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Total number of printed pages – 3

B. Tech

PEEE 5402B

Seventh Semester Examination – 2011
INDUSTRIAL AUTOMATION AND CONTROL

Full Marks – 70

Time : 3 Hours

Answer Question No. 1 which is compulsory and any **five** from the rest.

The figures in the right-hand margin indicate marks.

1. Answer the following questions : 2×10
- (a) What are the principle characteristics of the first order process, and what is the effect of time delay in process control system ?
- (b) Compare P, PI, and PD controllers in terms of their transient and steady state performance.
- (c) Which is the single mode controller that cannot be used alone and why ?
- (d) What is the advantage of using substitution method over Routh's criterion for finding stability ?
- (e) List the advantages and disadvantages of feed forward and feedback control configuration.
- (f) What are the advantages of cascade control configuration ?
- (g) The temperature of a furnace is to be controlled. The rate of flow of fuel to the furnace is manipulated variable. Pressure of the fuel is secondary variable. Draw a cascade control scheme for this.
- (h) Compare pneumatic controllers with hydraulic controllers in terms of speed, power output, safety and effect of temperature variations.
- (i) Why do electronic controller's outputs form pneumatic and hydraulic controllers in terms of speed, size and flexibility ?
- (j) What is the difference between relay diagram and ladder diagram ?
2. (a) Using Zigler and Nichols method of tuning, find tuned parameters of PID controller for process having transfer function as $\frac{e^{-0.5s}}{(s+1)(2s+1)}$. All other elements in control loop have unity transfer function. 5

P.T.O.

- (b) Using direct substitution method, find stability range of K_p for the system having forward path transfer function as $\frac{4}{(10s^3 + 18s^2 + 8s + 1)}$ and feedback path element transfer function as unity. 5

3. (a) Consider the error voltage is given by the following relation :

$$E_p = t\% \quad (0-1 \text{ sec})$$

$$E_p = 1\% \quad (1-3 \text{ sec})$$

$$E_p = -\frac{1}{2}t + 2.5\% \quad (3-5 \text{ sec})$$

Find the controller output for a three mode controller, which produces an output with $K_p = 5$, $K_i = 0.5 \text{ sec}^{-1}$ and $K_d = 0.5 \text{ sec}$ take offset $P_o = 20\%$. 5

- (b) Error curve rises linearly to 1% in 0.5 min and remain fixed at 1% K_p is 2 and K_d is 1 min and $K_i = 0.5 \text{ min}^{-1}$ and offset $P_o = 0\%$. Find the controller output at $t = 0, 0.5, 1.0$ min. When controller is (i) PD mode, (ii) PI mode. 5

4. (a) The transfer function of a process is $\frac{4}{(s+2)}$. Measuring and controller elements have unity transfer function. Error is sampled at a rate of 10 samples per second. Sample error is given to ZOH having transfer function $\frac{1-e^{-sT}}{s}$

and output of ZOH is given to the process. Find the output continuous and discrete system at $t = 0, 0.1, 0.5$ sec. 6

- (b) Draw cascade control scheme for a jacket reactor in which hot oil is supplied to the jacket. Reactor temperature is the primary variable and jacket variable is the secondary variable. 4

5. (a) Explain the cavitations and flashing phenomena with the help of a diagram in case of a control valve. 4

- (b) A 1.5 inch control valve has following specification :

At 40% valve opening, $C_v = 13.3$. At 30% valve opening, $C_v = 9.6$. At 80% valve opening, $C_v = 25.9$. Calculate C_v at 90% valve opening when control valve has linear characteristics. 6

6. (a) Three tanks containing oil have to be monitored continuously. Design a warning system to light up whenever two or more tank are empty. A NO switch at the bottom of each tank get's energized whenever tank is found empty ? 5
- (b) Design a 1 : 4 DMUX using PLC ladder diagram. 5
7. (a) Draw a hierarchical DCS structure and explain function at each level. 5
- (b) List the six features provided by POC (process Operator Console) in a DCS. 5
8. Write notes on any *two* : 5x2
- (a) Override control scheme
- (b) Position and velocity algorithm in case of PID controllers
- (c) Two position and Multi position control mode.