P P SAVANI UNIVERSITY

Fifth Semester of B. Tech. Examination

December 2021

SECH3030 Instrumentation & Process Control

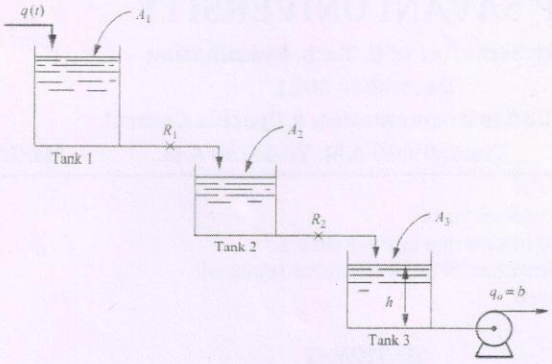
09.12.2021, Thursday **Time: 09:00 A.M. To 11:30 A.M.** **Maximum Marks: 60**

Instructions:

1. The question paper comprises of two sections.
2. Section I and II must be attempted in separate answer sheets.
3. Make suitable assumptions and draw neat figures wherever required.
4. Use of scientific calculator is allowed.

SECTION – I

Q - 1	**Answer the following: (Any five)**	**[05]**
(i)	State the classification of variables in chemical process in short.	
(ii)	Sketch modelling configuration of control process.	
(iii)	Give the transfer function of Step Input.	
(iv)	State the transfer function of first order system.	
(v)	An operator opens up the valve of the liquid level tank, what will be the effect on the time constant of the system?	
(vi)	If the damping factor of the underdamped system is decreased, the rise time of the system will _____ .	
(vii)	Plot the graph of inverse response consisting of two first order system connected in parallel.	
Q - 2 (a)	The thermometer with initial temperature of 27 ◦ C is dipped in a bath and maintained at 100 C with time constant of 1 min. What will be time taken by the thermometer to reach at 50 ◦ C. If the time constant is changed to 0.5 min and the bath reading increases with unsteady behavior as 4.5 ◦ C /min. What will be bath temperature at 1 min and 10 min?	**[05]**
Q - 2 (b)	Derive the transfer function of interacting system.	**[05]**
	OR	
Q - 2 (a)	Explain in detail the need of a control system.	**[05]**
Q - 2 (b)	Derive the value to input in Laplace form for the following types of input variables and explain the nature of function. a.Step Input b. sinusoidal input	**[05]**
Q - 3	Derive the transfer function of a second order system from the second order differential equation and also find the dynamic response of second order system with unit step input.	**[10]**
	OR	
Q - 3	$1.5\,\frac{d^2y}{dt^2} + \frac{dy}{dt} + 3y(t) = 15\,x(t)$ Find: a. overshoot b. decay ratio c. rise time d. response time e. time period of oscillation f. natural period of oscillation.	**[10]**
Q -4	A step change of magnitude 2 is introduced into a system having the following transfer function $G(s) = \frac{2}{s^2 + 2s + 4}$ What is the % overshoot?	**[05]**
	OR	
Q - 4	Determine the transfer function H(s)/Q(s) for the liquid-level system shown in Fig. Resistances R1 and R2 are linear. The flow rate from tank 3 is maintained constant at b by means of a pump; i.e., the flow rate from tank 3 is independent of head h. The tanks are noninteracting.	**[05]**



SECTION – II

Q - 1 Answer the Following: (Any FIVE) **[05]**

(i) What is stability?

(ii) State the P&ID symbol for Control Valve.

(iii) State the P&ID symbol for instrument air line

(iv) Barometer is used to measure _____.

(v) Rota meter is variable _____ flow meter.

(vi) Define transfer function.

(vii) State the P&ID symbol for electrical line.

Q - 2 (a) Develop Routh Array and check the stability of the system with transfer function. **[05]**

$6s^3 + 22s^2 + 6s + (1 + k) = 0$ for all k > 0.

Q - 2 (b) Explain in brief steps to prepare root locus diagram **[05]**

OR

Q - 2 (a) Sketch the root locus of unity feedback system with open loop transfer function as 'k' varied from 0 to ∞.

$$G(s)H(s) = \frac{k}{s(s+2)(s+3)}$$

Q - 2 (b) Explain parts of instrumentation and control.

Q - 3 (a) State various level measurement instruments and discuss any one in detail.

Q - 3 (b) Explain working principle, construction and applications of thermocouples.

OR

Q - 3 (a) Explain the principle, construction and working of the inferential flow meters. **[05]**

Q - 3 (b) Explain the temperature measurement by thermisters. **[05]**

Q - 4 Attempt any one. **[05]**

(i) Write a short note on manometers.

(ii) Write a short note on pressure gauges used in process industry.

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3. Make suitable assumptions and draw neat figures wherever required.
4. Use of scientific calculator is allowed.

SECTION – I

Q - 1	Answer the Following: (Any FIVE)	**[05]**
(i)	State the laplace trasform of a unit step change.	
(ii)	Define ramp input function.	
(iii)	What is offset?	
(iv)	Define first order system.	
(v)	Explain the significance of time constant.	
(vi)	Define overdamped second order system.	
(vii)	Explain significance of overshoot.	
Q - 2 (a)	Solve the differential equation by using Laplace transform. $y''-2y'-y=1$, where, $y(0)=-1, y'(0)=1$.	**[05]**
Q - 2 (b)	Derive the transfer function for mercury thermometer as first order system. Also derive step response.	**[05]**

OR

Q - 2 (a)	Derive the transfer function of interacting system.	**[05]**
Q - 2 (b)	The thermometer with initial temperature of 27 °C is dipped in a bath and maintained at 100°C with time constant of 1 min. What will be time taken by the thermometer to reach at 50°C. If the time constant is changed to 0.5 min and the bath reading increases with unsteady behavior as 4.5 °C /min. What will be bath temperature at 1 min and 10 min?	**[05]**
Q - 3 (a)	A step change of magnitude 2 is introduced into a system having the following transfer function $$G(s) = \frac{2}{s^2 + 2s + 4}$$ Calculate time constant, damping factor, overshoot and decay ratio.	**[05]**
Q - 3 (b)	Define proportional controllers. Derive its transfer function.	**[05]**

OR

Q - 3 (a)	Describe the classification of variables in chemical process.	**[05]**
Q - 3 (b)	Explain the ultimate value of the response with step input for second order system and plot the graph.	**[05]**
Q - 4	Attempt any one.	**[05]**
(i)	Write a brief note on control valves with schematic.	
(ii)	Discuss the types of controllers.	

SECTION – II

Q - 1	**Answer the following: (Any five)**	**[05]**
(i)	What is the relation between natural frequency of oscillation and frequency of oscillation?	
(ii)	When the damping coefficient is greater than unity, the system is a. Over damped b. Critically damped c. Under damped d. Highly fluctuating	
(iii)	State transfer function of PI Controller.	

(iv) What is the use of bimetallic thermometer?

(v) Describe the functioning of air to close valve.

(vi) How can we convert air to open valve to air to close valve.

(vii) The disadvantage of glass thermometer is

a. fragility b. inaccurateness

c. heating d. cooling

(viii) The value of Overshoot for $\zeta = 1$ is _____ .

Q - 2 (a) Mention the steps to develop Routh Array Method. **[05]**

Q - 2 (b) Using Routh Array and check the stability of the system with transfer function **[08]**

$s^4 + 8s^3 + 18s^2 + 16s + 5 = 0$ for all k > 0.

OR

Q - 2 (a) Mention the steps to develop Root Locus Diagram. **[05]**

Q - 2 (b) Sketch the root locus of unity feedback system with open loop transfer function as 'k' varied from 0 to ∞. **[08]**

$$G(s)H(s) = \frac{k}{s(s+2)(s+3)}$$

Q - 3 Draw the symbols used in piping and instrumentation diagram. **[07]**

OR

Q - 3 Explain parts of instrumentation and control. **[07]**

Q - 4 Explain the principal, construction and working of the mass flowmeters with a neat diagram. **[05]**

OR

Q - 4 Explain the principal, construction and working of the pressure transducer measurement devices with a neat diagram. **[05]**

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