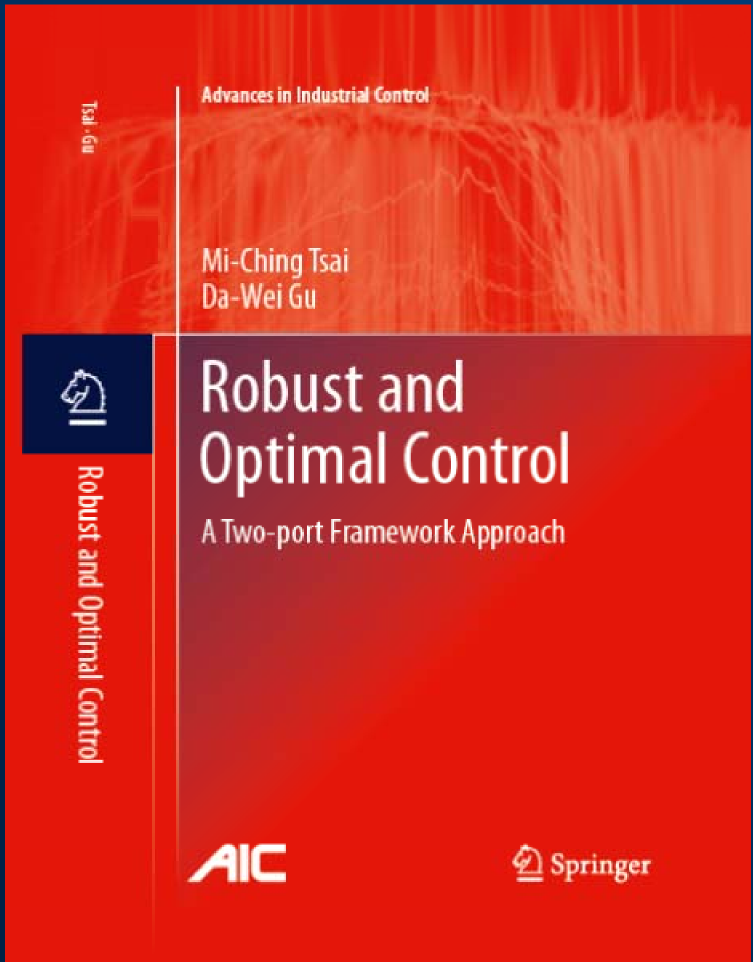

Robust and Optimal Control

A Two-port Framework Approach

Design Example

Classical PDF Controller Design

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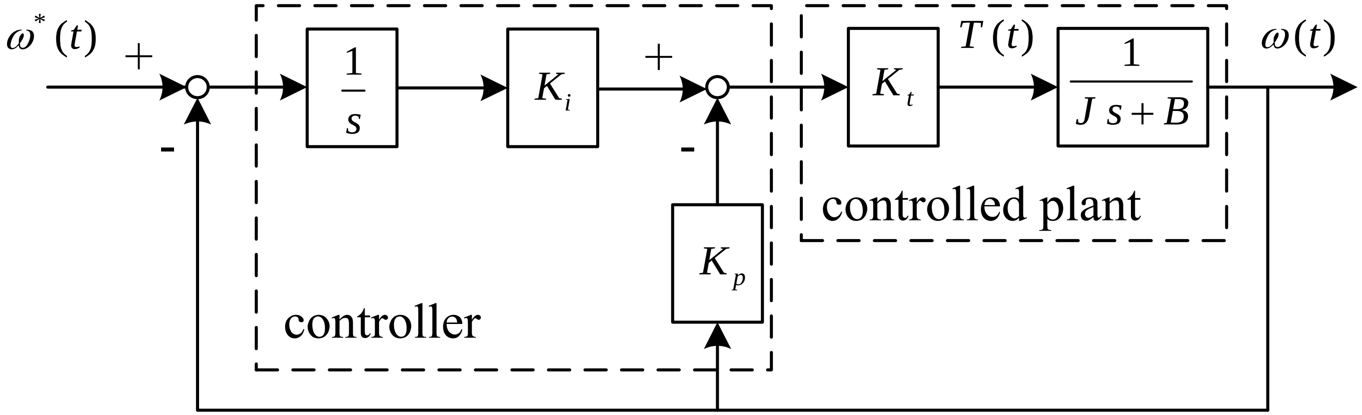
Speed control with classical PDF controller



closed-loop transfer function: $T(s)=\frac{\omega(s)}{\omega^*(s)}=\frac{\left(K_iK_t/J\right)}{s^2+\left[(B+K_PK_t)/J\right]s+\left(K_iK_t/J\right)}$

conventional controller design: coefficient comparison

damping ratio : ζ bandwidth : $BW=\omega_n(1-2\zeta^2+\sqrt{2-4\zeta^2+4\zeta^4})^{0.5}$

$\boldsymbol{K_I=\frac{J\,\omega_n^2}{K_t}}$ & $\boldsymbol{K_P=\frac{2J\zeta\omega_n - B}{K_t}}$

For the **nominal model**, the controller design could be finished easily.

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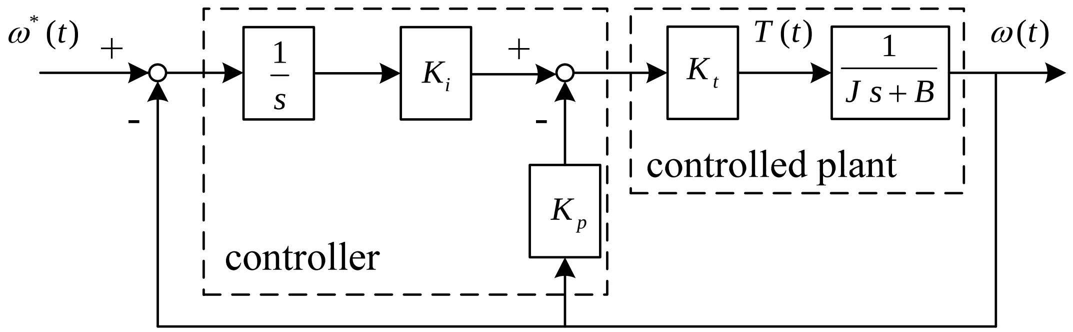


moment of inertia : $J = 5.77\times10^{-5}$

viscous friction constant : $B = 0.55\times10^{-3}$

torque constant : $K_t = 0.21$

For $\zeta = 0.9$ & $B.W. = 100$ Hz , the PDF controller parameters are determined by

$$K_i = J\,\omega_n^2 / K_t = 194.74$$

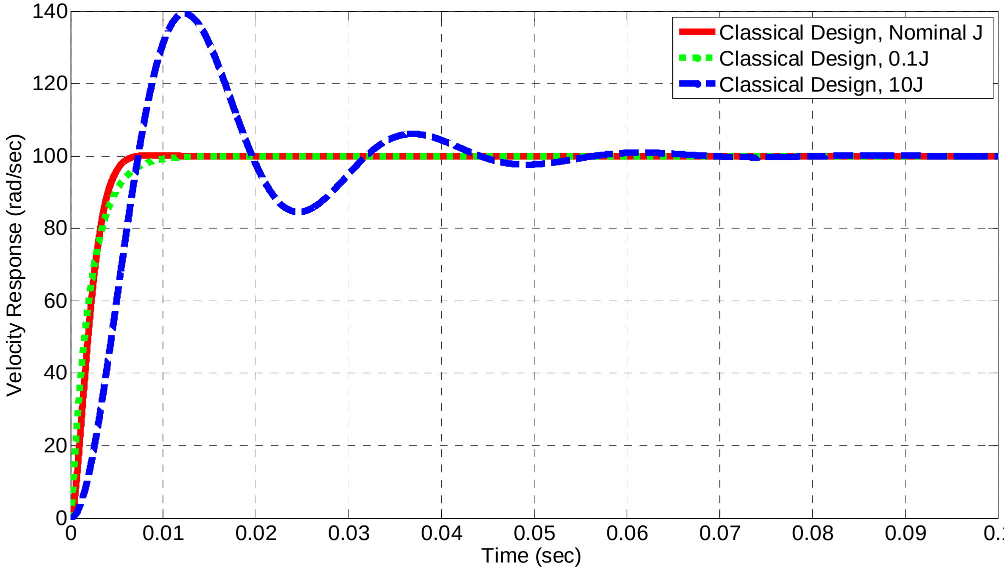
$$K_p = (2J\zeta\omega_n - B)/K_t = 0.41$$

The effect of model uncertainty:

$$J = 0.1J_o$$

$$J = J_o$$

$$J = 10J_o$$



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Characteristic equation:

$$Js^2 + (B + K_p K_t)s + K_t K_i = 0 \Rightarrow 1 + kL(s) = 0,\ L(s) = \frac{(B + K_p K_t)s + K_t K_i}{s^2},\ k = \frac{1}{J}$$

Root locus plot according to variation of $\frac{1}{J}$