Code No: RR320803 **Set No. 1**

III B.Tech II Semester Supplimentary Examinations, Aug/Sep 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. Consider a liquid surge tank shown in (figure1) in which the outflow q of the tank is linearly related to the height, h of the liquid in the tank. Find the transfer function relating the changes in outflow to the change in the inflow q_i. Assume q is related to the head h by q=h/R. [16]

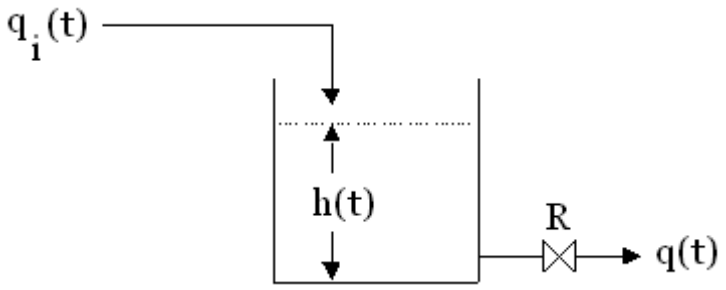

Figure 1

2. Assuming the flow in the manometer to be laminar and the steady-state friction for drag force in laminar flow to apply at each instant, determine a transfer function between the applied pressure P_1 and the manometer reading h. It will simplify the calculations if, for inertial terms, the velocity profile is assumed to be flat. From transfer function, written in the standard second order form, list
   (a) the steady state gain,
   (b) τ and
   (c) ζ
   Comment on these parameters as they are related to the physical nature of the problem. [4+4+4+4]

3. (a) Give the advantages and disadvantages of pneumatic controllers with electronic controller.
   (b) Define proportional band and gain of a controller. How are they related. [8+8]

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 how Routh test used for determining the stability of a control system for a general polynomial characteristic equation

(b) Write about the draw backs of Routh test and how are they overcome. [10+6]

6. Sketch the root loci for the control system having the characteristics equation

$$1 + \frac{K}{(s+1)(s+2)(s+4)} = 0$$

Locate quantitatively all the poles, zeros, asymptotes, break away point and imaginary axis cutting points [16]

7. For the transfer function shown below, sketch the gain versus frequency portion of the asymptotic plot of the Bode diagram. Determine the actual value of gain and phase angle at $\omega = 1$ Determine the phase angle as $\omega \to \infty$

$$G(s) = \frac{2(0.1s+1)}{s^2(10s+1)}$$

Indicate very clearly the slopes of the asymptotic bode diagram of G(s) [16]

8. (a) Explain feedforward control using a neat schematic.

(b) Present a comparative analysis of feedforward and feedback strategies [8+8]

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Code No: RR320803 **Set No. 2**

III B.Tech II Semester Supplimentary Examinations, Aug/Sep 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. Consider a liquid surge tank shown in (figure1) in which the outflow q of the tank is linearly related to the height, h of the liquid in the tank. Find the transfer function relating the changes in outflow to the change in the inflow q_i. Assume q is related to the head h by q=h/R. [16]

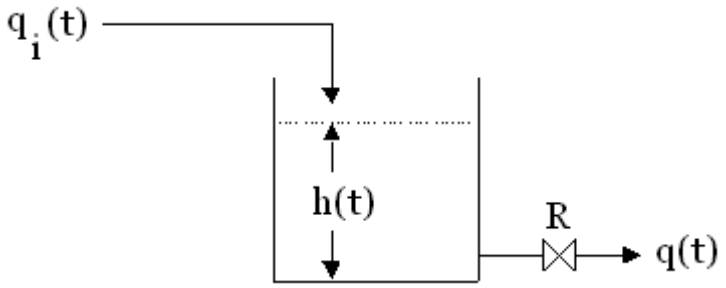

Figure 1

2. An under damped second order system is represented by the transfer function $\frac{Y(s)}{X(s)} = \frac{1}{\tau^2 s^2 + 2\zeta s + 1}$. The input is subjected to a disturbance of the form X(t) = U(t) (Unit step function) Derive, the expression for the response Y(t), and obtain the expression for overshoot. [10+6]

3. Develop the block diagram of closed loop reactor control system and derive the transfer functions of different components. Describe the system in detail. [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 how Routh test used for determining the stability of a control system for a general polynomial characteristic equation
   (b) Write about the draw backs of Routh test and how are they overcome. [10+6]

6. Discuss the rules for plotting root - locus diagrams in detail. [16]

7. Define the frequency response analysis. What means could you use to represent the results of the frequency response analysis for a dynamic system? [16]

8. Explain how dead time compensation can be made when the process contains large transportation lag. [16]

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Code No: RR320803 **Set No. 3**

III B.Tech II Semester Supplimentary Examinations, Aug/Sep 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) What is a transfer function? How is it useful in solving problems of process dynamics? How do you represent the transfer function by a block diagram?
   (b) A temperature sensing device can be modeled as a first order system with a time constant of 6 sec. It is suddenly subjected to a step input change of 25^0 C to 150^0 C. What temperature will be indicated after 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. The transfer function of PD controller in industry is given by $\frac{P}{\varepsilon} = K_c \frac{\tau_D s+1}{(\tau_D/\beta)s+1}$ where β is a constant. If a unit step change in error is introduced into the controller show that P(t) = $K_c(1 + Ae^{-\beta t/\tau_D})$, where A is a function of β. [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. Discuss the rules for plotting root - locus diagrams in detail. [16]

7. Write briefly on the following.
   (a) Gain and phase margins
   (b) Frequency response for process control. [8+8]

8. (a) Explain ratio control in detail with a neat schematic diagram.
   (b) Quote some commonly encountered examples from chemical industry where ratio control can be used. [8+8]

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

III B.Tech II Semester Supplimentary Examinations, Aug/Sep 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) What is a first order system ? What are its characteristic parameters ? Define the time constant and rise time for a first order system.
   (b) An isothermal, constant hold up, constant through put CSTR with a first order irreversible reaction is described by

$$\frac{dC_A}{dt} + \left(\frac{F}{V} + k\right) C_A = \frac{F}{V} C_{Ao}$$

   Assuming F, V, and k as constants, derive an expression for the solution of reactant concentration C_A for a step change in feed concentration C_{A0}. [8+8]

2. Define and discuss the following terms:
   (a) Quadratic lag
   (b) Dead time
   (c) Period of oscillation
   (d) Natural period of oscillation. [4+4+4+4]

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. For the control system whose 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 value of these imaginary roots and the remaining two roots. [8+8]

6. Determine the stability of the following two systems given their characteristic equations
   $S^4 + 5S^3 + 3S^2 + 1 = 0$
   $10S^3 + 17S^2 + 8S + 1 + K_c = 0$
   Using Root Locus method. [8+8]

7. Plot the Bode diagram for the open loop transfer function of a control system given below which represents the PD control of three tanks in series; with transportation lag in the measuring element.

$$G(s) = \frac{10(0.5s+1)e^{-s/10}}{(s+1)^2(0.1s+1)}$$

[16]

8. (a) Explain feedforward control using a neat schematic.
   (b) Present a comparative analysis of feedforward and feedback strategies [8+8]

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