Computer Exercise 1
EL2520 Control Theory and Practice

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Disturbance attenuation

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

The denominator degree should be at a minimum at the same order as the numerator for the controller to be proper, so we chose to add two extra poles. As mentioned in the computer exercise introduction we choose to add the poles on the form of $1/(\frac{s}{p}+1)$ to not change the low-frequency gain. p is chosen greater than zero, to make the controller stable.

The feedback controller in exercise 4.2.2 is:

$$F_y(s) = \frac{3.125s^3 + 78.13s^2 + 1562s + 6250}{s^3 + 100s^2 + 2500s} \tag{1}$$

with added poles on the same form as above with $p_1 = p_2 = 50$, $\omega_I = 5$ and $\omega_c = 10$.

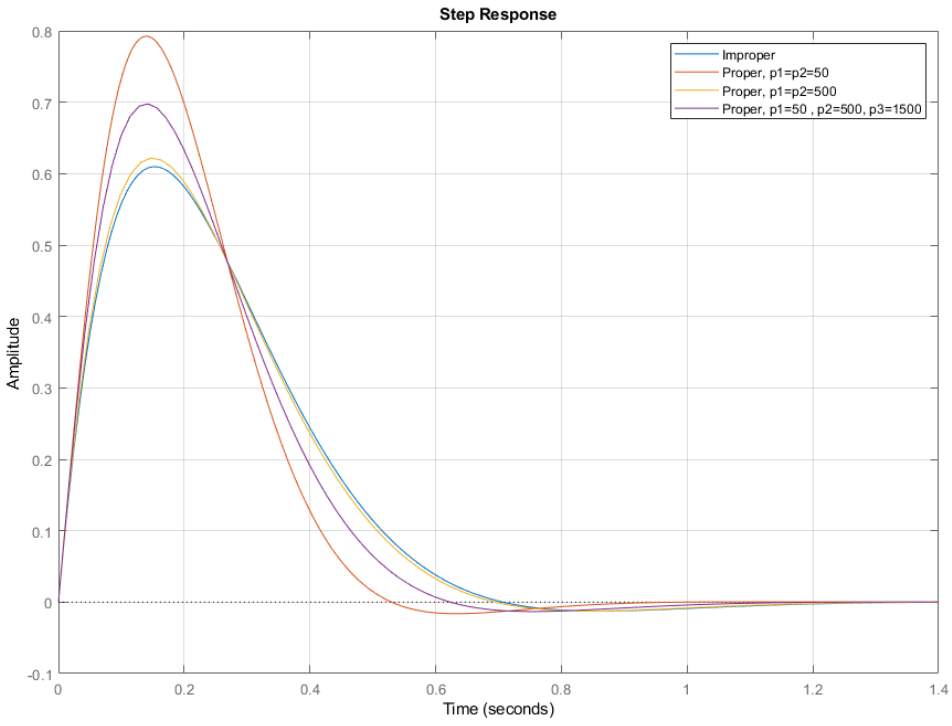

Figure 1: Step disturbance, exercise 4.2.2

The feedback controller and prefilter in exercise 4.2.3 is:

$$F_y(s) = \frac{11.24s^4 + 414s^3 + 8945s^2 + 88980s + 266000}{s^4 + 133.8s^3 + 5881s^2 + 84520s} \tag{2}$$

$$F_r(s) = \frac{1}{1 + 0.09s} \tag{3}$$

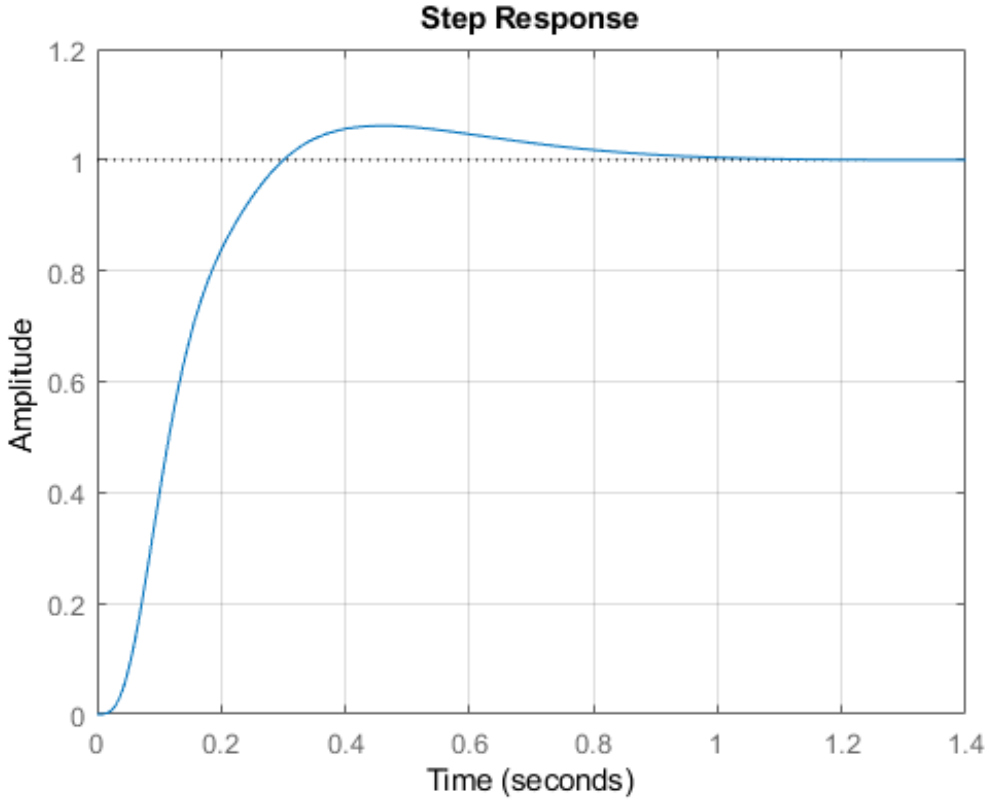

Figure 2: Reference step, exercise 4.2.3

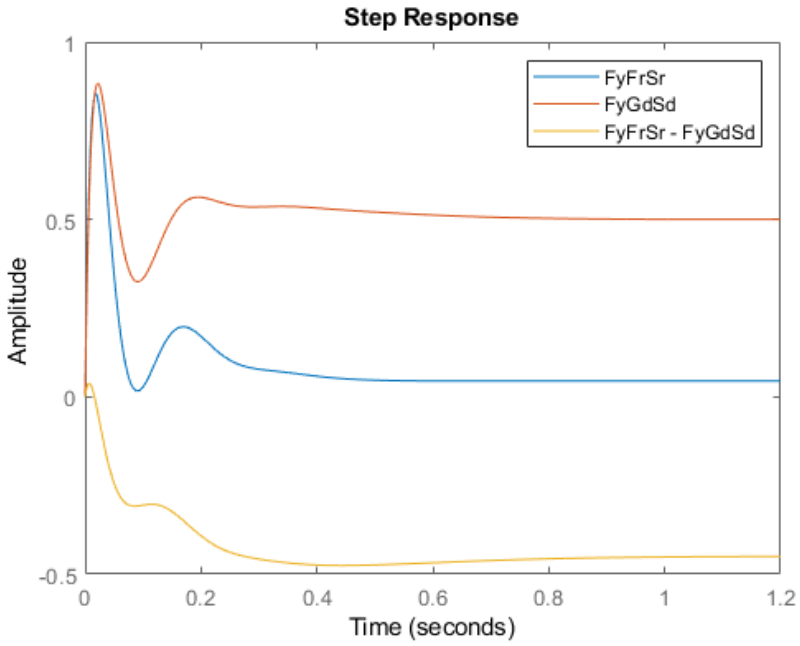

Figure 3: Control signal for a disturbance or a reference step (plus a combination of these)

Did you manage to fulfill all the specifications? If not, what do you think makes the specifications difficult to achieve?

Yes, all requirements are met.

- *The rise time for a step change in the reference signal less than 0.2 s and the overshoot is less than 10%.*
  ◇ The rise time ended up at 0.18 s and the overshoot around 6.2%.
- *For a step in the disturbance,* $|y(t)| \leq 1 \; \forall \; t$ *and* $|y(t)| \leq 0.1$ *for* $t > 0.5$ *s.*
  ◇ The largest value overall for $|y(t)|$ is below 0.5, see Figure 2, and the largest value after $t = 0.5$ is below 0.095.
- *Since the signals are scaled, the control signal obeys* $|u(t)| \leq 1 \; \forall \; t$*.*
  ◇ $|u(t)|$ is less than one for all t ass one could observe from the Figure 3.

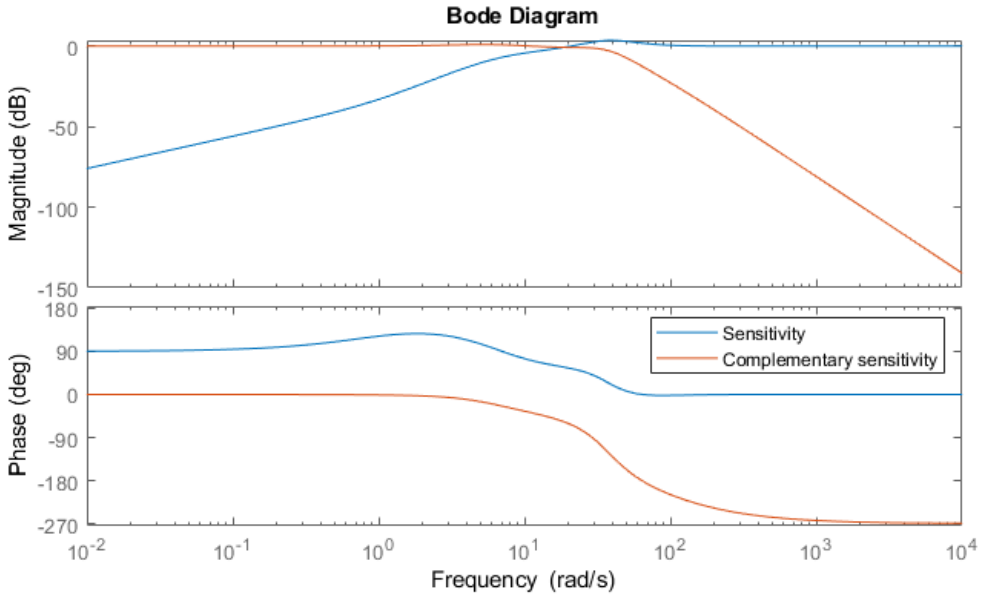

Figure 4: Bode diagram of sensitivity and complementary sensitivity functions, exercise 4.2.4)