# Ph.D. Qualifying Examination

Controls

Spring 2017

<u>Instructions:</u>

- There are 4 problems.
- Time allowed: 2 hours.
- Exam is closed book and closed-notes (one sheet of formulas is allowed)
- Problems count 25 points each (total = 100 points).
- You **MUST** show your work to get partial credit.
- Calculators are allowed.
- Laptops, cell phones, and similar electronic devices are not allowed.

Problem 1.

For the system shown in the Figure, find the gear ratio N_1/N_2 so that the settling time for a step torque input is 16 seconds.
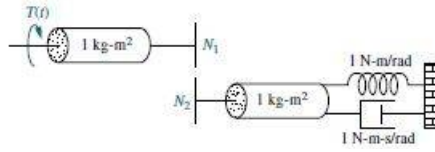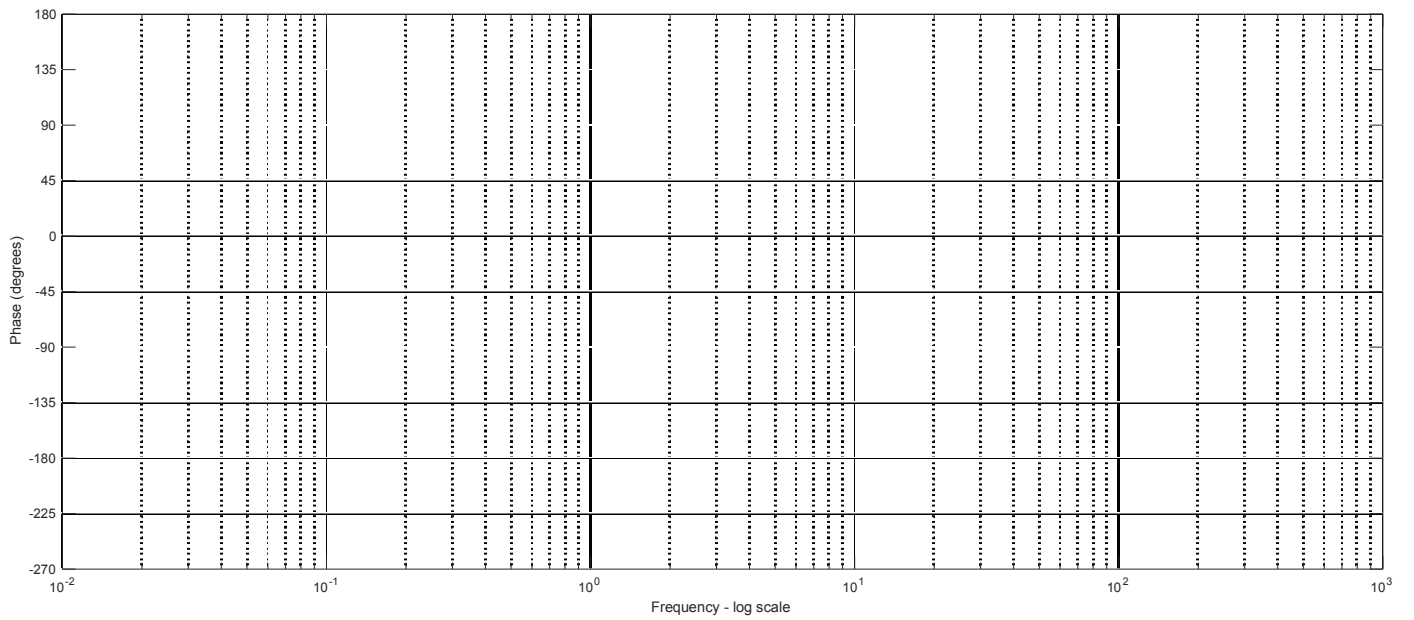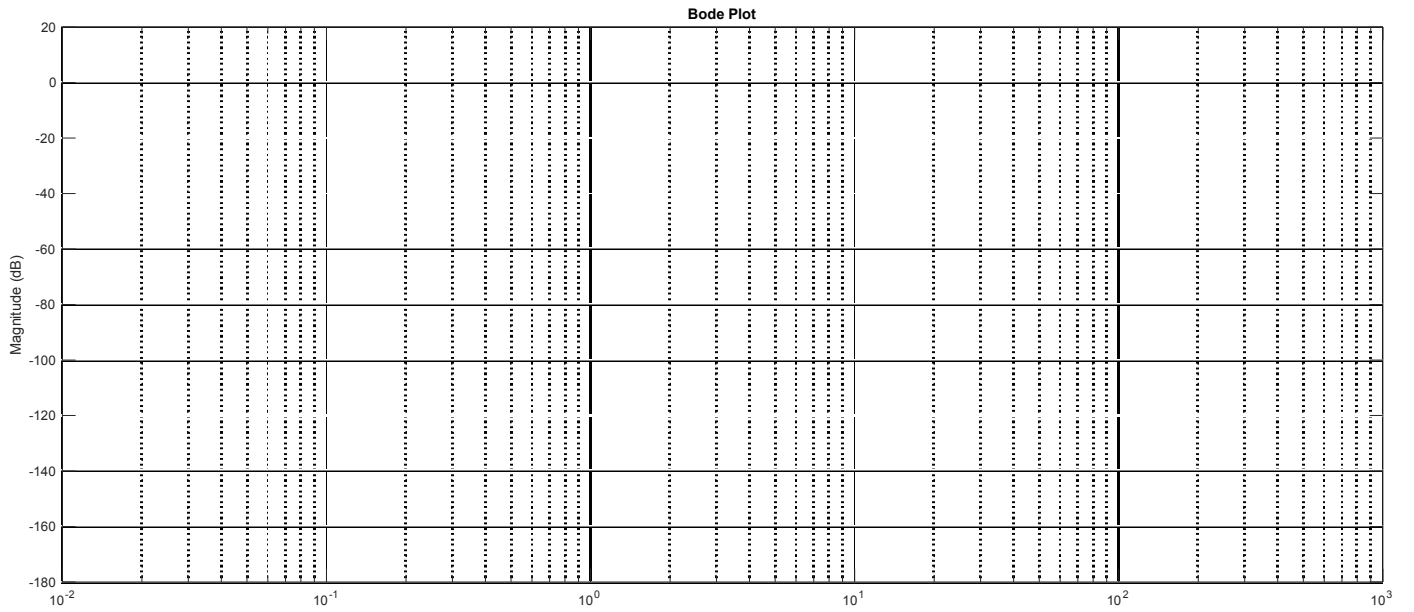
Problem 2.

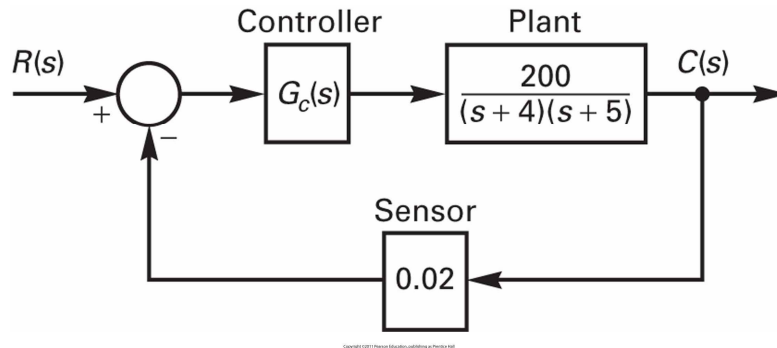Plot the magnitude and phase Bode plots for the following transfer function:

$$G(s)=\frac{s}{(s+1)(s+10)(s^2+2s+2500)}$$

Use the graph paper on the following page.

Bode Plot

Problem 3.
Consider the dc generator control system shown here. Assume that the system is stable for all parts of this problem. The units of both the input and output signals are in volts.

(a) For $G_c(s)=1$, find the system type, the appropriate static error constant, and the steady-state error for a unit input of the waveform which yields a nonzero constant error.

(b) A PI controller is designed with $G_c(s)=1.0+\dfrac{0.1}{s}$. Repeat part (a) for this design.

Problem 4.

The root-locus diagram for a linear feedback control system is shown below. Assuming a step input, what value of K will result in the smallest attainable settling time?

Root Locus