INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal, Hyderabad-500043

Department of Electrical and Electronics Engineering

TUTORIAL QUESTION BANK

Course Name	**:**	**CONTROL SYSTEMS**
Course Code	**:**	**AEE009**
Class	**:**	**B.Tech IV Semester**
Branch	**:**	**Electrical and Electronics engineering**
Year	**:**	**2018– 2019**
Course Coordinator	**:**	**Dr. P Sridhar, Professor**
Course Faculty	**:**	**Ms. S Swathi, Assistant Professor**

I. COURSE OBJECTIVES:

The course should enable the students to:

I	Organize modeling and analysis of electrical and mechanical systems.
II	Analyse control systems by block diagrams and signal flow graph technique.
III	Demonstrate the analytical and graphical techniques to study the stability.
IV	Illustrate the frequency domain and state space analysis.

II. COURSE LEARNING OUTCOMES:

Students, who complete the course, will have demonstrated the ability to do the following:

S. No	Description
CAEE009.01	Differentiate between open loop, closed loop system and their importance in real time applications.
CAEE009.02	Predict the transfer function of translational and rotational mechanical, electrical system using differential equation method.
CAEE009.03	Analyze the analogy between electrical, translation and rotational mechanical systems.
CAEE009.04	Apply the block diagram and signal flow graph technique to determine transfer function of a control systems.
CAEE009.05	Demonstrate the response of first order and second order systems with various standard test signals.
CAEE009.06	Estimate the steady state error and its effect on the performance of control systems and gives the importance of PID controllers.
CAEE009.07	Summarize the procedure of Routh – Hurwirtz criteria to study the stability of physical systems.
CAEE009.08	List the steps required to draw the root – locus of any control system and predict the stability.

CAEE009.09	Explain the effect on stability by adding zeros and poles to the transfer function of control system.
CAEE009.10	Discuss the method of Bode plot and Polar plot to calculate gain margin and phase margin of control system.
CAEE009.11	Describe the characteristics of control system and its stability by plotting Nyquist plot**.**
CAEE009.12	Compare the behaviour of control system in terms of time domain and frequency domain response.
CAEE009.13	Define the state model of control system using its block diagram and give the role of diagonalization in state space analysis.
CAEE009.14	Formulate the state transmission matrix and explain the concept of controllability and observability.
CAEE009.15	Design of lag, lead, lag – lead compensator to improve stability of control system.
CAEE009.16	Apply the concept of different stability criterions and time, frequency response solution to solve real time world applications.
CAEE009.17	Explore the knowledge and skills of employability to succeed in national and international level competitive examinations.

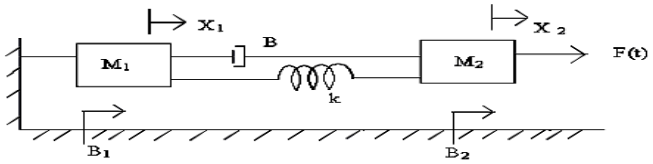
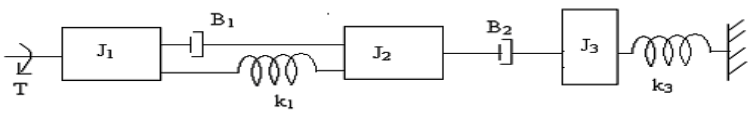
TUTORIAL QUESTION BANK

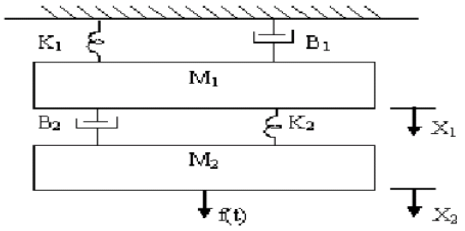
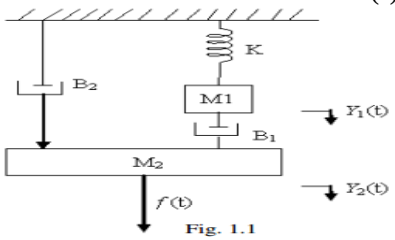
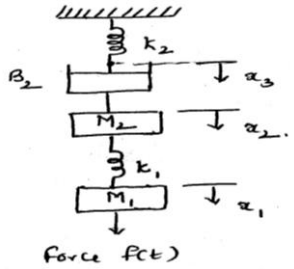
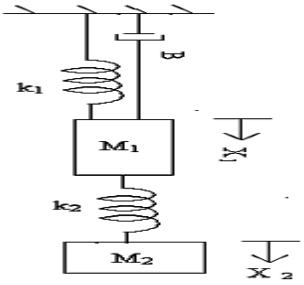
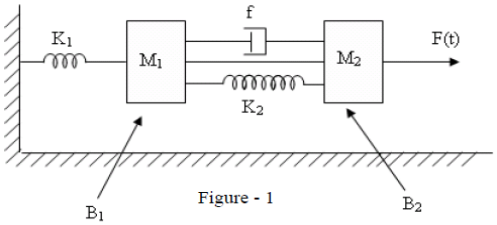
UNIT – I

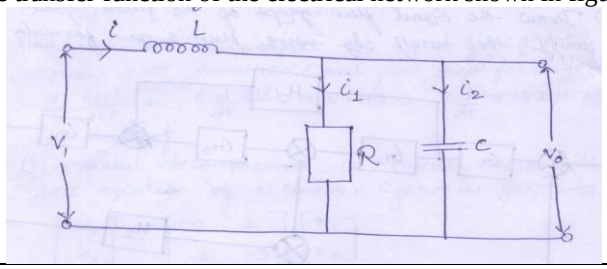
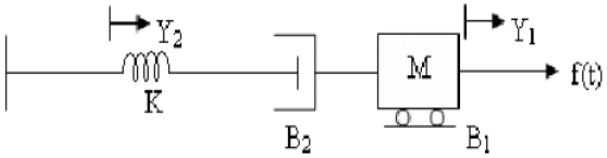
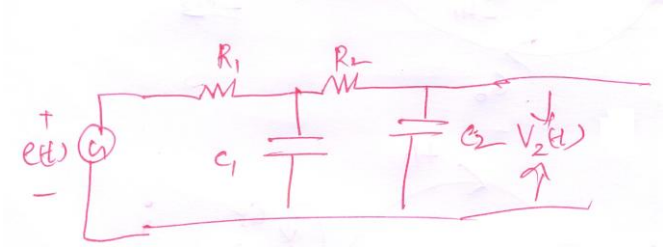
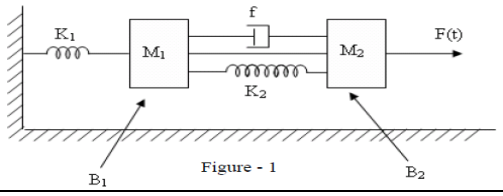
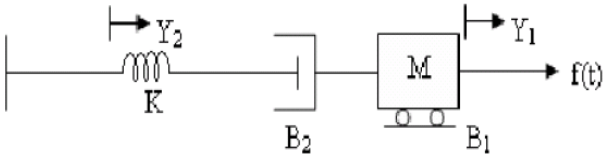
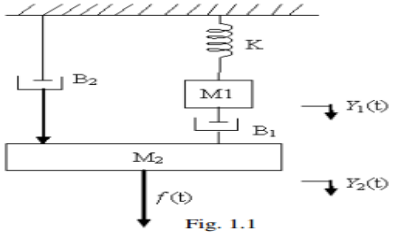
INTRODUCTION AND MODELING OF PHYSICAL SYSTEMS

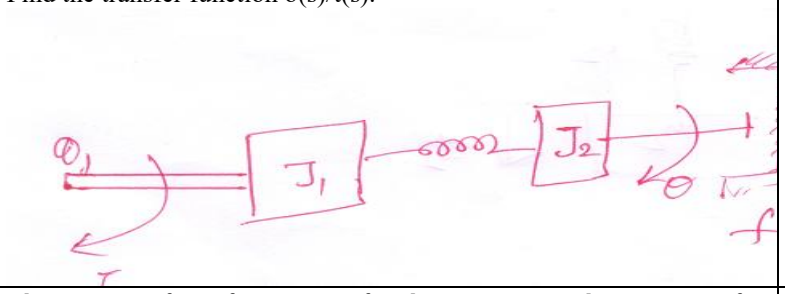
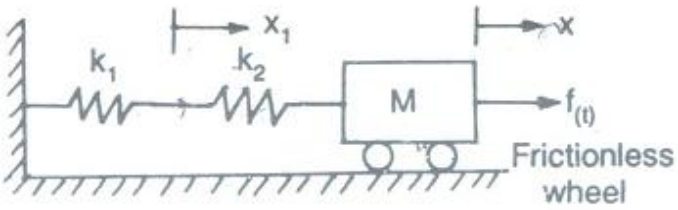
PART – A (SHORT ANSWER QUESTIONS)

S. No	QUESTION	Blooms Taxonomy Level	Course Learning Outcomes
1	What is control system?	Remember	CAEE009.01
2	Define open loop control system?	Understand	CAEE009.01
3	Define closed loop control system?	Understand	CAEE009.01
4	Define transfer function?	Remember	CAEE009.02
5	Write examples for open loop and closed loop control systems?	Understand	CAEE009.01
6	Compare open loop and closed loop control systems?	Understand	CAEE009.03
7	What are the basic elements used for modelling mechanical rotational system?	Understand	CAEE009.03
8	Write the force balance equation of ideal mass element?	Understand	CAEE009.03
9	Write the force balance equation of ideal dashpot element?	Understand	CAEE009.03
10	Write the force balance equation of ideal spring element?	Remember	CAEE009.03
11	Write the analogous electrical elements in force voltage analogy for the elements of mechanical translational system?	Remember	CAEE009.03
12	Write the analogous electrical elements in force current analogy for the elements of mechanical translational system?	Remember	CAEE009.03
13	What are the basic elements used for modelling mechanical translational system?	Remember	CAEE009.03

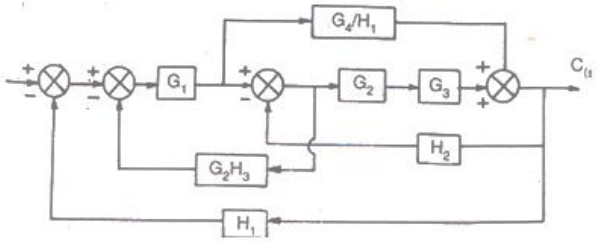
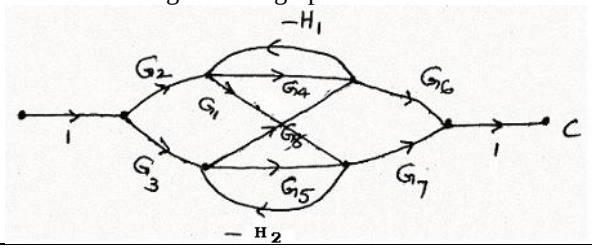
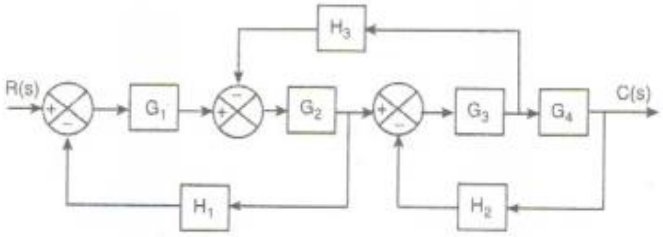
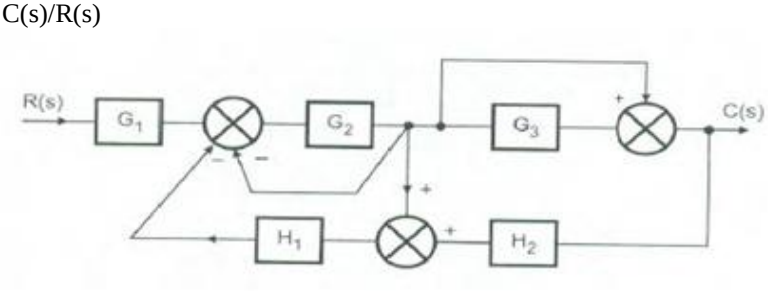
14	Write the torque balance equation of ideal rotational mass element?	Remember	CAEE009.03
15	Write the torque balance equation of ideal dash-pot element?	Understand	CAEE009.03
PART - B (LONG ANSWER QUESTIONS)			
1	Explain open loop & closed loop control systems by giving suitable Examples & also highlights their merits & demerits?	Understand	CAEE009.01
3	Explain the difference between open loop and closed loop systems?	Remember	CAEE009.01
4	Illustrate at least three applications of feedback control systems?	Remember	CAEE009.01
5	Explain the classification of control systems?	Remember	CAEE009.01
6	Explain the advantages of systems with feedback? What are the effects of feedback On the performance of a system? Briefly explain?	Remember	CAEE009.01
7	Explain the traffic control systems using open loop and closed loop system	Understand	CAEE009.01
8	Explain the basic components of control systems?	Understand	CAEE009.01
9	What is mathematical model of a physical system? Explain briefly?	Remember	CAEE009.02
10	What is transfer function and what are the advantages and limitations?	Understand	CAEE009.02
11	Explain the temperature control system using open loop and closed loop systems?	Understand	CAEE009.01
12	Human being is an example of closed loop system. Justify your answer?	Remember	CAEE009.01
13	Explain translator and rotary elements of mechanical systems?	Remember	CAEE009.02
14	Define transfer function and state its advantages and disadvantages? Determine the transfer function of RLC series circuit if the voltage across the capacitor is a output variable and input is voltage source v(s).	Remember	CAEE009.02
15	Write the analogous quantities in force-voltage analogy and force – current analogy.	Remember	CAEE009.03
PART - C (PROBLEM SOLVING AND CRITICAL THINKING QUESTIONS)			
1	Write the differential equations governing the Mechanical system shown in fig. and determine the transfer function? 	Understand	CAEE009.02
2	Write the differential equations governing the Mechanical rotational system shown in fig. find the transfer function? 	Understand	CAEE009.02

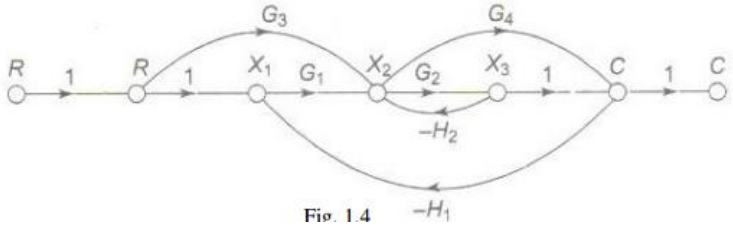
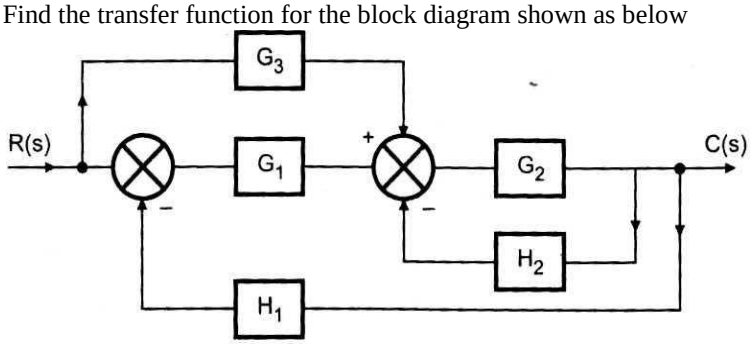
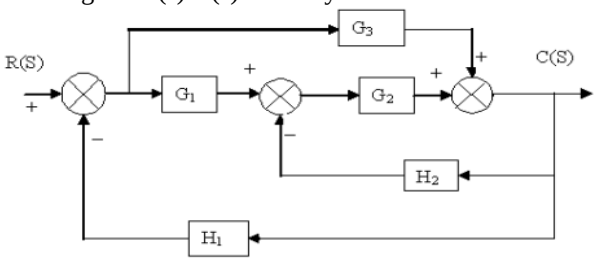
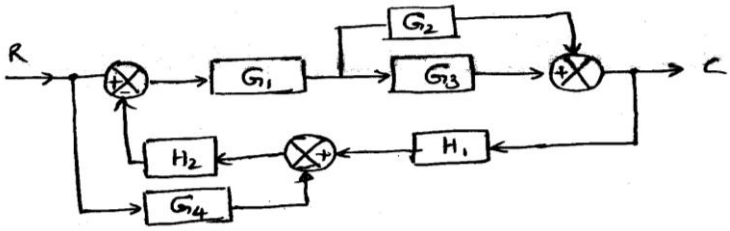
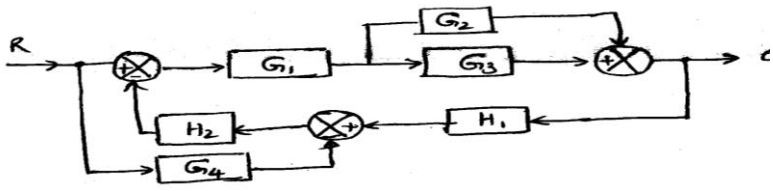
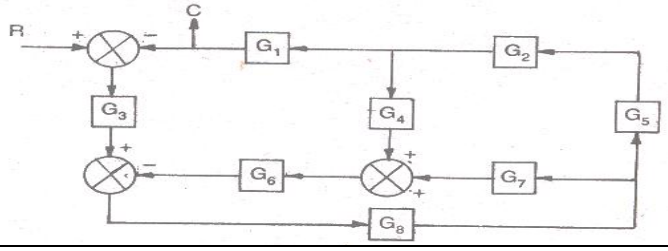
3	Obtain the transfer function X1(s)/F(s) for the mechanical system as shown in figure. 	Understand	CAEE009.02
4	Write the differential equations governing the mechanical system shown below and determine the transfer function Y1(s)/F(s).  Fig. 1.1	Remember	CAEE009.02
5	Draw the electrical analogous circuit of the mechanical system shown below. 	Understand	CAEE009.02
6	Determine the transfer function Y2(S)/F(S) of the system shown in fig. 	Understand	CAEE009.02
7	Obtain the transfer function Y1(s)/F(s) of the mechanical system shown in figure 1  Figure - 1	Understand	CAEE009.02

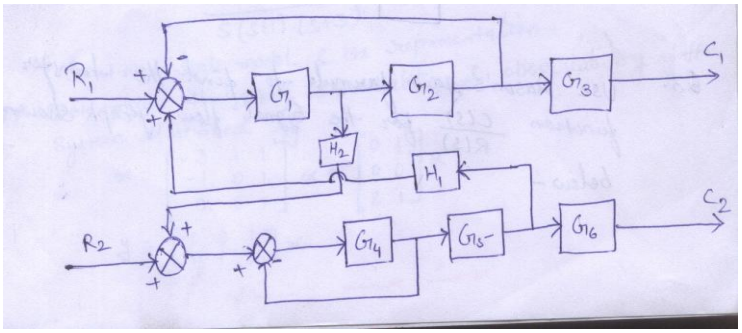
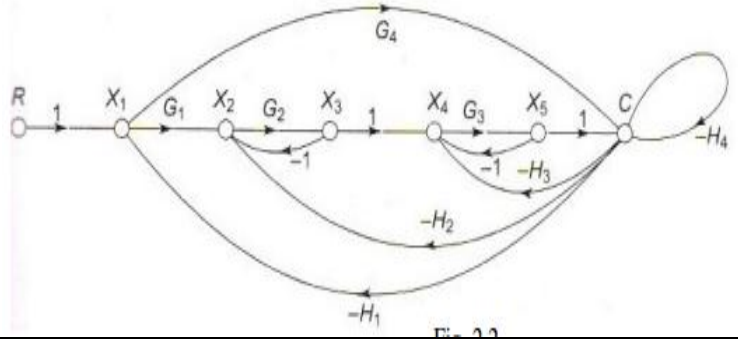
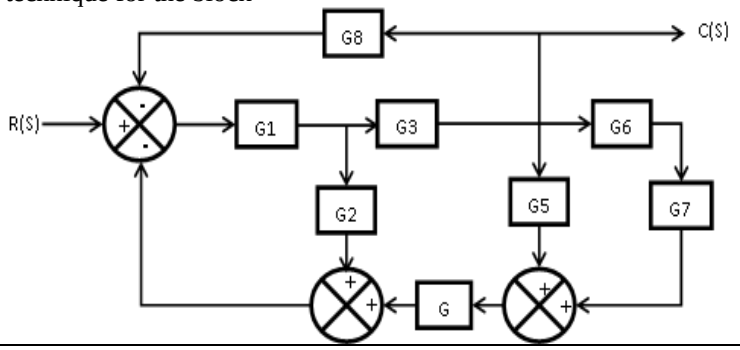
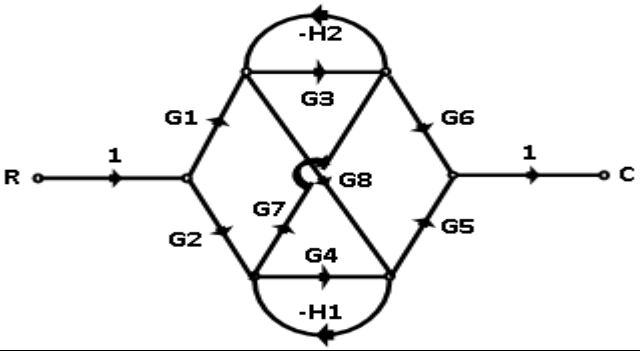
8	Find the transfer function of the electrical network shown in figure. 	Remember	CAEE009.02
9	For the mechanical system shown in Figure 3, determine the transfer function Y1(s)/F(s) 	Remember	CAEE009.02
10	For the given electrical circuit find transfer function v2(s)/e(s) 	Remember	CAEE009.02
11	Obtain the transfer function Y2(s)/F(s) of the mechanical system shown in figure 1  Figure - 1	Remember	CAEE009.02
12	For the mechanical system shown in Figure 3, determine the transfer function Y2(s)/F(s) 	Understand	CAEE009.02
13	Write the differential equations governing the mechanical system shown below and determine the transfer function Y2(s)/F(s).  Fig. 1.1	Understand	CAEE009.02

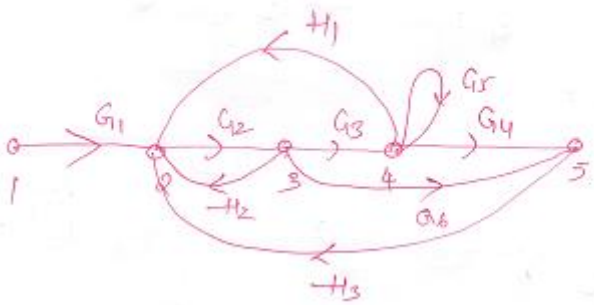
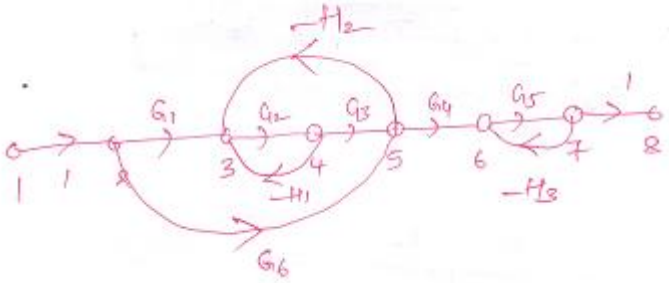
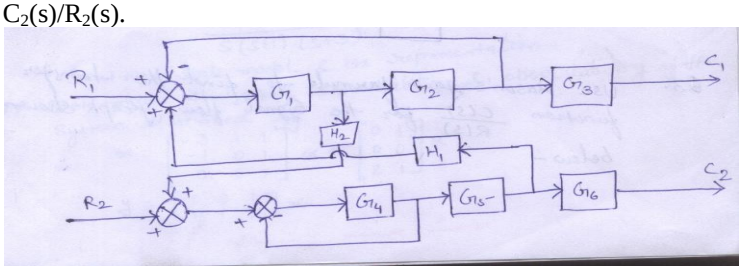
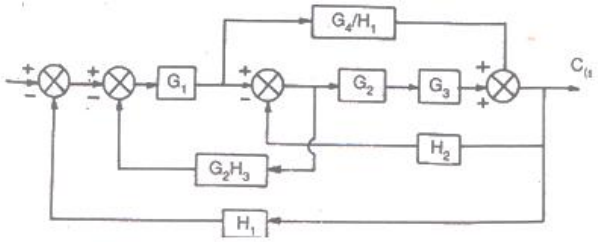
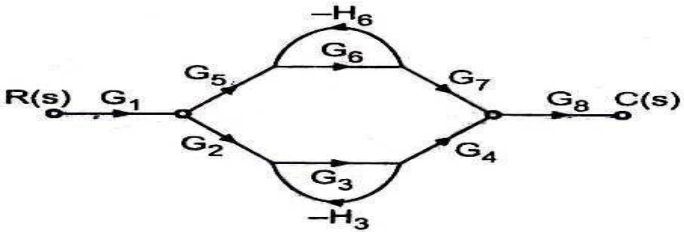
14	Find the transfer function ɵ(s)/t(s).  	Understand	CAEE009.02
15	Obtain transfer function of the system shown in fig.  	Understand	CAEE009.02
	UNIT - II		
	BLOCK DIAGRAM REDUCTION AND TIME RESPONSE ANALYSIS		
	PART – A (SHORT ANSWER QUESTIONS)		
1	What is block diagram?	Remember	CAEE009.04
2	What is the basis for framing the rules of block diagram reduction technique?	Remember	CAEE009.04
3	What are the components of block diagram?	Remember	CAEE009.04
4	What is transmittance?	Remember	CAEE009.04
5	What is sink and source?	Remember	CAEE009.04
6	Write Masons Gain formula?	Understand	CAEE009.04
7	Define non- touching loop?	Remember	CAEE009.04
8	What is a signal flow graph?	Remember	CAEE009.04
9	Define forward path?	Understand	CAEE009.04
10	Write the rule for moving summing point a head of a block?	Understand	CAEE009.04
11	Define loop?	Understand	CAEE009.04
12	What is Proportional controller and what are its advantages?	Remember	CAEE009.06
13	What is the drawback in P-controller?	Understand	CAEE009.06
14	What is integral control action? What is the advantage and disadvantage in integral controller?	Understand	CAEE009.06
15	What is PI, PD, PID controller?	Remember	CAEE009.06
16	Define Damping ratio.	Understand	CAEE009.05
17	Distinguish between type and order of a system?	Understand	CAEE009.05
18	Define rise, Delay time	Understand	CAEE009.05

19	Define Peak time? Write formula?	Remember	CAEE009.05
20	Give the relation between generalized and static error coefficients?	Remember	CAEE009.05
21	What are generalized error coefficients?	Remember	CAEE009.05
22	Define settling time and write formula?	Remember	CAEE009.05
23	Define Peak overshoot and write formula?	Understand	CAEE009.05
24	How the system is classified depending on the value of damping?	Understand	CAEE009.05
25	Find the type and order of the system G(S)=40/S(s+4)(s+5)(s+2)	Remember	CAEE009.05
26	Find the type and order of the system G(S)=40/S(s+4)(s+5)(s+2)	Understand	CAEE009.05
PART - B (LONG ANSWER QUESTIONS)			
1	Derive the transfer function of a field controlled DC servomotor and develop its block diagram. State the assumptions made if any.	Understand	CAEE009.04
2	Derive the transfer function of an armature controlled DC servomotor and develop its block diagram	Remember	CAEE009.04
3	(a) Write short notes on impulse response of a system? (b) Explain and derive the relation between impulse response and transfer function?	Understand	CAEE009.05
4	(a) Explain the differences between field controlled and armature controlled DC servomotor? (b) Explain the practical applications of servomotors?	Remember	CAEE009.04
5	What is the basis for framing the rules of block diagram reduction technique? What are drawbacks of the block diagram reduction technique?	Remember	CAEE009.04
6	Explain properties of signal flow graphs? Explain the need of signal flow graph representation for any system	Understand	CAEE009.04
7	How do you construct a signal flow graph from the equations?	Understand	CAEE009.04
8	Explain briefly about mason's gain formula?	Remember	CAEE009.04
9	What are advantages of signal flow graph over block diagram?	Remember	CAEE009.04
10	Explain about various test signals used in control systems?	Remember	CAEE009.04
11	Derive the expression for time domain specification of a under damped second order system to a step input?	Understand	CAEE009.05
12	Derive the transient response of under damped second order system when excited by unit step input?	Understand	CAEE009.05
13	Derive the transient response of over damped second order system when excited by unit step input?	Remember	CAEE009.05
14	(a)How steady state error of a control system is determined? How it can be reduced? (b) Derive the static error constants and list the disadvantages?	Understand	CAEE009.05
15	For a system $G(s)H(s) = \frac{K}{S^2(S+2)(S+3)}$ Find the value of K to limit steady state error to 10 when input to system is $1 + 10t + \frac{40}{2}t^2$	Understand	CAEE009.05
16	Explain error constants K_p, K_v and K_a for type I system?	Understand	CAEE009.05
17	Explain the effect of PI control on the performance of control system?	Remember	CAEE009.06
18	What are P, D, and I controllers? Why D controller is not used in control systems?	Remember	CAEE009.06
19	Discuss the advantages and disadvantages of proportional, proportional derivative, proportional integral control system?	Remember	CAEE009.06

20	Derive the transient response of un damped second order system when excited by unit step input?	Remember	CAEE009.06
21	Derive the transient response of critically damped second order system when excited by unit step input?	Understand	CAEE009.06
22	Explain the effect of PD control on the performance of control system.	Understand	CAEE009.06
23	Explain error constants K_p, K_v and K_a for type II system.	Remember	CAEE009.05
24	What are generalized error constants? State the advantages and significance of generalized error constants?	Understand	CAEE009.05
PART - C (PROBLEM SOLVING AND CRITICAL THINKING QUESTIONS)			
1	Determine the overall transfer function C(S)/R(S) for the system shown in fig 	Understand	CAEE009.04
2	Discuss Mason's gain formula. Obtain the overall transfer function C/R from the signal flow graph shown. 	Understand	CAEE009.04
3	Determine the transfer function C(S)/R(S) of the system shown below fig. 2.3 by block diagram reduction method 	Understand	CAEE009.04
4	Reduce the given block diagram and hence obtain the transfer function C(s)/R(s) 	Understand	CAEE009.04

5	For the signal flow graph shown below fig.1.4, find the overall gain  Fig. 1.4	Understand	CAEE009.04
6	Find the transfer function for the block diagram shown as below  	Understand	CAEE009.04
7	Find the overall gain C(s)/R(s) of the system shown below?  	Understand	CAEE009.04
8	Draw a signal flow graph and evaluate the closed-loop transfer function of a system whose block diagram is given as follows:  	Understand	CAEE009.04
9	Draw a signal flow graph and evaluate the closed-loop transfer function of a system whose block diagram is given as follows  	Understand	CAEE009.04
10	Find the closed loop transfer function of the system  	Understand	CAEE009.04

11	Reduce the given block diagram and hence obtain the transfer function $C_1(s)/R_1(s)$. 	Understand	CAEE009.04
12	For the signal flow graph shown below fig.2.2 using Mason's gain formula obtain C(s)/R(s). 	Understand	CAEE009.04
13	Find the closed loop transfer function using block diagram reduction technique for the block 	Understand	CAEE009.04
14	find the transfer function through the Mason's gain formula for the figure given below 	Understand	CAEE009.04

15	Apply masons gain formula to find its transfer function. 	Understand	CAEE009.04
16	For the signal flow graph find transfer function. 	Understand	CAEE009.04
17	Reduce the given block diagram and hence obtain the transfer function $C_2(s)/R_2(s)$. 	Understand	CAEE009.04
18	Determine the overall transfer function C(S)/R(S) for the system shown in fig 	Understand	CAEE009.04
19	Obtain the overall transfer function C/R from the signal flow graph shown. 	Understand	CAEE009.04

20	A unity feedback system has $G(s) = \frac{40(S+2)}{S(S+1)(S+4)}$ Determine (i) Type of the system (ii) All error coefficients and (iii) Error for the ramp input with magnitude 4	Understand	CAEE009.05
21	For a unity feedback system whose open loop transfer function is G(s) = 50/(1+0.1s)(1+2s) , find the position, velocity & acceleration error Constants.	Understand	CAEE009.05
22	A unity feedback system is characterized by an open loop transfer function $G(s) = \frac{K}{S(S+10)}$ Determine gain 'K' so that system will have a damping ratio of 0.5. For this value of 'K' determine settling time, peak overshoot and time to peak overshoot for a unit step input. Also obtain closed loop response in time domain	Understand	CAEE009.05
23	The open loop transfer function of a unity feedback system is given by $G(s) = \frac{K}{S(TS+1)}$ where K and T are positive constants. By what factor should the amplifier gain be reduced so that the peck overshoot of unit step response of the system is reduced from 75% to 25%?	Understand	CAEE009.05
24	A unity feed-back system is characterized by the open-loop transfer function: $G(s) = \frac{1}{s(0.5s+1)(0.2s+1)}$. Determine the steady-state errors for unity-step, unit-ramp and unit-acceleration input. Also find the damping ration and natural frequency of the dominant roots.	Understand	CAEE009.05
25	The forward transfer function of a unity feedback type1, second order system has a pole at -2. The nature of gain k is so adjusted that damping ratio is 0.4. The above equation is subjected to input r(t)=1+4t. Find steady state error?	Understand	CAEE009.05
26	A feedback control system is described as G(s) = 50/s(s+2)(s+5) , H(s) = 1/s For a unit step input, determine the steady state error constants & errors.	Understand	CAEE009.05
27	The closed loop transfer function of a unity feedback control system is given by- C(s)/R(s) = 10/(s^2+4s+5) Determine (i) Damping ratio (ii) Natural undammed resonance frequency (iii) Percentage peak overshoot (iv) Expression for error response	Understand	CAEE009.05
28	For a unity feedback system whose open loop transfer function is G(s) = 50/(1+0.1s)(1+2s) , find the position, velocity & acceleration error Constants.	Understand	CAEE009.05
29	The open loop transfer function of a control system with unity feedback is given by $G(s) = \frac{100}{s(s+0.1s)}$. Determine the steady state error of the system when the input is 10+10t+4t^2	Understand	CAEE009.05
30	A feedback control system is described as G(s) = 50/s(s+3)(s+5) , H(s) = 1/s For a unit step input, determine the steady state error constants & errors.	Understand	CAEE009.05
31	For a system $G(s)H(s) = \frac{K}{S^2(S+2)(S+6)}$ Find the value of K to limit steady state error to 10 when input to system is $1 + 10t + \frac{40}{2}t^2$	Understand	CAEE009.05

32	A unity feedback system has $G(s) = \frac{40(S+2)}{S(S+3)(S+4)}$ Determine (i) Type of the system (ii) All error coefficients and (iii) Error for the ramp input with magnitude 4	Understand	CAEE009.05
33	For a unity feedback system whose open loop transfer function is G(s) = 50/(1+s)(1+2s) , find the position, velocity & acceleration error Constants.	Understand	CAEE009.05
34	The closed loop transfer function of a unity feedback control system is given by- C(s)/R(s) = 20/(s^2+16s+25) Determine (i) Damping ratio (ii) Natural undammed resonance frequency (iii) Percentage peak overshoot (iv) Expression for error response	Understand	CAEE009.05
	UNIT – III		
	CONCEPT OF STABILITY AND ROOT LOCUS TECHNIQUE		
	PART – A (SHORT ANSWER QUESTIONS)		
1	Define BIBO stability. What is the necessary condition for stability?	Understand	CAEE009.07
2	What is characteristic equation?	Understand	CAEE009.07
3	What is the relation between stability and coefficient of characteristic polynomial?	Understand	CAEE009.07
4	What will be the nature of impulse response when the roots of characteristic equation are lying on imaginary axis?	Remember	CAEE009.07
5	What will be the nature of impulse response if the roots of characteristic equation are lying on right half s-plane?	Understand	CAEE009.07
6	What is routh stability criterion?	Understand	CAEE009.07
7	What is auxiliary polynomial?	Understand	CAEE009.07
8	What is quadratic symmetry?	Understand	CAEE009.07
9	In routh array what conclusion you can make when there is a row of all zeros?	Understand	CAEE009.07
10	What is limitedly stable system?	Understand	CAEE009.07
11	Define absolute stability?	Understand	CAEE009.07
12	Define marginal stability?	Understand	CAEE009.07
13	Define conditional stability?	Understand	CAEE009.07
14	Define stable system?	Understand	CAEE009.07
15	Define Critically stable system?	Understand	CAEE009.07
16	Define conditionally stable system?	Understand	CAEE009.07
17	For the represented by the following characteristic equation say whether the necessary condition for stability is satisfied or not $s^4+3s^3+4s^2+5s+10=0$	Understand	CAEE009.07
18	For the represented by the following characteristic equation say whether the necessary condition for stability is satisfied or not $s^4+3s^3+4s^2+5s+10=0$	Understand	CAEE009.07
19	For the represented by the following characteristic equation say whether the necessary condition for stability is satisfied or not $s^6 - 2s^5+s^3+s^2+s+6=0$	Understand	CAEE009.07

20	For the represented by the following characteristic equation say whether the necessary condition for stability is satisfied or not $s^5+4s^4-5s^3-4s^2+2s+1=0$	Understand	CAEE009.07
21	How the roots of characteristic equation are related to stability?	Understand	CAEE009.07
22	For the represented by the following characteristic equation say whether the necessary condition for stability is satisfied or not 5 $s^4+4s^2+5s+10=0$	Understand	CAEE009.07
23	For the represented by the following characteristic equation say whether the necessary condition for stability is satisfied or not $3s^3+4s^2+5s+10=0$	Understand	CAEE009.08
24	For the represented by the following characteristic equation say whether the necessary condition for stability is satisfied or not $s^6+2s^5+3s^3+s^2+s+6=0$	Understand	CAEE009.08
25	For the represented by the following characteristic equation say whether the necessary condition for stability is satisfied or not $s^5+4s^4-5s^3-6s^2+2s+1=0$	Understand	CAEE009.08
26	What is root locus? How will you find root locus on real axis?	Understand	CAEE009.07
27	What are asymptotes?	Understand	CAEE009.08
28	What is centroid, how it is calculated?	Remember	CAEE009.08
29	What is breakaway point?	Remember	CAEE009.08
30	What is dominant pole?	Remember	CAEE009.08
31	What is break in point?	Remember	CAEE009.08
32	Determine poles for G(S)=40/S(s+4)(s+5)	Remember	CAEE009.09
33	Determine poles for G(S)=40/S(s+6)(s+2)	Understand	CAEE009.09
34	Determine the zeros for G(S)=40(s+2)(s+6)/(s+4)(s+5)	Understand	CAEE009.09
35	Determine the zeros for G(S)=10(s+6)(s+8)/(s+3)(s+2)	Understand	CAEE009.09
36	How will you find the gain K at a point on root locus?	Understand	CAEE009.09
PART – B (LONG ANSWER QUESTIONS)			
1	Define the terms (i) absolute stability (ii) marginal stability (iii)conditional stability (iv) stable system(v) Critically stable system (vi) conditionally stable system?	Remember	CAEE009.07
2	State Routh's stability criterion. State their advantages and limitations of Routh Hurwitz criteria?	Understand	CAEE009.07
3	what are the necessary conditions to have all the roots of characteristics equation in the left half of s-plane?	Remember	CAEE009.07
4	By means of Routh criterion ,determine the stability represented by characteristic equation ,$s^4+2s^3+8s^2+4s+3=0$	Remember	CAEE009.07
5	The open loop transfer function of a unity feedback system is given by $G(s)=\frac{K}{S(1+0.25S)(1+0.4S)}$.find the restriction on k so that the closed loop system is absolutely stable.	Understand	CAEE009.07
6	Check the stability of the given characteristic equation using Routh's method $S^6+2S^5+8S^4+12S^3+20S^2+16S+16=0$	Understand	CAEE009.07
7	Locate the poles and zeros on the S-plane of a system G(s)=13(s+7)(s+9)/(s^2+5s+8)	Remember	CAEE009.07
8	Using the routh's criterion determine the stability of the system represented by characteristic equation $s^4+8s^3+18s^2+16s+5=0$	Understand	CAEE009.07

9	Using the routh's criterion determine the stability of the system represented by characteristic equation $s^7+9s^6+24s^5+24s^3+24s^2+23s+15$	Understand	CAEE009.07
10	Using the routh's criterion determine the stability of the system represented by characteristic equation $s^4+s^3+5s^2+4s+4=0$	Understand	CAEE009.07
11	Using the routh's criterion determine the stability of the system represented by characteristic equation $s^7+9s^6+24s^5+24s^3+24s^2+23s+15$	Understand	CAEE009.07
12	Using the routh's criterion determine the stability of the system represented by characteristic equation $s^4+s^3+5s^2+4s+4=0$	Understand	CAEE009.07
13	The characteristic equation for certain feedback control systems is given below $s^4+4s^3+13s^2+36s+k=0$.determine the range of k for the system to be stable.	Understand	CAEE009.07
14	The open loop transfer function of a unity feedback system is given by $G(s) = K/S(S^2 + s + 1)(s + 2)$ .find the range of K system will oscillate and what is frequency of oscillation	Understand	CAEE009.07
15	The open loop transfer function of a unity feedback system is given by $G(s) = \frac{K(s+13)}{S(s+3)(s+7)}$.find the restriction on k so that the closed loop system is stable.	Remember	CAEE009.07
16	Explain the steps for the construction of root locus?	Remember	CAEE009.08
17	What is break away and break in points? how to determine them?	Remember	CAEE009.08
18	The open loop transfer function of a control system is given by G(s) H(s) $=\frac{K}{S(S+6)(S^2+4S+13)}$ sketch complete root locus.	Understand	CAEE009.08
19	Write important rules of root locus to construct to construct?	Understand	CAEE009.08
20	Sketch the root locus $G(S)=K/s(s^2+6s+10)$, $H(S)=1$	Understand	CAEE009.08
21	Construct the routh array for the unity feedback system G(s)=10/s(s+2)(s+4)(s+6)	Remember	CAEE009.08
22	What is centroid? How to calculate it?	Remember	CAEE009.08
23	state the effect of addition of poles and zeros on root locus and the stability of the system	Remember	CAEE009.09
PART - C (PROBLEM SOLVING AND CRITICAL THINKING QUESTIONS)			
1	With the help of Routh Hurwitz criterion comments upon the stability of the system having the following characteristic equation $S^6+s^5-2s^4-3s^3-7s^2-4s-4=0$	Understand	CAEE009.07
2	How many roots does each of the following polynomials have in the right half of the s-plane $s^4+2s^3+4s^2+8s+15$	Understand	CAEE009.07
3	The system having characteristic equation2 $s^4+4s^2+1=0$ (i) the number of roots in the left half of s-plane (ii) the number of roots in the right half of s-plane (iii)The number of roots on imaginary axis use RH stability criterion.	Remember	CAEE009.07
4	A unity feedback system has an open loop transfer function $G(s) = \frac{K}{(s+2)(s^2+4s+5)}$. Use RH test to determine the range of positive values of K for which the system is stable	Remember	CAEE009.07
5	Find the range of K for stability of the system with characteristic equation $s^4+3s^3+3s^2+2s+k=0$	Understand	CAEE009.07

6	For the unity feedback system the open loop T.F. is $G(s) = \frac{K}{S(1+0.6S)(1+0.4S)}$ Determine(a) Range of values of K,marginal K (c) Frequency of sustained oscillations	Understand	CAEE009.07
7	Using the routh's criterion determine the stability of the system represented by characteristic equation $s^5+s^4+2s^3+2s^2+3s+5=0$ also determine the roots lying on the right half of the s-plane	Understand	CAEE009.08
8	Sketch the Root Locus for the unity feedback system with $G(s)H(s) = \frac{K}{S(S+1)(S+3)(S+6)}$ Find the breakaway point on real axis and find K of damping ratio=0.5	Understand	CAEE009.08
9	Sketch the complete Root Locus of the system $G(s) = \frac{K}{S(S+2)(S^2+4S+13)}$	Understand	CAEE009.08
10	Sketch root locus plot for unity feedback system whose open loop T.F is given by G(S)=$\frac{k(s+0.5)}{s^2(s+4.5)}$	Understand	CAEE009.08
11	Sketch the root locus plot of a unity feedback system whose open loop T.F is G(s)=$\frac{s}{(s^2+4)(s+2)}$	Understand	CAEE009.08
12	Construct the routh array for the unity feedback system G(s)=10/s(s+2)(s+6)(s+7)	Remember	CAEE009.08
13	Sketch the root locus of open loop transfer function given below? $G(s) = \frac{K}{S(S+3)(S^2+2S+2)}$	Understand	CAEE009.08
14	Sketch the root locus of open loop transfer function given below? $G(s) = \frac{K}{S(S^2+8S+20)}$	Remember	CAEE009.08
15	Sketch the root locus of open loop transfer function given below? $G(s) = \frac{K}{S(S+2)(S^2+2S+2)}$	Remember	CAEE009.08

UNIT – IV

FREQUENCY DOMAIN ANALYSIS

PART – A (SHORT ANSWER QUESTIONS)

1	Define frequency response? With advantages of frequency response analysis?	Remember	CAEE009.10
2	Define frequency domain specifications?	Understand	CAEE009.12
3	Define Resonant Peak.	Understand	CAEE009.10
4	Define Bode plot? What are the advantages of Bode Plot?	Understand	CAEE009.10
5	Define gain margin and phase margin?	Understand	CAEE009.10
6	Define corner frequency.	Remember	CAEE009.11
7	Explain Gain cross-over frequency and phase cross-over frequency?	Remember	CAEE009.11
8	What is polar plot?	Understand	CAEE009.11
9	Define Bandwidth?	Remember	CAEE009.11
10	What are advantages of frequency response analysis?	Understand	CAEE009.12
11	Write the expression for resonant peak?	Remember	CAEE009.12
12	What is cut-off rate?	Remember	CAEE009.10

13	Write the expression for resonant frequency?	Remember	CAEE009.12
14	Define corner frequency?	Remember	CAEE009.10
15	Define polar plot?	Understand	CAEE009.11
16	What is nyquist plot?	Remember	CAEE009.11
PART – B (LONG ANSWER QUESTIONS)			
1	What is frequency response? What are advantages of frequency response analysis?	Understand	CAEE009.12
2	write short notes on various frequency domain specifications	Understand	CAEE009.12
3	Explain the steps for the construction of Bode plot? What are the advantages of Bode Plot?	Understand	CAEE009.10
4	Sketch the Bode plot for the open loop transfer function $$G(s) = \frac{10(S+3)}{S(S+2)(S^2+4S+100)}$$	Understand	CAEE009.10
5	The open loop transfer function of a system is $$G(s) = \frac{K}{S(1+S)(1+0.1S)}$$ Determine the value of K such that (i) Gain Margin = 10dB and (ii) Phase Margin = 50 degree	Remember	CAEE009.10
6	For H(s)=1, $G(s)=Ke^{-0.2s}/s(s+2)(s+8)$. Determine K so that(i) phase margin is 45^0 (ii.) value of k for the gain margin to be 10db	Remember	CAEE009.10
7	Given the open loop transfer function $\frac{20}{s(1+3s)(1+4S)}$ Draw the Bode plot and hence the phase and gain margins.	Understand	CAEE009.10
8	Sketch the bode plot for a system with unity feedback having the transfer function, and assess its closed-loop stability. $$G(s) = \frac{75}{S(s^2+16s+100)}$$	Understand	CAEE009.10
9	Sketch the bode plot for a system with unity feedback having the transfer function, and assess its closed-loop stability. $$G(s) = \frac{10}{S(1+0.4s)(1+0.1s)}$$	Understand	CAEE009.10
10	Derive expression for resonant peak and resonant frequency and hence establish correlation between time and frequency response.	Remember	CAEE009.10
11	Define the following terms i) Gain cross over frequency ii)Resonant peak iii)Resonant frequency iv)Band width	Understand	CAEE009.10
12	Sketch the bode plot for a system with unity feedback having the transfer function, and assess its closed-loop stability. $$G(s) = \frac{50(1+0.1S)}{S(1+0.01S)(1+S)}$$	Understand	CAEE009.10
13	Sketch the bode plot for a system with unity feedback having the transfer function, and assess its closed-loop stability. $$G(s) = \frac{30(1+0.1S)}{S(1+0.01s)(1+s)}$$	Understand	CAEE009.10
14	Sketch the bode plot for a system with unity feedback having the transfer function, and assess its closed-loop stability. $$G(s) = \frac{100(1+0.1S)}{S(1+0.2s)(1+0.5s)}$$	Understand	CAEE009.10
15	Sketch the bode plot for a system with unity feedback having the transfer function, and assess its closed-loop stability. $$G(s) = G(s) = \frac{40(1+s)}{(1+5s)(s^2+2s+4)}$$	Understand	CAEE009.10

16	Draw the polar plot for open loop transfer function for unity feedback system G(s)= $\frac{1}{s(1+s)(1+2s)}$.determine gain margin, phase margin?	Understand	CAEE009.11
PART - C (PROBLEM SOLVING AND CRITICAL THINKING QUESTIONS)			
1	Given damping ratioξ=0.7 and ω_n=10 rad/sec find the resonant peak, resonant frequency and band width.	Remember	CAEE009.12
2	For a second order system with unity feedback G(s) =$\frac{200}{s(s+8)}$.find various frequency domain specifications.	Remember	CAEE009.12
3	Sketch bode plot of a system G(s)=$\frac{1}{(1+s)(1+2s)}$	Understand	CAEE009.12
4	Draw the exact bode plots and find the gain margin and phase margin of a system represented by G(s)H(s)=$\frac{10(s+1)}{s\,(s+0.05)(s+3)(s+5)}$	Understand	CAEE009.12
5	Draw the exact bode plots and find the gain margin and phase margin of a system represented by G(s)=$\frac{10(s+1)}{s\,(s+0.05)(s+3)(s+5)}$,H(S)=1	Understand	CAEE009.11
6	The open loop transfer function of a unity feedback system is G(s) =$\frac{50K}{s\,(s+10)(s+5)(s+1)}$ find the gain margin and phase margin using bode plot?	Understand	CAEE009.12
7	Sketch the bode plot for transfer function G(s)= $\frac{Ks^2}{(1+0.2s)(1+0.02s)}$and find value of K such that gain cross over frequency is 5 rad/sec	Understand	CAEE009.11
8	Sketch the bode plot or a system G(s) =$\frac{15(s+5)}{s\,(s^2+16s+100)}$.hence determine the stability of the system.	Understand	CAEE009.11
9	Sketch the bode plots of G(s)=$\frac{e^{-0.1s}28.5}{s(1+s)(1+0.1s)}$.hence find the gain cross over frequency	Understand	CAEE009.11
10	A unity feedback control system has G(s)=$\frac{K}{s(s+1)(1+\frac{s}{10})}$.find the value of K so that GM=12db and PM=30deg.	Understand	CAEE009.12
11	Given damping ratioξ=0.8 and ω_n=10 rad/sec find the resonant peak, resonant frequency and band width	Understand	CAEE009.12
12	For a second order system with unity feedback G(s) =$\frac{200}{s(s+6)}$.find various frequency domain specifications.	Understand	CAEE009.12
13	Calculate the damping ratio and natural frequency of second order system is 0.5 and 8 rad/sec respectively. Calculate the resonant peak and resonant frequency?	Understand	CAEE009.11
14	Sketch the bode plots of G(s) =$\frac{Ke^{-0.2s}}{s(S+2)(S+8)}$..Find k so that the system is stable with,(a) gain margin equal to 2db. (b)phase margin equal to 45deg	Understand	CAEE009.10
15	Sketch the bode plot for a system with unity feedback having the transfer function, and assess its closed-loop stability. $G(s) = \frac{30}{S(1+3s)(1+4s)}$	Understand	CAEE009.10
16	Sketch polar plot for G(S) = $\frac{1}{S^2(1+s)(1+2s)}$ with unity feedback system. Determine gain margin and phase margin.	Understand	CAEE009.11
17	Obtain the range of values of K for which the following open loop transfer function is stable use nyquist stability criterion .G(S)H(S)=K(S+1)/$S^2(s+2)(s+4)$	Understand	CAEE009.11
18	Obtain the range of values of K for which the following open loop transfer function is stable use nyquist stability criterion .G(S)H(S)=K/s(s^2+2s+2).	Understand	CAEE009.11

UNIT – V			
STATE SPACE ANALYSIS AND COMPENSATORS			
PART - A (SHORT ANSWER QUESTIONS)			
1	What are the advantages of state space analysis?	Remember	CAEE009.13
2	What are draw backs of transfer function model analysis	Understand	CAEE009.13
3	Define state?	Understand	CAEE009.13
4	Define state variable?	Remember	CAEE009.13
5	Define state vector??	Remember	CAEE009.13
6	What are the properties of state transition matrix?	Understand	CAEE009.13
7	Write resolving matrix?	Remember	CAEE009.13
8	Define observability?	Understand	CAEE009.13
9	Define controllability?	Understand	CAEE009.14
10	How the modal matrix can be determined?	Understand	CAEE009.13
11	What is i/p and o/p space?	Understand	CAEE009.13
12	What are eigen values?	Understand	CAEE009.14
PART - B (LONG ANSWER QUESTIONS)			
1	Explain the state variable and state transition matrix?	Understand	CAEE009.13
2	Write shot notes on formulation of state equations?	Remember	CAEE009.13
3	Derive the expression for the calculation of the transfer function from the state variables for the analysis of system?	Understand	CAEE009.13
4	Write short notes on canonical form of representation .list its advantages and disadvantages?	Understand	CAEE009.13
8	Write properties of state transition matrix?	Remember	CAEE009.13
9	State and explain controllability and observability?	Remember	CAEE009.13
10	Write the necessary and sufficient conditions for complete state controllability and observability?	Understand	CAEE009.13
11	What is compensator?	Remember	CAEE009.15
12	Define lead compensator?	Understand	CAEE009.15
13	Define lag compensator?	Understand	CAEE009.15
14	Define lag-lead compensator?	Understand	CAEE009.14
15	What are the various compensation schemes used in practice?	Understand	CAEE009.14
PART - C (PROBLEM SOLVING AND CRITICAL THINKING QUESTIONS)			
1	Linear time invariant system is described by the following state model. Obtain the canonical form of the state model. $\begin{bmatrix}\dot{x}_1\\ \dot{x}_2\end{bmatrix}=\begin{bmatrix}-1 & 1\\ 1 & -2\end{bmatrix}\begin{bmatrix}x_1\\ x_2\end{bmatrix}+\begin{bmatrix}0\\ 1\end{bmatrix}$u and y=$[1/3 \quad -1/3]$	Understand	CAEE009.13
2	convert the following system matrix to canonical form $A=\begin{bmatrix}1 & 2 & 1\\ -1 & 0 & 2\\ 1 & 3 & -1\end{bmatrix}$	Understand	CAEE009.13

3	a linear time invariant system is described by the following state model.obtain the canonical form of state model $\begin{bmatrix}\dot{x}_1\\ \dot{x}_2\end{bmatrix}=\begin{bmatrix}-1 & 0\\ 0 & -3\end{bmatrix}\begin{bmatrix}x_1\\ x_2\end{bmatrix}+\begin{bmatrix}1\\ 1\end{bmatrix}$u and y=$\begin{bmatrix}-1 & -2\end{bmatrix}\begin{bmatrix}x_1\\ x_2\end{bmatrix}$	Understand	CAEE009.13
4	convert the following system matrix to canonical form and hence calculate the STM A=$\begin{bmatrix}4 & 1 & -2\\ 1 & 0 & 2\\ 1 & -1 & 3\end{bmatrix}$	Understand	CAEE009.13
5	a system variables for the state variable representation of the system are, A=$\begin{bmatrix}-1 & 1\\ 1 & -2\end{bmatrix}$,B=$\begin{bmatrix}0\\ 1\end{bmatrix}$, $C=[1 \quad 0]$ Determine the complete state response and the output response of the system for the initial state X(0)=$\begin{bmatrix}-1\\ 0\end{bmatrix}$	Understand	CAEE009.13
6	for the state equation $\dot{x}$=Ax Where A=$\begin{bmatrix}0 & 1 & 0\\ 3 & 0 & 2\\ -12 & -7 & -6\end{bmatrix}$.find the intial condition vector x(0) which will excite only the mode corresponding to eigen value with the most negative real part.	Understand	CAEE009.13
7	consider the differential equation system given by $y+3\ddot{y}+2\dot{Y}=0$, y(0)=0.1,y(0)=0.05. Obtain the response y(t),subjected to the given intial condition	Understand	CAEE009.13
8	consider the system described by the state equation X(t)=$\begin{bmatrix}1 & e^{-t}\\ 0 & -1\end{bmatrix}$x(t)+$\begin{bmatrix}0\\ 1\end{bmatrix}$ $u(t)$	Understand	CAEE009.13
9	determine the state controllability and observability of the following system $\begin{bmatrix}\dot{x}_1\\ \dot{x}_2\end{bmatrix}=\begin{bmatrix}-3 & -1\\ -2 & 1.5\end{bmatrix}\begin{bmatrix}x_1\\ x_2\end{bmatrix}+\begin{bmatrix}1\\ 4\end{bmatrix}$u C=[0 1]	Understand	CAEE009.13
10	examine the observability of the system given below using canonical form $\begin{bmatrix}\dot{x}_1\\ \dot{x}_2\\ \dot{x}_3\end{bmatrix}=\begin{bmatrix}0 & 1 & 0\\ 0 & 1 & 1\\ 0 & -2 & -3\end{bmatrix}\begin{bmatrix}x1\\ x2\\ x3\end{bmatrix}+\begin{bmatrix}0\\ 0\\ 1\end{bmatrix}$u Y=[3 4 1]$\begin{bmatrix}x1\\ x2\\ x3\end{bmatrix}$	Understand	CAEE009.14
11	Design a suitable lag compensator for a system with, G(S) = $\frac{4}{S(S+2)}$ to meet the specifications as a. $K_v \geq 5$ sec^{-1} b. P. M $\geq +40^0$ c. G.M. $\geq +10$ db.	Understand	CAEE009.15
12	Design a lead compensator using root locus for the system with , G(S) = $\frac{4}{S(S+2)}$ to meet the specifications as a. Damping ratio = 0.5 b. setting time = 2 sec.	Understand	CAEE009.15

13	Design a suitable lag compensator root locus for the system with, $G(S) = \frac{K}{S(S+1)(S+2)}$ to meet the specifications as a. Damping ratio = 0.5 b. $K_v \geq 5\ sec^{-1}$ c. Undamped natural frequency = 0.7 rad/sec	Understand	CAEE009.15

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