Computer Exercise 4
EL2520 Control Theory and Practice

Ilian Corneliussen
ilianc@kth.se
950418-2438

Stine Olsson
stine@kth.se
930527-5746

April 28, 2020

Minimum phase case

Dynamic decoupling

The dynamic decoupling in exercise 3.2.1 is

$$W(s) = \begin{bmatrix} 1 & -\frac{0.0148}{s+0.0213} \\ -\frac{0.0134}{s+0.0257} & 1 \end{bmatrix} \tag{1}$$

Is the controller good?
When analysing the sensitivity, S and the robustness, T one can notice how S and T are not crossing at the cross over frequency $\omega_c = 0.1$, which is desired but instead at around $\omega = [0.02, 0.04]$, which results in less damping for both noise and disturbance. But overall the S and T Bode plot looks normal which in conclusion gives a good result. The controller is relatively good due to the low raise time and relative low overshoot. Here the overshoot is less than 20% for both y1 and y2 for input signal u1 and u2.

Are the output signals coupled?
No, as seen in Figure 2, y1 is not affected by u2 and y2 is not affected by u1, hence the system is decoupled.

Glover-MacFarlane robust loop-shaping

What are the similarities and differences compared to the nominal design?
In Glover-MacFarlane case the S and T are crossing at the cross over frequency and does also have a generally lower overshoot, see Figure 3 compared with Figure 2. The raise time is almost the same in both cases. Also both controllers are successfully decoupled.

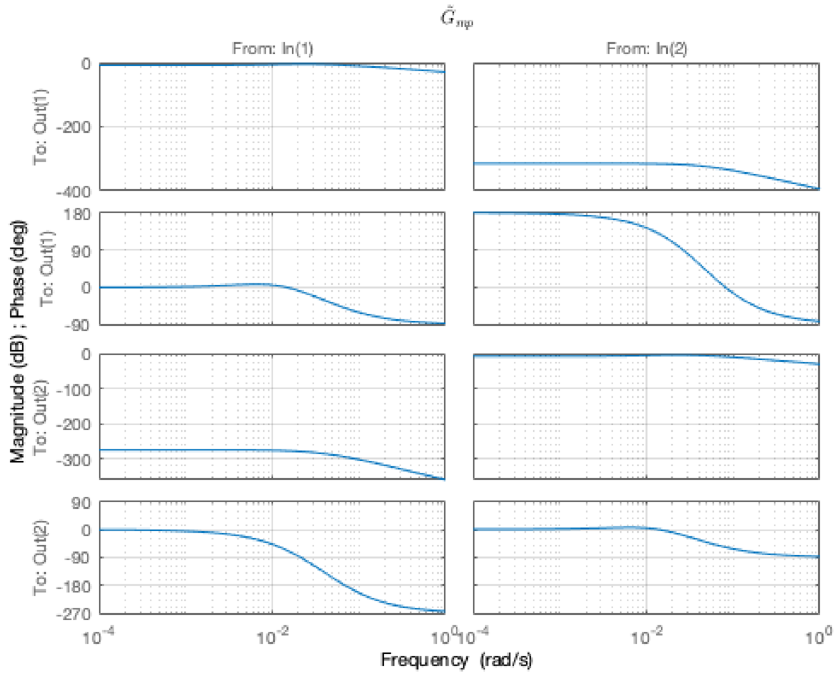
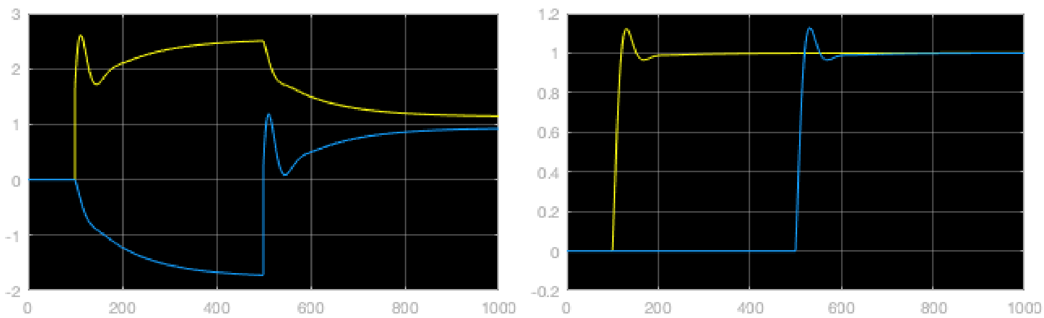


Figure 1: Bode diagram of $\tilde{G}(s)$ derived in exercise 3.2.1



u, minimum phase

y, minimum phase

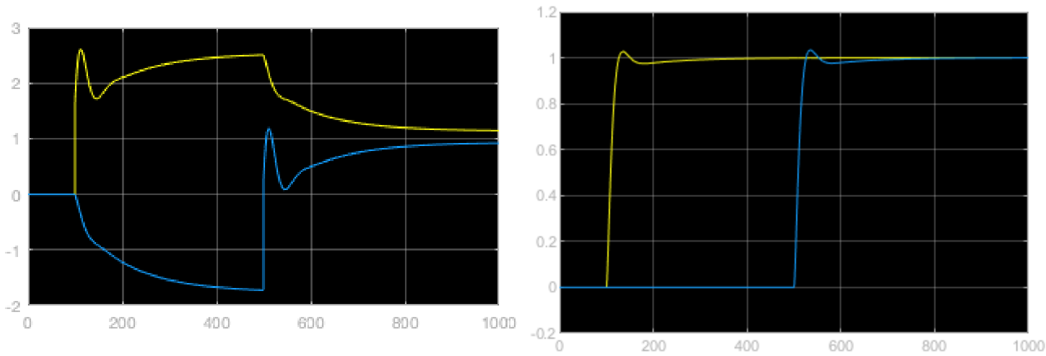
Figure 2: Simulink plots from exercise 3.2.4

Non-minimum phase case

Dynamic decoupling

The dynamic decoupling in exercise 3.2.1 is

$$W(s) = \begin{bmatrix} \frac{-1.1430 \cdot s - 0.1039}{s + 0.2} & \frac{0.2}{s + 0.2} \\ \frac{0.2}{s + 0.2} & \frac{-1.6150 \cdot s + 0.1386}{s + 0.2} \end{bmatrix} \tag{2}$$



u, non-minimum phase

y, non-minimum phase

Figure 3: Simulink plots from exercise 3.2.4

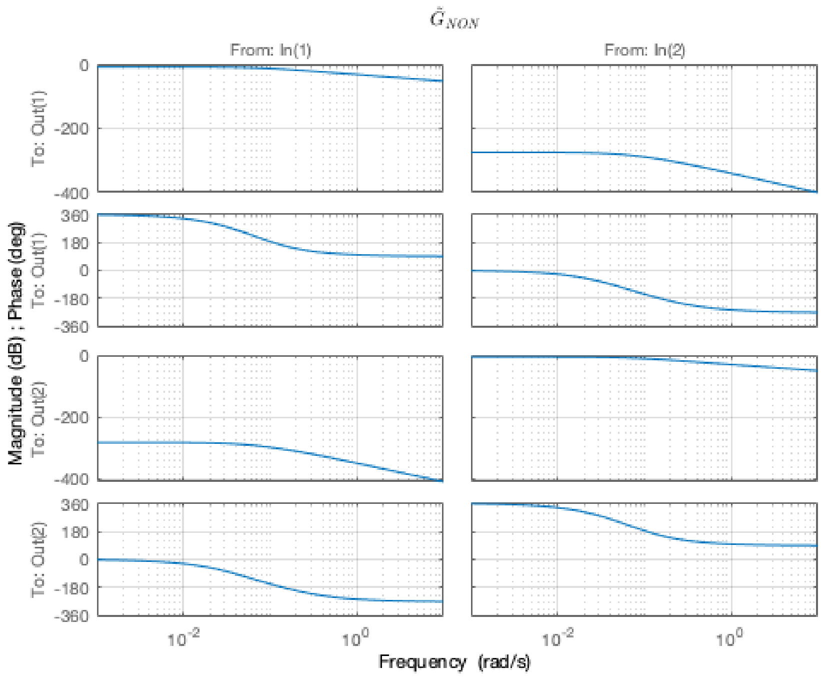
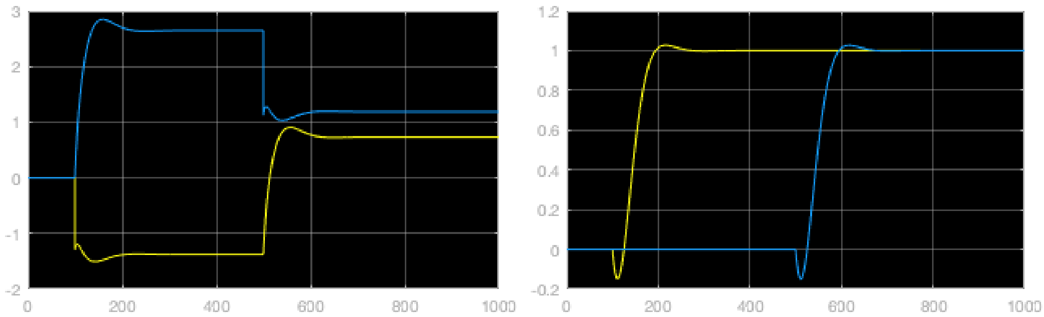


Figure 4: Bode diagram of $\tilde{G}(s)$ derived in exercise 3.2.1

Is the controller good?

By analysing S and T for the non-minimum phase, it is notable that they are crossing at the desired cross-over frequency, $\omega_c = 0.02$. and since S is damping disturbance and T is damping noise, both noise and disturbance are damped. The overshoot, undershoot and raise time is quite small hence the controller is considered good.

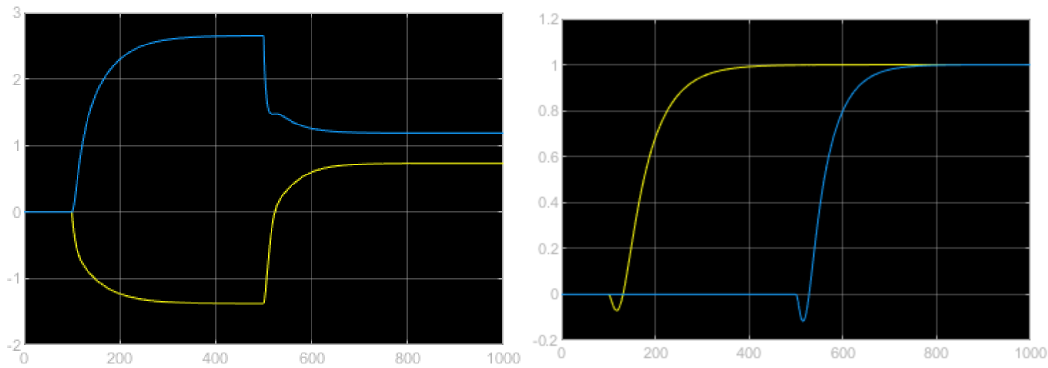


u, non-minimum phase   y, non-minimum phase

Figure 5: Simulink plots from exercise 3.2.4

Are the output signals coupled?
No, as seen in Figure 5, y1 is not affected by u2 and y2 is not affected by u1, hence the system is decoupled.

Glover-MacFarlane robust loop-shaping



u, non-minimum phase   y, non-minimum phase

Figure 6: Simulink plots from exercise 3.3.4

What are the similarities and differences compared to the nominal design?
In both cases the S and T are crossing close to the cross over frequency, but the Glover-MacFarlance case has no overshoot and a lower undershoot but with the drawback of an higher raise time. Which one that performs best depends on the application. Also both controllers are successfully decoupled.