Enrolment No./Seat No_____

GUJARAT TECHNOLOGICAL UNIVERSITY

BE- SEMESTER– V EXAMINATION – SUMMER 2026

Subject Code:3150504 Date:06-06-2026

Subject Name: Instrumentation and Process Control

Time: 02:30 PM TO 05:00 PM Total Marks:70

Instructions:

1. **Attempt all questions.**
2. **Make suitable assumptions wherever necessary.**
3. **Figures to the right indicate full marks.**
4. **Simple and non-programmable scientific calculators are allowed.**

			MARKS
Q.1	**(a)**	Give the Laplace transform for the following 1. Sin kt 2. Cosh kt 3. $e^{-at}\sin kt$	**03**
	(b)	State and prove the Initial-Value Theorem	**04**
	(c)	Determine the x(t) for x(s) $$x(s) = \frac{1}{s^2(s+1)}$$	**07**
Q.2	**(a)**	What is transportation lag? Explain with example.	**03**
	(b)	Explain first order system by giving physical example of mixing process.	**04**
	(c)	Derive the transfer function of mercury thermometer. List the assumptions and justify them.	**07**
		OR	
	(c)	A thermometer having a time constant of 1 min is initially at 34 ^{o}C and steady state condition. It is immersed in a bath maintained at 100 ^{o}C at time t = 0. Determine the temperature reading of thermometer at t = 1.1 min.	**07**
Q.3	**(a)**	Explain the overshoot, decay ratio and response time for second order underdamped system.	**03**
	(b)	What is Servo Problem? Explain with example from chemical industry.	**04**
	(c)	Derive the transfer function of damped vibrator as second order system and find the critically damped step response.	**07**
		OR	
Q.3	**(a)**	With neat sketch explain the various parts of control system.	**03**
	(b)	Differentiate between Interacting and Non-interacting system.	**04**
	(c)	Discuss the rules for reduction of block diagram with example of each.	**07**
Q.4	**(a)**	Derive the overall transfer function of PID control.	**03**
	(b)	What is ratio control? Give important applications of it in chemical industry.	**04**
	(c)	The characteristics equation of control system is given as following $$s^3 + 6s^2 + 11s + 6(1 + K_c) = 0$$	**07**

(1) Determine the value of K_c for which system is stable system using Routh test

(2) Determine the roots of the characteristic equation when value of K_c for which the system is on the threshold of instability.

OR

Q.4	**(a)**	What is ON/OFF control? Discuss applications of ON/OFF Control.	**03**
	(b)	What is regulator Problem? Explain with example from chemical industry.	**04**
	(c)	Discuss Phase margin and Gain margin using stability criteria for Bode diagram.	**07**
Q.5	**(a)**	List the various methods used in industrial process for pressure measurement.	**03**
	(b)	Explain the working principal and construction of bimetallic thermometer.	**04**
	(c)	Discuss the construction and working of Distributed Control System (DCS) with all merits and demerits.	**07**

OR

Q.5	**(a)**	List the various methods used in industrial process for liquid level measurement.	**03**
	(b)	Discuss the working principal of bubbler system	**04**
	(c)	Explain principle, construction and working of radiation pyrometer.	**07**

****

Enrolment No./Seat No_____

GUJARAT TECHNOLOGICAL UNIVERSITY

BE - SEMESTER–V EXAMINATION – SUMMER 2025

Subject Code:3150504 Date:28-05-2025

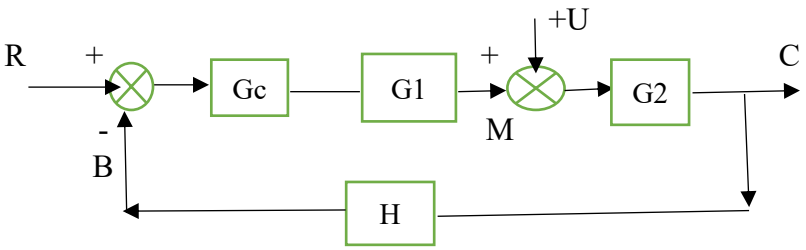
Subject Name:Instrumentation and Process Control

Time:02:30 PM TO 05:00 PM Total Marks:70

Instructions:

1. **Attempt all questions.**
2. **Make suitable assumptions wherever necessary.**
3. **Figures to the right indicate full marks.**
4. **Simple and non-programmable scientific calculators are allowed.**

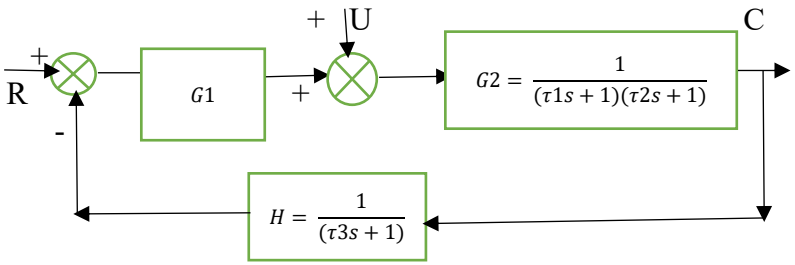
			MARKS
Q.1	**(a)**	Explain Transportation lag with transfer function.	**03**
	(b)	Derive and plot the response of impulse function for first order system $\frac{Y(s)}{X(s)} = \frac{1}{\tau s+1}$.	**04**
	(c)	Prove that for liquid level system with constant flow outlet the step change in initial flow rate gives response as a ramp function which grows without limit.	**07**
Q.2	**(a)**	Show that the ultimate change in height $H(t)$ for a unit step change in initial flowrate $Q(t)$ is simply resistance R.	**03**
	(b)	Discuss Overshoot in process control with suitable example.	**04**
	(c)	For second order critically damped system find the value of Y(t) for unit step change in X(t). $\frac{Y(s)}{X(s)} = \frac{1}{\tau^2 s^2+2\varepsilon\tau s+1}$	**07**
		OR	
	(c)	Explain the Cohen – Coon controller tuning method for setting of parameter in P, PI, and PID feedback control system.	**07**
Q.3	**(a)**	Discuss the selection criteria for the controller based on the Offset value.	**03**
	(b)	Why negative feedback systems are used in Process Control?	**04**
	(c)	Determine stability using Root locus diagram for the open loop transfer function $G(s) = \frac{Kc}{(s+1)(0.5s+1)}$	**07**
		OR	
Q.3	**(a)**	Find the overall transfer function C(S)/U(S) for change in load (R= 0) for given control system	**03**



	(b)	Draw Piping and instrumentation diagram for control system of heat exchanger with suitable labelling.	**04**
	(c)	Discuss in detail about Pneumatic control valve with figure.	**07**

Q.4 **(a)** Write in brief about ON / OFF control. **03**

(b) Determine the stability of the system shown in Fig. for which a PI controller is used. Use τ_1 =1, τ_2 =1/2, τ_3 = 1/3, kc = 5 and τ_I = 0.25 using routh criteria. $G1 = kc(1 + \frac{1}{\tau IS})$ **04**



(c) Draw Bode diagram plots for first order system having Amplitude Ratio AR $= \frac{1}{\sqrt{\tau^2\omega^2+1}}$ **07**

OR

Q.4 **(a)** Describe Peltier effect of thermocouple. **03**

(b) Draw figure for capillary type viscometer with suitable labelling. **04**

(c) Discuss DCS (Distributed Control System) in detail. **07**

Q.5 **(a)** Define: 1) Span 2) Drift 3) Error **03**

(b) Explain principle and working of displacement float gauge for level measurement. **04**

(c) Discuss Bellow electrical pressure gauge with suitable figure. **07**

OR

Q.5 **(a)** Discuss Wet bulb thermometer for humidity measurement. **03**

(b) Describe the working of Rotameter. **04**

(c) Explain Ratio control with suitable example. **07**

****

Enrolment No./Seat No_____

GUJARAT TECHNOLOGICAL UNIVERSITY

BE - SEMESTER–V (NEW) EXAMINATION – SUMMER 2024

Subject Code:3150504 Date:31-05-2024

Subject Name:Instrumentation and Process Control

Time:02:30 PM TO 05:00 PM Total Marks:70

Instructions:

1. **Attempt all questions.**
2. **Make suitable assumptions wherever necessary.**
3. **Figures to the right indicate full marks.**
4. **Simple and non-programmable scientific calculators are allowed.**

			MARKS
Q.1	**(a)**	Give resistance capacitance lag for following systems. (1) Liquid filled thermometer (2) Liquid level in a tank (3) Mixing tank	**03**
	(b)	Discuss the importance of process control in chemical industry.	**04**
	(c)	Derive transfer function for first order system using mercury in glass thermometer using suitable assumptions.	**07**
Q.2	**(a)**	Differentiate between Open loop and closed loop control system.	**03**
	(b)	Discuss servo problem and regulator problem.	**04**
	(c)	Define second order system. Derive the transfer function of U-Tube Manometer in which pressure P is acting in one limb and other limb is open to the atmosphere.	**07**
		OR	
	(c)	For two interacting first order liquid level systems derive the transfer function.	**07**
Q.3	**(a)**	Draw the general block diagram of a simple control system with positive feedback and explain each term.	**03**
	(b)	Explain air to open & air to closed control valve with neat sketch.	**04**
	(c)	A step change of magnitude 4 is introduced into a system having the transfer function $\frac{y(s)}{x(s)} = \frac{16}{1.5s^2+2.4s+6}$ Determine (a) Percent overshoot (b) Rise time (c) Period of oscillation (d) Natural period of oscillation	**07**
		OR	
Q.3	**(a)**	Discuss the various components of a control system with example.	**03**
	(b)	Derive and discuss the transfer function for PI & PD controller.	**04**
	(c)	Explain in details the terms used to describe an underdamped system.	**07**
Q.4	**(a)**	Describe PLC and SCADA in brief.	**03**
	(b)	Discuss Phase margin and Gain margin using stability criteria for Bode diagram.	**04**
	(c)	Given the characteristic equation, determine the stability by the Routh criterion $s^4 + 3s^3 + 5s^2 + 4s + 2 = 0$	**07**

OR

Q.4	**(a)**	Mention advantages and disadvantages of Distributed Control System	**03**
	(b)	What are Bode diagrams? Explain the graphical rules for Bode diagrams.	**04**
	(c)	Explain Nyquist stability criteria.	**07**
Q.5	**(a)**	Discuss the principal of measurement in Bimetallic Thermometer.	**03**
	(b)	Explain any two static and dynamic characteristics of an instrument.	**04**
	(c)	Discuss pressure spring thermometer with neat sketch	**07**

OR

Q.5	**(a)**	Discuss the principal of liquid level measurement in bubbler system	**03**
	(b)	Explain working of optical pyrometer with schematic	**04**
	(c)	Discuss construction and working of Rotameter.	**07**

****

Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

BE – SEMESTER- V EXAMINATION-SUMMER 2023

Subject Code: 3150504 Date: 03/07/2023

Subject Name: Instrumentation and Process Control

Time: 02:30 PM TO 05:00 PM Total Marks: 70

Instructions:

1. **Attempt all questions.**
2. **Make suitable assumptions wherever necessary.**
3. **Figures to the right indicate full marks.**
4. **Simple and non-programmable scientific calculators are allowed.**

			MARKS
Q.1	**(a)**	Give Significance of Damping co-efficient.	**03**
	(b)	Write the statements for initial value theorem and final value theorem.	**04**
	(c)	Discuss Servo and Regulatory mechanism.	**07**
Q.2	**(a)**	Explain Impulse input in detail.	**03**
	(b)	Derive transfer function of the Mixing process.	**04**
	(c)	Differentiate Interacting and Non interacting systems.	**07**
		OR	
	(c)	A mercury thermometer having a time constant of 0.1 min is placed in a temperature bath 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 10/Π cycles/min, plot the ultimate response of the thermometer reading as a function of time. What is the phase lag?	**07**
Q.3	**(a)**	Place the following transfer function in standard first-order form, and identify the time constant and the steady state gain. $$\frac{Y(s)}{X(s)} = \frac{2}{s + (\frac{1}{3})}$$	**03**
	(b)	Explain the statement for sinusoidal response. “The output lags behind the input by an angle frequency f and the signal is attenuated”.	**04**
	(c)	Derive equation of Offset for PI controller.	**07**
		OR	
Q.3	**(a)**	Discuss ON/OFF controller.	**03**
	(b)	Explain difference between Negative and Positive feedback control system.	**04**
	(c)	Derive the transfer function for the liquid level which exhibits first-order dynamics as the Head responds to changes in the Flow input to the tank.	**07**
Q.4	**(a)**	Define: Accuracy, Span, Drift	**03**
	(b)	Explain difference between Air to open and Air to close valve.	**04**
	(c)	Explain component parts of Block diagram of a simple control system with figure.	**07**
		OR	

Q.4 **(a)** Explain Phase margin and Gain Margin. **03**

(b) Write the statements of Routh Theorem. **04**

(c) A step change of magnitude 4 is introduced into a system having the transfer function **07**

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

Determine

(a) Percent overshoot

(b) Rise time

(c) Period of oscillation

(d) Natural period of oscillation

Q.5 **(a)** Discuss working of Bourdon Gauge. **03**

(b) Give Classification of liquid level measurement systems. **04**

(c) Discuss Ziegler-Nichols method for Controller tuning. **07**

OR

Q.5 **(a)** Discuss Dip effect in filled system thermometer. **03**

(b) Explain PLC (Programable Logic Controller) and DCS (Distributed Control System). **04**

(c) Discuss construction and working of Rota meter. **07**

****

Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

BE - SEMESTER–V(NEW) EXAMINATION – SUMMER 2022

Subject Code:3150504 Date:07/06/2022

Subject Name:Instrumentation and Process Control

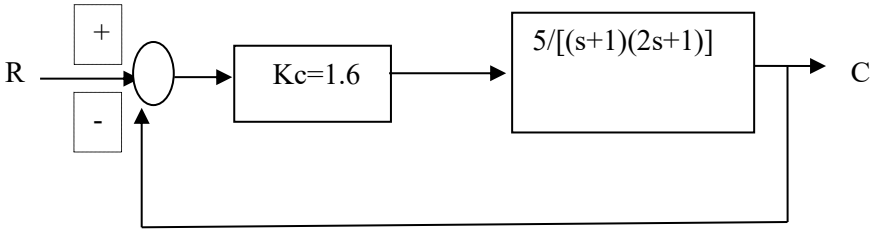
Time:02:30 PM TO 05:00 PM Total Marks: 70

Instructions:

1. **Attempt all questions.**
2. **Make suitable assumptions wherever necessary.**
3. **Figures to the right indicate full marks.**
4. **Simple and non-programmable scientific calculators are allowed.**

			MARKS
Q.1	**(a)**	Define step and input function.	**03**
	(b)	Find the Laplace transform of f(t) = 1 & f(t) = t	**04**
	(c)	Derive the transfer function of mercury thermometer. Determine the response equation of mercury thermometer for step function.	**07**
Q.2	**(a)**	Solve $\frac{dx}{dt} + 3x = 0, x(0) = 2$	**03**
	(b)	Derive the transfer function for Interacting system.	**04**
	(c)	Solve the following differential equation by Laplace transform: $$\frac{d^3x}{dt^3} + 2\frac{d^2x}{dt^2} - \frac{dx}{dt} - 2x = 4 + e^{2t}$$ $$x(0) = 1, x'(0) = 0, x'' = -1$$	**07**
		OR	
	(c)	Find the inverse Laplace Transform of the function: $$\bar{x}(s) = \frac{4S + 5}{(S-1)^2(S+2)}$$	**07**
Q.3	**(a)**	Define dead zone and dead time lag	**03**
	(b)	Explain Servomechanism type problem and Regulator problem	**04**
	(c)	Define second order system. Derive the transfer function of U-Tube Manometer	**07**
		OR	
Q.3	**(a)**	Derive transfer function for transportation lag.	**03**
	(b)	Define: overshoot, decay ratio, response time and period of oscillations.	**04**
	(c)	Write a note on Bellows differential pressure element with neat sketch.	**07**
Q.4	**(a)**	Distinguish between Negative Feedback and Positive Feedback.	**03**
	(b)	Describe the importance of root locus method in brief.	**04**
	(c)	Discuss pressure spring thermometer with neat sketch.	**07**
		OR	
Q.4	**(a)**	Highlight on hygrometer & hydrometer.	**03**
	(b)	Differentiate between Open loop and closed loop control system.	**04**
	(c)	Given the characteristic equation, determine the stability by the Routh criterion $s^4 + 3s^2 + 5s^2 + 4s + 2 = 0$	**07**
Q.5	**(a)**	Describe PLC, DCS, and SCADA in brief.	**03**
	(b)	Describe the bubbler system for liquid level measurement with neat sketch.	**04**

(c) The set point of the control system shown in figure below is given a step change of 0.1 unit. Determine: (a) The maximum value of C and (b) The offset. **07**



OR

Q.5 **(a)** Write significance of gain margin and phase margin. **03**

(b) What is offset? Explain P, PI and PID controller. **04**

(c) Plot the bode diagram for the system whose overall transfer function is 1/(s+1)(s+5) **07**

****