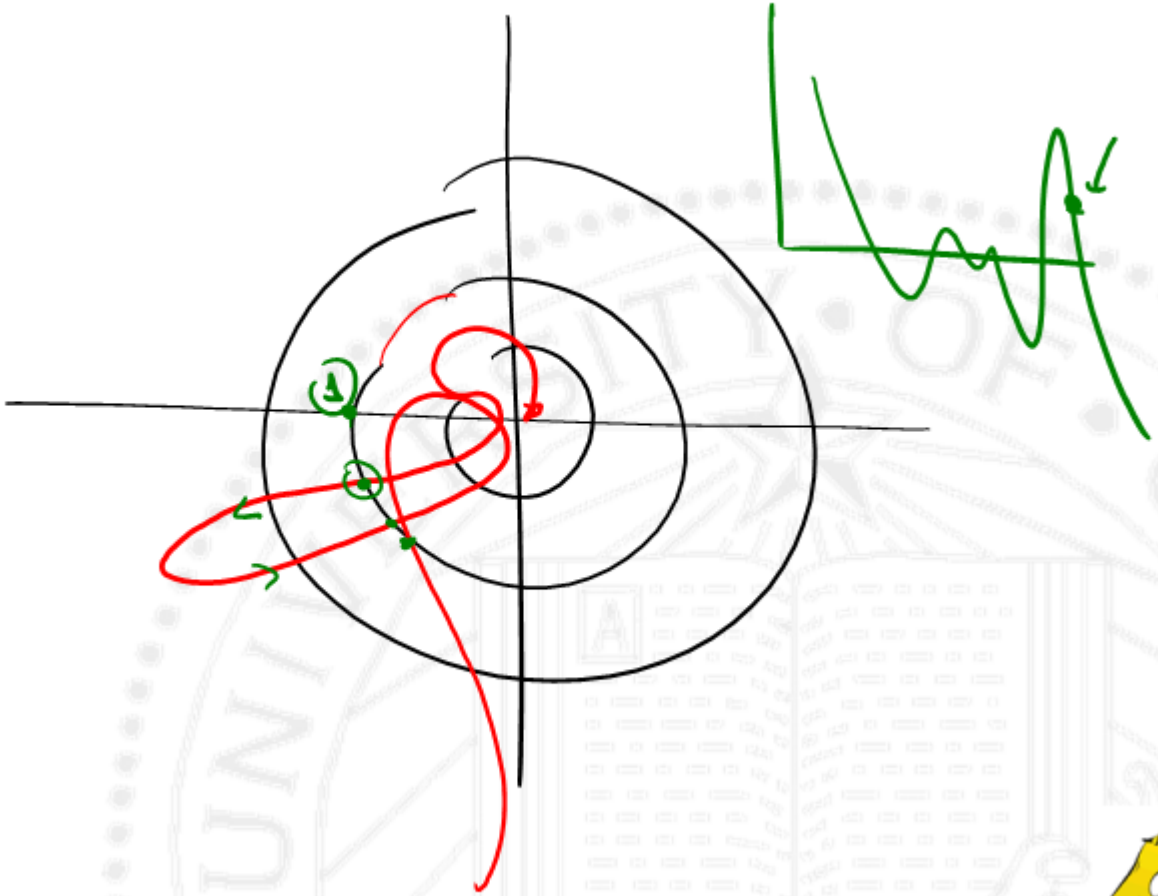


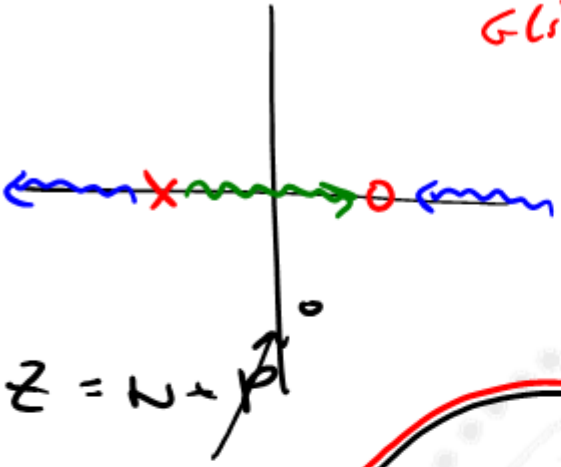
$K > 2$



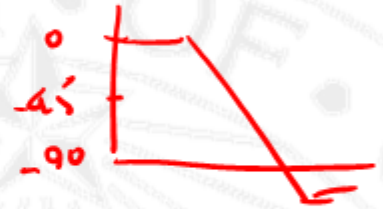



1
GM
PM

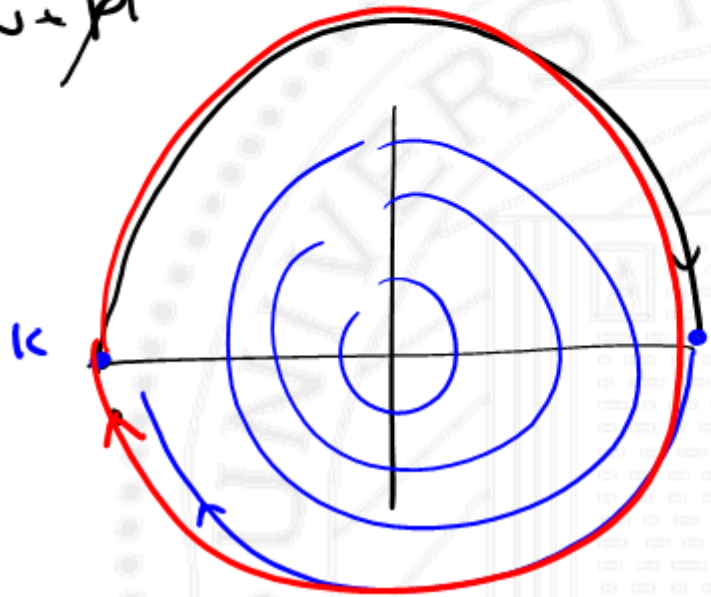




$G(s) = \frac{s-a}{s+a}$



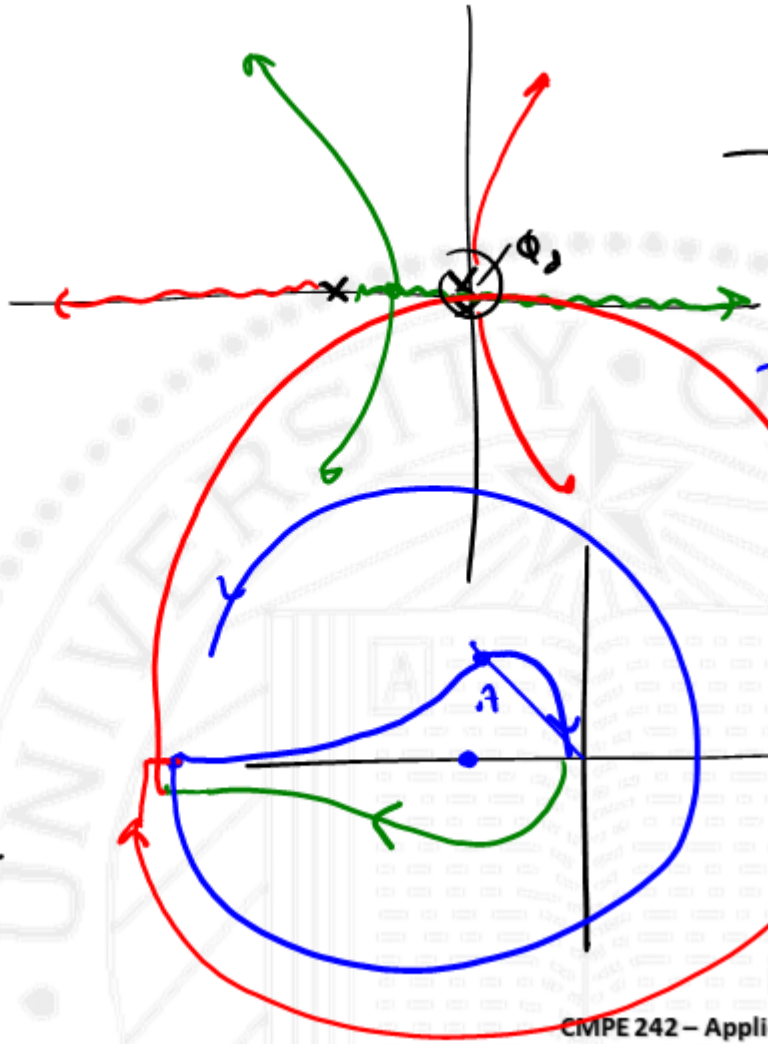
$z = x + jy$



$|HK| < 1$

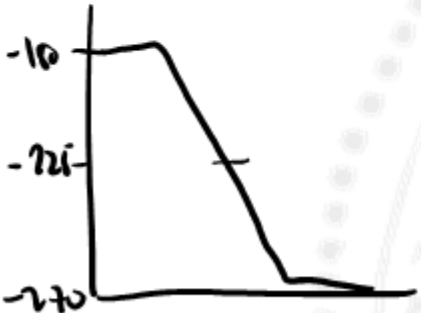
system is stable

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



$Z = N + P$

0 1 2



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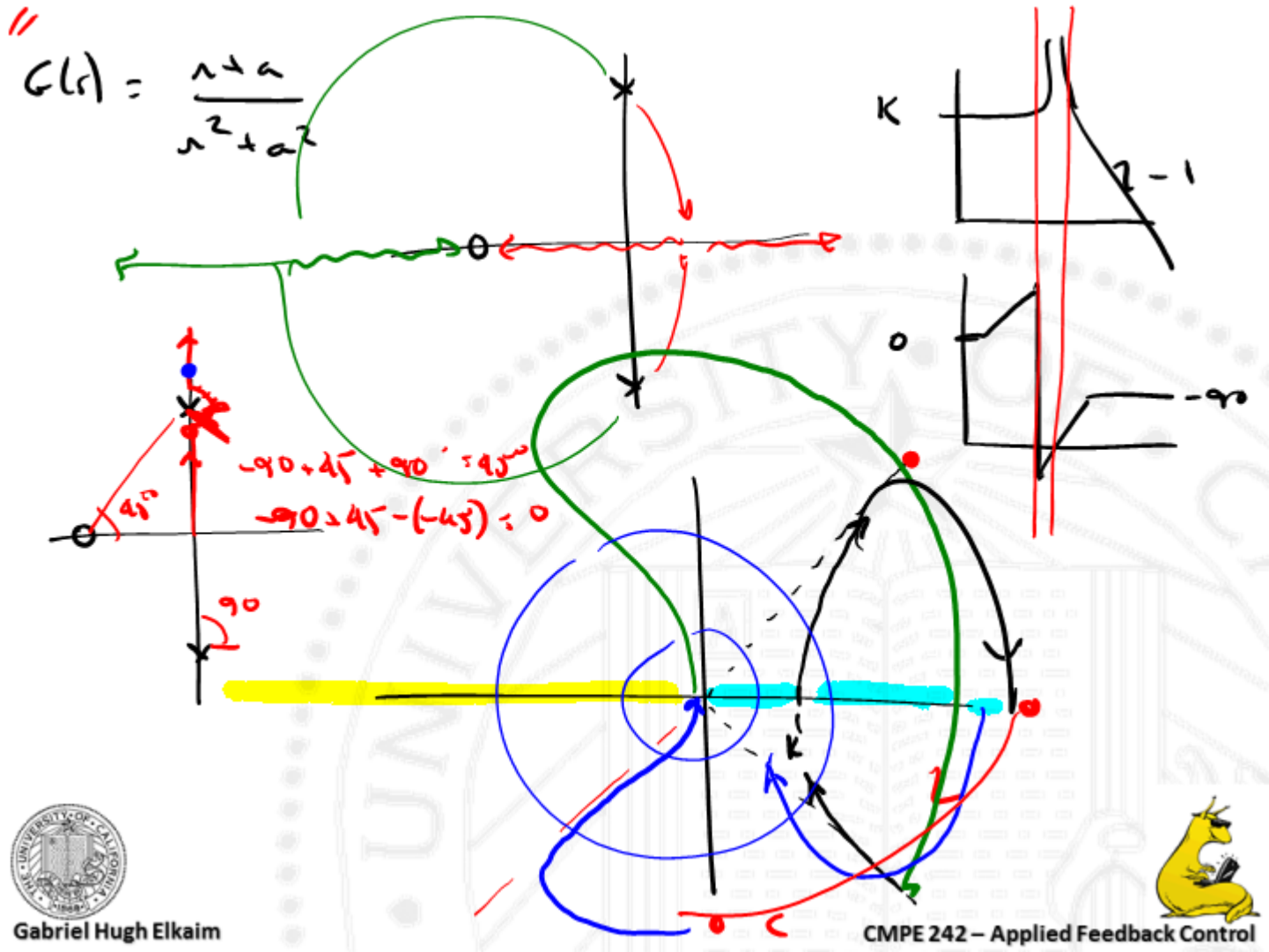
G(s) = (s+a) / (s^2+a^2)
K
z = -1
0
-90
-90+45+90 = 45°
-90+45-(-45) = 0
45°
90
K
0