EE 141 – Final
Spring 2021

06/08/21
Duration: 2 hours and 50 minutes

The final is open book.
Please carefully justify all your answers.
You are requested to have your camera turned on so that we can see you and your work at all times and until you upload your work to Gradescope. We will be recording the exam.
You are not allowed to communicate with others, by any means, during the exam.
The use of* MATLAB *or other software is NOT permitted.
Once you finish the exam, scan it and upload it to Gradescope.
Note that different students will receive different exams.

Problem 1: Consider the following Bode plot.

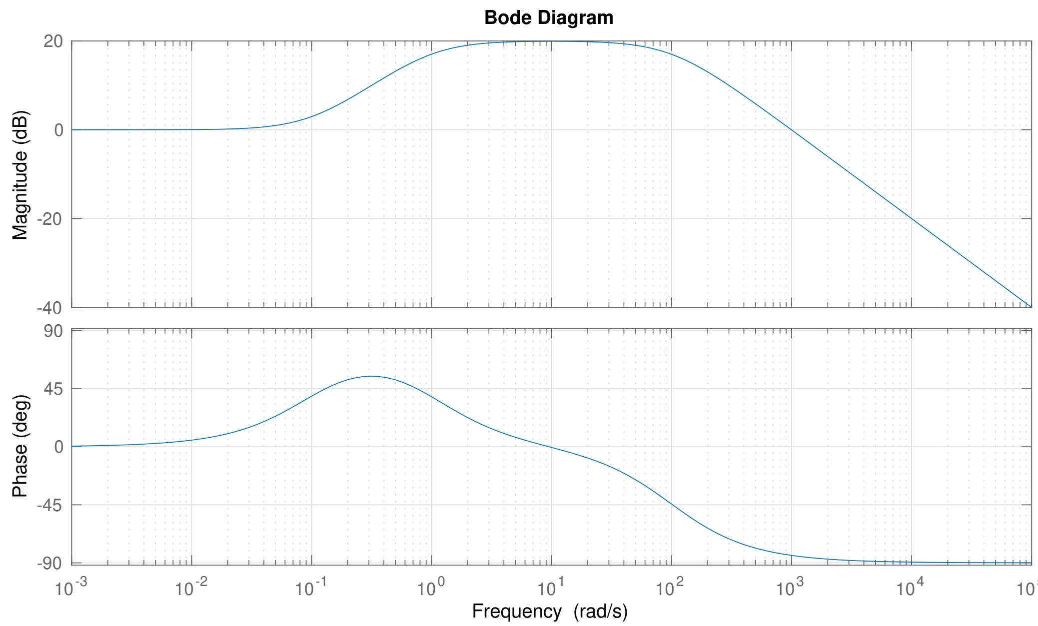

Figure 1: Bode plot for Problem 1.

1. What is the transfer function $G(s)$ whose Bode plot is given in Figure 1?
2. Can you design a gain K so that $KG(s)$ in open-loop has zero steady state error to step inputs?
3. Can you design a gain K so that the settling time of $KG(s)$ in open-loop is smaller than 20 seconds?
4. Design a controller, for the system described by $G(s)$, so that the resulting closed-loop system tracks step inputs with zero steady state error.

Problem 2: Consider the transfer function:

$$G(s) = \frac{(s+12)(s-5)}{(s+8)(s^2-4s+10)}$$

1. Sketch the root locus for G.
2. For which values of a proportional controller's gain would be closed-loop system be stable?
3. Can you stabilize this system with a proportional controller while ensuring absence of oscillatory behavior?
4. If you only consider the 2 slowest poles, what controller value would you choose to keep the overshoot below 3%?

Problem 3 Consider the transfer function:

$$G(s) = \frac{(s+1)(s-100)}{(s^2+20s+200)}.$$

1. Sketch the Bode plot for G.
2. What is the phase margin?
3. Use the gain margin to determine if the system is stable when placed in a unitary feedback loop with a proportional controller with K = 1.5.
4. Design a controller that attenuates all the frequencies above 100 rad/s and achieves a DC gain of 1.