

Name \_\_\_\_\_

Circle one: Section 1510 1610

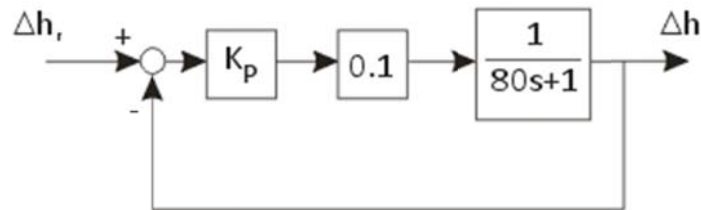
## ME 422 – Quiz 3

Winter 2011

In giving your answer, the answer alone is not enough. Make sure you clearly give your rationale for arriving at the answer. It must be clear to me how you arrive at your answer.

Weights: a, b, c, d = 16% each; e = 36% for a total of 100%

1. A tank system has the level control system



- a. Draw the system's root locus.
- b. Describe the operation of the system as  $K_p$  is increased. Are there any values of  $K_p$  that cause the system to be unstable? To oscillate? How exactly does the system's behavior change as  $K_p$  is increased? Be sure to include the rationale for your answers.
- c. In the above loop, the valve gain is actually 0.1 gpm/%-valve-opening. The design steady state of the valve is 65%. With a unit step input, how high could  $K_p$  be set without saturating the valve?

d. Now outfit the loop with a PI controller. Calculate  $G_{OL}$  for the PI loop in a compact form that will allow you to plot the root locus (just numerator and denominator).

e. With the PI controller, consider the three cases, all with  $K_p > 0$ : i)  $K_I < 0$ , ii)  $K_I/K_p < 1/80$ , iii)  $K_I/K_p > 1/80$ . Draw the root locus for each of these cases in the table below. For each case and for low, medium, and high values of  $K_p$ , answer yes or no to the questions about stability and oscillatory behavior.

Case	$K_I < 0$	$K_I/K_p < 1/80$	$K_I/K_p > 1/80$
Root locus			
$K_p$ low	Stable? _____ (Y/N) Oscillates? _____ (Y/N)	Stable? _____ (Y/N) Oscillates? _____ (Y/N)	Stable? _____ (Y/N) Oscillates? _____ (Y/N)
$K_p$ medium	Stable? _____ (Y/N) Oscillates? _____ (Y/N)	Stable? _____ (Y/N) Oscillates? _____ (Y/N)	Stable? _____ (Y/N) Oscillates? _____ (Y/N)
$K_p$ high	Stable? _____ (Y/N) Oscillates? _____ (Y/N)	Stable? _____ (Y/N) Oscillates? _____ (Y/N)	Stable? _____ (Y/N) Oscillates? _____ (Y/N)