Question Paper

Exam Date & Time: 29-Nov-2022 (09:00 AM - 12:00 PM)

MANIPAL ACADEMY OF HIGHER EDUCATION

V SEMESTER B. TECH END SEMESTER EXAMINATIONS, NOVEMBER 2022

PROCESS INSTRUMENTATION AND CONTROL [ICE 3154]

Marks: 50 **Duration: 180 mins.**

DESCRIPTIVE TYPE

Answer all the questions.

Answer all questions

1) Define thermal capacitance and thermal resistance. Mention their units. (2)

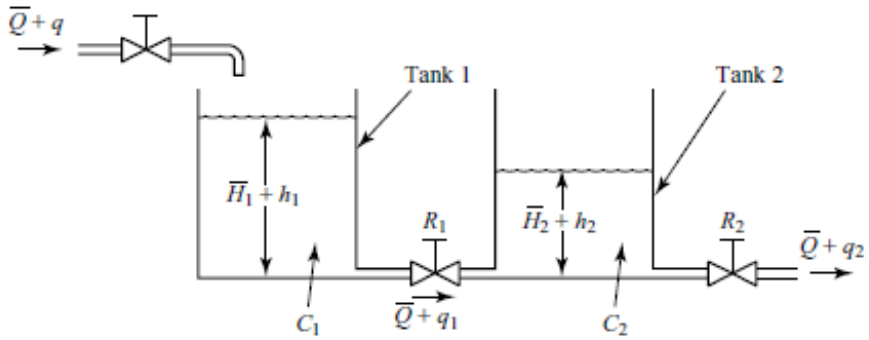
[CO1, PO1, PO2, BL2]

2) Two non-interacting tanks are connected in series. Given R_2=1 and the time constants are τ_1=1, τ_2=0.5. Sketch the response of the level in tank 2 if a unit step change is made in the inlet flow rate of tank 1(Plot the response for t=0 to 10 seconds). (3)

[CO1, PO1, PO2, BL3]

3) Obtain the transfer function $Q_2(s)$ /Q(s) for the liquid level system shown in figure. (5)

[CO1, PO1, PO2, BL3]



4) What is neutral zone in a two-position controller? Describe with suitable schematic. (2)

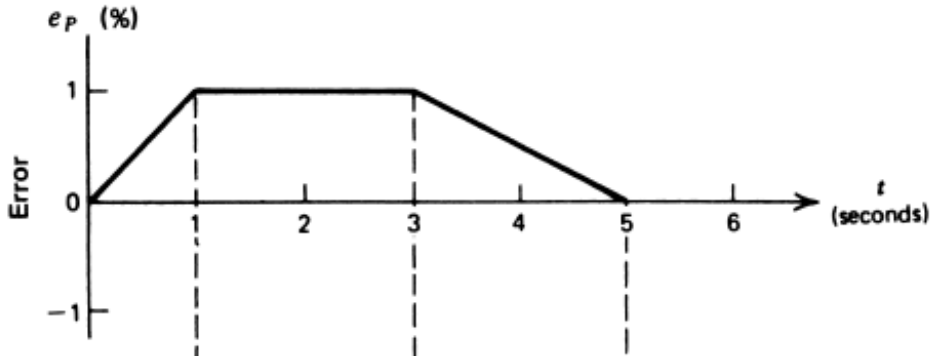
[CO2, PO3, PO4, BL2]

5) Using suitable assumptions prove that a proportional control leaves a permanent offset without any regard to the proportional gain. (3)

[CO2, PO3, PO4, BL2]

6) A three-mode controller with K_p=5 , K_I=0.7s^{-1}, K_D=0.5s and $p_I(0)$=20% . Plot the controller output for an error graph shown in figure. (5)

[CO2, PO3, PO4, BL3]



7) A liquid level system converts a 4-10 m level into a 4 to 20mA current. Design a three-mode controller that outputs 0-10V with a 60% PB, 0.04 min reset time and 0.06 min derivative time. Fastest expected change time is 0.6 min. (5)

[CO3, PO3, PO5, BL4]

8) A sensor converts from 0 to 2.0m into a 4 to 20 mA current. Design an OpAmp based error detector for a set point of 0.85m. (3)

[CO3, PO3, PO5, BL4]

9) From the given system description prove that cascade system is more stable than conventional feedback system. (2)

Characteristic equation with conventional feedback loop: $1+G_{p1}G_{p2}G_{c1}$

Characteristic equation of cascade system: $1+G_{p2}G_{c2}+G_{p1}G_{p2}G_{c1}\ G_{c2}$

Where $G_{p1}=1/(s+1)^{2,}$ $G_{p2}=1/(s+1)$, $G_{c1}=K_{c1,}$ $G_{c2}=K_{c2.}$

[CO5, PO1, PO2, PO3, PO4, PO5, BL2]

10) Explain Zeigler Nicholas open loop tuning method and get the controller parameters for a process where the temperature varies from 140°C to 330°C with a 220°C setpoint. The output is heater control voltage ranging from 0 to 24 V. The test is started with the system having a 14V output at steady state. The output is increased suddenly to 16.5V at which the temperature settles to 256°C. The delay time is 4min and response time is 8 min. (5)

[CO4, PO1, PO2, PO6, BL3]

11) What is meant by quarter decay ratio? What are its advantages over other performance evaluation parameters? (3)

[CO4, PO1, PO2, PO6, BL2]?

12) Name the control principle which can be used when disturbance as well as process output cannot be measured. With an example explain that control scheme. (2)

[CO5, PO1, PO2, PO3, PO4, PO5, BL2]

13) The output equation of an uncontrolled process is given as: (5)

$y(s)=G_p(s)m(s)+G_d(s)d(s)$,

where y(s)=output, $G_p(s)$=Process transfer function, $G_d(s)$=Disturbance transfer function, d(s)=Disturbance.

Design a feedforward controller for the above process considering the transfer functions of the measuring device and the final control element.

[CO5, PO1, PO2, PO3, PO4, PO5, BL4]

14) What is Smith predictor? Explain using appropriate mathematical analysis. (3)

[CO5, PO1, PO2, PO3, PO4, PO5, BL3]

15) Design a split range control for a process where the pH value of process liquid is brought closer to neutral by addition of either acid or caustic reagent liquids and explain its working. (Use air to open and air to close valve for acid and base inlet streams based on requirement). (2)

[CO5, PO1, PO2, PO3, PO4, PO5, BL4]

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