03 -- Thu Apr 16

AA ECE ME 548: Linear Multivariable Control

Prof Burden TA Tinu Spring 2020

if/when possible: keep video on; unmute to ask Q's

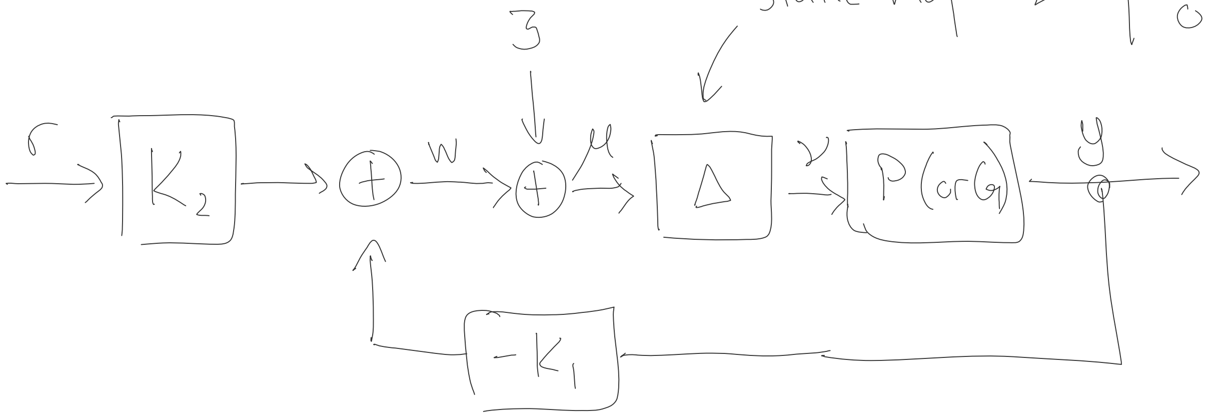
→ add headshot photo to Zoom profile; set preferred name at identity.uw.edu

today:

- ☑ ~10 min breakout to discuss
- ☑ HW 1 solution & self-assessment → due Sun Apr 19
- ☑ HW 2 Q's → due Fri Apr 17
- ☑ lec 3 Q's on optimization, dynamic programing, LQ regulation
- ☐ Prof OH

HW 2 p2 (d, e)

static map $\nu = \begin{bmatrix} 1+\delta & 0 \\ 0 & 1-\delta \end{bmatrix} \mu$



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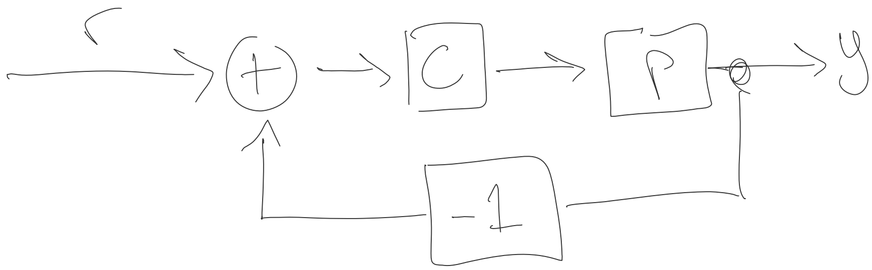
why is $-1 \in \mathbb{C}$ such a scary point?



$$T_{yr} = \underbrace{(I + PC)^{-1}}_{\text{only makes sense if } \det(I+PC) \neq 0} PC \quad \text{i.e.} \quad y = (I+PC)^{-1} PC\, r$$

in SISO case: $T_{yr} = \frac{PC}{1+PC}$, so need $1 + PC \neq 0$

i.e. $PC \neq -1$

* what is $s_m = d(\Omega, -1) = \min_{\omega} |-1 - L(j\omega)|$ measuring

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- suppose now we are given DT DE $x^+ = f(x,u)$, $x \in \mathbb{R}^d$, $u \in \mathbb{R}^m$ and we wish to choose inputs over time $u : [0,t] \to \mathbb{R}^m$ to minimize

$$c(\underbrace{x,u}_{\substack{x : [0,t] \to \mathbb{R}^d \\ u : [0,t] \to \mathbb{R}^m}}) = \underbrace{\ell(t, x(t))}_{\text{"final" cost}} + \sum_{\tau=0}^{t-1} \underbrace{\mathcal{L}(\tau, x(\tau), u(\tau))}_{\text{"running" cost}}$$

<u>idea</u>: the optimal control $u(\tau)$ to apply at time τ depends only on $x(\tau)$ — not on previous states/inputs

- letting $v^*_\tau(x(\tau))$ denote lowest (i.e. optimal) cost achievable from state $x(\tau) \in \mathbb{R}^d$ at time τ,

$$\underbrace{V^*_\tau(x(\tau))}_{\text{"value" of } x(\tau)} = \min_{u(\tau)\in\mathbb{R}^m} \left[\mathcal{L}(\tau, x(\tau), u(\tau)) + V^*_{\tau+1}(\underbrace{x(\tau+1)}_{=f(x(\tau),\, u(\tau))}) \right]$$