Computer Exercise 4
EL2520 Control Theory and Practice

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Minimum phase case

Dynamic decoupling

The dynamic decoupling in exercise 3.2.1 is

$$W(s) = \begin{bmatrix} 1 & \dfrac{-0.01476\,s - 0.0007656}{s^2 + 0.07317\,s + 0.001105} \\ \dfrac{-0.01336\,s - 0.0007541}{s^2 + 0.08217\,s + 0.001452} & 1 \end{bmatrix}$$

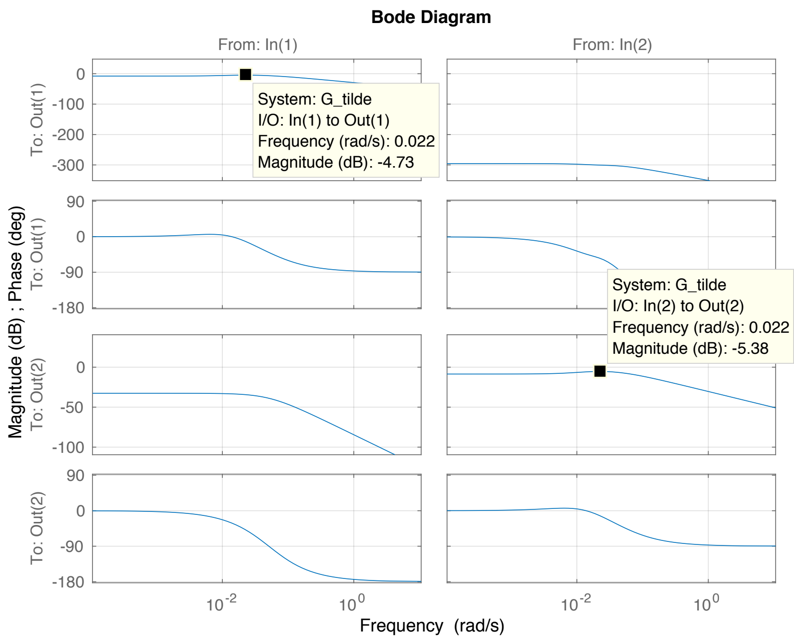
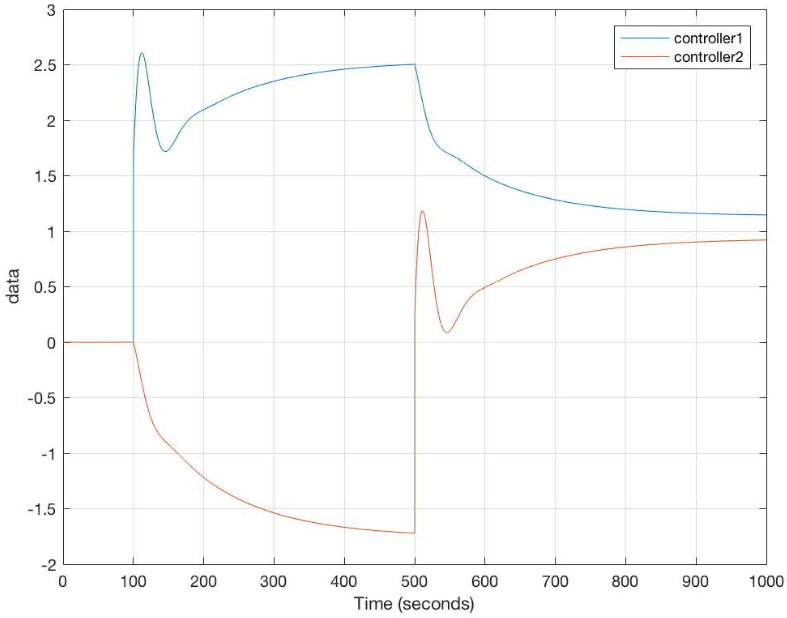


Figure 1: Bode diagram of G(s) derived in exercise 3.2.1



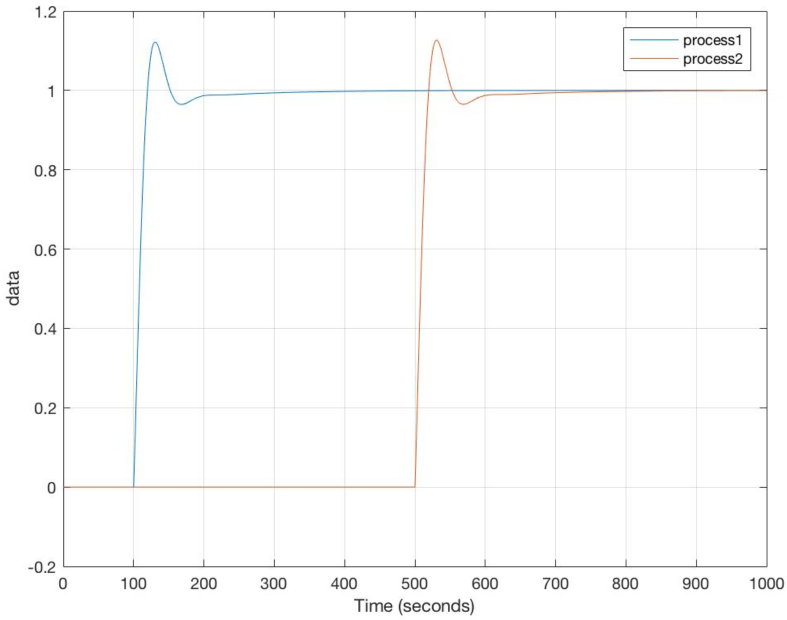


Figure 2: Simulink plots from exercise 3.2.4 (upper: plot of input u; lower: plot of output y)

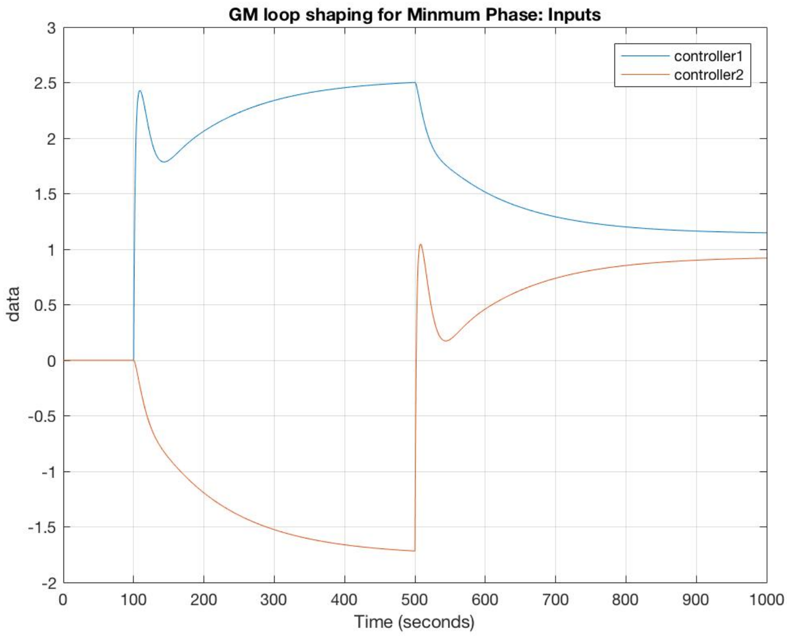
Is the controller good?

From Figure 1, we can see that the output y1 is largely attenuated when it is paired with input u2, and this also applies to output y2 with respect to u1. Since input u1, u2 should be paired to y1, y2 respectively, the controller in this case could be regarded as good.

Are the output signals coupled?

Figure 2 shows the evolution of controller signals and the system output. From the lower plot of Figure 2, we can observe that a step input on process 1 affects output y2 insignificantly, and vice versa. Thus, the output signals are successfully decoupled.

Glover-MacFarlane robust loop-shaping



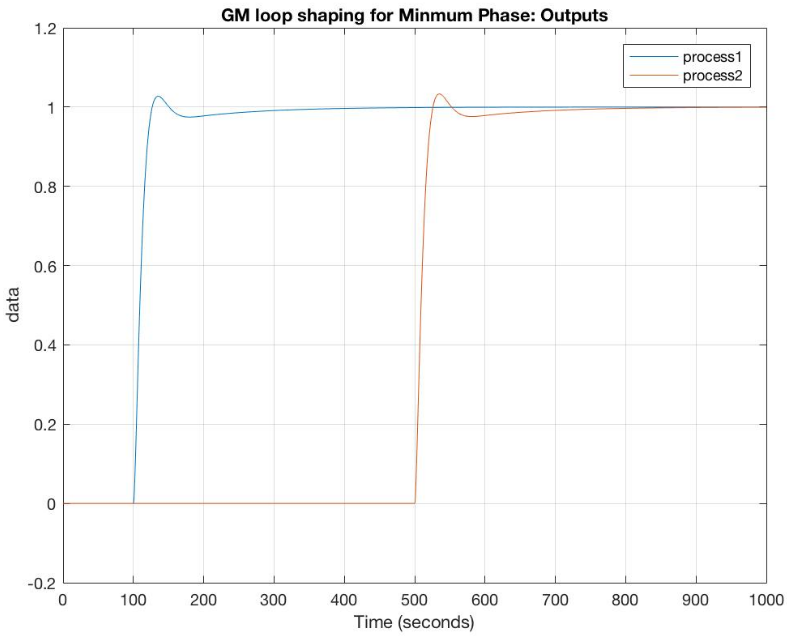


Figure 3: Simulink plots from exercise 3.3.4(upper: plot of input u; lower: plot of output y)

What are the similarities and differences compared to the nominal design?
Both design methods could generate controllers which could successfully decouple the output signals. Compared to the nominal one, the Glover-MacFarlane controller results in a lower overshoot of output, and an increase of rising time and settling time. Besides, a better robustness is guaranteed.

Non-minimum phase case

Dynamic decoupling

The dynamic decoupling in exercise 3.2.1 is

$$W(s) = \begin{bmatrix} \dfrac{-1.143s^2 - 0.1575\,s - 0.004874}{s^2 + 0.2469\,s + 0.009384} & \dfrac{0.2}{s + 0.2} \\ \dfrac{0.2}{s + 0.2} & \dfrac{-1.615s^2 - 0.2211\,s - 0.007077}{s^2 + 0.2511\,s + 0.01021} \end{bmatrix}$$

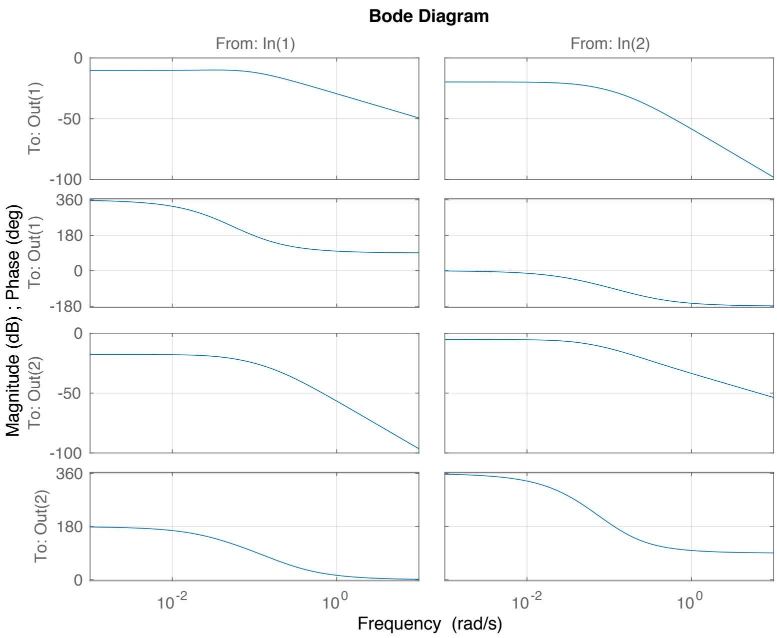
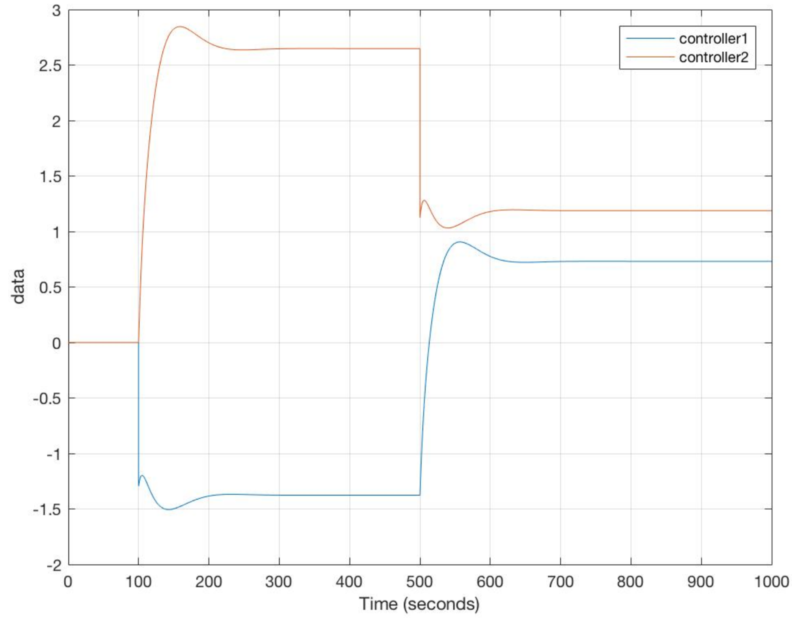


Figure 4: Bode diagram of G(s) derived in exercise 3.2.1



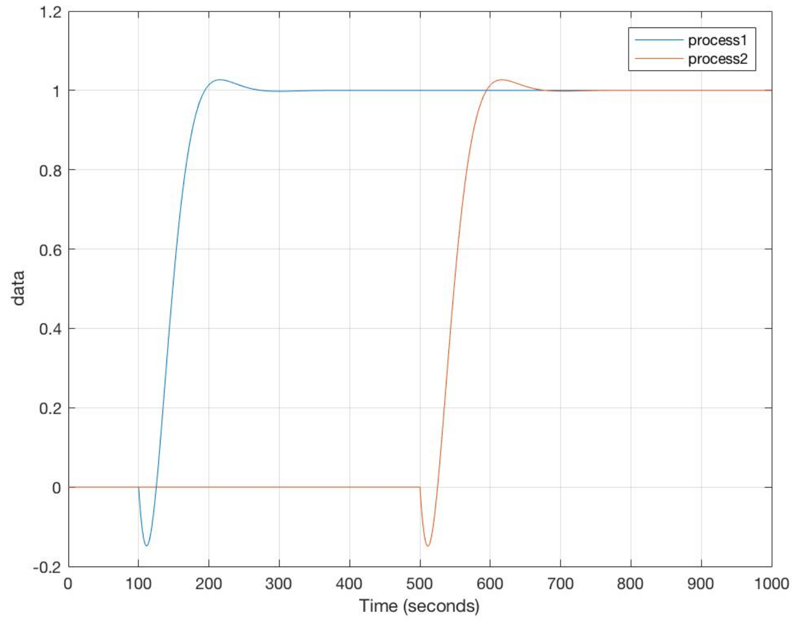


Figure 5: Simulink plots from exercise 3.2.4 (upper: plot of input u; lower: plot of output y)

Is the controller good?

The output of both processes can reach the level of setpoint in a quick manner and no steady errors are observed in this case. Besides, an acceptable overshoot is shown in both of the step responses. Therefore, the controller seems good in general.

Are the output signals coupled?

From the lower plot of Figure 5, we can observe that a step input on process 1 has no effect on process 2, and vice versa. Thus, the output signals are successfully decoupled.

Glover-MacFarlane robust loop-shaping

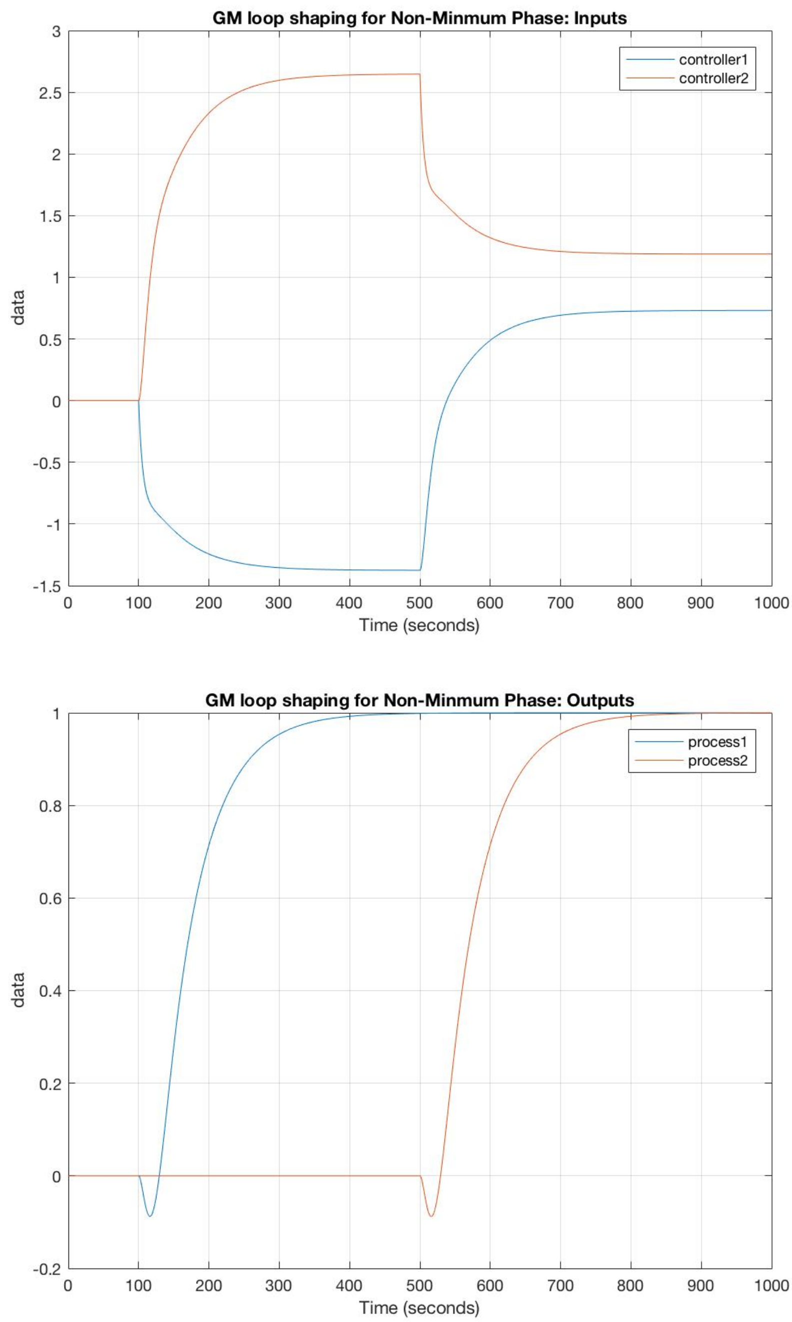


Figure 6: Simulink plots from exercise 3.3.4

What are the similarities and differences compared to the nominal design?
Both controller achieve good decoupling and control performances. However, from what is observed in Figure 6, Glover-MacFarlane controller performs better on overshooting since no overshoot exists in the step response at the cost of a slight increase of rising time and settling time.