Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

BE- SEMESTER–V EXAMINATION – WINTER 2025

Subject Code:3150504 Date:02-12-2025

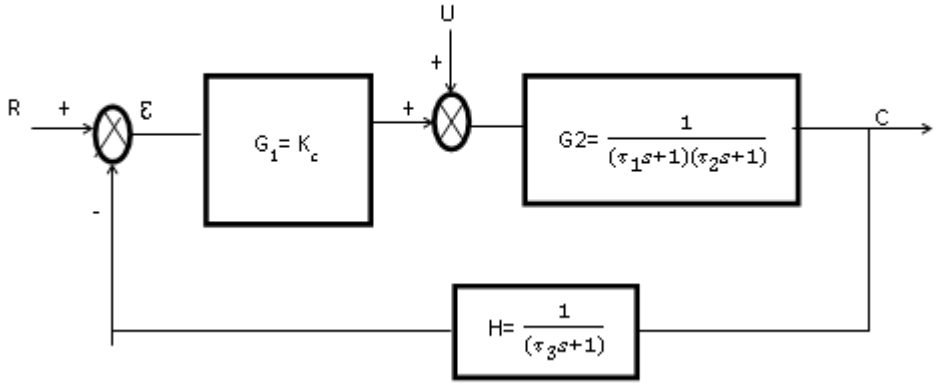
Subject Name: Instrumentation and Process Control

Time: 10:30 AM TO 01:00 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)**	Discuss advantages of automatic control of a process.	**03**
	(b)	Differentiate between Feedback and feed forward control system with example.	**04**
	(c)	Derive the transfer function of mercury thermometer. Determine the response equation of mercury thermometer for Ramp function.	**07**
Q.2	**(a)**	State and prove translation of transform.	**03**
	(b)	$\frac{d^2x}{dt^2} + 2\frac{\mathrm{dx}}{\mathrm{dt}} + x = 1$ $x\,(0) = x'(0) = 0$ Solve the differential equation by Laplace transform	**04**
	(c)	Derive the transfer function of Manometer in which pressure P is acting in one limb and other limb is open to the atmosphere.	**07**
		OR	
	(c)	Derive the transfer function for 'loading' system where second tank will be load by first tank.	**07**
Q.3	**(a)**	Differentiate between interacting and non-interacting system	**03**
	(b)	Develop a transfer function relating the tank outlet temperature to changes in the inlet temperature considering mixed tank heater system	**04**
	(c)	For a second order transfer function with $\tau = 1$ and $\zeta = 0.8$, being distributed with a sine wave input 3 sin (0.5t). Determine the form of the response after transient have decayed and steady state oscillations are established.	**07**
		OR	
Q.3	**(a)**	Explain gain margin and phase margin.	**03**
	(b)	Differentiate between transfer lag and transportation lag.	**04**
	(c)	Discuss Bode plot for first order system	**07**
Q.4	**(a)**	Discuss the Nyquist stability criteria.	**03**
	(b)	Write in brief about PD controllers and its transfer function	**04**
	(c)	Determine the stability criteria of the system shown below for which PI controller is used. Use $\tau_1 = 1, \tau_2 = \frac{1}{2}, \tau_3 = \frac{1}{3}, K_c = 5$ and $\tau_I = 0.25$.	**07**

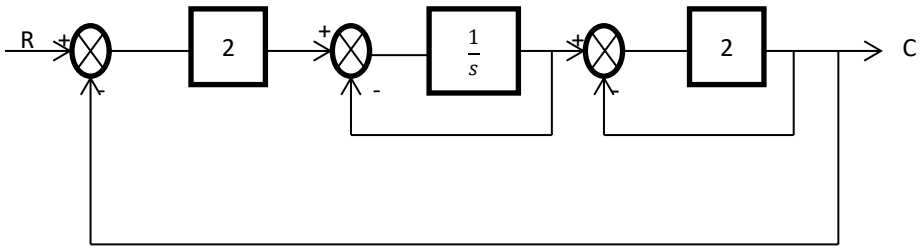


OR

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

(b) Derive the transfer function of PID control **04**

(c) For the control system diagram shown below. derive the transfer function C(s)/ R(s) **07**



Q.5 **(a)** Describe PLC, DCS, and SCADA in brief. **03**

(b) Explain dynamic characteristics of an instrument. **04**

(c) Explain construction and working of optical pyrometer. **07**

OR

Q.5 **(a)** Explain working of wet bulb and dry bulb thermometer used for measurement of relative humidity. **03**

(b) Discuss the pitot tube for flow measurement. **04**

(c) Explain the principal, construction and working of bellows differential-pressure gauge. **07**

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Enrolment No./Seat No_____

GUJARAT TECHNOLOGICAL UNIVERSITY

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

Subject Code:3150504 Date:17-12-2024

Subject Name:Instrumentation and Process Control

Time:10:30 AM TO 01:00 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. Cos kt 2. Sinh kt 3. e^{-at}	**03**
	(b)	State and prove the final value theorem.	**04**
	(c)	Solve the following by using Laplace transforms $\frac{dx}{dt} + x = 1 \qquad x(0) = 0$	**07**
Q.2	**(a)**	Define the following 1. Gain 2. Transportation Lag 3. Time Constant	**03**
	(b)	List the assumption made for derivation of transfer function of mercury thermometer and justify.	**04**
	(c)	Derive the transfer function and step response of mixing process.	**07**
		OR	
	(c)	A Storage tank contains a liquid which is pumped by a centrifugal pump at as steady rate. Liquid enters the tank at volumetric flow rate 200 Liter/hr and liquid level reaches steady-state value of 40 cm. If input flow rate is suddenly increased to 300 Liter/hr, Find level response and liquid level after 1 minutes by deriving transfer function and step response. (Cross section area of tank: 15 cm x 15 cm)	**07**
Q.3	**(a)**	What are advantages and disadvantages of P-control? Give application of P-Control.	**03**
	(b)	Discuss characteristics of underdamped step response for second order system.	**04**
	(c)	Derive the transfer function of U tube manometer as second order system.	**07**
		OR	
Q.3	**(a)**	Explain the following in control system 1. Load Variable 2. Set Point 3. Control Variable	**03**

	(b)	Differentiate between Feed-forward control and Feed-back control.	**04**
	(c)	Derive the transfer function of two non-interacting tanks and discuss nature of response after compare with second order system.	**07**
Q.4	**(a)**	What is controller? Explain its importance in close loop control system.	**03**
	(b)	What are advantages and disadvantages of PI-control? Give application of PI-Control.	**04**
	(c)	The characteristics equation of control system is given as following $s^3 + 3s^2 + 2s + K = 0$ Determine (1) The value of K for which system is stable system using Routh test (2) The value of K for which system is marginally stable (3) The frequency of system for sustain oscillations	**07**

OR

Q.4	**(a)**	Explain the working of cascade control system.	**03**
	(b)	Differentiate between servo-type and regulator-type problem.	**04**
	(c)	Explain the frequency response analysis of First order control system by bode diagram.	**07**
Q.5	**(a)**	Discuss the advantages with application of DCS.	**03**
	(b)	Explain the working principal and construction of Thermocouples.	**04**
	(c)	Explain principle, construction and working of bubbler system.	**07**

OR

Q.5	**(a)**	List the static and dynamic characteristics of Instruments.	**03**
	(b)	List the various instrument used for Viscosity measurement and explain working of any one.	**04**
	(c)	Explain principle, construction and working of pirani vacuum gauge.	**07**

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Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

BE - SEMESTER–V (NEW) EXAMINATION – WINTER 2023

Subject Code:3150504 Date:20-12-2023

Subject Name: Instrumentation and Process Control

Time:10:30 AM TO 01:00 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.**

Q.1	**(a)**	Define Time Constant.	**03**
	(b)	Discuss the importance of process control in industry.	**04**
	(c)	Solve following differential equation using Laplace Transform $\frac{d^2x}{dt^2} + 4\frac{dx}{dt} + 3x = 1 \qquad given \;\; x(0) = x'(0) = 0$	**07**
Q.2	**(a)**	Give the Laplace Transform of following functions. i. $e^{-2t}\sin t$ ii. $\delta(t)$ iii. t^2e^t	**03**
	(b)	Explain the significance of deviation variables.	**04**
	(c)	Derive transfer function for a mercury in glass thermometer. What is the value of process gain for the mercury in glass thermometer?	**07**
		OR	
	(c)	A thermometer with time constant 10 sec showing a steady temperature 35^{O}C is suddenly immersed in heated oil bath at 200^{O} C. Find: i. Time required for temperature reading of 150^{o} C. ii. Temperature reading on the thermometer after 25 sec.	**07**
Q.3	**(a)**	Define a first order system.	**03**
	(b)	Explain negative and positive feedback control systems	**04**
	(c)	Explain the merits and demerits of Proportional, Integral and Derivative action in a feedback controller.	**07**
		OR	
Q.3	**(a)**	What is open loop control system?	**03**
	(b)	Discuss the significance of the damping coefficient.	**04**
	(c)	Discuss the characteristics of an underdamped second order response.	**07**
Q.4	**(a)**	What is controller gain?	**03**
	(b)	Explain gain margin and phase margin.	**04**
	(c)	Obtain the overall transfer function of a servo mechanism negative feedback control system.	**07**
		OR	
Q.4	**(a)**	Define stability for a control system.	**03**
	(b)	Explain controller tuning using Ziegler-Nichols method	**04**
	(c)	Determine the stability of the control system having the open loop transfer function: $G(s) = \frac{K_c}{s(s+1)(s+2)}$	**07**
Q.5	**(a)**	Define: Drift, hysteresis and speed of response	**03**
	(b)	Explain advantages and disadvantages of Distributed Control System.	**04**
	(c)	Describe the principle, construction and working of optical pyrometer.	**07**

OR

Q.5	**(a)**	Define: Accuracy, precision and reproducibility	**03**
	(b)	Explain SCADA system	**04**
	(c)	Describe the principle, construction working and applications of the bourdon tube pressure gauge.	**07**

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Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

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

Subject Code:3150504 Date:09-01-2023

Subject Name:Instrumentation and Process Control

Time:10:30 AM TO 01:00 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 of the following a. Cosh (kt) b. Cos (t) c. Sin (kt)	**03**
	(b)	If the Laplace transform of a function $\frac{4}{s\,(s+2)(s+4)}$ is time domain, as t→∞, Determine the final value of the response.	**04**
	(c)	Derive the transfer function of mercury thermometer as first order system.	**07**
Q.2	**(a)**	Summarize the time constant of first order system: Thermometer, Liquid-level process and Mixing process.	**03**
	(b)	Differentiate between Interacting systems and Non-interacting system.	**04**
	(c)	Explain various component and variable of control system for stirred-tank heater.	**07**
		OR	
	(c)	The transfer function of a control system is given by $$G(s) = \frac{1}{(1+5s)^2}$$ Determine the value of damping factor (ζ) and predict the output response for unit step change in input. Find the output response after 30 second.	**07**
Q.3	**(a)**	What is regulator type problem? Explain with examples.	**03**
	(b)	Discuss the merits and demerits of Feed-forward control strategy.	**04**
	(c)	Derive the transfer function of mercury manometer.	**07**
		OR	
Q.3	**(a)**	What is servo type problem? Explain with examples.	**03**
	(b)	Discuss the merits and demerits of Feed-back control strategy.	**04**
	(c)	The characteristic equation of control system is given as $S^4 + 20S^3 + 15S^2 + 2S + K = 0$ Determine 1. The value of K for which system is stable using routh stability criteria. 2. Value of K for which stem is marginally stable and Complex roots of the system.	**07**
Q.4	**(a)**	Write a short note: ON/OFF controller.	**03**
	(b)	Discuss the advantages and limitations of Internal Model Control (IMC).	**04**
	(c)	Discuss the Nyquist stability criteria.	**07**

OR

Q.4	**(a)**	Derive the transfer function of PID controller and discuss advantages of PID control.	**03**
	(b)	What is the objective of ratio control system? Give Three applications in chemical industry.	**04**
	(c)	Discuss various static characteristics of instrument.	**07**
Q.5	**(a)**	List the advantages of DCS.	**03**
	(b)	Explain seebeck effect of Thermocouple.	**04**
	(c)	Explain construction and working of optical pyrometer.	**07**

OR

Q.5	**(a)**	Explain method for direct measurement of liquid level.	**03**
	(b)	Discuss dry bulb and wet bulb method for measurement of humidity.	**04**
	(c)	Explain construction and working of McLeod gauge.	**07**

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