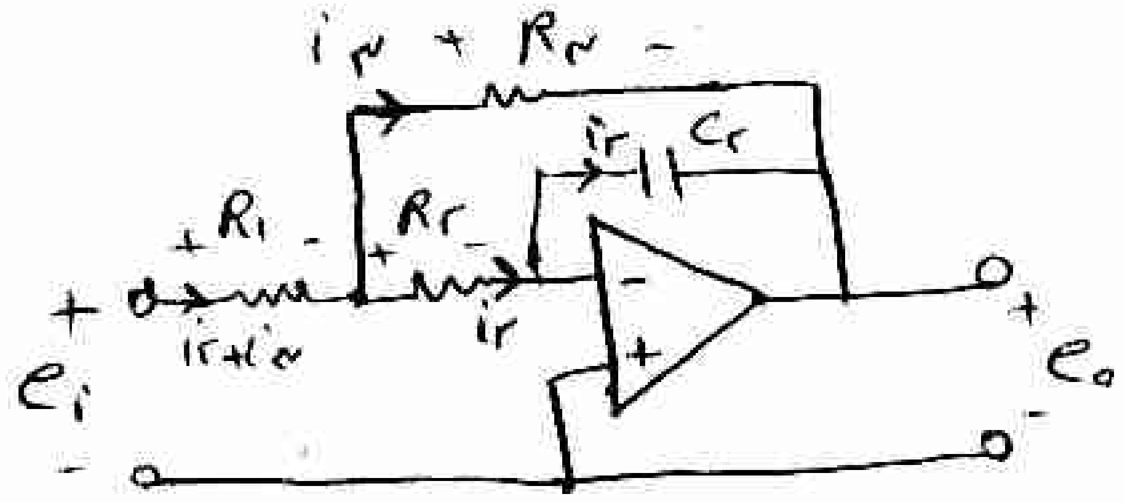
حل سوالات میان ترم :



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$$v_{R_3} = R_2 i_2 + \frac{1}{C_2 s} i_2 \to v_{R_3} = \left(R_2+\frac{1}{C_2 s}\right) i_2$$

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$$e_i = (i_2+i_3)R_1 + R_2 i_2 \to e_i = \left[i_2 + \left(\frac{R_2}{R_3}+\frac{1}{C_2 R_3 s}\right) i_2\right]R_1 + R_2 i_2$$

$$\to e_i = \frac{R_1R_3C_2 s + R_1R_2C_2 s + R_1 + R_2R_3C_2 s}{R_3C_2 s}\, i_2$$

$$\to i_2 = \frac{R_3 C_2 s}{(R_1R_3C_2+R_1R_2C_2+R_2R_3C_2)s+R_1}\, e_i$$

$$i_2 \times \frac{1}{C_2 s} + e_o = 0 \longrightarrow \frac{R_3}{C_2(R_1R_3+R_1R_2+R_2R_3)s+R_1}\, e_i = -e_o$$

$$\to \frac{e_o}{e_i} = -\frac{R_3}{C_2(R_1R_3+R_1R_2+R_2R_3)s+R_1}$$ تابع تبدیل

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۲ - در حالت تعادل، نیروی جاذبه وارد به هر کدام از اجسام با نیروهای وارد از طرف فنر و دمپر متصل به آنها برابر است

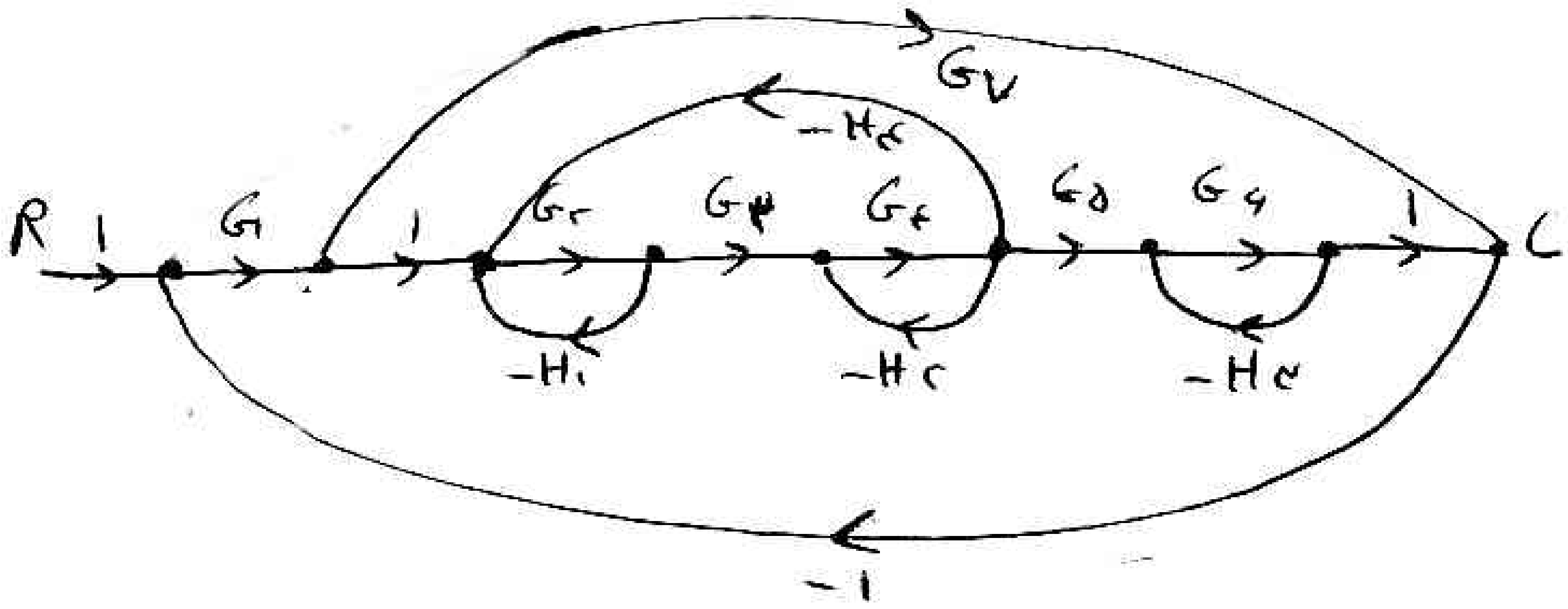
معادلات دیفرانسیل سیستم برای هرگونه تغییر وضعیت اجسام از حالت تعادل :

$$-k_1 y_1 - b(\dot{y}_1-\dot{y}_2) = m_1 \ddot{y}_1$$
$$-k_2 y_2 - b(\dot{y}_2-\dot{y}_1) = m_2 \ddot{y}_2$$

$$\begin{cases} y_1 = x_1 & \dot{y}_1 = x_3 \\ y_2 = x_2 & \dot{y}_2 = x_4 \end{cases}$$

$$\Rightarrow \begin{cases} \dot{x}_1 = x_3 \\ \dot{x}_2 = x_4 \\ \dot{x}_3 = -\frac{k_1}{m_1}x_1 - \frac{b}{m_1}x_3 + \frac{b}{m_1}x_4 \\ \dot{x}_4 = -\frac{k_2}{m_2}x_2 + \frac{b}{m_2}x_3 - \frac{b}{m_2}x_4 \end{cases} \Rightarrow \begin{pmatrix} \dot{x}_1 \\ \dot{x}_2 \\ \dot{x}_3 \\ \dot{x}_4 \end{pmatrix} = \begin{pmatrix} 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \\ -\frac{k_1}{m_1} & 0 & -\frac{b}{m_1} & \frac{b}{m_1} \\ 0 & -\frac{k_2}{m_2} & \frac{b}{m_2} & -\frac{b}{m_2} \end{pmatrix} \begin{pmatrix} x_1 \\ x_2 \\ x_3 \\ x_4 \end{pmatrix}$$

$$\begin{cases} y_1 = x_1 \\ y_2 = x_2 \end{cases} \Rightarrow \begin{pmatrix} y_1 \\ y_2 \end{pmatrix} = \begin{pmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \end{pmatrix} \begin{pmatrix} x_1 \\ x_2 \\ x_3 \\ x_4 \end{pmatrix}$$ معادلات خروجی



$P_1: G_1G_2G_3G_4G_5G_6$

$P_2: G_1G_7$

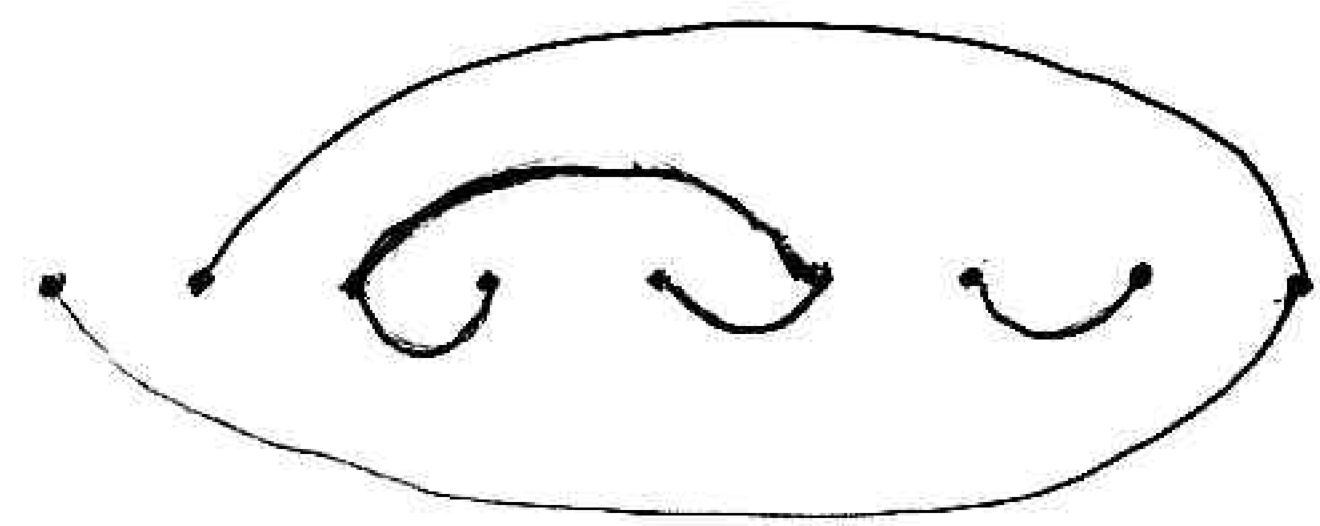
$C_1: -G_2H_1 \qquad C_4: -G_2G_3G_4H_4$

$C_2: -G_4H_2 \qquad C_5: -G_1G_7$

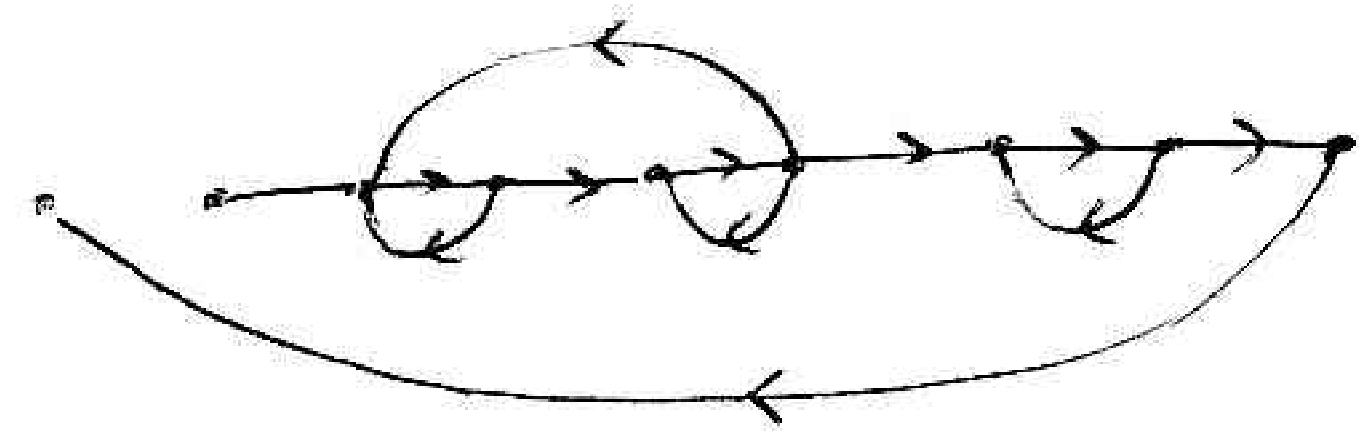
$C_3: -G_6H_3 \qquad C_6: -G_1G_2G_3G_4G_5G_6$

$$\Delta = 1-(C_1+C_2+C_3+C_4+C_5+C_6)+(C_1C_2+C_1C_3+C_2C_3+C_4C_3+C_4C_5+C_1C_5+C_2C_5$$
$$+C_3C_5)-(C_1C_2C_3+C_1C_2C_5+C_2C_3C_5+C_3C_4C_5)+(C_1C_2C_3C_5)$$

$\Delta_1 = 1$



$$\Delta_2 = 1-(C_1+C_2+C_3+C_4)+$$
$$(C_1C_2+C_1C_3+C_2C_3+C_3C_4)-$$
$$(C_1C_2C_3)$$



$$\frac{C}{R} = \frac{P_1\Delta_1+P_2\Delta_2}{\Delta}$$

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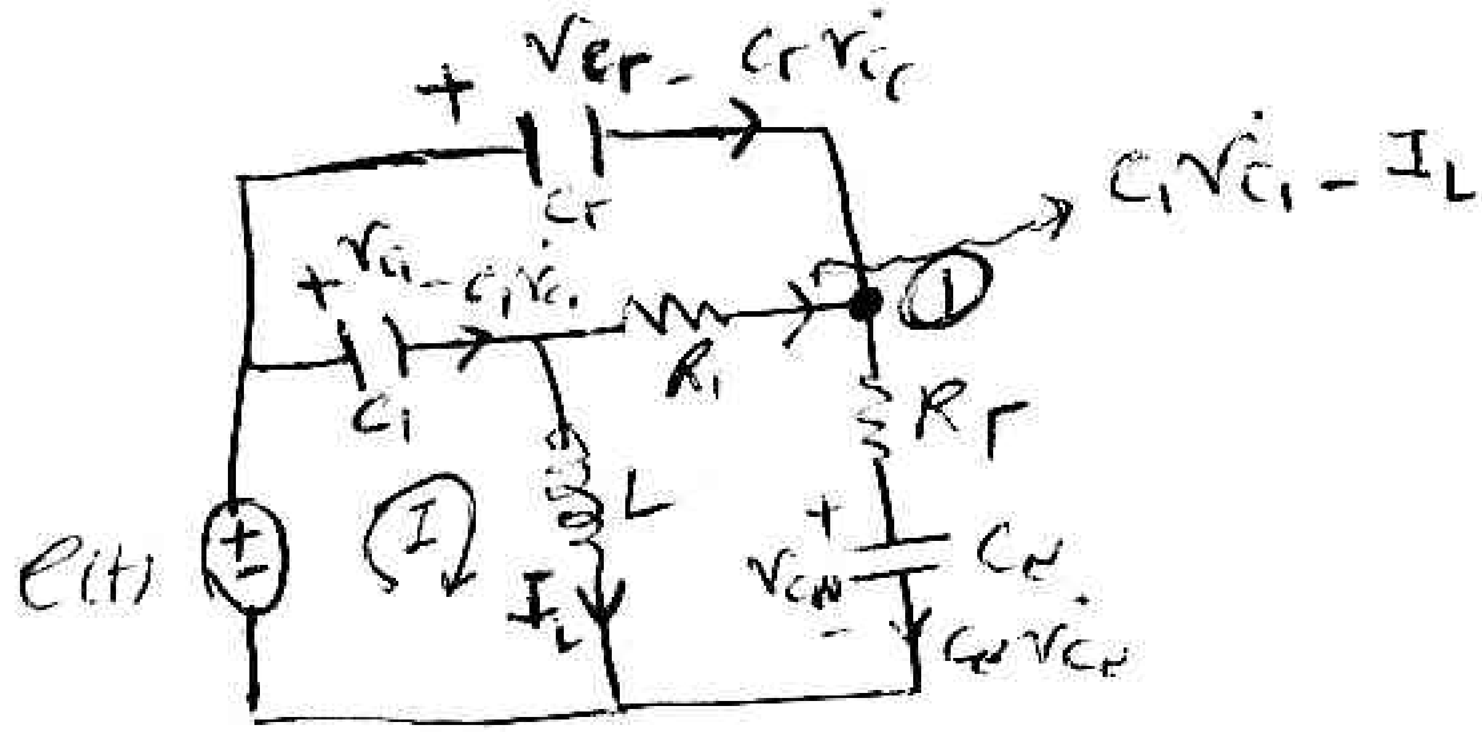
$$\frac{C}{R} = \frac{\omega_n^2}{s^2+2\zeta\omega_n s+\omega_n^2} \qquad M_p = e^{-\zeta\pi/\sqrt{1-\zeta^2}} = 0/25 \rightarrow -\frac{\zeta\pi}{\sqrt{1-\zeta^2}} = \ln 0/25$$

$$\rightarrow \frac{\zeta\pi}{\sqrt{1-\zeta^2}} = 1,3862 \rightarrow \zeta^2\pi^2 = 1,9218\,(1-\zeta^2) \rightarrow (\pi^2+1,9218)\,\zeta^2 = 1,9218 \rightarrow \zeta \simeq 0/4$$

$$t_p = \frac{\pi}{\omega_n\sqrt{1-\zeta^2}} \Rightarrow \frac{\pi}{\omega_n\sqrt{1-(0/4)^2}} = 0/1 \rightarrow \omega_n = 34/27$$



- ۵

KVL I: $e(t) = v_{C_1} + L\dfrac{dI_L}{dt} \rightarrow \dfrac{dI_L}{dt} = -\dfrac{v_{C_1}}{L} + \dfrac{e(t)}{L}$

KVL حلقه بیرونی : $e(t) = v_{C_2} + R_2C_3\dfrac{dv_{C_3}}{dt} + v_{C_3} \rightarrow \dfrac{dv_{C_3}}{dt} = -\dfrac{v_{C_2}}{R_2C_3} - \dfrac{v_{C_3}}{R_2C_3} + \dfrac{e(t)}{R_2C_3}$

KVL حلقه بالایی : $-v_{C_1} + v_{C_2} = R_1\left(C_1\dfrac{dv_{C_1}}{dt} - I_L\right) \rightarrow \dfrac{dv_{C_1}}{dt} = -\dfrac{v_{C_1}}{R_1C_1} + \dfrac{v_{C_2}}{R_1C_1} + \dfrac{I_L}{C_1}$

① در KCL : $C_2\dfrac{dv_{C_2}}{dt} = C_3\dfrac{dv_{C_3}}{dt} - \left(C_1\dfrac{dv_{C_1}}{dt} - I_L\right)$

$$\rightarrow C_2\frac{dv_{C_2}}{dt} = -\frac{v_{C_2}}{R_2} - \frac{v_{C_3}}{R_2} + \frac{e(t)}{R_2} + \frac{v_{C_1}}{R_1} - \frac{v_{C_2}}{R_1} - \cancel{I_L} + I_L$$

$$\rightarrow \frac{dv_{C_2}}{dt} = -\frac{v_{C_1}}{R_1C_2} - \left(\frac{1}{R_1} + \frac{1}{R_2}\right)\frac{v_{C_2}}{C_2} - \frac{v_{C_3}}{R_2C_2} + \frac{e(t)}{R_2C_2}$$

$$\begin{cases} v_{C_1} = x_1 \\ v_{C_2} = x_2 \\ v_{C_3} = x_3 \\ I_L = x_4 \end{cases} \Rightarrow \begin{pmatrix} \dot{x}_1 \\ \dot{x}_2 \\ \dot{x}_3 \\ \dot{x}_4 \end{pmatrix} = \begin{pmatrix} -\frac{1}{R_1C_1} & \frac{1}{R_1C_1} & 0 & \frac{1}{C_1} \\ -\frac{1}{R_1C_2} & -\frac{R_1+R_2}{R_1R_2C_2} & -\frac{1}{R_2C_2} & 0 \\ 0 & -\frac{1}{R_2C_3} & -\frac{1}{R_2C_3} & 0 \\ -\frac{1}{L} & 0 & 0 & 0 \end{pmatrix} \begin{pmatrix} x_1 \\ x_2 \\ x_3 \\ x_4 \end{pmatrix} + \begin{pmatrix} 0 \\ 1/R_2C_2 \\ 1/R_2C_3 \\ 1/L \end{pmatrix} e(t)$$