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

III B.Tech. I Semester Regular Examinations, November -2005
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

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1. (a) A flow head equation has the equation $q = h^n$. Calculate the resistance.
   (b) A liquid storage device is spherical in shape. Calculate the capacitance as a function of head.
   (c) If the outflow at a vessel is proportional to the square root of head, what shape vessel results in
      i. a steady change in head
      ii. a rate of change of head proportional to head? [4+4+8]

2. (a) Differentiate between a "Servo operation" and "Regulator operation".
   (b) Give a typical example for servo operation and explain.
   (c) Explain the regulator operation with an example. [4+6+6]

3. (a) Briefly discuss the characteristics of proportional control mode. Mention the type of processes for which proportional controller is most suited.
   (b) A proportional controller has a gain of 3. Plot the controller output for the error given below figure1 if Po = 50%. (Po – controller output with no error)

   [8+8]

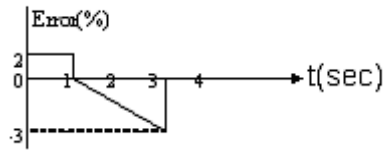

Figure 1:

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) Show by sketches how proportional and reset action rates are to be determined. What is the effect of the derivative action on maximum deviation and stabilizing time?

(b) A PID controller has a steady out put pressure of 0.4 kg/cm^2 . The set point is now lowered at the rate of 1cm/min. Obtain the nature of the output pressure. Assume K_C =0.1 kg/cm^2 /cm. T_R =1.2 min. and T_D = 0.5 min. [10+6]

6. (a) Explain the principle of operation of a stepping motor and give its sole as an actuator.

   (b) A hydraulic system uses pistons of diameter 2cm and 40cm. What force on the small piston will raise a 500 kg mass. [10+6]

7. Write short notes on.

   (a) Globe Valves

   (b) Ball valves

   (c) Louvers [6+6+4]

8. What are the main advantages and disadvantages of cascade control? For what kind of processes can you employ cascade control? [16]

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

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

Answer any FIVE Questions
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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) Is the Thermometer Bulb and well arrangement a non-interacting system? Justify your answer.
   (b) Write the differential equations and determine the transfer function for Thermometer bulb and well arrangement. [6+10]
3. (a) Explain with a neat sketch depicting the error vs controller output, the principle of a proportional controller action.
   (b) With an example, explain how offset error in proportional controller occurs. Suggest a way to overcome the offset error. [8+8]
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. (a) A 4-20mA control signal is loaded by a 100-Ω resistor and must produce a 20-40 volt motor drive signal. Find an equation relating the input current to the output voltage.
   (b) Explain with an example the need of signal conditioning system in the final control operation. [8+8]
7. (a) Briefly explain valve sizing.
   (b) A fully open valve passes 200gpm of water at a pressure differential of 10.0psi calculate valve sizing. [8+8]

8. Discuss the design techniques related to multiple input and multiple output (MIMO) control system? [16]

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

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

Answer any FIVE Questions
All Questions carry equal marks

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1. (a) Derive the transfer function H(S)/Q(S) for the liquid level system shown below figure2. The resistances are linear. H and Q are deviation variables. Derive the transfer function of the system.

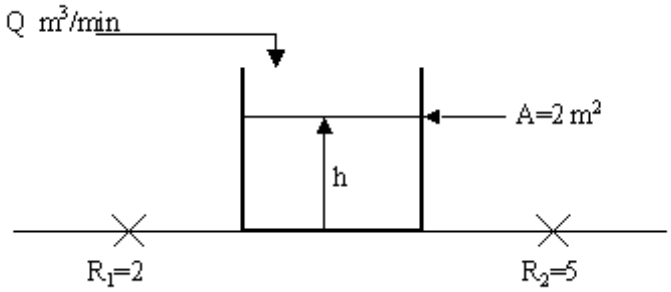

Figure 2:

   (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) Give one example for non-interacting first order elements in series.

   (b) Write the differential equation for this combination and determine the transfer function.

   (c) Comment on the transfer function. [3+10+3]

3. (a) Determine the controller actions present in the controllers given below figure3. Also find the proportional gain, derivative and integral time if they exist.

   (b) A PI controller has K_p=5 and K_I=6 sec. Find the controller output for an error given by e_p =4 sin(πt). Also find the phase shift between error and controller output. [8+8]

4. (a) Explain with a neat sketch, the working principle of a displacement type pneumatic proportional controller. Discuss the effect of adding the negative feedback.

   (b) With necessary diagrams, describe a hydraulic integral controller. Explain how integral time can be adjusted. [8+8]

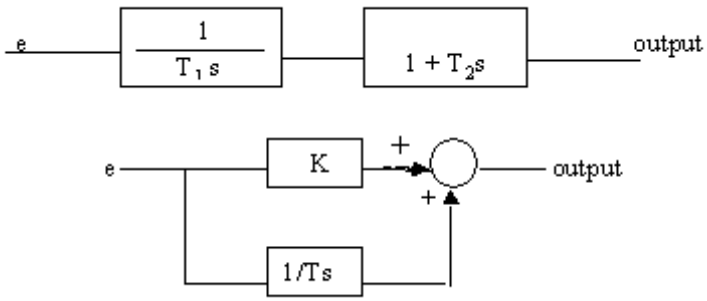

Figure 3:

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 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. Draw the feed forward and feed back control systems that regulate the flow through the pipe? Discuss about both the control systems and give reasons to select any of the two systems in maintaining the desired flow? [16]

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

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1. (a) A flow head equation has the equation $q = h^n$. Calculate the resistance.
   (b) A liquid storage device is spherical in shape. Calculate the capacitance as a function of head.
   (c) If the outflow at a vessel is proportional to the square root of head, what shape vessel results in
      i. a steady change in head
      ii. a rate of change of head proportional to head? [4+4+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) Discuss the effects of an integral controller on the closed loop response of first order process.
   (b) With neat sketches, explain the principle of derivative control action. Summarize its characteristics. [8+8]

4. (a) Describe with a neat sketch, the principle of a force type pneumatic PD controller. Mention the merits of pneumatic controller.
   (b) Explain with relevant equations, the implementation of the single mode control action with electronic circuits. [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. Explain the principle of a direct and reverse pneumatic actuator. [16]

7. Write steps followed in choosing a valve for better control of flow and should be cost effective. [16]

8. (a) Explain the principles of cascade controller tuning.

(b) State the fundamental difference feed forward and conventional feed back control.

(c) Why is a process model required for feed forward controller? [5+6+5]

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