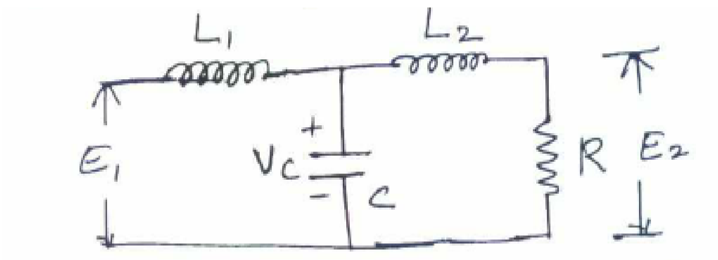
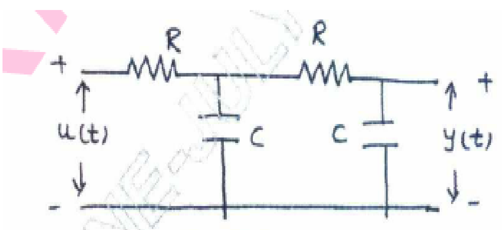
Assignment – 3 Control Systems

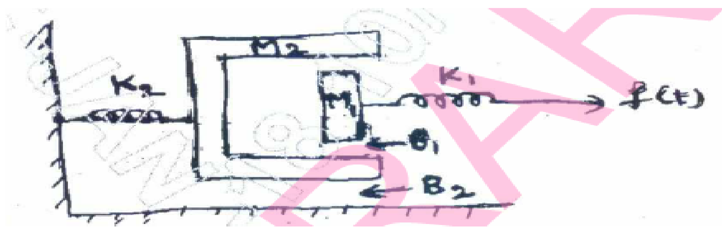
Model Assignment Questions							
Crs Code:	BEC403	Sem:	4	Marks:	10	Time:	90 – 120 minutes
Course:	Control Systems						

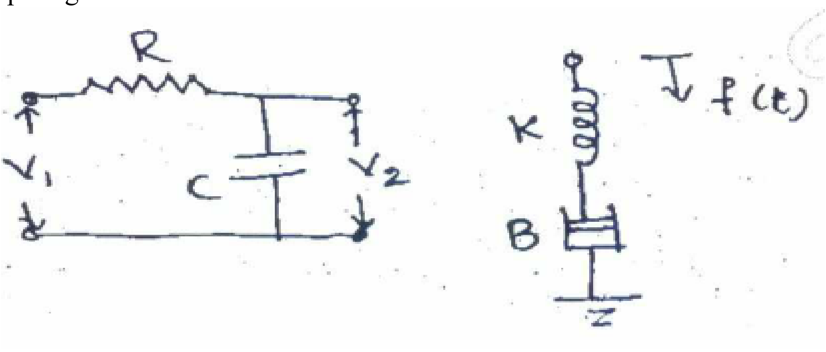
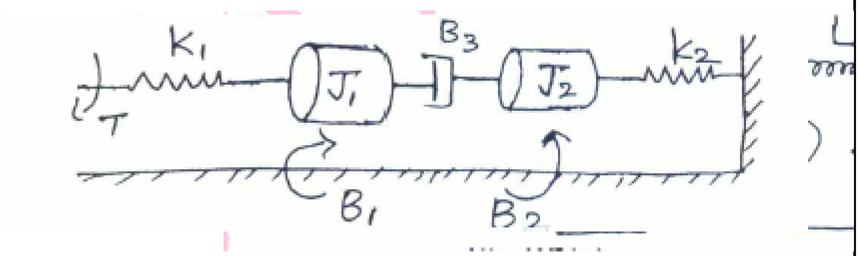
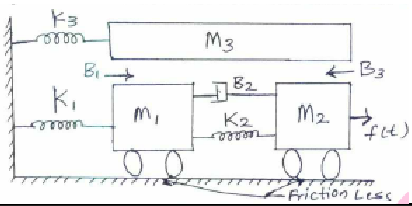
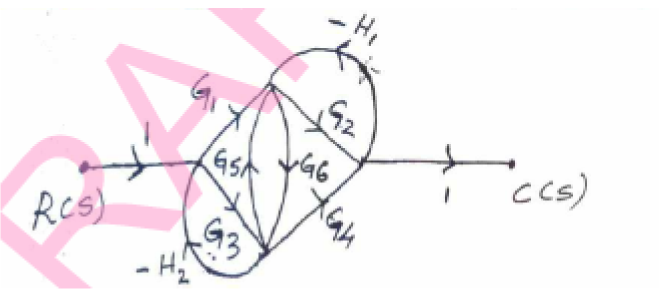
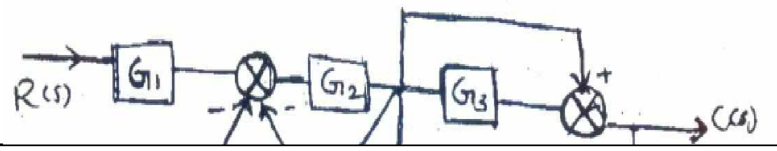
SNo	Assignment Description	Marks	CO	Level
1.	Obtain the state model of given electrical network shown in Fig. 	7	CO5	L3
2.	Find the state-tarannsition matrix for $A = \begin{bmatrix} 0 & -1 \\ +2 & -3 \end{bmatrix}.$	8	CO5	L3
3.	linear time invariant system is characterized by the homogeneous state equation $\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \end{bmatrix} = \begin{bmatrix} 1 & 0 \\ 1 & 1 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix}$ Compute the solution of homogeneous equation, assume the initial state vector. $x_0 = \begin{bmatrix} 1 \\ 0 \end{bmatrix}.$	7	CO5	L3
4.	Obtain an appropriate state model for a system re mented by an electric circuit as shown in below Fig. 	8	CO5	L3
5.	Find the transfer function of the system having state model. $\dot{X} = \begin{bmatrix} 0 & 1 \\ \end{bmatrix} \begin{bmatrix} x_1 \\ \end{bmatrix} + \begin{bmatrix} 0 \\ \end{bmatrix} u \quad \text{and} \quad y = \begin{bmatrix} 1 & 0 \end{bmatrix} \begin{bmatrix} x_1 \\ \end{bmatrix}$	7	CO5	L3

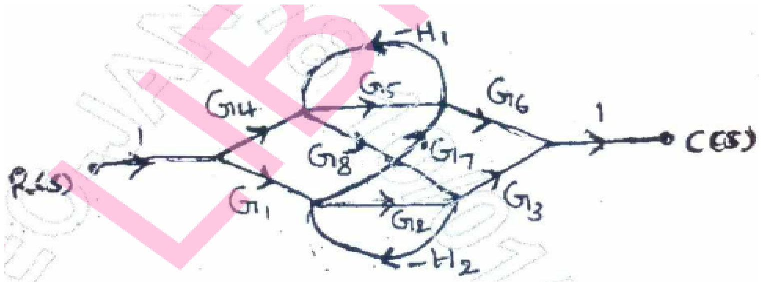
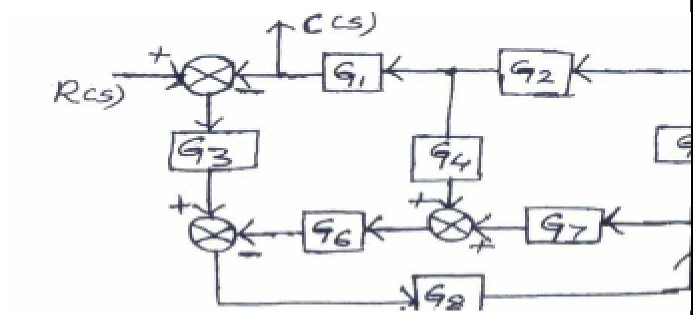
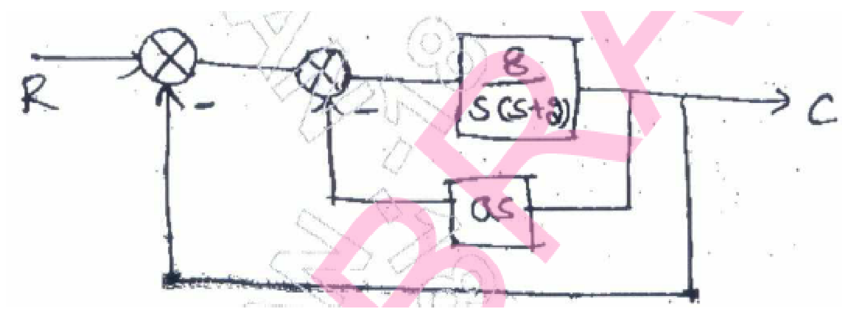
6.	Obtain the state model for the system represented by the differential equation $$\frac{d^3y(t)}{dt^3}+6\frac{d^2y(t)}{dt^2}+11\frac{dy(t)}{dt}+10y(t)=3u(t).$$	8	CO5	L3
7.	State the properties of state transition matrix.	7	CO5	L2
8.	single input single output system has the state and output equations $$\dot{x}=\begin{bmatrix}0 & 1\\ -6 & -5\end{bmatrix}x+\begin{bmatrix}0\\ 1\end{bmatrix}r$$ $$y=\begin{bmatrix}5 & 0\end{bmatrix}x$$ i) Determine its transfer function (ii) Find its state transition matrix.	8	CO5	L3
9.	Draw polar plot of $G(s)H(s) = 100/ (s^2 +10S+100)$	**10**	CO5	L3
10.	Draw the polar plot for the following open-loop transfer function $G(S)H(s) = 1/ (1+ 0.1s)$	**10**	CO5	L3
11.	Sketch the Nyquist plot for a system with the open-loop transfer function : $G(s)H(s) = (k (1+ 0.5s)(1 + s)) / ((1 + 10s)(s —1))$. Determine the range of values of 'K' for which the system is stable.	**10**	CO5	L3
12.	Explain Nyquist stability criteria	**10**	CO5	L3
13.	Using Nyquist stability criterion, find the closed loop stability of a negative feedback control system whose open-loop transfer function is given by $G(s)H(s) = 5 /(s(s —1))$	**10**	CO5	L3

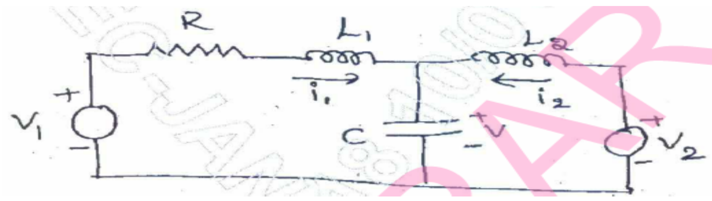
F. EXAM PREPARATION

1. University Model Question Paper

Course:	Control Systems					Month / Year	June/2020	
Crs Code:	18EC43	Sem:	4	Marks:	100	Time:	180 minutes	
Module		Answer all FIVE full questions. All questions carry equal marks.				**Marks**	**CO**	**Level**
1	a	Define control system. Distinguish between open loop and closed loop systems with examples.				6	CO1	L3
	b	Write the differential equations for the mechanical system shown in Fig. and obtain F-V and F-1 analogous electrical networks. 				7	CO1	L3

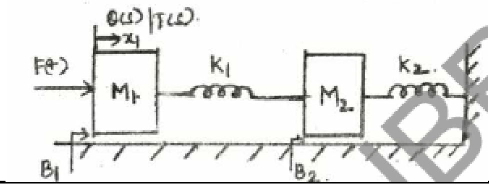
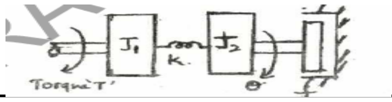
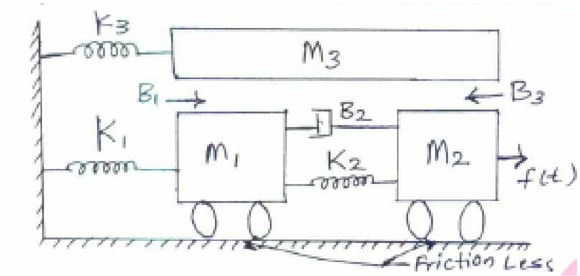
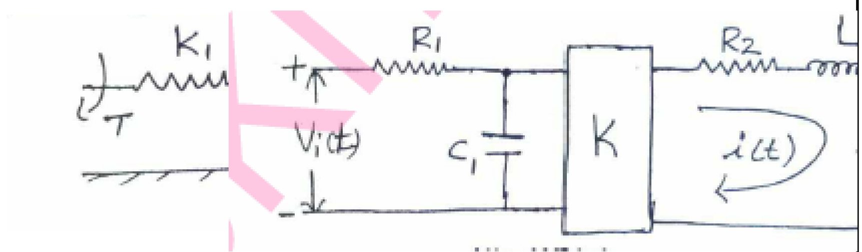
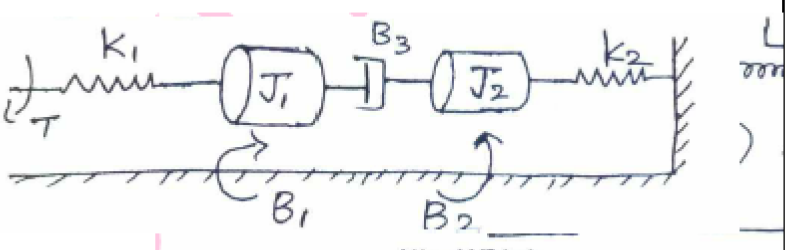
	c	Show that two systems shown in Fig.Q2(a) are analogous systems, by comparing their functions. 	7	CO1	L3
		OR			
	a	For the circuit shown in below Fig 'IC' is the gain of an ideal amplifier. Determine the transfer function I(s) / V (s) 	8	CO1	L3
	b	For the mechanical system shown in Fig.Q1(b): i) Draw the mechanical network. ii) Obtain equations of motion. H.) Draw an electrical network based on force current analogy. 	8		
	c	Explain linear and non-linear control system.	4		
		MODULE-2			
2	a	Using Mason's gain formula, find the gain of the system shown in Fig. 	8	CO2	L3
	b	Define the follwing terms with respect SFG (i) Input node (ii) output node (iii) loop (iv) forward path	4	CO2	L2
	c	Reduce the block diagram shown in Fig.Q2(c) using reduction rules and obtain C(s)/R(s). 	8	CO2	L3

		OR			
	a	Using Mason's gain formula, find the gain of the system shown in Fig.  	10		
	b	Obtain C(s)/R(s) for the block diagram shown in below Fig using block diagram reduction techniques.  	10		
		MODULE-3			
3	a	Obtain an expression for time response of the first order system subjected to unit step input.	6	CO3	L3
	b	Explain proportional + integral + differential controller and their effect on stability.	7	CO3	L3
	c	A unity feedback system is characterized by an open loop transfer function $G(s) = K/ (s(s+10))$. Determine the gain K so that system will have a damping ratio of 0.5. For this value of K,find settling time (2% criterion), peak overshoot and time to peak overshoot for a unit step input.	7	CO3	L3
		OR		CO	L
	a	With a neat sketch explain all the time domain specifications.	12	CO4	L3
	b	For the system shown in Fig. Determine the value of 'a' which gives damping factor 0.7. What is the steady state error to unit ramp input for value of 'a'.  	8	CO4	L3
		MODULE-4			
4	a	The open loop transfer function of a system is $G(s) = K / (s(1 + 0.5s)(1 + 0.2s))$ using Bode plot. Find K so that : i) Gain margin is 6dB ii) Phase margin is 25°.	10	CO4	L3

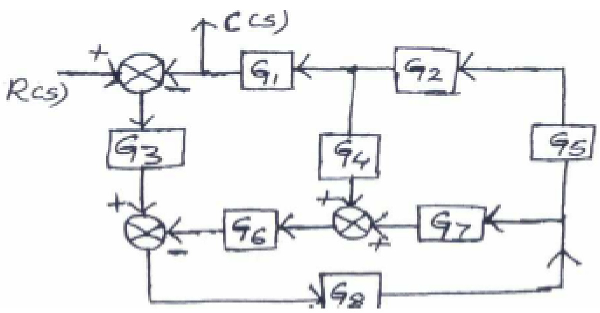
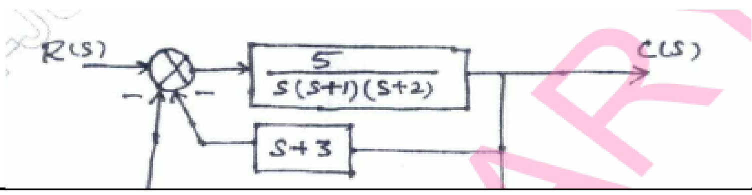
	b	List the advantages of Root Locus method.	3	CO4	L2
	c	Using RH criterion determine the stability of the system having the characteristic equation $s^6 + 2s^5 + 5s^4 + 8s^3 + 8s^2 + 8s + 4 = 0$.	7	CO4	L2
		OR			
	a	The open loop transfer function of a control system is given by $$G(s) = \frac{k}{s(s+2)(s^2+6s+2s)}.$$ Sketch the complete root locus as k is varied from zero to infinity.	10	CO4	L2
	b	The open loop transfer function of a control system is $G(s)H(s) = 1/(s^2+s+2)$. Sketch the Bode plot and analyze the gain margin and phase margin.	10	CO4	L3
		MODULE-5			
5	a	Find the transfer function of the system having state model. $$\dot{X} = \begin{bmatrix} 0 & 1 \\ -2 & -3 \end{bmatrix}\begin{bmatrix} x_1 \\ x_2 \end{bmatrix} + \begin{bmatrix} 0 \\ 1 \end{bmatrix}u \text{ and } y = \begin{bmatrix} 1 & 0 \end{bmatrix}\begin{bmatrix} x_1 \\ x_2 \end{bmatrix}$$	10	CO5	L3
	b	Consider the circuit of Fig. Identify suitable state variables and write its state vector matrix equation. Note that there are two inputs. 	10	CO10	L3
		OR			
	a	Find the state-tarannsition matrix for $$A = \begin{bmatrix} 0 & -1 \\ +2 & -3 \end{bmatrix}.$$	8	CO5	L3
	b	A single input single output system has the state and output equations $$\dot{x} = \begin{bmatrix} 0 & 1 \\ -6 & -5 \end{bmatrix}x + \begin{bmatrix} 0 \\ 1 \end{bmatrix}r$$ $$y = \begin{bmatrix} 5 & 0 \end{bmatrix}x$$ i) Determine its transfer function (ii) Find its state transition matrix.	12	CO5	L3

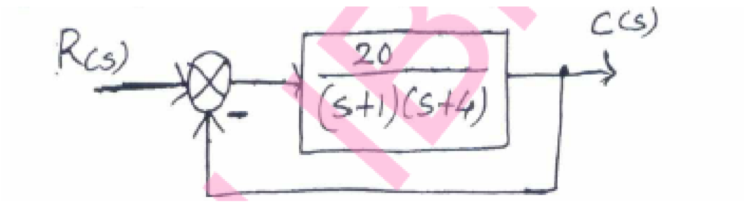
2. SEE Important Questions

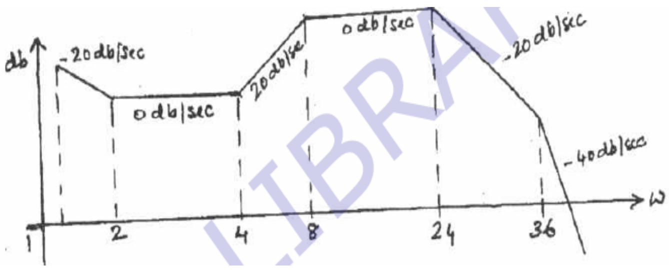
Course:						Month / Year	
Crs Code:	1	Sem:		Marks:		Time:	

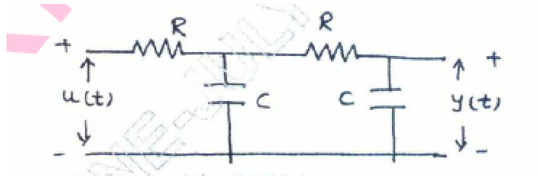
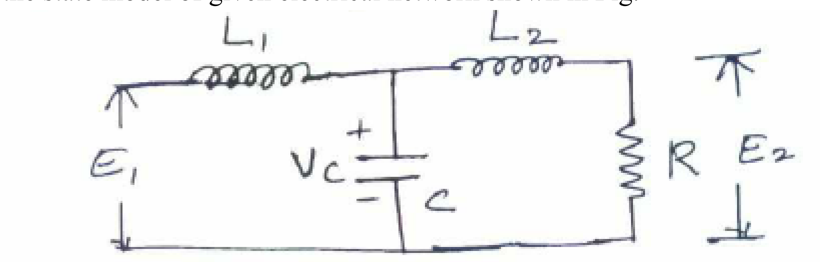
	Note	Answer all FIVE full questions. All questions carry equal marks.	-	-	
Module	Qno.	Important Question	**Marks**	**CO**	**Year**
1	1	For the mechanical system shown in below Fig. (i)Obtain its mathematical model .(ii)Write the performance equation (iii)Obtain its Force-Voltage and Force-current analogous circuits 	10	CO1	
	2	Distinguish closed loop control system from open loop control system with suitable examples.	10	CO1	
	3	Obtain the transfer function of the system shown in below Fig. 	10	CO1	
	4	Explain linear and non-linear control system.	10	CO1	
	5	For the mechanical system shown in Fig.Q1(b): i) Draw the mechanical network. ii) Obtain equations of motion. H.) Draw an electrical network based on force current analogy. 	10	CO1	
	6	For the circuit shown in below Fig 'IC' is the gain of an ideal amplifier. Determine the transfer function I(s) / V (s) 	10	CO1	
	7	For the circuit shown in below Fig 'IC' is the gain of an ideal amplifier. Determine the transfer function I(s) / V (s) 	10	CO1	

2	8	ApplyBlock diagram reduction technique to find the transfer function C(S)/ R(s) for the system shown	10	CO2	
	9	Apply Block diagram reduction technique to find the transfer function C(S)/ R(s) for the system shown	10	CO2	
	10	Apply Mason’s Gain formula to find the transfer function for the signal flow graph shown	10	CO2	
	11	Construct the signal flow graph for the block diagram shown Find the transfer function using Mason’s gain formula.	10	CO2	

	12	Construct the block diagram for the signal flow shown in Fig 14 and find the transfer function using block diagram reduction technique. Verify the answer using Mason's gain formula.	10	CO2	
	13	Construct the signal flow graph for the electrical network shown in Fig and find the transfer function. Also verify the answer using block diagram reduction technique	10	CO2	
	14	Obtain C(s)/R(s) for the block diagram shown in below Fig using block diagram reduction techniques. 	10	CO2	
3	15	For the system shown in Fig. Find the : i) system type ii) static error constants kp, k_v and ka and iii) the steady state error for an input r(t) = 3 + 2t. 	10	CO3	

	16	Find the step-response, C(t) for the system described by $C(s) / R(s) = 4/ (S+ 4)$ Also find the time constant, rise time and settling time.	10	CO3	
	17	Write short notes on PI controller.	10	CO3	
	18	Derive the expression for unit step response for 1st order control system with closed loop transfer function $K/(S+1/t)$	10	CO3	
	19	Derive the expression for unit step response for 2^{nd} order control system with closed loop transfer function $K/(S+1/t)$	10	CO3	
	20	Write short notes on PD controller.	10	CO3	
	21	List the standard test inputs used in control system and write their Laplace transform.	10	CO3	
	22	Find Kp, Kv, Ka and steady state error for a system with open loop transfer function as $G(s) / H(s) = (10(s + 2)(s + 3)) / (s(s +1)(s + 4)(s + 5))$ where the input is $r(t) = 3 + t + t^2$.	10	CO3	
	23	For the system shown in Fig, obtain closed loop transfer function, damping ratio natural frequency and expression for the output response if subjected to unit step input. 	10	CO3	
	24	Define rise time and maximum overshoot and write their formula.	10	CO3	
	25	For a given system $G(s) / H(s) = 2 K / (s (s + 2)(s + 3))$. Find the value of K to limit steady state error to 10 when input to system is $1+10t + 20t^2$.	10	CO3	
	26	For a unity feedback control system with $G(s) = 64/ (s(s + 9.6))$ Write the output response to a unit step input. Determine: i) The response at t = 0.1 sec. ii) Settling time for ± 2% of steady state.	10	CO3	
	27	A control system with open loop transfer function K(S+2)/(S2+10S+20) produces 20% steady state error with unit step input. Determine the value of constant K.	10	CO3	
	28	Derive the expression for unit step response for 1st order control system with closed loop transfer function $K/(S+1/t)$	10	CO3	
	29	Derive the expression for unit step response for 2^{nd} order control system with closed loop transfer function $K/(S+1/t)$	10	CO3	
4	30	Determine the ranges of K such that the characteristic equation : $S^3 +3(K + 1)S^2 + (7K + 5)S + (4K + 7) = 0$, has roots more negative than S = -1.	10	CO4	
	31	Find the range of K for which the system with closed loop transfer function $K / (S(S+2)(S^2+ S+1))$ is stable. For what value of K the system oscillates and what is the corresponding frequency of oscillation.	10	CO4	
	32	The open loop transfer function of a feedback control system is given by $K/(S(S+2)(S+1))$. Construct the root locus and find the range of K for which the closed loop system is stable. .	10	CO4	
	33	Check the;&ability of the given characteristic equation using Routh's method.$S^6 + 2S^5 + 8S^4 + 12S^3 + 20S^2 + 16S + 16 = 0$.	10	CO4	
	34	Mention few limitations of Routh's criterion	10	CO4	
	35	Construct the root locus of a control system with characteristic equation (S2+2S+2) + K(S+4)=0. Determine the stability of the closed loop system. Show that a part of root locus is a circle of radius √10 units with centre at	10	CO4	

		(-4, 0).			
	36	Sketch the complete root locus of system having, $G(s) = K / (S(S+1)(S+2)(S+3))$	10	CO4	
	37	Consider the system with G(S)H(S) = . K / (S (S -1)(S+ 4)) Find whether S = —2 point is on root locus or not using angle condition.	10	CO4	
	38	Sketch the root locus plot for a negative feedback control system whose open loop transfer function is given by $G(s)H(s) = K / (s(s+3)(s^2 + 2s + 2))$ for all values of K ranging from 0 to infinity. Also find the value of K for a damping ratio of 0.5	10	CO4	
	39	Sketch the rough nature of the root locus of a certain control system whose C.E is given by $s^3 + 9s^2 + Ks + K = 0$, comment on the stability.	10	CO4	
	40	Explain Rouths-Harwitz stability criterion.	10	CO4	
	41	$s^6 + 4s^5 + 3s^4 — 16s^2 — 64s — 48 = 0$. Find the number of roots of this equation real part, zero real part and negative real part using RH criterion.	10	CO4	
	42	The open loop transfer function of a system is G(s) = K/ (s (1+ s)(1+ 0.1s)) Determine the values of K such that (i) gain margin = 10 dB ii) phase margin = 24°. Use Bode plot.	10	CO4	
	43	Derive the expression for resonant peak 'Mr' and corresponding resonant frequency `Wr' for a second—order under-damped system in frequency response analysis.	10	CO4	
	44	Sketch the Nyquist plot for a system with the open-loop transfer function : G(s)H(s) = (k (1+ 0.5s)(1 + s)) / ((1 + 10s)(s —1)) . Determine the range of values of 'K' for which the system is stable.	10	CO4	
	45	Explain Nyquist stability criteria	10	CO4	
	46	For a closed loop control system G(s) = 100 / (s (s+8), H(s) = 1. Determine the resonant peak and resonant frequency.	10	CO4	
	47	Explain lag-lead compensator network and briefly discuss the effects of lead-lag compensator.	10	CO4	
	48	Using Nyquist stability criterion, find the closed loop stability of a negative feedback control system whose open-loop transfer function is given by G(s)H(s) = 5 /(s(s —1))	10	CO4	
	49	For a unity feedback system $G(s) = 242((s+5))/ (s(s+1)(s^2 + 5s + 121))$ Sketch the bode plot and find gain crossover freq,phase crossover freq, gain margin and phase margin.	10	CO4	
	50	Construct the Bode plot for the system with open loop transfer function $\frac{K}{S(S+1)(1+0.1S)}$ Determine the value of K such that (a) gain margin = 10db (b) Phase margin = 500.	10	CO4	
	51	Determine the transfer function of a system whose asymptotic Bode plot is as shown in fig 	10	CO4	
5	52	Find the state-tarannsition matrix for $A = \begin{bmatrix} 0 & -1 \\ +2 & -3 \end{bmatrix}$.	10	CO5	
	53	Obtain an appropriate state model for a system re mented by an electric circuit as shown in below Fig.	10	CO4	

					
	54	linear time invariant system is characterized by the homogeneous state equation $$\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \end{bmatrix} = \begin{bmatrix} 1 & 0 \\ 1 & 1 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix}$$ Compute the solution of homogeneous equation, assume the initial state vector. $$X_0 = \begin{bmatrix} 1 \\ 0 \end{bmatrix}.$$	10	CO4	
	55	State the properties of state transition matrix.	10	CO4	
	56	Find the transfer function of the system having state model. $$\dot{X} = \begin{bmatrix} 0 & 1 \\ -2 & -3 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} + \begin{bmatrix} 0 \\ 1 \end{bmatrix} u \quad \text{and} \quad y = \begin{bmatrix} 1 & 0 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix}$$	10	CO4	
	57	Obtain the state model for the system represented by the differential equation $$\frac{d^3y(t)}{dt^3} + 6\frac{d^2y(t)}{dt^2} + 11\frac{dy(t)}{dt} + 10y(t)$$		CO4	
	58	Obtain the state model of given electrical network shown in Fig. 		CO4	
	59	Find the state transition matrix for $$A = \begin{bmatrix} 0 & -1 \\ 2 & -3 \end{bmatrix}.$$		CO4	
	60	single input single output system has the state and output equations i) Determine its transfer function (ii) Find its state transition matrix. $$\dot{x} = \begin{bmatrix} 0 & 1 \\ -6 & -5 \end{bmatrix} x + \begin{bmatrix} 0 \\ 1 \end{bmatrix} r$$ $$y = \begin{bmatrix} 5 & 0 \end{bmatrix} x$$		CO4	
	61	Draw polar plot of G(s)H(s) = 100/ (s^2 +10S+100)	**10**	CO5	
	62	Draw the polar plot for the following open-loop transfer function G(S)H(S) = 1/ (1+ 0.1s)	**10**	CO5	

	63	Sketch the Nyquist plot for a system with the open-loop transfer function : $G(s)H(s) = (k\ (1+ 0.5s)(1 + s)) / ((1 + 10s)(s - 1))$. Determine the range of values of 'K' for which the system is stable.	**10**	CO5	
	64	Explain Nyquist stability criteria	**10**	CO5	
	65	Using Nyquist stability criterion, find the closed loop stability of a negative feedback control system whose open-loop transfer function is given by $G(s)H(s) = 5 /(s(s - 1))$	**10**	CO5	

Course Outcome Computation

Academic Year:

Odd / Even semester

INTERNAL TEST Course Outcome QUESTION NO	**T1**	**T2**	**T3**
MAX MARKS			
USN-1			
USN-2			
USN-3			
USN-4			
USN-5			
USN-6			
Average CO Attainment			

LV Threshold : 3:>60%, 2:>=50% and <=60%, 1: <=49%

CO1 Computation :(2+2+2+3)/4 = 10/4=2.5

PO Computation

Program Outcome	PO1	PO3	PO3	PO1	PO12	PO12	PO6	PO1
Weight of CO - PO	3	1	3	2	2	3	3	1
Course Outcome								CO8
Test/Quiz/Lab	T1			T2			T3	
QUESTION NO								
MAX MARKS								
USN-1								
USN-2								
USN-3								
USN-4								
USN-5								
USN-6								
Average CO Attainment								