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

SAINTGITS COLLEGE OF ENGINEERING (AUTONOMOUS)

(AFFILIATED TO APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY, THIRUVANANTHAPURAM)

FIFTH SEMESTER B. TECH DEGREE EXAMINATION (Regular), DECEMBER 2022
CHEMICAL ENGINEERING
(2020 SCHEME)

Course Code : **20CHT307**

Course Name: **Instrumentation and Process Control**

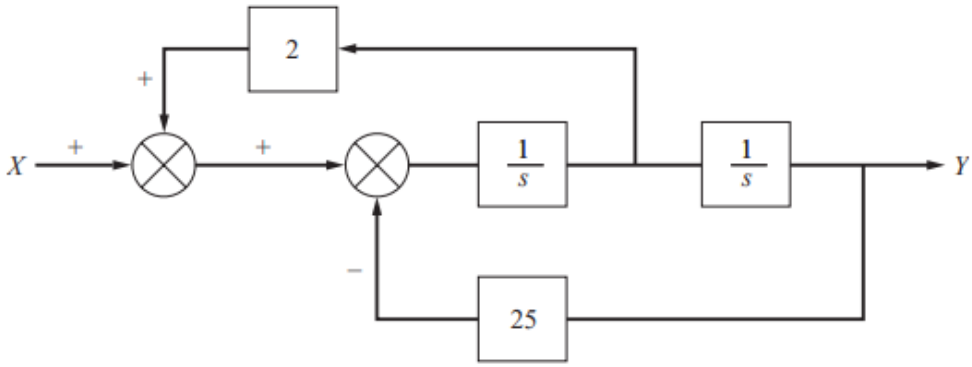
Max. Marks : **100** **Duration: 3 Hours**

Normal /Semi-log graph sheet shall be provided on request

PART A

(Answer all questions. Each question carries 3 marks)

1. Write a note on conductivity meters.
2. List the advantages and disadvantages of a Coriolis meter.
3. State the initial value and final value theorem.
4. Find the inverse Laplace of X(s) = $\frac{1}{s(s+1)(0.5s+1)}$
5. List out the different controllers with its corresponding transfer function.
6. Draw the graphical representation of step, ramp, sinusoidal functions. Give the Laplace transform of each.
7. Derive the overall transfer function for control system given below:



8. Explain servo and regulator problem in control system with suitable examples.
9. Elaborate on the frequency response methods and its relevance in process control.
10. Explain the terms gain margin and phase margin.

PART B

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

MODULE I

11. a) Explain the static characteristics of instruments. (8)
    b) Describe the principle and working of a Bourdon gauge. (6)

OR

12. a) Explain any one differential flow meter with a detailed sketch. (8)
    b) Describe the working of a thermocouple, list the various types and applications. (6)

MODULE II

13. a) Solve the following by using Laplace transform:

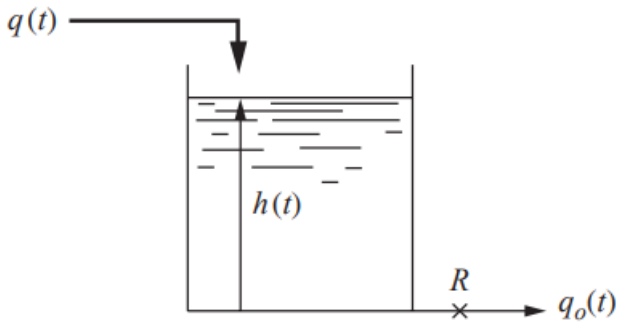
$$\frac{d^3x}{dt^3} + 2\frac{d^2x}{dt^2} - \frac{dx}{dt} - 2x = 4 + e^{2t}$$ (10)

with initial conditions x (0) =1, x' (0) =0, x" (0) = -1

    b) Sketch the following function: u(t)- 2u(t-1) + u(t-3) (4)

OR

14. a) A thermometer with a time constant of 5 sec is at steady state at 0 ^{0}C. Suddenly it is immersed into a boiling water bath.
        (i) Determine the time taken for the thermometer to read 80 ^{0}C. (8)
        (ii) Determine the reading of the thermometer at 4 sec.
    b) Derive the transfer function $Q_0(s)/Q(s)$ for the liquid level system shown in the figure below. List the assumptions made.



(6)

MODULE III

15. a) The overall transfer function of a control system is given as:

$$G(s) = \frac{16}{1.5s^2 + 2.4s + 6}$$

A step change of 6 is introduced into the system. Determine the following: (10)

        (i) Overshoot
        (ii) Period of oscillation

(iii) Ultimate value of response
(iv) Maximum value of response
(v) Rise time.

b) Compare the transfer functions $\frac{H(s)}{Q(s)}$ for a non-interacting and interacting two tank system. (4)

OR

16. a) Describe the working principle of a control valve with a neat sketch. Write down their basic classification. (8)

b) A unit step change in error is introduced into a PID controller. If Kc=10, T_I=1, T_D=0.5, obtain the response of the system. (6)

MODULE IV

17. a) Plot the root locus diagram for the transfer function: G(s)=$\frac{K}{(s+1)(s+2)(s+3)}$. Find the value of K for stability. (10)

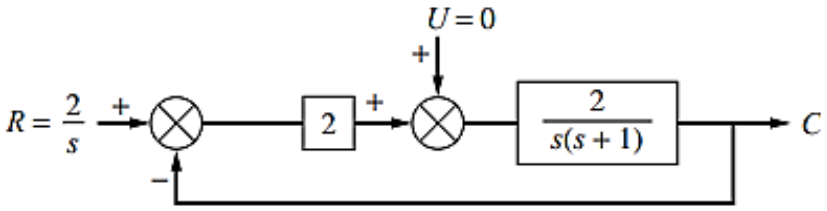
b) Describe the Routh Stability Criteria. What are some limitations of using this method. (4)

OR

18. a) Determine the range of K values for stability if the closed loop transfer function is:

$$\frac{C(s)}{R(s)} = \frac{K}{s(s^2+s+1)(s+2)+K}$$ (8)

b) For the control system shown below, determine:



(6)

(i) C(s)/R(s)
(ii) C (∞)
(iii) Offset

MODULE V

19. a) The open loop transfer function of a control system is given by,

$$G(s)=\frac{1}{s(2s+1)(s+1)}$$ (14)

Sketch the Bode plot and determine the Gain margin and Phase margin.

OR

20. a) Using Ziegler-Nichols tuning rules, determine the settings of PID controllers for a process whose open loop transfer function is given by (10)

$$G(s)=\frac{5e^{-0.2s}}{(s+1)(0.5s+1)}$$

b) Using substitution rule, determine the amplitude ratio and phase angle of a first order system. (4)

****