Home Work #4

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November 12, 2021

1 Question 1

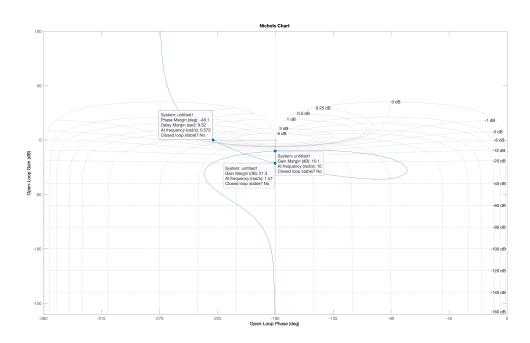
System:

$$G(s) = \frac{(s+1)(s+4)(s+8)}{s^3(s^2+0.2s+100)}$$

1.1 part a

• K = 0.5

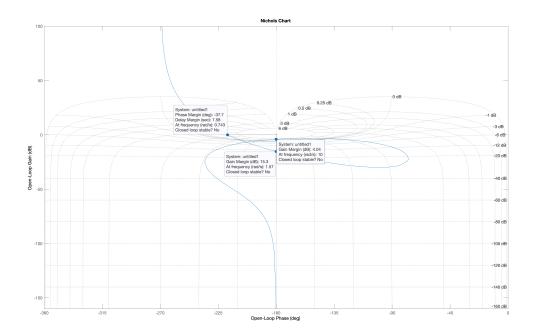
Figure 1: Nichols chart for KG, (K = 0.5)



 \bullet K=1

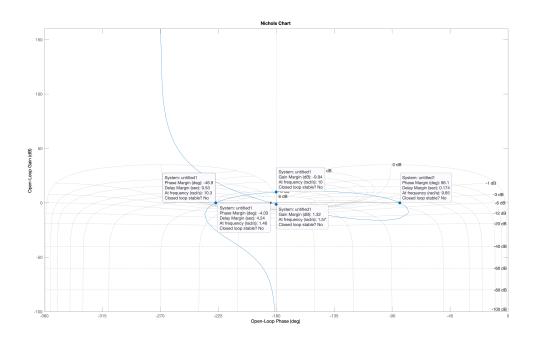
Ali BaniAsad 96108378 1.1 part a

Figure 2: Nichols chart for KG, (K = 1)



• K = 5

Figure 3: Nichols chart for KG, (K = 5)



Ali BaniAsad 96108378 1.2 part b

Phase margin and gain margin are shown in above figures and all closed loop systems are unstable with K form 1 to 5. In all of them phase margin is negetive.

1.2 part b

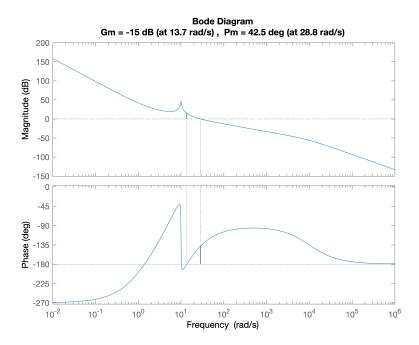
I use a zero and a far pole to make controller feasible.

Controller:

$$C(s) = \frac{2.2368 \times 10^5 (s+11.91)}{s+10^4}$$

Phase margin is above 40 degree.

Figure 4: Phase margin with controller



Maximum closed loop is below than 3 decibels.

Ali BaniAsad 96108378 1.2 part b

Figure 5: Nichols chart with controller

Setteing time and overshoot for step responde in closed loop system are shown in figure.

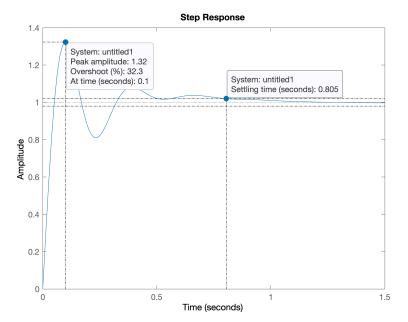


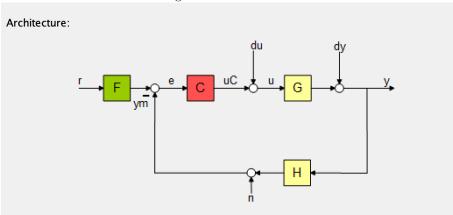
Figure 6: Step responde

Ali Bani Asad 96108378 $1.3 \quad \mathrm{part} \ \mathrm{c}$

1.3 part c

For transfer function we use common architecture.

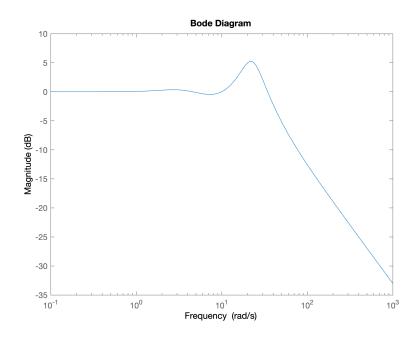
Figure 7: Architecture



 $\bullet\,$ r to y refrence

$$\frac{y}{r} = \frac{C(s)G(s)}{1 + C(s)G(s)}$$

Figure 8: r to y bode magnitude



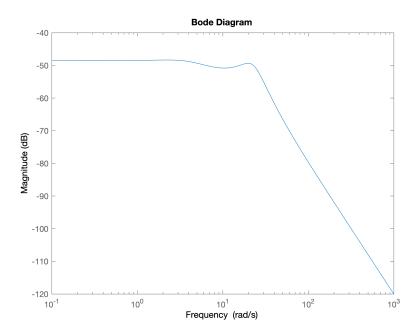
System has a good performance at high frequency but not good performance at low frequency.

Ali Bani Asad 96108378 $1.3 \quad \mathrm{part} \ \mathrm{c}$

• du to y distubance

$$\frac{y}{du} = \frac{G(s)}{1 + C(s)G(s)}$$

Figure 9: du to y bode magnitude



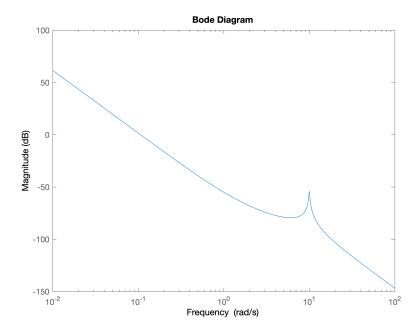
System has a better performance at high frequency but pretty good performance at low frequency.

• dy to y distubance

$$\frac{y}{dy} = \frac{1)}{C(s)G(s)}$$

Ali Bani Asad 96108378 $1.3 \quad \mathrm{part} \ \mathrm{c}$

Figure 10: dy to y bode magnitude



System has a good performance at high frequency but very bad performance at low frequency.

• n to y noise

$$\frac{y}{du} = \frac{-C(s)G(s)}{1 + C(s)G(s)}$$

Ali Bani Asad 96108378 $1.4 \quad \mathrm{part} \ \mathrm{d}$

Figure 11: n to y bode magnitude

System has a good performance at high frequency but not good performance at low frequency.

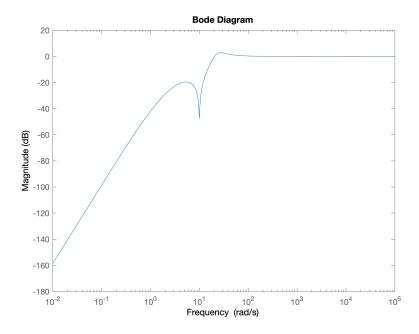
1.4 part d

 $\bullet\,$ sensitivity function

$$S_G^{G_{cl}} = \frac{1}{1 + C(s)G(s)}$$

Ali Bani Asad 96108378 $1.4 \quad \mathrm{part} \ \mathrm{d}$

Figure 12: sensitivity function bode magnitude



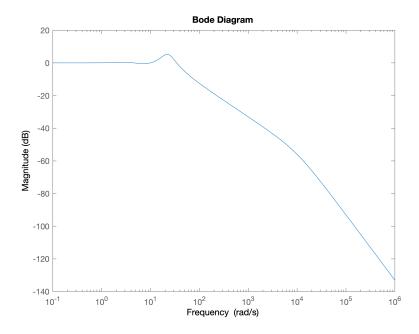
System sensitivity is very hight at high frequency but low at low frequency.

• complementary sensitivity function

$$S_G^{G_{cl}} = \frac{C(s)G(s)}{1 + C(s)G(s)}$$

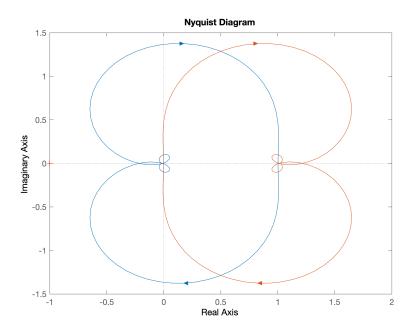
Ali Bani Asad 96108378 $1.4 \quad \mathrm{part} \ \mathrm{d}$

Figure 13: complementary sensitivity function bode magnitude



• Nichols chart for sensitivity function and complementary sensitivity function

Figure 14: nyquist chart



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