Assignment 4

Refined Root Locus Sketching and Bode plots

Refined Root Locus Sketching

For the following systems, sketch the root locus diagrams and where appropriate include the system's asymptotes (show calculations). Then calculate the break-away/in points for the root locus and the imaginary axis intercepts for the systems 1. In class we discussed two techniques for calculate the break-away/in points, I would like you to attempt both methods to compare their complexity (show working). For system 2, calculate the angle of departure for the complex root (instead of the break-away/in points). For ease of computation, you may round to the first decimal place, but state this in you answer.

$$\frac{s^2 - 3s + 2}{s^2 + 7s + 12} \tag{1}$$

$$\frac{s + 3}{0.9s^3 + 3s^2 + 5s + 2} \tag{2}$$

Bode Plots

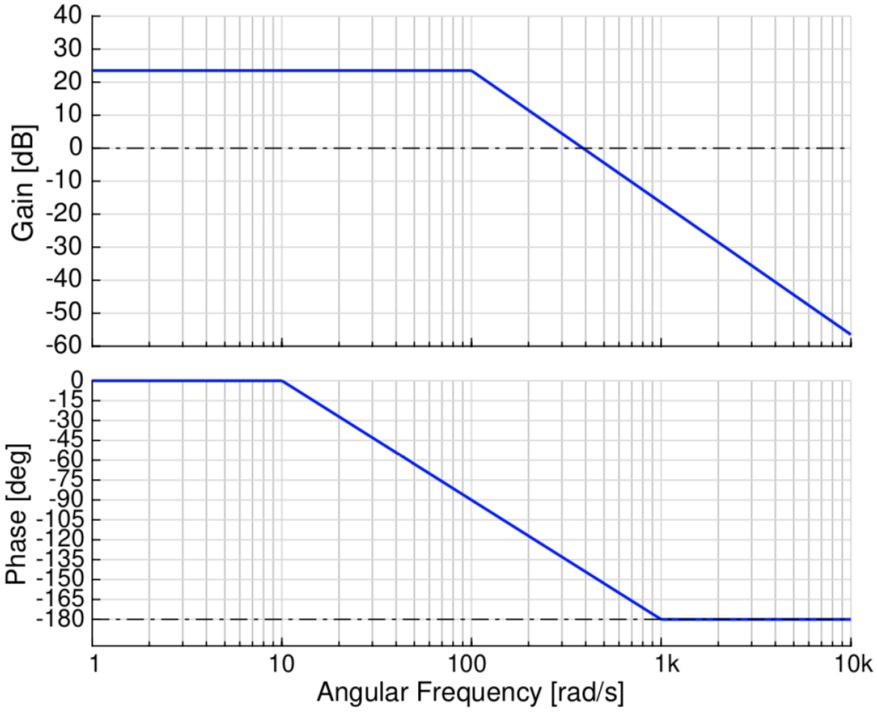
Note: Bode plot paper is available on the wiki, you dont have to print it out, you can "sketch" using any software (that can draw lines).

1. For the following systems, change the equation to the equivalent form, plot the gain, s^n, $(s + a)^{\pm 1}$ and $(s^2 + 2\zeta\omega_n s + \omega_n^2)^{\pm 1}$ terms separately on the same bode plot and graphically add them. Identify the gain and phase margins and comment on whether the closed loops system is stable or not. (show all working)

$$\frac{s + 30}{s^2 + 2s} \tag{3}$$

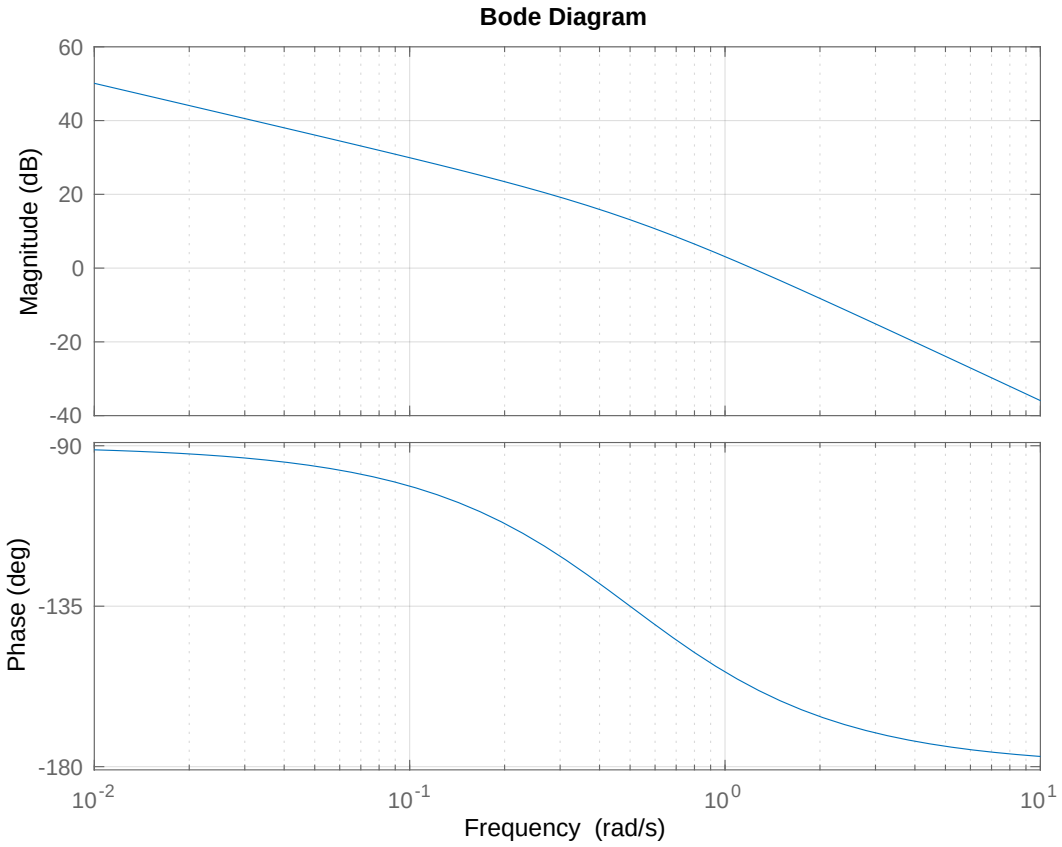
$$\frac{106}{s^3 + 16s + 64s} \tag{4}$$

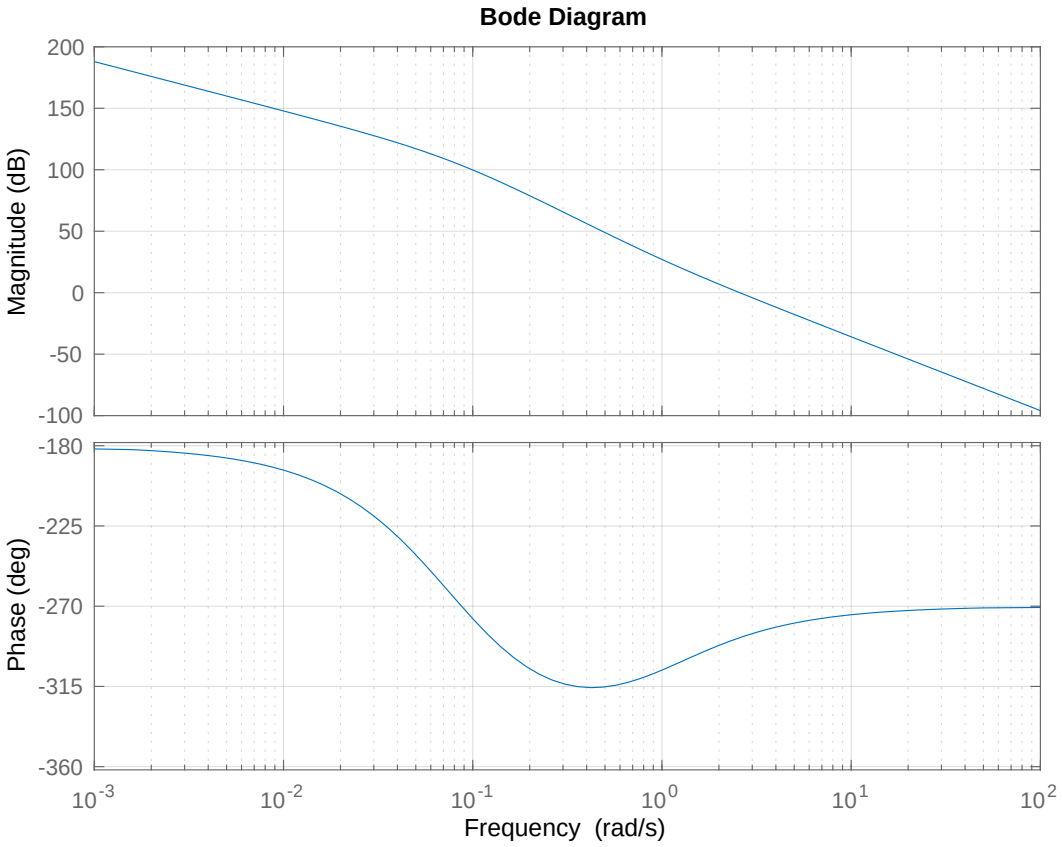
2. Drawn below is a Bode plot of an uncompensated open loop system for which your client wants no steady state error when applying a step input to the closed loop system. Their only other requirement is that the system's phase margin remains unchanged. Design a compensator to achieve this and draw the compensator, uncompensated system and compensated system on the same bode paper. Use Bode plot paper provided on page 19 to 22.

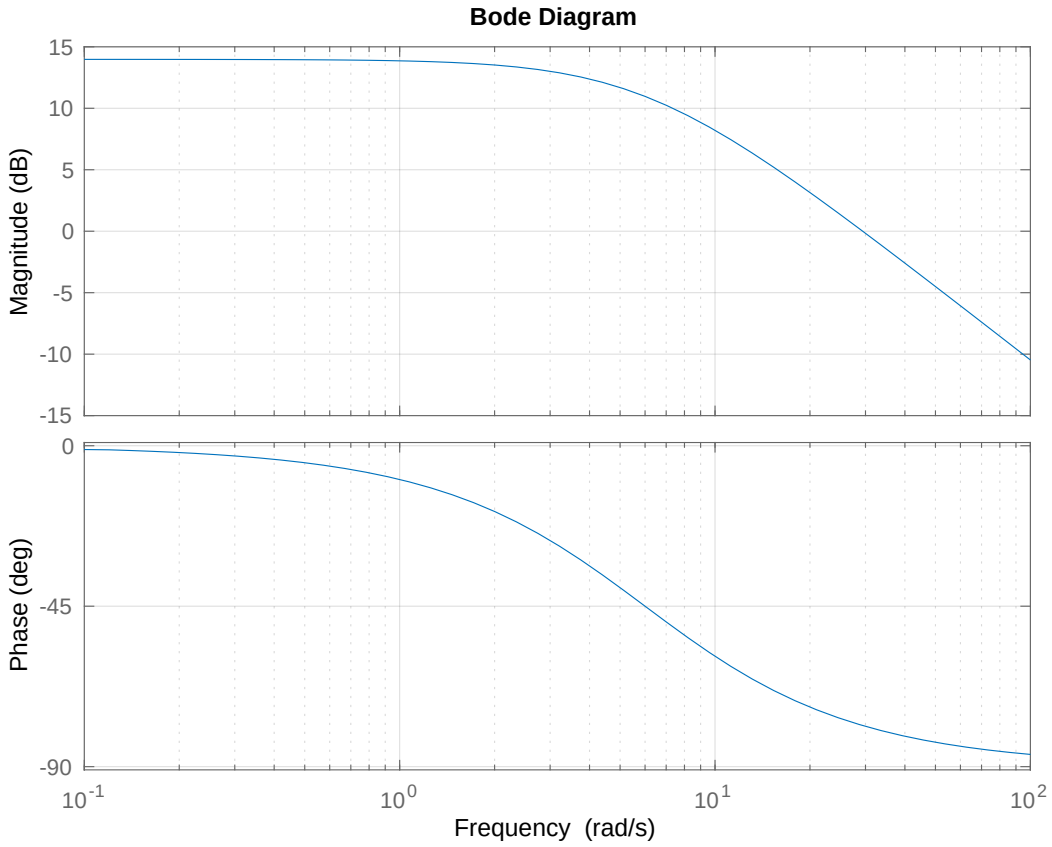


The client is nervous about the phase margin and has changed their mind, now requiring a larger phase margin. Describe how you could use a lead controller to achieve this, sketch it with the previous compensated system to show the potential improvement to the phase margin.

3. For the following systems, state the system type and read the approximate steady state error for a step, ramp and parabolic input from the plot. Be sure to show how you read the steady state error from the plot by drawing on the given plots.


Bode Diagram
Magnitude (dB)
60
40
20
0
-20
-40
Phase (deg)
-90
-135
-180
10^-2
10^-1
10^0
10^1
Frequency (rad/s)


Bode Diagram
Magnitude (dB)
200
150
100
50
0
-50
-100
Phase (deg)
-180
-225
-270
-315
-360
10^-3
10^-2
10^-1
10^0
10^1
10^2
Frequency (rad/s)


Bode Diagram
Magnitude (dB)
15
10
5
0
-5
-10
-15
Phase (deg)
0
-45
-90
10^{-1}
10^{0}
10^{1}
10^{2}
Frequency (rad/s)