53 (IE 601) PRCN

2018

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 out of **seven**.*

1. *(a)* Explain the following :   5×2=10

   (i) Servo Control

   (ii) Regulatory Control

   (iii) Self Regulatory Process

   (iv) Lumped Parameter System

   (v) Distributed Parameter System

(b) Following parameter are given for a tank : area $= 0.15m^2$; height at steady state is $1.0m$ when discharge given by $K\sqrt{h}$ is 0.6×10^{-3} m^3/sec.

If inflow is suddenly increased to $0.2 \times 10^{-3}m^3/sec$, find the height of tank after $10\,min$ and at steady state.

10

2. (a) Design and derive the controller gain of Electronic PID Controller. 8

(b) Draw a plot of the three mode (PID) controller output for the errors percentage for given time are

$e_p = t\%$ at 0 to 1 sec (time)

$e_p = 1\%$ at 1 sec to 3 sec

$e_p = -0.5t + 2.5\%$ at 3 sec to 5 sec.

Assume $k_P = 5$, $K_I = 0.7s^{-1}$, $K_D = 0.5s$ and the controller output is 20% initially. 12

3. (a) Explain the features of integral wind up and Anti-wind up. 6

(b) Describe the evaluation criteria of integrals of the square error (ISE), absolute value of the error (IAE) and time-weighted absolute error (ITAE) of the controller settings. 8

(c) The Transfer Function of a 3-Tank system is $6/(2s+1)(4s+1)(6s+1)$ controller is proportional and all other elements have unity transfer function. Calculate the optimal values of PID-controller parameters based on ultimate cycle method of tuning. **6**

4. (a) The Transfer Functions for a cascade system are given as : **10**

$G_{p1} = 2/(3s+1)(2s+1)$; $\quad G_{p2} = 4/(s+2)$;

$G_{l2} = 1/(3s+1)$; $\quad G_{c1}$ is a P controller ;

$G_{c2} = 4$; $\quad G_{m1} = 0.04$; $\quad G_{m2} = 0.3$

(i) Calculate the ultimate value of K_{p1} for primary controller for which simple feedback and cascade loop go into oscillation.

(ii) Compare the offset for simple feedback and cascade loop when $K_{p1} = 10$.

(b) How many types of Selective Control System are available ? Discuss their characteristics. **10**

5. (a) Find the working force resulting from 350N applied to a 1·25cm radius forcing piston in a hydraulic actuator

      (i) if the working piston has a radius of 20cm. Then (ii) find the hydraulic pressure.   4

(b) The vapour pressure of the liquid flowing through a control valve is given as 0·7kg/cm^2. If the down stream pressure is 0·6 kg/cm^2, is there a possibility

      (i) for cavitation to occur ?

      (ii) for flashing to occur ?

      (iii) what should be the upstream pressure for making the condition to switch over from one state to another state if the pressure recovery ratio is 0·9 ?   6

(c) An equal percentage value has a Maximum flow of 50m^3/s and a minimum of 1·5m^3/s. If the full travel is 6cm, find the flow at a 2cm opening.   4

(d) Describe the working of an Electrical actuator with positioner.   6

6.   *(a)* Explain the inherent characteristics of control valve ? How they differ when the control valve is put in line (process/operation) ?   8

     (b) Flow through a linear value (constant sensitivity type characteristics) is given by $Q/Q_{max} = I/R[1+(R-1)S/S_{max}]$

where Q is the flow of any lift 'S', Q_{max} is the maximum flow at maximum lift S_{max} and R is the rangeability.

If the value passes $200 m^3/m$ of water at a maximum lift of $6 cm$, and the rangeability is 30, compute the value sensitivity.   4

     (c) Find the set point Element (G_{SP}) and feed forward controller (G_{CP}) of a generalized feed forward control process.   8

7. *(a)* What is the distillation column ? Derive its modeling equation. 10

   (b) Write short notes on the operation of Drying and Heat Exchangers. 10