SRM VALLIAMMAI ENGINEERING COLLEGE
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DEPARTMENT OF
ELECTRONICS AND COMMUNICATION ENGINEERING

QUESTION BANK

III SEMESTER

1905009 –CONTROL SYSTEMS ENGINEERING

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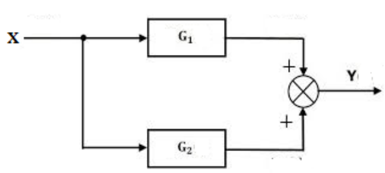
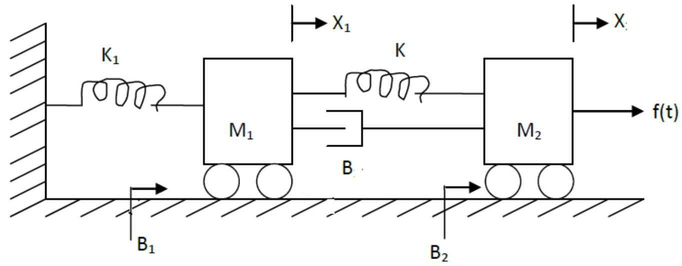
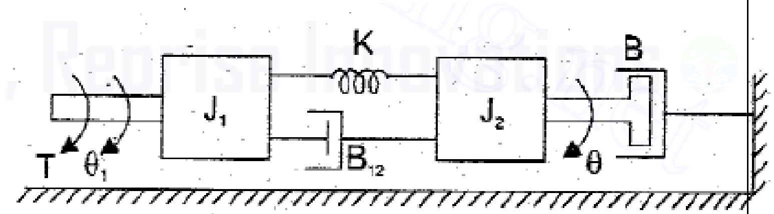
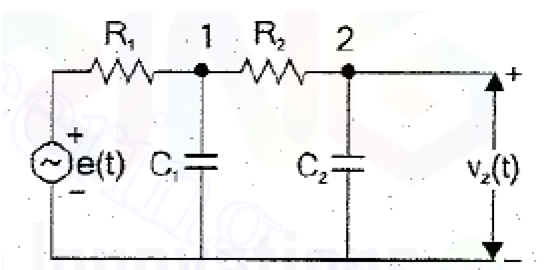
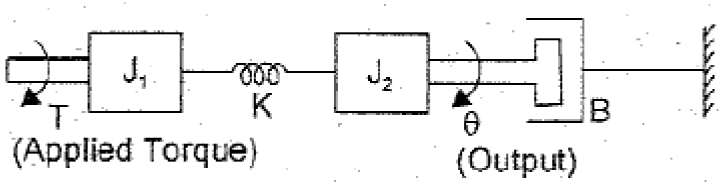
UNIT I SYSTEMS COMPONENTS AND THEIR REPRESENTATION

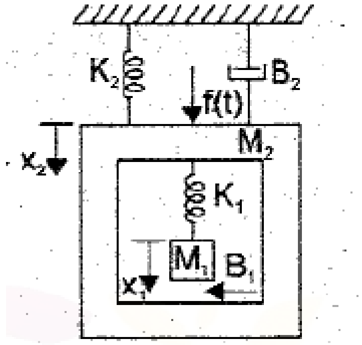
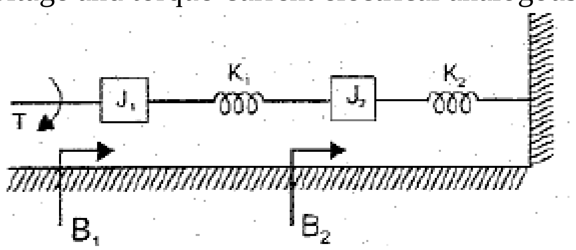
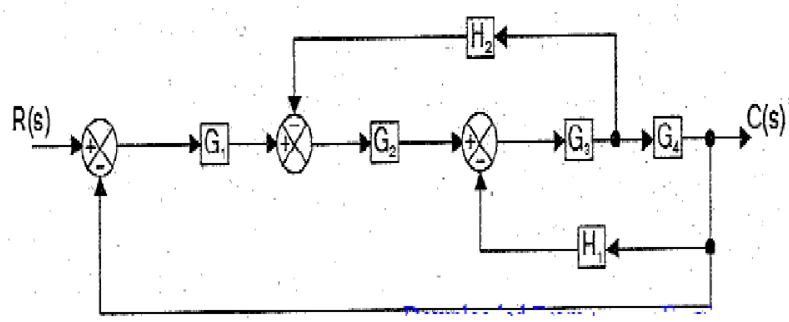
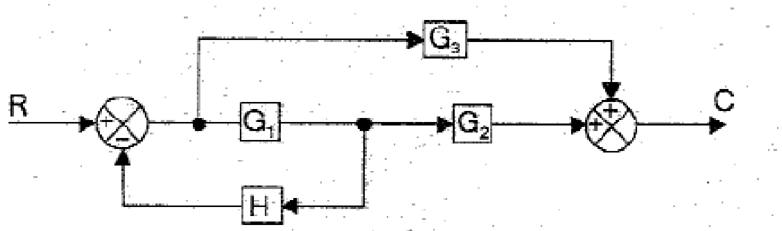
Control System : Terminology and Basic Structure-Open loop and Closed Loop Systems- Feed forward and Feedback control theory- Electrical and Mechanical Transfer Function Models-Block diagram Models-Signal flow graphs models-DC and AC servo Systems- Synchros -Multivariable control system.

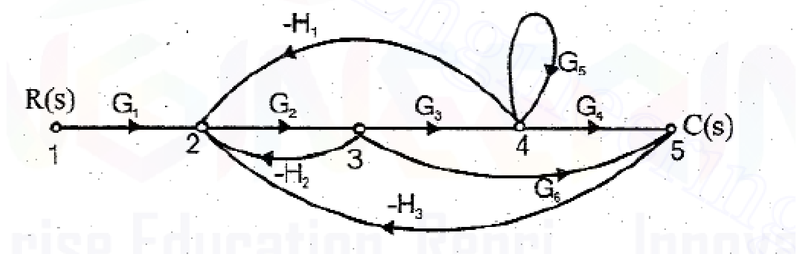
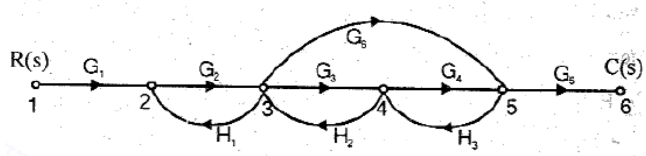
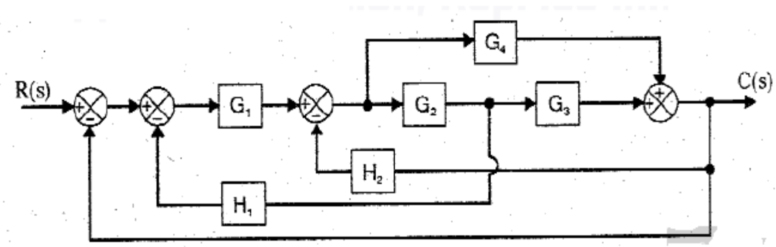
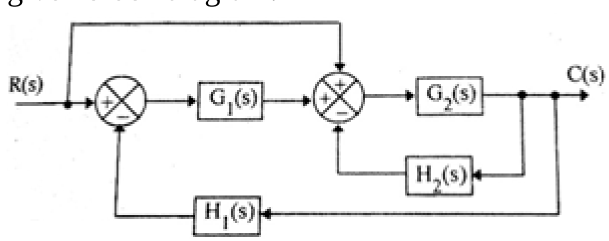
PART - A

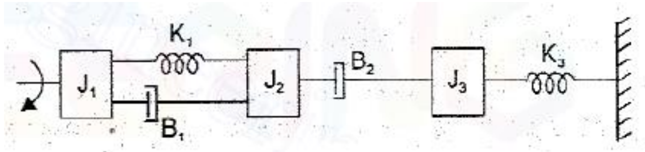
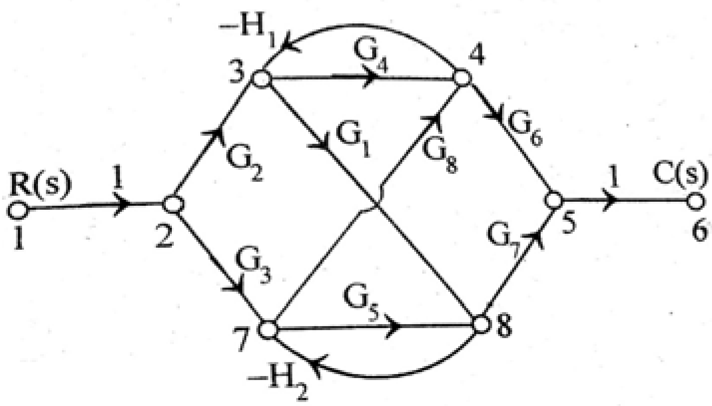
Q.No.	Questions	BT Level	Competence
1.	Define control system.	BTL1	Remembering
2.	What is feedback? What type of feedback is preferred for control system?	BTL1	Remembering
3.	Distinguish between open loop and closed loop system.	BTL 4	Analyzing
4.	Construct the block diagram for closed loop control system.	BTL 6	Creating
5.	Narrate about time invariant system.	BTL1	Remembering
6.	Express the transfer function of a control system.	BTL 2	Understanding
7.	Mention the basic elements of the translational mechanical system.	BTL1	Remembering
8.	Illustrate the Force Current analogy of a translational mechanical system.	BTL 2	Understanding
9.	Observe the ideal spring in a control system and write the force balance equation.	BTL 5	Evaluating
10.	Outline the characteristics of the block diagram in the control system, mention the components of the block diagram.	BTL1	Remembering
11.	Interpret how the signal flow graph is used to represent a control system.	BTL 3	Applying
12.	List the properties of signal flow graph.	BTL 3	Applying
13.	Demonstrate loop and non-touching loops.	BTL 2	Understanding
14.	Write the Mason’s Gain formula	BTL1	Remembering
15.	Apply the block diagram reduction rule to combine the feed forward paths. 	BTL 3	Applying
16.	Enumerate the features of a servo motor.	BTL 4	Analyzing
17.	Compare AC and DC servo motor.	BTL 4	Analyzing
18.	Summarize the working principle of synchros.	BTL 5	Evaluating
19.	Examine and narrate the null position in synchro.	BTL 2	Understanding
20.	Generalize the concept of multi variable control system	BTL 6	Creating

PART –B

1.	(i)	Write the differential equations governing the mechanical system 	(7)	BTL1	Remembering
	(ii)	Determine the transfer function for the system described in (i)	(6)		
2.	(i)	Formulate the differential equation defining the mechanical rotational system given below 	(7)	BTL 6	Creating
	(ii)	Derive the transfer function for the system given above.	(6)		
3.	Examine the given electrical network and deduce the transfer function. 		(13)	BTL 2	Understanding
4.	(i)	Exhibit the mechanical rotational system with an appropriate differential equations 	(7)	BTL 3	Applying
	(ii)	Interpret the transfer function of the system shown in the above section(i)	(6)		

5.	Illustrate the mechanical system with the Force Voltage and Force Current electrical analogous circuit.  	(13)	BTL 2	Understanding
6.	Demonstrate the given mechanical rotational system with torque-voltage and torque-current electrical analogous circuits.  	(13)	BTL 2	Understanding
7.	(i) State the block diagram reduction rules with example.	(7)	BTL1	Remembering
	(ii) Mention in detail about any five terminologies used in signal flow graph	(6)		
8.	Evaluate the transfer function C(s)/R(s) for the given system  	(13)	BTL 5	Evaluating
9.	Deduce the transfer function C/R for the given system  	(13)	BTL 4	Analyzing

10.	Apply Masons gain formula to determine the transfer function of the given signal flow graph 		(13)	BTL 3	Applying
11.	(i)	The signal flow graph of the closed loop feedback system is show below, Determine the closed loop transfer function. 	(10)	BTL1	Remembering
	(ii)	Draw the block diagram representation for the above system.	(3)		
12.	Interpret the transfer function by converting the block diagram into signal flow graph. 		(13)	BTL 4	Analyzing
13.	Classify the DC Servomotor and explain in detail with an appropriate example.		(13)	BTL 4	Analyzing
14.	(i)	Describe the working of AC servomotor in control systems	(10)	BTL1	Remembering
	(ii)	Write the advantages of AC servomotor.	(3)		
		PART –C			
1.	Evaluate the transfer function of the system by reducing the given block diagram. 		(15)	BTL 5	Evaluating

2.	Devise a torque-voltage, torque-current analogous circuit and verify it by writing mesh and node equations.  		BTL 6	Creating
	(i) Devise a torque-voltage analogous circuit verify it by writing mesh and node equations	(7)		
	(ii) Devise a torque-current analogous circuit verify it by writing mesh and node equations	(8)		
3.	Using the mason's gain formula formulate the gain of the following system:  	(15)	BTL 6	Creating
4.	Assess the synchro pair operation and evaluate how synchro can be used as an error detector	(15)	BTL 5	Evaluating

UNIT II TIME REPONSE ANALYSIS

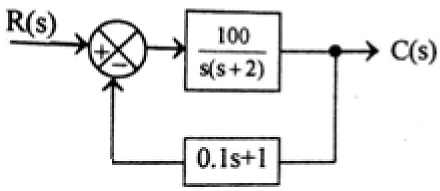
Transient response-steady state response-Measures of performance of the standard first order and second order system-effect on an additional zero and an additional pole-steady error constant and system- type number-PID control-Analytical design for PD,PI,PID control systems.

PART – A

Q.No	Questions	BT Level	Competence
1.	What is time response?	BTL 1	Remembering
2.	Name the test signals used in control system.	BTL 1	Remembering
3.	Interpret the importance of test signal.	BTL 2	Understanding
4.	Distinguish between the order and type of system	BTL 4	Analyzing
5.	Point out the different time domain specifications.	BTL 1	Remembering
6.	Explain how the system is classified by applying the value of damping?	BTL 3	Applying
7.	Define pole and zero of a function F(s).	BTL 1	Remembering

8.	Illustrate peak overshoot.	BTL 2	Understanding
9.	Assess the significance of rise time.	BTL 5	Evaluating
10.	Estimate the damped frequency of oscillation for a second order system which has a damping ratio of 0.6 and natural frequency of oscillation is 10	BTL 5	Evaluating
11.	Examine the impact of steady state error in a control system.	BTL 4	Analyzing
12.	A unity feedback system has an open loop transfer function of $G(s) = \frac{10}{(s+1)(s+2)}$. Formulate the steady state error for unit step input.	BTL 6	Creating
13.	Exhibit the damped frequency of oscillation in a control system.	BTL 3	Applying
14.	Solve for the type and order of the system $G(s)H(s) = \frac{(s+4)}{(s-2)(s+0.25)}$	BTL 6	Creating
15.	How did the type number of a system is identified? Mention its significance.	BTL 1	Remembering
16.	Enumerate the advantage and drawback of integral control action.	BTL 4	Analyzing
17.	Express the transfer functions of PI and PID controllers.	BTL 2	Understanding
18.	Why derivative controller is not used separately in control applications?	BTL 2	Understanding
19.	Deduce the effect of PI controller on system performance.	BTL 3	Applying
20.	Write the relation between generalized and static error coefficients.	BTL 1	Remembering

PART –B					
1.	Analyze the response of a closed loop first order system for a unit step input. Plot the response of the system.		(13)	BTL 4	Analyzing
2.	(i)	Name the various standard test signals?	(3)	BTL 1	Remembering
	(ii)	Draw the characteristics diagram and obtain the mathematical representation of the test signals	(10)		
3.	Summarize the response of undamped second order system for unit step input.		(13)	BTL 5	Evaluating
4.	Obtain the response of unity feedback system whose open loop transfer function is G(s) = 4/[S(S+5)] and when the input is unit step.		(13)	BTL 1	Remembering
5.	The unity feedback system is characterized by an open loop transfer function G(s) = K/[S(S+10)].			BTL 3	Applying
	(i)	Examine the gain K , so that the system will have a damping ratio of 0.5 for this value of K.	(7)		
	(ii)	Examine peak overshoot for a unit step input.	(6)		
6.	The open loop transfer function of a unity feedback system is given by G(s) = K/[S(ST + 1)], where K and T are positive constant. Deduce by what factor the amplifier gain K should be reduced, so that the peak overshoot of unit step response of the system is reduced from 75% to 25%.		(13)	BTL 4	Analyzing

7.	(i)	Illustrate how the type number of a control system is identified.	(7)	BTL 2	Understanding
	(ii)	Describe about the order of the system.	(6)		
8.		Formulate the expression for steady state error by applying Final value theorem.	(13)	BTL 3	Applying
9.		For a unity feedback control system, the open loop transfer function is $(s) = \frac{10(s+2)}{s^2(s+1)}$		BTL 4	Analyzing
	(i)	Find the position, velocity, acceleration error constants.	(7)		
	(ii)	Compute the steady state error when the input is R(s) where $(s) = R(s) = \frac{3}{s} - \frac{2}{s^2} + \frac{1}{3s^3}$	(6)		
10.		A positional control system with velocity feedback is shown. Discuss the response of the system for unit step input 	(13)	BTL 1	Remembering
11.		Derive the expression for Kp,Kv, and Ka for Type 0,1 and 2 systems when the input is unit step, ramp and parabola.	(13)	BTL 2	Understanding
12.	(i)	The open loop transfer function of a servo system with unity feedback is $G(s) = \frac{10}{s(0.1s+1)}$. Determine the static error constants of the system.	(9)	BTL 2	Understanding
	(ii)	Discuss the effect on an additional zero and an additional pole on a system.	(4)		
13.		For the given open loop transfer function G(s) for servomechanism, interpret what type of input signal give rise to a constant steady state error and calculate the value. $G(s) = \frac{10}{s^2(s+1)(s+2)}$	(13)	BTL 6	Creating
14.		With suitable block diagrams and equations, explain the different types of controllers employed in control systems.	(13)	BTL 1	Remembering
		PART - C			
1.		A unity feedback system has the forward transfer function $$G(s) = \frac{K(2s+1)}{s(5s+1)(1+s)^2}$$ When the input is r(t) = 1+6t, Evaluate the minimum value of K so that the steady state error is less than 0.1	(15)	BTL 5	Evaluating

2.	Measurements conducted on a servo mechanism show that the system response to be $C(t) = 1 + 0.2e^{-60t} - 1.2e^{-10t}$ when subjected to a unit step input.		BTL 6	Creating
	(i) Obtain an expression for closed loop transfer function	(8)		
	(ii) Compute the undamped natural frequency and damping ratio	(7)		
3.	Consider a unity feedback system with a closed loop transfer $C(s)/R(s) = (Ks+b)/(s^2 + as + b)$. Determine the open loop transfer function G(s). Show that steady state error with unit ramp input is given by (a-k)/b	(15)	BTL 6	Creating
4.	Generalize the effects of P, PI and PID controllers on the system dynamics.	(15)	BTL 5	Evaluating

UNIT III FREQUENCY RESPONSE AND SYSTEM ANALYSIS

Closed loop frequency response-Performance specification in frequency domain-Frequency response of standard second order system - Bode Plot - Polar Plot - Nyquist plots-Design of compensators using Bode plots-Cascade lead compensation-Cascade lag compensation-Cascade lag - lead compensation

PART - A

Q.No.	Questions	BT Level	Competence
1.	Derive the transfer function of a lead compensator network.	BTL 6	Creating
2.	Define Phase margin & gain margin.	BTL 2	Remembering
3.	Illustrate the need for compensation.	BTL 3	Applying
4.	What is meant by frequency response?	BTL 1	Remembering
5.	Describe Lag-Lead compensation.	BTL 2	Understanding
6.	Evaluate the shape of polar plot for the open loop transfer function $G(s)H(s) = 1/(s(1+Ts))$	BTL 5	Evaluating
7.	Why frequency domain analysis is needed?	BTL 1	Remembering
8.	List the advantages of Frequency Response Analysis.	BTL 2	Understanding
9.	Write about gain crossover Frequency.	BTL 1	Remembering
10.	State the significance of Nichol's plot.	BTL 2	Understanding
11.	Demonstrate the correlation between time and frequency response.	BTL 3	Applying
12.	Explain compensators and list types of compensators.	BTL 4	Analyzing
13.	Formulate the transfer function of a lead compensator network.	BTL 6	Creating
14.	Summarize about minimum phase system?	BTL 1	Remembering
15.	Discuss about the corner frequency in frequency response analysis?	BTL 2	Understanding
16.	Draw the circuit of lead compensator and draw its pole zero diagram.	BTL 1	Remembering
17.	Frame the specifications required for frequency domain analysis?	BTL 3	Applying
18.	Compare series compensator and feedback compensator	BTL 4	Analyzing
19.	Determine the phase angle of the given transfer function	BTL 5	Evaluating

	$G(s)=10/[s(1+0.4 s)(1+ 0.1s)]$		
20.	Analyze the correlation between the time and frequency response.	BTL 4	Analyzing

	PART –B				
1.	(i)	Enumerate the procedure for magnitude plot of Bode plot.	(7)	BTL 1	Remembering
	(ii)	Find out the procedure for phase plot of bode plot.	(6)		
2.	(i)	Calculate the system gain K by sketching the magnitude plot of Bode plot for the transfer function $G(S) = KS^2/[(1+0.2S)\ (1+0.02S)]$ with gain cross over frequency of 5rad/sec.	(7)	BTL 3	Applying
	(ii)	Obtain the Phase plot for the above transfer function.	(6)		
3.	Sketch the bode plot for the transfer function $G(S) = 75(1+0.2S)/[S(S^2+16S+100)]$ and determine phase margin and gain margin.		(13)	BTL 2	Understanding
4.	Analyze the bode plot for the function given by $G(S) =5(1+2S)/[(1+4S)(1+0.25S)]$.		(13)	BTL 4	Analyzing
5.	Obtain the polar plot for the following systems (i)Type - 0, Order - 3 (ii) Type - 2, Order - 4		(7) (6)	BTL 2	Understanding
6.	(i)	Evaluate open loop transfer function of a unity feedback system given by $G(S) = 1/[S(1+S)(1+2S)]$. Sketch the polar plot.	(9)	BTL 5	Evaluating
	(ii)	Evaluate the gain and phase margin for the above system.	(4)		
7.	(i)	Report on the polar plot of an open loop transfer function of a unity feedback system given by $G(S) =1/[S^2(1+S)(1+2S)]$. Sketch the polar plot .	(9)	BTL 2	Understanding
	(ii)	Determine the gain and phase margin for the above system.	(4)		
8.	Interpret the phase margin by sketching the polar plot of a unity feedback system given by $G(S)=(1+0.2S)(1+0.025S)/[S^2 (1+0.005S)\ (1+0.001S)]$		(13)	BTL 3	Applying
9.	Explain the need for compensator and give its types with circuit details.		(13)	BTL 1	Remembering
10.	Write down the procedure for designing lag compensator using bode plot.		(13)	BTL 1	Remembering
11.	Construct a suitable lag compensator so that phase margin is 40^o and the steady state error for ramp input is less than or equal to 0.2 for a unity feedback system having an open loop transfer function of $G(S) = K/[S\ (1+2S)]$.		(13)	BTL 6	Creating
12.	Write down the procedure for designing lead compensator using bode plot.		(13)	BTL 1	Remembering

13.	Analyze a phase lead compensator for the system G(S) = K/[S (S+1)] to satisfy the phase margin ≥ 45^o,steady state error for a unit ramp input ≤ 1/15 and gain crossover frequency < 7.5 rad/sec.	(13)	BTL 4	Analyzing
14.	Examine a lag-lead compensator to meet velocity error constant of 80 and phase margin γ ≥ 35^o for a unity feedback system whose transfer function is G(S) = K/[S (S+3) (S+6)].	(13)	BTL 4	Analyzing
	PART –C			
1.	Determine the gain margin equal to 2dB and phase margin equal to 45^o for G(S)= $Ke^{-0.2S}$/[S(S+2)(S+8)].	(15)	BTL 5	Evaluating
2.	(i) Consider a unity feedback system having an open loop transfer function G(S) = K/[S(1+0.2S)(1+0.05S)]. Evaluate the Value of K by polar plot for gain margin=18dB and phase margin is 60^0.	(11)	BTL 5	Evaluating
	(ii) For the gain value of K=10, find the gain margin and phase margin for the above system.	(4)		
3.	Construct a phase lag series compensator for a open loop transfer function of certain unity feedback control system given by G(S) = K/[S(S+4)(S+80)].It is desired to have phase margin to be at least 33^o and the velocity error constant K_V =30 Sec^{-1}.	(15)	BTL 6	Creating
4.	Design a lead compensator for a unity feedback system with open loop transfer function, G(S) = K/[S(S+1)(S+5)] to satisfy velocity error constant ≥ 50 and phase margin ≥ 20^o.	(15)	BTL 6	Creating

UNIT IV CONCEPTS OF STABILITY ANALYSIS

Concept of stability-Bounded - Input Bounded- Output stability-Routh stability criterion-Relative stability - Root locus concept-Guidelines for sketching root locus - Nyquist stability criterion.

PART – A

Q.No	Questions	BT Level	Competence
1.	What is characteristic equation?	BTL 1	Remembering
2.	Quote BIBO stability criterion.	BTL 2	Understanding
3.	State Routh's criterion for stability.	BTL 1	Remembering
4.	Write the necessary and sufficient condition for stability.	BTL 6	Creating
5.	List the advantages of Routh Hurwitz stability criterion?	BTL 1	Remembering
6.	Give any two limitations of Routh stability criterion.	BTL 2	Understanding
7.	Find the range of K for stability of a closed loop system with characteristic equations $S^4+8S^3+36S^2+80S+K=0$ using Routh stability criterion.	BTL 5	Evaluating

8.	Point out the main objective of root locus analysis technique.	BTL 4	Analyzing
9.	Interpret the relationship between roots of characteristic equation and stability.	BTL 3	Applying
10.	Identify the meaning of relative stability.	BTL 1	Remembering
11.	Examine dominant pole location in s-plane and its significance.	BTL 4	Analyzing
12.	Evaluate the effects of adding a zero to a system?	BTL 5	Applying
13.	How centroid of the asymptotes found in root locus technique?	BTL 4	Analyzing
14.	How will you find root locus on real axis?	BTL 4	Analyzing
15.	Illustrate the effects of adding open loop poles and zeros on the nature of the root locus and on system?	BTL 3	Applying
16.	Predict about the stability of the system when the roots of the characteristic equation are lying on imaginary axis?	BTL 2	Understanding
17.	Is addition of a pole will make a system more stable? Justify your answer.	BTL 2	Understanding
18.	State Nyquist stability criterion.	BTL 1	Remembering
19.	The Nyquist plot of G (jω)H(jω) for a closed loop control system, passes through (-1,j0) point in the GH plane. What is the gain margin of the system in dB?	BTL 3	Applying
20.	Formulate the advantages of Nyquist stability criterion over that of Routh criterion.	BTL 6	Creating

PART –B					
1.	Explain stability and the steps to be followed for Routh-Hurwitz criterion.		(13)	BTL 1	Remembering
2.	Consider the sixth order system with the characteristic equation $S^6+2S^5+8S^4+12S^3+20S^2+16S+16 = 0$. Use Routh-Hurwitz criterion to examine the stability of the system and comment on location of the roots of the characteristics equation.		(13)	BTL 4	Analyzing
3.	Apply Routh array and determine the stability of the system represented by the characteristic equation, $S^5+S^4+2S^3+2S^2+3S+5= 0$. Comment on the location of characteristic equation.		(13)	BTL 3	Applying
4.	(i)	Evaluate the stability of the system by using Routh stability criterion for the equation $9S^5-20S^4+10S^3-S^2-9S-10 = 0$.	(9)	BTL 5	Evaluating
	(ii)	Identify the location of the roots and comment.	(4)		
5.	Determine the location of roots on S- Plane and stability for the polynomial $S^7+9S^6+24S^5+24S^4+24S^3+24S^2+23S+15=0$		(13)	BTL 4	Analyzing

6.	Examine the range of K for the stability of unity feedback system whose open loop transfer function is $G(S) = K/[S (S+1) (S+2)]$.		(13)	BTL 4	Analyzing
7.	A feedback system has open loop transfer function of $G(S) = Ke^{-S}/[S(S^2+5S+9)]$.		(13)	BTL 3	Applying
8.	(i)	Describe the concept of encircled and enclosed used to apply Nyquist criterion.	(4)	BTL 1	Remembering
	(ii)	Summarize on the relationship between the enclosure of poles and zeros by the S plane closed contour and number of encirclements of the origin of F(S) plane.	(9)		
9.	(i)	Express the mathematical preliminaries for Nyquist stability criterion.	(6)	BTL 2	Understanding
	(ii)	Write the procedure for applying Nyquist Stability Criterion.	(7)		
10.	(i)	Construct the Nyquist plot for a system whose open loop transfer function is given by $G(S) H(S) = K(1+S)^2/S^3$.	(10)	BTL 6	Creating
	(ii)	Find the range of K for stability.	(3)		
11.	Discuss briefly about the steps to be followed to construct a root locus plot of a given transfer function.		(13)	BTL 2	Understanding
12.	(i)	Identify the root locus of a unity feedback system having transfer function $G(S) = K/[S(S^2+4S+13)]$.	(10)	BTL 2	Understanding
	(ii)	Find the range of K for which the system is stable.	(3)		
13.	Sketch the root locus of the system whose open loop transfer function is $G(s)=K/[S (S+2) (S+4)]$. Find the value of K so that damping ratio of the closed loop system is 0.5.		(13)	BTL 1	Remembering
14.	The open loop transfer function of a unity feedback system $G(S) = K(S+9)/ [S(S^2+4S+11)]$, sketch the root locus of the system.		(13)	BTL 1	Remembering
	PART - C				
1.	(i)	The open loop transfer function of a unity feedback system is given by $G(S) = K/ (S+2) (S+4) (S^2+6S+25)$. By applying the Routh criterion, discuss the stability of the closed loop system as a function of K.	(8)	BTL 5	Evaluating
	(ii)	Determine the value of K of the open loop transfer function given by $G(S) = K/(S+1) (S+5) (S^2+6S+25)$, which will cause sustained oscillations in the closed loop system. Find out the corresponding oscillating frequencies.	(7)		
2.	Determine the range of K for which closed loop system is stable for the open loop transfer function $G(S) H(S)=K/[S(S+2)/(S+10)]$ by drawing the Nyquist plot.		(15)	BTL 5	Evaluating
3.	(i)	Formulate the stability of closed loop system by Nyquist stability criterion, whose open loop transfer function is given by, $G(S) H(S)=(S+2)/(S+1)(S-1)$.	(11)	BTL 6	Creating

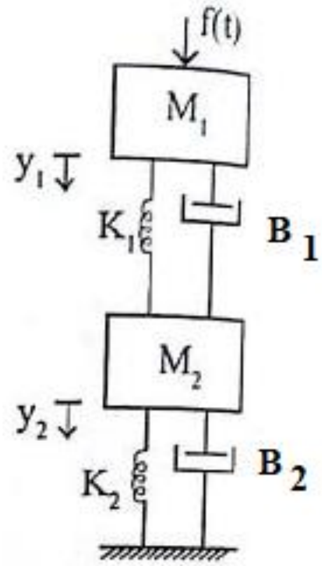
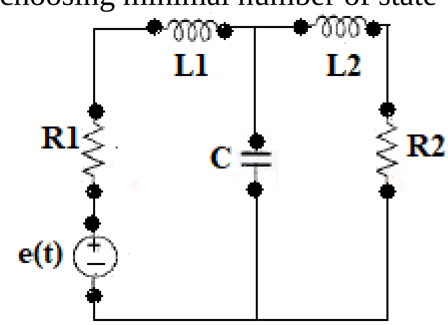
	(ii)	Comment on the stability of the open loop and closed loop system for the above mentioned open loop transfer function.	(4)		
4.	(i)	Construct the root locus of a unity feedback system whose open loop transfer is G(S) H(S)= K(S+1.5)/[S(S+1)(S+5)].	(12)	BTL 6	Creating
	(ii)	Formulate the range of K for the system to be stable.	(3)		

UNIT V CONTROL SYSTEM ANALYSIS USING STATE VARIABLE METHODS

State variable representation-Conversion of state variable models to transfer functions-Conversion of transfer functions to state variable models - Solution of state equations-Concepts of Controllability and Observability-Stability of linear systems-Equivalence between transfer function and state variable representations-State variable analysis of digital control system-Digital control design using state feedback.

PART A

Q. No	Questions	BT Level	Competence
1.	Write the state model of n^{th} order system	BTL3	Applying
2.	Analyze the basic elements used to construct the state diagram?	BTL 4	Analyzing
3.	Draw the block diagram representation of state model.	BTL 2	Understanding
4.	Mention the advantages of state space analysis?	BTL3	Applying
5.	List down the draw backs in transfer function model analysis?	BTL 4	Analyzing
6.	Illustrate the state model using the signal flow graph?	BTL 2	Understanding
7.	Define state and state variable	BTL 1	Remembering
8.	Discuss about state vector?	BTL 1	Remembering
9.	How will you analyze the controllability and observability of a system using kalman's Test?	BTL 4	Analyzing
10.	Describe about state space?	BTL 1	Remembering
11.	Summarize the disadvantages in choosing phase variable for state space modeling?	BTL 2	Understanding
12.	Outline the properties of state transition matrix?	BTL 2	Understanding
13.	State the solution of homogenous state equation	BTL 1	Remembering
14.	What do you meant by controllability?	BTL 1	Remembering
15.	Identify the difference between transfer function and state space system	BTL3	Applying
16.	Point out the state equation and output equation of the state model.	BTL 1	Remembering
17.	Develop the advantages and disadvantages in canonical form of state model	BTL 6	Creating
18.	Formulate the block diagram of the state model of a discrete time system	BTL 6	Creating
19.	Deduce the state model of n^{th} order discrete time system	BTL 5	Evaluating
20.	Evaluate the state model of a discrete time system using signal flow graph	BTL 5	Evaluating

<table>
<tr><th colspan="6">PART – B</th></tr>
<tr><td rowspan="2">1.</td><td>(i)</td><td>For the given mechanical system, write the differential equations governing the system.

</td><td>(7)</td><td rowspan="2">BTL 2</td><td rowspan="2">Understanding</td></tr>
<tr><td>(ii)</td><td>Construct the state model of the given mechanical system</td><td>(6)</td></tr>
<tr><td rowspan="2">2.</td><td>(i)</td><td>Analyze the given electrical network and write down the differential equations governing the system.</td><td>(7)</td><td rowspan="2">BTL4</td><td rowspan="2">Analyzing</td></tr>
<tr><td>(ii)</td><td>Obtain the state model of the given electrical network by choosing minimal number of state variables

</td><td>(6)</td></tr>
<tr><td rowspan="2">3.</td><td>(i)</td><td>Construct a state model for the system characterized by the differential equation
$$\frac{d^3y}{dt^3} + 6\,\frac{d^2y}{dt^2} + 11\frac{dy}{dt} + 6y + u = 0$$</td><td>(7)</td><td rowspan="2">BTL 1</td><td rowspan="2">Remembering</td></tr>
<tr><td>(ii)</td><td>Give the block diagram representation of the derived state space model</td><td>(6)</td></tr>
<tr><td>4.</td><td colspan="2">Obtain the state space representation of observable canonical form
$$\frac{Y(s)}{U(s)} = \frac{s+4}{s^2+5s+2}$$</td><td>(13)</td><td>BTL 4</td><td>Analyzing</td></tr>
</table>

5.	Write down the state space representation of controllable canonical form $$\frac{Y(s)}{U(s)} = \frac{10(s+4)}{s(s+1)(s+3)}$$	(13)	BTL 1	Remembering
6.	Deduce the canonical state model for the given transfer function $$\frac{Y(s)}{U(s)} = \frac{10(s+4)}{s(s+1)(s+3)}$$	(13)	BTL 2	Understanding
7.	Obtain the transfer function of the system defined by the following state space model $$\begin{bmatrix}\dot{x}1\\ \dot{x}2\\ \dot{x}3\end{bmatrix} = \begin{bmatrix}-2 & 1 & 0\\ 0 & -3 & 1\\ -3 & -4 & -5\end{bmatrix}\begin{bmatrix}x1\\ x2\\ x3\end{bmatrix} + \begin{bmatrix}0\\ 0\\ 1\end{bmatrix}u$$ $$y = \begin{bmatrix}0 & 1 & 0\end{bmatrix}\begin{bmatrix}x1\\ x2\\ x3\end{bmatrix}$$	(13)	BTL 1	Remembering
8.	Calculate e^{At}. If $A = \begin{bmatrix}0 & 1\\ -2 & -3\end{bmatrix}$	(13)	BTL 4	Analyzing
9.	A LTI system is characterized by homogenous state equation $$\begin{bmatrix}\dot{x}1\\ \dot{x}2\end{bmatrix} = \begin{bmatrix}1 & 0\\ 1 & 1\end{bmatrix}\begin{bmatrix}x1\\ x2\end{bmatrix}$$ Compute the solution of the homogenous equation , assuming initial state vector $X0 = \begin{bmatrix}1\\ 0\end{bmatrix}$	(13)	BTL 3	Applying
10.	A state space system is described by the following state equation $$\begin{bmatrix}\dot{x}1\\ \dot{x}2\\ \dot{x}3\end{bmatrix} = \begin{bmatrix}-1 & 0 & 0\\ 1 & -2 & 0\\ 2 & 1 & -3\end{bmatrix}\begin{bmatrix}x1\\ x2\\ x3\end{bmatrix} + \begin{bmatrix}10\\ 1\\ 0\end{bmatrix}u$$ Apply a suitable method to check whether the system is observable.	(13)	BTL 3	Applying
11.	Conduct a suitable test to check whether the system is controllable $$\begin{bmatrix}\dot{x}1\\ \dot{x}2\\ \dot{x}3\end{bmatrix} = \begin{bmatrix}0 & 1 & 0\\ 0 & 0 & 1\\ 0 & -2 & -3\end{bmatrix}\begin{bmatrix}x1\\ x2\\ x3\end{bmatrix} + \begin{bmatrix}0\\ 0\\ 10\end{bmatrix}u$$	(13)	BTL 1	Remembering
12.	(i) Derive the expressions for Gilberts Method of Testing observability and controllability?	(8)	BTL 2	Understanding
	(ii) Deduce the digital control design using state feedback with necessary steps	(5)		
13.	For the given digital transfer function $$\frac{Y(z)}{U(z)} = \frac{4z^3 - 12z^2 + 13z - 7}{(z-1)^2(z-2)}$$ Develop the state model in Jordan Canonical Form	(13)	BTL 6	Creating
14.	The state model of a discrete time system is given by X(k+1) = A X(k) + B U(k) Y(k) = C X(k) + D U(k) Determine its transfer function.	(13)	BTL 5	Evaluating

PART - C				
1.	Elaborate whether the system is completely (i) Controllable (ii) Observable $\begin{bmatrix}\dot{x}1\\ \dot{x}2\\ \dot{x}3\end{bmatrix} = \begin{bmatrix}0 & 0 & 1\\ -2 & -3 & 0\\ 0 & 2 & -3\end{bmatrix}\begin{bmatrix}x1\\ x2\\ x3\end{bmatrix} + \begin{bmatrix}0\\ 2\\ 0\end{bmatrix}u$ $y = \begin{bmatrix}1 & 0 & 0\end{bmatrix}\begin{bmatrix}x1\\ x2\\ x3\end{bmatrix}$	 (8) (7)	BTL6	Creating
2.	A LTI system is characterized by Non homogenous state equation $\begin{bmatrix}\dot{x}1\\ \dot{x}2\end{bmatrix} = \begin{bmatrix}0 & 1\\ -2 & -3\end{bmatrix}\begin{bmatrix}x1\\ x2\end{bmatrix} + \begin{bmatrix}0\\ 1\end{bmatrix}u$ Compute the solution of the Non homogenous equation , assuming initial state vector $X0 = \begin{bmatrix}1\\ 0\end{bmatrix}$	(15)	BTL 5	Evaluating
3.	(i) Determine the canonical state model of the systems whose transfer function is 2(s+5)/[(s+2)(s+3)(s+4)].	(11)	BTL 6	Creating
	(ii) Formulate e^{At} for the above transfer function.	(4)		
4.	A Discrete time system is described by the difference equation y(k+2) +5y(k+1) +6y(k) = u(k) y(0) = y(1) = 0; T = 1 Sec Determine a state model in canonical form.	(15)	BTL 5	Evaluating