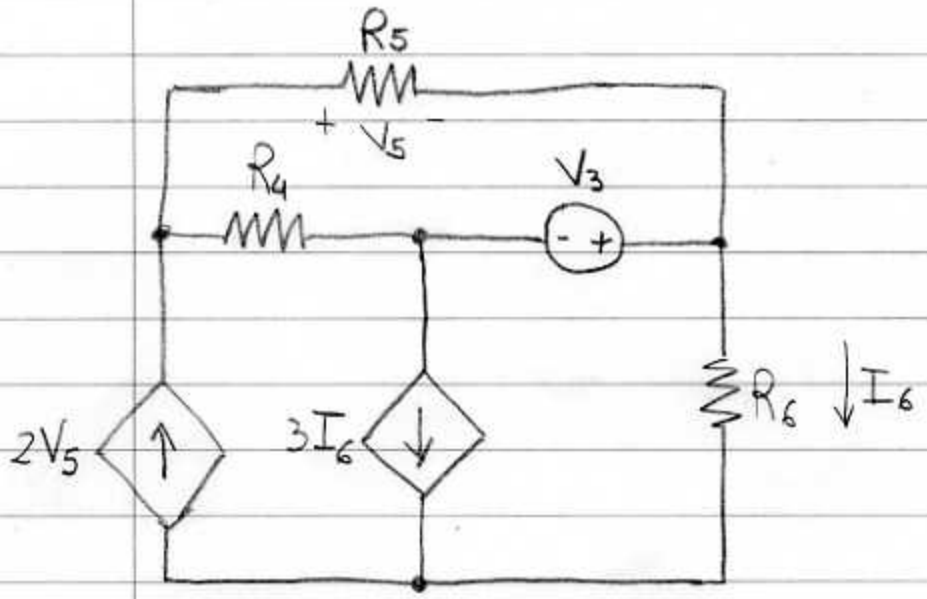
EE 40 HW 1: Circuits Analysis



$R_4 = 1\ \Omega$
$R_5 = 1/2\ \Omega$
$R_6 = 1/3\ \Omega$
$V_3 = 1\ V$

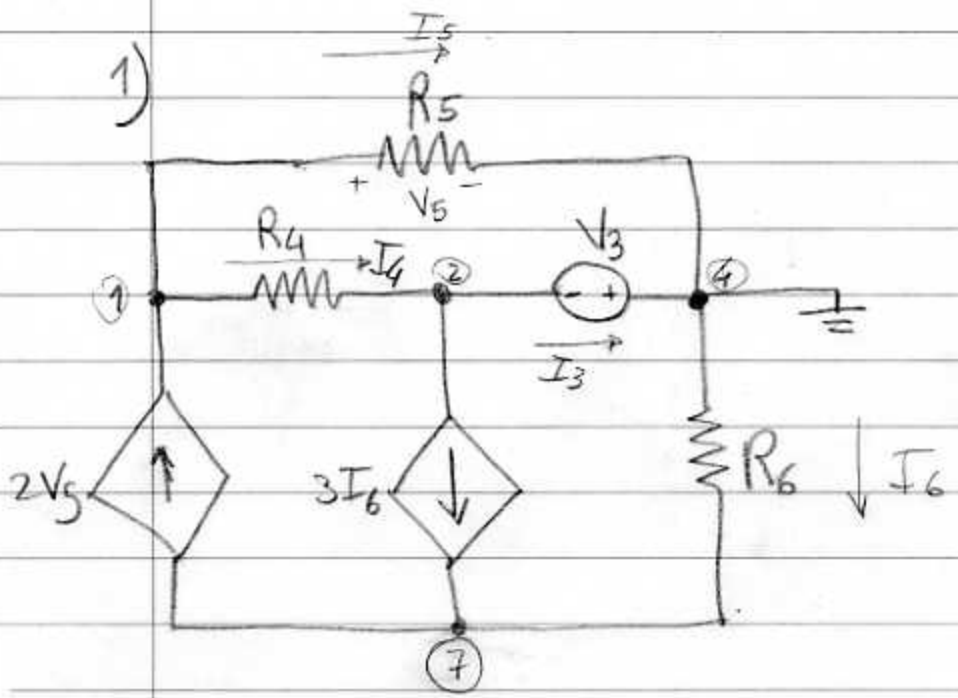
Definition: Given a circuit C, <u>Solve the circuit</u> means to find current through and voltage across each element of the circuit.

1) Solve the circuit using Node-Voltage Analysis

2) Solve the circuit using Mesh-Current Analysis

EE40 HW1 SOLUTION

1)



I pick node 4 to be the reference node so that $V_2 = -V_3$ and it is no longer an unknown. Also I have fixed reference directions an polarities.

① $I_5 + I_4 - 2V_5 = 0$

② $3I_6 + I_3 - I_4 = 0$

⑦ $2V_5 - 3I_6 - I_6 = 0$

Note that $V_5 = V_1$, and $V_2 = -V_3$

① $\frac{V_1}{R_5} + \frac{V_1 - V_2}{R_4} - 2V_1 = 0$

② $\frac{-3V_7}{R_6} + I_3 - \frac{(V_1 - V_2)}{R_4} = 0$

⑦ $2V_1 + \frac{3V_7}{R_6} + \frac{V_7}{R_6} = 0$

$\Downarrow V_2 = -V_3$

① $\frac{V_1}{R_5} + \frac{V_1 + V_3}{R_4} - 2V_1 = 0$

② $\frac{-3V_7}{R_6} + I_3 - \frac{(V_1 + V_3)}{R_4} = 0$

⑦ $2V_1 + 4\frac{V_7}{R_6} = 0$

We have 3 eqns in 3 unknowns:
V_1, V_7, I_3

from ① $\rightarrow V_1\left(\frac{1}{R_5} + \frac{1}{R_4} - 2\right) = -\frac{V_3}{R_4}$

$\Rightarrow V_1 = -1$

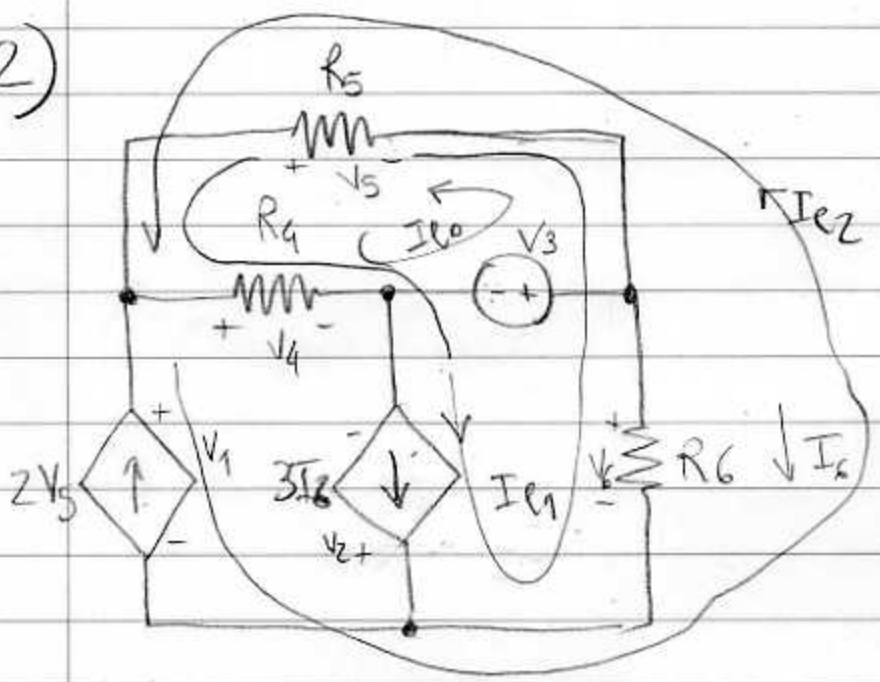
from ⑦ → $-2 + \frac{4V_7}{R_6} = 0 \Rightarrow V_7 = \frac{2}{12} = \frac{1}{6}$

from ② →

$$\frac{-9}{6} + I_3 - 0 = 0$$

$$\Rightarrow I_3 = \frac{9}{6} = \frac{3}{2}$$

2)



$$I_{e2} = -2V_5 \Rightarrow V_5 = -\frac{I_{e2}}{2}$$

$$I_{e1} = 3I_6 \Rightarrow I_6 = \frac{I_{e1}}{3}$$

(l_0) $V_4 - V_3 - V_5 = 0$

(l_1) $V_4 - V_2 - V_6 - V_5 = 0$

(l_2) $V_1 - V_6 - V_5 = 0$

(l_0) $R_4(I_{l_0} + I_{e_1}) - V_3 + I_{e_2}/2 = 0$

(l_1) $R_4(I_{e_0} + I_{e_1}) - V_2 - \frac{R_6 I_{e_1}}{3} + \frac{I_{e_2}}{2} = 0$

(l_2) $V_1 - \frac{R_6 I_{e_1}}{3} + \frac{I_{e_2}}{2} = 0$

$I_{e_2} = +2R_5(I_{e_0} + I_{e_1} + I_{e_2}) \Rightarrow I_{e_2}(1-2R_5) = 2R_5(I_{e_0} + I_{e_1})$

$I_{e_1} = -3(I_{e_1} + I_{l_2}) \Rightarrow 4I_{e_1} = -3I_{e_2}$

$I_{l_2}(1-2R_5) = 2R_5(I_{e_0} - 3I_{e_2}/4)$

$I_{l_2}(1-2R_5 + 3R_5/2) = 2R_5 I_{e_0}$

$\frac{3I_{l_2}}{4} = I_{e_0} \Rightarrow I_{e_2} = \frac{4I_{e_0}}{3}$

$I_{l_1} = -I_{e_0}$

from l_0 → $R_4(I_{l_0} - I_{l_0}) - V_3 + \frac{2 I_{l_0}}{3} = 0$

$\Rightarrow I_{l_0} = \frac{3V_3}{2} = \frac{3}{2}$

$\Rightarrow I_{l_1} = -\frac{3}{2}$, $I_{l_2} = 2$

from l_2 → $V_1 + \frac{R6}{2} + 1 = 0$

$\Rightarrow V_1 + \frac{1}{6} + 1 = 0 \Rightarrow V_1 = -\frac{7}{6}$

from l_1 → $-V_2 + \frac{3}{2}\frac{R6}{3} + 1 = 0$

$-V_2 + \frac{1}{6} + 1 = 0$

$V_2 = \frac{7}{6}$

Now you can compute all the other currents.