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Total Number of Pages : 02

Course : B.Tech  
Sub\_Code : REI6C001

6<sup>th</sup> Semester Regular/ Back Examination: 2022-23

SUBJECT: Process Control and Instrumentation

BRANCH(S): AEIE

Time : 3 Hour

Max Marks : 100

Q.Code : M506

Answer Question No.1 (Part-1) which is compulsory, any eight from Part-II and any two from Part-III.

The figures in the right hand margin indicate marks.

Part-I

Q1 Answer the following questions: (2 x 10)

- Describe nominal load of a system.
- Define Neutral zone in two position control mode.
- Describe dead time in a system.
- Write down the mathematical expression of a direct acting proportional controller.
- In a P controller If proportional band is 25%, then a 2% change in error will cause how much % change in controller output?
- Why a resistor is connected in series with the input capacitor while designing an analog derivative mode op-amp controller?
- Differentiate Direct Digital Control from conventional Controller.
- What is the use of sample and hold devices?
- State the function of relay in process control.
- A stepper motor has 10° per step and must rotate at 250 rpm. What input pulse rate, in pulses per second, is required?

Part-II

Q2 Only Focused-Short Answer Type Questions- (Answer Any Eight out of Twelve) (6 x 8)

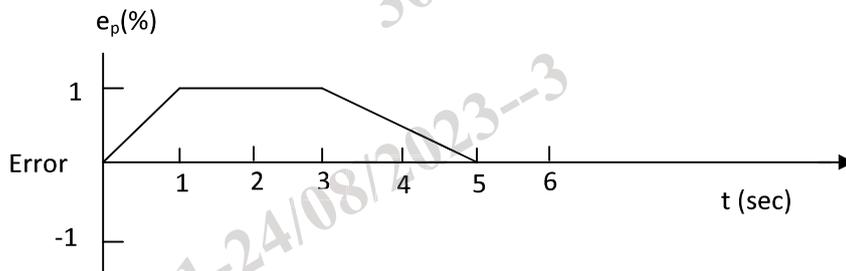
- With an example explain process equation.
- A liquid-level control system linearly converts a displacement of 2 to 3 m into a 4 to 20-mA control signal. A relay serves as the two-position controller to open or close an inlet valve. The relay closes at 12 mA and opens at 10 mA. Find (a) the relation between displacement level and current, and (b) the neutral zone or displacement gap in meters.
- Describe the procedure to tune a controller by Cohen-Coon method with proper diagram.
- For a unity feedback system, process transfer function is given by  $G_p(s) = \frac{1}{s(s+1)(s+5)}$ . The controller is of PID mode. Calculate the optimal values of controller parameter based on ultimate cycle method of tuning.
- Discuss the reasons for which electronic controller outperform Pneumatic and hydraulic controller.

- f) Design an analog proportional-integral controller with 80% PB and 0.03-min reset time. Use (0-5) V input and (0-12) V output.
- g) An integral control system will have a measurement range of 0.4 to 2.0 V and an output range of 0 to 6.8 V. Design an op amp integral controller to implement a gain of  $K_I = 4\%/(\%-\text{min})$ . Specify the values of  $G_I$ ,  $R$  and  $C$ .
- h) Derive the expression of digital PID controller in position and velocity form.
- i) A magnetic amplifier requires a 5 to 10 V input signal from a 4 to 20 mA control signal. Design a signal-conversion system to provide this relationship.
- j) Write down the advantages of pneumatic system over electrical system. Describe the principle of operation of current-to-pressure conversion with neat diagram.
- k) Explain direct acting and reverse acting pneumatic actuator with neat diagram.
- l) Describe different types of control valve.

### Part-III

#### Only Long Answer Type Questions (Answer Any Two out of Four)

- Q3** What do you mean by process control? Why it is required? Draw physical diagram and block diagram of a process control loop and briefly explain each elements in the loop. **(16)**
- Q4** Suppose the error shown in below figure is applied to a proportional-derivative controller with  $K_P = 5$ ,  $K_D = 0.5 \text{ s}$  and  $p_0 = 20\%$ . Draw a graph of the resulting controller output. If the same error is applied to three-mode controller with  $K_P = 5$ ,  $K_I = 0.7 \text{ s}^{-1}$ ,  $K_D = 0.5 \text{ s}$  and  $p_I(0) = 20\%$  what will be the shape of the controller output. **(16)**



- Q5** A temperature-control system inputs the controlled variable as a range from 0 to 4 V. The output is a heater requiring 0 to 8 V. A PID is to be used with  $K_P = 2.4\%/%$ ,  $K_I = 9\%/(\%-\text{min})$  and  $K_D = 0.7\%/(\%/ \text{min})$ . The period of the fastest expected change is estimated to be 8 s. Develop the electronic PID circuit. **(16)**
- Q6** Why final control operation is necessary? Describe different elements of final control operation. Give one example with neat diagram of a process control showing the final control operations. **(16)**