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

$$W(s) = \begin{bmatrix} 1 & -\frac{0.01476}{s+0.0213} \\ -\frac{0.01336}{s+0.02572} & 1 \end{bmatrix}$$

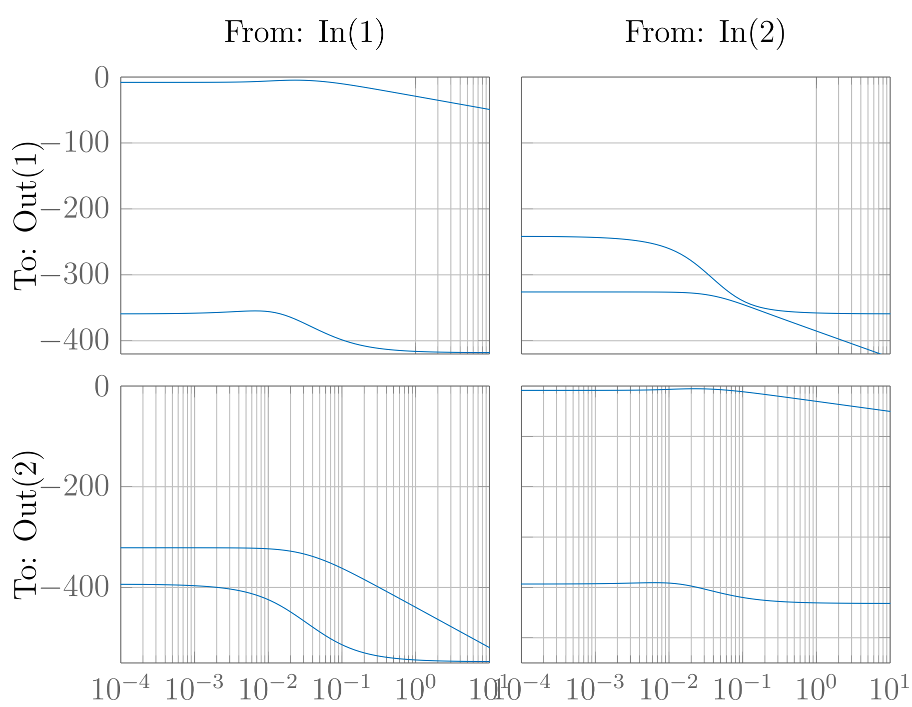

Figure 1: Bode diagram of $\tilde{G}(s)$ derived in exercise 3.2.1

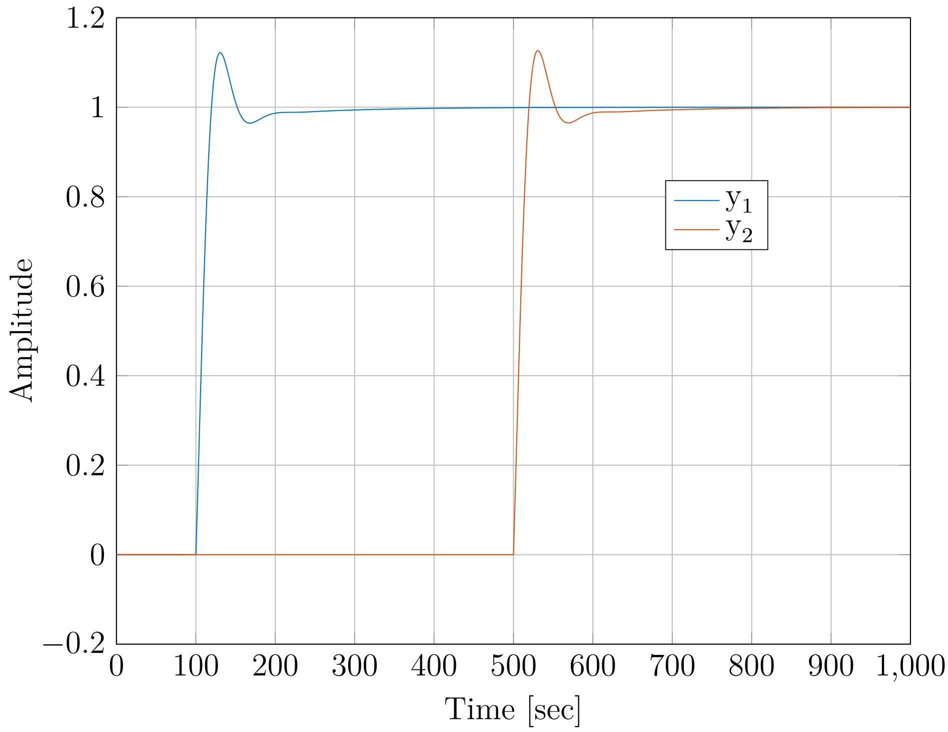

Figure 2: Simulink plots from exercise 3.2.4

In this case, inputs u_1, u_2 should be paired to outputs y_1 and y_2 respectively. Figure 1 shows that input u_2 is severely attenuated with respect to output y_1; exactly the same happens with respect to input u_1 and output y_2. The controller is thus successful.

Figure 2 exhibits the step responses of the closed-loop system. It is evident that the output signal y_2, seen here with red colour, is not in the least influenced by the preceding step input u_1. Output y_1 exhibits the same behaviour with respect to the step input u_2. The output signals are now decoupled.

Glover-MacFarlane robust loop-shaping

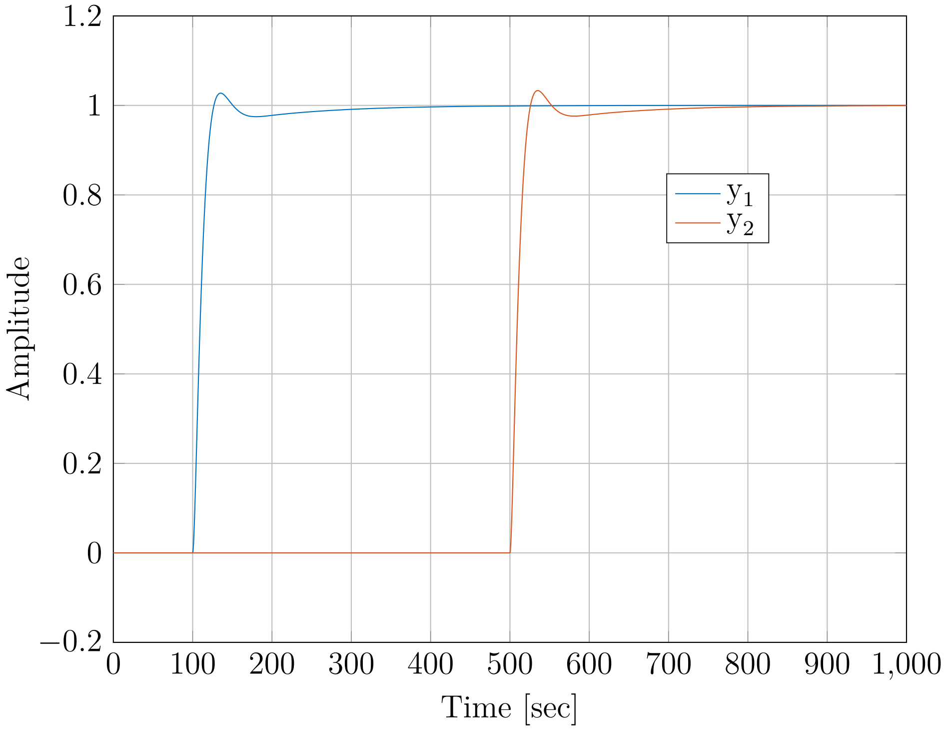

Figure 3: Simulink plots from exercise 3.3.4

Figure 3 illustrates the step responses of the closed-loop system after shaping the open loop using the Glover-McFarlane method. Both this and the nominal design method result in successful decoupling, however the Glover-McFarlane method takes provision towards robustness. In this case, comparing the latter method to the former, we can see that it results in lower overshoot, but with the usual (although small) increase in rise and settling times.

Non-minimum phase case

Dynamic decoupling

The dynamic decoupling in exercise 3.2.1 is

$$W(s) = \begin{bmatrix} \dfrac{0.2}{s+0.2} & \dfrac{-1.615s - 0.1386}{s+0.2} \\[2ex] \dfrac{-1.143s - 0.1039}{s+0.2} & \dfrac{0.2}{s+0.2} \end{bmatrix}$$

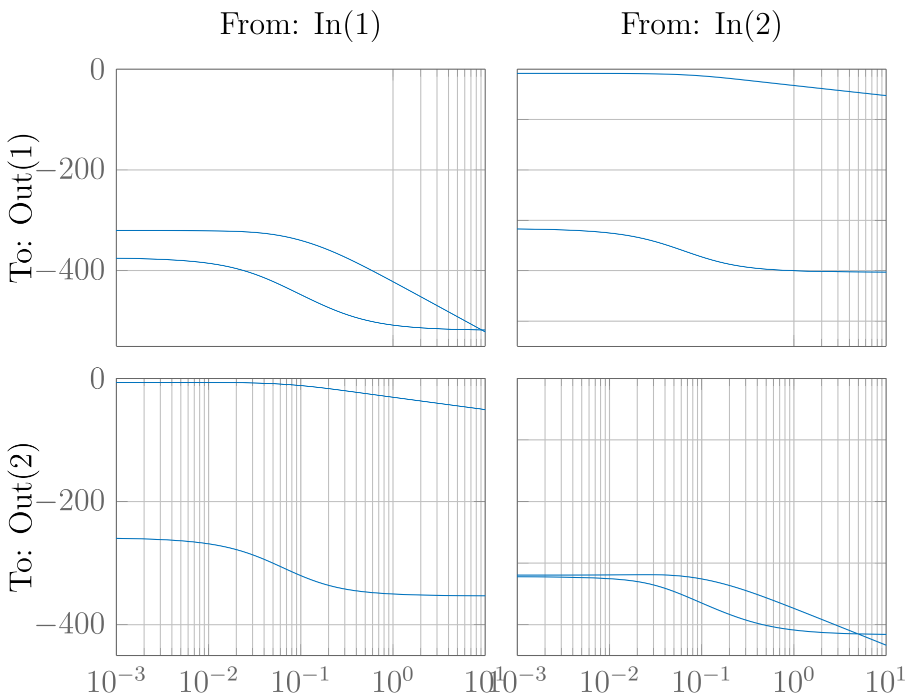

Figure 4: Bode diagram of $\tilde{G}(s)$ derived in exercise 3.2.1

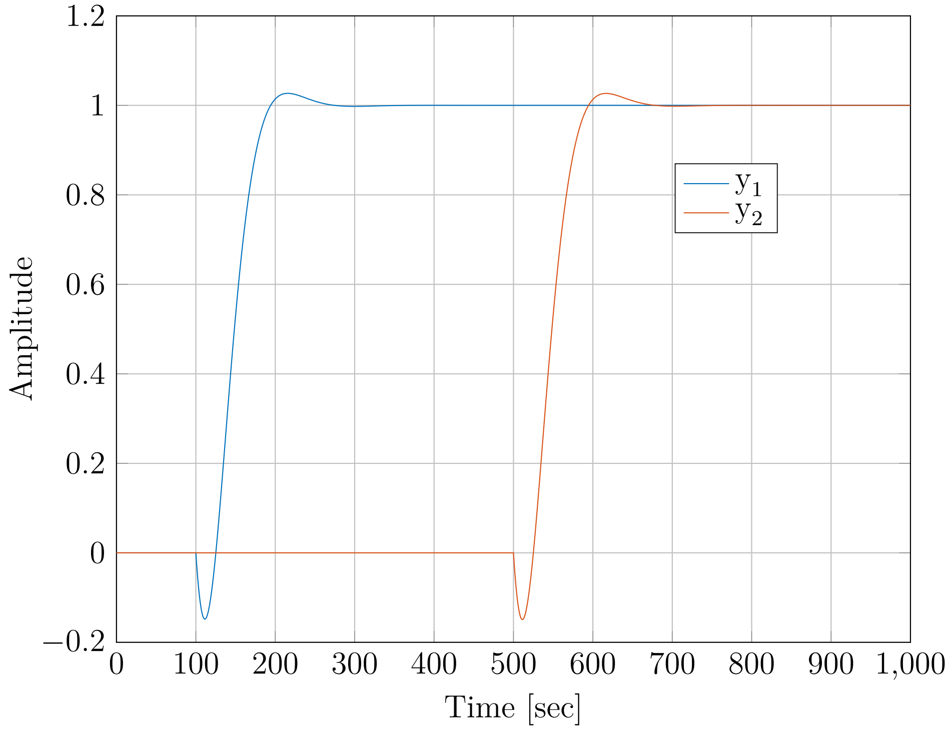

Figure 5: Simulink plots from exercise 3.2.4

In this case, inputs u_1, u_2 should be paired to outputs y_2 and y_1 respectively. Figure 4 shows that input u_2 is severely attenuated with respect to output y_2; exactly the same happens with respect to input u_2 and output y_1. The controller is thus successful.

Figure 5 exhibits the step responses of the closed-loop system. It is evident that the output signal y_2, seen here with red colour, is not in the least influenced by the preceding step input u_2. Output y_2 exhibits the same behaviour with respect to the step input u_1. The output signals are now decoupled.

Glover-MacFarlane robust loop-shaping

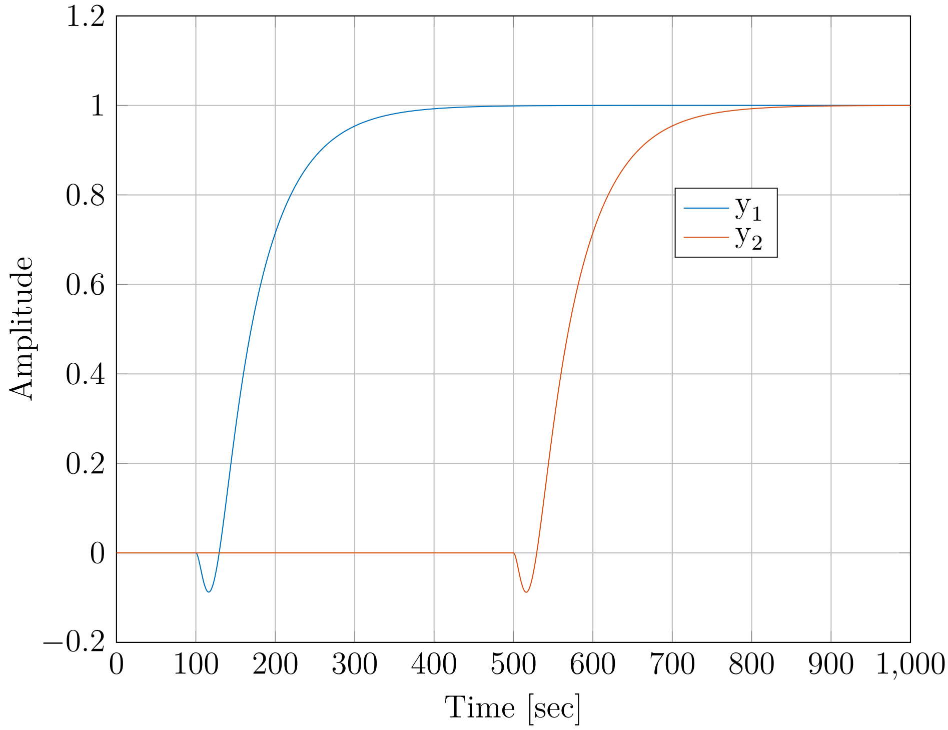

Figure 6: Simulink plots from exercise 3.3.4

Figure 6 illustrates the step responses of the closed-loop system after shaping the open loop using the Glover-McFarlane method. Both this and the nominal design method result in successful decoupling, however the Glover-McFarlane method takes provision towards robustness. In this case, comparing the latter method to the former, we can see that it results in no overshoot at all, but with a somewhat major increase in rise and settling times.