03 -- Tue Apr 7

AA/ECE/ME 548: Linear Multivariable Control

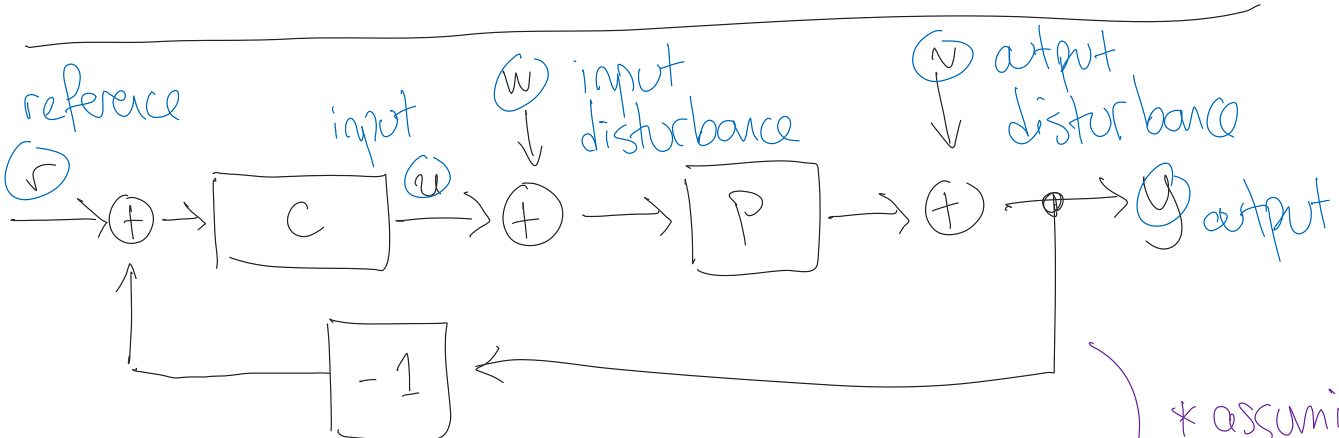
Prof Burden TA Tinu Spring 2020

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

* update Zoom profile with your preferred name

today:

- ☑ TA OH 11a Thu & 12:30p Fri
- ☑ HW0 solution & self-assessment
- ☑ HW1 overview & Q's
- ☑ MIMO systems
- ☑ Prof OH → HW0

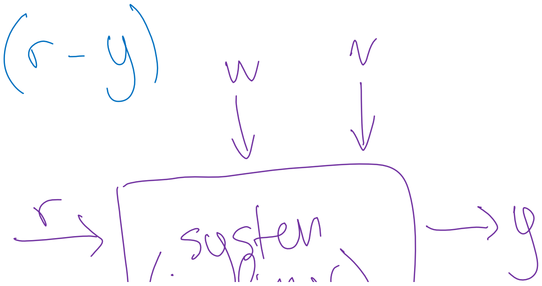


* assuming all transformations are linear

→ determine T_{yr}, T_{yw}, T_{yv}

– $y = v + P(w+u) = v + Pw + PC(r-y)$

$\iff \underbrace{y + PCy} = v + Pw + PCr$



$\iff y + PCy$

$$\underbrace{(I+PC)}_{\text{* assume nonsingular, i.e. invertible}} y = v + Pw + PCr$$

$r \rightarrow \boxed{\text{system (is linear)}} \rightarrow y$

$$\iff y = \underbrace{(I+PC)^{-1}}_{T_{yv}} v + \underbrace{(I+PC)^{-1}P}_{T_{yw}} w + \underbrace{(I+PC)^{-1}PC}_{T_{yr}} r$$

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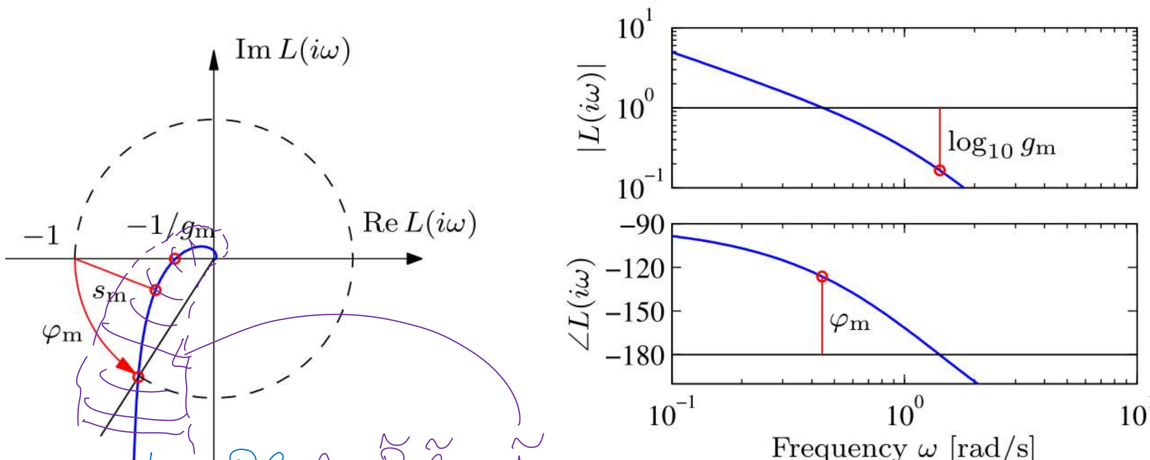
ex: $m\ell^2\ddot{q} + mg\sin q = u - b\dot{q}\,.$

$$x = \begin{bmatrix} q \\ \dot{q} \end{bmatrix} \Rightarrow \dot{x} = \begin{bmatrix} \dot{q} \\ \ddot{q}(q,\dot{q},u) \end{bmatrix} = f(q,\dot{q},u)$$

equilibrium: $= 0 \iff \dot{q} = 0$ and $\ddot{q} = 0$

(dynamic eq: $\ddot{q} = 0$)



$L = PC \simeq \tilde{P}\tilde{C} = \tilde{L}$

Q: how to use s_m in practice?

A: $\|\tilde{L}(j\omega) - L(j\omega)\| < s_m$ guarantees stability

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Q: what does "robustness" mean in practice?

A: robustness quantifies how much performance changes or how close we get to instability when:

(i) external disturbance is applied

(ii) actual process / controller differs from nominal