Register No.: ..... Name: .....

SAINTGITS COLLEGE OF ENGINEERING (AUTONOMOUS)

(AFFILIATED TO APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY, THIRUVANANTHAPURAM)

FIFTH SEMESTER B.TECH DEGREE EXAMINATION (R,S), DECEMBER 2023
CHEMICAL ENGINEERING
(2020 SCHEME)

Course Code : **20CHT307**

Course Name: **Instrumentation and Process Control**

Max. Marks : **100** **Duration: 3 Hours**

Normal/ semi log graph sheets shall be provided

PART A

(Answer all questions. Each question carries 3 marks)

1. Suggest any two instruments each for low, medium and high-pressure measurement.
2. With the help of neat sketch, explain the working of Coriolis meter.
3. Sketch the following function f(t) = u(t)-2u(t-1)+u(t-3).
4. Obtain y (t) for $y\,(s) = \frac{s^2+2s}{s^4}$.
5. Differentiate the principle of air to open and air to close valves with figure.
6. Write down the transfer functions of P, PI and PID controllers.
7. Differentiate closed loop and open loop process.
8. Explain the Routh-Hurwitz criterion for stability with the help of the theorem.
9. Define gain margin and phase margin.
10. Define the Bode stability criterion and crossover frequency.

PART B

(Answer one full question from each module, each question carries 14 marks)

MODULE I

11. a) Explain the principle and working of a Bourdon gauge with a neat sketch. (7)
    b) With a neat diagram explain the components and working of radiation pyrometer. (7)

OR

12. a) Name the working principle of thermocouple. Explain the same with suitable figure. (7)
    b) Explain the dynamic characteristics of a measuring instrument. (7)

MODULE II

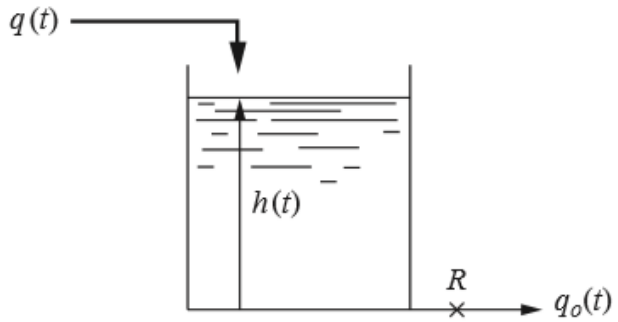
13. a) Solve the following differential equations using Laplace transforms. (7)

$$\frac{dy}{dt} + 3y = 10t\,;y\,(0) = 0$$

b) Derive the transfer function of mercury thermometer. List the assumptions made.
A thermometer having a time constant of 1 min is initially at 50 °C. It is immersed in a bath maintained at 100 °C at t = 0. Determine the temperature reading at t = 1.2 min. (7)

OR

14. Derive the transfer function H (s)/Q(s) for the liquid level system given in below.



(14)

Derive the unit step response if the transfer function for single tank liquid level system is given by G(s) = 3/(10 s+1). Identify the numerical values of parameters of the system.

MODULE III

15. Starting from first principles, derive the transfer functions $H_1(s)/Q(s)$ and $H_2(s)/Q(s)$ for the liquid-level system shown in Fig. P 6–7. The resistances are linear and $R_1=R_2=1$. Note that two streams are flowing from tank 1, one of which flows into tank 2. You are expected to give numerical values of the parameters in the transfer functions and to show clearly how you derived the transfer functions. (14)

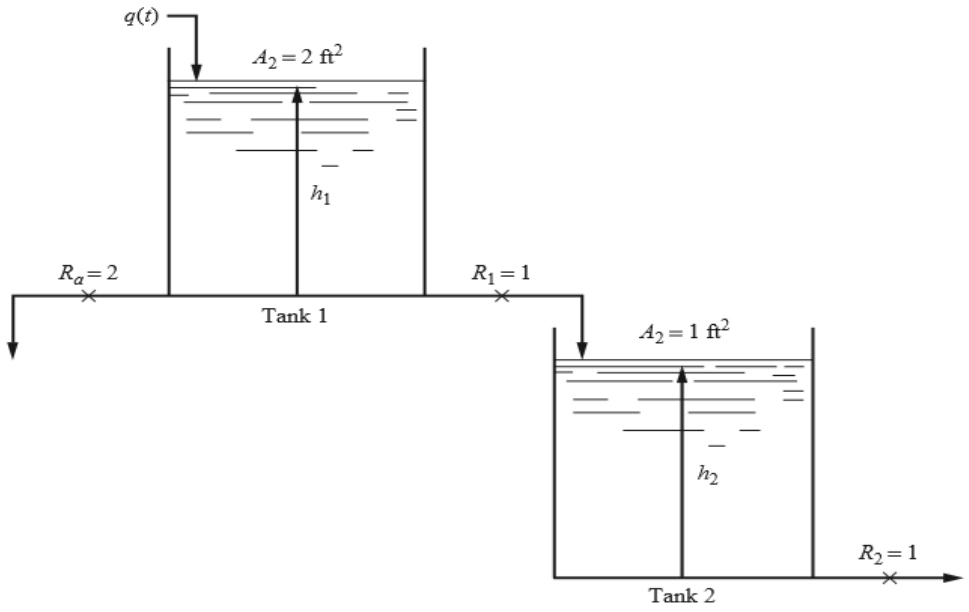


FIGURE P6–7

OR

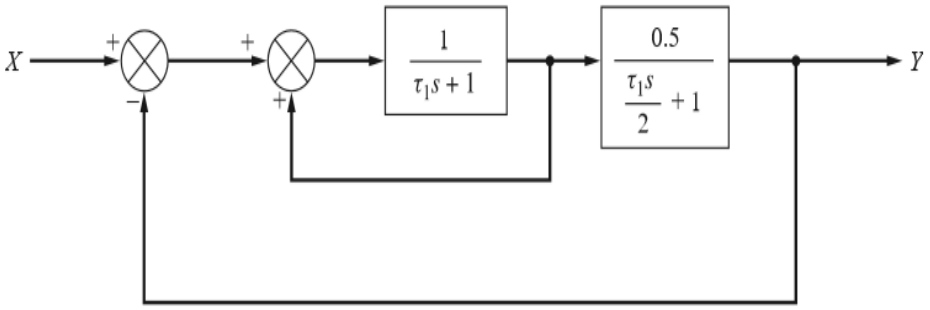
16. A step change of magnitude 4 is introduced into a system having the transfer function

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

Determine (14)
(a) Percent overshoot
(b) Rise time
(c) Maximum value of Y (t)
(d) Ultimate value of Y (t)
(e) Period of oscillation

MODULE IV

17. a) Find the transfer function Y(s)/X(s) of the system shown in Figure below.

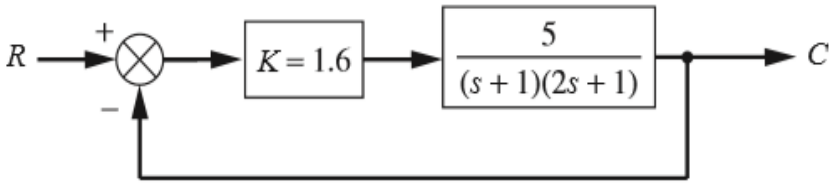


(7)

b) The set point of the control system shown in Figure below is given a (7)

step change of 0.1 unit. Determine

(a) Ultimate value of C.
(b) The offset.



OR

18. Plot the root locus diagram for $1 + \frac{K}{S\,(S+1)(S+2)} = 0$ (14)

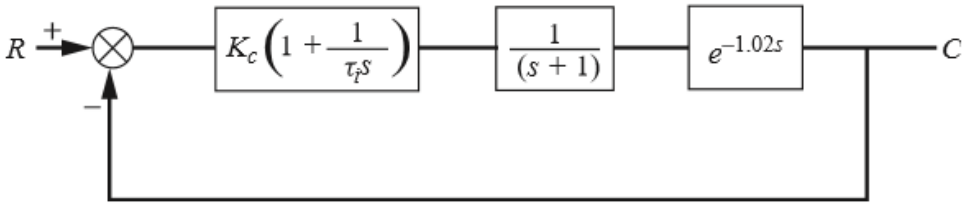
MODULE V

19. Sketch the Bode plot for the open loop transfer function using semi-log graph. (14)

$$G(s) = \frac{(0.5s + 1)e^{-0.1s}}{s\,(5s + 1)}$$

OR

20. Write down the Ziegler-Nichols controller settings for P, PI and PID controllers. Using the Ziegler-Nichols rules, determine the PI controller settings for the two-tank chemical-reactor system given below. (14)



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