

Fourth Semester B.E./B.Tech. Degree Examination, June/July 2024

Control Systems

Time: 3 hrs.

Max. Marks: 100

Note: 1. Answer any FIVE full questions, choosing ONE full question from each module. 2. M: Marks, L: Bloom's level, C: Course outcomes.

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		Module – 1	M	L	С
Q.1	a.	Define Control system. Write down any four differences between Open	4	L2	CO1
		Loop Control System and Closed Loop Control System.			
	b.	For the mechanical system shown in Fig. Q1(b), obtain the equivalent	8	L2	CO1
		electrical system using Force – Voltage method.	V/00/1	5,40 (* 250005.)	
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		Fig. Q1(b)			
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		V FC€)			
		6.			
	c.	For the mechanical system, shown in Fig. Q1(c), obtain the equivalent	8	L2	CO1
		electrical system using Force – Current method.			
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		327			
		B <sub>1</sub> M <sub>2</sub>			
		Fig. Q1(c)			
		ak, 3k3			
		9 HB3			
		M <sub>4</sub>			
		↓ \$c€)			
		OR '			
Q.2	a.	For the mechanical system shown in Fig. Q2(a), obtain the equivalent	7	L2	CO1
		electrical system using Force – Voltage method.			
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		Fig. Q2(a) $k_2$ $\beta$ $\beta$ $\beta$ $\beta$			
		$M_2$			
		V <sup>*</sup>			

b. For the mechanical system shown in Fig. Q2(b), obtain the equivalent electrical system using Force – Voltage method.  c. Draw the electrical network based on torque – current analogy and write performance equation for the mechanical system of Fig. Q2(c).  Fig. Q2(c)  By By Mason's gain formula for Fig. Q3(a).  Fig. Q3(a)  Fig. Q3(a)  Fig. Q3(b)  C. For the single flow graph of Fig. Q3(c), find the transfer function using Mason's gain formula.  Fig. Q3(c)						
Fig. Q2(b)  Fig. Q2(b)  Fig. Q2(c)  Solution  Fig. Q2(c)  Fig. Q2(c)  Fig. Q2(c)  Fig. Q3(a)  Fig. Q3(a)  Fig. Q3(a)  Fig. Q3(b)  Fig. Q3(c)		b.		7	L2	CO1
Fig. Q2(b)    Column   Fig. Q2(c)   Fig. Q2(c)   Fig. Q2(c)     Fig. Q2(c)   Fig. Q2(c)   Fig. Q2(c)     Fig. Q3(a)   Fig. Q3(b)     Fig. Q3(b)   Fig. Q3(c)   Fig. Q3(c)     Fig. Q3(c)   Fig. Q3(c)   Fig. Q3(c)     Column   Fig. Q3(c)   Fig. Q3(c)     Column   Fig. Q3(c)   Fig. Q3(c)     Column   Fig. Q3(c)   Fig. Q3(c)     Fig. Q3(c)   Fig. Q3(c)   Fig. Q3(c)     Fig. Q3(c)   Fig. Q3(c)			electrical system using Force – Voltage method.			
Fig. Q2(b)    Column   Fig. Q2(c)   Fig. Q2(c)   Fig. Q2(c)						
Fig. Q2(b)    Column   Fig. Q2(c)   Fig. Q2(c)   Fig. Q2(c)			K23 HB3			
Fig. Q2(b)    Column   Fig. Q2(c)   Fig. Q2(c)   Fig. Q2(c)			3x, M2			
c. Draw the electrical network based on torque – current analogy and write performance equation for the mechanical system of Fig. Q2(c).  Fig. Q2(c)  By By Mason's gain formula for Fig. Q3(a).  By C(s)  Fig. Q3(a)  Fig. Q3(a)  C(s)  Fig. Q3(a)  By Mason's gain formula for Fig. Q3(a).  C(s)  Fig. Q3(b)  C(s)  Fig. Q3(c)  Fig. Q3(c)  Fig. Q3(c)  Fig. Q3(c)  Fig. Q3(c)  Fig. Q3(c)  C(s)  Fig. Q3(c)			B <sub>1</sub>			
c. Draw the electrical network based on torque – current analogy and write performance equation for the mechanical system of Fig. Q2(c).  Fig. Q2(c)  By By Mason's gain formula for Fig. Q3(a).  By C(s)  Fig. Q3(a)  Fig. Q3(a)  C(s)  Fig. Q3(a)  By Mason's gain formula for Fig. Q3(a).  C(s)  Fig. Q3(b)  C(s)  Fig. Q3(c)  Fig. Q3(c)  Fig. Q3(c)  Fig. Q3(c)  Fig. Q3(c)  Fig. Q3(c)  C(s)  Fig. Q3(c)			Fig. (22(b)			
performance equation for the mechanical system of Fig. Q2(c).  Fig. Q2(c)  Results of Fig. Q2(c).  Module – 2  Q.3 a. Find $\frac{C(s)}{R(s)}$ by Mason's gain formula for Fig. Q3(a).  Fig. Q3(a)  Fig. Q3(a)  b. Determine the transfer function $\frac{C(s)}{R(s)}$ of the system shown in Fig. Q3(b).  Fig. Q3(b)  C. For the single flow graph of Fig. Q3(c), find the transfer function using Mason's gain formula.  Fig. Q3(c)  Fig. Q3(c)			M <sub>1</sub>			
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Fig. Q2(c)  By Module - 2  Q.3 a. Find $\frac{C(s)}{R(s)}$ by Mason's gain formula for Fig. Q3(a).  Fig. Q3(a)  By Mason's gain formula for Fig. Q3(a).  Fig. Q3(b)  Case Control of the system shown in Fig. Q3(b).  Fig. Q3(b)  Fig. Q3(c)		C.		U	LL	COI
Module – 2  Q.3 a. Find $\frac{C(s)}{R(s)}$ by Mason's gain formula for Fig. Q3(a).  Fig. Q3(a)  b. Determine the transfer function $\frac{C(s)}{R(s)}$ of the system shown in Fig. Q3(b).  Fig. Q3(b)  c. For the single flow graph of Fig. Q3(c), find the transfer function using Mason's gain formula.  8 L3 CO3  Fig. Q3(c)						
Module – 2  Q.3 a. Find $\frac{C(s)}{R(s)}$ by Mason's gain formula for Fig. Q3(a).  Fig. Q3(a)  b. Determine the transfer function $\frac{C(s)}{R(s)}$ of the system shown in Fig. Q3(b).  Fig. Q3(b)  c. For the single flow graph of Fig. Q3(c), find the transfer function using Mason's gain formula.  8 L3 CO3  Fig. Q3(c)			$(J_1)$ $(J_2)$ $(J_3)$			
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a. Find $\frac{C(s)}{R(s)}$ by Mason's gain formula for Fig. Q3(a).  6 L3 CO3  b. Determine the transfer function $\frac{C(s)}{R(s)}$ of the system shown in Fig. Q3(b).  7 Fig. Q3(b)  7 Fig. Q3(c)  8 L3 CO3  8 L3 CO3  Fig. Q3(c)  Fig. Q3(c)  Fig. Q3(c)						
b. Determine the transfer function $\frac{C(s)}{R(s)}$ of the system shown in Fig. Q3(b).  b. Determine the transfer function $\frac{C(s)}{R(s)}$ of the system shown in Fig. Q3(b).  c. For the single flow graph of Fig. Q3(c), find the transfer function using Mason's gain formula.  8 L3 CO3  Fig. Q3(c)			Module – 2			
Fig. Q3(a)  b. Determine the transfer function $\frac{C(s)}{R(s)}$ of the system shown in Fig. Q3(b).  Fig. Q3(b)  Fig. Q3(c)	0.3	9	Find $\frac{C(s)}{s}$ by Mason's gain formula for Fig. O3(a)	6	L3	CO3
Fig. Q3(a)  b. Determine the transfer function $\frac{C(s)}{R(s)}$ of the system shown in Fig. Q3(b).  6 L3 CO3  Fig. Q3(b)  c. For the single flow graph of Fig. Q3(c), find the transfer function using Mason's gain formula.  8 L3 CO3  Fig. Q3(c)	Q.S	a.	$\frac{1}{R(s)}$ by Mason's gain formula for Fig. $QS(a)$ .			4
Fig. Q3(a)  b. Determine the transfer function $\frac{C(s)}{R(s)}$ of the system shown in Fig. Q3(b).  6 L3 CO3  Fig. Q3(b)  c. For the single flow graph of Fig. Q3(c), find the transfer function using Mason's gain formula.  8 L3 CO3  Fig. Q3(c)			-He			
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b. Determine the transfer function $\frac{C(s)}{R(s)}$ of the system shown in Fig. Q3(b).  Fig. Q3(b)  Fig. Q3(c)			164			
b. Determine the transfer function $\frac{C(s)}{R(s)}$ of the system shown in Fig. Q3(b).  Fig. Q3(b)  Fig. Q3(c)			Fig. Q3(a)			
Fig. Q3(b)  C. For the single flow graph of Fig. Q3(c), find the transfer function using Mason's gain formula.  Solve Fig. Q3(c)  Fig. Q3(c)  Fig. Q3(c)			- A <sub>3</sub>			
Fig. Q3(b)  C. For the single flow graph of Fig. Q3(c), find the transfer function using Mason's gain formula.  Solve Fig. Q3(c)  Fig. Q3(c)  Fig. Q3(c)						
Fig. Q3(b)  C. For the single flow graph of Fig. Q3(c), find the transfer function using Mason's gain formula.  Solve Fig. Q3(c)  Fig. Q3(c)  Fig. Q3(c)		h	Determine the transfer function C(s) of the system shown in Fig. O2(h)	6	L3	CO3
Fig. Q3(b)  Fig. Q3(b)  C. For the single flow graph of Fig. Q3(c), find the transfer function using Mason's gain formula.  Fig. Q3(c)  Fig. Q3(c)		D.	R(s) of the system shown in Fig. Q5(b).	è		
Fig. Q3(b)  Fig. Q3(b)  RCS  Fig. Q3(c), find the transfer function using 8 L3 CO3  Fig. Q3(c)  Fig. Q3(c)  Fig. Q3(c)			93			
Fig. Q3(b)  Fig. Q3(b)  RCS  Fig. Q3(c), find the transfer function using 8 L3 CO3  Fig. Q3(c)  Fig. Q3(c)  Fig. Q3(c)			Pital			
c. For the single flow graph of Fig. Q3(c), find the transfer function using 8 L3 CO3 Mason's gain formula.			12 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1			
c. For the single flow graph of Fig. Q3(c), find the transfer function using 8 L3 CO3 Mason's gain formula.			Fig O2(h)			
c. For the single flow graph of Fig. Q3(c), find the transfer function using 8 L3 CO3 Mason's gain formula.						
Mason's gain formula. $G_1$ $G_2$ $G_3$ $G_4$ $G_5$ $G_6$ $G_6$ $G_6$ $G_7$ $G_8$ $G_9$ $G_{12}$ $G_{13}$ $G_{14}$ $G_{15}$ $G_$			17.13			To.
Mason's gain formula. $G_1$ $G_2$ $G_3$ $G_4$ $G_5$ $G_6$ $G_6$ $G_6$ $G_7$ $G_8$ $G_9$ $G_{12}$ $G_{13}$ $G_{14}$ $G_{15}$ $G_$		c.	For the single flow graph of Fig. Q3(c), find the transfer function using	8	L3	CO3
Fig. Q3(c) $ \begin{array}{ccccccccccccccccccccccccccccccccccc$			Mason's gain formula.			
Fig. Q3(c) $ \begin{array}{ccccccccccccccccccccccccccccccccccc$						
Fig. Q3(c)			7 42			
Fig. Q3(c)			RCS) 1 GEA 4GE 1 CCS)			₩ '.
Fig. Q3(c)			Ga			
						2:

		OR			
Q.4	a.	Reduce the block diagram to its canonical form and obtain C(s)/R(s) of the system of Fig. Q4(a).	6	L3	CO3
		RCD Cas			
		(CS)			
		Fig. Q4(a)			
				-	~~~
	b.	Obtain the transfer function of the single flow graph shown in Fig. Q4(b), using Mason's gain formula.	6	L3	CO3
		-H <sub>2</sub> 345			
		Fig. Q4(b) Fig. Q4(b)			
	c.	Reduce the block diagram of Fig. Q4(c) to its simple form and obtain $C(s)/R(s)$ .	8	L3	CO3
		RCS CO CO			
		Fig. Q4(c)			
		Module – 3			
Q.5	a.	With the help of graphical representation and mathematical expression, explain the following test signals: i) Step signal ii) Ramp signal iii) Impulse signal iv) Parabolic signal.	8	L3	CO2
	b.	Find Kp, Kv, Ka and steady state error for a system with Open loop transfer function $G(s) H(s) = \frac{10(s+2)(s+3)}{s(s+1)(s+4)(s+5)}$ , where $r(t) = 3 + t + t^2$ .	6	L3	CO2
	c.	The Open loop transfer function of a servo system with unity feedback is given as $G(s) = \frac{10}{s}$ . Find out static error constants and obtain steady.	.6	L3	CO2
		given as $G(s) = \frac{10}{s(0.1s+1)}$ . Find out static error constants and obtain steady			
		state error when an input $r(t) = A_0 + A_1 t + \frac{A_2}{2} t^2$ is applied.			
		OR			
Q.6	a.	For a unity feedback control system with $G(s) = \frac{64}{s(s+9.6)}$ , write the output	10	L2	CO3
		response to a unit step input. Determine  1) The response at t = 0.1 set			
		<ul> <li>2) Maximum value of response and the time at which it occurs.</li> <li>3) Settling time.</li> </ul>			

	b.	For the system shown in Fig. Q6(b),  1) Identify the type of C(s) / E(s)	10	L2	CO3
		<ul> <li>2) Find values of Kp, Kv, Ka.</li> <li>3) If r(t) = 10u(t), find steady state value of the output.</li> </ul>			
		Fig. Q6(b) $ \begin{array}{c} R(s) \\ F(s) \\ F(s)$			
		Module – 4			
Q.7	a.	Find the number of roots with positive real part, zero real part and negative real part for a system $s^6 + 4s^5 + 3s^4 - 16s^2 - 64s - 48 = 0$ .	6	L2	CO4
	b.	For a unity feedback system,	6	L2	CO4
		$G(s) = \frac{K}{s(1+0.4s)(1+0.25s)}, \text{ find range of values of K, Marginal value of K and frequency of sustained oscillations.}$		-	
	c.	Explain the angle condition in Root locus. Test the following points using angle condition for the system $G(s) H(s) = \frac{K}{s(s+2)(s+4)}.$ i) $s = -0.75$ ii) $s = -1 + j4$ .	8	L2	CO4
0.0		OR	10	T 0	004
Q.8	a.	Sketch the complete root locus and comment on the stability of the system $G(s) \ H(s) = \frac{K}{s(s+1)(s+2)(s+3)}.$	12	L2	CO4
	b.	Sketch the Bode plot for the transfer fl. Find value of 'K' for $W_{gc} = 5 \text{ rad/sec.}$ $G(s) = \frac{K s^2}{(1 + s^2)^{3/2}}$	8	L2	CO4
		$G(s) = \frac{K s^2}{(1+0.2s)(1+0.02s)}$			
Q.9	a.	For a certain control system	10	1.2	COS
4.0	64.	$G(s) H(s) = \frac{K}{s(s+2)(s+10)}, \text{ sketch the Nyquist plot and hence calculate the}$	10	L2	CO5
		range values of K for stability.			
	b.	Explain the Lag compensator and Lead compensator with the help of a circuit diagram.	10	L2	CO5
		OR			
		UK			

	a.	Construct the state model using phase variables if the system is described by the differential equation	6	L2	CO
		$\frac{d^3y(t)}{dt^3} + 4\frac{d^2y(t)}{dt^2} + 7\frac{dy(t)}{dt} + 2y(t) = 5u(t)$ . Also draw the state diagram.		-1	
			_	¥ 0	000
	b.	The transfer function of a control system is	7	L2	CO
		$\frac{Y(s)}{U(s)} = \frac{s^2 + 3s + 4}{s^3 + 2s^2 + 3s + 2}$ . Obtain the State model using signal flow graph.			
		0(8) 8 + 28 + 38 + 2			
(	c.	Find the state transition matrix for	7	L1	C
		$A = \begin{bmatrix} 0 & -1 \\ +2 & -3 \end{bmatrix}$			
		[+2 -3]			
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