U.S.N.										

B.M.S. College of Engineering, Bengaluru-560019

Autonomous Institute Affiliated to VTU

July 2023 Semester End Main Examinations

Program: B.E. | **Semester: VI**
Branch: Biotechnology | **Duration: 3 hrs.**
Course Code: 19BT6DE3PCA | **Max Marks: 100**
Course: Process Control and Automation | **Date: 17.07.2023**

Instructions: 1. Answer any FIVE full questions, choosing one full question from each unit.
2. Missing data, if any, may be suitably assumed.

			CO	PO	Marks
		UNIT – I			
1	a)	(i) Find the inverse Laplace Transform of $$\frac{d^3x}{dt^3} + 2\frac{d^2x}{dt^2} - \frac{dx}{dt} - 2x = 4 + e^{2t}$$ $$x(0) = 1 \quad x'(0) = 0 \quad x''(0) = -1$$ (ii) Estimate the final value of the function x(t) for which the Laplace transform is $$x(s) = \frac{1}{s\left(s^3 + 3s^2 + 3s + 1\right)}$$	*CO2*	*PO1*	**10**
	b)	Describe the characteristic features of Laplace Transform of any five input functions.	*CO2*	*PO1*	**04**
	c)	Draw a block diagram showing all components of a process control system in a stirred tank reactor, where temperature is the control variable. Explain the function of each of the components briefly.	*CO1*	*PO*	**06**
		UNIT – II			
2	a)	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 input and ultimate response of the thermometer reading as a function of time. Calculate the phase lag.	*CO2*	*PO1*	**10**
	b)	Discuss the significance of converting non-linear to linear systems taking liquid-level systems as an example. Also derive the transfer function for the linearization.	*CO2*	*PO1*	**10**

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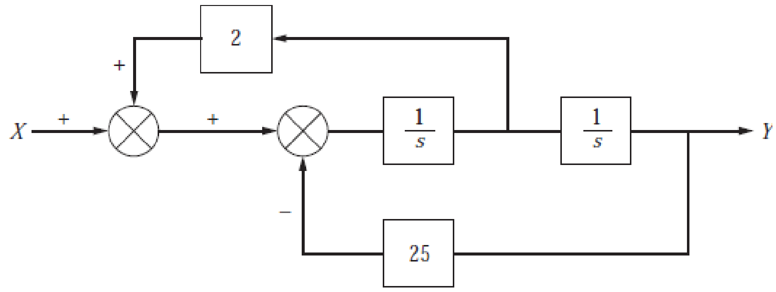
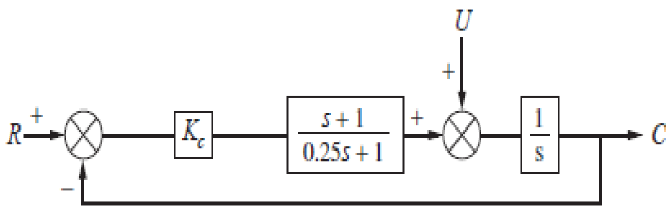
<tr><td></td><td></td><td></td><td>UNIT-III</td><td></td><td></td><td></td></tr>
<tr><td></td><td>3</td><td>a)</td><td>Derive the transfer function for a damped vibrator with a neat illustration. State all assumptions.</td><td>CO2</td><td>PO1</td><td>10</td></tr>
<tr><td></td><td></td><td>b)</td><td>A step change of magnitude 100 is introduced into a system having the transfer function $Y(S)/X(S) = 100/(s^2 + 15s + 100)$. Determine (i) % overshoot (ii) Rise time (iii) Maximum value of Y(t)
(iv) Ultimate value of Y(t) and (v) Period of Oscillation.</td><td>CO2</td><td>PO1</td><td>10</td></tr>
<tr><td></td><td></td><td></td><td>UNIT –IV</td><td></td><td></td><td></td></tr>
<tr><td></td><td>4</td><td>a)</td><td>Derive overall transfer function for change in set point and develop reduced block diagram.</td><td>CO4</td><td>PO3
PO5</td><td>10</td></tr>
<tr><td></td><td></td><td>b)</td><td>Develop the transfer function Y/X for the following control system

</td><td>CO4</td><td>PO3</td><td>10</td></tr>
<tr><td></td><td></td><td></td><td>OR</td><td></td><td></td><td></td></tr>
<tr><td></td><td>5</td><td>a)</td><td>For the control system shown in figure,
(i) Obtain the closed loop transfer function C/U
(ii) Find the value of K_c for which the closed loop response has a $\zeta = 2.3$
(iii) Estimate the offset for a unit-step change in U, if $K_c = 4$.

</td><td>CO2</td><td>PO1</td><td>10</td></tr>
<tr><td></td><td></td><td>b)</td><td>A pneumatic PI temperature controller has an output pressure of 10 psig when the set point and process temperature coincide. The set point is suddenly increased by 10 ^{0}F (i.e., a step change in error is introduced), and the following data are obtained. Determine the actual gain (psig per degree Fahrenheit) and the integral time.
<table>
<tr><th>Time, s</th><th>psig</th></tr>
<tr><td>0−</td><td>10</td></tr>
<tr><td>0+</td><td>8</td></tr>
<tr><td>20</td><td>7</td></tr>
<tr><td>60</td><td>5</td></tr>
<tr><td>90</td><td>3.5</td></tr>
</table></td><td>CO2</td><td>PO1</td><td>10</td></tr>
</table>

			UNIT – V			
	6	a)	Explain in detail, Bode diagrams for first order systems. Draw neat schematic of Bode plots.	*CO1*	*PO*	**10**
		b)	Plot the root locus diagram for the transfer function, G = 1/s(s+3).	*CO3*	*PO2*	**10**
			OR			
	7	a)	State the theorems of Routh array test. Given the characteristic equation $s^4 + 5s^3 + 2s + 10 = 0$, analyze the stability of the process system by the Routh criterion.	*CO3*	*PO2*	**10**
		b)	Plot the root locus diagram for the transfer function, $G = \frac{1}{s(s^2+5s+6)}$	*CO3*	*PO2*	**10**

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