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

III B.Tech. II Semester Regular Examinations, January -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) What is called a "Dead End System"? Explain one such system with neat diagram.
   (b) Write the differential equation of this system and get the transfer function.
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. (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.
4. (a) Develop an electronic two position controller with 0-5 volts input and a 0.0 or 10.0 volt output. The set point is 2.5v and the neutral zone is to be 1v about this setpoint.
   (b) A proportional pneumatic controller has equal area bellows. If 3-15 psi signals are used on input and output, find the ratio of pivot distances that provides a 25%proportional band.
5. Illustrate with relevant graphs the following methods of optimum settings from the plant response.
   (a) Damped oscillation method.
   (b) Reaction - curve method.
6. Explain the principle of a direct and reverse pneumatic actuator.
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. Write short notes on

(a) Feed forward control

(b) Override control

(c) Ratio control.

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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. System 1 and system 2 have resistances equal to 1 and 2 respectively. The capacitance of system 1 is 1 where as for the system 2, it is 2.
   (a) Determine the time constants of System 1 and system 2.
   (b) Forming a dead end interacting system with System 1 and 2, determine the overall transfer function.
   (c) Determine the effective time constants of this interacting system.
2. (a) Give one example for 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. (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.
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.
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?
6. (a) An equal percentage control valve has a range ability of 32. If the maximum flow rate is Find the flow at 2/3 and 4/5 open settings. $100ms^3/hr$.
   (b) Explain
      i. quick opening
      ii. linear
      iii. equal percentage characteristics of a control valve.
7. Write steps followed in choosing a valve for better control of flow and should be cost effective.

8. Explain feed forward control for the following
   (a) Heat exchangers
   (b) Drum boiler
   (c) Distillation column.

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Code No: RR322301 **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 Cylindrical tank with an area of $20ft^2$ and a height of 10 ft has a normal liquid depth of 6ft. The flow to the tank is10 ± 1cubic ft/min, and the liquid is discharged through a control valve to a process at atmospheric pressure. (1 ft = 0.305 metre) Calculate the time constant if the tank is
   (a) Open to the atmosphere
   (b) Closed, with a constant pressure of 10 psig above the liquid.
   (c) Closed, with a fixed amount of air sealed above the liquid. The initial pressure is 10 psig.
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.
3. (a) Discuss relative advantages and disadvantages of the proportional, integral and derivative control actions.
   (b) Discuss the characteristic effects of a proportional controller on the closed loop response of a process.
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.
5. (a) Explain the detailed procedure for Ziegler - Nichols method PID settings. In the Ziegler - Nichols method, the critical gain was found to be 4.2 and the
   (b) critical period was 2.21 minutes. Find the standard settings for
      i. Proportional mode control
      ii. PI control
      iii. PID control.
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 $0.008w^3/s/(kPa)^{1/2}$.Find

i. the flow rate in m^3/sec.

ii. flow velocity in m/sec.

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 (density78lb/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. What is a ratio control system? Why it is useful for the process control? Give any three examples?

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

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

Answer any FIVE Questions
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1. (a) An open loop cylindrical tank 1.2 metre in diameter is filled with water to a depth of 0.9 metre. The water flows out through a 2-inch control valve at an average rate of 0 .136 cubic metre/min. If the input is increased from 0.136 to 0.182 cubic metre/min, what is the new depth in the tank and about how long will it take to accomplish 95%of the change in level?
   (b) Calculate the transfer function relating tank level to valve position, and compare with the transfer function relating level and input flow.
2. Differentiate between a continuous process and a batch process. Support your answer explaining with one continuous process and one batch process with neat diagrams.
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.
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.
5. (a) Discuss in brief the frequency response method of process controller tuning with Bode plot.
   (b) In an application of the Ziegler - Nichols method; a process begins oscillation with a 30% proportional band in an 11.5min period. Find the normal three ? mode controller settings.
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.
7. (a) Centrifugal pump is available as a fluid source for a heat exchanger. At maximum flow the head is 100 psig, and at shut off the head is 40psig. At maximum flow, line losses are 15 psi and the heat exchanger pressure drop is 75psi. The control valve back pressure is atmospheric. Can this pump be used?
   (b) Explain about flashing problem in control valves.

8. Discuss the rational of cascade control and demonstrate why it provides better performance than feed back control?

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