53 (IE 601) PRCN

2019

PROCESS CONTROL

Paper : IE 601

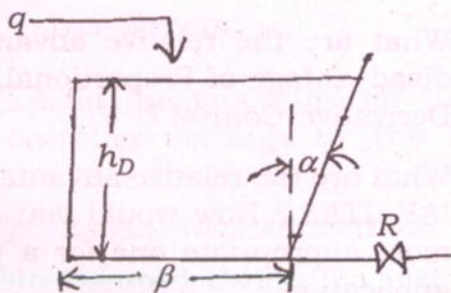*Full Marks : 100*

Time : Three hours

***The figures in the margin indicate
full marks for the questions.***

*Answer **any five** questions.*

1. (a) What is the need for Process Control ?
Explain its benefits to the Process
Industry.   5
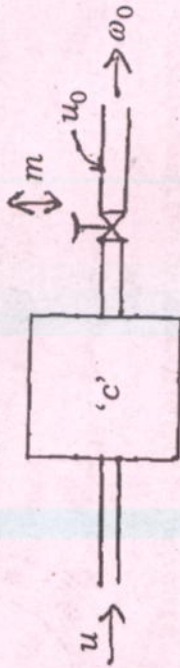
(b)   10

Develop a formula for finding the Time Constant of the liquid level shown. The average operating level is 'h_D'. The Resistance 'R' is linear. The tank has three vertical walls and one that slopes at an angle 'α' from the vertical. The distance separating parallel walls is 1.   5

(c) Derive the process equation for the single capacitance Gas Process.   5

'u' – Constant Gas Flow–Inlet

'c' – Controlled variable; vessel pressure c *psig*

'm' – Stem position of outlet valve, manipulated variable

'ω_0' – Gas flow–Outlet.

2. (a) What are the relative advantage and disadvantage of Proportional, Integral, Derivative Control?   6

(b) What are the relative advantage of ISE, IAE, ITAE? How would you select the most appropriate one for a particular application?   6

(c) The PI controller indicates an ouput of 12 mA when the error is zero. The set point is suddenly increased to 14 mA and the controller output is recorded as given below :

Time t, sec	0	10	20	30
Output mA	14	16	18	20

Find k_p and T_i.   5

(d) Define Proportional Band. Give the relationship between PB and k_p.   3

3. (a) Discuss the rational of a Cascade Control system and why it provides better response than feedback control. What kind of process can you employ cascade control ?   5

(b) Explain the advantage of using feed forward control in the Heat Exchanger Control System.   10

(c) Explain with an example Selective Control System.   5

4. (a) Explain the procedure for tuning the controller settings by the following methods—

   (i) Zeigler Nichols method

   (ii) Damped Oscillation method.   10

5. (b) What is meant by controller tuning? 4

(c) Comment on the selection of Controller for

    (i) Vapour Pressure Control

    (ii) Flow Control

    (iii) Temperature Control. 6

(i) Explain the Inherent valve characteristics of Pneumatic operated control valve. 6

(ii) Derive the relationship of % lift versus % flow for Linear, Equal Percentage valve. 5

(iii) Define Rangeability, C_V of a valve, Turndown ratio. 9

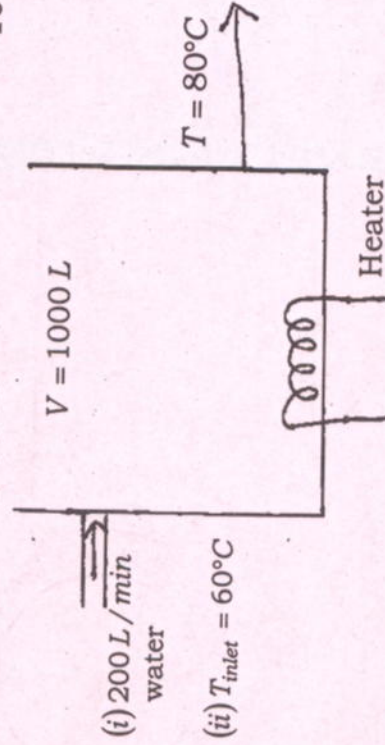6. Explain Two Unit operations used in Processes.

    (i) Distillation Process

    (ii) Mixing Process. 20

7. Write short notes on the following :
(any four)

    (i) I/P converter

    (ii) Valve Positioner

    (iii) Control Valve Sizing

    (iv) Adaptive Control

    (v) Process with Inverse Response

    (vi) Electronic P, PI, PID controllers.

20

8. (a) For the mixed tank heater, develop a transfer function relating the tank outlet temperature to changes in the inlet temperature.

Determine the response of the outlet temperature of the tank to a step change in the inlet temperature from $60°C$ to $70°C$. 10

$V = 1000\ L$

$T = 80°C$

Heater

(i) $200\ L/min$ water

(ii) $T_{inlet} = 60°C$

(b) Consider the mixing process in which a stream of solution containing dissolved salt flows at a constant volumetric flow rate 'q' into a tank of constant hold up volume 'V'. The concentration of the salt in the entering stream 'x' (mass of salt/volume) varies with time. It is desired to determine the transfer function relating the outlet concentration 'y' to the inlet concentration x. **10**

$x(t)$

q

$y(t)$

q

V

$y(t)$