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

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

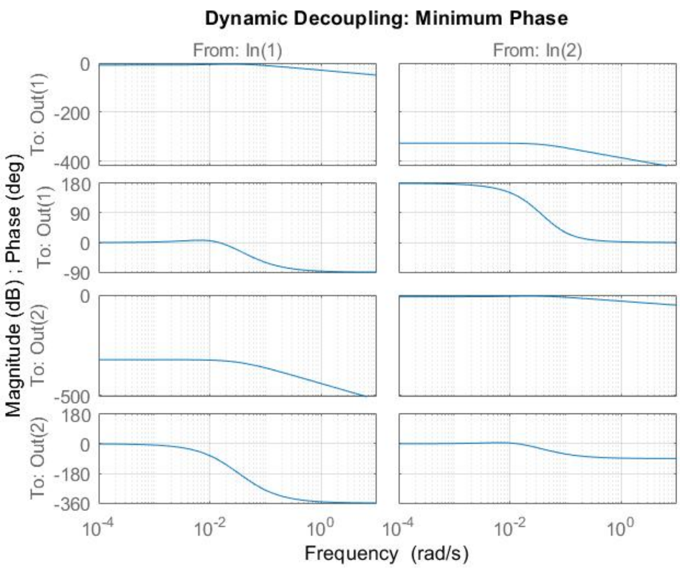

Figure 1: Bode diagram of $\tilde{G}(s)$ derived in exercise 3.2.1

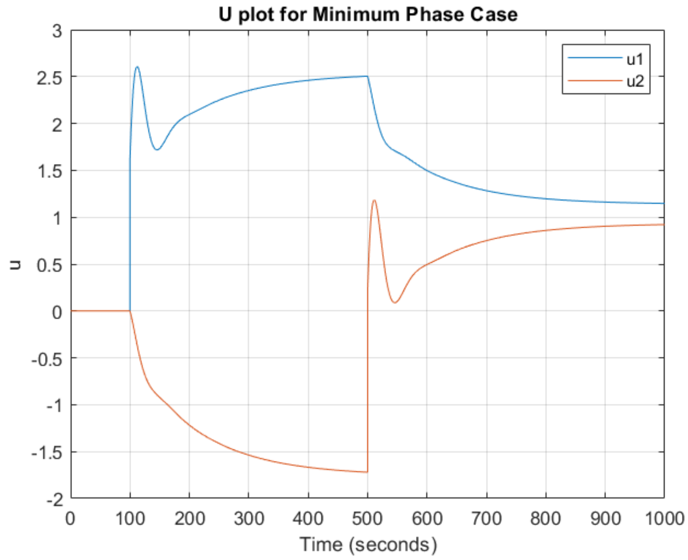

Figure 2: Simulink plots for input; from exercise 3.2.4

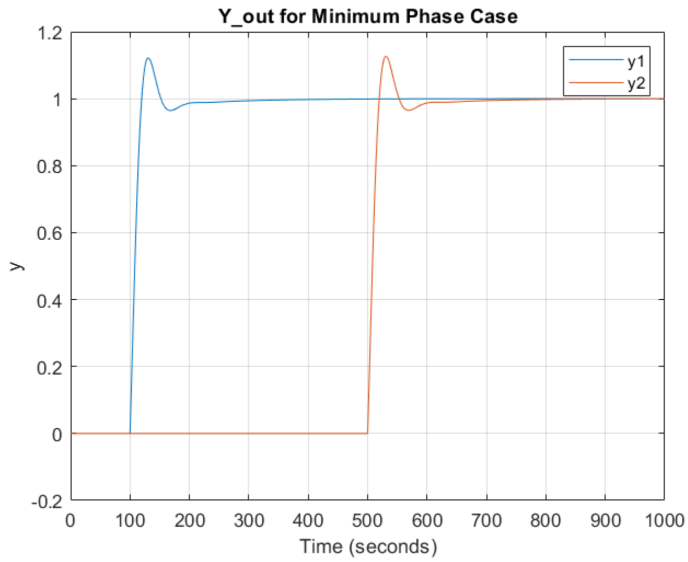

Figure 3: Simulink plots for output; from exercise 3.2.4

Is the controller good?

Yes controller is good, because from the above plots(fig.2 and fig.3), we can see that both the outputs y1 and y2 are tracked with 0 steady state error and minimal overshoot. Also, when the Singular Values of Sensitivity function and Complimentary Sensitivity functions were observed, we found that this controller offered very good attenuation to the input for the cross output disturbance(u1 and y2; u2 and y1).

Are the output signals coupled?
No, the output signals are not coupled. We can observe from the above plots(fig.2 and fig.3) that only output y1 is significantly affected by input u1 and output y2 is significantly affected when input u2 acts. Therefore, the output signals are decoupled.

Glover-MacFarlane robust loop-shaping

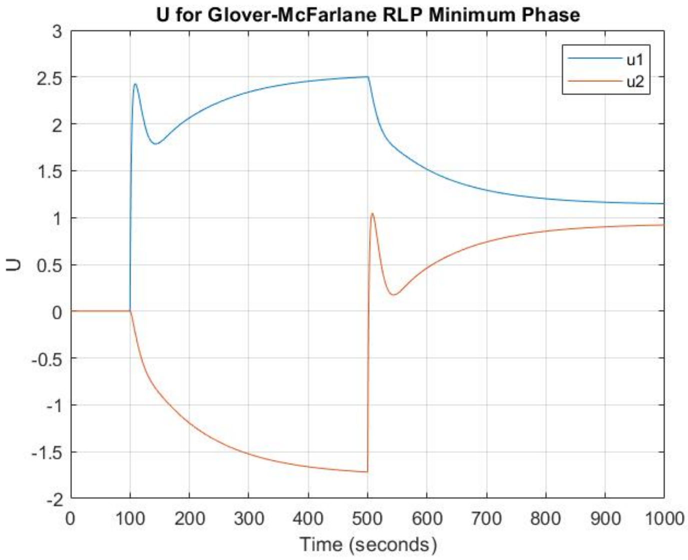

Figure 4: Simulink plots for input; from exercise 3.3.4

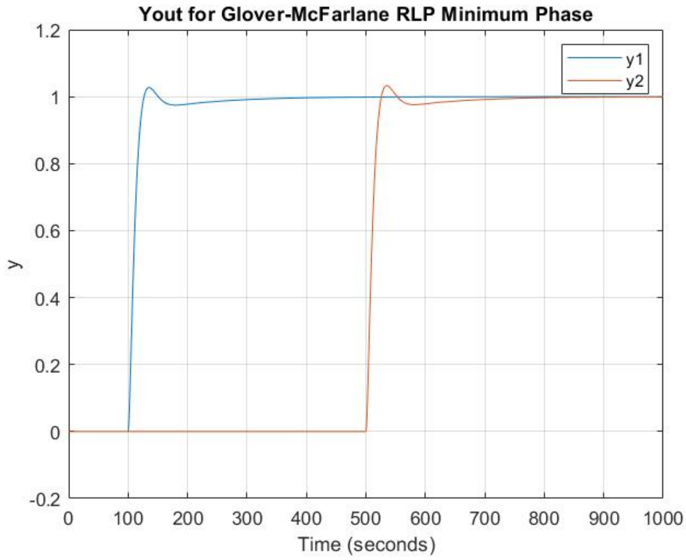

Figure 5: Simulink plots for output from exercise 3.3.4

What are the similarities and differences compared to the nominal design?
From the above plots we can observe that both the methods were successful in decoupling the system. If we talk about the performance of the system, both the methods produced good controllers which tracked the reference output with no steady state errors and acceptable overshoots but Glover-McFarlane's Robust Loop Shaping method produced lesser overshoot as compared to the nominal design.

Non-minimum phase case

Dynamic decoupling

The dynamic decoupling in exercise 3.2.1 is

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

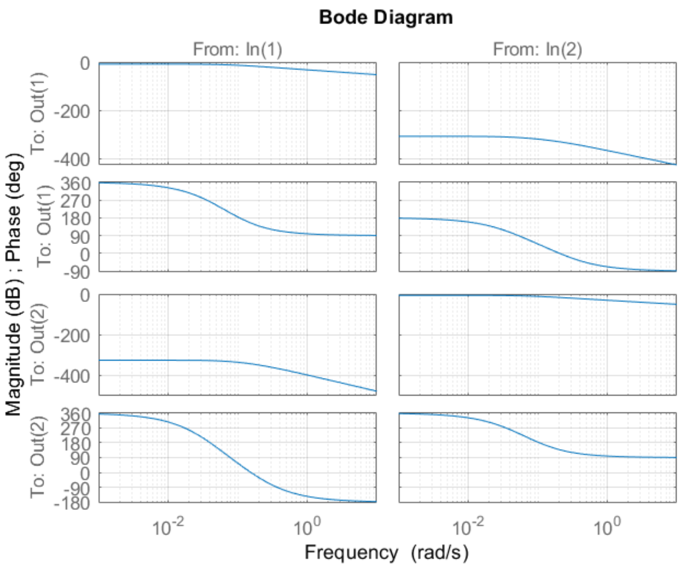

Figure 6: Bode diagram of $\tilde{G}(s)$ derived in exercise 3.2.1

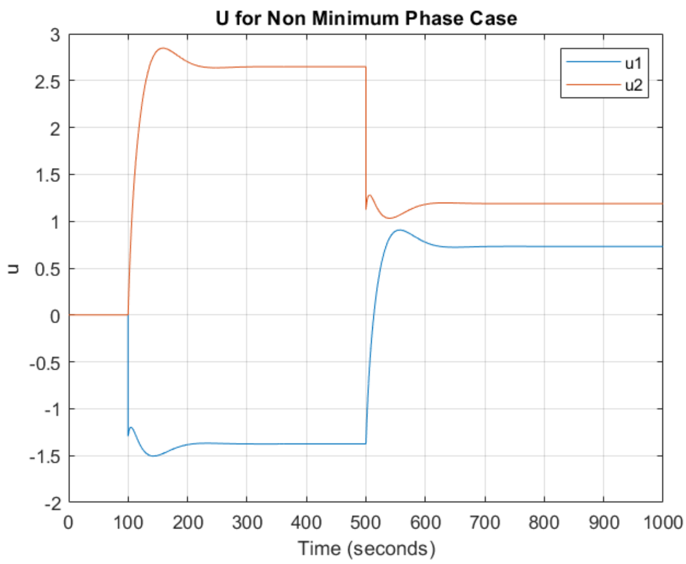

Figure 7: Simulink plots for input; from exercise 3.2.4

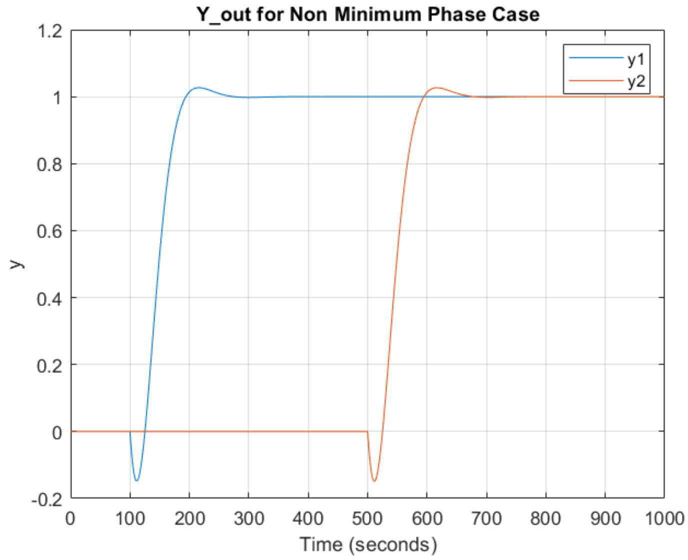

Figure 8: Simulink plots for output; from exercise 3.2.4

Is the controller good?
Yes controller is good, because from the above plots(fig.7 and fig.8), we can see that both the outputs y1 and y2 are tracked with 0 steady state error and minimal overshoot even though the rise time in this case is higher than that in the minimum phase case. Also, when the Singular Values of Sensitivity function and Complimentary Sensitivity functions were observed, we found that this controller offered very good attenuation to the input for the cross output disturbance(u1 and y1; u2 and y2)

Are the output signals coupled?
No, the output signals are not coupled. We can observe from the above plots(fig.7 and fig.8) that only output y1 is significantly affected by input u2 and output y2 is significantly affected when input u1 acts. Therefore, the output signals are decoupled.

Glover-MacFarlane robust loop-shaping

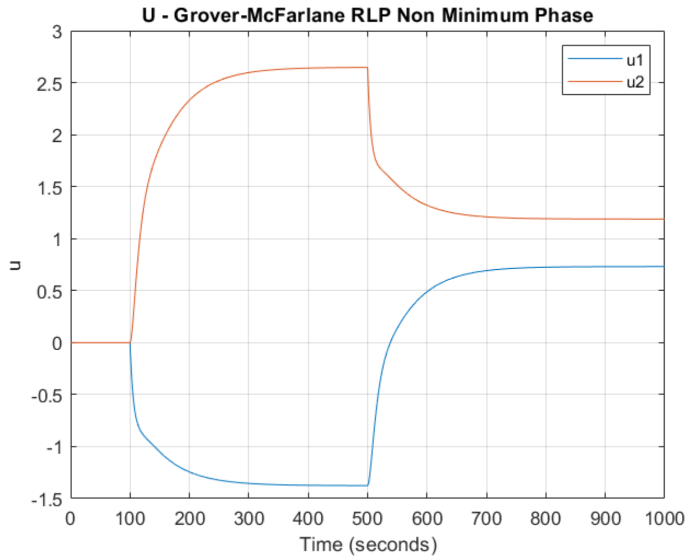

Figure 9: Simulink plots for input; from exercise 3.3.4

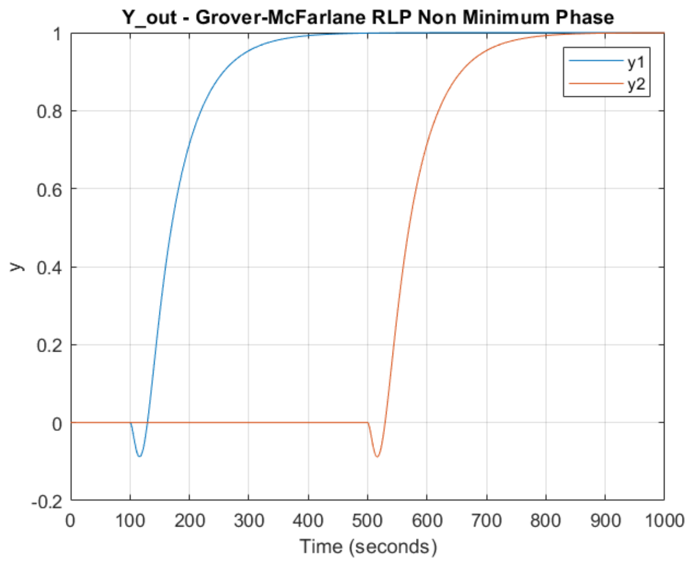

Figure 10: Simulink plots for output from exercise 3.3.4

What are the similarities and differences compared to the nominal design?
From the above plots we can observe that both the methods were successful

in decoupling the system. If we talk about the performance of the system, both the methods produced good controllers which tracked the reference output with no steady state errors. Glover-McFarlane's Robust Loop Shaping method produced no overshoot for non-minimum phase case, but it had a higher rising time than the nominal design.