Computer Exercise 2
EL2520 Control Theory and Practice

Shengyang Zhuang
szhuang@kth.se
20000802-T172

Daniel Briem
djbriem@kth.se
981228-T492

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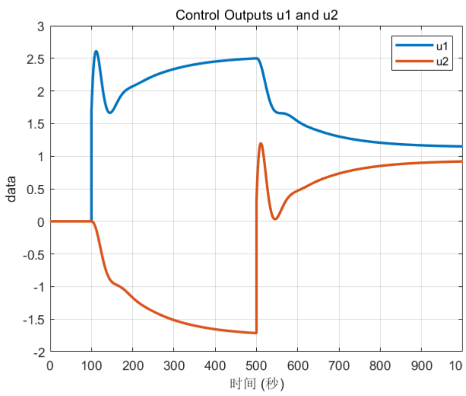
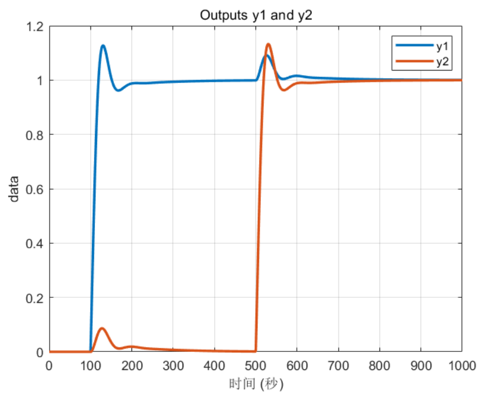
Minimum phase case

The controller is given by

$$F(s) = \begin{pmatrix} \frac{9.904s+1.678}{5.904s} & 0 \\ 0 & \frac{12.87s+2.014}{6.391s} \end{pmatrix}$$



(a) Simulation of control inputs



(b) Simulation of the outputs

Figure 1: Simulink plots from exercise 3.2.3

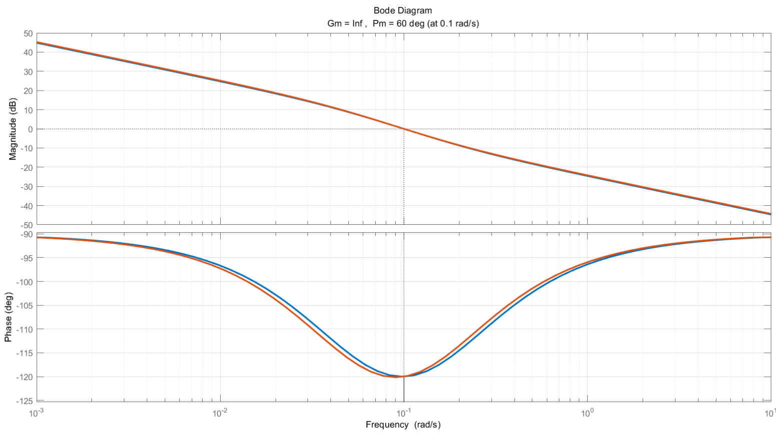


Figure 2: Bode diagram of the loop gain $L(s)$ from exercise 3.2.1

Is the controller good?
Fig.2 shows that through our designed decentralized controller, the phase margin is $\phi_m = 60°$(at 1.0rad/s) and $\phi_m = 60°$(at 1.0rad/s) for $l_{11}(s) = g_{11}(s)f_1(s)$(blue line) and $l_{22}(s) = g_{22}(s)f_2(s)$(red line) respectively. This corresponds to the intended phase margin and cross-over frequency. Besides, the course in fig. 1 shows a fast response to a step in the reference. Therefore, the controller is good.

Are the output signals coupled?
Yes, the output signals are coupled. Fig.1(b) shows that when the unit step signal was performed at $t = 100$, there is also a response at the output $y_2(t)$, though its peak amplitude is small, which is only around 0.0843. This situation also applies to the other way round when $t = 500$.

Non-minimum phase case

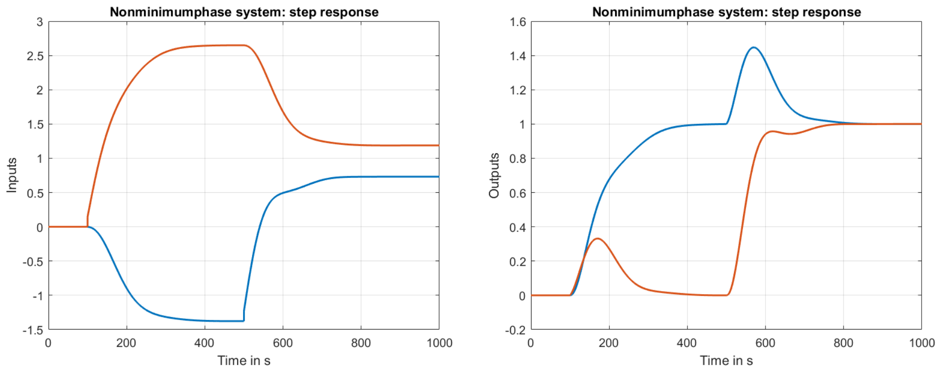
The controller is given by

$$F(s) = \begin{pmatrix} 0 & \frac{0.69s+0.14}{4.8s} \\ \frac{0.58s+0.15}{3.93s} & 0 \end{pmatrix}$$

Is the controller good?
The closed-loop has a quite low bandwith which is due to the RHP-zero. In the simlated outputs we see a large raise-time of almost 100s. The controller satisfies the requirements on crossover-frequency $w_c = 0.2\frac{\mathrm{rad}}{\mathrm{s}}$ and phase-margin of $\varphi_{\mathrm{m}} = \pi/3$ for both SISO-systems, as can be seen in fig. 4.

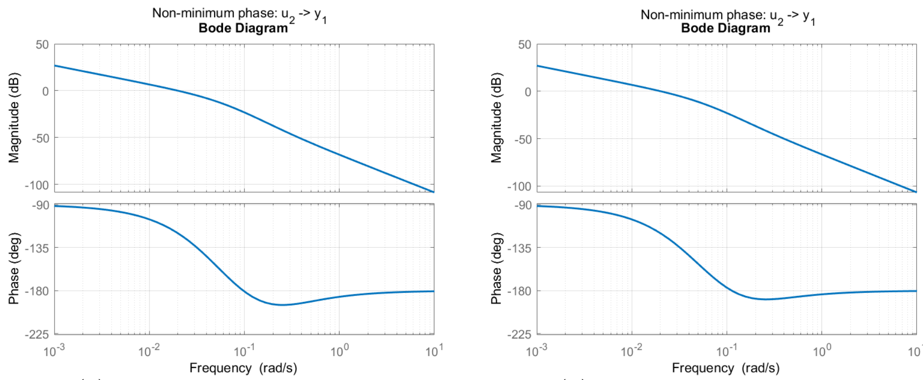
Are the output signals coupled?
Yes, the outputs are still coupled, also in the non-minimum phase system. One can see this in fig. 3(b). When there is a step in the reference for the

first output there occurs also a deviation in the second output and vice-versa. With a deviation of around 0.4, this coupling is quite strong, especially in comparison to the minimum phase system.



(a) Bode-plot of G (b) Simulation of the outputs

Figure 3: Simulink plots from exercise 3.2.3



(a) Bode-plot of $G_{12}F_{12}$ (b) Bode-plot of $G_{21}F_{21}$

Figure 4: Bode diagram of the loop gain $L(s)$ from exercise 3.2.1