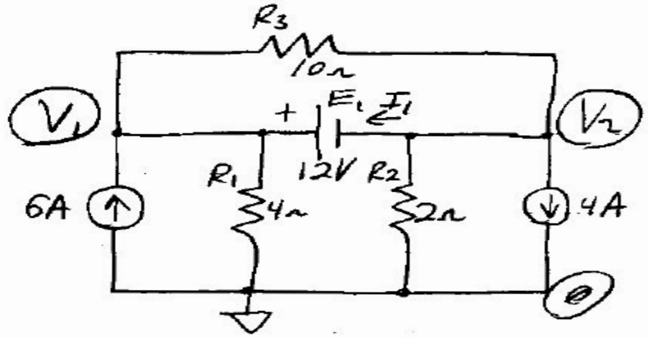
IF A VOLTAGE SOURCE IS PRESENT:

1 - CONVERT IT & SERIES "R" TO A PRACTICAL CURRENT SOURCE
2 - CHOOSE ONE END OF THE VOLTAGE SOURCE AS THE REF. NODE
3 - SUPERNODE APPROACH

(EXAMPLE 8.22)

Example 8.24 in 13th ed



(FIND THE NODE VOLTAGES)

"MODIFIED" SUPERNODE APPROACH

V_1: $6 + I_1 = \dfrac{V_1 - V_2}{R_3} + \dfrac{V_1}{R_1}$

$6 + I_1 = \dfrac{V_1}{10} - \dfrac{V_2}{10} + \dfrac{V_1}{4} \Rightarrow 6 = 0.35V_1 - 0.1V_2 - I_1 \qquad (1)$

V_2: $0 = \dfrac{V_2 - V_1}{R_3} + I_1 + \dfrac{V_2}{R_2} + 4 \Rightarrow 0 = \dfrac{V_2}{10} - \dfrac{V_1}{10} + I_1 + \dfrac{V_2}{2} + 4$

$-4 = -0.1V_1 + 0.6V_2 + I_1 \qquad (2)$

TWO EQUATIONS, THREE UNKNOWNS! WE NEED ANOTHER INDEPENDENT EQUATION:

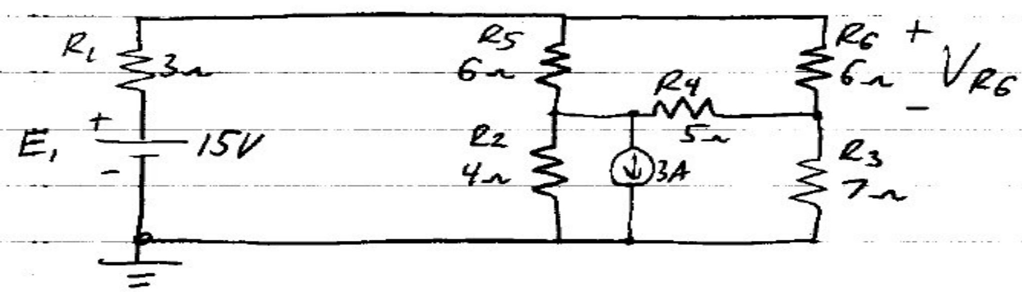
$V_1 - V_2 = E_1 \Rightarrow 12 = V_1 - V_2 \qquad (3)$

SOLVE:

$$\left.\begin{aligned} 6 &= 0.35V_1 - 0.1V_2 - I_1 \\ -4 &= -0.1V_1 + 0.6V_2 + I_1 \\ 12 &= V_1 - V_2 + 0I_1 \end{aligned}\right\} \boxed{\begin{aligned} V_1 &= 10.67V \\ V_2 &= -1.33V \\ I_1 &= -2.13A \end{aligned}}$$

ANOTHER NODAL ANALYSIS PROBLEM
(ICP).

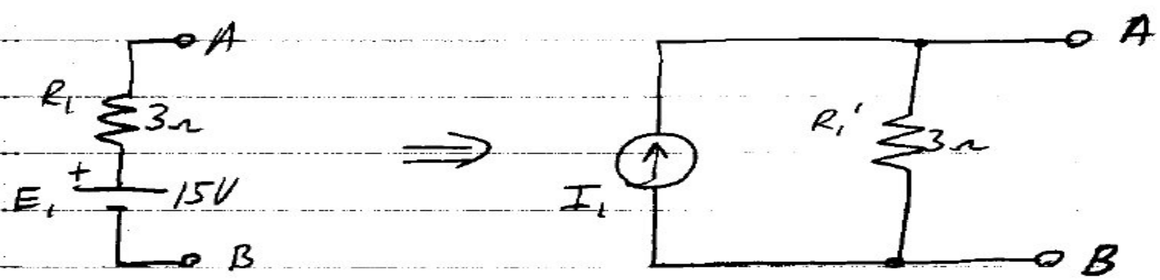
(EXAMPLE)



USE NODAL ANALYSIS TO FIND ALL NODE VOLTAGES & V_{R6}.

(1) CONVERT E_1, R_1 TO I_1, R_1' (SOURCE TRANSFORMATION)

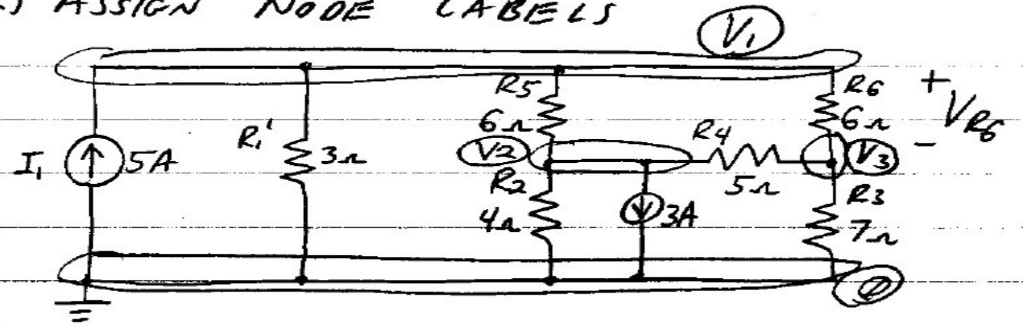
ONE APPROACH



$$I_1 = E_1/R_1 = \frac{15V}{3\Omega} = \underline{\underline{5A}}$$

REDRAW THE CIRCUIT:

(2) ASSIGN NODE LABELS



(3) KCL AT EACH NODE $\qquad \sum I_{ENTERING} = \sum I_{LEAVING}$

FOR V_1 :

$$I_1 = \frac{V_1}{R_1'} + \frac{V_1 - V_2}{R_5} + \frac{V_1 - V_3}{R_6}$$

$$I_1 = V_1\left(\frac{1}{R_1'} + \frac{1}{R_5} + \frac{1}{R_6}\right) - V_2\left(\frac{1}{R_5}\right) - V_3\left(\frac{1}{R_6}\right)$$

$$5 = 0.6667\,V_1 - 0.1667\,V_2 - 0.1667\,V_3 \qquad (1)$$

FOR V_2 :

$$0 = 3 + \frac{V_2 - V_1}{R_5} + \frac{V_2}{R_2} + \frac{V_2 - V_3}{R_4}$$

$$-3 = -V_1\left(\frac{1}{R_5}\right) + V_2\left(\frac{1}{R_5} + \frac{1}{R_2} + \frac{1}{R_4}\right) - V_3\left(\frac{1}{R_4}\right)$$

$$-3 = -0.1667\,V_1 + 0.6167\,V_2 - 0.2\,V_3 \qquad (2)$$

For V3:

0=(V3-V1)/R6 + (V3-V2)/R4 + V3/R3

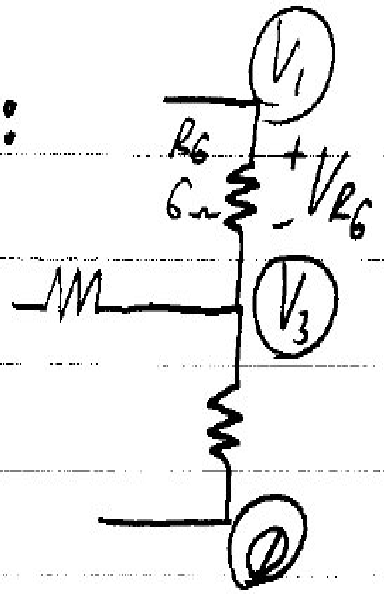
$$0 = -V_1\left(\frac{1}{R_6}\right) - V_2\left(\frac{1}{R_4}\right) + V_3\left(\frac{1}{R_4} + \frac{1}{R_3} + \frac{1}{R_6}\right)$$

$$0 = -0.1667\,V_1 - 0.2\,V_2 + 0.5096\,V_3 \qquad (3)$$

SOLVE (1) → (3) :

$$\boxed{\begin{aligned} V_1 &= 7.24\,V \\ V_2 &= -2.45\,V \\ V_3 &= 1.41\,V \end{aligned}}$$

Find V_{R6}:



$$V_{R6} = V_1 - V_3$$
$$= 7.24V - 1.41V = \boxed{5.83V}$$