NARSIMHA REDDY ENGINEERING COLLEGE
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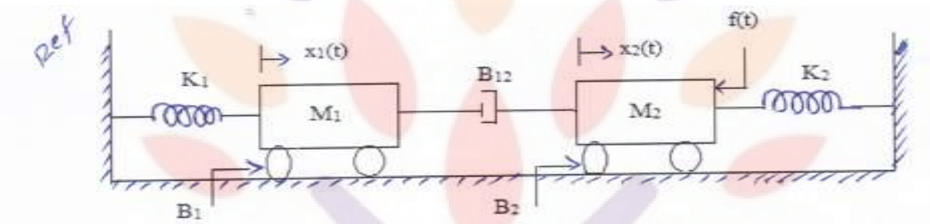
EC3103PC: CONTROL SYSTEMS

QUESTION BANK (DESCRIPTIVE)

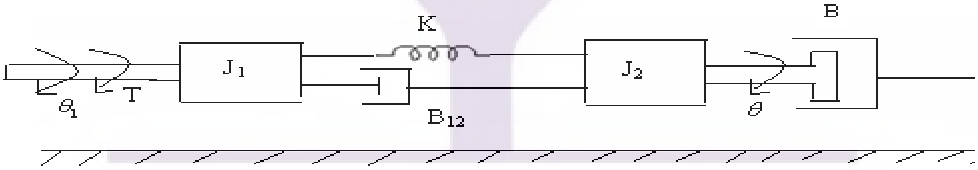
UNIT –I

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

Q.4

a. Compare open loop and closed loop control systems based on different aspects? [L2,CO1] 6M

b. Distinguish between Block diagram Reduction Technique and Signal Flow Graph? [L2,CO1] 4M

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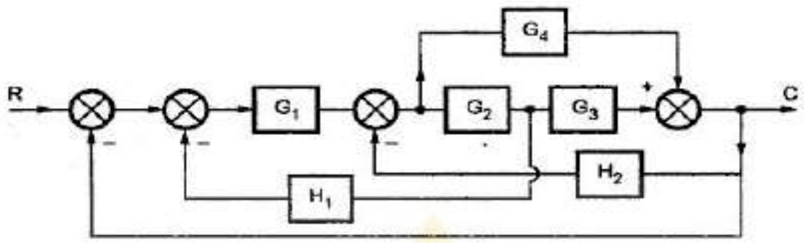
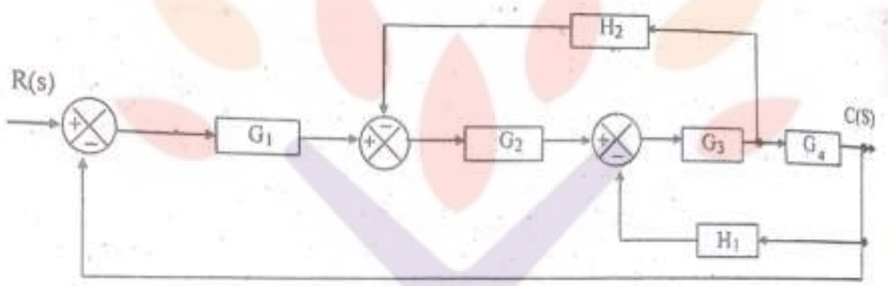
Q.5 Using Block diagram reduction technique find the Transfer Function of the system. [L5,CO1] 10M



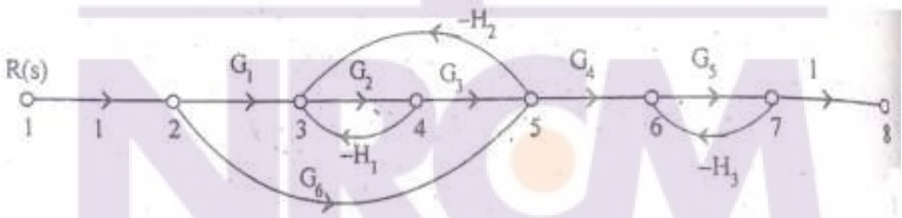
Q.6 a. Give the block diagram reduction rules to find the transfer function of the system. [L2,CO1] 8M

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

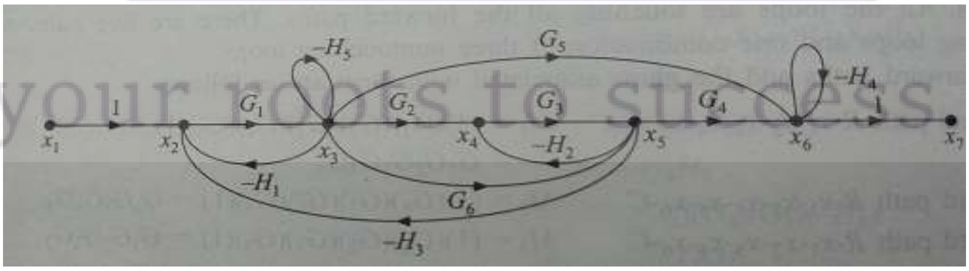
Q.7 For the system represented in the given figure, determine transfer function C(S)/R(S). [L3,CO1] 10M



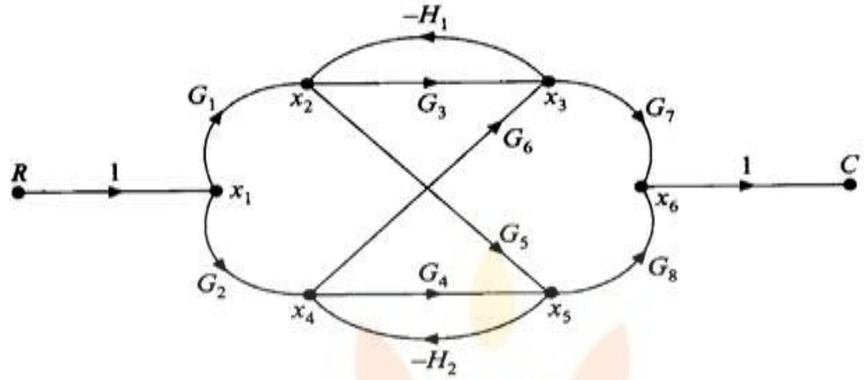
Q.8 Find the overall transfer function of the system whose signal flow graph is shown below. [L5,CO1] 10M



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' is the displacement of the input shaft and e =r – c. Determine undamped natural frequency, damping ratio and percentage maximum overshoot for unit step input. [L3,CO2] 10M

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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? [L3,CO2] 5M

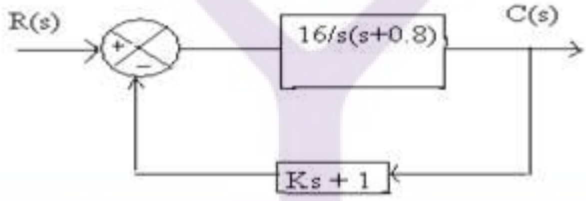
b. For servo mechanisms with open loop transfer function given below what type of input signal give rise to a constant steady state error and calculate their values. [L3,CO2] 5M

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

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 input is given by$\frac{(a-K)}{b}$ [L3,CO2] 5M

Q.9 For a unity feedback control system the open loop transfer function [L3,CO2] 10M

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

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

(ii) The steady state error when the input is **R(S)** = $\frac{3}{S} - \frac{2}{S^2} + \frac{1}{3S^3}$.

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

(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: [L5,CO3] 10M

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

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

Q.3 The open loop Transfer function of a unity feedback control system is given by **G(s)H(s)** = $\frac{K}{(S+2)(S+4)(S^2+6S+25)}$ Determine the value of K which will cause sustained oscillationsin the closed loop system and what is the corresponding oscillation Frequency. [L3,CO3] 10M

Q.4 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.5 Explain the procedure for constructing root locus. [L2,CO3] 10M

Q.6 Sketch the root locus of the system whose open loop transfer function is **G(s) H(s) =** $\frac{K}{S(S+2)(S+4)}$. [L3,CO3] 10M

Q.7 Sketch the root locus of the system whose open loop transfer function is [L3,CO3] 10M

$$G(s)\,H(s) = \frac{K}{S(S^2+4S+13)}$$

Q.8 Sketch the root locus of the system whose open loop transfer function is [L3,CO3] 10M

$$G(s)\,H(s) = \frac{K(S+9)}{S(S^2+4S+11)}$$

Q.9 Sketch the root locus of the system whose open loop transfer function is [L3,CO3] 10M

$$G(s)\,H(s) = \frac{K(S^2+6S+25)}{S(S+1)(S+2)}$$

Q.10 Sketch the root locus of the system whose open loop transfer function is [L3,CO3] 10M

$$G(s)H(s) = \frac{K}{S(S^2+6S+10)}$$

Q.11
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)** = $\frac{K e^{-0.1s}}{S(S+1)(1+0.1S)}$ [L3,CO4] 10M

Q.2 Sketch the Bode plot for the system having the following transfer function [L3,CO4] 10M

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

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)** = $\frac{20(0.1S+1)}{S^2(0.2S+1)\,(0.02S+1)}$ From the bode plot determine (a) Gain Margin (b) Phase Margin (c) Comment on the stability	[L3,CO4]	10M
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

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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: $\dot{X} = \begin{pmatrix} \mathbf{0} & \mathbf{1} \\ \mathbf{-2} & \mathbf{-3} \end{pmatrix}\mathbf{X} + \begin{pmatrix} \mathbf{0} \\ \mathbf{1} \end{pmatrix}\mathbf{U}$ with the unit step input and the initial conditions are $\mathbf{X(0)} = \begin{pmatrix} \mathbf{1} \\ \mathbf{1} \end{pmatrix}$.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 $Y = (1 \quad 0 \quad 0)X$

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

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

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

	b.	For the state equation: $\dot{X} = \begin{pmatrix} 1 & 0 \\ 1 & 1 \end{pmatrix} X + \begin{pmatrix} 0 \\ 1 \end{pmatrix} U$ when, $X(0) = \begin{pmatrix} 1 \\ 0 \end{pmatrix}$. Find the solution of the state equation for the unit step input.	[L2,CO5]	7M
Q.9	a.	Find the state model of the differential equation is $\dddot{y} + 2\ddot{y} + 3\dot{y} + 4y = u$	[L2,CO5]	5M
	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. $\dot{X}$ = Ax + Bu and y = Cx + Du	[L1,CO5]	5M
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

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