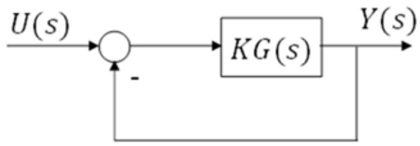
Problems

Controls - 1

Consider the following unity negative feedback system



K=1, G(s)= $\frac{9}{s(s+a)}$

1) Find the closed-loop transfer function $G_{CL}(s) = \frac{Y(s)}{U(s)}$. **(8 points)**

2) Calculate the undamped natural frequency (ω_n) of the closed-loop system. **(8 points)**

3) Find a value for "a" such that the closed-loop system damping ratio (ζ) is 20%. **(8 points)**

4) Find the 2% settling time and the percent overshoot of the closed-loop system response due to a step input **(8 points)**

5) Plot the root locus of the system by varying the gain K. **(8 points)**

6) On the root locus, mark the poles that correspond to critical damping. **(7 points)**

7) What is the value of gain K to achieve the critical damping? **(8 points)**

Let us consider a new plant G(s), the Bode plot is in the next page.

8) Which one of the following transfer functions represent G(s), why? **(8 points)**

(a) G(s)= $\frac{s}{(s+a)}$, (b) G(s)= $\frac{1}{s(s+a)}$, (c) G(s)= $\frac{s}{s^2+as+b}$, (d) G(s)= $\frac{1}{s(s^2+as+b)}$

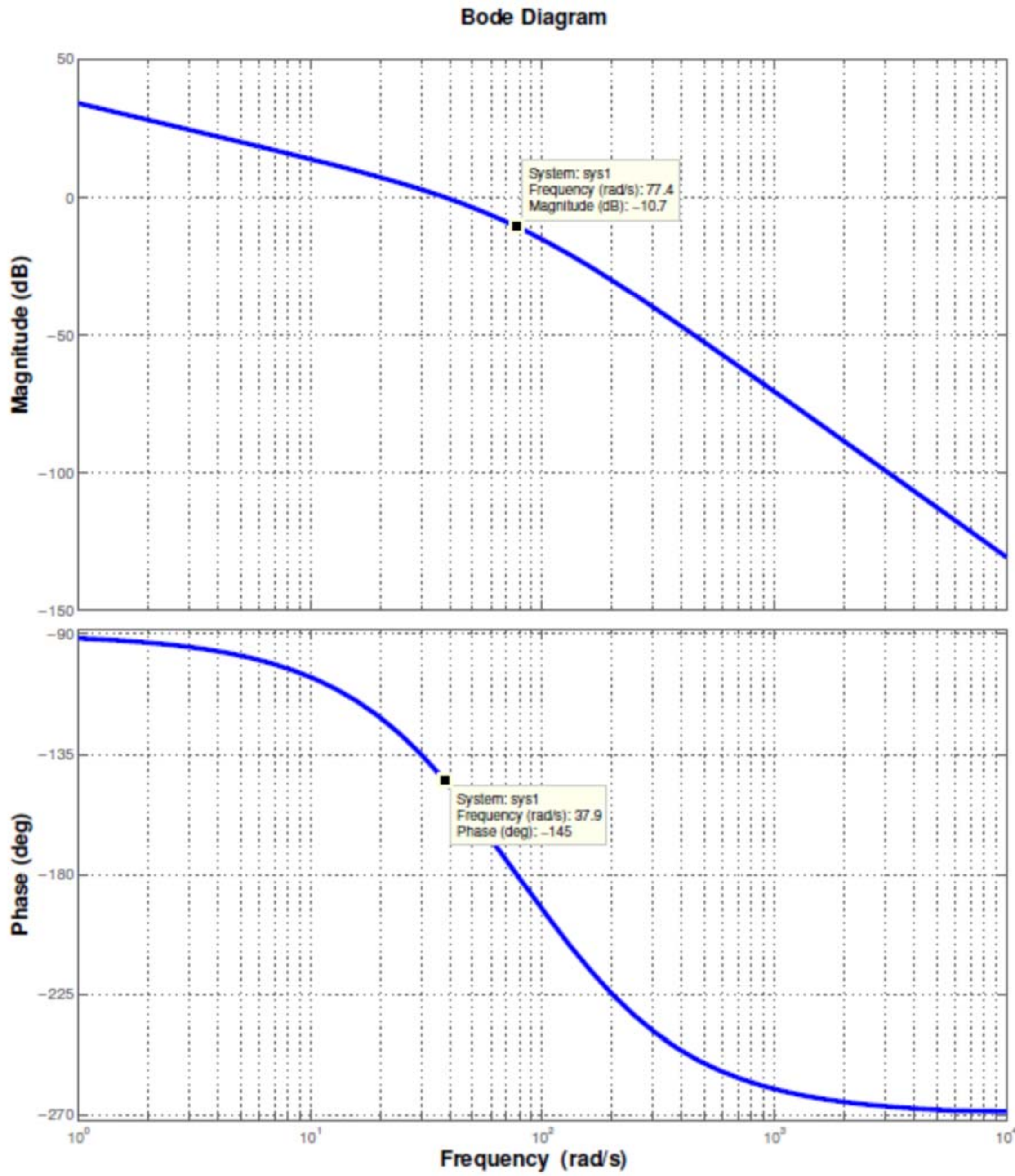
9) From the Bode plot, assuming that G(s) is the open loop transfer function, what is the gain margin? **(7 points)**

10) Again, assuming that G(s) is the open loop transfer function, what is the phase margin? **(7 points)**

11) If a unity negative feedback loop were closed around G(s), would the system be stable at gain K=1? **(7 points)**

12) On a separate figure, sketch the Nyquist plot of G(s) using data from the Bode plot. **(8 points)**

13) Clearly mark the gain margin and phase margin on the Nyquist plot. **(8 points)**


Bode Diagram
System: sys1
Frequency (rad/s): 77.4
Magnitude (dB): -10.7
System: sys1
Frequency (rad/s): 37.9
Phase (deg): -145
Magnitude (dB)
Phase (deg)
Frequency (rad/s)