Registration No.: | | | | | | | | | | |

Total Number of Pages: 02

Course: B.Tech
Sub_Code: REI6C001

6th Semester Regular/Back Examination: 2024-25
SUBJECT: Process Control and Instrumentation
BRANCH(S): AEIE, EIE
Time: 3 Hours
Max Marks: 100
Q.Code: S090

Answer Question No.1 (Part-I) 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)**

a) Define process control. Give one example.
b) A sensor resistance changes linearly from 100 Ω to 180 Ω as temperature changes from 20 °C to 120 °C. Find a linear equation relating resistance and temperature.
c) Discuss process lag and control lag in process control.
d) Compare electronics controller with pneumatic controller.
e) If 100% change input causes only 50% change in output then, what is the value of proportional band of the system.
f) Why digital controller is better than analog controller?
g) What is the importance of sample and hold device?
h) Give one example where signal conversion is required in final control operation.
i) How a pneumatic signal is amplified? Explain with neat diagram.
j) Write down one application of control valve. What is the relation between flow rate and pressure drop across control valve?

Part-II

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

a) Discuss one example of process control loop. Draw its physical diagram and block diagram.
b) With an example explain process equation.
c) An integral controller is used for speed control with a setpoint of 12 rpm within a 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 s for a constant error(e_p).
d) For a unity feedback system, process transfer function is given by $\boldsymbol{G_p(s)} = \frac{1}{s(s+1)(s+5)}$ .The controller is of PID mode. Calculate the optimal values of controller parameter based on ultimate cycle method of tuning.
e) Level measurement in a sump tank is provided by a transducer scaled as 0.2 V/m. A pump is to be turned on by application of +5 V when the sump level exceeds 2.0 m. The pump is to be turned back off when the sump level drops to 1.5 m. Develop a two-position electronic controller.
f) Why pneumatic controllers are still in use? Explain the operation of pneumatic PID controller with neat diagram.

g) Draw a flow control loop using direct digital controller and explain its operation.

h) Velocity algorithm of digital PID controller is immune to integral windup. Explain.

i) Design current to pressure converter using flapper nozzle system. Explain its operation.

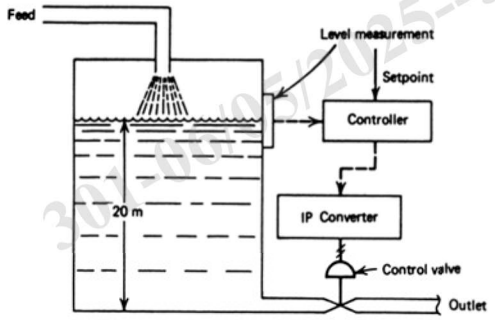
j) A hydraulic system uses pistons of diameter 2 cm and 40 cm.

I. What force on the small piston will raise a 500-kg mass?

II. What pneumatic pressure is required on the small piston to produce the necessary force to raise the 500-kg mass?

k) Why pneumatic and hydraulic actuators are often used in industry? Find the relation between shaft position and signal pressure for pneumatic actuator. Why pneumatic actuators cannot be used for heavy loads?

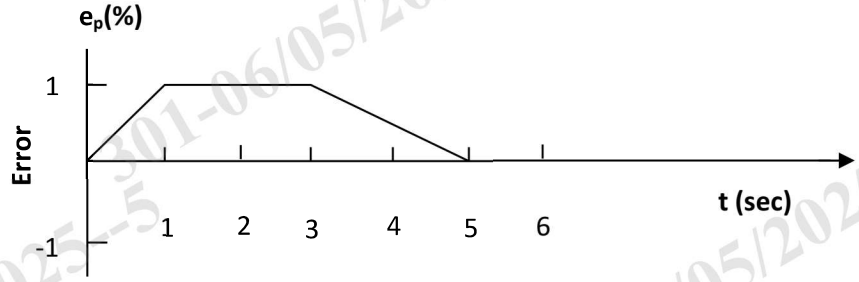
l) The level of water in a tank is to be controlled at 20 m, and the output flow rate is nominally 65 m^3/ hr through a control valve, as shown in Figure below. Under nominal conditions, determine the required valve size in inches and centimetres.



Part-III

Only Long Answer Type Questions (Answer Any Two out of Four) **(16 x 2)**

Q3 Suppose the error shown in below figure is applied to a proportional-derivative controller with K_P = 5, K_D = 0.5 s and p_0 = 20%. Draw a graph of the resulting controller output. If the same error is applied to proportional-integral-derivative (PID) controller with K_P = 5, K_I = 0.7 s^{-1}, K_D = 0.5 s and $p_I(0)$ = 20% what will be the shape of the controller output. **(16)**



Q4 What do you mean by direct acting and reverse acting controller? Write down the types of controller modes used in process control. Explain one mode of controller from each type. **(16)**

Q5 Draw the block diagram of final control operation. Explain the function of each block. Describe one process control system with neat diagram, showing the final control operations. **(16)**

Q6 Write down different types of AC and DC motors. Explain the working principle of stepper motor with neat diagram. Give one example where electrical actuator is used. **(16)**