

Home Work #5

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1 Question 1

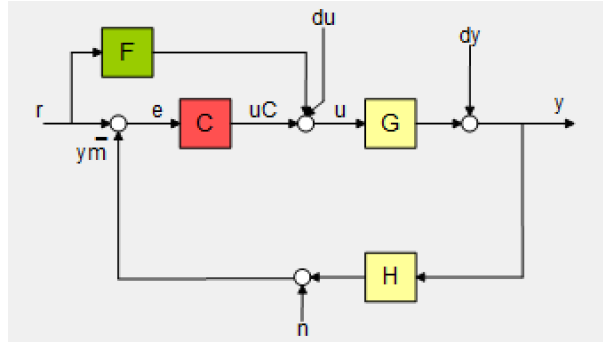
System:

$$G(s) = \frac{s+1}{s^2-2s+4}$$

System is NMP (Non Minimum Phase) because it have poles in right side and system is unstable.

Architector:

Figure 1: Architector of system in siso matlab toolbox

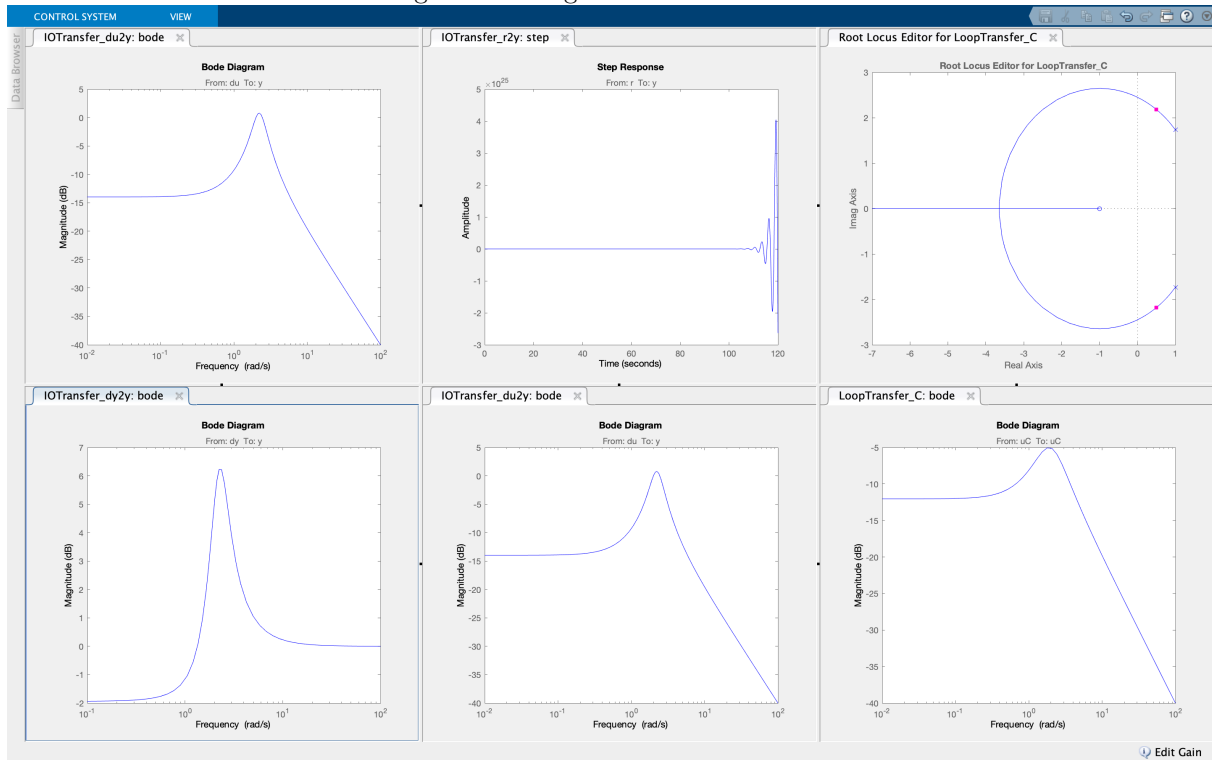


1.1 part a

In condition without controller from architector $C(s) = 1$ and $F(s) = 0$.

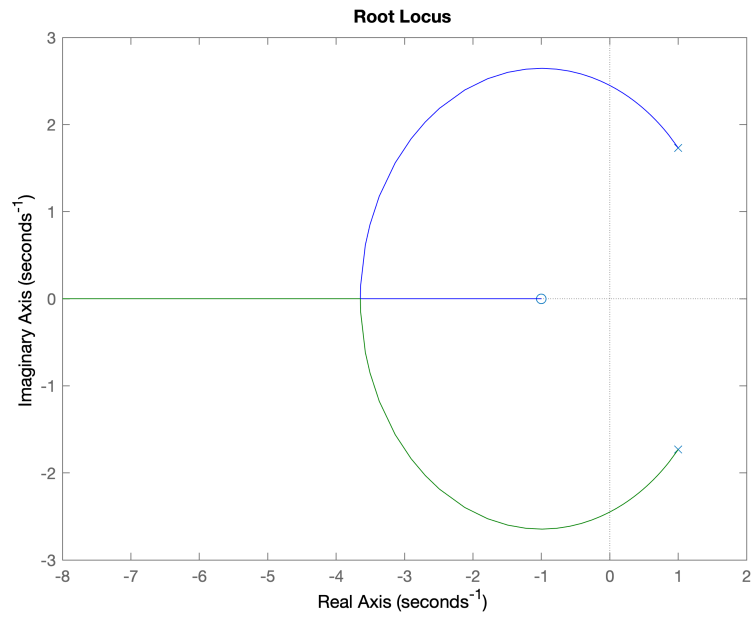
- all figures from siso toolbox

Figure 2: All figures from siso toolbox



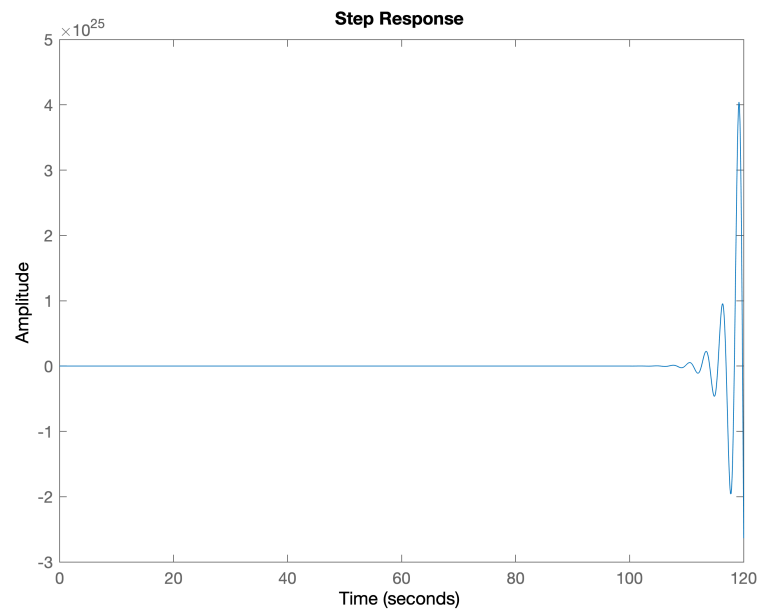
- root locus

Figure 3: root locus



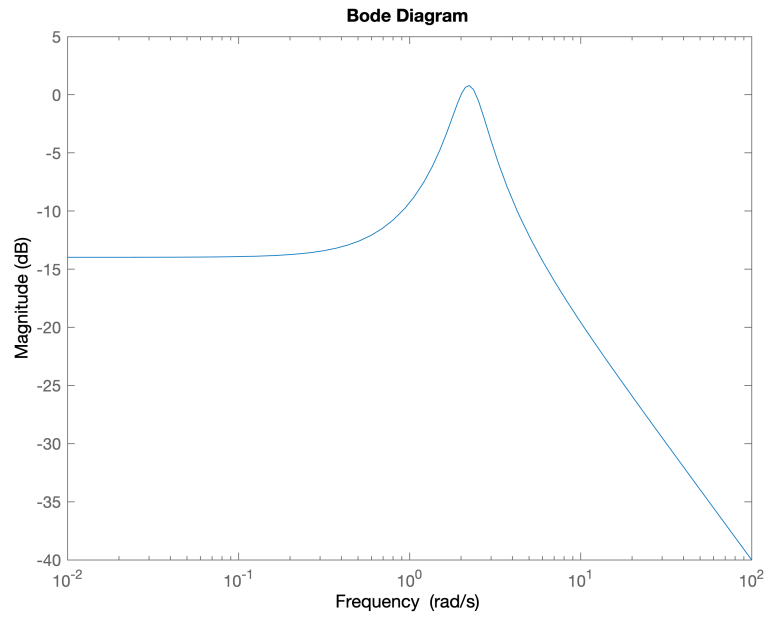
- step response for closeloop system

Figure 4: step response for closeloop system



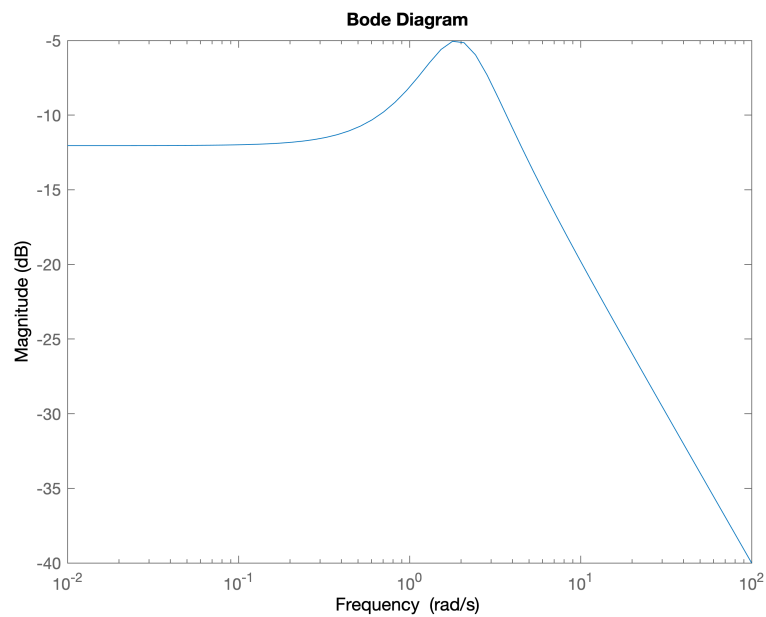
- closeloop bode (magnitude)

Figure 5: closeloop bode (magnitude)



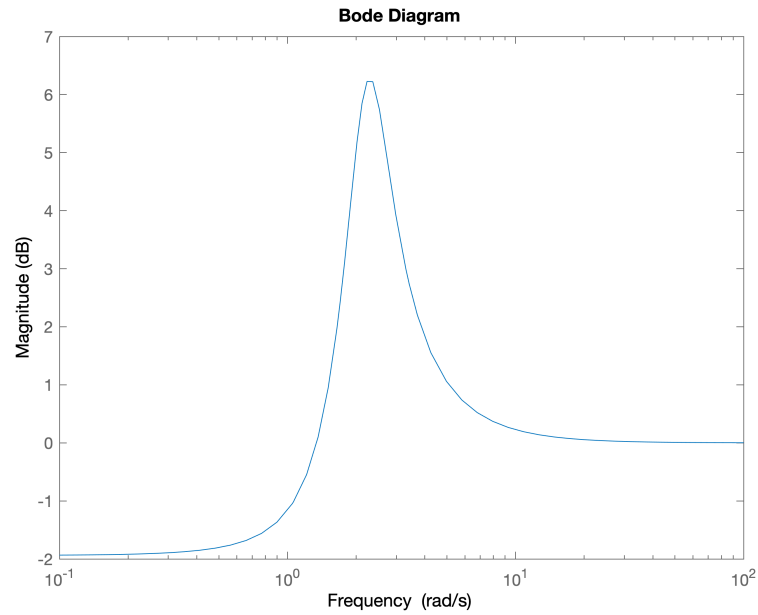
- openloop bode (magnitude)

Figure 6: openloop bode (magnitude)



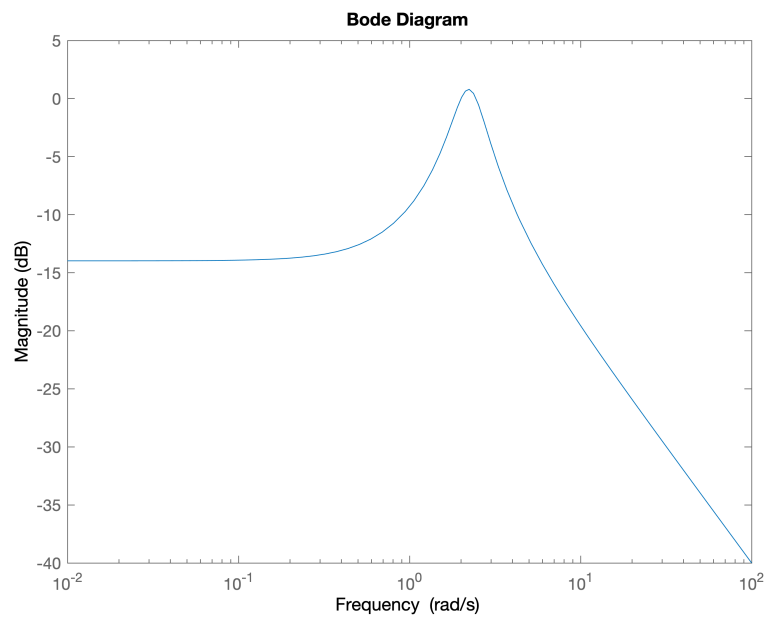
- sensitivity function

Figure 7: sensitivity function



- complementary sensitivity function

Figure 8: complementary sensitivity function



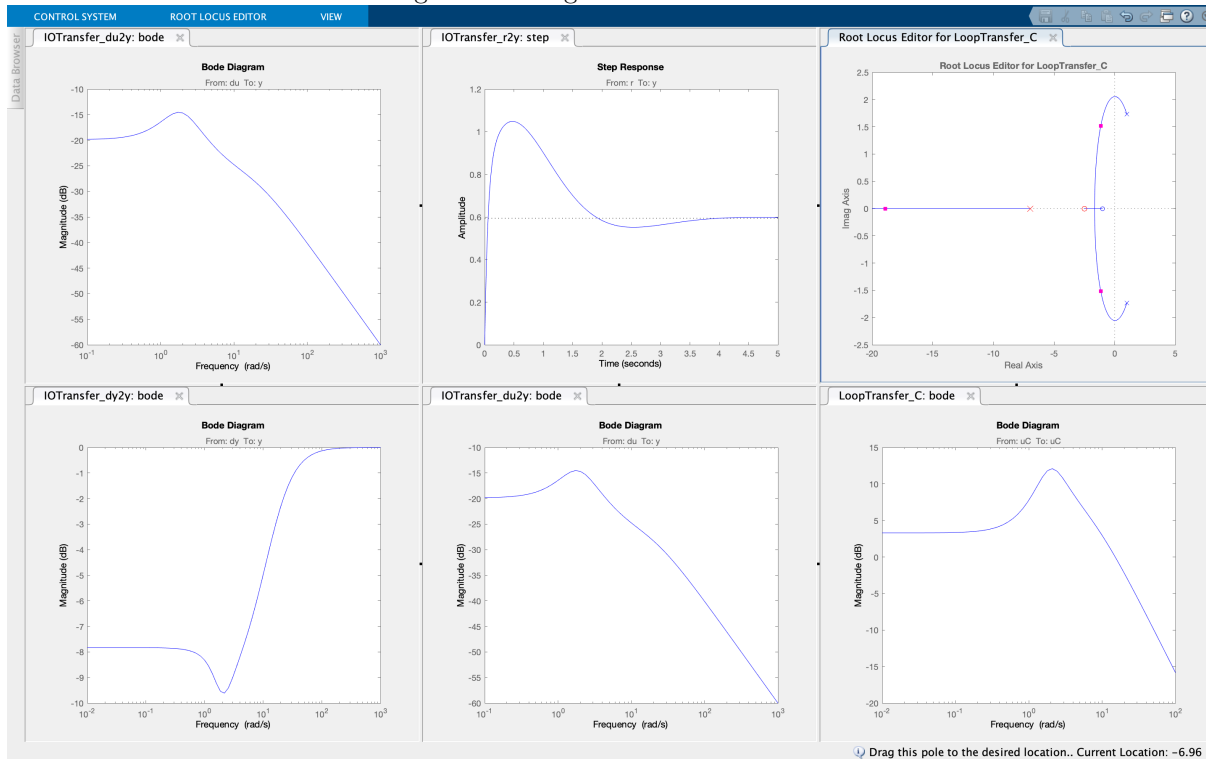
1.2 part b

We design a lead controller with siso toolbox.

$$C(s) = \frac{16.231(s + 2.51)}{s + 6.963}$$

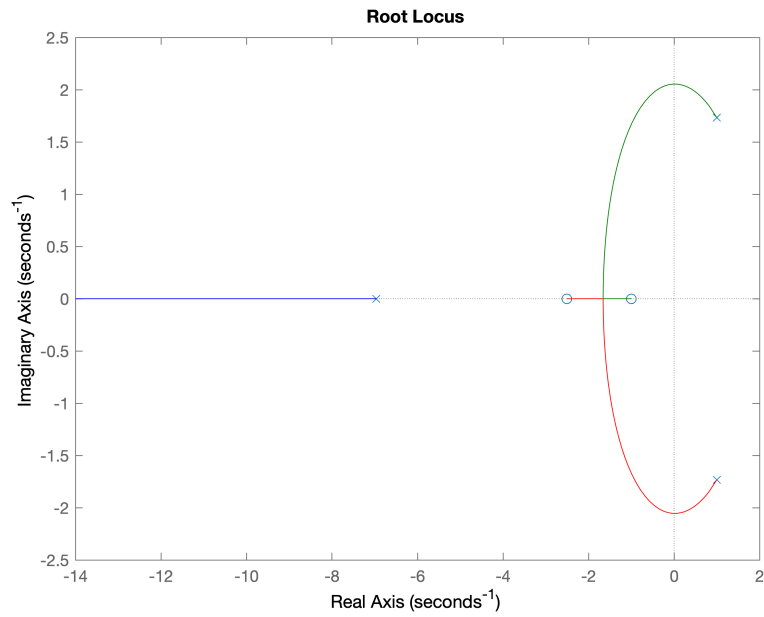
- all figures from siso toolbox

Figure 9: All figures from siso toolbox



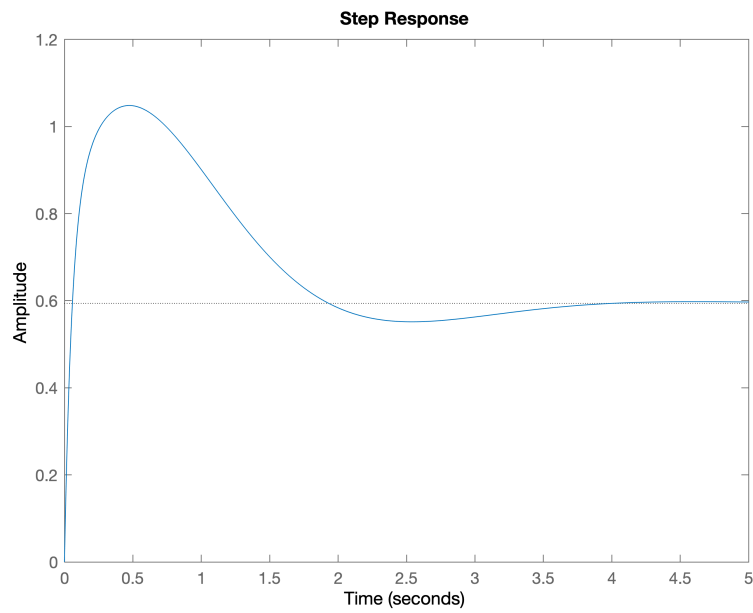
- root locus with lead controller

Figure 10: root locus



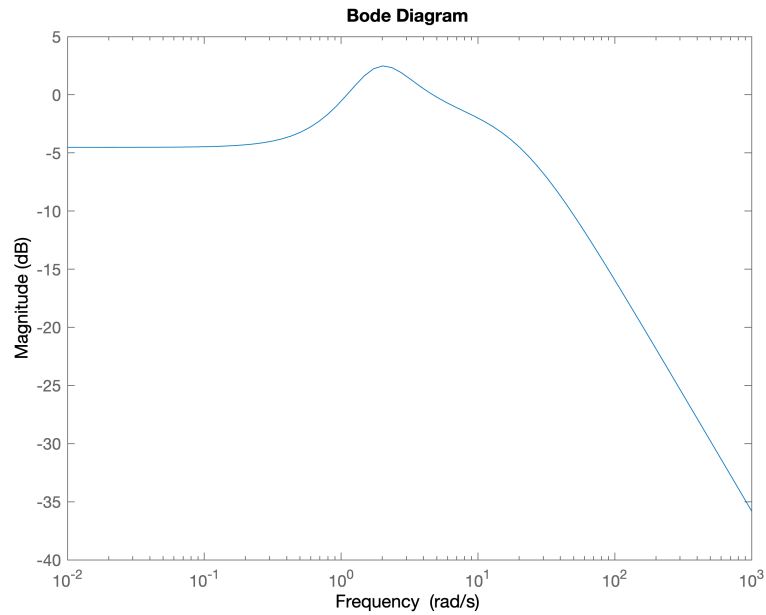
- step response for closeloop system with lead controller

Figure 11: step response for closeloop system



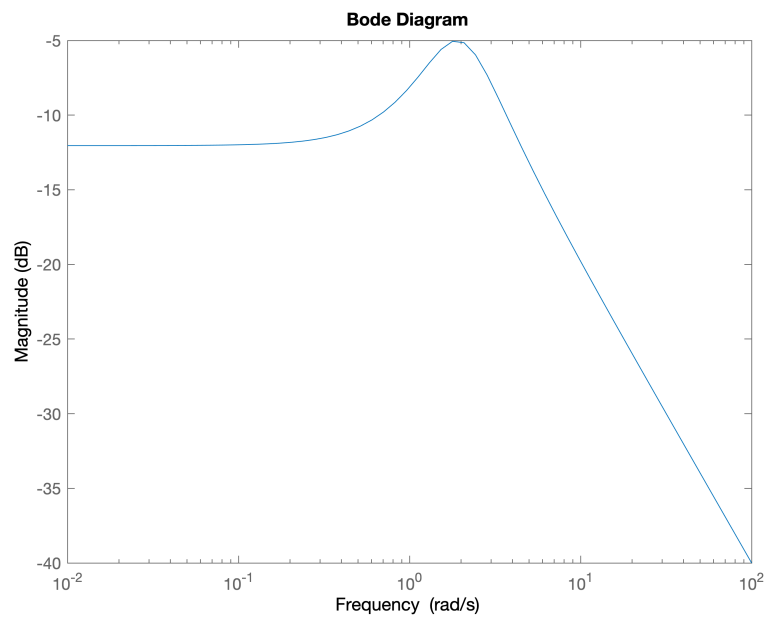
- closeloop bode (magnitude) with lead controller

Figure 12: closeloop bode (magnitude)



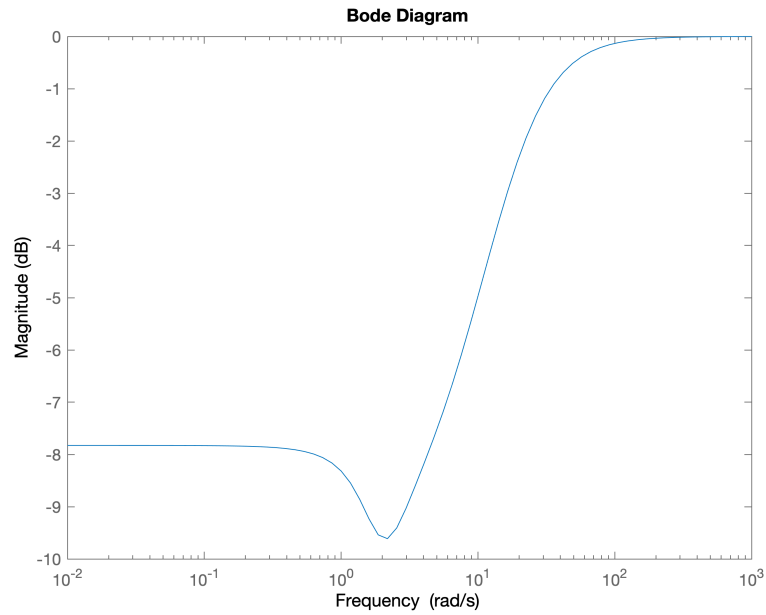
- openloop bode (magnitude) with lead controller

Figure 13: openloop bode (magnitude)



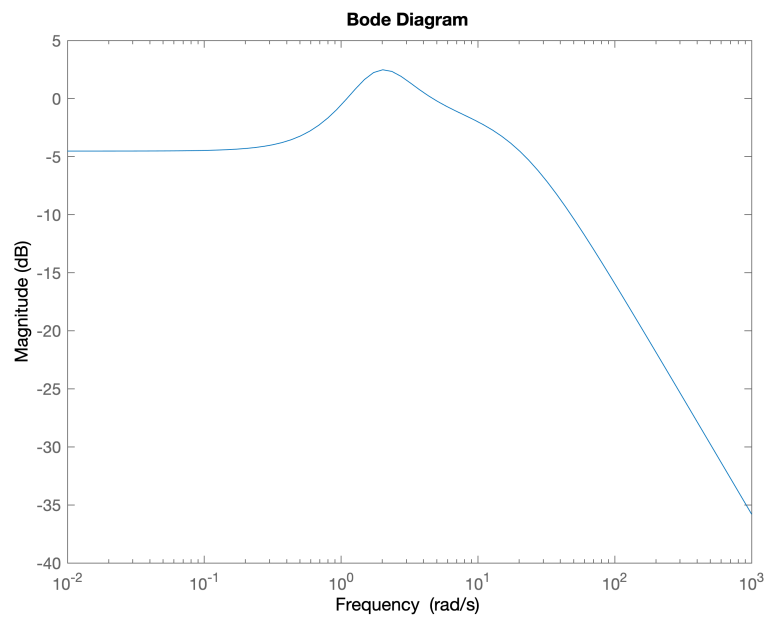
- sensitivity function with lead controller

Figure 14: sensitivity function



- complementary sensitivity function with lead controller

Figure 15: complementary sensitivity function



System is stable with controller and have a noise cancelation for frequency after $100_{rad/sec}$ and it have effect on system about -20_{dB} . System have very good disturbance rejection about $1_{rad/sec}$ and have a good disturbance rejection about $10_{rad/sec}$ and disturbance have effect on system about -5_{dB} .

In this question we don't know what is plant and actuator and how noise or disturbance effect on system and about what frequency so we assume that noise is about more than $100_{rad/sec}$ and disturbance is about $10_{rad/sec}$ and -5_{dB} is a low effect and system work well.

No. System have steady state error. we could increase gain in controller but it needed very high gain controller and no actuator can do this so we can't make steady state error zero with this requirements.

1.3 part c

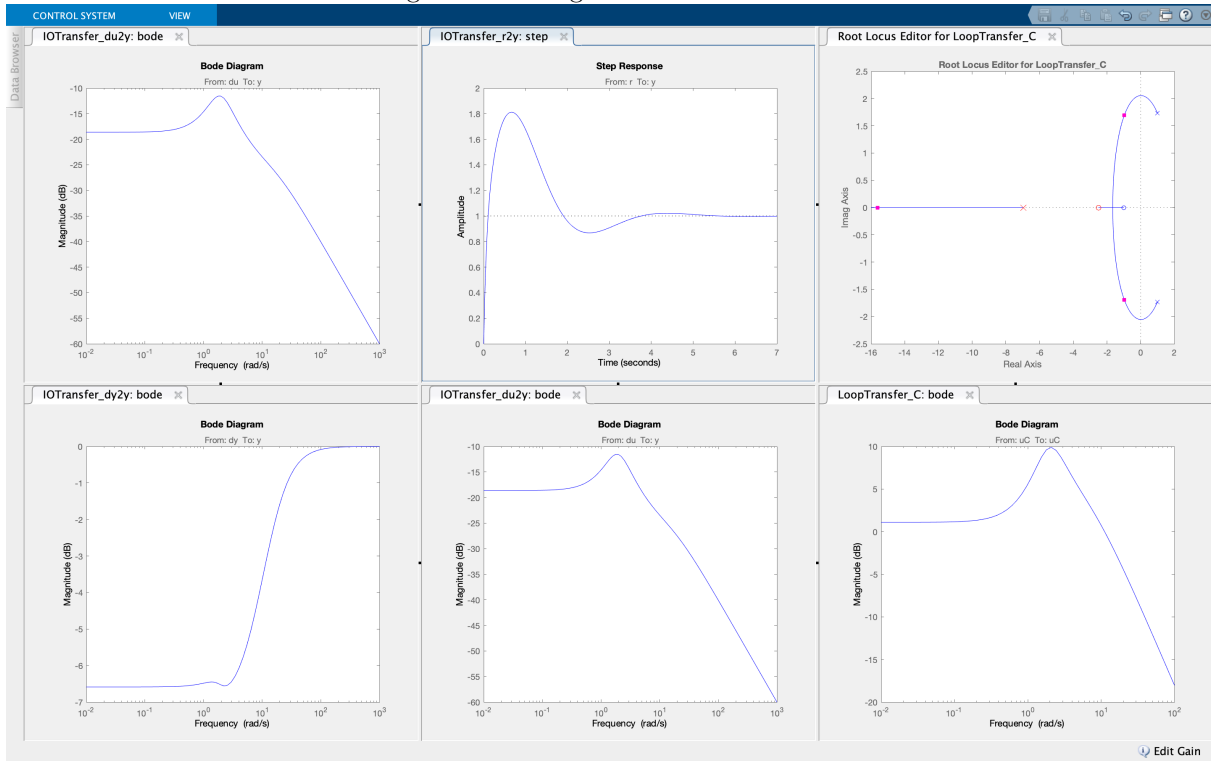
Now we design feedforward controller to make steady state error zero.

$$\lim_{s \rightarrow 0} \frac{s+1}{s^2-2s+4} = 4 \rightarrow F(s) = 4$$

With this controller steady state is zero and with lead controller (that we have designed in part d) we achieve requirements.

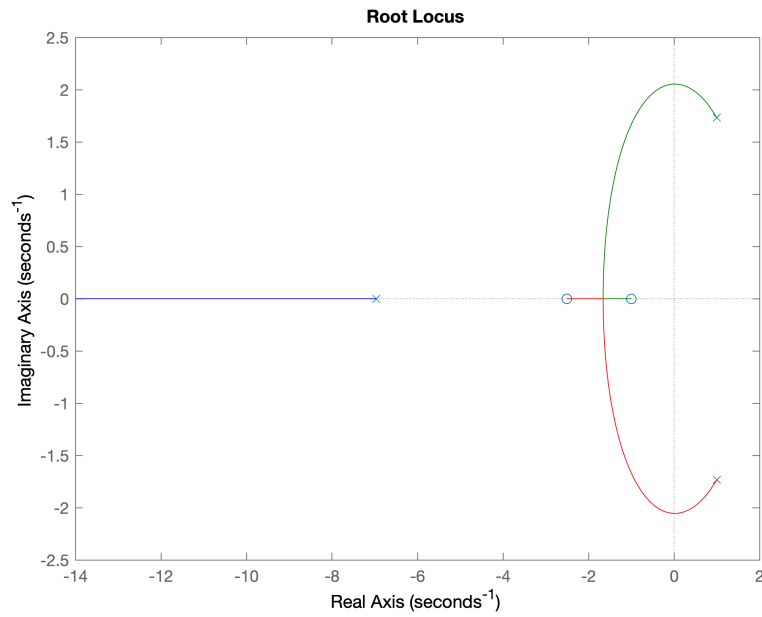
- all figures from siso toolbox

Figure 16: All figures from siso toolbox



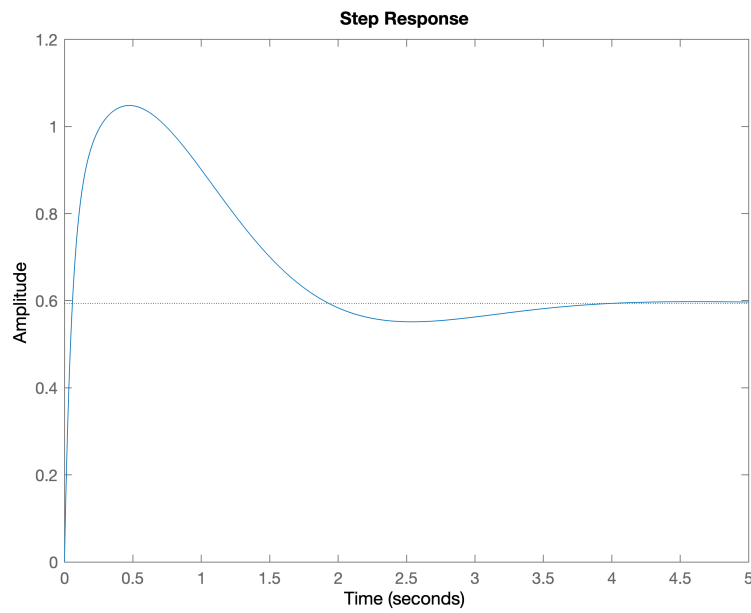
- root locus with lead and feedforward controller

Figure 17: root locus



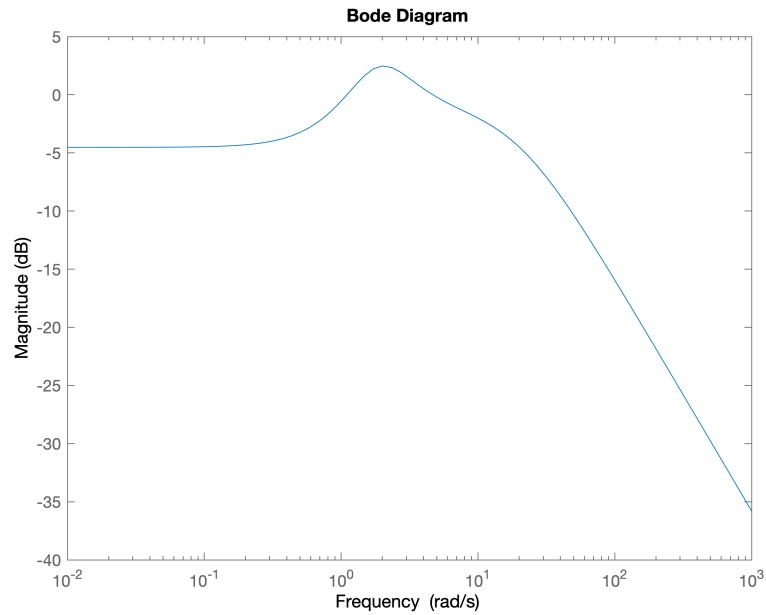
- step response for closeloop system with lead and feedforward controller

Figure 18: step response for closeloop system



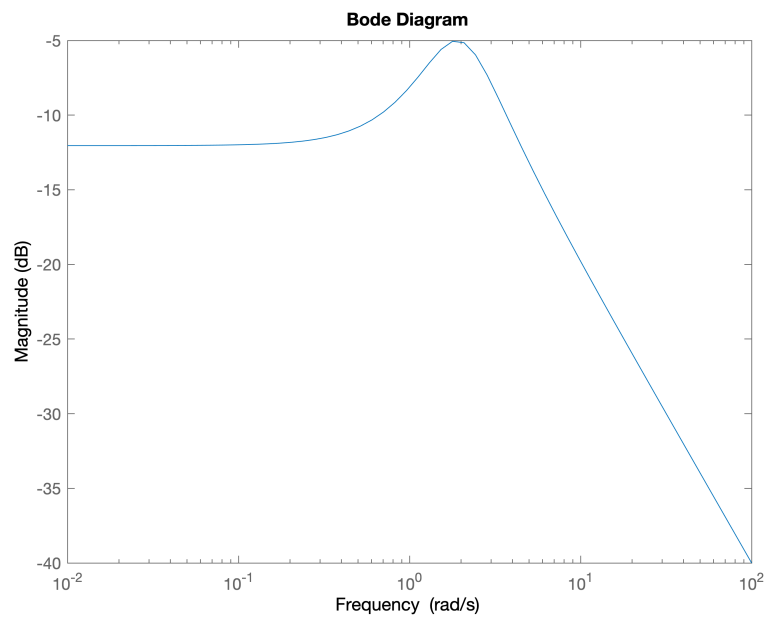
- closeloop bode (magnitude) with lead and feedforward controller

Figure 19: closeloop bode (magnitude)



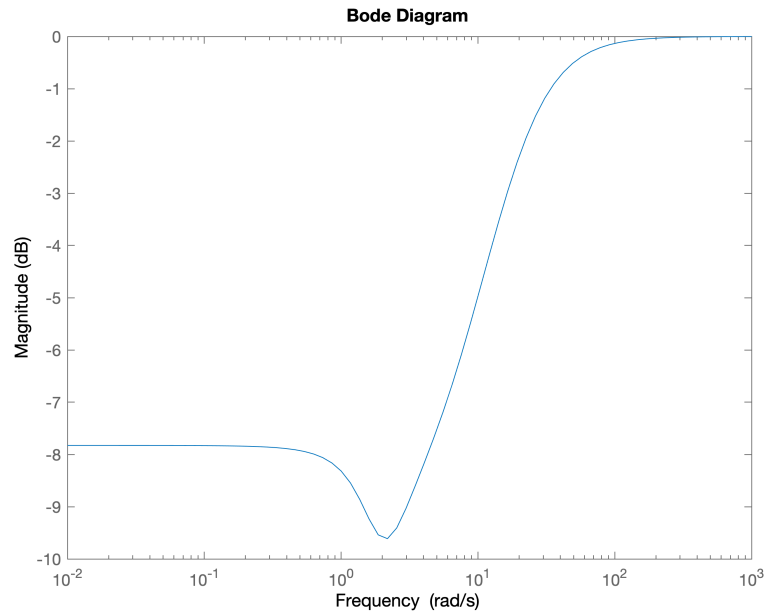
- openloop bode (magnitude) with lead and feedforward controller

Figure 20: openloop bode (magnitude)



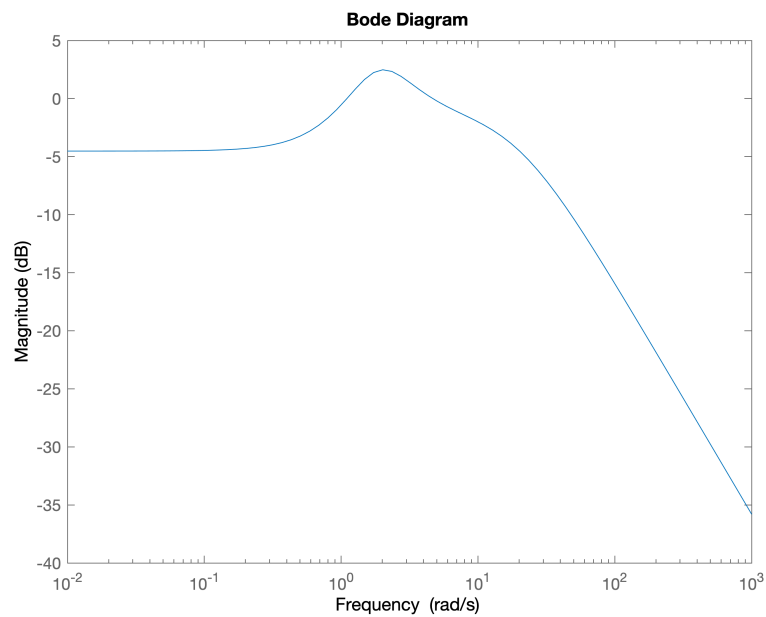
- sensitivity function with lead and feedforward controller

Figure 21: sensitivity function



- complementary sensitivity function with lead and feedforward controller

Figure 22: complementary sensitivity function



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