Computer Exercise 1
EL2520 Control Theory and Practice

Kartik Chari
kartikc@kth.se
960807-0174

Devendra Sharma
devendra@kth.se
940815-NNNN

March 31, 2019

Disturbance attenuation

How should the extra poles be chosen in exercise 4.2.1? Motivate!

In order to make the improper feedback controller (F_y) proper, we need to add a number of poles such that $n(P_{new}) = n(Z) - n(P)$ i.e. 2 in our case. The location of the poles should be chosen such that the frequency response of the closed loop transfer function from d to y remains the same. Also, the step response of the disturbance transfer function should remain the same. Thus, after trying various pole locations, we found the above conditions satisfy if both the poles are located at a distance $>= 50 * \omega_c$ from the origin on the LHP. We chose $70 * \omega_c$

The feedback controller(Proper) in exercise 4.2.2 is

$$F_y(s) = (\frac{s + \omega_{\mathrm{I}}}{s})(\frac{p_1 * p_2}{(s + p_1)(s + p_1)}) * G^{-1} * G_{\mathrm{d}}$$

$\Longrightarrow$

$$F_y(s) = (\frac{s + 5.6700}{s})(\frac{99.4730 * 99.4730}{(s + 99.4730)(s + 99.4730)})(\frac{10s^3 + 210s^2 + 4200s + 4000}{8000s + 8000})$$

Here, ω_{I} was taken as $0.57 * \omega_{\mathrm{c}}$ and the Poles p_1 and p_2 were placed at a distance $10^*\omega_{\mathrm{c}}$ from the Origin.

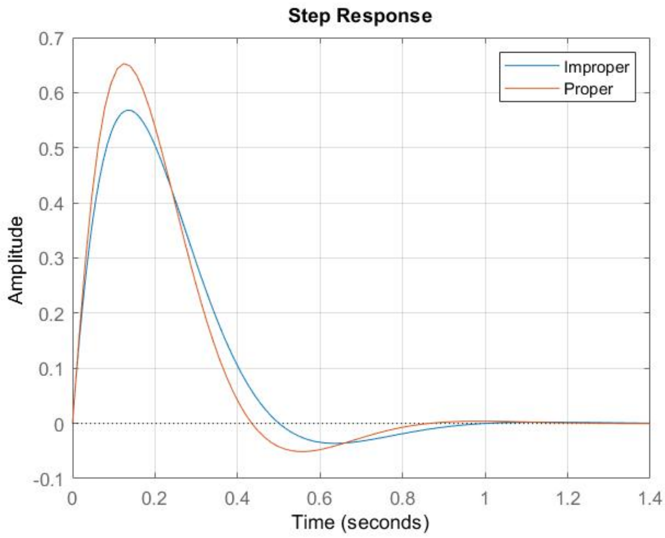


Figure 1: **Response of Closed Loop TF from d to y for a unit step disturbance for both Proper and Improper $\mathbf{F_y}$ - Exercise 4.2.2**

The feedback controller and pre-filter in exercise 4.2.3 is

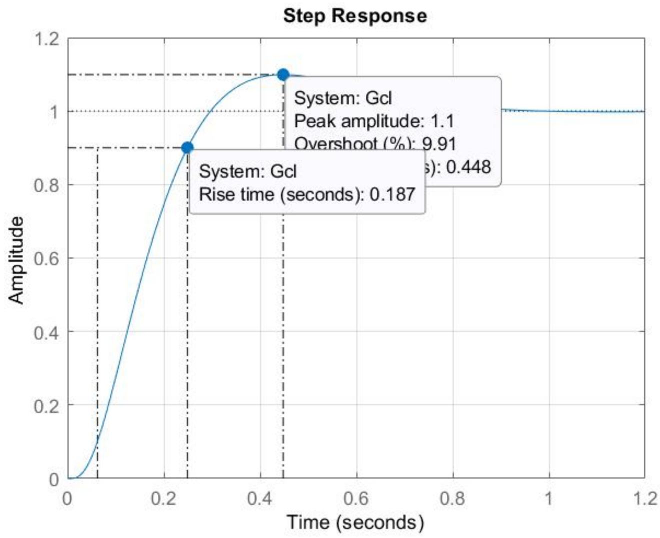
$$F_y(s) = (\frac{s+\omega_{\mathrm{I}}}{s})(\frac{p_1 * p_2}{(s+p_1)(s+p_1)})(\frac{\tau_{\mathrm{D}}+1}{\beta\tau_{\mathrm{D}}+1}) * K * G^{-1} * G_{\mathrm{d}}$$

$$F_r(s) = \frac{1}{\tau s+1}$$

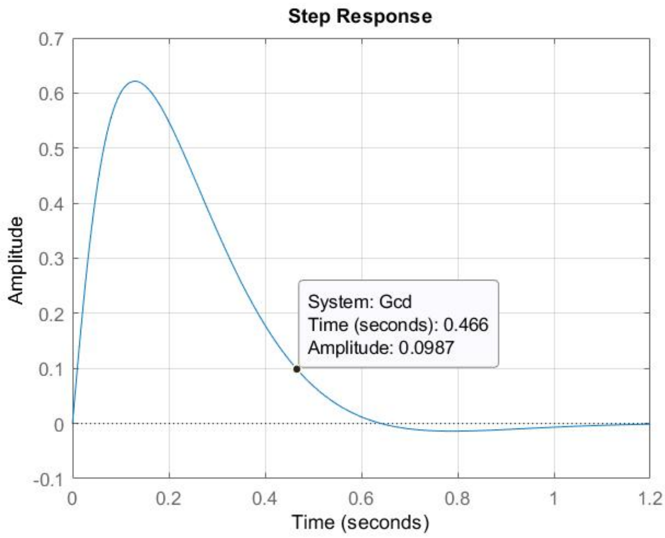
where

ω_c	ω_I	K	τ_D	β	$p_1 = p_2$	τ
9.9473	$0.57\omega_c$	0.9778	0.0941	0.7920	$10\omega_c$	0.1

Table 1: The values of coefficients for $F_y(s)$ and $F_r(s)$.



(a) Unit Step response for the CLTF from r to y



(b) Unit Step Disturbance response for the CLTF from d to y

Figure 2: **Reference step, exercise 4.2.3**

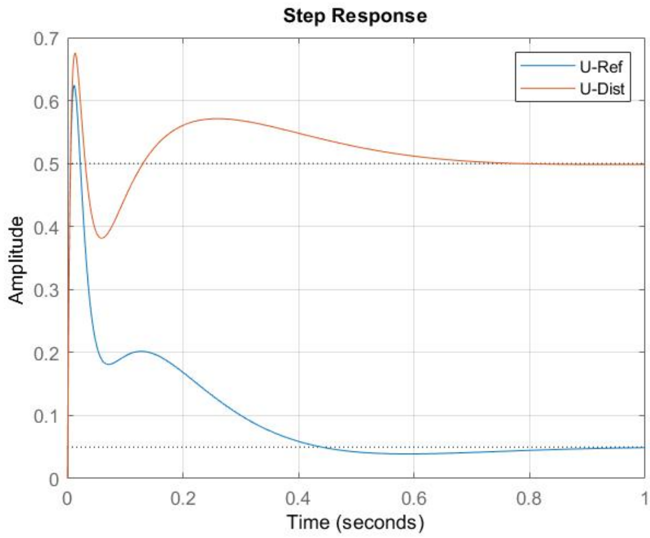


Figure 3: **Control signal for a disturbance or a reference step (plus a combination of these)**

Did you manage to fulfill all the specifications? If not, what do you think makes the specifications difficult to achieve?
Yes, We managed to fulfill all the specifications specified using the above 2-DOF controller

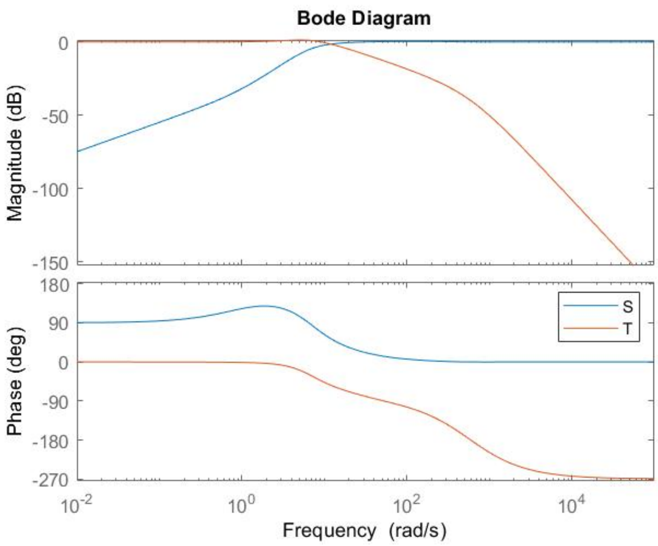


Figure 4: **Bode diagram of sensitivity and complementary sensitivity functions, exercise 4.2.4**