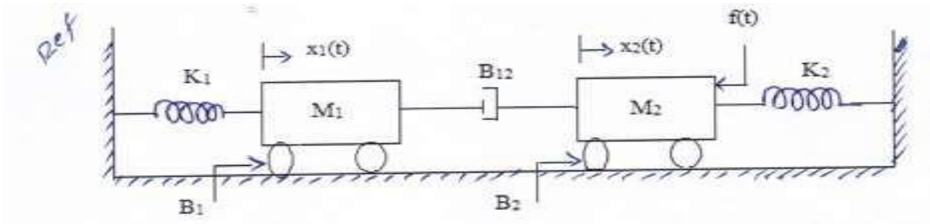
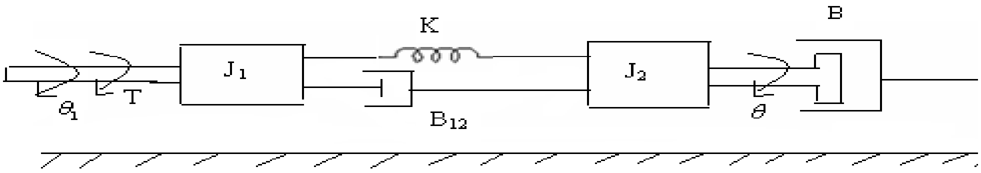
UNIT –I

CONTROL SYSTEMS CONCEPTS

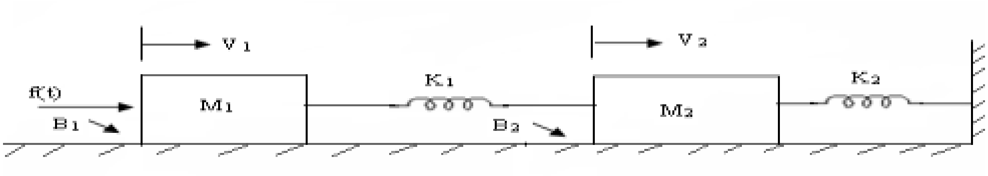
Q.1 For the mechanical system shown in Fig, determine the transfer functions $\frac{X1(s)}{F(s)}$ & $\frac{X2(s)}{F(s)}$ [L3,CO1] 10M



Q.2 Write the differential equations governing the mechanical rotational system shown in the figure and find transfer function. [L3,CO1] 10M



Q.3 For the mechanical system shown in the figure draw the force-voltage and force-current analogous circuits. [L6,CO1] 10M

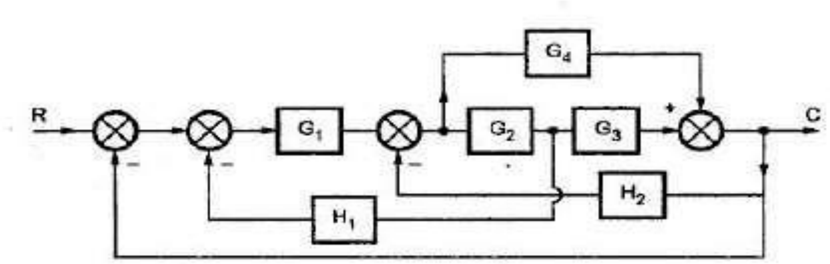


[L2,CO1] 6M

Q.4
a. Compare open loop and closed loop control systems based on different aspects? [L2,CO1] 4M

b. Distinguish between Block diagram Reduction Technique and Signal Flow Graph?

Q.5 Using Block diagram reduction technique find the Transfer Function of the system. [L5,CO1] 10M

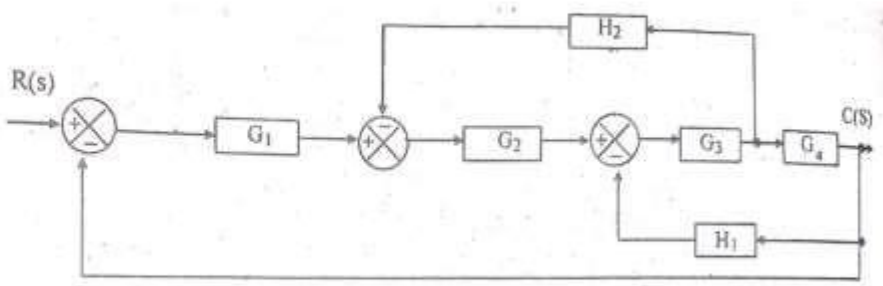


Q.6

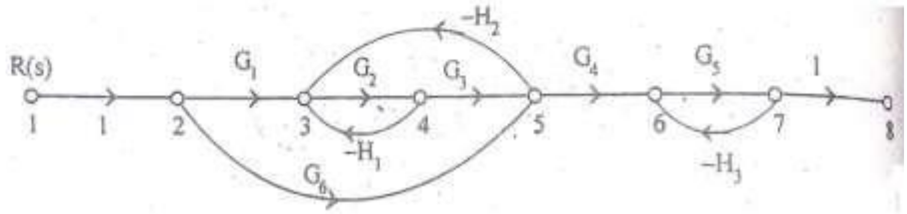
a. Give the block diagram reduction rules to find the transfer function of the system. [L2,CO1] 8M

a. List the properties of signal flow graph. [L1,CO1] 4M

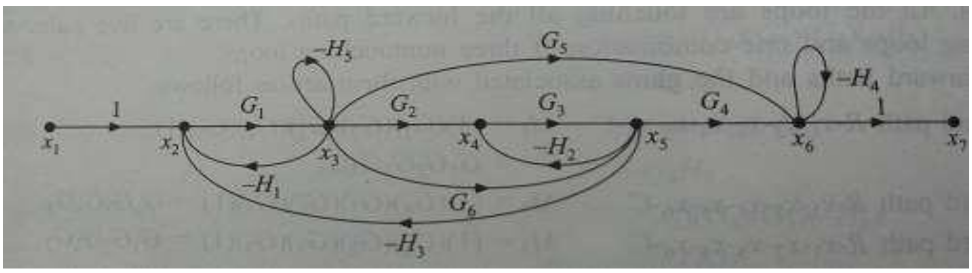
Q.7 For the system represented in the given figure, determine transfer function C(S)/R(S). [L3,CO1] 10M



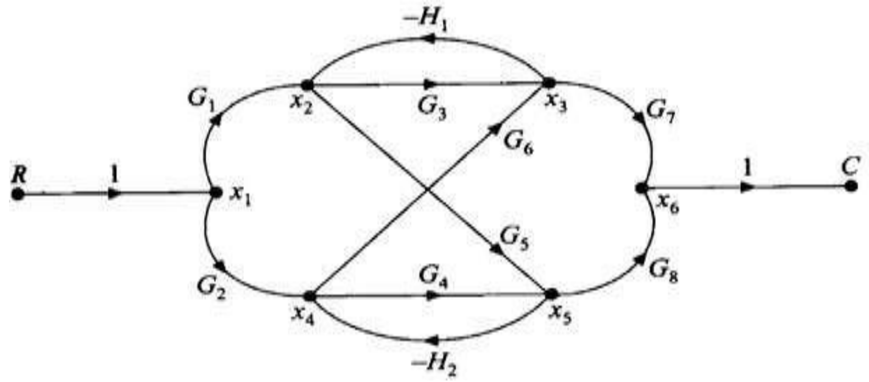
Q.8 Find the overall transfer function of the system whose signal flow graph is shown below. [L5,CO1] 10M



Q.9 Obtain the transfer function of the system whose signal flow graph is shown below. [L3,CO1] 10M



Q.10 Using mason gain formula find the transfer function $\frac{C}{R}$ for the signal flow graph shown in figure. [L3,CO1] 10M



Q.11

i) Define control systems? [L1,CO1] 2M

ii) What is feedback? What type of feedback is employed in control systems? [L2,CO1] 2M

iii) Define transfer function? [L1,CO1] 2M

iv) What is block diagram? What are the basic components of block diagram? [L2,CO1] 2M

v) Explain transmittance [L4,CO1] 2M

UNIT-II

TIME RESPONSE ANALYSIS

Q.1 List out the time domain specifications and derive the expressions for Rise time, Peak time and Peak overshoot. [L1,CO2] 10M

Q.2 Find all the time domain specifications for a unity feedback control system whose open loop transfer function is given by **G(S) =** $\frac{25}{S(S+5)}$. [L2,CO2] 10M

Q.3 A closed loop servo is represented by the differential equation: $\frac{d^2c}{dt^2} + 8\frac{dc}{dt} = 64e$. Where 'c' is the displacement of the output shaft, 'r' the displacementof the input shaft and e =r – c. Determine undamped natural frequency, damping ratio and percentage maximum overshoot for unit step input. [L3,CO2] 10M

[L3,CO2] 5M

[L3,CO2] 5M

Q.4 a. Measurements conducted on a servo mechanism, show the system response to be $c(t) = 1+0.2e^{-60t} - 1.2e^{-10t}$ When subject to a unit step input.Obtain an expression for closed loop transfer function, determine the undamped natural frequency, damping ratio?

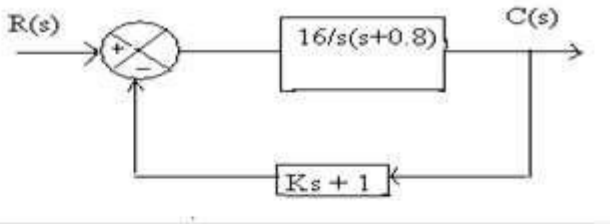
b. For servo mechanisms with open loop transfer function given below what type of input signal give rise to a constant steady state error and calculate their values.

$$G(s)H(s)=\frac{10}{S^2(S+1)(S+2)}.$$

Q.5 A unity feedback control system has an open loop transfer function, **G(s) =** $\frac{10}{S(S+2)}$. Find the rise time, percentage overshoot, peak time and settling time for a step input of 12 units. [L5,CO2] 10M

Q.6 Define steady state error? Derive the static error components for Type 0, Type 1 &Type 2 systems? [L1,CO2] 10M

Q.7 A positional control system with velocity feedback shown in figure. What is the response c(t) to the unit step input. Given that damping ratio=0.5.Also determine rise time, peak time, maximum overshoot and settling time. [L3,CO2] 10M



Q.8 a. A For servo mechanisms with open loop transfer function given below what type of input signal give rise to a constant steady state error and calculate their values. [L3,CO2] 5M

$$G(s)H(s)=\frac{20(S+2)}{S(S+1)(S+3)}$$

b. Consider a unity feedback system with a closed loop transfer function $\frac{C(S)}{R(S)}=\frac{KS+b}{(S^2+aS+b)}$. Calculate open loop transfer function G(s). Show that steady state error with unit ramp [L3,CO2] 5M

input is given by $\frac{(a-K)}{b}$ [L3,CO2] 10M

Q.9 For a unity feedback control system the open loop transfer function

$$G(S) = \frac{1(S+2)}{S^2(S+1)}.$$

(i) Determine the position, velocity and acceleration error constants.

Q.10	a.	What is the characteristic equation? List the significance of characteristic equation.	[L1,CO2]	2M
	b.	The system has **G(s) =** $\frac{K}{S(1+ST)}$ with unity feedback where K & T are constant. Determine the factor by which gain **'K'** should be multiplied to reduce the overshot from **75%** to **25%?**	[L3,CO2]	8M
Q.11	i)	How the system is classified depending on the value of damping ratio?	[L4,CO2]	2M
	ii)	List the time domain specifications?	[L1,CO2]	2M
	iii)	Define peak overshoot?	[L1,CO2]	2M
	iv)	Define accelerating error constant?	[L1,CO2]	2M
	v)	What is the need for a controller?	[L2,CO2]	2M

UNIT –III

STABILITY ANALYSIS IN CONTROL SYSTEMS

Q.1 With the help of Routh's stability criterion find the stability of the following systems represented by the characteristic equations: [L5,CO3] 10M

(a) $s^4 + 8 s^3 + 18 s^2 + 16s + 5 = 0.$

(b) $s^6 + 2s^5 + 8s^4 + 12s^3 + 20s^2 + 16s + 16 = 0.$

Q.2 With the help of Routh's stability criterion find the stability of the following systems represented by the characteristic equations:

(a) $s^5 + s^4 + 2 s^3 + 2 s^2 + 3s + 5 = 0$

(b) $9s^5 - 20s^4 + 10 s^3 - s^2 - 9s - 10 = 0$

Q.3	Determine the range of K for stability of unity feedback system whose open loop transfer function is **G(s) H(s) =** $\frac{K}{S(S+1)(S+2)}$ using Routh's stability criterion.	[L3,CO3]	10M
Q.4	Explain the procedure for constructing root locus.	[L2,CO3]	10M
Q.5	Sketch the root locus of the system whose open loop transfer function is **G(s) H(s) =** $\frac{K}{S(S+2)(S+4)}$.	[L3,CO3]	10M
Q.6	Sketch the root locus of the system whose open loop transfer function is **G(s) H(s) =** $\frac{K}{S(S^2+4S+13)}$	[L3,CO3]	10M
Q.7	Sketch the root locus of the system whose open loop transfer function is **G(s) H(s) =** $\frac{K(S+9)}{S(S^2+4S+11)}$	[L3,CO3]	10M
Q.8	Sketch the root locus of the system whose open loop transfer function is **G(s) H(s) =** $\frac{(S^2+6S+25)}{S(S+1)(S+2)}$	[L3,CO3]	10M
Q.9	Sketch the root locus of the system whose open loop transfer function is **G(s)H(s) =** $\frac{K}{S(S^2+6S+10)}$	[L3,CO3]	10M

Q.10

i)	Explain BIBO stability?	[L12,CO3]	2M
ii)	What is the necessary condition for stability?	[L2,CO3]	2M
iii)	Define root locus?	[L1,CO3]	2M
iv)	What is centroid? How the centroid is calculated?	[L2,CO3]	2M
v)	What is limitedly stable system?	[L2,CO3]	2M

UNIT-IV

FREQUENCY RESPONSE ANALYSIS

Q.1 Sketch the Bode plot for the following transfer function **G(s)H(s)** = $\frac{(K\,e^{-0.1s})}{S(S+1)\,(1+0.1S)}$

Q.2 Sketch the Bode plot for the system having the following transfer function

$$= \frac{15\,(S+5)}{S(S^2+16S+100)}$$

Q.3 a. Define and derive the expression for resonant frequency. [L1,CO4] 5M

b. Draw the magnitude bode plot for the system having the following transfer function: **G(s) H(s)** = $\frac{2000\,(S+1)}{S(S+10)\,(S+40)}$ [L3,CO4] 5M

Q.4 Derive the expressions for resonant peak and resonant frequency and hence establish the correlation between time response and frequency response. [L3,CO4] 10M

Q.5 Draw the Bode plot for the following Transfer Function **G(s) H(s)** = $\frac{20(0.1S+1)}{S^2(0.2S+1)\,(0.02S+1)}$ [L3,CO4] 10M

From the bode plot determine (a) Gain Margin (b) Phase Margin (c) Comment on the stability

Q.6 a. Given ξ **= 0.7** and ω_n **= 10 rad/sec.** Calculate resonant peak, resonant frequency and bandwidth. [L3,CO4] 5M

b. Sketch the polar plot for the open loop transfer function of a unity feedback system is given by **G(s) =** $\frac{1}{S(1+S)\,(1+2S)}$**.** Determine Gain Margin & Phase Margin. [L3,CO4] 5M

Q.7 A system is given by **G(s) H(s) =** $\frac{(4S+1)}{S^2(S+1)\,(2S+1)}$ Sketch the nyquist plot and determine the stability of the system. [L3,CO4] 10M

Q.8 Draw the Nyquist plot for the system whose open loop transfer function is, **G(s)H(s) =** $\frac{K}{S(S+2)\,(S+10)}$**.** Determine the range of K for which closed loop system is stable. [L3,CO4] 10M

Q.9 Obtain the transfer function of Lead Compensator, draw pole-zero plot and write the procedure for design of Lead Compensator using Bode plot. [L3,CO4] 10M

Q.10		Obtain the transfer function of Lag Compensator, draw pole-zero plot and write the procedure for design of Lag Compensator using Bode plot.	[L3,CO4] 10M
Q.11	i)	Define phase margine ?	[L1,CO4] 2M
	ii)	Write the expression for resonant peak and resonant frequency?	[L3,CO4] 2M
	iii)	What is phase and gain cross over frequency?	[L2,CO4] 2M
	iv)	What are the frequency domain specifications?	[L2,CO4] 2M
	v)	What is frequency response?	[L2,CO4] 2M

UNIT-V

STATE SPACE ANALYSIS

Q.1 Determine the Solution for Homogeneous and Non homogeneous State equations [L3,CO5] 10M

Q.2 For the state equation: $\dot{X} = \begin{pmatrix} 0 & 1 \\ -2 & -3 \end{pmatrix} X + \begin{pmatrix} 0 \\ 1 \end{pmatrix} U$ with the unit step input and the initial conditions are $X(0) = \begin{pmatrix} 1 \\ 1 \end{pmatrix}$. Solve the following (a) State transition matrix [L3,CO5] 10M

(b) Solution of the state equation.

Q.3 A system is characterized by the following state space equations: [L3,CO5]

$\dot{X}_1 = -3x_1 + x_2$; $\dot{X}_2 = -2x_1 + u$; $Y = x_1$

(a) Find the transfer function of the system and Stability of the system. 5M

(b) Compute the STM 5M

Q.4 a. State the properties of State Transition Matrix. [L1,CO5] 5M

b. Diagonalize the following system matrix $A = \begin{pmatrix} 0 & 6 & -5 \\ 1 & 0 & 2 \\ 3 & 2 & 4 \end{pmatrix}$ [L3,CO5] 5M

Q.5 a. Find state variable representation of an armature controlled D.C.motor. [L2,CO5] 5M

b. A state model of a system is given as: [L3,CO5] 5M

$\dot{X} = \begin{pmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ -6 & -11 & -6 \end{pmatrix} X + \begin{pmatrix} 0 \\ 0 \\ 1 \end{pmatrix} U$ and $Y = (1 \;\; 0 \;\; 0)X$

Determine: (i) The Eigen Values. (ii) The State Transition Matrix.

Q.6 a. Derive the expression for the transfer function and poles of the system from the state model. $\dot{X} = Ax + Bu$ and $y = Cx + Du$ [L3,CO5] 5M

b. Diagonalize the following system matrix $A = \begin{pmatrix} 4 & 1 & -2 \\ 1 & 0 & 2 \\ 1 & -1 & 3 \end{pmatrix}$ [L3,CO5] 5M

Q.7 Obtain a state model for the system whose Transfer function is given by [L2,CO5] 10M

$$G(s)\,H(s) = \frac{(7S^2+12S+8)}{(S^3+6S^2+11S+9)}$$

Q.8 a. State the properties of STM. [L1,CO5] 3M

b. For the state equation: $\dot{X} = \begin{pmatrix} \mathbf{1} & \mathbf{0} \\ \mathbf{1} & \mathbf{1} \end{pmatrix}\mathbf{X} + \begin{pmatrix} \mathbf{0} \\ \mathbf{1} \end{pmatrix}\mathbf{U}$ when, $\mathbf{X(0)} = \begin{pmatrix} \mathbf{1} \\ \mathbf{0} \end{pmatrix}$. [L2,CO5] 7M

Find the solution of the state equation for the unit step input.

Q.9 a. Find the state model of the differential equation is [L2,CO5] 5M

$$\dddot{y} + 2\ddot{y} + 3\dot{y} + 4y = u$$

b. Diagonalize the following system matrix $A = \begin{pmatrix} 0 & 1 & 0 \\ 3 & 0 & 2 \\ -12 & -7 & -6 \end{pmatrix}$ [L1,CO5] 5M

Q.10 a. Define state, state variable, state equation. [L1,CO5] 5M

b. Derive the expression for the transfer function from the state model. [L1,CO5] 5M

$$\dot{X} = Ax + Bu \text{ and } y = Cx + Du$$

Q.11	i)	List out the properties of STM?	[L1,CO5]	2M
	ii)	Write the state equation?	[L3,CO5]	2M
	iii)	Define state variable?	[L2,CO5]	2M
	iv)	What is Diagonalize matrix?	[L2,CO5]	2M
	v)	Write the formula for solutions of state equation?	[L3,CO5]	2M