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## Sixth Semester B.E. Degree Examination, June/July 2023

### Process Control and Automation

Time: 3 hrs.

Max. Marks: 100

*Note: Answer any FIVE full questions, choosing ONE full question from each module.*

#### Module-1

- 1 a. Explain with a neat diagram, any one method devices of liquid level. (10 Marks)
- b. Explain about the electrical methods for the measurement of temperature. (10 Marks)

OR

- 2 a. Explain with neat diagram, any two flow measurement devices. (10 Marks)
- b. Explain about the instruments and process for the measurement of physio-chemical properties such as pH, Dissolved oxygen and Turbidity. (10 Marks)

#### Module-2

- 3 a. Define and explain mathematically the various forcing functions. (10 Marks)
- b. Solve the following equation for  $x(t)$ ,  $\frac{dx}{dt} = \int_0^t x(t)dt - t$ ,  $x(0) = 3$ . (10 Marks)

OR

- 4 a. A mercury thermometer having a time constant of 0.1 min is placed in a temperature both at  $100^\circ\text{F}$  and allowed to come to equilibrium with the bath. At time  $t = 0$ , the temperature of the bath begins to vary sinusoidally about its average temperature of  $100^\circ\text{F}$  with an amplitude of  $2^\circ\text{F}$ . If the frequency of oscillation is  $\frac{10}{\pi}$  cycles/min, plot the ultimate response of the thermometer reading as a function of time. What is phase lag? (10 Marks)
- b. Determine the transfer function  $\frac{H(s)}{Q(s)}$  for the liquid level system shown in Fig. Q4 (b). Resistances  $R_1$  and  $R_2$  are linear. The flow rate from the tank 3 is maintained constant at  $b$  by means of a pump ; i.e. the flow rate from tank 3 is independent of head 'h'. The tanks are non-interacting.

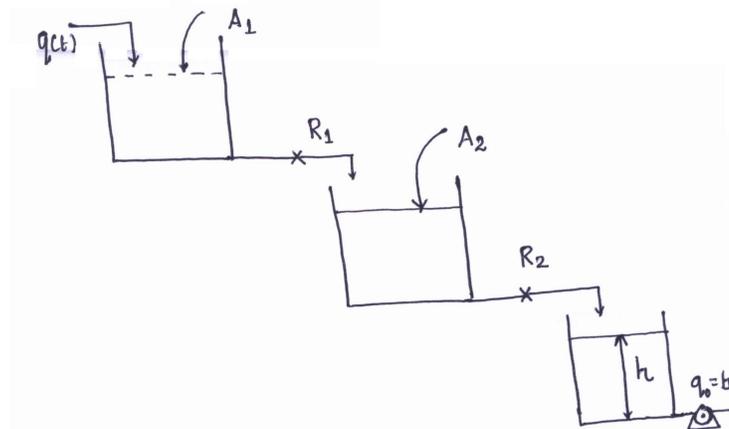


Fig. Q4 (b)  
1 of 3

(10 Marks)

**Module-3**

- 5 a. Derive a transfer function for a manometer with a neat diagram. (10 Marks)  
 b. A step change of magnitude 4 is introduced into a system having the transfer function,

$$\frac{Y(s)}{X(s)} = \frac{10}{s^2 + 1.6s + 4}$$

Determine

- (i) Percent overshoot.
- (ii) Rise time
- (iii) Maximum value of  $Y(t)$ .
- (iv) Ultimate value of  $Y(t)$
- (v) Period of oscillation.

(10 Marks)

**OR**

- 6 a. Determine  $Y(0)$ ,  $Y(0.6)$  and  $Y(\infty)$ . If  $Y(S) = \frac{1}{S} \cdot \frac{25(S+1)}{S^2 + 2S + 25}$ . (10 Marks)

- b. Sketch the response  $Y(t)$ . If  $Y(s) = \frac{e^{-2s}}{s^2 + 1.2s + 1}$ . Determine  $Y(t)$  for  $t = 0, 1, 5$  and  $\infty$ .

(10 Marks)

**Module-4**

- 7 a. Evaluate the characteristic of offset for both servo and Regulatory problem for P-controller in a first order system. Assume,  $G_f = G_m = 1$ . (10 Marks)  
 b. Write a neat sketch, explain various components and function of pneumatic control valve. (10 Marks)

(10 Marks)

**OR**

- 8 a. Determine the overall transfer function,  $\frac{C(s)}{R(s)}$  for the given block given below.

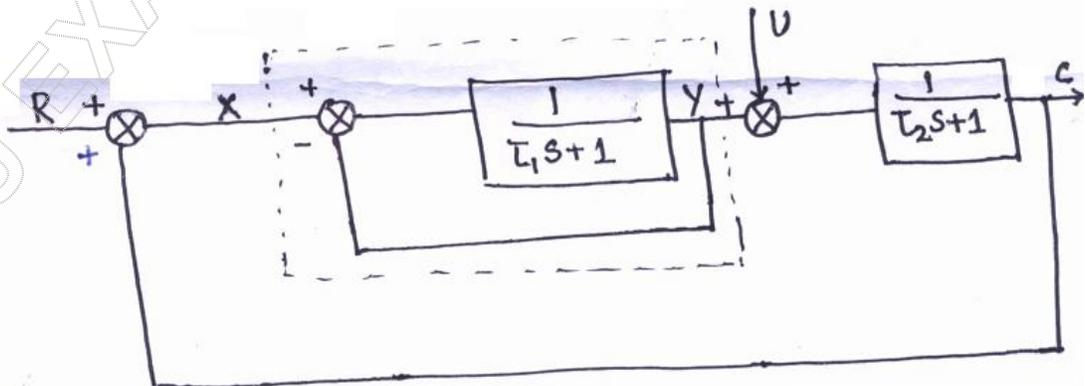


Fig. Q8 (a)

(10 Marks)

- b. A pneumatic proportional controller is used to control temperature within the range of 60 to 100 °F. The controller is adjusted so that the output pressure goes from 3 psi (valve fully open) to 15 psi (valve fully closed) as the measured temperature goes for 71 to 75 °F with the set point held constant. Find the gain and the proportional band. (10 Marks)

**Module-5**

- 9 a. Explain about the theorems of Routh Array to determine the stability of systems. (06 Marks)  
 b. Write the characteristics equation and construct the routh Array for the control system shown in Fig. Q9 (b). Is the system stable for, (a)  $K_C = 9.5$ , (b)  $K_C = 11$  (c)  $K_C = 12$

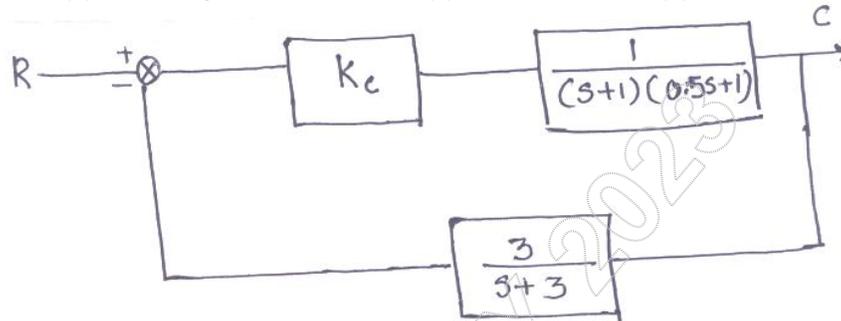


Fig. Q9 (b)

(14 Marks)

**OR**

- 10 a. Explain the steps involved to determine the stability of a system by using Root loci. (08 Marks)  
 b. Sketch the bode plot for the following transfer function and determine phase margin and gain margin.

$$G(s) = \frac{75(1 + 0.2s)}{s(s^2 + 16s + 100)}$$

(12 Marks)

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