Code No: RR311004 **Set No. 1**

III B.Tech I Semester Regular Examinations, November 2006
PROCESS CONTROL INSTRUMENTATION
(Common to Electronics & Instrumentation Engineering and Instrumentation & Control Engineering)

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

Answer any FIVE Questions
All Questions carry equal marks

⋆ ⋆ ⋆ ⋆ ⋆

1. (a) A tank having a cross sectional area of 2 square metre is operating at steady state with an input flow rate of 2 cubic metre / min. The flow – head characteristics are as shown in the figure1a

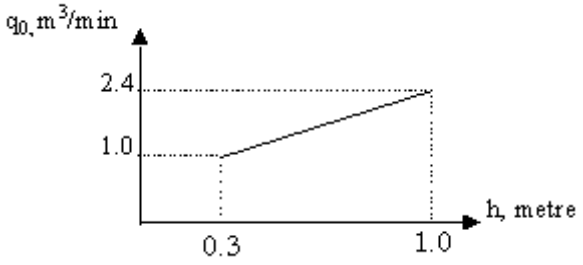

Figure 1a

   (b) Find the transfer function H(S) / Q(S).

   (c) Derive the expression for the response of the system for a step change and draw the response curve.

   (d) If the flow to the tank increases from 2 to 2.2 cubic metre according to a step change, calculate the level h two minutes after the change occurs. [6+6+4]

2. Three identical tanks are operated in series in non-interacting fashion. For each tank, R=1 and t = 1. If the deviation in flow rate to the first tank is an impulse function of magnitude 2, determine

   (a) An expression for H(S) where H is the deviation in level in the third tank.

   (b) Obtain the expression for H(t).

   (c) Sketch the response H(t). [7+6+3]

3. (a) A two position controller is used to open and close a fill valve with an open flow 2cub.met./min in to a 5m diameter cylindrical tank. The tank has a constant outflow of 1cub.met./min. The level in the tank has to be maintained at a setpoint of 12m with neutral zone of 1m.

      i. Calculate the cycling period.

      ii. Plot the level vs time graph.

   (b) Distinguish between continuous & discontinuous controller modes. [12+4]

4. (a) Explain in detail, the realization of proportional-integral action with the aid of bellows, flapper-nozzle etc.

(b) Draw a three mode electronic controller and derive the expression for the output voltage. [8+8]

5. (a) What is a optimum - tuning control? What are its different approaches?

   (b) How are the interactions in control being channelized to optimize the control action in a boiler? [8+8]

6. Explain the principle of a direct and reverse pneumatic actuator. [16]

7. (a) The area of opening of a valve versus lift is given by $A = a + bx^2$. Derive the flow versus lift characteristic for this parabolic valve?

   (b) Liquid Glycerin (density $78 lb/ft^3$) is require at a maximum flow of 18gpm. The line drop is 40 psi and the valve pressure drop is 10 psi what size plug valve is required? [8+8]

8. Under what conditions will the steady state feed forward control system yield the same performance as dynamic feed forward controller in rejecting the effect of disturbance? [16]

⋆ ⋆ ⋆ ⋆ ⋆

Code No: RR311004 **Set No. 2**

III B.Tech I Semester Regular Examinations, November 2006
PROCESS CONTROL INSTRUMENTATION
(Common to Electronics & Instrumentation Engineering and Instrumentation & Control Engineering)

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

Answer any FIVE Questions
All Questions carry equal marks

⋆ ⋆ ⋆ ⋆ ⋆

1. (a) Mercury thermometer is a first order system - Say "True" or "False".
   (b) Prove your answer by deriving the transfer function of this system.
   (c) How will this system behave with a linearly varying input? Explain the dynamics. [2+6+8]

2. (a) Say whether heated tank and an immersed thermometer with negligible interaction is interacting or non-interacting. Justify your answer.
   (b) Write the differential equations and determine the transfer functions individually for heated tank and thermometer.
   (c) Determine the overall transfer function of this combination. How is this transfer function related with the individual transfer function? [3+9+4]

3. (a) Explain with analytic expression, the concept of a single controller mode which is anticipatory in nature. List its characteristics.
   (b) Why a pure derivative is not preferred? Draw the derivative controller output for the error given below figure3b. (Assume the relevant settings) [8+8]

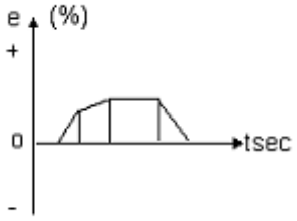

Figure 3b

4. (a) Explain in detail, the realization of proportional-integral action with the aid of bellows, flapper-nozzle etc.
   (b) Draw a three mode electronic controller and derive the expression for the output voltage. [8+8]

5. (a) Explain how controller settings for minimum error integral obtained.
   (b) Determine the effective system parameters from the following transient response, and predict the critical frequency and maximum gain. [8+8]

K_C = 0.6 K, c max

$$T_R = \frac{P_v}{2.0}$$

$$T_D = \frac{P_v}{8}$$

6. (a) Explain the baffle - Nozzle system with the help of its characteristic curves.
   (b) Explain the pneumatic booster and what is its need.
   (c) Differentiate between direct and reverse action final control operation.[6+6+4]

7. A heating furnace requires a control valve passing 10gpm preheated light fuel oil (SP.gr. = 0.8) at full load and only 2 gpm at the smallest heating load. The source pressure constant at 50psi gage, but there is 10psi drop in the oil pre heater and 20 psi drop at the furnace burner nozzles. Remaining pressure drop occurs only at control valve when it is fully opened.
   (a) Find out control valve size required for the above application.
   (b) Find out required rangeability of the valve
   (c) Find out characteristic coefficient (α). [6+4+6]

8. (a) What control strategy is needed for improved performance when input and output of a process affected by significant disturbance?
   (b) What is compensation in a closed operation? Explain with neat diagram.

   [8+8]

⋆ ⋆ ⋆ ⋆ ⋆

Code No: RR311004 **Set No. 3**

III B.Tech I Semester Regular Examinations, November 2006
PROCESS CONTROL INSTRUMENTATION
(Common to Electronics & Instrumentation Engineering and Instrumentation & Control Engineering)

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

Answer any FIVE Questions
All Questions carry equal marks

⋆ ⋆ ⋆ ⋆ ⋆

1. (a) What are single capacity systems? Give one example and explain why it is called so?
   (b) Write the differential equation of this system and determine the transfer function.
   (c) Study the response of this pure capacity system to a step change in input.

   [5+5+6]

2. (a) Say whether heated tank and an immersed thermometer with negligible interaction is interacting or non-interacting. Justify your answer.
   (b) Write the differential equations and determine the transfer functions individually for heated tank and thermometer.
   (c) Determine the overall transfer function of this combination. How is this transfer function related with the individual transfer function? [3+9+4]

3. (a) Explain with analytic expression, the concept of a single controller mode which is anticipatory in nature. List its characteristics.
   (b) Why a pure derivative is not preferred? Draw the derivative controller output for the error given below figure3b. (Assume the relevant settings) [8+8]

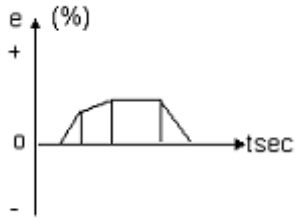

Figure 3b

4. Describe with necessary sketches, the principle of the following controllers.
   (a) force type pneumatic PI controller.
   (b) hydraulic PI controller. [8+8]

5. (a) What is meant by process tuning and list the various methods of tuning of PID parameters.
   (b) Discuss process reaction method for control loop tuning. [8+8]

6. (a) Give the principle of the control valve and give its O/P equation.
   (b) A pressure difference of 1.5 psi occurs across a constriction in a 4 cm diameter pipe. The constriction constant is 0.008 $w^3/s/(kPa)^{1/2}$. Find
      i. the flow rate in m^3/sec.
      ii. flow velocity in m/sec. [8+8]

7. (a) The area of opening of a valve versus lift is given by $A = a + bx^2$. Derive the flow versus lift characteristic for this parabolic valve?
   (b) Liquid Glycerin (density 78lb/ft^3) is require at a maximum flow of 18gpm. The line drop is 40 psi and the valve pressure drop is 10 psi what size plug valve is required? [8+8]

8. Under what conditions will the steady state feed forward control system yield the same performance as dynamic feed forward controller in rejecting the effect of disturbance? [16]

⋆ ⋆ ⋆ ⋆ ⋆

Code No: RR311004 **Set No. 4**

III B.Tech I Semester Regular Examinations, November 2006
PROCESS CONTROL INSTRUMENTATION
(Common to Electronics & Instrumentation Engineering and Instrumentation & Control Engineering)

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

Answer any FIVE Questions
All Questions carry equal marks

⋆ ⋆ ⋆ ⋆ ⋆

1. (a) Derive the transfer function H(S)/Q(S) for the liquid level system shown below figure1a. The resistances are linear. H and Q are deviation variables. Derive the transfer function of the system.

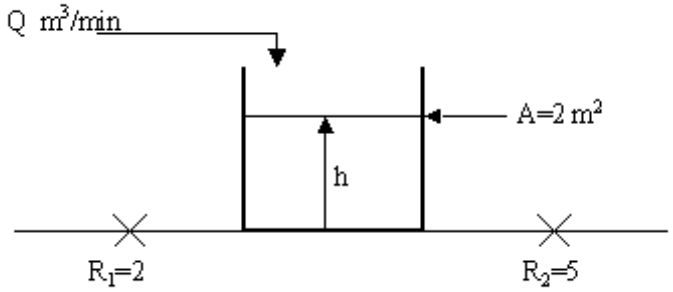

Figure 1a

(b) What modification you have to make in the transfer function if a disturbance U occurs in inflow.

(c) Write the expression for the response if the above system experiences a step change in Q. [6+5+5]

2. (a) Say whether heated tank and an immersed thermometer with negligible interaction is interacting or non-interacting. Justify your answer.

(b) Write the differential equations and determine the transfer functions individually for heated tank and thermometer.

(c) Determine the overall transfer function of this combination. How is this transfer function related with the individual transfer function? [3+9+4]

3. (a) what is meant by differential gap and how it is related to the performance of the final control element?

(b) Define proportional band. Explain the relation between proportional gain, proportional band and offset error.

(c) With a neat sketch explain the integral controller mode action. Summarize the characteristics. [5+5+6]

4. (a) Briefly explain the principle of operation of a displacement type pneumatic PD controller. How the derivative time can be adjusted in this controller.

(b) Outline the design steps involved in developing an electronic PI controller.

[8+8]

5. (a) What is meant by process tuning and list the various methods of tuning of PID parameters.
   (b) Discuss process reaction method for control loop tuning. [8+8]
6. (a) Explain how a DC motor can be used as an actuator for a final control operation.
   (b) What force is generated by 90 kPa acting on a $30cm^2$ area diaphragms.

[10+6]

7. Write about the rotating shaft valves? [16]
8. (a) Explain the process of controlling reflux in distillation column.
   (b) Explain the control of indirect bottom product in a distillation column.

[8+8]

⋆ ⋆ ⋆ ⋆ ⋆