Some Exercise Problems

Please READ Chapter 7 to Chapter 9. Please read related part of Appendix B. Type and run all MATLAB programs provided in those pages. Note that for most of the exercises below you can doublecheck your solutions using MATLAB’s root locus function (rlocus).

1. Steady State Errors

For the system shown in Figure 1.

(a) What is the system type?
(b) For which input type we have finite error and what is the corresponding error level?

2. First Steps in Root Locus

For each of the root loci shown in Figure 2, tell whether or not the sketch can be a root locus. If the sketch cannot be a root locus, explain why. Give all reasons.
3. **First Root Locus Sketches...**

Sketch the general shape of the root locus for each of the open-loop pole-zero plots shown in Figure 3.

4. **Root Locus Exercise for Unity Feedback Systems...**

Sketch the root locus for the unity feedback system shown in Figure 4 for the following transfer functions:

(a) \( G(s) = \frac{K(s+2)(s+8)}{s^2+8s+25} \)

(b) \( G(s) = \frac{K(s^2+4)}{s^2+1} \)

(c) \( G(s) = \frac{K}{(s+2)^3(s+4)} \)
5. *Slightly spiced up Root Locus plot*

Let

\[ G(s) = \frac{K(s + 1)}{s^2(s + 9)} \]

in Figure 4.

(a) Plot the root locus

(b) Write an expression for the closed loop transfer function at the point where the three closed-loop poles meet.

6. *PID Control Design Example*

For the unity feedback system with feedforward transfer function

\[ G(s) = \frac{K}{(s + 4)(s + 6)(s + 10)} \]

do the following:

(a) Design a PID controller that will yield

- no more than 25% overshoot,
- no more than 2-second settling time,
- zero steady state error for step and ramp inputs.

(b) Use Simulink to verify your design.