Code No: R05320803 **Set No. 1**

III B.Tech II Semester Regular Examinations, Apr/May 2008
PROCESS DYNAMICS AND CONTROL
(Chemical Engineering)

Time: 3 hours **Max Marks: 80**

Answer any FIVE Questions
All Questions carry equal marks

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1. (a) Find the initial value of the function that has the following transform $x(s) = \frac{s^4-6s^2+9s-8}{s(s-2)(s^3+2s^2-s-2)}$

   (b) Find the final value of the function for which the Laplace transform is $x(s) = \frac{1}{s(s^3+3s^2+3s+1)}$. [8+8]

2. Show the block diagram representation of several non-interacting 1^{st} order systems in series. How do you express the overall transfer function from individual transfer functions of several 1st order system in series? [16]

3. What are the various components of Control system? Explain them in detail. [16]

4. Determine the transfer function Y(s)/X(s) for the block diagram shown in figure 4. [16]

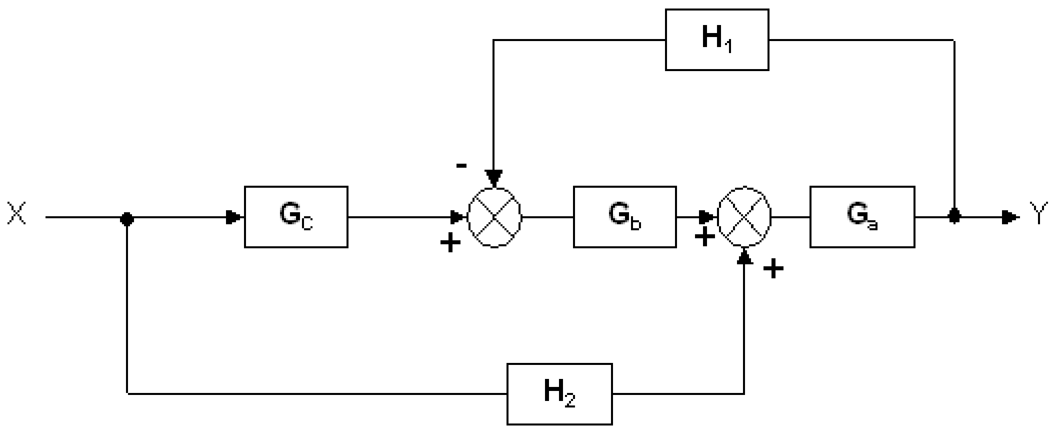

Figure 4

5. For the control system shown in the figure 5, the characteristic equation is $s^4 + 4s^3 + 6s^2 + 4s + (1+K) = 0$.

   (a) Determine the value of K above which the system is unstable.

   (b) Determine the value of K for which two of the roots are on the imaginary axis, and determine the values of these imaginary roots and the remaining two roots. [8+8]

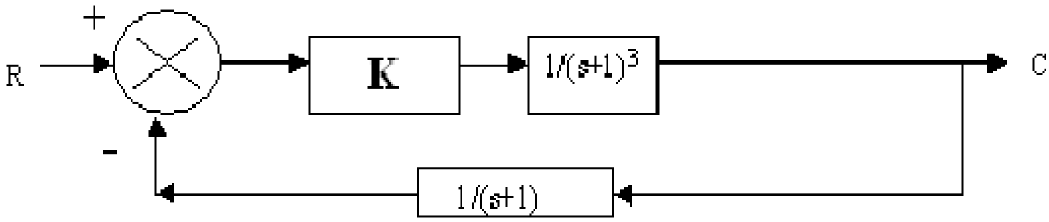

Figure 5

6. Plot the asymptotic Bode diagram for
   (a) P - I controller.
   (b) P - D controller. [8+8]
7. List out the rules for design of IMC controller considering a step change in disturbance. [16]
8. Explain the effect of each mode in a PID controller on the transient response of a controlled process. [16]

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Code No: R05320803

Set No. 2

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PROCESS DYNAMICS AND CONTROL
(Chemical Engineering)

Time: 3 hours **Max Marks: 80**

Answer any FIVE Questions
All Questions carry equal marks

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1. A Liquid process shown in figure 1 is operating at steady state condition, when the following disturbances occur at time t=0, 2ft^3 of water is added suddenly to the tank. At t=1, 3ft^3 of water is added suddenly to the tank. Sketch the response of the tank in terms of level versus time and determine the level at t=0, 0.5, 1.0, and 1.5. Time constant of the process is 1 min. [16]

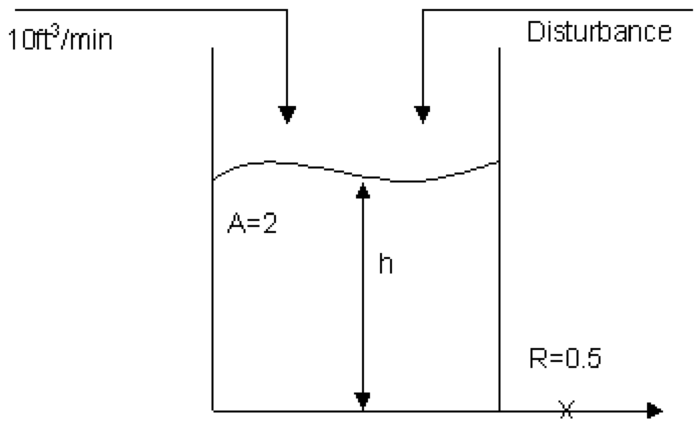

Figure 1

2. A second order system is found to have the following transfer function

$\frac{Y(s)}{X(s)} = \frac{1}{(2.5s^2+1.5s+1)}$

Find out

(a) Damping coefficient
(b) Overshoot
(c) Natural Frequency
(d) Y(t) for unit impulse input. [4×4]

3. What do you understand by the term Control System? Explain its industrial significance with a suitable example? [16]

4. Determine the transfer function C/R, C/U_1 and B/U_2 for the system shown in figure 4. Also determine an expression for C in terms of R and U_1 for the situation when both set-point change and load change occur simultaneously. [16]

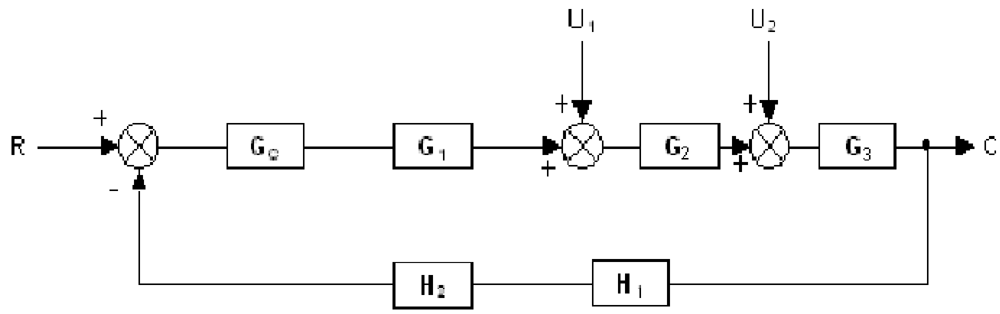

Figure 4

5. (a) Test the stability of the system whose characteristic equation is given by $s^5 + 2s^4 + 5s^3 + 10s^2 + 4s + 8 = 0$.

   (b) Determine the range of K such that feedback system having characteristic equation $s\,(s^2 + s + 1)\,(s + 4) + K = 0$, will be stable. [8+8]

6. (a) Explain how one can tune a controller by the use of a Bode plot.

   (b) Draw the Bode diagram for the open loop transfer function $G(s) = \frac{10(0.5s+1)e^{-s/10}}{(0.1s+1)(s+1)^2}$. [8+8]

7. Discuss the rationale of a cascade control system and demonstrate why it provides better response than simple feedback. [16]

8. Explain the flow-lift characteristics of control valve. Distinguish between inherent valve characteristics and effective valve characteristics. [16]

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Code No: R05320803 **Set No. 3**

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PROCESS DYNAMICS AND CONTROL
(Chemical Engineering)

Time: 3 hours **Max Marks: 80**

Answer any FIVE Questions
All Questions carry equal marks
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1. Derive the transfer function H(s)/Q(s) for the liquid level system shown in figure 1, when the tank level operates about the steady state value of h_s=1m. The pump removes water at a constant rate of $10m^3$. This rate is independent of head. The cross sectional area of the tank is $1m^2$ and the resistance R is $0.5m/m^3/min$. [16]

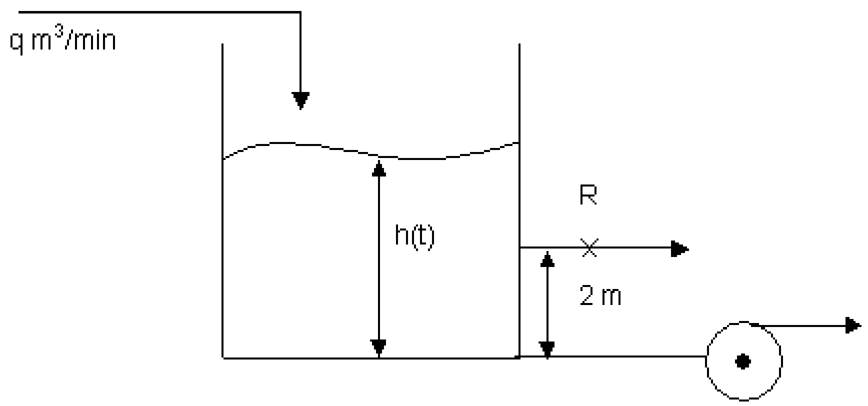

Figure 1

2. (a) Define step, impulse and sinusoidal input functions. Write their mathematical equations with graphical representation.
   (b) A thermometer has a time constant of 15 sec and an initial temperature of 20 ^{0}C is suddenly expanded to a temperature of 100 ^{0}C and held there. Determine the rise time and the temperature at the rise time. [6+10]

3. Why the concept of feed forward in control system is generated, explain about it? [16]

4. Determine the transfer function Y(s)/X(s) for the block diagram shown in figure 4. [16]

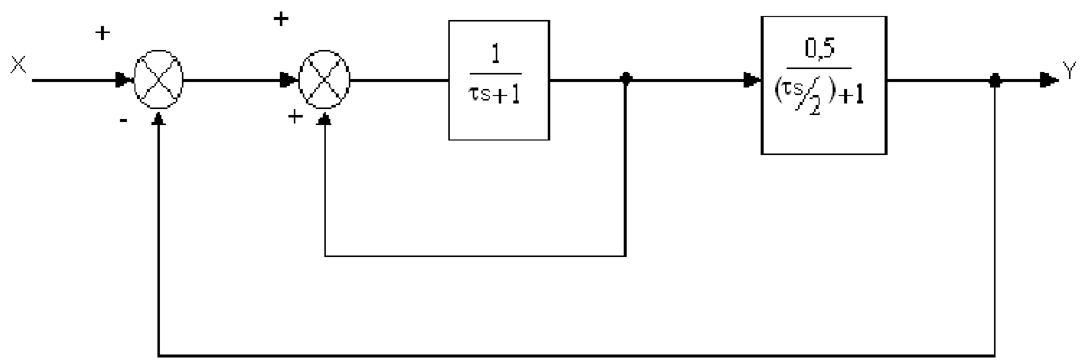

Figure 4

5. (a) Discuss the merits and demerits of Routh test.
   (b) Determine the stability of control system whose characteristic equation is $s^6 + 2s^5 + 12s^3 + 20s^2 + 16s + 16 = 0$. [8+8]

6. Sketch the root locus for the following equation
   $1+\frac{K}{s(s+1)(s+2)} = 0$
   On the sketch locate quantitatively all poles, zeroes, and asymptotes. In addition show the parameter that is being varied along the root locus and direction in which the loci travel as this parameter is increased. [16]

7. With a suitable example, explain the purpose and implementation of cascade control. [16]

8. Write short notes on
   (a) Integral of the square of error.
   (b) Integral of time-weighted absolute error. [8+8]

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Time: 3 hours **Max Marks: 80**

Answer any FIVE Questions
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1. Obtain $y(t)$ for
   (a) $y(s) = \frac{s+1}{s^2+2s+5}$
   (b) $y(s) = \frac{s^2+2s}{s^4}$
   (c) $y(s) = \frac{2s}{(s-1)^3}$. [5+6+5]
2. Define and discuss the following terms with the help of a neat diagram:
   (a) Overshoot
   (b) Decay ratio
   (c) Rise time
   (d) Response time. [4×4]
3. The heat transfer equipment shown in figure 3 consists of two tanks one nested inside the other. Heat is transferred by convection through the wall of inner tank. The contents of each tank are well mixed. The following data and information apply:

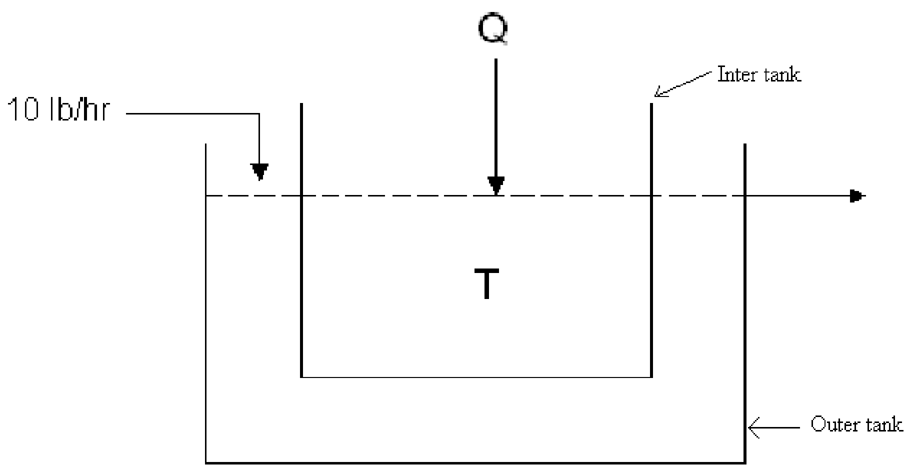

Figure 3

   (a) The Hold up volume of inner and outer tank are same i.e 1 m^3
   (b) The cross sectional area for heat transfer between the tanks is 1 m^2

(c) The overall heat transfer coefficient for the flow of heat between the tanks is 10 kcal/(hr)(m^2)(^{0}C)

(d) The heat capacity of fluid is 1 kcal/(kg)(^{0}C), density of fluid is 850 kg/m^3.

Initially the temperature of the feed stream to the outer tank and the contents of it are at 100 ^{0}C. The contents of inner tank are initially at 100 ^{0}C. At time zero the flow of heat to inner tank (Q) is changed according to a step change from 0 to 50 kcal/hr

(a) Obtain a expression for the laplace transform of the temperature of the inner tank T(s)

(b) invert T(s) and obtain T for time = 0, 5 hr, 10 hr, ∞. [16]

4. For the control system shown in figure 4 given below determine:

(a) C(s)/R(s)

(b) C(∞)

(c) Offset

(d) C(0.5)

(e) Whether the closed loop response is oscillatory. [16]

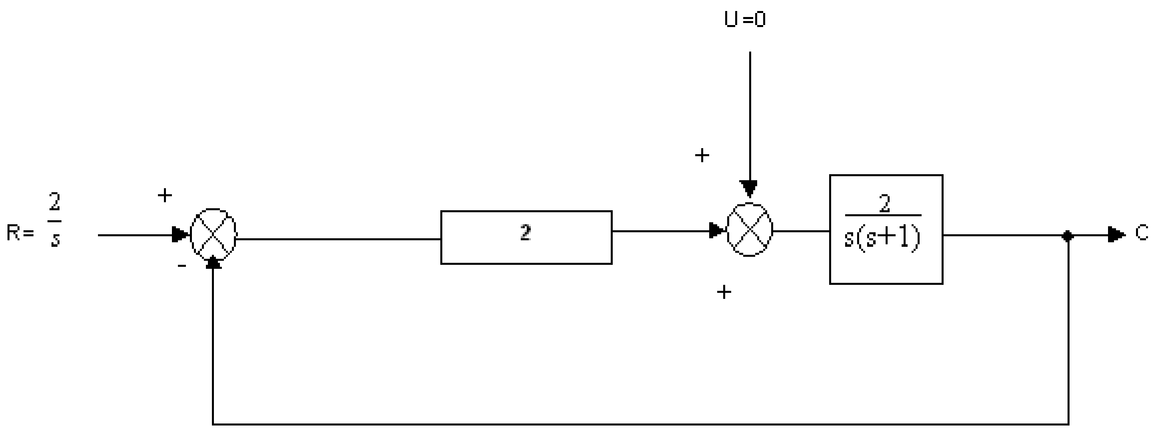

Figure 4

5. In the control system shown in the figure 5, find the value of K_c for which the system is on the verge of instability. The controller is replaced by a PD controller, for which the transfer function is $K_c(\tau_D s + 1)$. If $K_c = 10$, determine the range of τ_D for which the system is stable. [16]

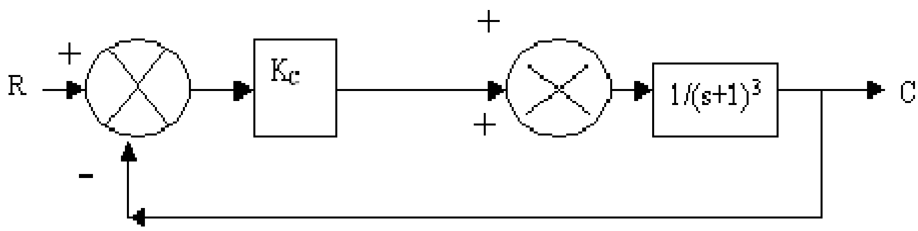

Figure 5

6. Draw the root locus diagram for the system shown 6, where $G_c = K_c(1+0.5s+1/s)$. [16]

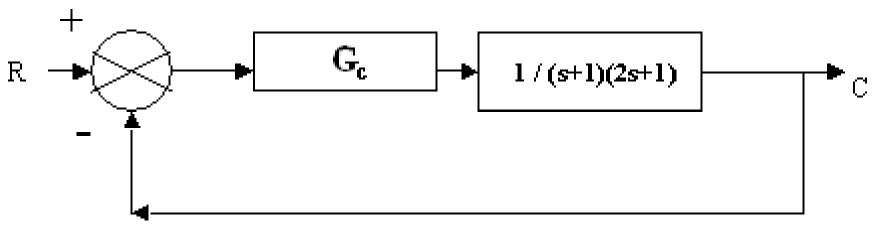

Figure 6

7. Discuss the rationale of a cascade control system and demonstrate why it provides better response than simple feedback. [16]

8. Discuss the criteria for good control. [16]

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