

CM416 Exam 2
January 27, 1999 7-9pm

Name: _____

Box No. _____

1. (15 pts) a) Find the equivalent transfer function from y_{set} to y for the system shown in Figure 1.

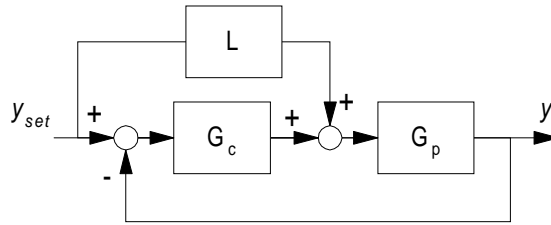


Figure 1.

- b) (15 pts) With

$$L = \frac{1}{3} \quad G_c = K_c \quad G_p = \frac{3}{(20 \cdot s + 1) \cdot (s + 1) \cdot (5 \cdot s + 1)}$$

the closed-loop transfer function from $L[y_{set}]$ to $L[y]$ should be

$$\frac{(1 + 3 \cdot K_c)}{(100 \cdot s^3 + 125 \cdot s^2 + 26 \cdot s + 1 + 3 \cdot K_c)}$$

Determine the maximum range of proportional gain, K_c , allowed for stability of the process.

- c) (15 pts) Based on a step change in set point, $y_{set} = \alpha \mu(t)$, and using the same values for L , G_c and G_p as in question (b) above, what is the steady-state offset,

$$\text{offset} = y_{set}(\infty) - y(\infty)$$

in terms of K_c ?

2. (20 pts) Given the following process model:

$$\frac{d}{dt}x_1 = -3 \cdot x_1 + x_2 + 2 \cdot u$$

$$\frac{d}{dt}x_2 = 2 \cdot x_1 - 2 \cdot x_2 + u$$

$$y = x_1 + x_2$$

Find the transfer function from $L[u]$ to $L[y]$, assuming all initial conditions are zero.

3. (15 pts) The plot in Figure 2 shows the response of concentration, C , when the process is under proportional feedback control, with K_c as the proportional gain. Using these plots, what are the prescribed values by the Ziegler-Nichols method for K_c , t_I and t_D for the PID controller?

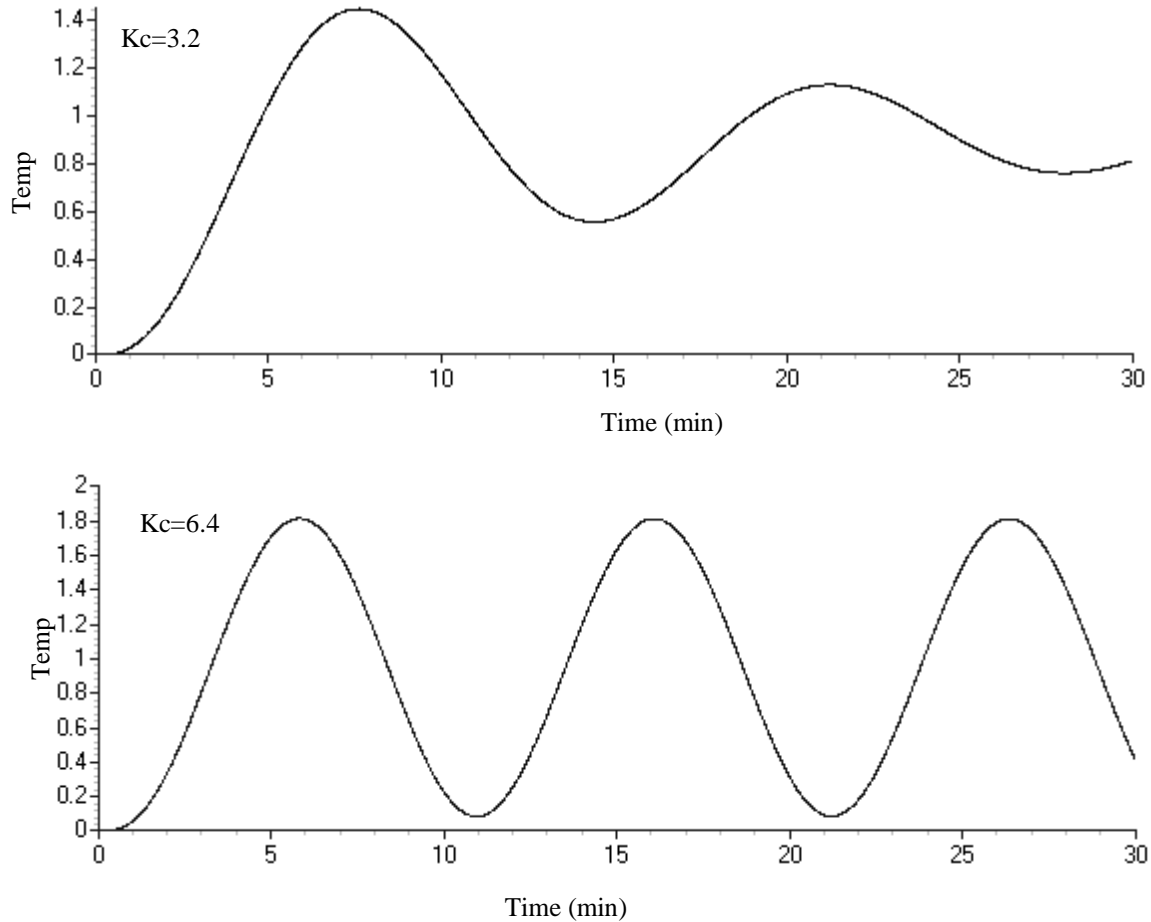


Figure 2.

4. (20 pts) Suppose the Laplace transform of x is given by

$$\hat{x}(s) = \frac{5s - 1}{(s + 1)[(s + 2)^2 + 4^2]s}$$

determine $x(t)$.

5. (Bonus: 10 pts) Find the Laplace transform of

$$f(t) = 3 \sin\left[2t + \left(\frac{\pi}{2}\right)\right]$$