Thapar University, Patiala

End Sem Exam, Process Dynamics &Control (CH-009)

MM: 36 Time: 3hrs Date: 22/05/2007

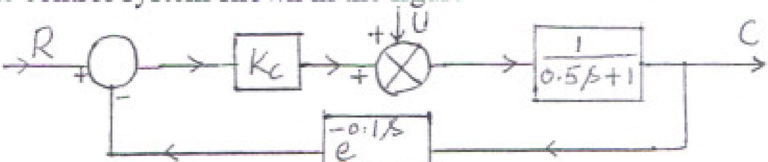
Q1 Using a log-log and semi-log graph paper plot the Bode diagrams for the following transfer functions: 7

(a) $G(s) = 10s/[(s+1)(0.1s+1)^2]$

(b) $G(s) = K_c[1+ \tau_D s+(1/\tau_I s)]$; where $K_c = 10$, $\tau_D = 100$, $\tau_I = 1$

Label corner frequencies and give slopes of asymptotes.

Q2 For the control system shown in the figure 7



(a)Using Laplce domain analysis, calculate the values of K_C for which the system is stable.

(b)With frequency domain analysis, design the controller using minimum recommended design value of gain margin.

(c) Design the controller using minimum recommended value of phase margin Will the system be still stable if dead time increases to 0.15 from 0.1

Q3 (a)Using the example of stirred tank heater with a pipe at the outlet, show how will you arrive at the Bode stability criterion? 4

(b) Show that the expansion for AR and Φ is same in time and frequency domain.

Q4. A mercury thermometer with a time constant of 10 sec is allowed to come to equilibrium in the room air at 75° F. Then it is placed in the 400° F oil bath for a length of time less than 1 sec and quickly removed from the bath and re-exposed to the 75° F ambient conditions. The heat transfer coefficient to the thermometer in air is one-fifth of that in the oil bath. If 10 sec after the thermometer is removed from **the bath** it reads 98° F, estimate the length of time that the thermometer was in the bath. 4

Q5. A liquid reactant A at a concentration C_i (t) is fed to a CSTR of constant volume V at **a** constant feed rate of F (volume/time) and exits the reactor at a concentration of Co(t). A reacts by first order rate constant k to give product B. Prepare a block diagram for the reactor. Sketch the response of the reactor to a step change in input concentration. 4

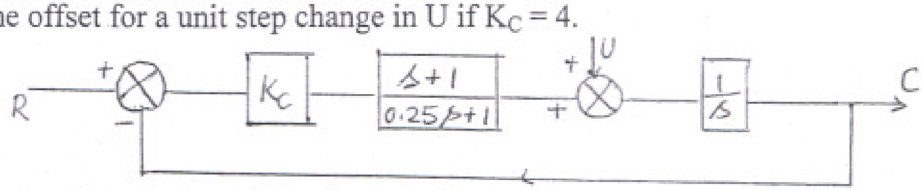
Q6 A two tank non-interacting system is operating at steady state when a step change is made in the flow rate to the first tank. The transient response is critically damped and it takes 1 min for the change in level of the second tank to reach 50 percent of the total change. If the ratio of the X-sectional areas of the two tanks is A_1/A_2 calculate the ratio of the outlet resistances of the two tanks, R_1/R_2. 4

How long does it take for the change in level of the first tank to reach 90 percent of the total change?

Q7 For the control system shown obtain the closed loop transfer function C/U.

(a) Find the value of K_C for which the closed loop response has a ζ of 2.3.

(b) Find the offset for a unit step change in U if $K_C = 4$. 4



Q8 Define servo and regulator problem in control. 2