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

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

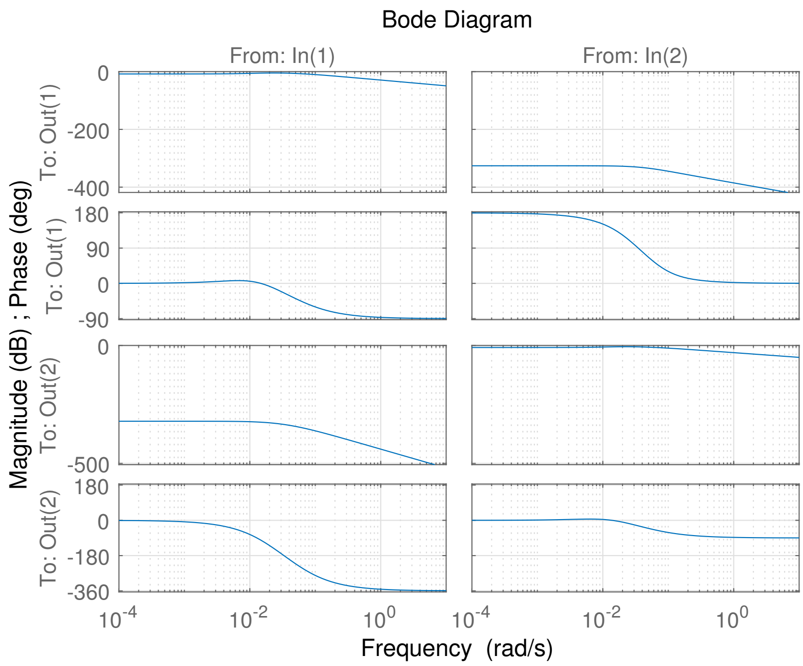

Figure 1: Bode diagram of $\tilde{G}(s)$ derived in exercise 3.2.1

- Is the controller good?

  In minimum phase case, u_1 and u_2 should be paired with y_1 and y_2 respectively. From fig 1, u_1 is attenuated for y_2 (which is $\tilde{g}_{1,2}$). Same attenuation for u_2 respect to y_1 (which is $\tilde{g}_{2,1}$). So, the controller is good.

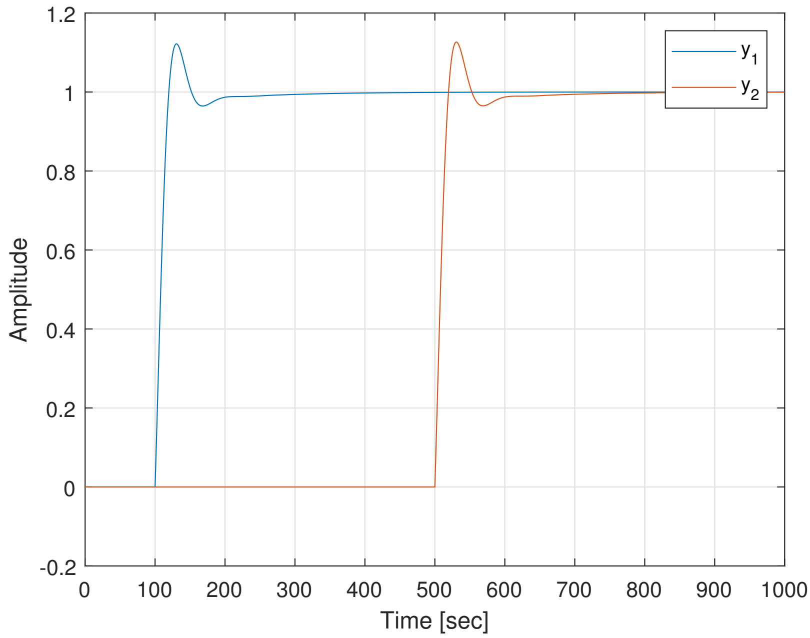

Figure 2: Simulink plots from exercise 3.2.4

- Are the output signals coupled?

  From fig 2 we can see the step responses of the closed-loop system and it is obvious that, y_1 is influenced by u_1 and y_2 is influenced by u_2. So the output signals are coupled.

Glover-MacFarlane robust loop-shaping

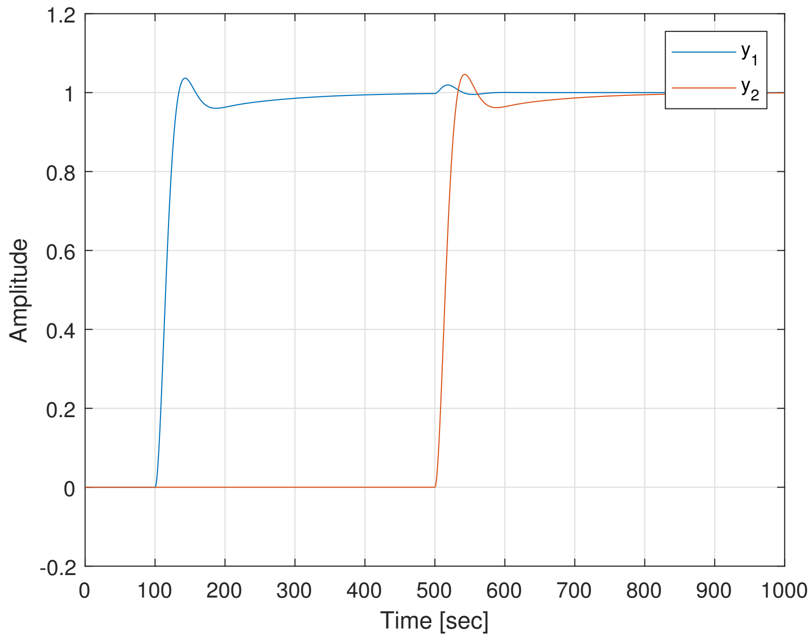

Figure 3: Simulink plots from exercise 3.3.4

- What are the similarities and differences compared to the nominal design?

From fig 3, we can see that the overshoot of response is lowered. However, in our case, the output y_1 is slightly influenced by input u_2, meaning the Glover-McFarlane doesn't as good decoupling as the nominal design, but it really improve the robustness.

Non-minimum phase case

Dynamic decoupling

The dynamic decoupling in exercise 3.2.1 is

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

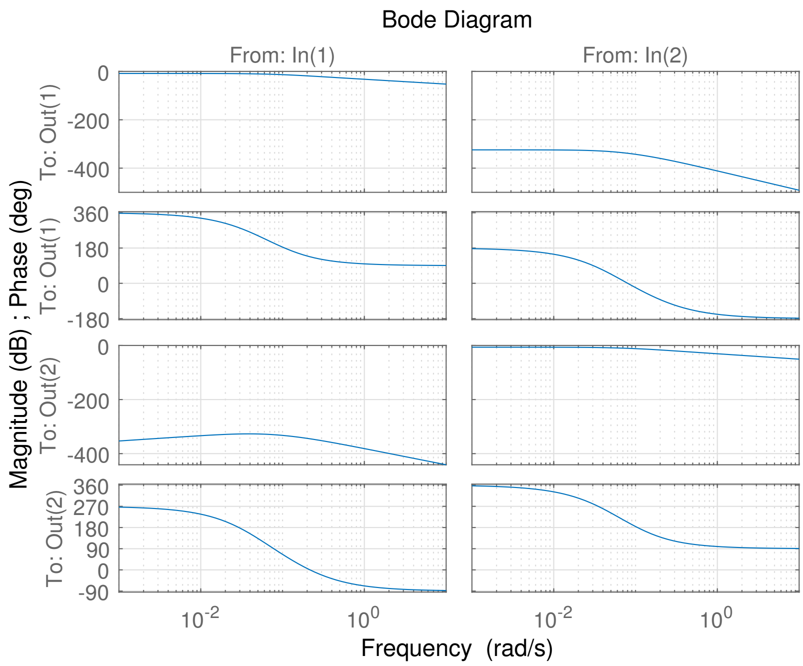

Figure 4: Bode diagram of $\tilde{G}(s)$ derived in exercise 3.2.1

- Is the controller good?

  In non-minimum phase case, u_1 and u_2 should be paired with y_2 and y_1 respectively. From fig 4, u_1 is attenuated for y_1. Same attenuation for u_1 respect to y_1. Also, from fig 5, the overshoot seems to be small. In all, the controller is good.

- Are the output signals coupled?

  From fig 5, it is obvious that y_2 is coupled with u_1 and y_1 is coupled with u_2. So, the output signals are coupled.

Glover-MacFarlane robust loop-shaping

- What are the similarities and differences compared to the nominal design?

  Compare fig 5 and 6, we can see that the overshoot in Glover-MacFarlane is eliminated and the "overshoot" below 0 is reduced as well. So, the Glover-MacFarlane method gives more robust loop-shaping. Also, the output signals are maintained to be coupled well.

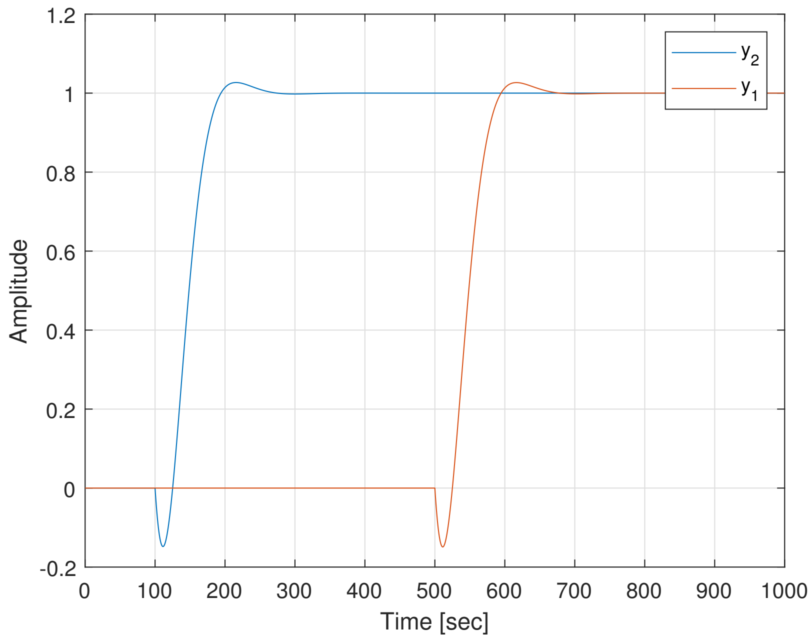

Figure 5: Simulink plots from exercise 3.2.4

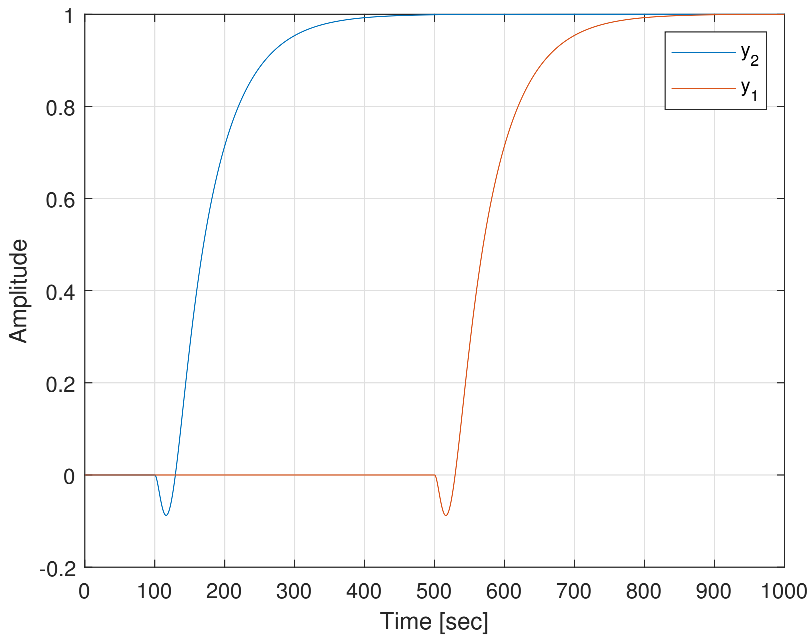

Figure 6: Simulink plots from exercise 3.3.4