Computer Exercise 1
EL2520 Control Theory and Practice

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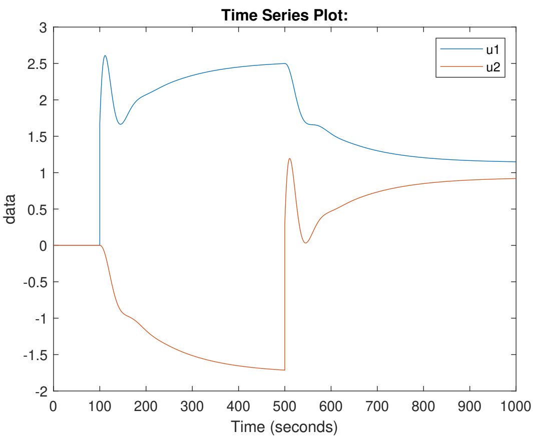
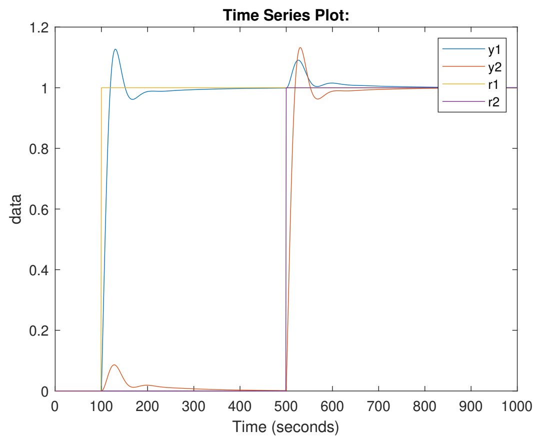
Minimum phase case

The controller is given by

$$F(s) = \begin{bmatrix} 1.6776(1 + \dfrac{1}{5.904s}) & 0 \\ 0 & 2.0137(1 + \dfrac{1}{6.391s}) \end{bmatrix}$$



(a) Response of the control signal u.



(b) Response of the output y with the reference r.

Figure 1: Simulink plots from exercise 3.2.3.

From fig 1b, we can conclude that the two outputs are coupled but not strongly coupled, since both of the inputs, r_1 and r_2 would affect both outputs. However, r_1 can have much obvious effect on y_1 and r_2 can have much obvious effect on y_2. However, when r_1 comes, y_1 increases much more than y_2, and y_2 recover to its original state after a while, which is similar for the case of r_2. Thus, the pairing is satisfied. Also, as we can see, the overshooting is small enough.

From fig 3, which is the singular values of the S and T of the system, the singular values are both small when the frequency approaching the ω_c, implying the controller is good. Also, we can learn that the controller will be more sensitive and less robust to the disturbance at low frequency, and less sensitive and more robust to the disturbance at high frequency.

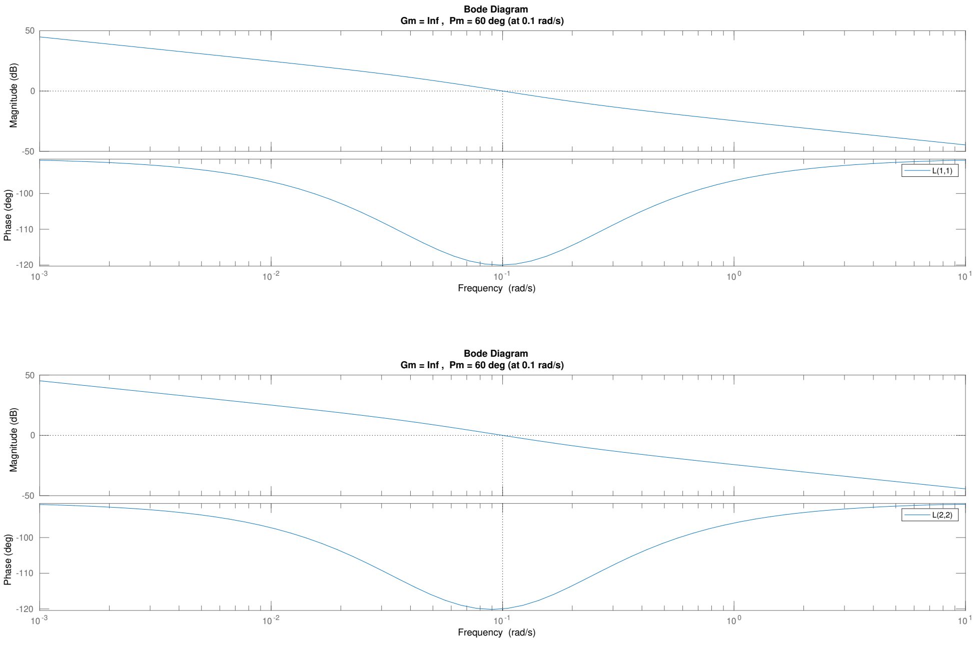
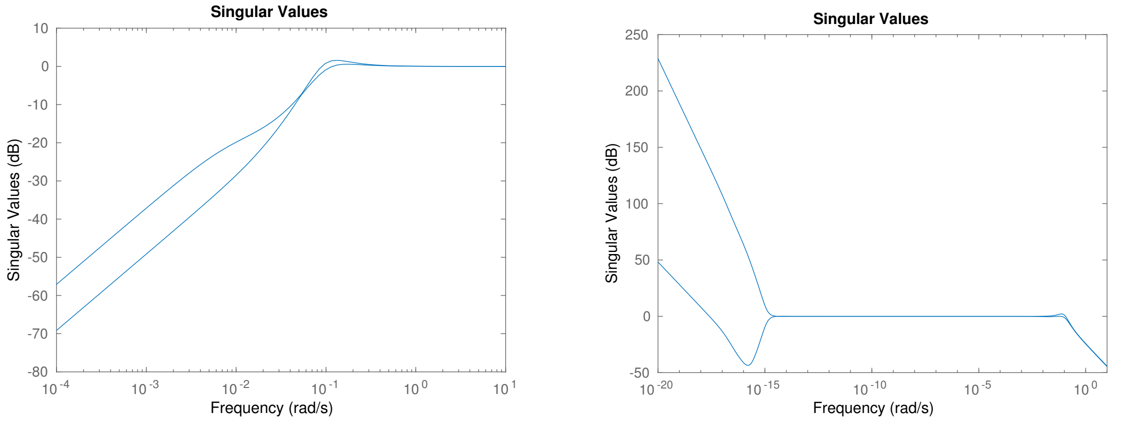


Figure 2: Bode diagram of the loop gain $L(s)$ from exercise 3.2.1.



(a) Singular values of the sensitivity S.

(b) Singular values of the complementary sensitivity T.

Figure 3: Singular values of S and T.

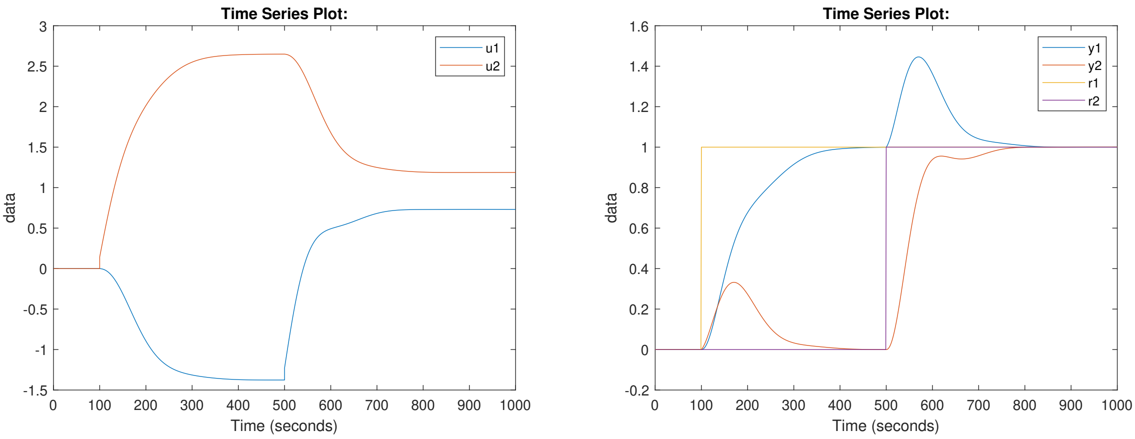
Non-minimum phase case

The controller is given by

$$F(s) = \begin{bmatrix} 0 & 0.1437(1 + \dfrac{1}{4.8107s}) \\ 0.1469(1 + \dfrac{1}{3.9426s}) & 0 \end{bmatrix}$$

The singular values of the sensitivity and complementary sensentivity are shown in the fig 6a and 6b. As we see, the controller will be more sensitive and less robust to the disturbance at low frequency, and less sensitive and more robust to the disturbance at high frequency.

As shown in the fig 4, the outputs are coupled and it is still strongly coupled. When given



(a) Response of the control signal u.

(b) Response of the output y with the reference r.

Figure 4: Simulink plots from exercise 3.2.3.

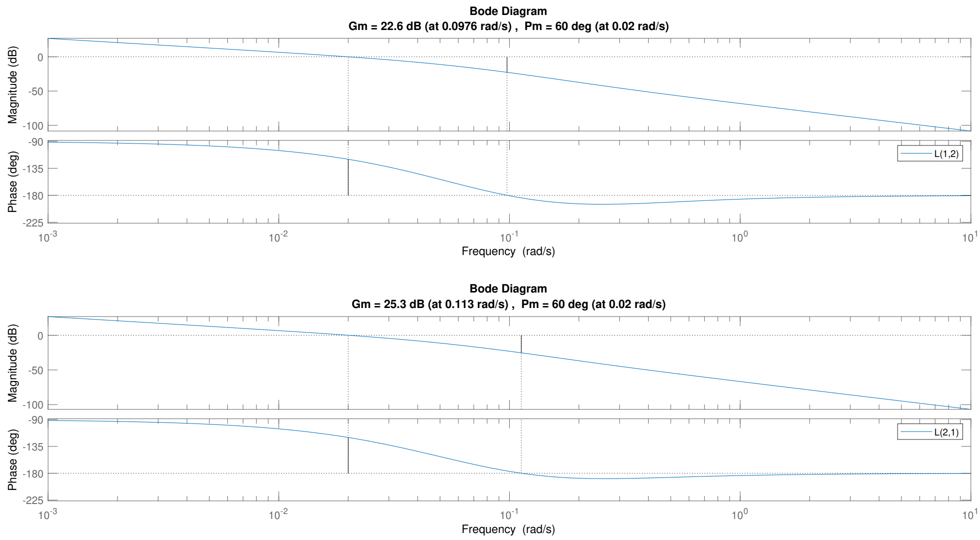
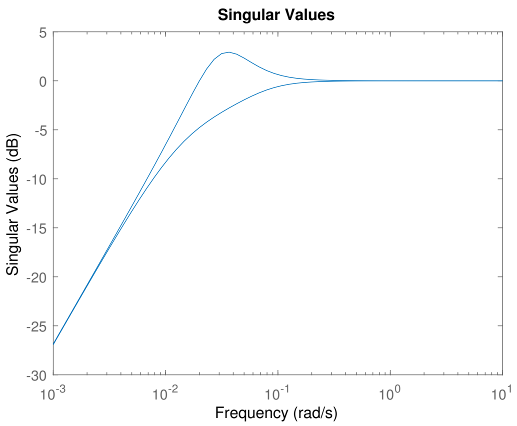
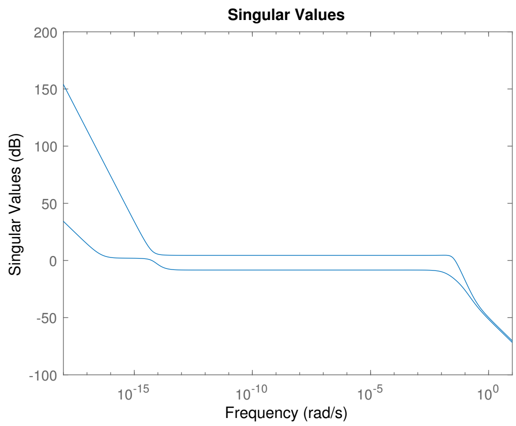


Figure 5: Bode diagram of the loop gain $L(s)$ from exercise 3.2.1.

a step response, the unrelated output will gain more impulse than minimum phase case, but it needs more time to be steady again. So we can conclude that the controller is not good enough.



(a) Singular values of sensitivity S.



(b) Singular values of complementary sensitivity T.

Figure 6: Singular values of S and T.