ME 422 – Quiz 1
Fall 2012

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.

1. Compare and contrast two systems. System A consists of a first-order actuator/plant (K, T) controlled by a proportional controller (K_p) in its standard location, both blocks contained in a unity-feedback control loop. System B consists of a first-order actuator/plant (K,T) but with the controller (K_p) moved into the feedback path.

a) Draw the two loops.

System A:

System B:

b) What are the closed-loop transfer functions of each loop?

\[ G_1 = \frac{K_p K}{T s + 1 + K_p K} = \frac{K_p K}{1 + K_p s + 1} \]

\[ G_2 = \frac{K}{T s + 1 + K_p K} = \frac{K P}{1 + K_p s + 1} \]

c) Give the appropriate performance parameters for each closed-loop \((T_{cl}, K_{cl}, \omega_n, \zeta)\) whichever are appropriate.

\[ T_{cl1} = \frac{T}{1 + K_p k} \quad \text{Same} \quad T_{cl2} = \frac{T}{1 + K_p k} \]

\[ K_{cl1} = \frac{K_p K}{1 + K_p k} \quad \text{2} \quad K_{cl2} = K / (1 + K_p k) \]

d) If you turn up \(K_p\), how will this affect each loop’s step response? How will their responses be the same? How will they be different? Show an example step response for each system if you wish.

\[ T_{cl1} = T_{cl2} \quad \text{so speed of each system is same} \]

\[ K_{cl1} \neq K_{cl2}. \quad \text{If turn up } K_p, \quad K_{cl1} \rightarrow 1 \]

Go on to problem 2 on back...
2. For the system at right
   a) Write its ODEs.

   \[ 2 \text{ min} \quad L_1 \frac{d^2 i_1}{dt^2} + R_i_1 - L_1 i_2 - R i_2 = V_i \]
   \[ L_1 \frac{d^2 i_1}{dt^2} + \frac{1}{C} \int i_2 dt + L_2 \frac{d i_2}{dt} + R i_2 \]
   \[ - L_1 i_1 - R i_1 = 0 \]

   b) Draw the block diagram for the system.

   \[ i_1 = \frac{1}{L_1} (\frac{-1}{R} i_i + L_1 \frac{d i_2}{dt} + R i_2 + V_i) \]
   \[ i_2 = \frac{1}{L_1 + L_2} \left( \frac{-1}{C} \int i_2 dt + R i_2 + L_1 \frac{d i_1}{dt} + R i_1 \right) \]

   c) In the block diagram, make sure to include the output, \( v_o(t) \).