King Abdulaziz University

College of Engineering , Chemical Engineering Dept.

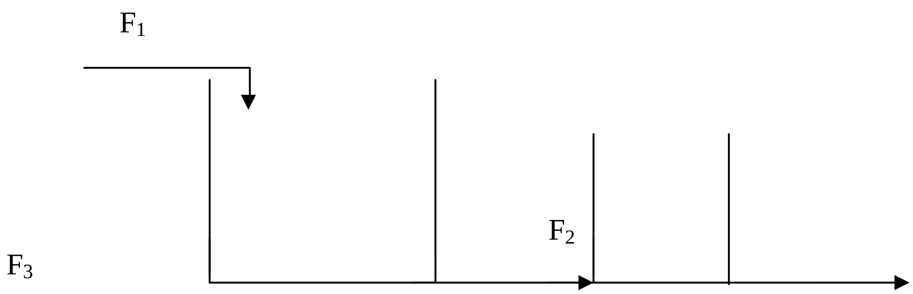
Fall 2004 HW# 8 Ch.E 442

(Design)

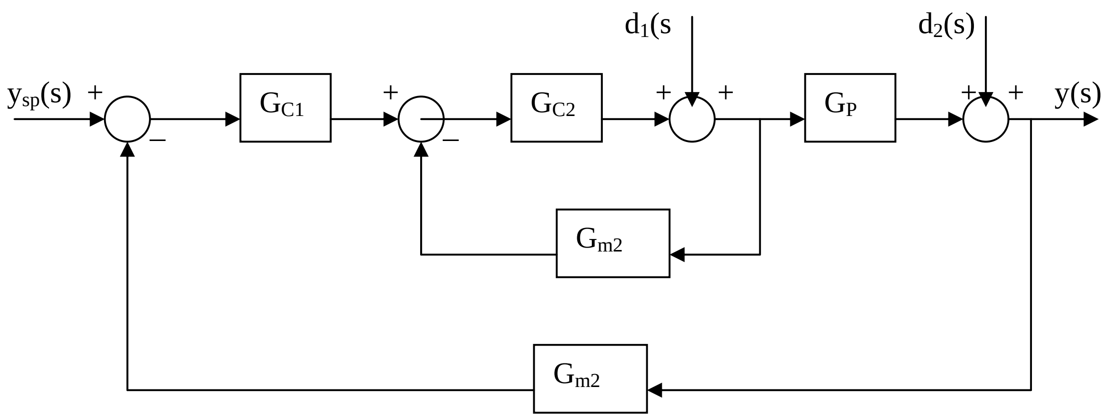
1. Problem IV.2 in the textbook (Chemical Process control by G. Stephanopoulos).

2. Consider the two interacting tanks shown in the figure. We wants to control the liquid level h2 of tank 2 by manipulating flow rate F_1 through a proportional controller. Assume that tank 1 has a cross-sectional area of 5 ft^2; while for tank 2 the cross-sectional area is 2 ft^2. Initially, the system is at steady state with F_1 =1ft^3/min, h_1= 4ft, and h_2 = 3ft. Find the values of the controller gain that produce

   a- A critically damped response, or
   b- An underdapmed response with decay ratio equal to ¼ for h_2.
   c- For each of the two cases above, describe the dynamic response of liquid level h_1 in tank 1 for a unit step change in the step change in the set point of h_2. Sketch qualitatively these two responses.



3. Consider the block diagram Shown below, which includes two control loops.



Assume Gm1 = Gm2 = 1 and Gp = 10/[(s+1)(2s+1)]

a) Derive an expression for the closed-loop response to a unit step change in the set point, assuming that both controllers are proportional with K_{c1} and K_{c2}.
b) Examine if the closed-loop response exhibits an offset to a unit step change in the set point. If it does, compute the value of the offset. If it does no, explain why.
c) Suppose that K_{c2} =1. Find the values of K_{c1} which produces (1) a critically damped response, and (2) an underdamped response with a decay ratio ¼.
d) Sketch the closed-loop response for each of the two cases in part (c).
e) Compute the closed-loop poles for the two cases in part (c). What do you observe?