NARASIMHA REDDY ENGINEERING COLLEGE

(Autonomous)

Approved by AICTE, New Delhi & Affiliated to JNTUH, Hyderabad

Accredited by NAAC with A Grade, Accredited by NBA

ELECTRICAL AND ELECTRONICS ENGINEERING

QUESTION BANK

COURSE TITLE: CONTROL SYSTEM

COURSE CODE: 23EE502

REGULATION: NR23

COURSE OBJECTIVE:

- To understand the different ways of system representations such as Transfer function representation and state space representations and to assess the system dynamic response.
- To assess the system performance using time domain analysis and methods for improving it.
- To assess the system performance using frequency domain analysis and techniques for improving the performance.
- To design various controllers and compensators to improve system performance.

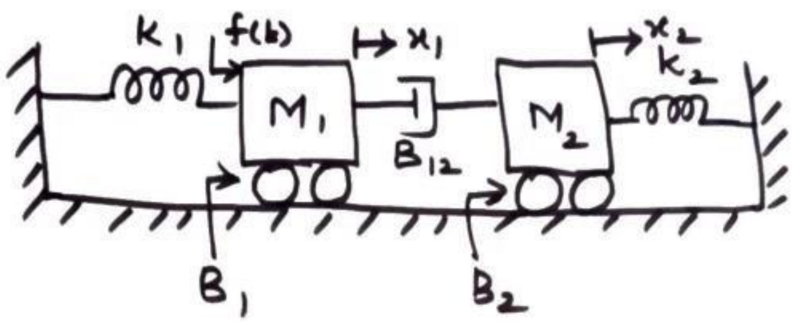
COURSE OUTCOMES (CO's) :

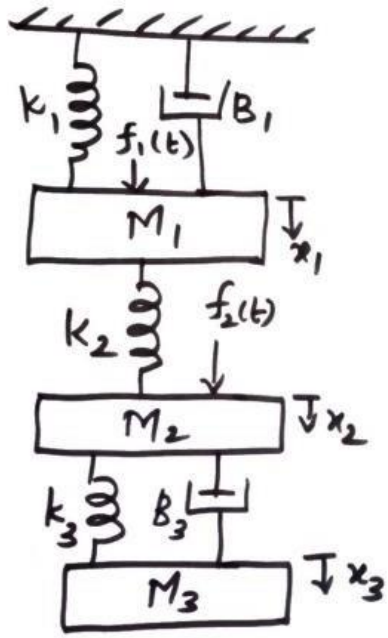
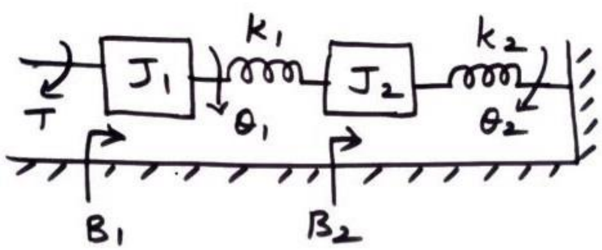
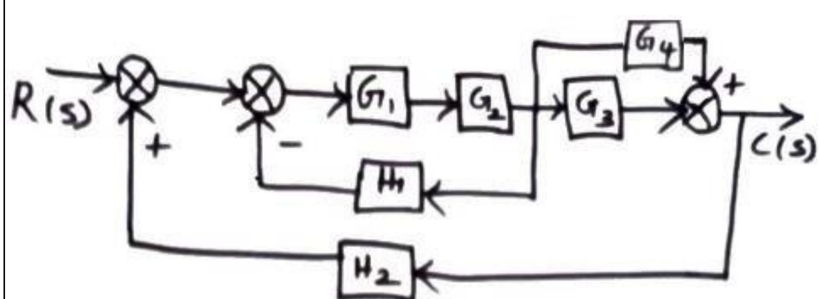
CO1	Model linear time-invariant systems using transfer functions and state-space representations for electrical, mechanical, and electromechanical systems.
CO2	Analyze the time-domain response of control systems using standard test inputs and derive transient and steady-state performance measures.
CO3	Evaluate system stability using Routh-Hurwitz criterion and root locus methods, and apply them to design basic feedback controllers.
CO4	Interpret frequency-domain responses using Bode, Polar, and Nyquist plots, and analyze relative stability through gain and phase margins.
CO5	Design and analyze state-space models, evaluate eigenvalues, and determine system properties such as controllability and observability.

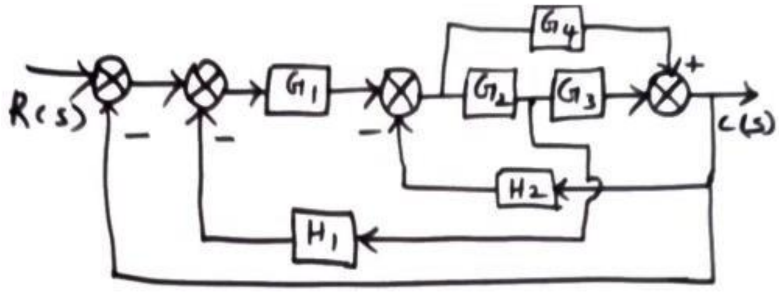
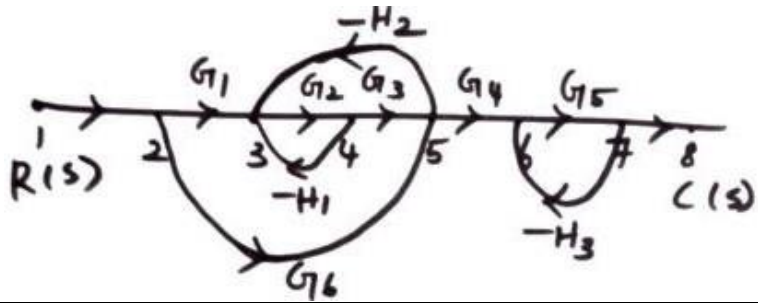
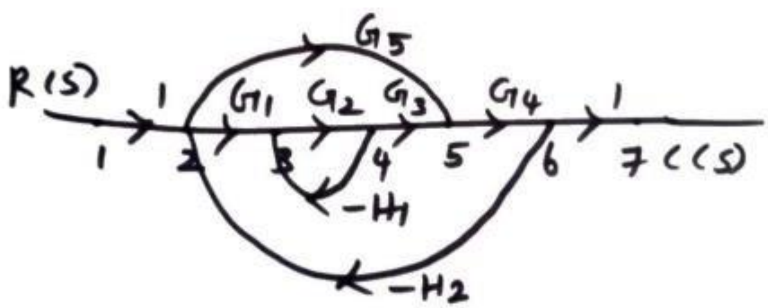
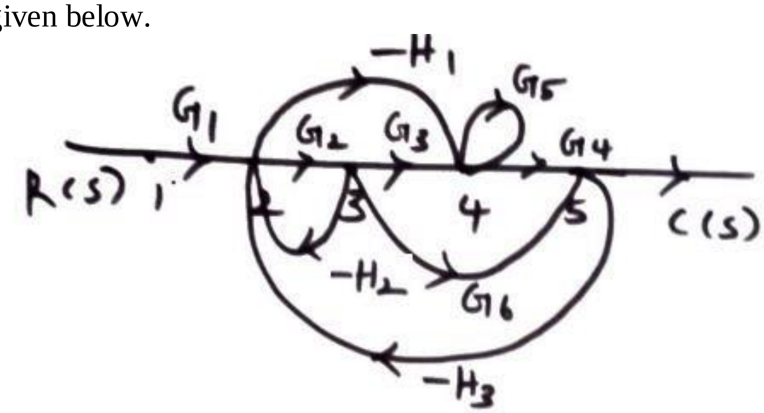
UNIT-I

Introduction to Control Systems

PART- A (SHORT ANSWER QUESTIONS)

S. No		Questions	BT	CO	PO
Part – A (Short Answer Questions)					
1		What is control system? What are the types of control system and explain it?	BT2	CO1	PO1
2		Distinguish between open loop and closed loop control systems.	BT1	CO1	PO1
3		What are the properties of signal flow graph?	BT2	CO1	PO1
4		What are the basic elements used for modeling mechanical rotational system?	BT2	CO1	PO1
5		What are the characteristics of negative feedback?	BT3	CO1	PO2
6		What are the properties of signal flow graph?	BT3	CO1	PO2
7		Define transfer function.	BT2	CO1	PO2
8		Write the mason's gain formula?	BT2	CO1	PO1
9		What are all the components of Block diagram?	BT2	CO1	PO2
10		What are all the two types of electrical analogous of mechanical system?	BT3	CO1	PO1
Part – B (Long Answer Questions)					
11	a)	Distinguish between open loop and closed loop control systems. Explain in detail about the classification of control system.	BT3	CO1	PO2
	b)	Determine the transfer function $X_2(S) / F(S)$ of the mechanical system shown in figure. 	BT2	CO1	PO2
12	a)	Write the governing differential equations of the mechanical system shown in figure. Draw the force voltage and force current electrical analogous circuits and verify by writing mesh and nod equations.	BT4	CO1	PO2

					
	b)	Write the governing differential equations of the mechanical rotational system shown in figure. Draw the torque voltage and torque current electrical analogous circuits and verify by writing mesh and nod equations. 	BT3	CO1	PO3
13	a)	Use block diagram reduction technique and derive the transfer function. 	BT3	CO1	PO2
	b)	Use block diagram reduction technique and derive the transfer function.	BT2	CO1	PO2

					
14	a)	Find the overall transfer function of the system whose signal flow graph is given below. 	BT3	CO1	PO2
	b)	Find the overall transfer function of the system whose signal flow graph is given below. 	BT3	CO1	PO3
15	a)	Find the overall transfer function of the system whose signal flow graph is given below. 	BT2	CO1	PO2
	b)	Derive the transfer function of Armature and Field controlled DC. motor with necessary circuits.	BT3	CO1	PO2

UNIT-II

TIME RESPONSE ANALYSIS

S. No		Questions	BT	CO	PO
Part – A (Short Answer Questions)					
1		What are transient and steady state response of a control system?	BT2	CO2	PO2
2		Distinguish between type and order of a system.	BT1	CO2	PO1
3		With reference to time response of a control system, define peak time.	BT3	CO2	PO2
4		What is first order and second order systems?	BT3	CO2	PO2
5		Define peak overshoot and settling time.	BT2	CO2	PO3
6		What will be the nature of response of a second order system with different types of damping?	BT2	CO2	PO1
7		What is the effect of PID controller on the system performance? Give the steady state error to a various standard input for type - 2 systems.	BT1	CO2	PO1
8		What is the effect of PID controller on the system performance? Why derivative controller is not used in control system?	BT3	CO2	PO2
9		Define delay time, rise time.	BT3	CO2	PO2
10		What is meant by steady state error?	BT2	CO2	PO3
Part – B (Long Answer Questions)					
11		List out the time domain specifications and derive the expressions for Rise time, Peak time and Peak overshoot.	BT3	CO2	PO2
12	a)	Obtain the response of a unity feedback control system whose open loop transfer function is given by G(S) = $\mathbf{5}\ /\boldsymbol{S}(\boldsymbol{S}+\mathbf{5})$	BT3	CO2	PO2
	b)	A closed loop servo is represented by the differential equation: $\boldsymbol{d}^2\boldsymbol{c}\ /\boldsymbol{dt}^2$ $\mathbf{2}$ + 8$\boldsymbol{dc}\ /\boldsymbol{dt}$ = 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.	BT3	CO2	PO2
13	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. G(s)H(s)= $\mathbf{10}\ /\boldsymbol{S}^2(\boldsymbol{S}+\mathbf{1})(\boldsymbol{S}+\mathbf{2})$	BT2	CO2	PO2
	b)	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.	BT3	CO2	PO3
14	a)	A unity feedback control system has an open loop transfer function, G(s) = $\mathbf{10}\ /\boldsymbol{S}(\boldsymbol{S}+\mathbf{2})$. Find the rise time, percentage overshoot, peak time and settling time for a step input of 12 units.	BT3	CO2	PO2
	b)	For a unity feedback control system the open loop transfer function G(S) = $\mathbf{10}/(\boldsymbol{S}+\mathbf{2})\ /\boldsymbol{S}^2(\boldsymbol{S}+\mathbf{1})$. (i) Determine the position, velocity and acceleration error constants. [L3,CO2] 10M QUESTION BANK 2020-21 CONTROL SYSTEMS Page 5 (ii) The steady state error when the input is R(S) = $\mathbf{3}\ /\boldsymbol{S} - \mathbf{2}/S^2 + \mathbf{1}\ /\mathbf{3}\boldsymbol{S}^2$.			
15	a)	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.	BT3	CO2	PO2
	b)	Determine the time response specifications and expression for output of the system described by the differential equation $\frac{d^2y}{dt^2}+$	BT2	CO2	PO2

		$4\frac{dy}{dt} + 8y = 8x$ for unit step input (y- output and x-input).			

UNIT-III

Stability Analysis in Time Domain & Root Locus Technique

S. No		Questions	BT	CO	PO
Part – A (Short Answer Questions)					
1		What is centroid? How the centroid is calculated?	BT1	CO3	PO1
2		Define root locus.	BT1	CO3	PO2
3		What is limitedly stable system?	BT2	CO3	PO2
4		What is the breakaway and break in point?	BT2	CO3	PO2
5		What is the Routh stability criterion?	BT2	CO3	PO2
6		What is the dominant pole?	BT2	CO3	PO2
7		Defined BIBO Stability.	BT2	CO3	PO2
8		What are the main advantages of root locus.	BT2	CO3	PO2
9		What is the necessary condition for stability?	BT3	CO3	PO2
10		What is marginally stable system?			
Part – B (Long Answer Questions)					
11	a)	With the help of Routh's stability criterion find the stability of the following systems represented by the characteristic equations: $S^6 + 2S^5 + 2S^4 + 3S^3 + 5S^2 + 2S + 1 = 0$	BT3	CO3	PO2
	b)	With the help of Routh's stability criterion find the stability of the following systems represented by the characteristic equations $S^5 + 2S^4 + 3S^3 + 6S^2 + 2S + 1 = 0$	BT3	CO3	PO3
12		Sketch the root locus of the system whose open loop transfer function is G(s) H(s) = $\mathbf{K} / \boldsymbol{S} (\boldsymbol{S}^2 + \mathbf{4}\boldsymbol{S} + \mathbf{13})$	BT3	CO3	PO2
13	a)	Explain the procedure for constructing root locus.	BT3	CO3	PO2
	b)	With the help of Routh's stability criterion find the stability of the following systems represented by the characteristic equation. 9s 5 -20s 4 + 10 s 3 - s 2 - 9s - 10 = 0	BT3	CO3	PO2
14	a)	Sketch the root locus of the system whose open loop transfer function is G(s) H(s) = $\boldsymbol{K}(\boldsymbol{S}+\mathbf{9})/\boldsymbol{S}(\boldsymbol{S}^{2}+\mathbf{4}\boldsymbol{S}+\mathbf{11})$	BT2	CO3	PO2
15	a)	Sketch the root locus of the system whose open loop transfer function is G(s)H(s) = $\mathbf{K}/\boldsymbol{S} (\boldsymbol{S}^2+\mathbf{6}\boldsymbol{S}+\mathbf{10})$	BT2	CO3	PO2
16	a)	Sketch the root locus of the system whose open loop transfer function is G(s) H(s) = $\mathbf{K}/\boldsymbol{S}(\boldsymbol{S} + \mathbf{2}) (\boldsymbol{S}+\mathbf{4})$	BT3	CO3	PO2

UNIT-IV

FREQUENCY RESPONSE ANALYSIS

PART- A (SHORT ANSWER QUESTIONS)

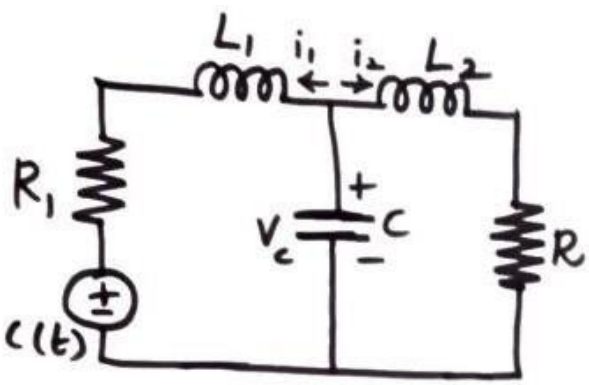
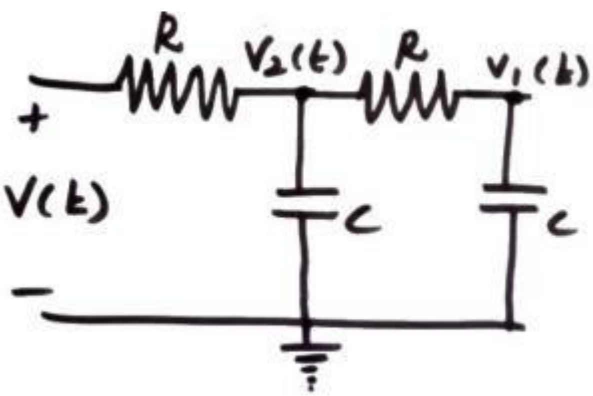
S. No		Questions	BT	CO	PO
Part – A (Short Answer Questions)					
1		Write the expression for resonant peak and resonant frequency?	BT1	CO4	PO1
2		What is phase margin? Define –Gain Margin?	BT2	CO4	PO2
3		What are the frequency domain specifications?	BT2	CO4	PO2
4		What is phase and gain cross over frequency?	BT2	CO4	PO2
5		What is frequency response? What are the advantages of frequency response analysis?	BT2	CO4	PO3
6		What are the main advantages of Bode plot?	BT1	CO4	PO2
7		Draw the polar plot of G(s)=1/(1+sT).	BT2	CO4	PO2
8		Draw the bode plot of $G(s)=K/S^n$	BT2	CO4	PO2
9		What is the polar plot?	BT1	CO4	PO1
10		What is the resonant frequency?	BT2	CO4	PO2
Part – B (Long Answer Questions)					
11	a)	Sketch the Bode plot for the system having the following transfer function $G(s) = 75\,(1+0.2S)/\,S(S^2 + 16S + 100)$ To determine the a) phase margin and gain margin.	BT2	CO4	PO2
12	a)	Sketch the polar plot for the open loop transfer function of a unity feedback system is given by $G(s) = 1\ S(1 + S)\ (1+ 2S)$. Determine Gain Margin & Phase Margin.	BT1	CO4	PO2
13	a)	Obtain the transfer function of Lead Compensator, draw pole-zero plot and write the procedure for design of Lead Compensator using Bode plot.	BT2	CO4	PO2
14	a)	Obtain the transfer function of Lag Compensator, draw pole-zero plot and write the procedure for design of Lag Compensator using Bode plot.			
15		Draw the Nyquist plot for the system whose open loop transfer function is, $G(s)H(s) = K\ S(S+2)\ (S+10)$. Determine the range of K for which closed loop system is stable.			

UNIT-V

State Variable Analysis and Concepts of State Variables

PART- A (SHORT ANSWER QUESTIONS)

S.No	Questions	BT	CO	PO
Part – A (Short Answer Questions)				
1	Determine the Solution for Homogeneous and Non homogeneous State equations	BT2	CO5	PO2
2	Write the state transition matrix?	BT2	CO5	PO2
3	Define state variable?	BT1	CO5	PO3
4	What is Diagonalize matrix?	BT1	CO5	PO2
5	Write the formula for solutions of state equation.	BT2	CO5	PO2
6	State the properties of State Transition Matrix.	BT1	CO5	PO2
7	Define Observability of a system.	BT2	CO5	PO2
8	Give the concept of controllability.	BT2	CO5	PO1

9		State sampling Theorem. Draw Sampler and Hold Circuit.	BT2	CO5	PO2
10		Write the formula for solutions of state equation.	BT3	CO5	PO2
Part – B (Long Answer Questions)					
11	a)	Define state, state variable, state equation	BT2	CO5	PO3
	b)	Distinguish between transfer function and state variable approach.	BT2	CO5	PO2
12	a)	Define state diagram. Write the state equation. Define state variable. Define state.	BT1	CO5	PO2
	b)	Obtain the state model of electrical network shown in figure by choosing minimum number of state variables.  	BT2	CO5	PO2
13	a)	Obtain the state model of electrical network shown in figure by choosing minimum number of state variables.  	BT1	CO5	PO2
	b)	Obtain the state model of the system whose transfer function is given by $\frac{Y(S)}{U(S)} = \frac{5S+6}{S^2+2S+3}$	BT3	CO5	PO2
14	a)	Determine the canonical state model of the system whose transfer function is given by $\frac{Y(S)}{U(S)} = \frac{2(S+5)}{(S+2)(S+3)(S+4)}$	BT2	CO5	PO1
	b)	Obtain the transfer function from state model $\begin{bmatrix}\dot{x}_1\\ \dot{x}_2\end{bmatrix} = \begin{bmatrix}-5 & -1\\ 3 & -1\end{bmatrix}\begin{bmatrix}x_1\\ x_2\end{bmatrix} + \begin{bmatrix}2\\ 5\end{bmatrix}u$ and $y = \begin{bmatrix}1 & 2\end{bmatrix}\begin{bmatrix}x_1\\ x_2\end{bmatrix}$	BT1	CO5	PO2

			BT	CO	PO
15	a)	Obtain the transfer function from state model $\begin{bmatrix}\dot{x}_1\\ \dot{x}_2\end{bmatrix} = \begin{bmatrix}0 & 1\\ -2 & -3\end{bmatrix}\begin{bmatrix}x_1\\ x_2\end{bmatrix} + \begin{bmatrix}0\\ 1\end{bmatrix}u$ and $y = \begin{bmatrix}1 & 0\end{bmatrix}\begin{bmatrix}x_1\\ x_2\end{bmatrix}$	BT4	CO5	PO2
	b)	Determine the state controllability and observability of the system $A = \begin{bmatrix}-3 & 1 & 1\\ -1 & 0 & 1\\ 0 & 0 & 1\end{bmatrix}$ $B = \begin{bmatrix}0 & 1\\ 0 & 0\\ 2 & 1\end{bmatrix}$ $C = \begin{bmatrix}0 & 0 & 1\\ 1 & 1 & 0\end{bmatrix}$	BT4	CO5	PO3

* **Blooms Taxonomy Level (BT)** (L1 – Remembering; L2 – Understanding; L3 – Applying; L4 – Analyzing; L5 – Evaluating; L6 – Creating

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