Code No: RR320803

Set No. 1

III B.Tech II Semester Supplimentary 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) Define a transfer function. How do you relate process inputs and outputs by a transfer function? What are the properties of transfer functions?
   (b) The input and output concentrations of a well stirred vessel of volume V are x and y, respectively, and the inflow and outflow rates are q_i and q. No reaction occurs. Write the unsteady state material balance for the system, and write an expression for the solution of y. [8+8]

2. Calculate the transient response of a second order system whose transfer function is $\frac{5}{(4s+1)(2s+1)}$ for unit step change in input. [16]

3. Explain in detail with a block diagram working mechanism of a proportional integral derivative pneumatic controller. [16]

4. (a) Develop the block diagram of a generalized feed back control system with one disturbance, incorporating in each block the appropriate transfer function and on each stream the appropriate variable. [8]
   (b) Develop the closed loop responses for set point and load changes. [4+4]

5. Give transfer function
   $\frac{Y(S)}{X(S)} = \frac{6}{3s^2+4s^2+5S+1}$
   Analyse the stability of the system when controlled by proportional controller using Routh?s stability criteria. [16]

6. Sketch the root-locus diagram for the system shown in (figure 6). If the system is unstable at higher values of k_c, find the roots on the imaginary axis and the corresponding value of k_c. [16]

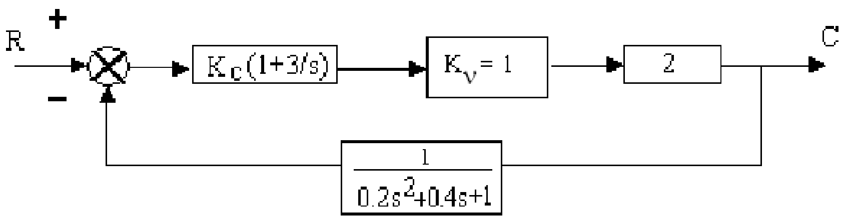

Figure 6

7. (a) Discuss gain and phase margins in controller system design by frequency response analysis. Write the design specifications for gain and phase margins
   (b) Construct general Bode plots for the following;

i. A first order system

ii. Two first order systems in series [8+8]

8. Explain in detail "Internal Model Control" method of control using a schematic diagram. [16]

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Code No: RR320803 **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) Derive an expression for the dynamic response of a general first order system for ramp change in input.
   (b) A mercury thermometer having first order dynamics with a time constant of 60 sec is placed in a temperature batch of 40^0 C. After the thermometer reaches its steady state, it is suddenly placed in a bath at 35^0 C at time t=0. Calculate the variation of temperature with time for a period of 60 sec considering an incremental time of 10 sec. [8+8]

2. Calculate the transient response of a second order system whose transfer function is $\frac{5}{(4s+1)(2s+1)}$ for unit step change in input. [16]

3. Write short notes on:
   (a) Negation feedback versus positive feedback.
   (b) Servo problem versus Regulator problem. [8+8]

4. The location of the load change in a control loop may affect the system response. In the block diagram shown in the figure 4 given below, a unit – step change in load enters at either location 1 or location 2. [8+8]
   (a) What is the offset when the load enters at location 1 and when it enters at location 2?
   (b) Sketch the transient response to a step change in U_1 and to a step change in U_2.

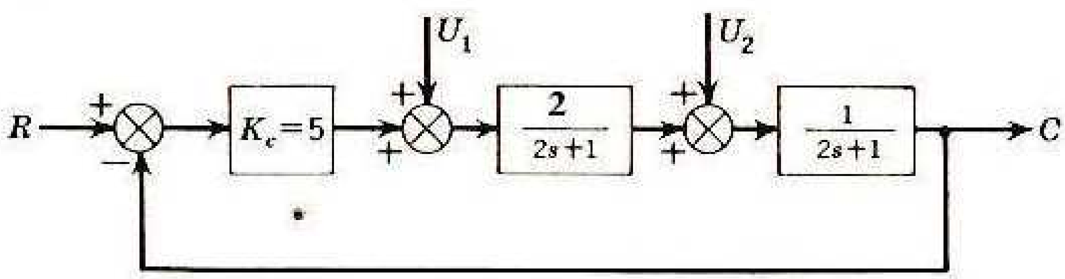

Figure 4

5. (a) Determine the stability by Routh criterion. The characteristic equation is $S^4 + 3S^3 + 5S^2 + 4S + 2 = 0$
   (b) What is the significance of block diagram in control system analysis? [8+8]

6. A control system representing a two-tank liquid level system having a PID controller and a first order-measuring lag has the following open-loop transfer function

$$G = K_c \frac{1 + 2s/3 + 1/3s}{(20s + 1)(10s + 1)(0.5s + 1)}$$

Construct the root locus diagram for the above system. [16]

7. Construct Bode diagrams for the following: [4+4+4+4]
   (a) P - controller
   (b) PI controller
   (c) PID controller
   (d) Transportation lag.

8. Discuss the Cohen and Coon rules of controller tuning in detail. [16]

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Code No: RR320803

Set No. 3

III B.Tech II Semester Supplimentary 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) Derive an expression for the dynamic response of a general first order system for ramp change in input.
   (b) A mercury thermometer having first order dynamics with a time constant of 60 sec is placed in a temperature batch of 40^0 C. After the thermometer reaches its steady state, it is suddenly placed in a bath at 35^0 C at time t=0. Calculate the variation of temperature with time for a period of 60 sec considering an incremental time of 10 sec. [8+8]

2. Two non-interacting tanks are connected in series. The transfer function relating the level, h_2 in the second tank to the inflow, q to the first tank is given by the following transfer function,

$$\frac{H_2(s)}{Q(s)} = \frac{R_2}{(\tau_1 s + 1)(\tau_2 s + 1)}$$

   The time constants are τ_1=0.5 seconds and τ_2=1 seconds, and the resistance to out flow $R_2 = 1$. Sketch the response of the level in tank 2 if a unit step change is made in inlet flow rate to tank 1. [16]

3. A first order process is controlled by a PD controller. The control valve is assumed to be a first order. Assuming the measuring element is having negligible time constant, develop a block diagram for the feedback control system and obtain an overall transfer function. [16]

4. (a) Develop the block diagram of a generalized feed back control system with one disturbance, incorporating in each block the appropriate transfer function and on each stream the appropriate variable. [8]
   (b) Develop the closed loop responses for set point and load changes. [4+4]

5. (a) Discuss the theorems of the Routh test
   (b) For characteristic equation $s^4 + 6s^3 + 11s^2 + 36s + 120 = 0$, determine the stability using Routh Criterion. [8+8]

6. (a) Explain the concept of Root Locus.
   (b) Explain the procedure of plotting root locus diagram. State also the rules. [8+8]

7. Describe the method of control system design by frequency response method. Explain how it helps the designer. [16]

8. (a) Compare and contrast negative feedback with positive feedback.
   (b) Compare double seated and single seated control valve [8+8]

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Code No: RR320803 **Set No. 4**

III B.Tech II Semester Supplimentary 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 mercury thermometer having first order dynamics with a time constant of 60 sec is placed in a temperature bath at 40^0 C. After the thermometer resumes steady state, it is suddenly placed in a bath at 45^0 C at t=0 and left there for 60 sec, after which it is immediately returned to the bath at 40^0 C.
   (a) Draw a sketch showing the variation of thermometer reading with time.
   (b) Calculate the thermometer reading at t=70 sec and t=120 sec. [8+8]

2. Show that for the under damped second order system $G(s) = \frac{Y(s)}{X(s)} = \frac{1}{\tau^2 s^2+2\phi\tau s+1}$ the step response equation is $Y(t) = 1 - \frac{1}{\sqrt{1-\phi^2}} e^{-\phi t/\tau} \sin(\sqrt{1-\phi^2}\frac{t}{\tau} + \tan^{-1}\frac{\sqrt{1-\phi^2}}{\phi})$ [16]

3. Discuss the working principle & mechanism of pneumatic PID controller with the help of a neat schematic diagram [16]

4. (a) Develop the block diagram of a generalized feed back control system with one disturbance, incorporating in each block the appropriate transfer function and on each stream the appropriate variable. [8]
   (b) Develop the closed loop responses for set point and load changes. [4+4]

5. (a) Determine the stability by Routh criterion. The characteristic equation is $S^4 + 3S^3 + 5S^2 + 4S + 2 = 0$
   (b) What is the significance of block diagram in control system analysis? [8+8]

6. Sketch the root-locus diagram for the system shown in (figure 6). If the system is unstable at higher values of k_c, find the roots on the imaginary axis and the corresponding value of k_c. [16]

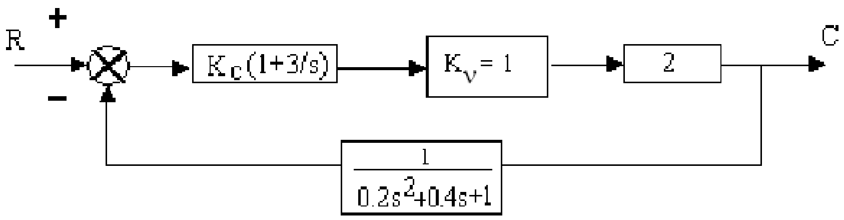

Figure 6

7. Plot the asymptotic Bode diagram for the PID controller

$$G(s) = K_c(1 + \tau_D s + 1/\tau_1 s)$$

where $K_c = 10$, $\tau_1 = 1$, $\tau_D = 100$. Label corner frequencies and give slopes of asymptotes. [16]

8. (a) Write in detail about the Zeigler-Nichols controller settings.
   (b) Write about the precautions to be taken in applying Z-N method. [8+8]

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