Total No. of printed pages = 5

19/6th Sem/UIE 604

2022

PROCESS CONTROL AND INSTRUMENTATION

Full Marks – 100

Time – Three hours

The figures in the margin indicate full marks for the questions.

Answer any *five* questions.

1. (a) Explain the performance characteristics and its advantages ? 10

   (b) Explain the fundamental elements of measurement system with pressure actuated thermometer as an example ? 10

2. (a) Compare the features of ON-OFF, P, PI, PD and PID control modes. Also draw their characteristics. 10

[Turn over

(b) For a unity feedback system, process transfer function is given by

$$G_p(s) = \frac{8}{(3s+1)(4s+2)(5s+3)}$$

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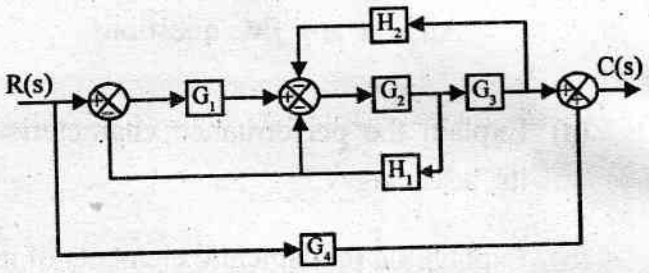
The controller is of PID mode. Calculate the optimal values of controller parameter based on ultimate cycle method of tuning. 10

3. (a) Obtain the closed loop transfer C(s)/R(s) of the system whose block diagram is shown in fig.1. 10



(b) Determine the transfer function $H_4(s)/Q_i(s)$ for the liquid level system shown in figure 1. [Resistances R_1, R_2 & R_3 are linear. The flow rate from tank-4 is maintained constant at 'a' by means of a pump] 10

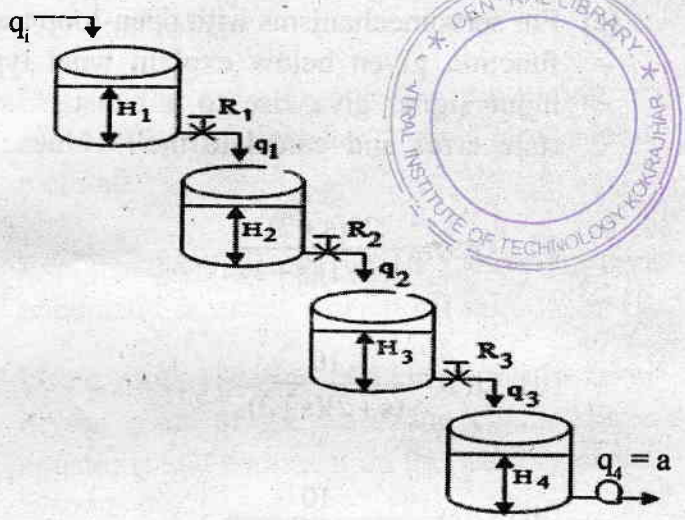


Fig. 1

4. (a) The forward path transfer function of a unity feedback control system is given by G(s). Obtain an expression for unit step response of the system. 6

$$G(s) = \frac{3}{s(s+5)}.$$

(b) A unity feedback control system has an open-loop transfer function, G(s). Find the natural frequency, damping ratio, peal time, percentage overshoot and settling time for a step input of 10 units. 8

$$G(s) = \frac{10}{s(s+4)}.$$

(c) For servomechanisms with open-loop transfer function given below explain what type of input signal give rise to a constant steady state error and calculate their values : 6

(i) $G(s) = \frac{20(s+2)}{s(s+1)(s+3)}$

(ii) $G(s) = \frac{10}{(s+2)(s+3)}$

(iii) $G(s) = \frac{10}{s^2(s+1)(s+2)}$.

5. (a) What are the inherent characteristics of the control valve ? List the types control valves and its applications ? 10

(b) An equal percentage valve has a maximum flow of 60 m^3/s and a minimum of 2 m^3/s. If the full travel is 10 cm, find the flow at a 5 cm opening. 4

(c) Discuss on control valve sizing. Find the proper C_v for a valve that must pump 160 gallons of ethyl alcohol per minute with a specific gravity of 0.8 at maximum pressure of 60 psi and identify the required valve size. 6

6. (a) Design and derive the gains of Pneumatic PID Controller ? 8

(b) Explain the steps involved in the tuning of controllers by open-loop and closed-loop methods. 12

7. (a) Explain the function of I/P converter and pneumatic actuator (air to close). 10

(b) Using routh criterion, determine the location of the roots of the following characteristic equations and comment on the stability of the systems ? 10

(i) $s^4 + 2s^3 + 10s^2 + 8s + 3 = 0$

(ii) $s^5 + s^4 + 24s^3 + 48s^2 - 25s - 5 = 0$.