B.E. Instrumentation Engineering (Model Curriculum) Semester - VI

IN603M - Process Automation

P. Pages : 2 **GUG/S/23/14030**

Time : Three Hours Max. Marks : 80

Notes : 1. All questions carry marks as indicated.
2. Due credit will given to neatness and adequate dimensions.
3. Assume suitable data wherever necessary.
4. Illustrate your answers wherever necessary with the help of neat sketches.

1. a) Give the list of "Automation Types". Explain each type in brief. **8**

b) Analyze the degrees of freedom of "stirred-tank heating process (constant hold-up)" whose mathematical model given by the equation: $V\rho C\frac{dT}{dt} = wC(T_i - T) + Q$ **8**

W_i = mass flow rate
T_i = Inlet temp
Q = Heating rate
T = exit temp
W = outlet mass flowrate
ρ = density
C = Heat capacity

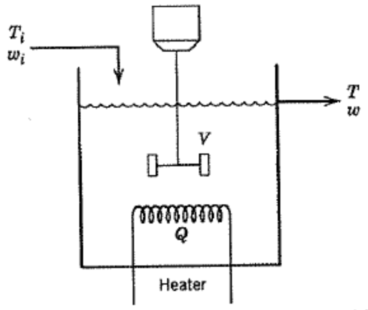


Figure Stirred-tank heating process with constant holdup, *V*.

OR

2. a) List and explain the examples of automation in Industry. **8**

b) A controller outputs a 4-20 mA signal to control motor speed from 140 to 600 rpm with linear dependence. **8**
Calculate :
a) Current corresponding to 310 rpm
b) The value of (a) expressed as the percentage of control output.

3. a) Explain "Floating-Control Mode" with suitable waveforms.

b) The temperature of water in a tank is controlled by a two-position controller,. When the heater is off the temperature drops at 2 K per minute. When the heater is on the temperature rises at 4 K per minute. The setpoint is 323 K and neutral zone is $\pm$ 4% of the setpoint. There is 0.5-min lag at both on and off switch points. Find the period of oscillation and plot the water temperature versus time.

OR

4. a) Discuss Integral-Control Mode with suitable waveforms and summarize the characteristics of the Integral mode. **8**

b) An Integral controller used for speed control with a setpoint of 12 rpm within range of 10 to 15 rpm. The controller output is 22% initially. The constant $K_I = -0.15\%$ controller output per second per percentage error. If the speed jumps to 13.5 rpm, calculate the controller output after 2 sec for a constant e_p. **8**

5. a) Explain Feedforward Control Systems which are often encountered in following Chemical processes. **8**

a) Heat Exchanger b) Drum Boiler
c) Distillation Column d) CSTR.

b) Explain “Ratio Control” to ratio of flow rates of two streams with suitable diagrams. **8**

OR

6. a) Explain “Programmed/Scheduled Adaptive Control” with block diagram. **8**

b) When “Self-adaptive Control” is used? Explain “Model-Reference Adaptive Control (MRAC)” with block diagram. **8**

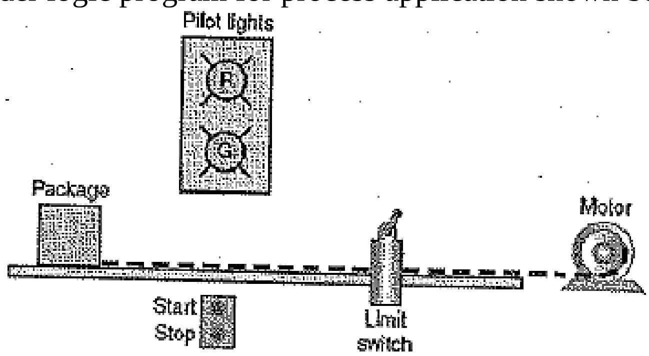
7. a) Explain the different parts of PLC in detail. Also list advantages and disadvantages of PLC. **8**

b) What is the need of Sourcing & Sinking? Explain Sourcing & Sinking in PLC Interfacing. **8**

OR

8. a) Explain “Analog I/O Modules” with suitable diagrams. **8**

b) Develop a PLC ladder logic program for process application shown below. **8**



The sequential task is as follows:
1) Start button is pressed.
2) Table motor is started.
3) Package moves to the position of the limit switch and automatically stops.

Other auxiliary features include:
- A stop button that will stop the table, for any reason, before the package reaches the limit switch position.
- A red pilot light to indicate the table is stopped
- A green pilot light to indicate the table is running.

9. a) Explain with a neat sketch the structure of a distributed control system (DCS). Discuss the functioning of its various parts. **8**

b) What is the difference between a PLC and DCS? How re PLC and DCS integrated for industrial process control? **8**

OR

10. a) What are the different types of displays available on a video screen of the DCS for plant information? Explain each one with a sample screen diagram. **8**

b) How is DCS programmed? How is the DCS configured to provide desired information? **8**

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