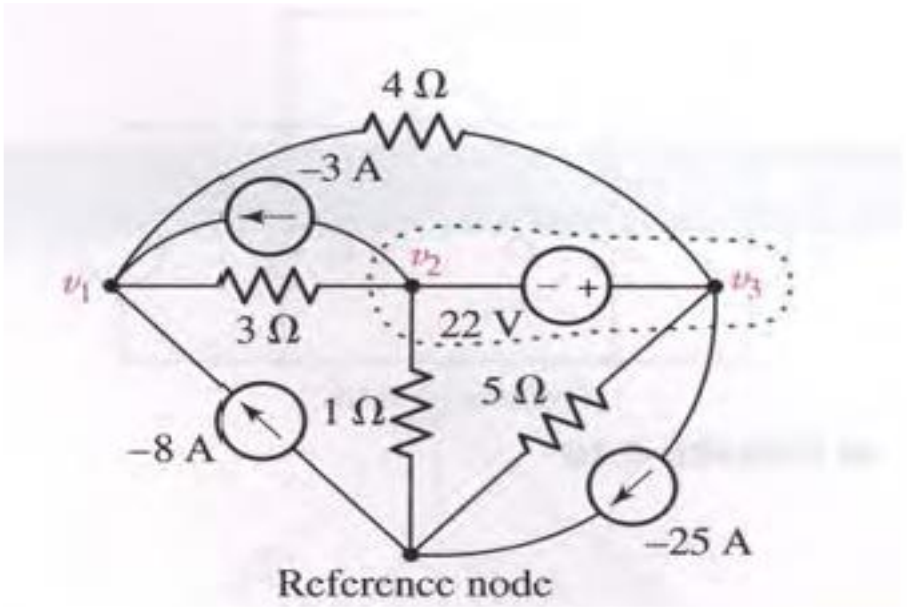
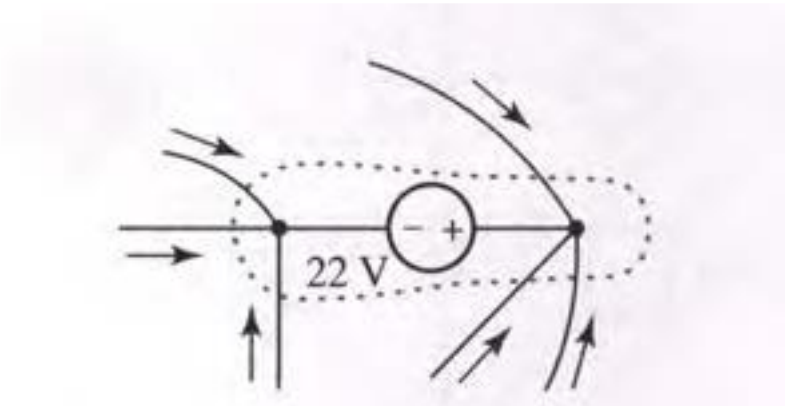
Chapter 4

Basic Nodal and Mesh Analysis

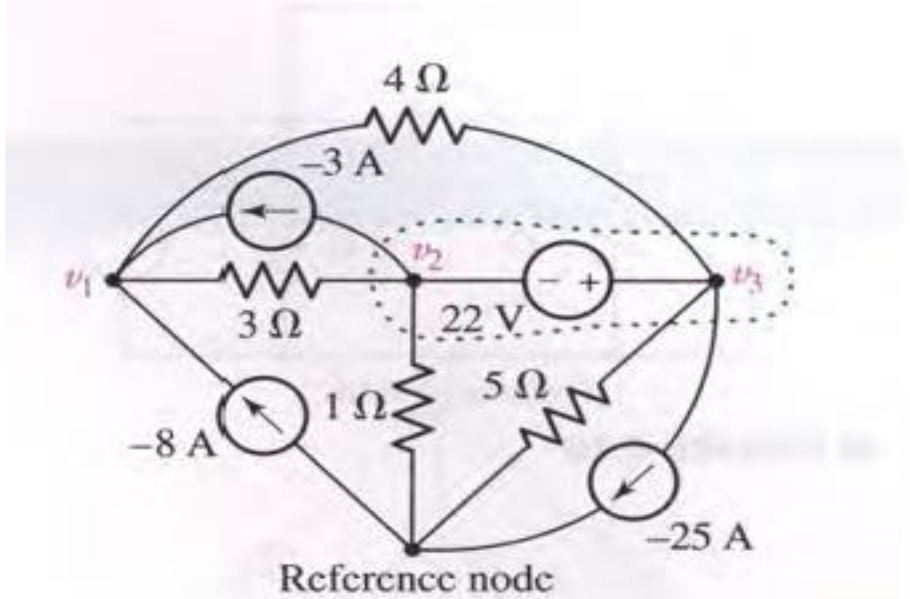
THE SUPERNODE

Super node is a case in which a voltage source comes between two nodes none of them Reference
Each super node gives two equations
One equation by relating the nodal voltages to the value of the voltage source
Another equation by applying KCL at the two nodes connecting the voltage source in the same equation





Determine the value of the unknown node voltage v_1 in the circuit



The KCL equation at node 1

$$-8 - 3 = \frac{v_1 - v_2}{3} + \frac{v_1 - v_3}{4}$$

$$0.5833v_1 - 0.3333v_2 - 0.2500v_3 = -11$$

KCL at super node 2+3

$$3 + 25 = \frac{v_2 - v_1}{3} + \frac{v_3 - v_1}{4} + \frac{v_3}{5} + \frac{v_2}{1}$$

$$-0.5833v_1 + 1.3333v_2 + 0.45v_3 = 28$$

$$v_2 - v_3 = -22$$

Solving equations we get v_1 is 1.071 V.

Determine the node-to-reference voltages in the circuit

$v_1 = -12$ V.

At node 2,

$$\frac{v_2 - v_1}{0.5} + \frac{v_2 - v_3}{2} = 14$$

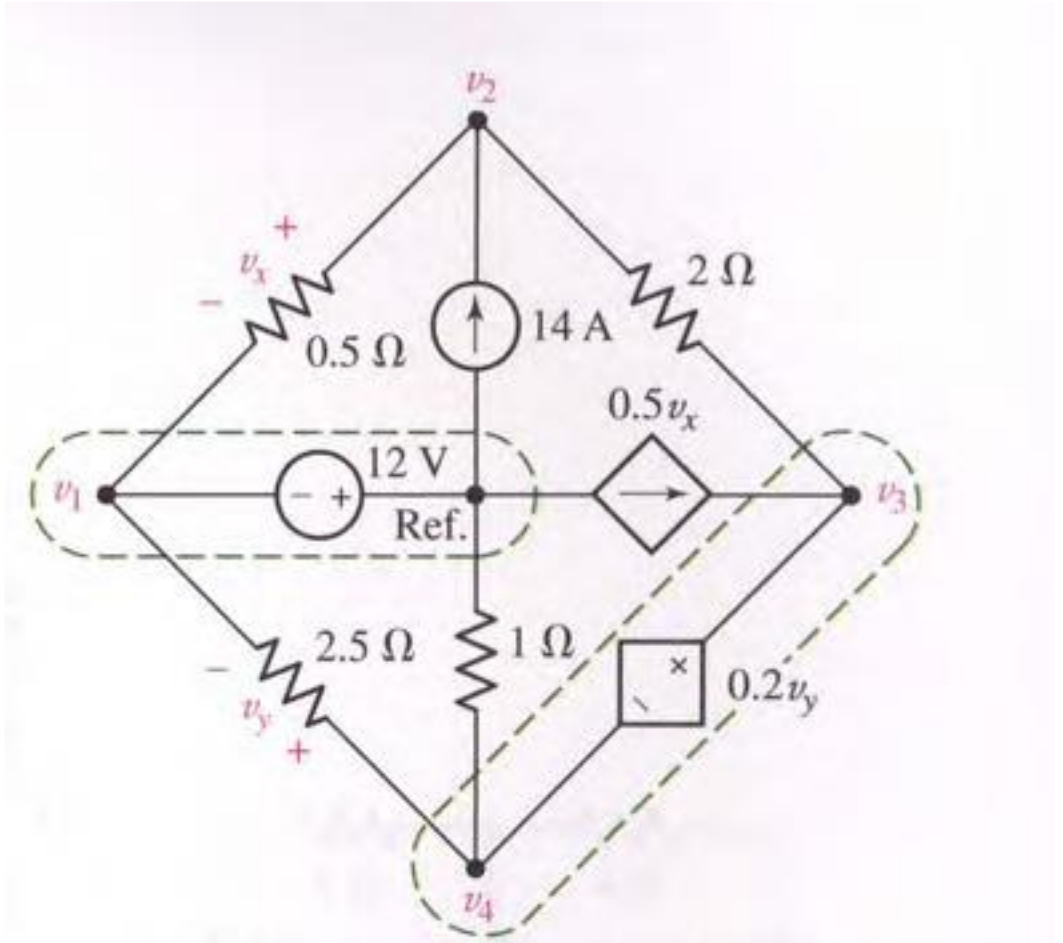
the 3-4 supernode,

$$0.5v_x = \frac{v_3 - v_2}{2} + \frac{v_4}{1} + \frac{v_4 - v_1}{2.5}$$

$$v_3 - v_4 = 0.2v_y$$

$$0.2v_y = 0.2(v_4 - v_1)$$

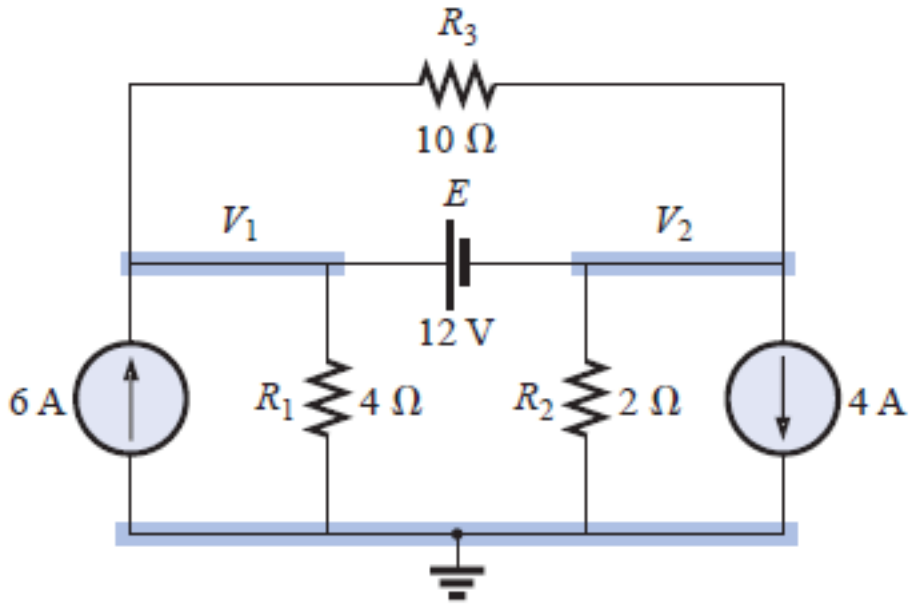
$$0.5v_x = 0.5(v_2 - v_1)$$



$$
\begin{aligned}
-2v_1 + 2.5v_2 - 0.5v_3 &= 14 \\
0.1v_1 - v_2 + 0.5v_3 + 1.4v_4 &= 0 \\
v_1 &= -12 \\
0.2v_1 + v_3 - 1.2v_4 &= 0
\end{aligned}
$$

Solving, $v_1 = -12$ V, $v_2 = -4$ V, $v_3 = 0$ V, and $v_4 = -2$ V.

Find nodal voltages v_1 and v_2



From super node

$$V_1 - V_2 = E = 12\,\text{V}$$

KVL at super node

$$\frac{V_1}{4} + \frac{V_1 - V_2}{10} + \frac{V_2}{2} + \frac{V_2 - V_1}{10} + 4 = 6$$

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

$$V_1 + 2V_2 = 8$$

$$12 + V_2 + 2V_2 = 8$$

$$3V_2 = -4$$

$$V_2 = \frac{-4}{3} = -1.333 volt$$

$$V_1 = 12 + V_2 = 12 - 1.333 = 10.667 volt$$