Examples on tuning PID controllers

Dr. David Di Ruscio
Telemark University College
Systems and Control Engineering
N-3914 Porsgrunn, Norway
Fax: +47 35 57 54 01
Tel: +47 35 57 51 68
Email: david.di.ruscio@hit.no

November 16, 2010

1 Tuning PI controller for 3rd order time delay system

Given a system with model

$$h_p(s) = K \frac{e^{-\tau s}}{(1 + T_1 s)(1 + T_2 s)^2}, \tag{1}$$

with model parameters $K = 1$, $\tau = 1$, $T_1 = 30$ and $T_2 = 1$.

1. Use the half rule for model reduction and find a first order model approximation of the form.

$$h_p(s) = K \frac{e^{-\tau s}}{1 + T s}. \tag{2}$$

2. Use the Skogestad SIMC method with the simple robust lower bound $T_c = \tau$ ion order to find the PI controller parameters.

3. Simulate the closed loop system with a unit step change in the reference, r, at time $t = 0$ and with a unit disturbance, v, at time $t = \frac{t_{\text{final}}}{2}$.

4. Plot the magnitude of the frequency response of the loop transfer function, $|h_0(j\omega)|$, and the magnitude of the sensitivity function $|S(j\omega)|$ as a function of frequency, $0 \leq \omega \leq \infty$.

5. Find the robustness margins of the feedback system, i.e. find gain Margin (GM), Phase Margin (PM), maximum time delay error, $d\tau_{\text{max}} = \frac{PM}{\omega_c}$ and the sensitivity index M_s.