for D_{in} free integrators in the plant dont matter thus

PD Type = 0

PID Type = 1

By Observation

$\boxed{F9}$ Longitudinal

PD type: 2 PID Type: 3

SSe Step: 0 SSe Step: 0 PD D_{in} Type:

SSe Ramp: 0 SSe Ramp: 0 PID D_{in} Type:

SSe Par: $\frac{M}{K_p}$ SSe Par: 0

$$M_a = \lim_{s \to 0} \cancel{s^2} \frac{K_p + sK_D}{\cancel{s^2} M} = \frac{K_p}{M}$$

Lateral inner

PD Type: 2 SSe Step: 0 SSe Ramp: 0 SSe Par: $\frac{K_p}{J}$

$$M_a = \cancel{s^2} \frac{1}{J\cancel{s^2}} (K_p + sK_D) = \frac{K_p}{J}$$ D_{in} Type: 0

Lateral outer

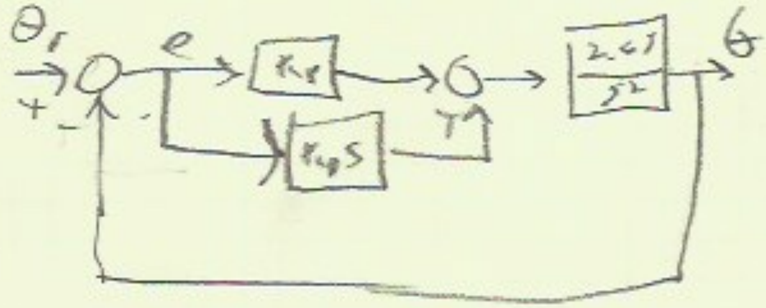
PD Type: 1 SSe Step: 0 SSe Ramp: $\frac{M}{F_c K_p}$ SSe Par: ∞

PID Type: 2 SSe Step: 0 SSe Ramp: 0 SSe Par: $\frac{M}{F_c K_i}$

D_{in}: PD Type: 0 PID Type: 1

$$M_v = \lim_{s \to 0} \cancel{s} \frac{F_e}{\cancel{s}(M + sM)} (K_p + sK_D) = \frac{F_c K_p}{M}$$

$$M_a = \lim_{s \to 0} \cancel{s^2} \frac{F_c}{\cancel{s}(M + sM)} \frac{(K_p s + s^2 K_D + K_i)}{\cancel{s}} = \frac{F_c K_i}{M}$$

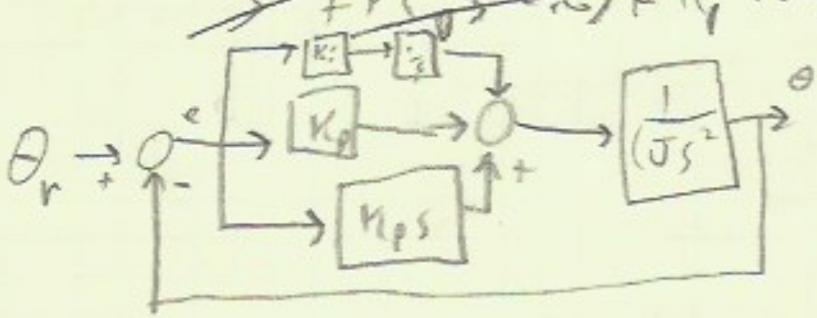


$$e(K_p + K_D s)\frac{2.65}{s^2} = \theta$$

$$(\theta_r - \theta)$$

$$\theta_r (K_p + K_D s)\, 2.65 = (s^2 + K_D s\, 2.65 + K_p 2.65)\theta$$

$$\theta = \frac{(K_p + \cancel{K_D s})\, 2.65}{\cancel{s^2 + K_D s\, 2.65 + K_p 2.65}}\, \theta_r$$



Note that the two systems vary only by constants

$$K_{DC} = 1$$

$$(\theta_r - \theta)(K_p s + K_D s^2 + K_i)\frac{1}{s}\frac{1}{Js^2} = \theta$$

$$\theta_r \frac{K_D s^2 + K_p s + K_i}{Js^3 + K_D s^2 + K_p s + K_i} = \theta \qquad K_{DC} = 1$$