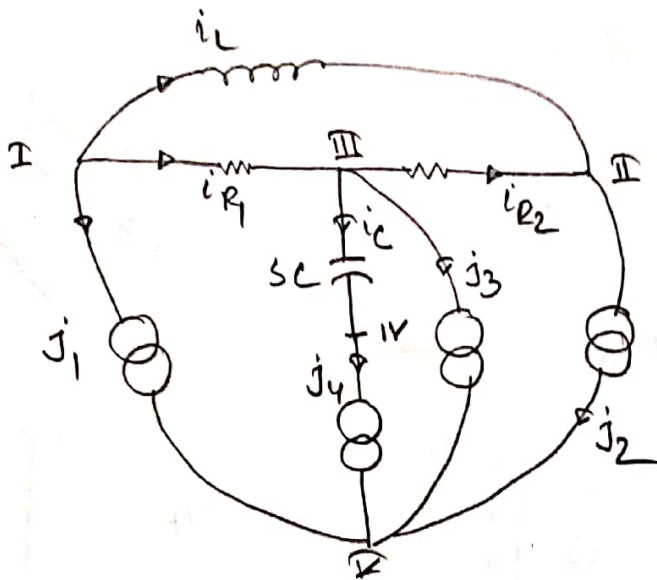


(a)



$$i_L = \frac{v_1 - v_2}{sL}$$

$$i_c = sC(v_3 - v_4)$$

$$i_{R1} = G_1(v_1 - v_3)$$

$$i_{R2} = G_2(v_3 - v_2)$$

$$j_1 = -i_L - i_{R1} = -\frac{v_1 - v_2}{sL} - G_1(v_1 - v_3)$$

$$= \left(-\frac{1}{sL} - G_1\right)v_1 + \frac{1}{sL}v_2 + G_1v_3$$

$$j_2 = i_L + i_{R2} = \frac{v_1}{sL} - \left(\frac{1}{sL} + G_2\right)v_2 + G_2v_3$$

$$j_3 = -i_c - i_{R2} + i_{R1}$$

$$= -sC(v_3 - v_4) - G_2(v_3 - v_2) + G_1(v_1 - v_3)$$

$$j_4 = G_1v_1 + G_2v_2 - (sC + G_2 + G_1)v_3 + sCv_4$$

$$j_4 = i_c = sC(v_3 - v_4)$$

Indefinite Admittance matrix =

$$\begin{bmatrix} \left(\frac{1}{sL} + G_1\right) & -\frac{1}{sL} & -G_1 & 0 \\ -\frac{1}{sL} & \frac{1}{sL} + G_2 & -G_2 & 0 \\ -G_1 & -G_2 & -sC + G_1 + G_2 & sC \\ 0 & 0 & sC & -sC \end{bmatrix}$$

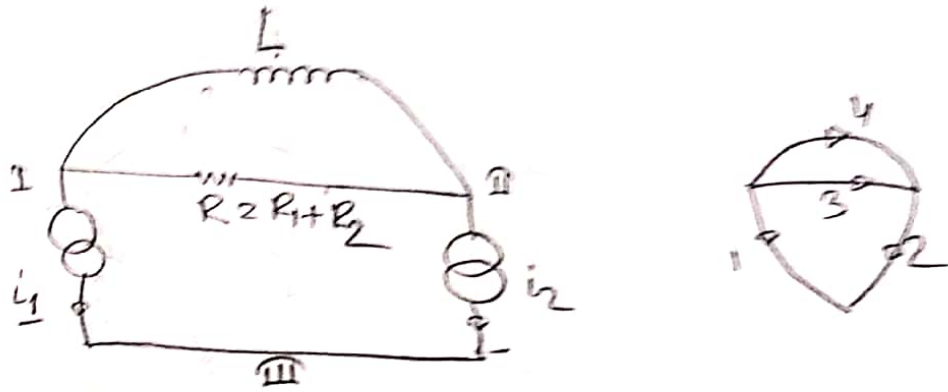
(b)

set $v_4 = 0$ then

$$\begin{bmatrix} -j_1 \\ -j_2 \\ -j_3 \end{bmatrix} = \begin{bmatrix} \frac{1}{sL} + G_1 & -\frac{1}{sL} & -G_1 \\ -\frac{1}{sL} & \frac{1}{sL} + G_2 & -G_2 \\ -G_1 & -G_2 & -sC + G_1 + G_2 \end{bmatrix} \begin{bmatrix} v_1 \\ v_2 \\ v_3 \end{bmatrix}$$

nodal admittance matrix

(c)



$$\begin{bmatrix} 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & G & 0 \\ 0 & 0 & 0 & \frac{1}{sL} \end{bmatrix} \begin{bmatrix} v_1 \\ v_2 \\ v_3 \\ v_4 \end{bmatrix} = \begin{bmatrix} 1 \\ 1 \\ 0 \\ 0 \end{bmatrix} \begin{bmatrix} i_1 \\ i_2 \\ i_3 \\ i_4 \end{bmatrix}$$

$$C \Rightarrow \begin{bmatrix} 0 \\ 0 \end{bmatrix} = \begin{bmatrix} 1 & 0 & 1 & 1 \\ 0 & 1 & -1 & -1 \end{bmatrix} \begin{bmatrix} i_1 \\ i_2 \\ i_3 \\ i_4 \end{bmatrix}$$

$$C Y_{b \times b} C^T = \begin{bmatrix} 1 & 0 & 1 & 1 \\ 0 & 1 & -1 & -1 \end{bmatrix} \begin{bmatrix} 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & G & 0 \\ 0 & 0 & 0 & \frac{1}{sL} \end{bmatrix} \begin{bmatrix} 1 & 0 \\ 0 & 1 \\ 1 & -1 \\ 1 & -1 \end{bmatrix}$$

$$= \begin{bmatrix} 0 & 0 & G & \frac{1}{sL} \\ 0 & 0 & -G & -\frac{1}{sL} \end{bmatrix} \begin{bmatrix} 1 \\ 0 \\ 1 \\ 1 \\ 0 \\ 1 \\ -1 \\ -1 \end{bmatrix}$$

$$= \begin{bmatrix} G + \frac{1}{sL} & -G - \frac{1}{sL} \\ -G - \frac{1}{sL} & G + \frac{1}{sL} \end{bmatrix}$$

$$Y = \begin{bmatrix} G + \frac{1}{sL} & -G - \frac{1}{sL} \\ -G - \frac{1}{sL} & G + \frac{1}{sL} \end{bmatrix}$$