CMPE-242
Applied Feedback Control

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Winter 2016

Midterm – end of next week ~ Feb. 19th

↑ ↑ ↑

3 hour take home

Formula sheet

$$\frac{s+3}{s(s+2)^2}$$

sys = tf([1 3], conv([1 0], conv([1 2],[1 2])))

abs( ) ||

angle( ) ∠

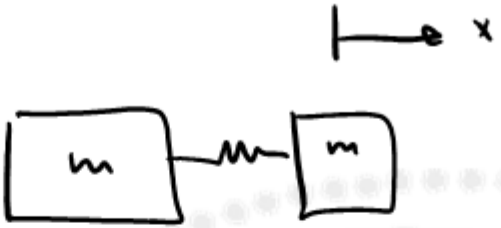
evalfr(sys, w) → G(jw)

p2map

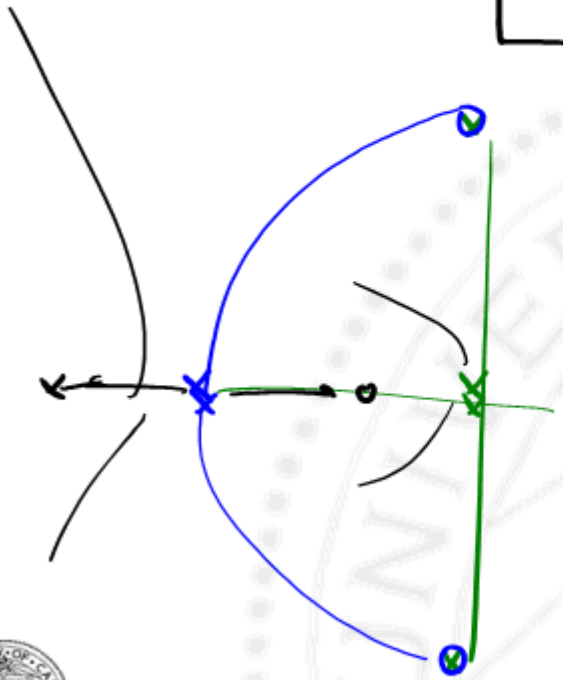
damp – wn]

$$\frac{s+3}{s^3 + \ldots}$$

#3, 4, 5



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



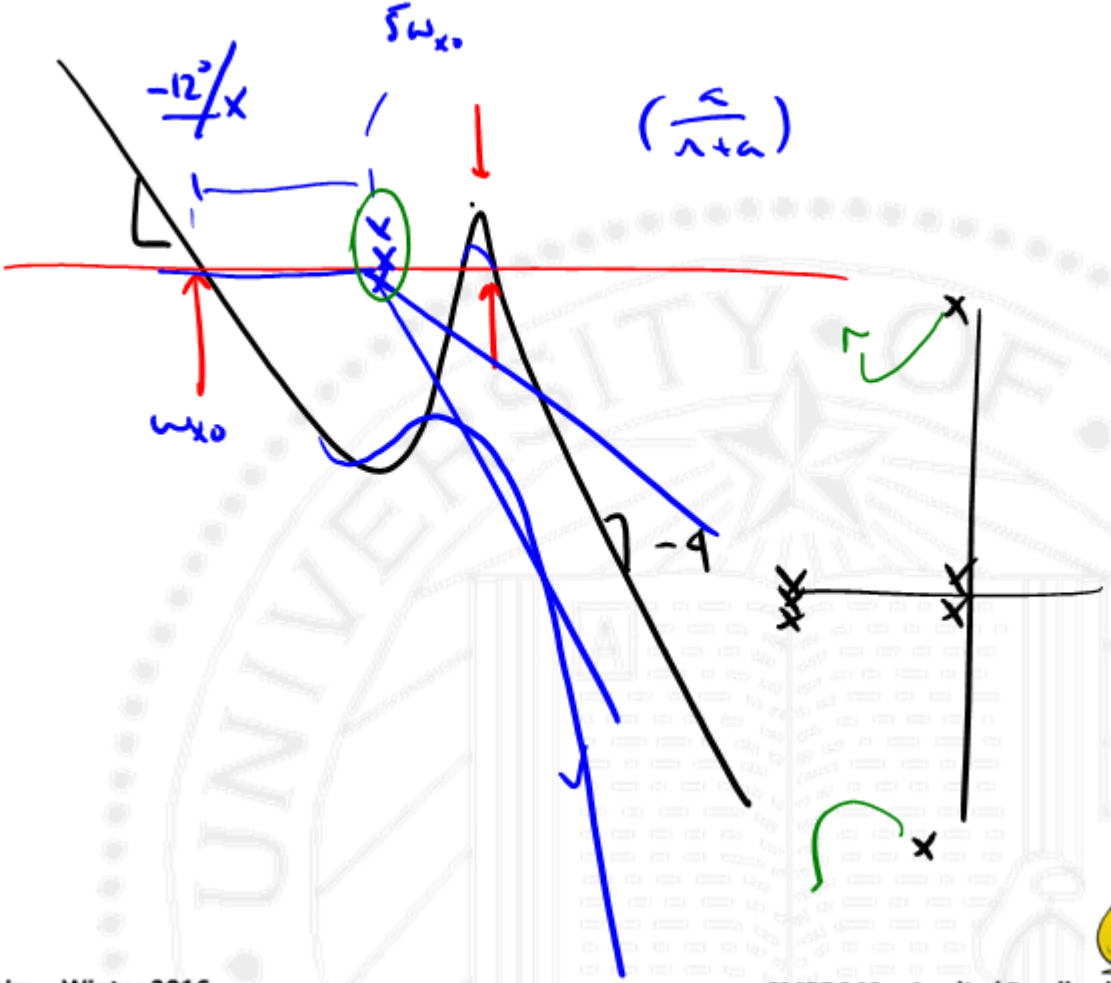
Part 3

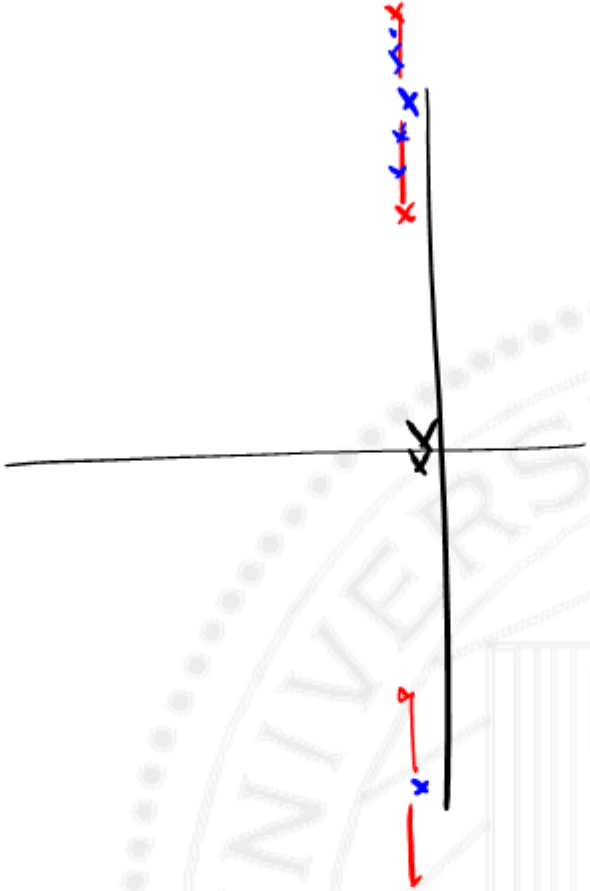
$\left|\frac{GK}{1+GK}\right|$ → Feedback

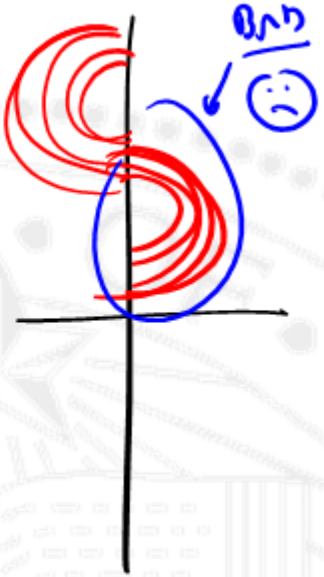
Feedback (K*G, 1)

step (G,1)

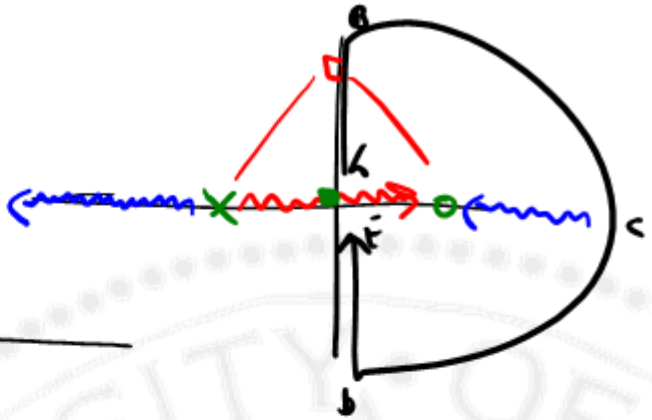
#9

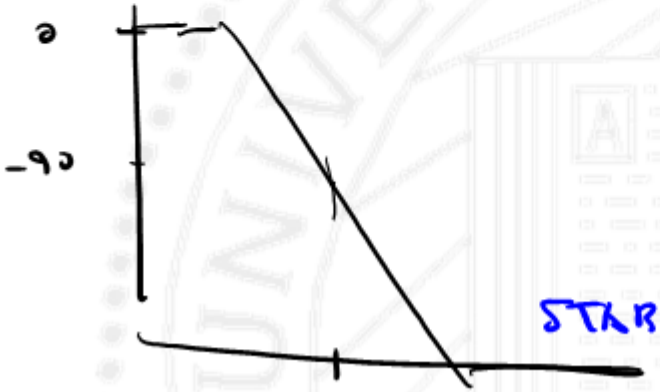


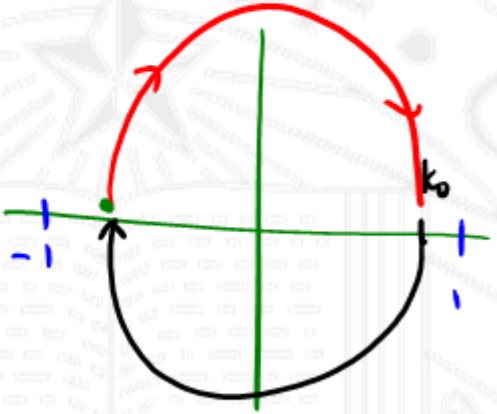



BAD

$K_0 \frac{s-a}{s+a}$

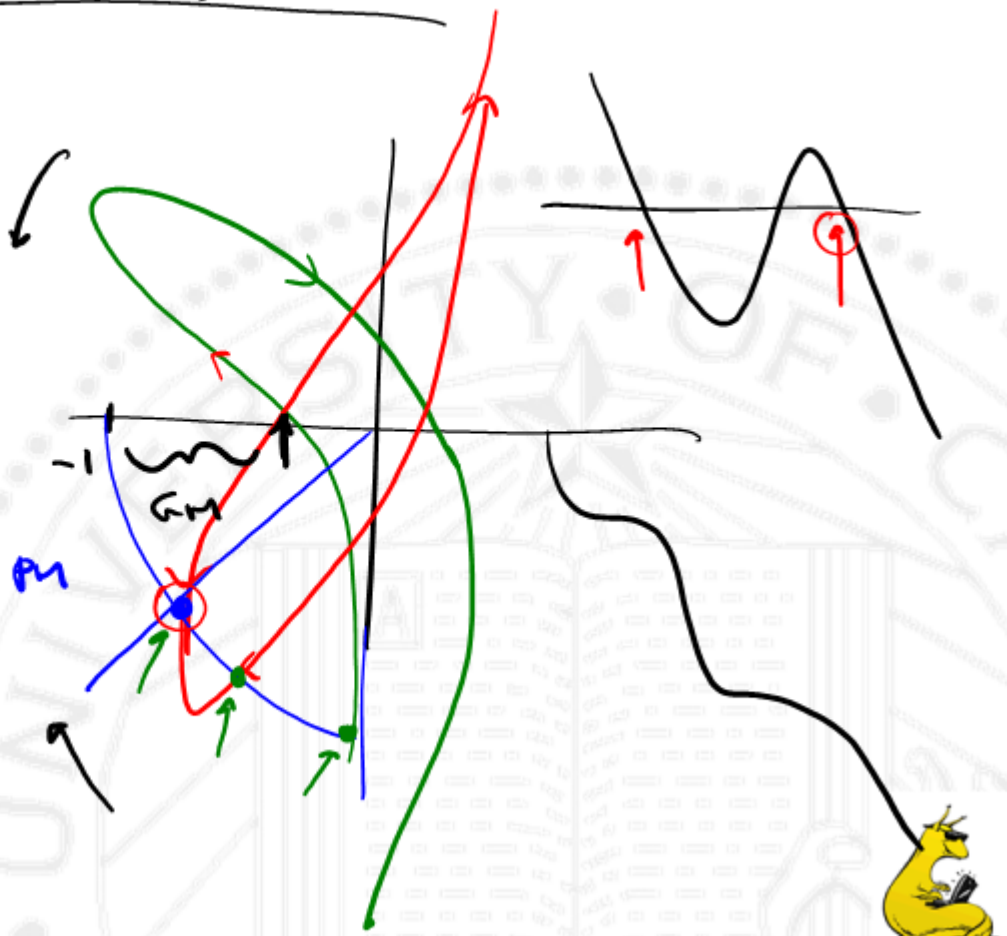


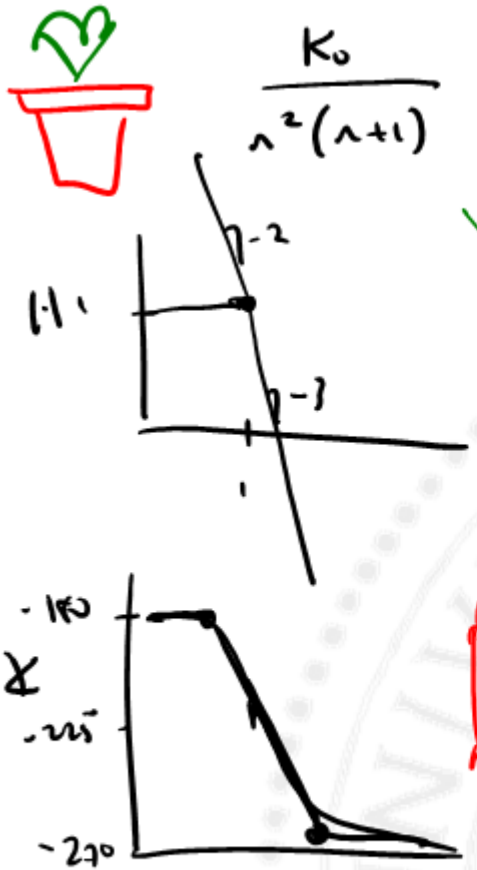


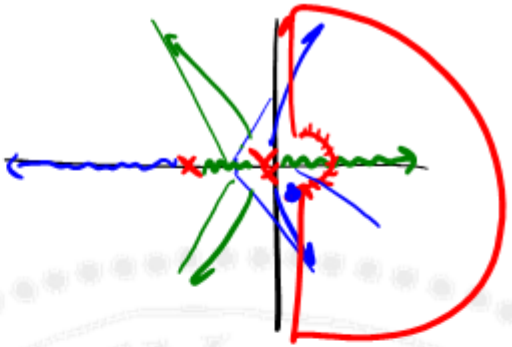


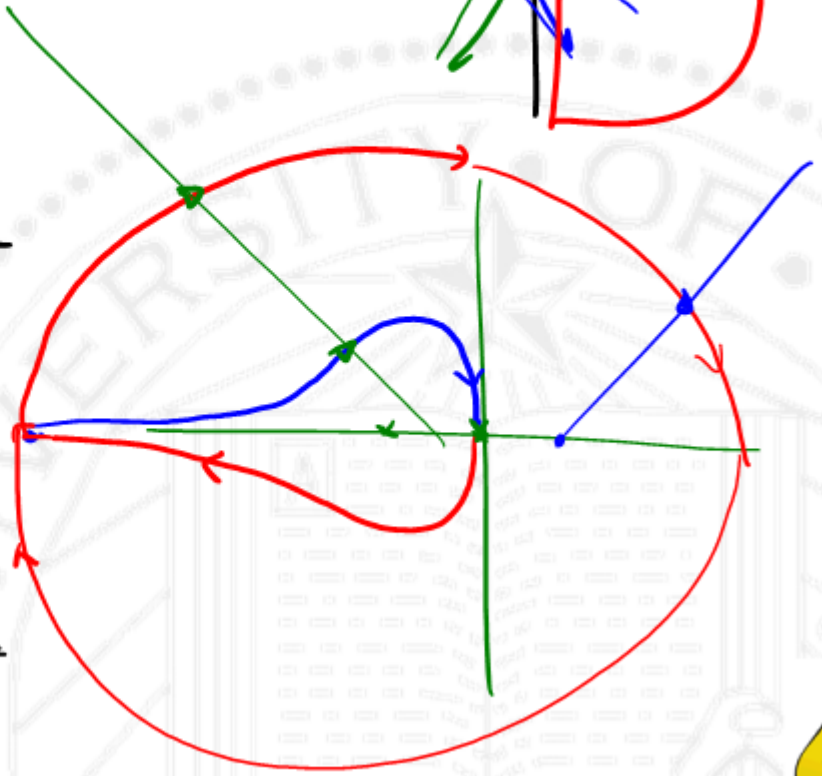
STABLE $\forall |K| < 1$..

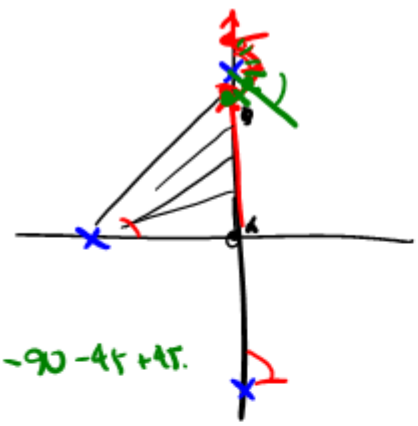
Gain Margin & Phase Margin

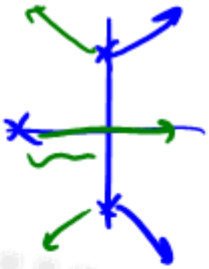



$\frac{K_0}{s^2(s+1)}$
-2
-1
1
-180
-225
-270





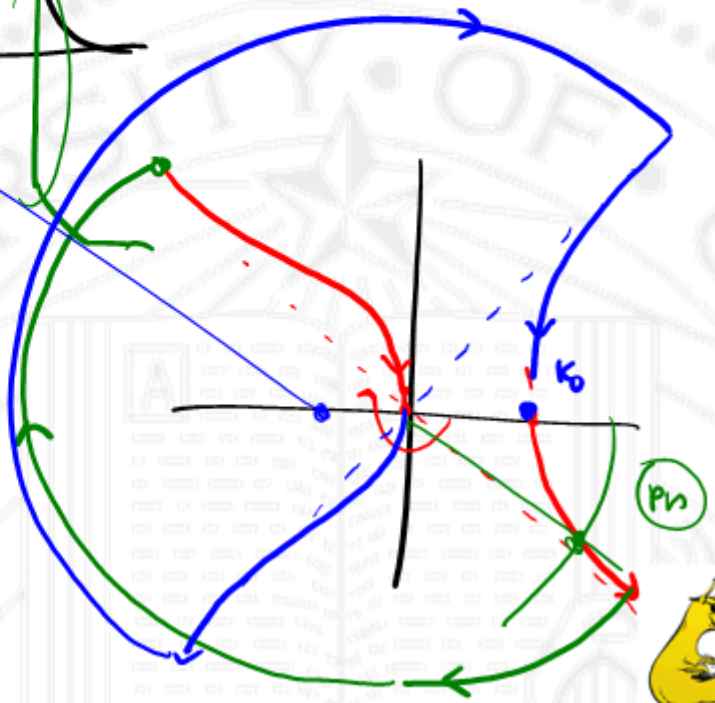


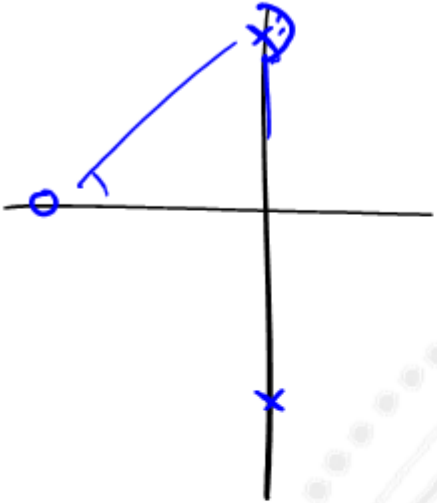


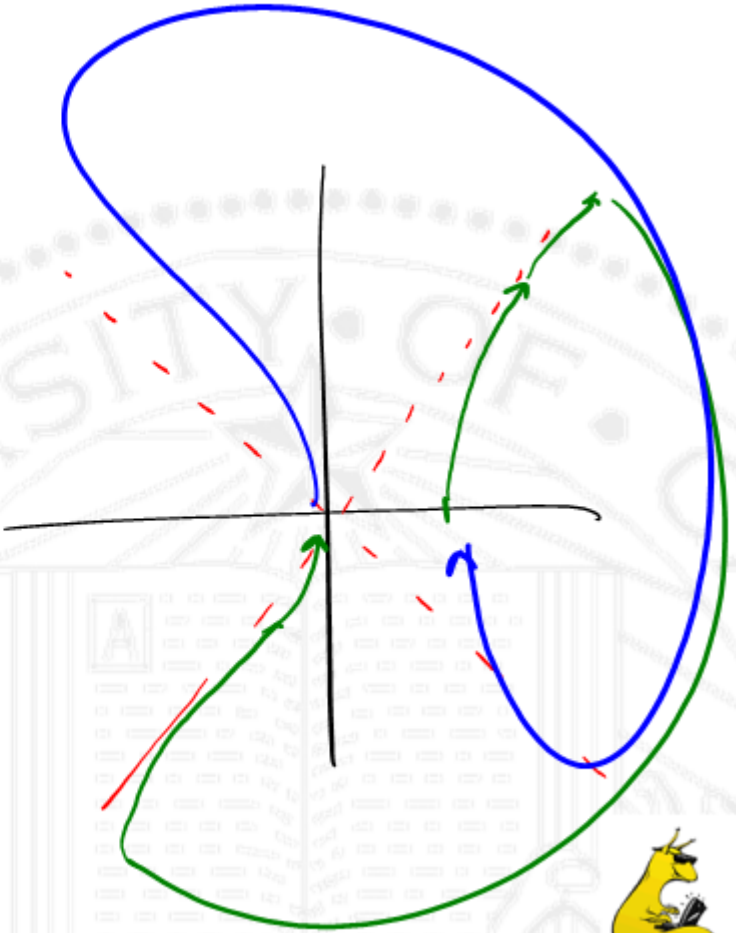
-225

-270

$\frac{1}{k}$



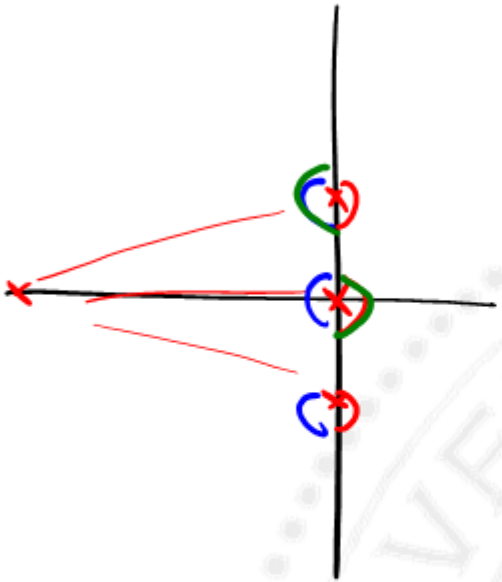


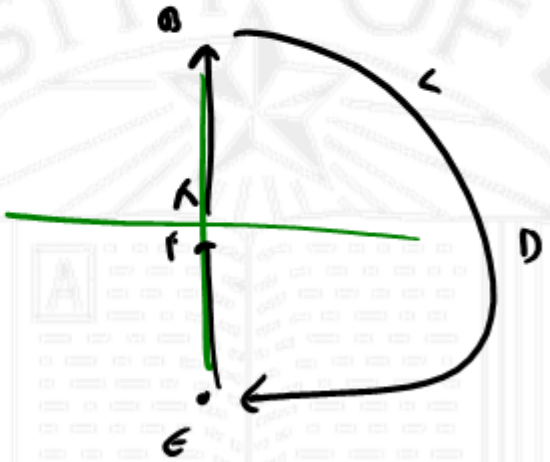


$Z = N + P$

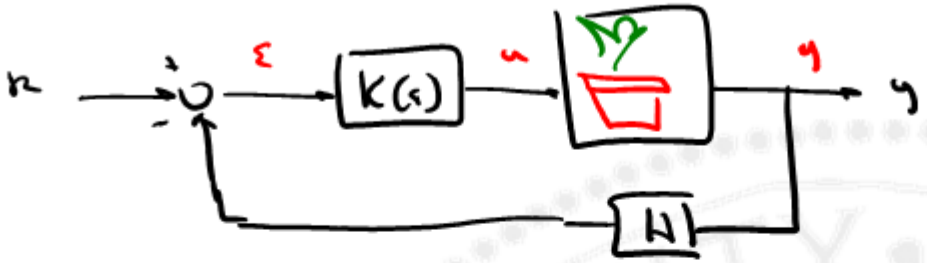
$P = 0$

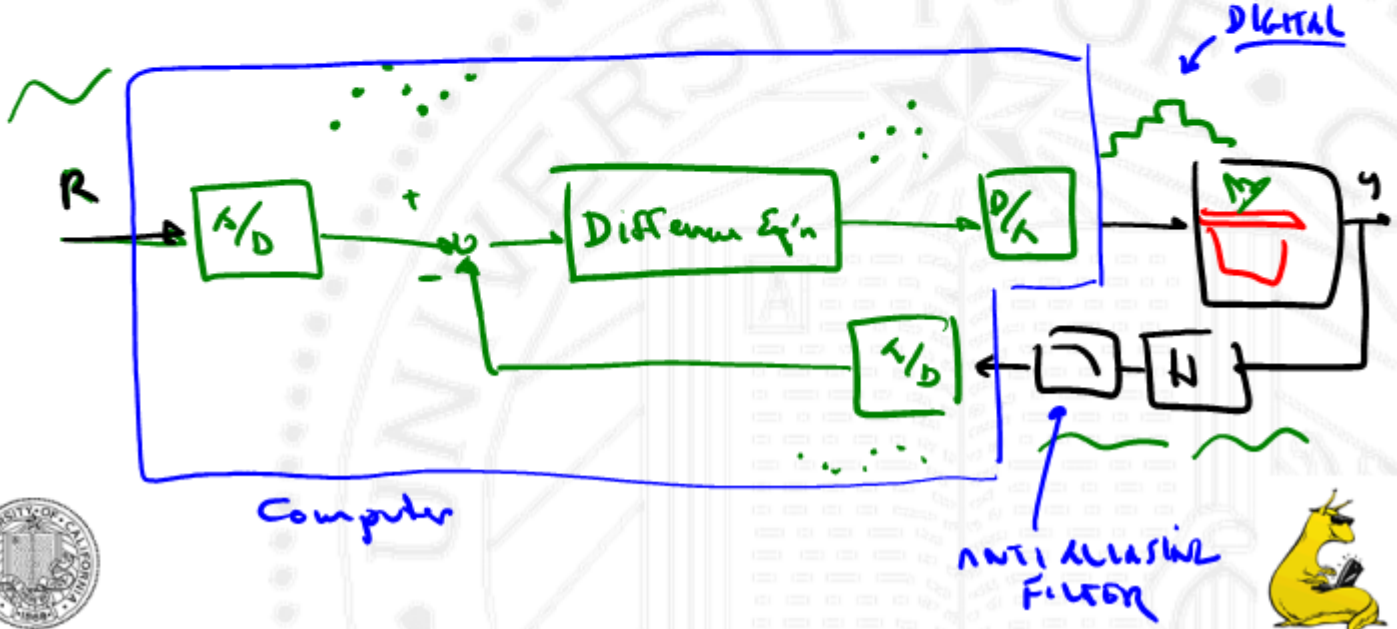
$P = 3$

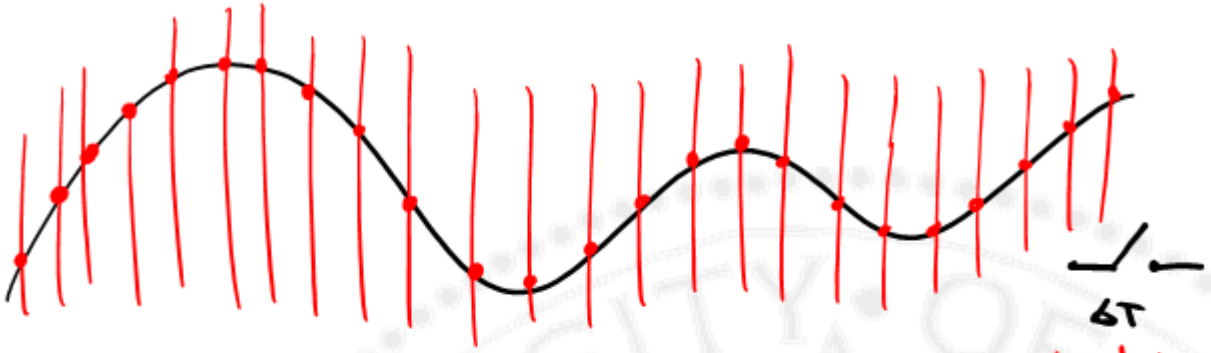


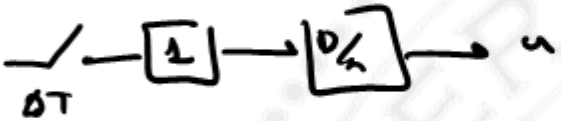


DIGITAL CONTROL — FPN ch. 8



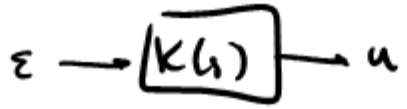






ZOH – zero order hold

$$K(s) = \frac{K}{s+a}$$



$$\frac{u}{\varepsilon} = \frac{K}{s+a} \qquad u(s+a) = K\varepsilon$$

$$\dot{u} + au = K\varepsilon$$

$$\frac{u_k - u_{k-1}}{\Delta T} + a u_k = K\varepsilon_k$$

$$u_k - u_{k-1} + a\Delta T u_k = K\Delta T \varepsilon_k$$

$$[1 + a\Delta T] u_k = K\Delta T \varepsilon_k + u_{k-1}$$

$$u_k = \left[\frac{K\Delta T}{1 + a\Delta T}\right]\varepsilon_k + \left[\frac{1}{1 + a\Delta T}\right] u_{k-1}$$

Init $u_{k-1} = \phi$

Read R_k

Read Y_k

Form $\varepsilon_k = R_k - Y_k$

$$u_k = \frac{1}{1+a\Delta T} \cdot u_{k-1} + \frac{k\Delta T}{1+a\Delta T}\varepsilon_k \quad \text{(calc)}$$

with u_k

$u_{k-1} = u_k$

Why go digital?

(1) Easy to change (NOT)

(2) Logic — "if-then-else"

(3) Non-linearity

(4) Cheap – already have μcontroller (if you do not account for debugging time)

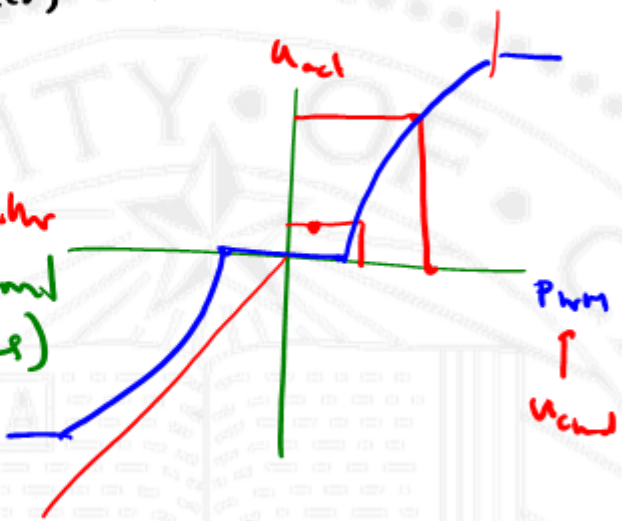
(5) Reproducible

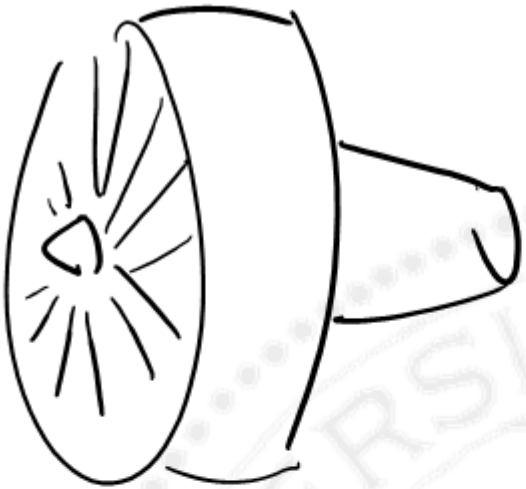
(6) Adaptable

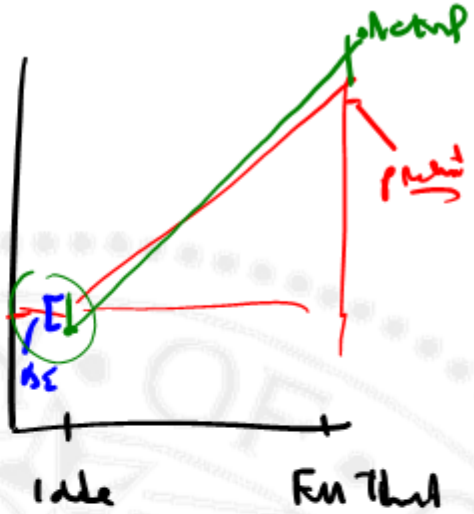
(7) Performance/Speed (not in)

DOES NOT DRIFT IN TIME/TEMP.

$K(s) \sim 10^{6}$






Idle
Full Thrust