Code No: RR322301 **Set No. 1**

III B.Tech II Semester Supplementary Examinations,
November/December 2005
INSTRUMENTATION & PROCESS CONTROL
(Bio-Technology)

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

Answer any FIVE Questions
All Questions carry equal marks

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1. (a) Show that the mercury thermometer which is suddenly immersed in hot water with some temperature will follow first order dynamics.
   (b) A thermometer having time constant of 1 min is initially at 50C. It is immersed in a bath maintained at 100^0 C at t =0;
      i. Determine the temperature reading at t = 1.2 min.
      ii. If at t = 1.5 min, the thermometer is removed from the bath and put in a bath at 75^0C, determine the maximum temperature indicated by the thermometer.
      iii. What will be the indicated temperature at t = 20 min? [6+10]

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 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 figure1. (Assume the relevant settings) [8+8]

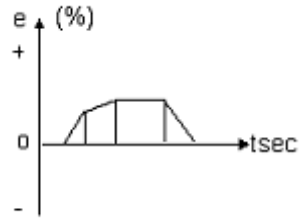

Figure 1:

4. (a) Explain the method of realizing an electronic PI controller employing delayed positive feedback. Derive the expression for proportional gain and integral time.
   (b) Explain with a neat sketch, the working principle of a moving vane type two position controller. [8+8]

5. (a) Explain the following terms as applicable to system evaluation with necessary graphs.
   i. Stability
   ii. measure of quality .
   (b) Discuss the quarter - amplitude criterion to evaluate the response. [8+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) Distinguish different types of butterfly valves.
   (b) Mention which are the rotating shaft valves. [12+4]
8. Explain feed forward control for the following
   (a) Heat exchangers
   (b) Drum boiler
   (c) Distillation column. [5+5+6]

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Code No: RR322301 **Set No. 2**

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

Answer any FIVE Questions
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1. In the following figure1, P_1,P_2 and P_3 refer to changes in the pressures upstream, in the tank and downstream respectively and the flows into and out of the tank are influenced by the tank pressure.

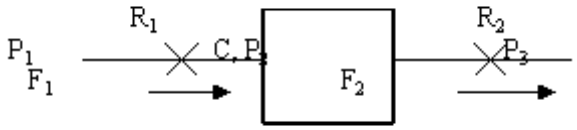

Figure 1:

   (a) Write the differential equation for the above system and get the transfer function.
   (b) What is the order of the above system? How will the order change if there are several inlets and outlets? [10+6]

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) Describe the output of a three mode controller for an assumed error variation. Discuss its features.
   (b) Specification of a PI controller are K_p=7, K_i= 2 sec^{-1} and $P_I(0)$ (controller output at t=0)=24%. Plot the controller output as the function of time for the given error as shown in figure2. [8+8]

4. (a) With a neat circuit diagram, explain the realization of an electronic two position controller with adjustable neutral zone.
   (b) Design an electronic proportional controllers for (0-12v) error input, 10% proportional band and 50% zero error controller output. [8+8]

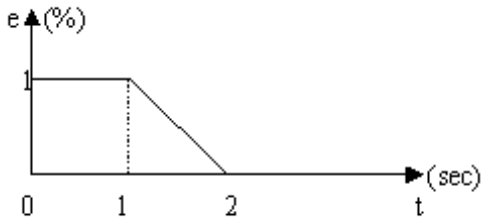

Figure 2:

5. (a) Plot the transient response of a process with time constants of 50sec and 20sec and a time delay of 10sec. Use the reaction curve method to obtain the recommended settings for a three - mode controller.
   (b) What is the phase margin for the recommended controller gain? [10+6]

6. (a) What is the principle of a solenoid and explain how it can be used to change the gears of a two-position transmission. (Let an SCR is used to activate the solenoid coil).
   (b) A stepping motor has 130 steps per revolution. Find the digital input rate that producer 10.5 revolutions per second. [10+6]

7. Write short notes on.
   (a) Sliding stem Valves
   (b) Rotating shaft Valves. [8+8]

8. (a) Explain clearly the split range control of the pressure in the steam header?
   (b) Determine the properties of the inner loop in a cascade control system and write the principle advantages of cascade control system? [8+8]

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Code No: RR322301 **Set No. 3**

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

Answer any FIVE Questions
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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) Define self regulation ?
   (b) Explain how self and non self regulated systems operate for step input with examples. [5+11]

3. (a) Explain with neat sketches, the characteristics of two position and three position controller modes.
   (b) What is cycling? Suggest a suitable modification to overcome cycling.

   [6+10]

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 the following terms as applicable to system evaluation with necessary graphs.
      i. Stability
      ii. measure of quality .
   (b) Discuss the quarter - amplitude criterion to evaluate the response. [8+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) 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. Explain the economic considerations of feed forward controller? [16]

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Code No: RR322301 **Set No. 4**

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1. In the following liquid level system as shown in figure1, the pump removes water at a constant rate of 10 m^3/min and this rate is independent of head. The cross sectional area of the tank is 1 m^2 and the resistance is 0.5 m/m^3/min. Derive the transfer function H(S)/Q(S) when
   (a) The tank level operates about the steady state value of h_s= 1 m.
   (b) The tank level operates about the steady state value of h_s = 3 m. [8+8]

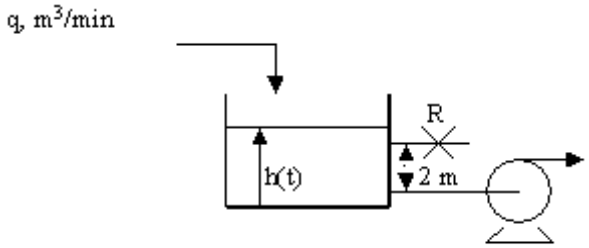

Figure 1:

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) 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) What are the advantages of the force type pneumatic controllers? Describe with neat diagrams, the working of a force type pneumatic proportional controller.
   (b) Explain the working principle of a hydraulic proportional controller. How proportional gain can be adjusted in this controller? [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) 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. Write about the rotating shaft valves? [16]

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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