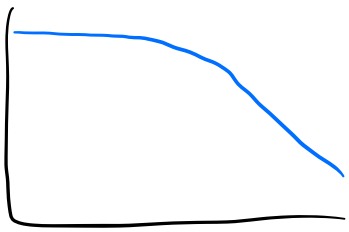
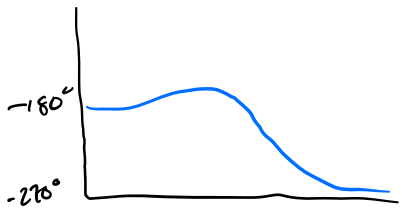
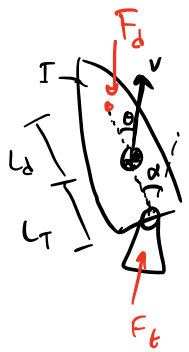
$\Delta_{OL}(s) = (s+\omega_\alpha)(Is^2+bs-F_d L_d)$





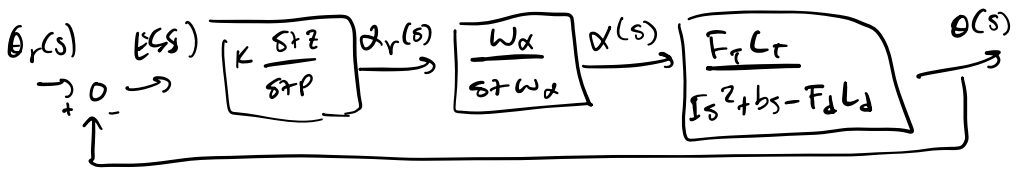
Ex. design lead to control θ

Require: PM 70°, GM 10dB $\omega_{BW} > 4$ r/s



Attitude: $\frac{\theta(s)}{\alpha(s)} = \frac{F_T L_T}{Is^2+bs-F_d L_d}$

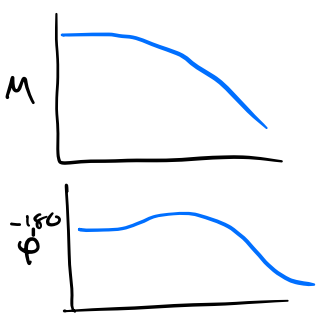
Thrust angle: $\frac{\alpha(s)}{\alpha_R(s)} = \frac{\omega_\alpha}{s+\omega_\alpha}$



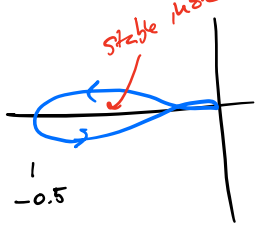
$\Delta_{OL}(s) = (s+\omega_\alpha)(Is^2+bs-F_d L_d)$

$s = -\omega_\alpha$ $\quad s = \frac{1}{2}(-b \pm$

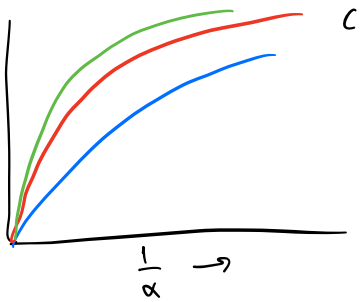
stable mode → Need $K > 2$, $K < 10$



Nyquist:



Want PM = 70° @ wbes → Need 90°



cascaded leads

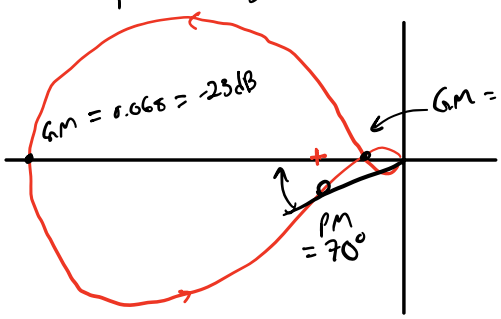
→ adds more poles, can add weird higher order behavior

– want double lead: Design 45° lead

→ Find gain s.t $K \cdot lead \cdot lead = 1$ @ ω_c

$= K\left(\frac{s+z}{s+p}\right)^2$ $\quad \varphi_{req} = 45°$ $\quad \omega_c = 4$ r/s $\rightarrow 1025\left(\frac{s+1.65}{s+9.7}\right)^2$

→ keep using nyquist (bode not quite right)



→ can also see w/ root locus