Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

BE- SEMESTER–V (NEW) EXAMINATION – WINTER 2020

Subject Code:3150504 Date:29/01/2021

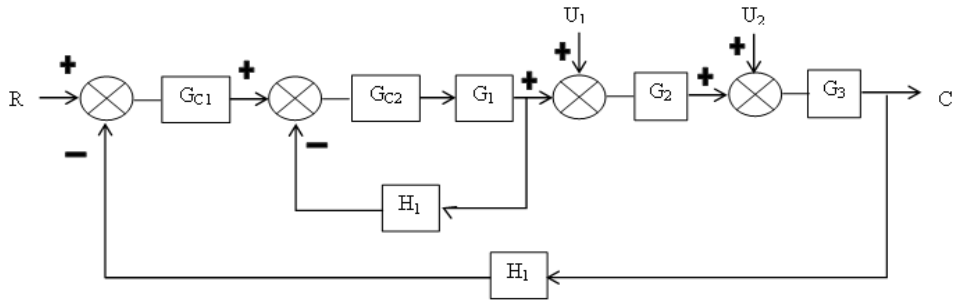
Subject Name:Instrumentation and Process Control

Time:10:30 AM TO 12:30 PM Total Marks: 56

Instructions:

1. **Attempt any FOUR questions out of EIGHT questions.**
2. **Make suitable assumptions wherever necessary.**
3. **Figures to the right indicate full marks.**

			Marks
Q.1	**(a)**	Give the Theoretical value of time constant of the following first order systems: 1. Mercury thermometer 2. Mixing process 3. Liquid level single tank system	**03**
	(b)	Determine f(t) for $f(s) = 1/[s^2(s + 1)]$	**04**
	(C)	A square storage tank contains a liquid which is pumped by a centrifugal pump at a steady rate. Liquid enters the tank at a volumetric flow rate 200 Liter Per Hour and liquid level reaches steady-state value of 40 cm. if input flow rate is suddenly increased to 300 Liter Per Hour. Find the level response and Height of Liquid after 1 min.(Cross Section Area of tank is 15 centimeter x 15 centimeter)	**07**
Q.2	**(a)**	Give the Laplace transform of the following 1. Cosh kt u(t) 2. Sin kt u(t) 3. t^n u(t)	**03**
	(b)	Derive the Laplace transforms of Step and Sine forcing function.	**04**
	(c)	Prove that Response of Non-interacting tanks always result in an overdamped or critically damped second order system and never in an underdamped.	**07**
Q.3	**(a)**	What is difference between Open-loop and Close-loop control system?	**03**
	(b)	Explain the following for underdamped response of second order system. 1. Overshoot 2. Decay Ratio 3. Rise Time 4. Response Time	**04**
	(c)	Determine the transfer function C/R for the system shown in Figure.	**07**



Q.4	**(a)**	Discuss the special case application of proportional control in ON-OFF control system.	**03**
	(b)	What is Regulator-type problem in control system? Explain with example.	**04**
	(c)	The characteristic equation of control system is given as following. $S^3 + 6s^2 + 11s + 6(1 + Kc) = 0$ Determine: 1. The Value of Kc for which the control system is stable. 2. The roots of the characteristic equation for the value of Kc for which the system is on the threshold of instability.	**07**
Q.5	**(a)**	Discuss the various components of a control system with example.	**03**
	(b)	Explain advantages and disadvantages of Distributed Control System.	**04**
	(c)	Discuss the rules for plotting Root-Locus Diagram for Negative Feedback control system.	**07**
Q.6	**(a)**	What is difference between P and PID control?	**03**
	(b)	Explain the Routh theorems for stability test of control system.	**04**
	(c)	Explain the Ziegler-Nichols Controller rule for setting of parameter in P, PI, and PID feedback control system.	**07**
Q.7	**(a)**	List various static characteristics of instruments and discuss any one in details	**03**
	(b)	What is difference in working between radiation pyrometer and optical pyrometer?	**04**
	(c)	List the various instruments used for measurement of vacuum. Explain construction and working of McLeod gage.	**07**
Q.8	**(a)**	Explain SCADA system.	**03**
	(b)	List the various instrument used for measurement of humidity. Explain working of wet bulb and dry bulb thermometer used for measurement of relative humidity.	**04**
	(c)	Explain the construction, working and application of Magnetic float gauge.	**07**

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Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

BE - SEMESTER–V (NEW) EXAMINATION – WINTER 2021

Subject Code:3150504 Date:17/12/2021

Subject Name:Instrumentation and Process Control

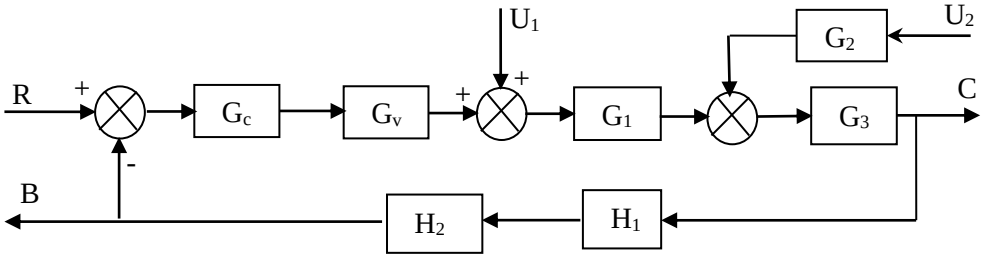
Time:02:30 PM TO 05:00 PM Total Marks: 70

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)	Give Laplace transform for following. (1) Cos kt (2) Sin h kt (3) t e^{-at} (4) t^n	**04**
	(c)	Solve this differential equation using Laplace transform $\frac{d^3x}{dt^3} + 3\frac{d^2x}{dt^2} + 3\frac{dx}{dt}$+ x =1 Given that x(0) = x'(0) =x''(0) =0	**07**
Q.2	**(a)**	Describe how damping coefficient is important for deciding nature of response of a second order system.	**03**
	(b)	Define following terms for under damping second order system (1) Overshoot (2) Decay Ratio (3) Rise time (4) Response time	**04**
	(c)	Derive the equation for overshoot.	**07**
		OR	
	(c)	A thermometer having first order dynamics with the time constant of 1 min. is placed in a temperature bath of 100° C. After it reaches steady state, it is suddenly placed in the temperature bath of 110° C at t=0 and left there for 1 min. and then it is immediately returned to the bath of 100° C. (i) Identify the type of forcing function. (ii) Obtain response of thermometer reading as a function of time.	**07**
Q. 3	**(a)**	Draw the block diagram for closed loop negative feedback control system and identify each of the components.	**03**
	(b)	Differentiate between Regulator control and Servo control with their area of applications.	**04**
	(c)	Derive the equation of transfer function and prove that liquid filled thermometer is a first order system.	**07**
		OR	
Q. 3	**(a)**	What is off set? Why it cannot be eliminated when P-controller is used?	**03**

(b) For the close loop control system diagram shown below, write the transfer functions for (1) C/R (2) C/U_1 (3) B/U_1 (4) B/R **04**



(c) Explain proportional band for a proportional controller with this numerical example. Proportional controller is used to control temperature within the range of 60 to 100 °F. The controller is adjusted so that the output pressure goes from 3 psi to 15 psi, as measured temperature goes from 71°F to 75 °F with the set point held constant. Find the gain and the proportional band. **07**

Q.4 **(a)** Explain Seeback effect of thermocouple. **03**

(b) Giving example of stirred tank heater system, explain the terms (i) Controlled variable (ii) Load Variable (iii) Set point (iv) Manipulated variable **04**

(c) Explain principle, construction and working of an optical pyrometer for temperature measurement. **07**

OR

Q.4 **(a)** Explain basic concept of SCADA system and its area of application. **03**

(b) Differentiate between 'air to open' and 'air to close' type of pneumatic control valves. Give your suggestions about which type of valve will be more suitable following systems. **04**
(1) Control valve fitted with steam inlet to an evaporator unit,
(2) Control valve fitted with cooling water inlet line to a condenser unit.

(c) For the given characteristic equation of control system determine the value of k or which the control system is marginally stable. **07**

$$s^3 + 4s^2 + 5s + 2 + 2k = 0$$

Q.5 **(a)** Classify the pressure measuring instruments. **03**

(b) List the various instrument used for measurement of humidity. Explain working of wet bulb and dry bulb thermometer used for measurement of relative humidity. **04**

(c) Explain Burdon pressure gauge for pressure measurement with neat sketch. **07**

OR

Q.5 **(a)** List various direct methods for level measurement. **03**

(b) Explain static characteristics of an instrument in brief. **04**

(c) Explain the construction, working and application of Magnetic float gauge. **07**

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Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

BE - SEMESTER–V (NEW) EXAMINATION – SUMMER 2021

Subject Code:3150504 Date:05/10/2021

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)**	What is stability? State bode stability criterion.	**03**
	(b)	Derive the transfer function of PID controller.	**04**
	(c)	Solve the following differential equation by using Laplace: $\frac{d^2x}{dt^2} + 2\frac{dx}{dt} + 2x = 2 \qquad where\ x(0) = x'(0) = 0$	**07**
Q-2	**(a)**	Give full names for PLC, DCS, and SCADA.	**03**
	(b)	Differentiate feedback and feed forward control system.	**04**
	(c)	Derive the transfer function for mixing process as first order system. Also derive the step response.	**07**
		OR	
	(c)	Transfer function for the system is: $G(s) = \frac{K_C}{(s+1)(s/2+1)(s/3+1)}$ Determine the values of Kc for which the system is stable.	**07**
Q-3	**(a)**	The transfer function for thermometer is $G(s) = \frac{1}{0.1s+1}$ The frequency of the bath-temperature variation is given as 10/π cycles/min. Find the frequency response	**03**
	(b)	Explain Unit pulse input function. Derive its Laplace transform.	**04**
	(c)	Explain with schematic the working of control valve and also discuss the transfer function of control valve.	**07**
		OR	
Q-3	**(a)**	State and prove initial value theorem.	**03**
	(b)	Define: 1. Manipulated Variable 2. Time constant 3. Overshoot 4. Transfer function.	**04**
	(c)	For two tanks in series (Interacting manner), Derive the transfer function relating height liquid in second tank and input flow at tank 1.	**07**
Q-4	**(a)**	Discuss servo and regulator problem.	**03**
	(b)	Discuss in brief the characteristics of second order underdamped system.	**04**
	(c)	Write a short note on PI controller.	**07**
		OR	
Q-4	**(a)**	Give the classification of various methods for level measurement.	**03**
	(b)	Explain the transportation lag and its transfer function.	**04**

	(c)	State various liquid column meters for pressure measurement. Explain inclined tube manometer with neat sketch.	**07**
Q-5	**(a)**	State the various pressure measurement instruments.	**03**
	(b)	Discuss the classification of flow meters.	**04**
	(c)	Explain construction, working and principle of Rotameter with sketch	**07**
		OR	
Q-5	**(a)**	Explain the static characteristics of instruments.	**03**
	(b)	Discuss any one pyrometer in brief.	**04**
	(c)	Describe the principle, construction and working of thermocouple used for temperature measurement.	**07**

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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

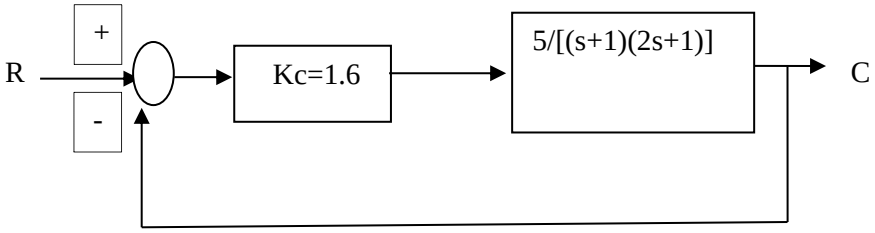
Time:02:30 PM TO 05:00 PM Total Marks: 70

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**

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