ME 5200/6200 Classical Controls **Fall 2024**

Homework 03 Due Thursday, Sept. 12 at the beginning of class. Please turn in a hardcopy.

Do the following problems and show all your work for full credit. Note: not all problems will be graded, but you must complete all problems to get full credit.

Problem 1

Consider the following first-order system:

$$G(s) = \frac{4}{s + 102}$$

(a) The DC gain of G(s)
(b) Plot the location of the poles and zeros (if any) in the s-plane. Label your axes and clearly indicate the location of the poles and zeros.
(c) The final value of the output for a unit step input (hint: use the final-value theorem)
(d) The time constant
(e) Use Matlab to make a plot of the step response
(a) From the Matlab step response plot, estimate the time constant. Explain any differences in your results with part (d).

Problem 2

Consider the following second-order system:

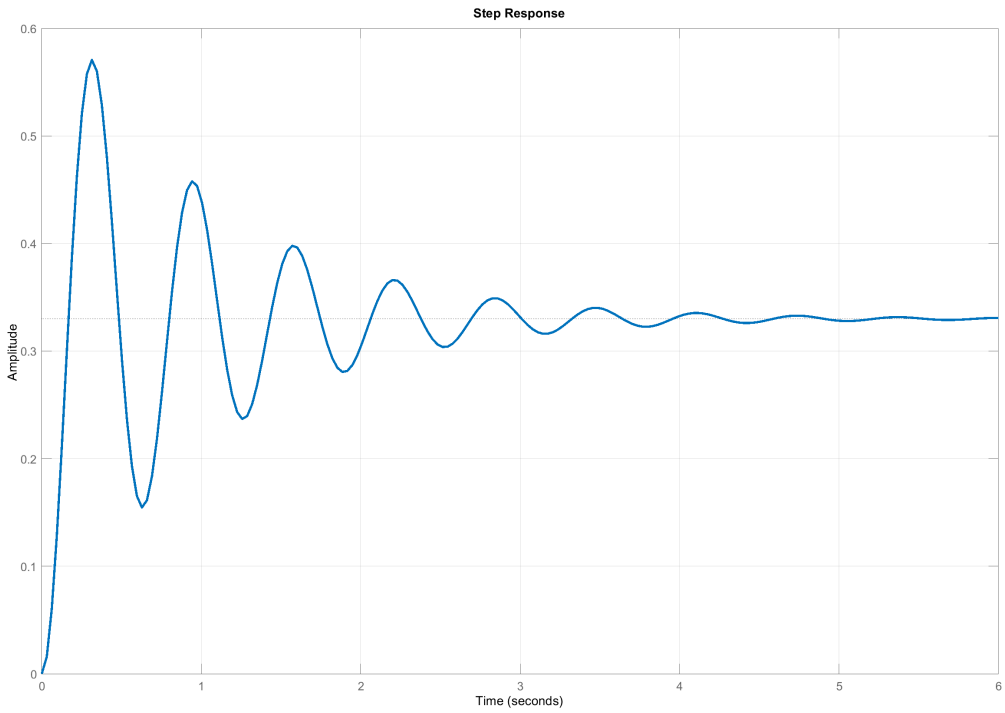
$$G(s) = \frac{2}{ss^2 + s + 2}$$

Determine:

(b) The DC gain of G(s)
(c) Plot the location of the poles and zeros (if any) in the s-plane. Label your axes and clearly indicate the location of the poles and zeros.
(d) The final value of the output for a unit step input (hint: use the final-value theorem)
(e) The damping ratio and natural frequency of the system
(f) The rise-time, time-to-peak, settling time, and percent overshoot. Find these values using the equations provided in class.
(g) Use Matlab to make a plot of the step response
(h) From the Matlab step response plot, estimate the rise-time, time-to-peak, settling time, and percent overshoot and compare to your answers in part (d). Explain any differences in your results.

Problem 3

Consider the following step response for a generic second-order system. Estimate the transfer function G(s) for the second-order system. Hint, you need to find the constants $\overline{K}$, ξ, and ω_n, then write out your estimated transfer function with the estimated parameters you found from the step response.



Problem 4

(a) If the step response of a second-order system does not oscillate, sketch the location of the poles in the s-plane.
(b) If the step response of a second-order system oscillates and decays, sketch the location of the poles in the s-plane.
(c) If the step response of a second-order system oscillates but the oscillations never decays, sketch the location of the poles in the s-plane.
(d) If the step response of a second-order system oscillates but the oscillations grows without bound as time increases, sketch the location of the poles in the s-plane.