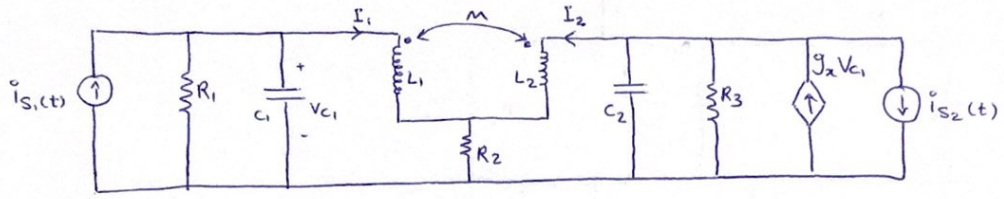
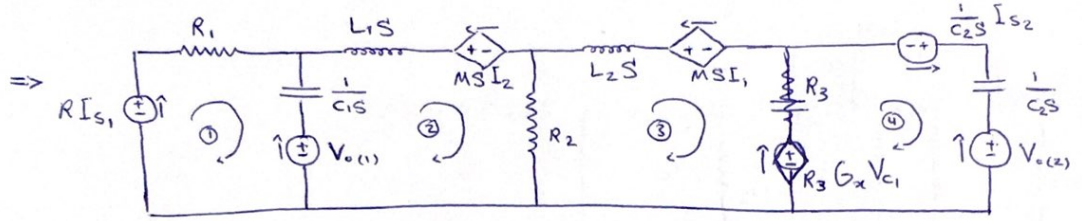
#4

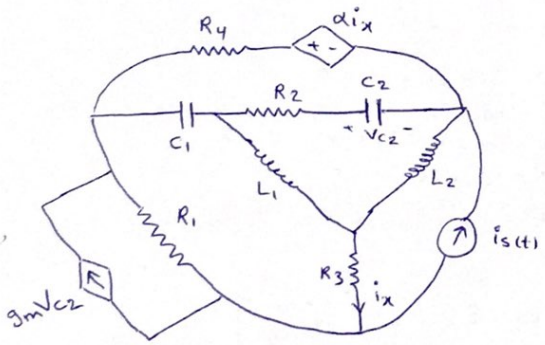


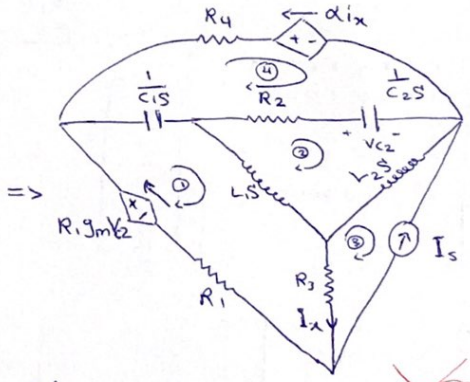


$$\begin{bmatrix} R_1+\frac{1}{C_1S} & \frac{-1}{C_1S} & 0 & 0 \\ \frac{-1}{C_1S} & L_1S+R_2+\frac{1}{C_1S} & -R_2-MS & 0 \\ \frac{R_3G_x}{C_1S}+0 & +MS-R_2-\frac{R_3G_x}{C_1S} & L_2S+R_3+R_2 & R_3 \\ 0 & 0 & -R_3 & R_3+\frac{1}{C_2S} \end{bmatrix} \begin{bmatrix} I_1 \\ I_2 \\ I_3 \\ I_4 \end{bmatrix} = \begin{bmatrix} RI_{S_1} \\ V_{o(1)} - MSI_2 \\ -MSI_1 - R_3G_xV_{C_1} \\ \frac{1}{C_2S}I_{S_2} - V_{o(2)} \end{bmatrix} \begin{matrix} RI_{S_1} \\ V_{o(1)} \\ 0 \\ 0 \end{matrix}$$

$$\left.\begin{aligned} \text{Nó 3: } & I_2 = -I_3 \\ \text{Nó 1: } & I_1 = I_2 \\ & V_{C_1} = \frac{1}{C_1S}(I_1 - I_2) \end{aligned}\right\}$$

#5

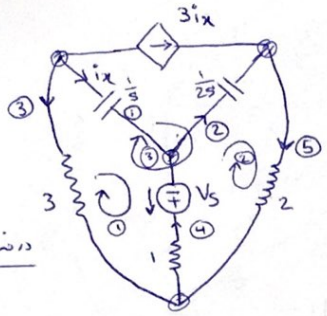




$$\begin{bmatrix} \frac{1}{C_1S}+L_1S+R_3+R_1 & +\frac{R_1g_m}{C_2S}-L_1S & -R_3 & \frac{-1}{C_1S} \\ -L_1S & R_2+\frac{1}{C_2S}+L_2S+L_1S & -L_2S & -R_2-\frac{1}{C_2S} \\ -R_3 & -L_2S & L_2S+R_3 & 0 \\ \frac{-1}{C_1S}+\alpha & -R_2-\frac{1}{C_2S} & 0+\alpha & R_4+\frac{1}{C_2S}+R_2+\frac{1}{C_1S} \end{bmatrix} \begin{bmatrix} I_1 \\ I_2 \\ I_3 \\ I_4 \end{bmatrix} = \begin{bmatrix} R_1g_mV_{C_2} \\ 0 \\ -I_S \\ -\alpha i_x \end{bmatrix} \begin{matrix} 0 \\ \\ \\ 0 \end{matrix}$$

$$\left.\begin{aligned} & V_{C_2} = I_{2x}\frac{1}{C_2S} \\ & I_x = I_1 - I_3 \\ & I_x = I_1 + I_S \end{aligned}\right\}$$

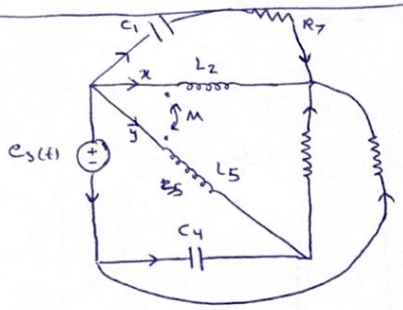
#6



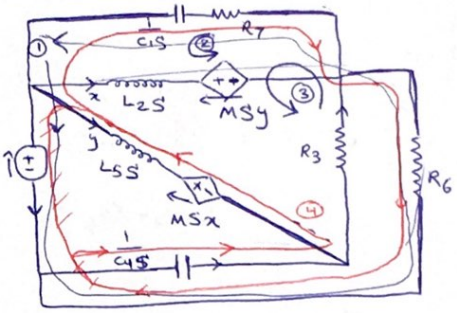
3,4,5 → درخت

$$\begin{bmatrix} \frac{1}{s}+1+3 & 1 & 3 \\ 1 & \frac{1}{2s}+3 & 2 \\ 3 & 2 & \frac{2+3}{2s} \end{bmatrix} \begin{bmatrix} I_1 \\ I_2 \\ I_3 \end{bmatrix} = \begin{bmatrix} V_s \\ -V_s \\ 0 \end{bmatrix}$$

#7



$\Rightarrow$

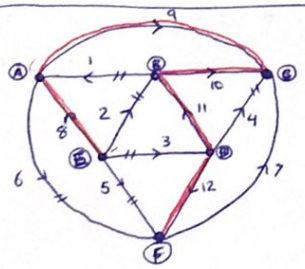


R_7, R_6, L_5 → درخت

$$\begin{bmatrix} R_6+R_7+\frac{1}{C_1S} & R_7+\frac{1}{C_1S} & R_7+\frac{1}{C_1S} & -R_7-\frac{1}{C_1S} \\ R_7+\frac{1}{C_1S} & R_7+\frac{1}{C_1S}+L_2S & \frac{1}{C_1S}+R_7+MS & \frac{-1}{C_1S}-R_7-MS \\ R_7+\frac{1}{C_1S} & R_7+\frac{1}{C_1S}+MS & R_3+R_7+\frac{1}{C_1S}+L_5S & -L_5S-R_7-\frac{1}{C_1S} \\ -R_7-\frac{1}{C_1S} & \frac{-1}{C_1S}-R_7-MS & -L_5S-R_7-\frac{1}{C_1S} & L_5S+R_7+\frac{1}{C_1S}+R_6+\frac{1}{C_4S} \end{bmatrix} \begin{bmatrix} I_1 \\ I_2 \\ I_3 \\ I_4 \end{bmatrix} = \begin{bmatrix} -E_s \\ -MSy \\ -MSx \\ MSx \end{bmatrix} \begin{matrix} \\ 0 \\ 0 \\ 0 \end{matrix}$$

$x = I_2 \;,\; y = I_3 - I_4$

#8



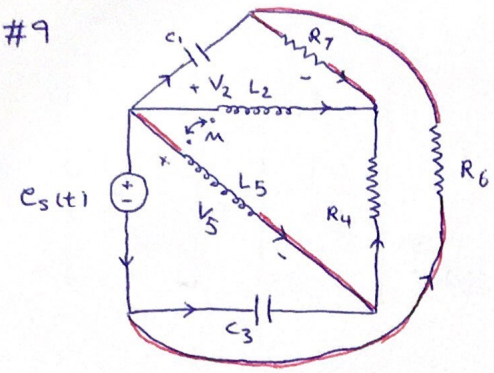
شاخه‌های درختی : $6-1=5$ → (8, 9, 10, 11, 12)

لینک : $12-5=7$ → (1, 2, 3, 4, 5, 6, 7)

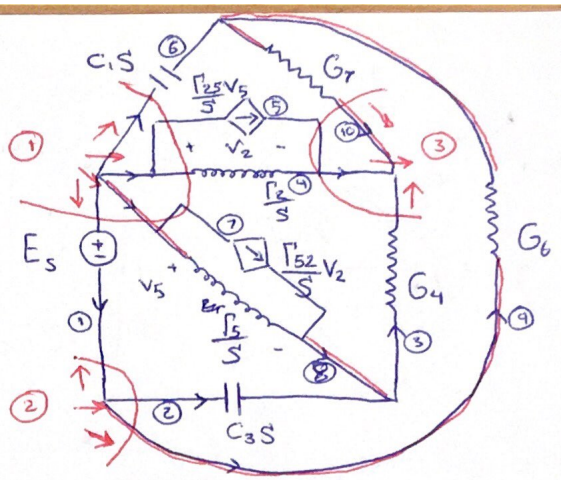
① : (1, 9, 10)
② : (8, 9, 10, 2)
③ : (9, 10, 11, 3, 8)
④ : (10, 4, 11)
⑤ : (8, 9, 10, 11, 12, 5)
⑥ : (12, 11, 10, 9, 6)
⑦ : (12, 11, 10, 7)

$$B = \begin{array}{c} \\ ① \\ ② \\ ③ \\ ④ \\ ⑤ \\ ⑥ \\ ⑦ \end{array} \begin{array}{c} \begin{array}{ccccccccccccc} 1 & 2 & 3 & 4 & 5 & 6 & 7 & 8 & 9 & 10 & 11 & 12 \end{array} \\ \begin{bmatrix} 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & -1 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 & 0 & 0 & -1 & -1 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 & 0 & 0 & -1 & -1 & 1 & 1 & 0 \\ 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & -1 & -1 & 0 \\ 0 & 0 & 0 & 0 & 1 & 0 & 0 & -1 & -1 & 1 & 1 & -1 \\ 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & -1 & 1 & 1 & -1 \\ 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & -1 & -1 & 1 \end{bmatrix} \end{array}$$

#9



$\Rightarrow$



روشن: $\begin{cases} L_5 \\ R_6 \\ R_7 \end{cases}$

$$\begin{bmatrix} \frac{\Gamma_5}{S} + \frac{\Gamma_2}{S} + C_1 S + \frac{\Gamma_{25}}{S} + \frac{\Gamma_{52}}{S} & 0 & \frac{\Gamma_2}{S} - \frac{\Gamma_{52}}{S} \\ 0 & C_3 S + G_6 & 0 \\ \frac{\Gamma_2}{S} + \frac{\Gamma_{25}}{S} & 0 & G_7 + \frac{\Gamma_2}{S} + G_4 \end{bmatrix} \begin{bmatrix} E_1 \\ E_2 \\ E_3 \end{bmatrix} = \begin{bmatrix} -\frac{\Gamma_{25}}{S} V_5 - \frac{\Gamma_{52}}{S} V_2 \\ 0 \\ -\frac{\Gamma_{25}}{S} V_5 \end{bmatrix}$$

$$Q = \begin{array}{c} \\ 1,8,7,4,5,6 \leftarrow ① \\ 1,2,9 \leftarrow ② \\ 3,4,5,10 \leftarrow ③ \end{array} \left[\begin{array}{cccccccc|ccc} 1 & 2 & 3 & 4 & 5 & 6 & 7 & 8 & 9 & 10 \\ \hline 1 & 0 & 0 & 1 & 1 & 1 & 1 & 1 & 0 & 0 \\ -1 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 1 & 1 & 1 & 0 & 0 & 0 & 0 & 1 \end{array}\right]$$

$$\left.\begin{array}{l} V_2 = E_1 - E_3 \\ V_5 = E_{31} \end{array}\right\}$$

#10

$$Q = \begin{bmatrix} 1 & 1 & -1 & 0 & -1 & -1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 & -1 & -1 & 0 & 0 & 0 \\ 0 & 0 & -1 & 0 & 0 & 0 & -1 & 1 & 0 \\ 0 & 0 & -1 & 0 & 0 & -1 & -1 & 0 & 1 \end{bmatrix}$$

درخت شبکه شبکه درخت شبکه شبکه شبکه درخت

$$\Rightarrow F = \begin{bmatrix} 1 & -1 & -1 & -1 & 0 \\ 0 & 0 & -1 & -1 & 0 \\ 0 & -1 & 0 & 0 & -1 \\ 0 & -1 & 0 & -1 & -1 \end{bmatrix} \Rightarrow -F^T = E = \begin{bmatrix} -1 & 0 & 0 & 0 \\ 1 & 0 & 1 & 1 \\ 1 & 1 & 0 & 0 \\ 1 & 1 & 0 & 1 \\ 0 & 0 & 1 & 1 \end{bmatrix}$$

$$\Rightarrow B = \begin{bmatrix} -1 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 1 & 0 & 1 & 0 & 0 & 0 & 0 & 1 & 1 \\ 1 & 0 & 0 & 1 & 1 & 0 & 0 & 0 & 0 \\ 1 & 0 & 0 & 1 & 0 & 1 & 0 & 0 & 1 \\ 0 & 0 & 0 & 0 & 0 & 0 & 1 & 1 & 1 \end{bmatrix}$$