HW #3 (2/6/23)

1) Chapter 5: 5.2 (rough sketch)

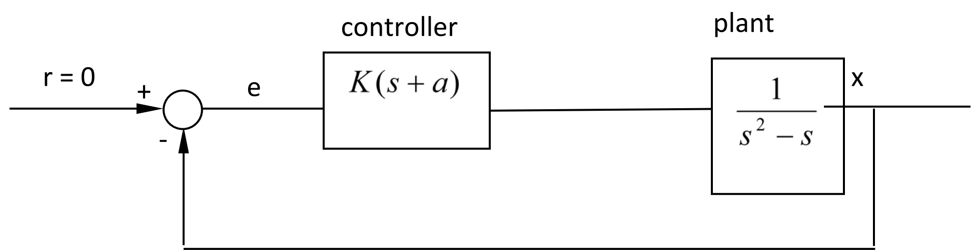
   Sketching RL Problems (verify with Matlab “rlocus”): 5.4-5.8 (just pick 2-3 of the a-f)

   Design Using RL Problems: 5.9-5.10, 5.12-5.13, 5.18-5.19, 5.36,5.40

   Pick 3-4: 5.22-5.30

2) Use Root-Locus to evaluate your controllers for Problems #5 and #7 on HW #2.
   a. First plot the root locus representing your original control design (include the roots for the selected gains). How do you feel about your design?
   b. If you see opportunity for improvement, re-design your controller using root-locus and provide your new design (control law and root locus plots)
   c. (Optional) Test your new controllers and provide plots of the controlled performance compared to your original controlled performance.

3) Consider the following system:



   a) Design the controller to have a closed-loop natural frequency of 100 rad/s with a damping ration of 0.707. What are the resulting K and a? Simulate your system.
   b) Introduce saturation and see how the performance of the system changes as the saturation limit is reduced. Can the performance somewhat be predicted by changing K in the root-locus?
   c) Set the saturation limit to the point where the system became unstable. Now redesign the controller to have 5% overshoot. What is the resulting closed-loop natural frequency? What are the values for K and a?

4) Design a control system for the ball and beam system.
   a. Develop the EOM
   b. Determine the beam inertia as well as the effective rolling inertia for the tennis ball (and air drag). Note, you may want to control the beam angle to determine the properties of the tennis ball (your inverted pendulum controller will probably work).

5) Develop a mode for the vehicle handling dynamics. Provide the EOMs from steer angle to lateral position.
    a. Determine the EOMs from steer angle to yaw rate. Consider designing a yaw rate controller for the vehicle and state if you can achieve an overdamped yaw rate response (i.e. no overshoot) with only proportional control (why/how)?
    b. Determine the transfer function from yaw rate to yaw
    c. Given Vx and Vy, determine the EOM(s) from yaw to lateral position. Note lateral position will be defined with respect to a heading to the desired line. Determine the transfer function from yaw (heading) to lateral position (state what you have to assume about or how you treat Vy).