

Lead-lag of PID - Speed, BW, & SS Error

Example:  $\phi_m > 50^\circ$ ,  $GM > 10 \text{ dB}$ ,  $t_r < 1.0 \text{ s}$ ,  $e_{ss} < 0.1$  from step

- Lead comp:  $\phi_{\max} = 48^\circ$ ,  $\omega_{\max} = \omega_{c, \text{des}} = 3 \text{ rad/s}$

$$\alpha = \frac{1 - \sin \phi}{1 + \sin \phi} = 0.146 \rightarrow L/R \approx 6.8$$

$$p = \omega / \sqrt{\alpha} \approx 7.89$$

$$z = \omega \sqrt{\alpha} \approx 1.15$$

$$= \frac{p}{z}$$