USN | | | | | | | | | | 18BT61

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 mercurty thermometer having a time constant of 0.1 min is placed in a temperature both at $100°F$ 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 $100°F$ with an amplitude of $2°F$. 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.
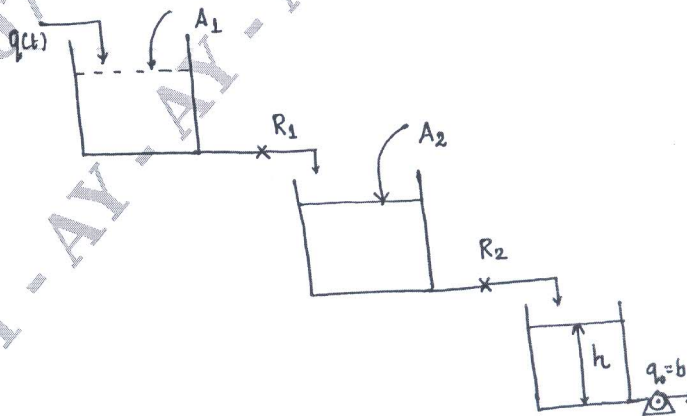

Fig. Q4 (b) **(10 Marks)**

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(∞). 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 ∞. **(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)**

OR

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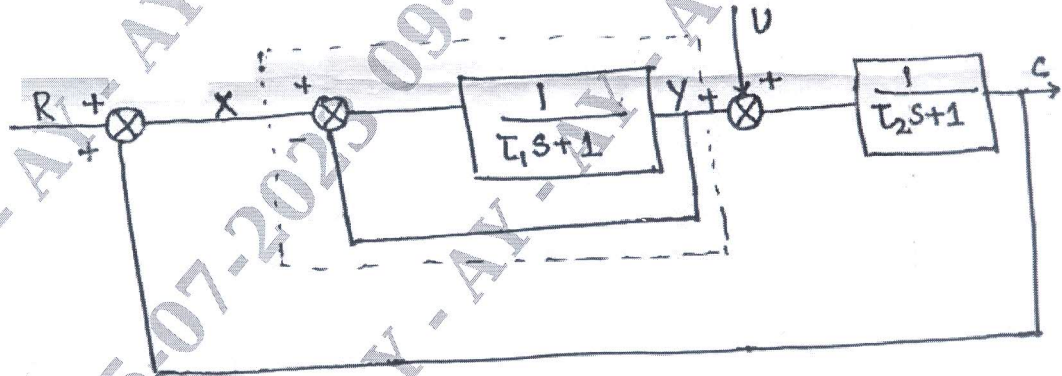

Fig. Q8 (a) **(10 Marks)**

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) $K_C = 12$
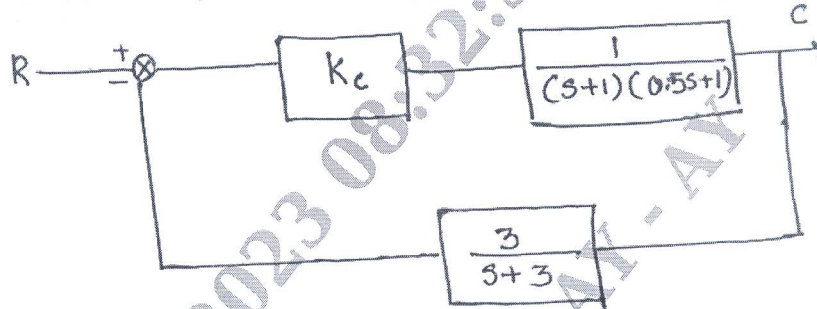

Fig. Q9 (b)   **(14 Marks)**

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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