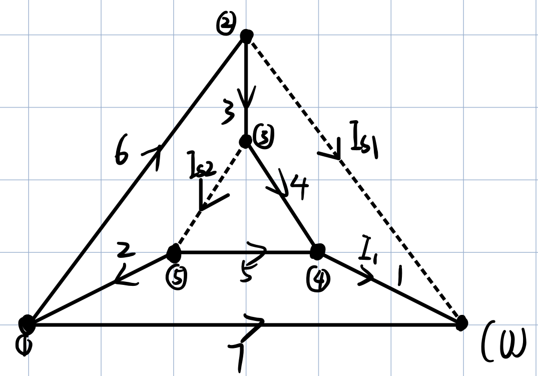
2-1 图 2-15 所示电路中，$L=1\text{H}$，$C=1\text{F}$，$R=1\Omega$，$\omega=1\text{rad/s}$，$I_s=1\angle 0^\circ\text{A}$，$\alpha=2$，$V_{s1}=1\angle 0^\circ\text{V}$，$V_{s2}=2\angle 0^\circ\text{V}$。试用修正节点法建立方程。



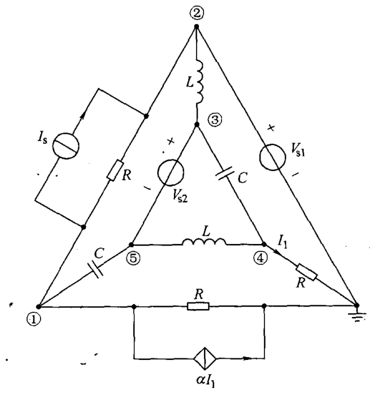


图 2-15　题 2-1 图

移去V_{s1} V_{s2}列写

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

$$\dot{U}_s=[\,0\ \ 0\ \ 0\ \ 0\ \ 0\ \ 0\ \ 0\,]^T$$

$$\dot{I}_s=[\,0\ \ 0\ \ 0\ \ 0\ \ 0\ \ I_s\ \ 0\,]^T$$

$$Y_e=\operatorname{diag}\left[\frac{1}{R}\ \ j\omega C\ \ \frac{1}{j\omega L}\ \ j\omega C\ \ \frac{1}{j\omega L}\ \ \frac{1}{R}\ \ \frac{1}{R}\right]$$

只存在一个流控流源，故 $G=0$　$\mu=0$　$R=0$

$$Y_b = (1+\beta) Y_e = \begin{bmatrix} \frac{1}{R} & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & j\omega C & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & \frac{1}{j\omega L} & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & j\omega C & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & \frac{1}{j\omega L} & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & \frac{1}{R} & 0 \\ \alpha & 0 & 0 & 0 & 0 & 0 & \frac{1}{R} \end{bmatrix}$$

$$\overline{Y_n} = A Y_b A^{-1} = \begin{bmatrix} 2+j & -1 & 0 & 2 & -j \\ -1 & 1-j & j & 0 & 0 \\ 0 & j & 0 & -j & 0 \\ 0 & 0 & -j & 1 & j \\ -j & 0 & 0 & j & 0 \end{bmatrix}$$

$$A_w = \begin{bmatrix} 0 & 1 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & -1 \end{bmatrix}^T$$

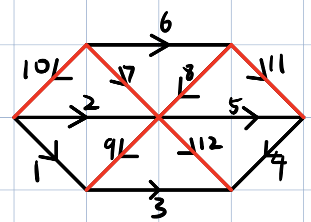
$$\overline{J_n} = A\overline{Y_b}\dot{U}_s - A\dot{I}_s = \begin{bmatrix} -1\angle 0^\circ & 1\angle 0^\circ & 0 & 0 & 0 \end{bmatrix}^T$$

节点电压方程：

$$\left[\begin{array}{c:c} \overline{Y_n} & A_w \\ \hdashline A_w^T & 0 \end{array}\right] \begin{bmatrix} V_n \\ \hdashline I_w \end{bmatrix} = \begin{bmatrix} \overline{J_n} \\ V_{ws} \end{bmatrix}$$

$$\left[\begin{array}{ccccc:cc} 2+j & -1 & 0 & 2 & -j & 0 & 0 \\ -1 & 1-j & j & 0 & 0 & 1 & 0 \\ 0 & j & 0 & -j & 0 & 0 & 1 \\ 0 & 0 & -j & 1 & j & 0 & 0 \\ -j & 0 & 0 & j & 0 & 0 & -1 \\ \hdashline 0 & 1 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & -1 & 0 & 0 \end{array}\right] \begin{bmatrix} \dot{V}_1 \\ \dot{V}_2 \\ \dot{V}_3 \\ \dot{V}_4 \\ \dot{V}_5 \\ \dot{I}_{s1} \\ \dot{I}_{s2} \end{bmatrix} = \begin{bmatrix} -1\angle 0^\circ \\ 1\angle 0^\circ \\ 0 \\ 0 \\ 0 \\ 1\angle 0^\circ \\ 2\angle 0^\circ \end{bmatrix}$$

2-3 图 2-17 所示电路中 $R_1=R_3=R_5=R_7=R_9=1\Omega$，$R_2=R_4=R_6=R_8=0.5\Omega$，$I_{s3}=1\text{A}$，$I_{s6}=2\text{A}$，$V_{s4}=4\text{V}$，$V_{s10}=1\text{V}$，$V_{s11}=2\text{V}$，$V_{s12}=3\text{V}$，试用割集法建立方程，并求支路电压向量。



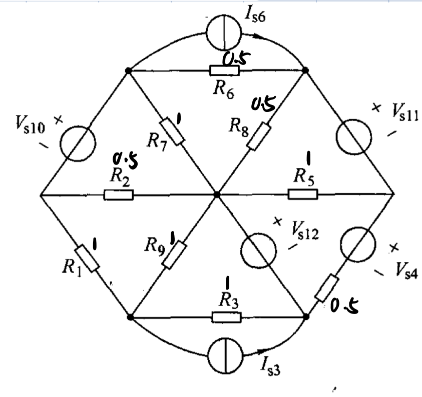


图 2-17 题 2-3 图

确定树为 7, 8, 9, 10, 11, 12

$$
\begin{array}{c}
\begin{array}{cccccccccccc} 1 & 2 & 3 & 4 & 5 & 6 & 7 & 8 & 9 & 10 & 11 & 12 \end{array} \\
Q_f = \left[\begin{array}{ccccccccc:ccc}
1 & 1 & 0 & 0 & 0 & 1 & 1 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 1 & -1 & -1 & 0 & 1 & 0 & 0 & 0 & 0 \\
1 & 0 & -1 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 \\
\hdashline
-1 & -1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 \\
0 & 0 & 0 & -1 & 1 & 0 & 0 & 0 & 0 & 0 & 1 & 0 \\
0 & 0 & 1 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1
\end{array}\right]
\end{array}
$$

支路导纳矩阵：

$$Y_{b1} = \mathrm{diag}\left[\frac{1}{R_1}\ \frac{1}{R_2}\ \frac{1}{R_3}\ \frac{1}{R_4}\ \frac{1}{R_5}\ \frac{1}{R_6}\ \frac{1}{R_7}\ \frac{1}{R_8}\ \frac{1}{R_9}\right]$$

电压源 $$U_s = \left[\begin{array}{ccccccccc:ccc} 0 & 0 & 0 & V_{s4} & 0 & 0 & 0 & 0 & 0 & V_{s10} & V_{s11} & V_{s12} \end{array}\right]^T$$

电流源 $$I_s = \left[\begin{array}{ccccccccc:ccc} 0 & 0 & I_{s3} & 0 & 0 & I_{s6} & 0 & 0 & 0 & 0 & 0 & 0 \end{array}\right]^T$$

割集导纳矩阵

$$Y_q = a_{11} Y_{b1} a_{11}^T$$

$$= \begin{bmatrix} 6 & -2 & 1 \\ -2 & 7 & 0 \\ 1 & 0 & 3 \end{bmatrix}$$

$$Y_q \dot{U}_{t1} = a_{11} Y_{b1} (\dot{U}_{s1} - a_{21}^T \dot{U}_{s2}) - a_{11} \dot{I}_{s1}$$

$$\begin{bmatrix} 6 & -2 & 1 \\ -2 & 7 & 0 \\ 1 & 0 & 3 \end{bmatrix} \begin{bmatrix} U_7 \\ U_8 \\ U_9 \end{bmatrix} = \begin{bmatrix} 1 \\ 10 \\ 5 \end{bmatrix}$$

解得 $\begin{cases} U_7 = 0.4299 \\ U_8 = 1.5514 \\ U_9 = 1.5234 \end{cases}$

$$U_t = \begin{bmatrix} 0.4299 \\ 1.5514 \\ 1.5234 \\ 1 \\ 2 \\ 3 \end{bmatrix} \qquad U_b = a_f^T U_t = \begin{bmatrix} 0.9533 \\ -0.5701 \\ 1.4766 \\ 2.5514 \\ 0.4486 \\ -1.1215 \\ 0.4299 \\ 1.5514 \\ 1.5234 \\ 1 \\ 2 \\ 3 \end{bmatrix}$$