Total number of printed pages – 7

B. Tech

CPCH 7305

Sixth Semester Examination – 2010

PROCESS DYNAMICS AND CONTROL

Full Marks – 70

Time : 3 Hours

*Answer Question No. **1** which is compulsory and any **five** from the rest.*

The figures in the right-hand margin indicate marks.

1. Write a note on the followings : 2×10

   (a) Cascade control system

   (b) Ratio controller

   (c) Pneumatic control valve

   (d) Ziegler-Nichols controller tuning

   (e) Corner frequency, crossover frequency and response frequency

P.T.O.

(f) Gain and Phase margin

(g) Nyquist plot and stability criteria

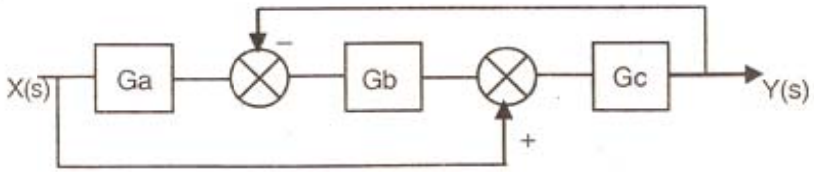
(h) Stable and unstable system

(i) Sampled data controllers

(j) Feed forward control system.

2. (a) Compare the response of a typical system to P, PI, and PID control action respectively. 5

(b) Determine Y(s)/X(s) for the following block diagram : 5



3. A step change of magnitude 4 is introduced to a system having transfer function 2×5

$\frac{Y(s)}{X(s)} = \frac{10}{s^2 + 1.6s + 4}$. Determine

(i) Percent overshoot

(ii) Rise time

(iii) Maximum value of Y(t)

(iv) Ultimate value of Y(t) and

(v) Period of oscillation.

4. (a) For the system with the following Transfer function : 5

$$G(s) = \frac{k_1 e^{-t_1 s}}{\tau_1 s + 1} - \frac{k_2 e^{-t_2 s}}{\tau_2 s + 1}$$

(i) Draw the block diagram of the system.

(ii) Find the condition that must be satisfied by six parameters k_1, k_2, τ_1, τ_2, t_1 and t_2 so that the system exhibits inverse response.

(iii) If the system exhibits inverse response, plot the response of the system.

(b) In a two tank mixing process (interacting type), the inlet concentration varies from 0 kg salt/m^3 to 1 kg salt/m^3 according to a step change being the inlet flow rate constant at 3 m^3/min. The holdup volume of each tank is 6 m^3. At what time does the salt concentration in the second tank reach 0.6 kg salt/m^3? 5

5. The open-loop transfer function of a control system is given by ;

$G(S) = [5(1+S)\ e^{-1S}] / [(1+2S)(S^2+S+1)]$

Where, the time constants are in minutes. Sketch the Bode plots for magnitude ratio and phase angle for the system for a frequency of 0.10 to 10.0 rad/minutes and determine the cross-over frequency. State the stability. 10

6. There are N-storage tanks of volume V arranged in series so that, when water is fed into the first tank an equal volume of liquid overflow from the first tank into the second tank and so on. Each tank initially contains component A at some concentration C_0 and is equipped with a perfect stirrer. At time t=0, a stream of zero concentration is fed into the first tank at a volumetric rate of 'q'. Find the resulting concentration in each tank as a function of time. Represent the system in State variable form. 10

7. (a) For a unity feedback system $G(s) = K/[(s+2)(s+4)(s^2+6s+25)]$, discuss the closed-loop stability as a function of K using Routh-Hurwitz criterion. 5

(b) Sketch the root locus diagram for the following open loop transfer function and comment on stability $G(s)=K(s+4)/s(s+1)$. 5

8. A first order process with time constant of 2 min is controlled by a three-mode controller with both integral time and derivative time set to 1min. 2×5

(i) Calculate damping factor of the closed system for proportional gain values 2 and 10.

(ii) Do damping factor and natural period of oscillation approach limiting values as proportional gain increases, and if so, what are these values?

(iii) Determine the offset for a unit-step change in load if proportional gain is 2.

(iv) Sketch the response curve for a unit-step change in load when proportional gain is 2.

(v) Determine the maximum value of output and the time at which it occurs.
