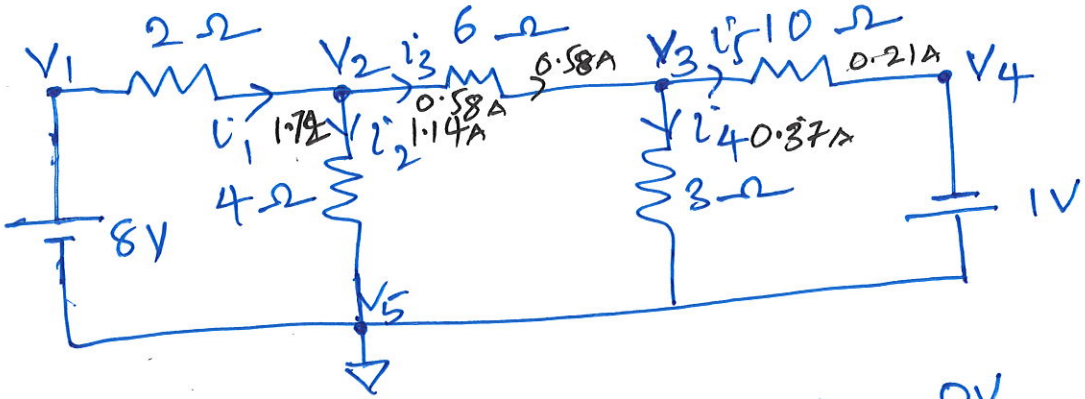
Nodal Analysis



$V_1 = 8V \quad V_4 = -1V \quad V_5 = 0V$

At node v_2, $i_1 = i_2 + i_3$ (KCL)

$i_1 = \frac{V_1 - v_2}{2} \quad i_2 = \frac{v_2}{4} \quad i_3 = \frac{v_2 - v_3}{6}$

$$\frac{8 - v_2}{2} = \frac{v_2}{4} + \frac{v_2 - v_3}{6}$$

$$\frac{8}{2} = \frac{v_2}{2} + \frac{v_2}{4} + \frac{v_2}{6} - \frac{v_3}{6}$$

$$\frac{11}{12} v_2 - \frac{v_3}{6} = 4$$

$$11 v_2 - 2 v_3 = 48 \quad - (1)$$

At node v_3: $i_3 = i_4 + i_5$ (KCL)

$i_3 = \frac{v_2 - v_3}{6} \quad i_5 = \frac{V_3 - V_4}{10} = \frac{v_3 + 1}{10}$

$i_4 = \frac{v_3}{3}$

$$\frac{v_2 - v_3}{6} = \frac{v_3}{3} + \frac{v_3 + 1}{10}$$

$$\frac{v_2}{6} - \frac{v_3}{6} - \frac{v_2}{3} - \frac{v_2}{10} = \frac{1}{10}$$

$$\frac{v_2}{6} - \frac{36 v_3}{60} = \frac{1}{10}$$

$$10 v_2 - 36 v_3 = 6 \quad -(2)$$

Solving (1) & 2

$$11 v_2 - 2 v_3 = 48$$

$$10 v_2 - 36 v_3 = 6$$

$$\begin{bmatrix} 11 & -2 \\ 10 & -36 \end{bmatrix} \begin{bmatrix} v_2 \\ v_3 \end{bmatrix} = \begin{bmatrix} 48 \\ 6 \end{bmatrix}$$

$$A = \begin{bmatrix} 11 & -2 \\ 10 & -36 \end{bmatrix} \quad X = \frac{v_2}{v_3} \quad B = \begin{bmatrix} 48 \\ 6 \end{bmatrix}$$

$$\text{Det}[A] = 11 \times (-36) - 10(-2) = -376$$

$$v_2 = \frac{\det \begin{bmatrix} 48 & -2 \\ 6 & -36 \end{bmatrix}}{\det [A]} = \frac{-1716}{-376} = 4.56\ V$$

$$v_3 = \frac{\det \begin{bmatrix} 11 & +48 \\ 10 & 6 \end{bmatrix}}{\det [A]} = \frac{-414}{-376} = 1.1\ V$$

$$i_1 = \frac{8 - 4.56}{2} = 1.72\ A \quad i_2 = 1.14 A$$

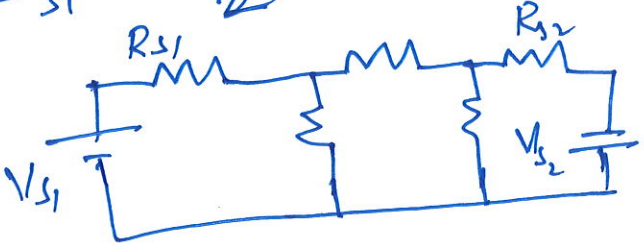
$$i_3 = 0.58 A \quad i_4 = 0.37 A \quad i_5 = 0.21 A$$

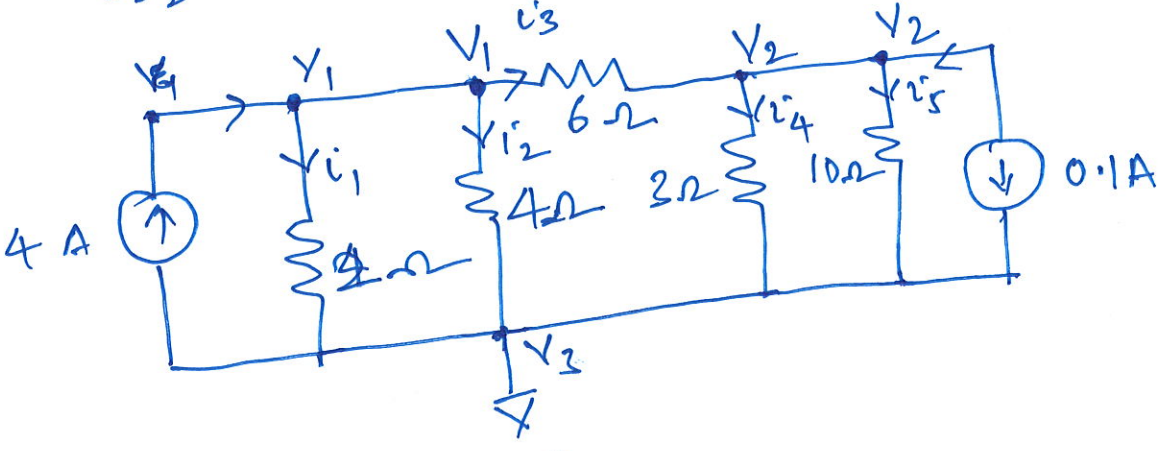
Using Source transformation

$V_{s_1} = 8V \quad R_{s_1} = 2\Omega \quad I_{s_1} = \frac{8}{2} = 4A$

$V_{s_2} = 1V \quad R_{s_2} = 10\Omega$

$I_{s_2} = 0.1A$





KCL at node V_1,

$$i_1 + i_2 + i_3 = 4A$$

$$i_1 = \frac{V_1}{2} \quad i_2 = \frac{V_1}{4} \quad i_3 = \frac{V_1 - V_2}{6}$$

$$\frac{V_1}{2} + \frac{V_1}{4} + \frac{V_1 - V_2}{6} = 4$$

$$\frac{11}{12} V_1 - \frac{1}{6} V_2 = 4 \Rightarrow 11V_1 - 2V_2 = 48 \quad -(1)$$

KCL at node V_2, $i_3 + (-0.1) = i_4 + i_5$

$$\frac{V_1 - V_2}{6} + (-0.1) = \frac{V_2}{3} + \frac{V_2}{10}$$

$$\frac{V_1}{6} + \frac{(-36)V_2}{60} = \frac{1}{10}$$

$$10v_1 - 36v_2 = 6 \quad - (2)$$

Solving (1) & (2)

$v_1 = 4.56\ V \quad v_2 = 1.1\ V$

$i_1 = 2.28\ A \quad i_2 = 1.14\ A \quad i_3 = 0.58\ A$ ~~0.19A~~

$i_4 = 0.37\ A \quad i_5 = 0.11\ A$