

Name \_\_\_\_\_

Section \_\_\_\_\_

ME 422Quiz 2

18 October 2010

In answering this problem, show all work. It is your obligation to show clearly how you arrived at your solution. In your solution clearly label the parts of the solution with the lower case letter to which they pertain.

1. A tank ( $K_T, T_T$ ) is equipped with a level control system that operates the inlet valve ( $K_V$ ) to adjust the inlet flow and thus the level in the tank. The control loop has unity feedback. The level control is provided by a proportional controller ( $K_C$ ). Assume for the following that  $K_T$ ,  $T_T$ , and  $K_V$  are all positive quantities. The subscripts OL, CL, and UFB stand respectively for “open loop”, “closed loop”, and “unity feedback”.
  - a. Draw the block diagram for this system.
  - b. What is the system's  $G_{OL}$ ?
  - c. What is the system's  $G_{CL}$ ?
  - d. What is the *loop time constant*, i.e. the closed-loop system's time constant ( $T_{CL}$ )?
  - e. What is the *loop gain*, i.e. the closed-loop system's steady-state gain ( $K_{CL}$ )?
  - f. What is the system *type*? From what transfer function do you determine it— $G_{OL}$ ,  $G_{CL}$ , or  $G_{UFB}$ ?
  - g. For what values of  $K_C$  will the system be stable? What transfer function do you use to determine this— $G_{OL}$ ,  $G_{CL}$ , or  $G_{UFB}$ ? Make sure in answering that your logic is made clear.
  - h. If the system is subjected to a unit step input, what will be the steady state error? What transfer function do you use to determine this— $G_{OL}$ ,  $G_{CL}$ , or  $G_{UFB}$ ?

		Type 0		Type 1		Type 2	
Input	$e_{ss}$	$e_{ss}$ constant	$e_{ss}$	$e_{ss}$ constant	$e_{ss}$	$e_{ss}$ constant	$e_{ss}$
Step	$\frac{1}{1 + K_p}$	$K_p = \text{constant}$	$\frac{1}{1 + K_p}$	$K_p = \infty$	0	$K_p = \infty$	0
Ramp	$\frac{1}{K_v}$	$K_v = 0$	$\infty$	$K_v = \text{constant}$	$\frac{1}{K_v}$	$K_v = \infty$	0
Parabola	$\frac{1}{K_a}$	$K_a = 0$	$\infty$	$K_a = 0$	$\infty$	$K_a = \text{constant}$	$\frac{1}{K_a}$