Enrolment No./Seat No_____

GUJARAT TECHNOLOGICAL UNIVERSITY

BE- SEMESTER– III EXAMINATION – SUMMER 2026

Subject Code:3130905 Date:02-07-2026

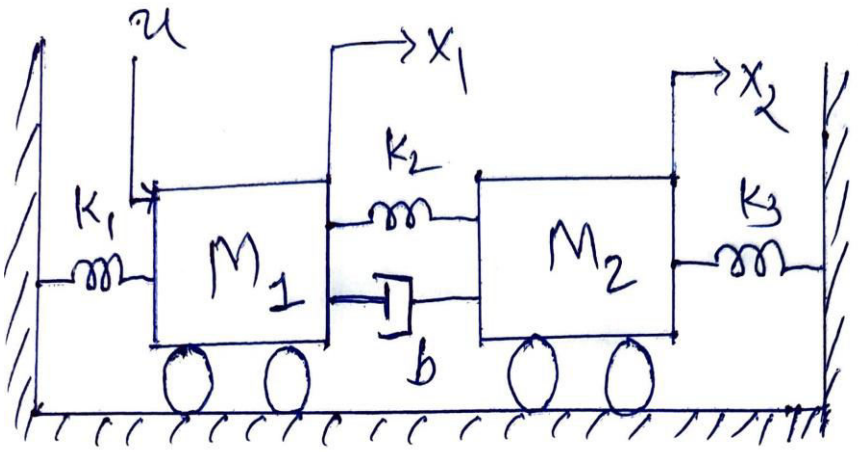
Subject Name:Control System Theory

Time:02:30 PM TO 05:00 PM Total Marks:70

Instructions:

1. **Attempt all questions.**
2. **Make suitable assumptions wherever necessary.**
3. **Figures to the right indicate full marks.**
4. **Simple and non-programmable scientific calculators are allowed.**

			MARKS
Q.1	**(a)**	Explain Standard Test Signals used in control system.	**03**
	(b)	Compare Open loop Vs Close loop control systems.	**04**
	(c)	Explain open loop control system with suitable example in detail.	**07**
Q.2	**(a)**	State advantages and limitations Routh's criteria.	**03**
	(b)	Define transfer function and State advantages and Dis-advantages of transfer function.	**04**
	(c)	The Characteristic equation of a feedback control system is $S^5+4S^4+8S^3+8S^2+7S+4=0$. Predict stability of system by using R-H criterion.	**07**
		OR	
	(c)	Describe the rules to reduce the Block Diagram to find transfer function of the control system.	**07**
Q.3	**(a)**	Calculate damping ratio and Undamped natural frequency of oscillation for the open loop transfer function of a servo system with unity feedback system: $G(S)=10/(S+2)(S+5)$	**03**
	(b)	Sketch the polar plot for the given transfer function G(s) = 10/S (S+2)	**04**
	(c)	Determine the transfer function for given mechanical system shown in below fig. and also draw the equivalent mechanical circuit.	**07**



Mechanical system

OR

Q.3	**(a)**	State limitations and effects of Lag compensator.	**03**
	(b)	Derive steady state error constants of the Type-1 system for a Step input.	**04**
	(c)	State and explain Nyquist Stability Criteria.	**07**
Q.4	**(a)**	Draw the step response of values of damping ration (i) $\zeta=1$ (ii) $\zeta < 1$ (iii) $\zeta>1$	**03**
	(b)	Define: Delay time, Rise time, Peak time and Settling time.	**04**
	(c)	Explain Proportional-Integral-Derivative (PID) Controller.	**07**

OR

Q.4	**(a)**	State the condition for stability of control system with respect to bode plot and Nyquist stability criterion.	**03**
	(b)	State the advantages of Bode Plot.	**04**
	(c)	Sketch the Root Locus Plot for the given transfer function $G(s)H(S)= K/S(S+4)(S^2+4S+20)$	**07**
Q.5	**(a)**	Define compensation. List out different types of compensations.	**03**
	(b)	Explain the effect of derivative control action on system performance.	**04**
	(c)	Write design procedure of Lag Compensation.	**07**

OR

Q.5	**(a)**	Define following terms. 1) State variable 2) State trajectory 3) State vector.	**03**
	(b)	Discuss properties of state transition matrix.	**04**
	(c)	Check Controllability and Observability of the system whose state model is given below.	**07**

$$\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \end{bmatrix} = \begin{bmatrix} -1 & 0 \\ 0 & -2 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} + \begin{bmatrix} 0 \\ 1 \end{bmatrix} u(t)$$

$$y(t) = \begin{bmatrix} 1 & 2 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix}$$

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Enrolment No./Seat No_____

GUJARAT TECHNOLOGICAL UNIVERSITY

BE - SEMESTER–III EXAMINATION – SUMMER 2025

Subject Code:3130905 Date:06-06-2025

Subject Name:Control System Theory

Time:02:30 PM TO 05:00 PM Total Marks:70

Instructions:

1. **Attempt all questions.**
2. **Make suitable assumptions wherever necessary.**
3. **Figures to the right indicate full marks.**
4. **Simple and non-programmable scientific calculators are allowed.**

			Marks
Q.1	**(a)**	Define the following terms. 1. Transfer function 2. Summing point 3. Take off point.	**03**
	(b)	Compare open loop and closed loop control systems.	**04**
	(c)	Explain block diagram reduction technique rules to find overall transfer function of control system.	**07**
Q.2	**(a)**	Define the standard test signals.	**03**
	(b)	Write advantages and features of transfer function.	**04**
	(c)	Determine the transfer function for given mechanical system shown in fig.1 and draw equivalent electrical circuit for F-V analogy.	**07**
		OR	
	(c)	Derive the transfer function of an armature-controlled D.C. motor.	**07**
Q.3	**(a)**	Define the following time response specifications. 1. Delay time 2. Rise time 3. Settling time	**03**
	(b)	Determine the stability of control system having following characteristic equation using R-H Criterion. $S^5+S^4+2S^3+2S^2+3S+5=0$	**04**
	(c)	Explain the analysis of first order system.	**07**
		OR	
Q.3	**(a)**	State the advantages of Nyquist plot.	**03**
	(b)	Sketch the polar plot for the transfer function $G(S)= 5/(S+1)(S+2)$	**04**
	(c)	Construct the bode plot for the given transfer function and determine the gain margin, phase margin and closed loop stability. $G(S)H(S)= 4/S(1+0.5S)(1+0.08S)$	**07**
Q.4	**(a)**	Draw the circuit of lead compensator and lag compensator.	**03**
	(b)	Explain about derivative control mode.	**04**
	(c)	Draw and explain the operation of electronic PID controller.	**07**
		OR	
Q.4	**(a)**	State the various compensation networks and different methods of compensation.	**03**
	(b)	Draw and explain polar plot of lag-lead network.	**04**
	(c)	Explain the design of Lag-Lead compensator using Root Locus.	**07**
Q.5	**(a)**	Write the properties of state transition matrix.	**03**
	(b)	State the advantages and limitations of state model using phase variables.	**04**
	(c)	Obtain the state space representation of given electrical circuit shown in fig.2	**07**
		OR	
Q.5	**(a)**	Define the terms: 1. Sate Variables 2. State Space 3. State Vector	**03**

(b) Find the controllability and Observability of the system described by the state equation: **04**

$$\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \end{bmatrix} = \begin{bmatrix} 3 & 0 \\ 2 & 4 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} + \begin{bmatrix} 0 \\ 1 \end{bmatrix} u$$

$$y = [1 \quad 0]\, x$$

(c) Obtain the state model of given mechanical model shown in fig.3 **07**

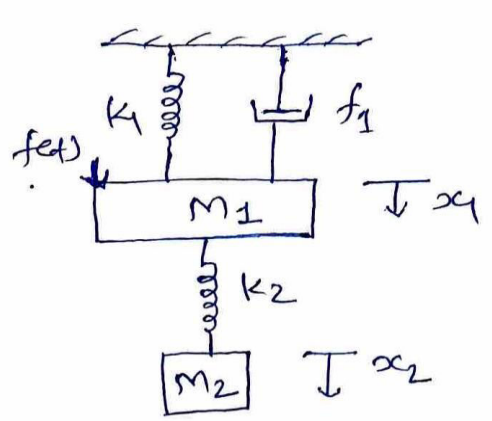


Fig. 1

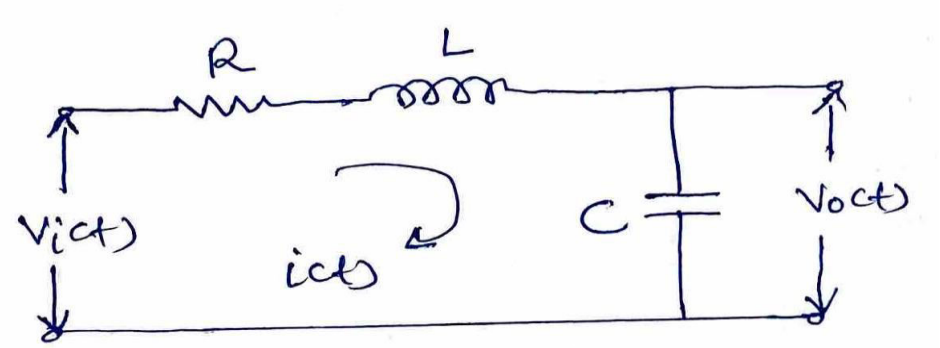


Fig : 2

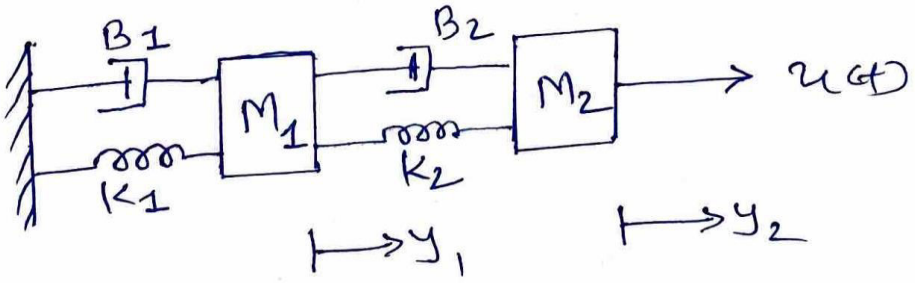


Fig : 3

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Enrolment No./Seat No_____

GUJARAT TECHNOLOGICAL UNIVERSITY

BE - SEMESTER–III (NEW) EXAMINATION – SUMMER 2024

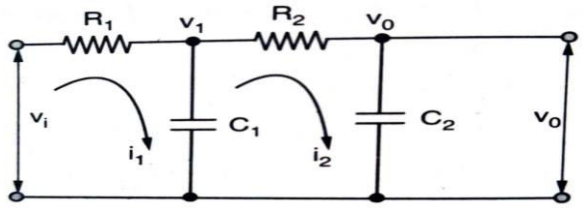
Subject Code:3130905 **Date:06-07-2024**

Subject Name: Control System Theory

Time:10:30 AM TO 01:00 PM **Total Marks:70**

Instructions:

1. **Attempt all questions.**
2. **Make suitable assumptions wherever necessary.**
3. **Figures to the right indicate full marks.**
4. **Simple and non-programmable scientific calculators are allowed.**

			MARKS
Q.1	**(a)**	Explain the block reduction technique for (a) shifting a summing point after the block (b) shifting a take-off point before a block (c) shifting a take-off point after a summing point	**03**
	(b)	A system is represented by $\frac{C(s)}{R(s)} = \frac{100}{s^2 + 7s + 25}$. Obtain the final value of $c(t)$ if the input $r(t)$ of 1.5 units.	**04**
	(c)	Obtain the transfer function of the circuit shown in the figure. for Comment on the response of the system $R_1 = R_2 = 1M\Omega, C_1 = 1\mu F, C_2 = 0.5\mu F$ 	**07**
Q.2	**(a)**	Define (a) Time response (b) Transient response (c) Steady state response	**03**
	(b)	Define (a) gain margin (b) phase margin (c) cut-off frequency	**04**
	(c)	A second order control system is represented by $\frac{\theta_o(s)}{T(s)} = \frac{1}{Js^2 + fs + K}$, where θ_o is the angular output and T is the input torque. If the step input of 10 N-m is applied, Design the value of J, f, and K for (1) Mp=6% (2) tp=1 sec (3) the steady state value of the output is 0.5 radian.	**07**
		OR	
	(c)	The maximum overshoot for a unity feedback control system having its forward path transfer function as $G(s) = \frac{K}{s(sT+1)}$ is to be reduced from 60% to 20%. The input to the system is a unit step function. Design the value of K to achieve the aforementioned reduction.	**07**
Q.3	**(a)**	State three advantages and dis-advantages of frequency domain approach	**03**
	(b)	Check the stability of the system having characteristics equation as $s^5 + s^4 + 2s^3 + 2s^2 + 3s + 15 = 0$ by writing Routh's array.	**04**
	(c)	Draw the root locus plot for a system having open loop transfer function as $G(s)H(s) = \frac{K}{s(s^2 + 2s + 2)}$. Comment on stability and response of the system	**07**
		OR	

Q.3 **(a)** Define (a) resonant peak (b) resonant frequency (c) cut-off rate **03**

(b) A unity feedback system has $G(s)=\frac{40(s+2)}{s(s+1)(s+4)}$. Obtain the steady state error for ramp input of magnitude 4. **04**

(c) Draw the root locus plot for a system having open loop transfer function as $G(s)H(s)=\frac{K}{s(s+1)(s+2)(s+3)}$. Comment on stability and response of the system **07**

Q.4 **(a)** State the effect of PD controller on the response of a second order system **03**

(b) Explain why PI controller reduces the steady state error of second order system to zero for ramp input **04**

(c) Draw the bode plot for a unity gain feedback system having $G(s)=\frac{80}{s(s+2)(s+20)}$ .Determine gain margin, phase margin, ω_{gc} , ω_{pc} and comment on stability **07**

OR

Q.4 **(a)** Define compensation. Explain series compensation. **03**

(b) Draw passive lag compensative network. Write the standard transfer function of the lag compensating network and hence draw PZ map and bode plot for the lag compensating network **04**

(c) A unity feedback control system has $G(s)=\frac{10}{s(s+1)(s+2)}$. Draw the Nyquist plot and comment on the stability of closed loop system **07**

Q.5 **(a)** State the advantages of state space approach **03**

(b) Derive the transfer function for a system with state model $\dot{x}=Ax+bu$, $y=Cx+Du$ **04**

(c) Consider a system having state model $\begin{bmatrix}\dot{x}_1\\ \dot{x}_2\end{bmatrix}=\begin{bmatrix}-2 & -3\\ 4 & 2\end{bmatrix}\begin{bmatrix}x_1\\ x_2\end{bmatrix}+\begin{bmatrix}3\\ 5\end{bmatrix}u$ and $y=\begin{bmatrix}1 & 1\end{bmatrix}\begin{bmatrix}x_1\\ x_2\end{bmatrix}$. Obtain its transfer function **07**

OR

Q.5 **(a)** Define (a) state variable (b) state vector (c) state space **03**

(b) State the properties of the state transition matrix **04**

(c) (a) Check observability of a system with system matrix $A=\begin{bmatrix}1 & 2\\ 3 & 4\end{bmatrix}$ and output matrix $C=\begin{bmatrix}1 & 2\end{bmatrix}$ **07**

(b) Check controllability of a system with system matrix $A=\begin{bmatrix}0 & 6 & -5\\ 1 & 0 & 2\\ 3 & 2 & 4\end{bmatrix}$ and input matrix $B=\begin{bmatrix}0\\ 1\\ 2\end{bmatrix}$

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Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

BE - SEMESTER–III(NEW) EXAMINATION – SUMMER 2023

Subject Code:3130905 Date:01-08-2023

Subject Name:Control System Theory

Time:02:30 PM TO 05:00 PM Total Marks:70

Instructions:

1. **Attempt all questions.**
2. **Make suitable assumptions wherever necessary.**
3. **Figures to the right indicate full marks.**
4. **Simple and non-programmable scientific calculators are allowed.**

			Marks
Q.1	**(a)**	Define following terms: 1. Control system 2. Plants 3. Process.	**03**
	(b)	Define the transfer function of a system.	**04**
	(c)	Determine the transfer function of the system shown in figure 1 by using block diagram reduction technique.	**07**

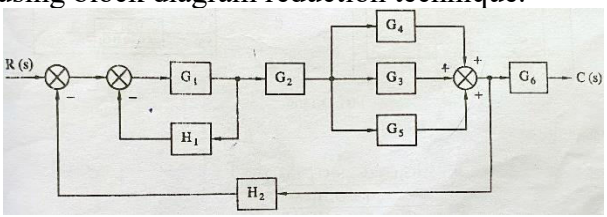


Figure 1

Q.2	**(a)**	Explain Steady state error.	**03**
	(b)	Explain about the time constant of first order system.	**04**
	(c)	Find K_p, Kv, K_a as well as steady state error for a system with open loop transfer function as G(S) H(S) = (10 (S+2) (S+3)) / (S (S+1) (S+5) (S+4)). Where input $r(t) = 3+t+t^2$.	**07**
		OR	
	(c)	List all the rules to construct a root locus and explain.	**07**
Q.3	**(a)**	State the advantages and limitation of frequency response analysis.	**03**
	(b)	For a second order system with unity feedback G(S) = 200/ S (S+8) response specification.	**04**
	(c)	For the unity feedback control system G(S) = 10 / S (S+1) (S+5). Sketch the bode plot. Determine the gain and phase margin. If the margin is increased to 150 %, what is the new gain margin and phase margin.	**07**
		OR	
Q.3	**(a)**	Write a brief note on polar plots with sketch of simple example.	**03**
	(b)	Sketch the polar plot for the given transfer function. G(s) = 10/ S+1	**04**
	(c)	Determine the stability of equation using roots criterion $S^3 + 6S^2 + 11S + 6 = 0$.	**07**
Q.4	**(a)**	Explain Nyquist stability criterion.	**03**
	(b)	Draw the Nyquist plot for the close loop transfer function. G(S) H(S) = 10 / (S+1) (S+2)	**04**
	(c)	Explain the derivative control mode. State it's characteristics.	**07**

OR

Q.4	**(a)**	Write a note on PID controller.	**03**
	(b)	Explain the Integral control mode and state it's characteristics.	**04**
	(c)	Draw the Nyquist plot for the close loop transfer function G(S) H(S) = 10 / S (S+1)	**07**
Q.5	**(a)**	What is compensation? Which is the various compensation scheme used in practice.	**03**
	(b)	Explain the design in frequency domain of load compensation.	**04**
	(c)	Obtain the state variable equation.	**07**

OR

Q.5	**(a)**	Obtain the state variable equation X = Ax + Bu and Y = Cx + Du. Also draw the state diagram.	**03**
	(b)	Define and explain following term w.r.t. frequency response. I. Gain margin II. Phase margin III. Gain cross over frequency IV. Phase cross over frequency	**04**
	(c)	Sketch the root locus of a unity feed back control system with G(S) = K / S (S+1) (S+3) and determine the value of K for marginal stability.	**07**

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Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

BE - SEMESTER– III (NEW) EXAMINATION – SUMMER 2022

Subject Code:3130905 Date:18-07-2022

Subject Name:Control System Theory

Time:02:30 PM TO 05:00 PM Total Marks:70

Instructions:

1. **Attempt all questions.**
2. **Make suitable assumptions wherever necessary.**
3. **Figures to the right indicate full marks.**
4. **Simple and non-programmable scientific calculators are allowed.**

Q.1	**(a)**	Define control system and give classification of control systems.	**03**
	(b)	State advantages and dis advantages of transfer function.	**04**
	(c)	Explain closed loop control system with suitable example in detail.	**07**
Q.2	**(a)**	Define transfer function and state methods to find transfer function of control system.	**03**
	(b)	Prepare table showing analogous quantities of Electrical and mechanical translation systems for F-V and F-I analogy.	**04**
	(c)	Determine the transfer function for given mechanical system shown in fig 1 and draw equivalent electrical circuit for F-V analogy.	**07**
		OR	
	(c)	Draw schematic diagram of Field controlled D.C. Motor and derive it's transfer function.	**07**
Q.3	**(a)**	List out the different types of Controllers.	**03**
	(b)	Define the following terms related to signal flow graph: 1. Source node 2. Sink node 3. Chain node. 4. Dummy node.	**04**
	(c)	Evaluate overall transfer function of the system shown in fig.2 using block diagram reduction technique.	**07**
		OR	
Q.3	**(a)**	Define the terms: - 1. Delay Time 2. Rise Time 3. Peak overshoot.	**03**
	(b)	For a system having G(S) = 15/(S+1) (S+3) , H(S)= 1. Determine (i) Characteristic equation (ii) Damping Ratio (iii) Undamped frequency.	**04**
	(c)	With neat sketch explain all the time response specifications.	**07**
Q.4	**(a)**	A system has G(S) = 50 (1+0.1S)/S (S+20) (0.02S+1) calculate corner frequencies of the system.	**03**
	(b)	State limitations of frequency Response Analysis.	**04**
	(c)	Explain constructional rules for Root Locus Technique.	**07**
		OR	
Q.4	**(a)**	Write technical note of Gain margin or Phase margin.	**03**
	(b)	Predict stability of control system for given characteristic equation using R-H Criterion. $S^5 + S^4 + 24S^3 + 48S^2 - 25S - 5 = 0$	**04**
	(c)	State and explain Nyquist Stability Criteria.	**07**
Q.5	**(a)**	Explain effect of PD controller on second order system.	**03**
	(b)	Write characteristics of PI (Proportional + Integral) Mode.	**04**
	(c)	Explain the design of lag compensator using root locus.	**07**
		OR	
Q.5	**(a)**	Define the terms: 1. State variable 2. State vector 3. State space.	**03**
	(b)	State advantages of State Variable Analysis.	**04**

(c) Obtain state model for given electrical system shown in fig 3. **07**

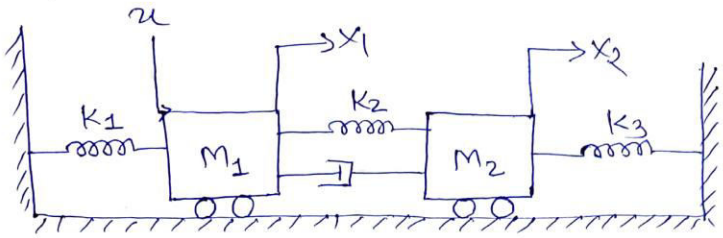


fig. 1

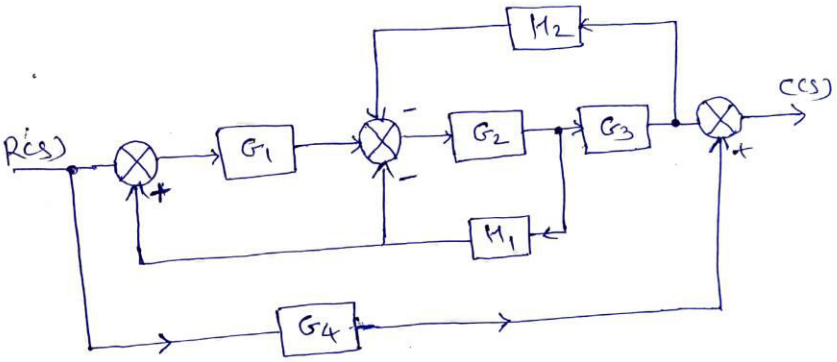


fig. 2

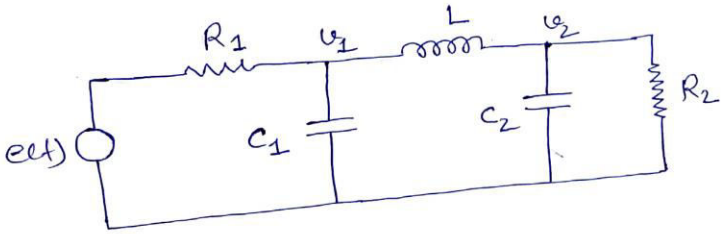


fig. 3

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