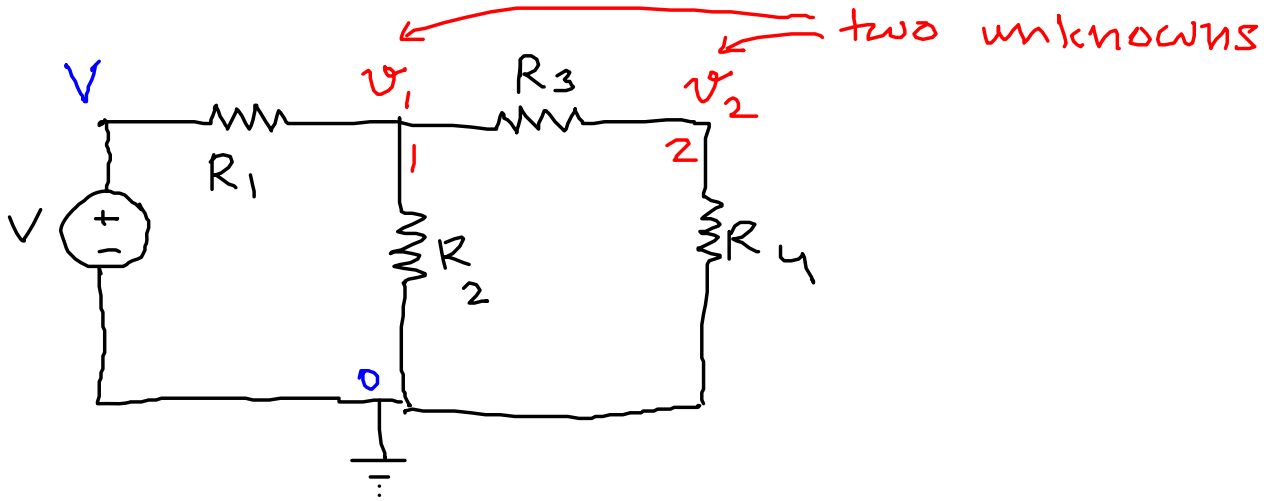
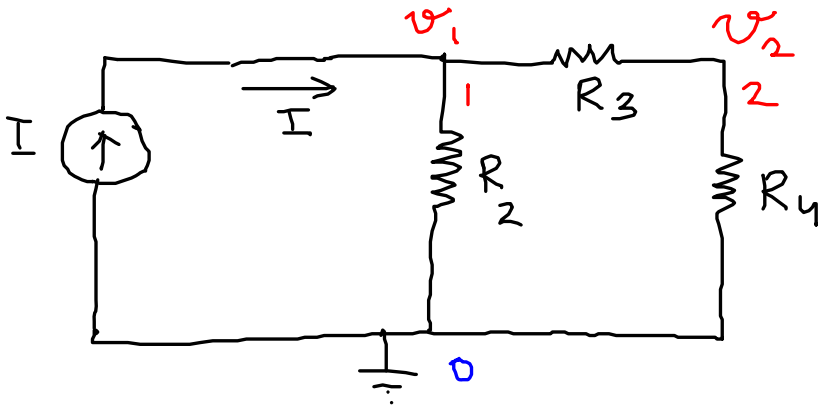


KCL 1: $\frac{V - v_1}{R_1} + \frac{0 - v_1}{R_2} + \frac{v_2 - v_1}{R_3} = 0$

KCL 2: $\frac{v_1 - v_2}{R_3} + \frac{0 - v_2}{R_4} = 0$

two equations in two unknowns



KCL 1: $I + \dfrac{0 - v_1}{R_2} + \dfrac{v_2 - v_1}{R_3} = 0$

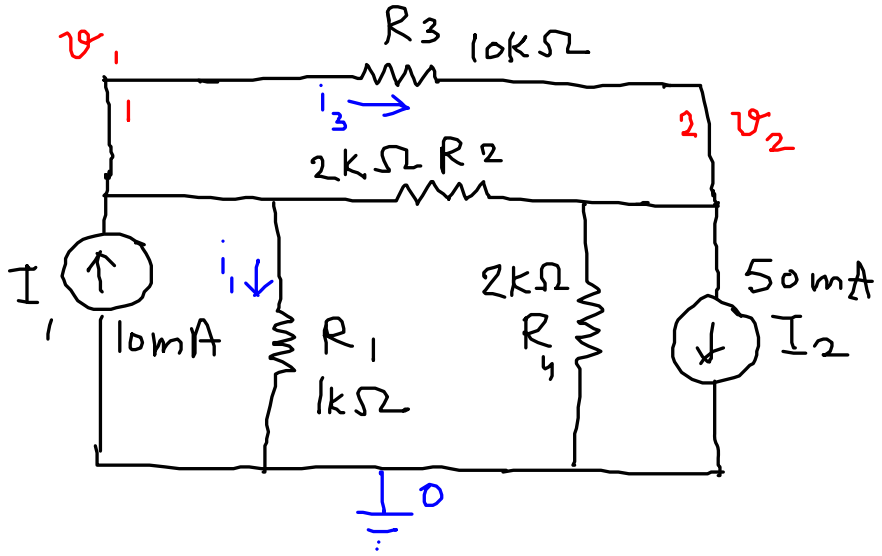
KCL 2: $\dfrac{v_1 - v_2}{R_3} + \dfrac{0 - v_2}{R_4} = 0$

Two equations two unknowns

Total number of unknown node voltages

$= n - 1 - m$

- n: total # of nodes
- 1: ground (known)
- m: # of voltage sources



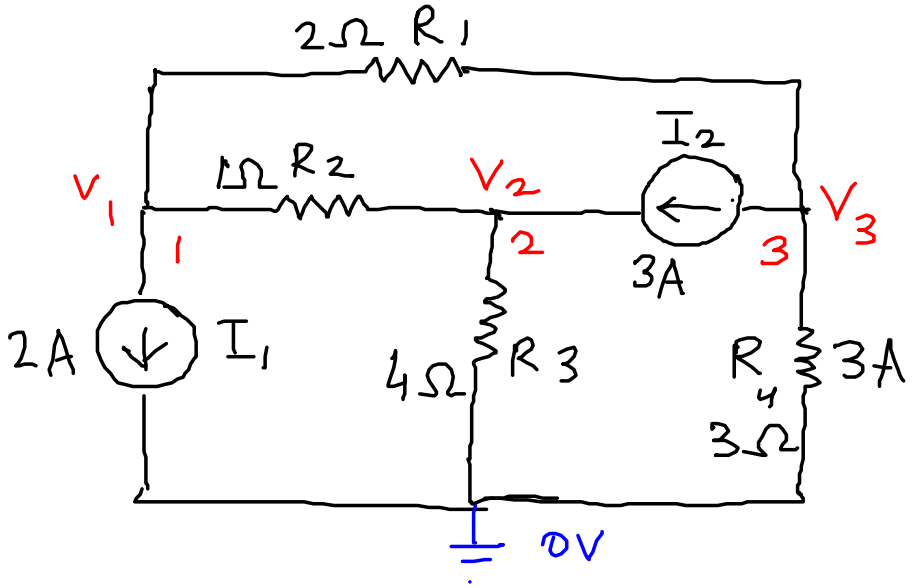
$$1: \quad 10\,mA + \frac{v_2 - v_1}{10k\Omega} + \frac{v_2 - v_1}{2k\Omega} + \frac{0 - v_1}{1k\Omega} = 0$$

$$2: \quad -50\,mA + \frac{v_1 - v_2}{10k\Omega} + \frac{v_1 - v_2}{2k\Omega} + \frac{0 - v_2}{2k\Omega} = 0$$

$$v_1 = -13.57\,V \qquad v_2 = -52.86\,V$$

$$i_1 = \frac{v_1 - 0}{1k\Omega} = -13.57\,mA$$

$$i_3 = \frac{v_1 - v_2}{10k\Omega} = \frac{-13.57 + 52.86}{10k} = 3.93\,mA$$



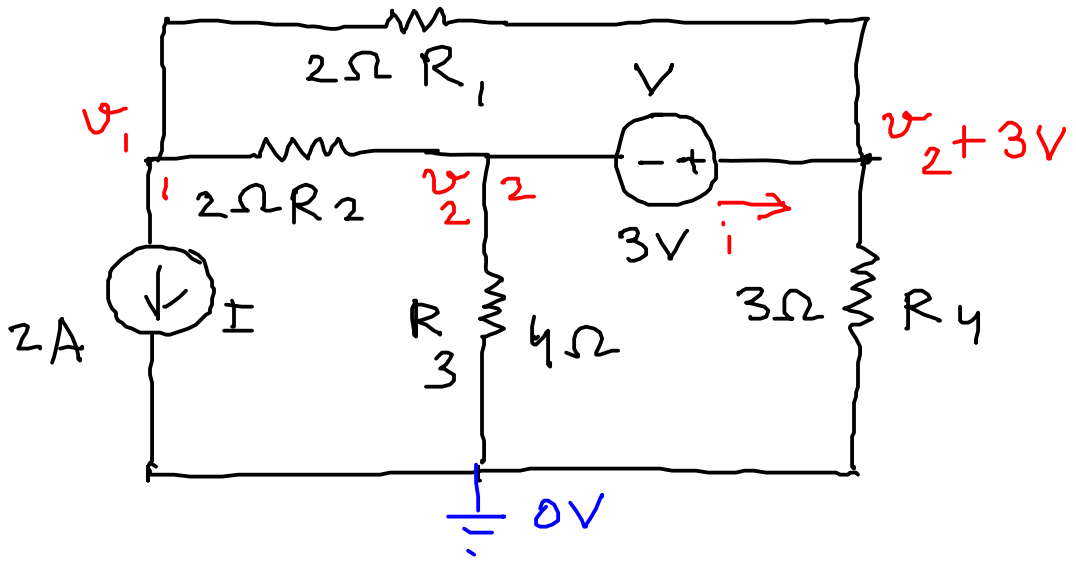
$$1: \quad -2A + \frac{V_2 - V_1}{1\Omega} + \frac{V_3 - V_1}{2\Omega} = 0$$

$$2: \quad 3A + \frac{V_1 - V_2}{1\Omega} + \frac{0 - V_2}{4\Omega} = 0$$

$$3: \quad -3A + \frac{V_1 - V_3}{2\Omega} + \frac{0 - V_3}{3\Omega} = 0$$

solution

$$v_1 = -3.5V \qquad v_2 = -0.4V \qquad v_3 = -5.7V$$



$$1: \quad -2 + \frac{v_2 - v_1}{2\Omega} + \frac{v_2 + 3V - v_1}{2\Omega} = 0$$

$$2: \quad \frac{v_1 - v_2}{2\Omega} + \frac{0 - v_2}{4\Omega} - i = 0$$

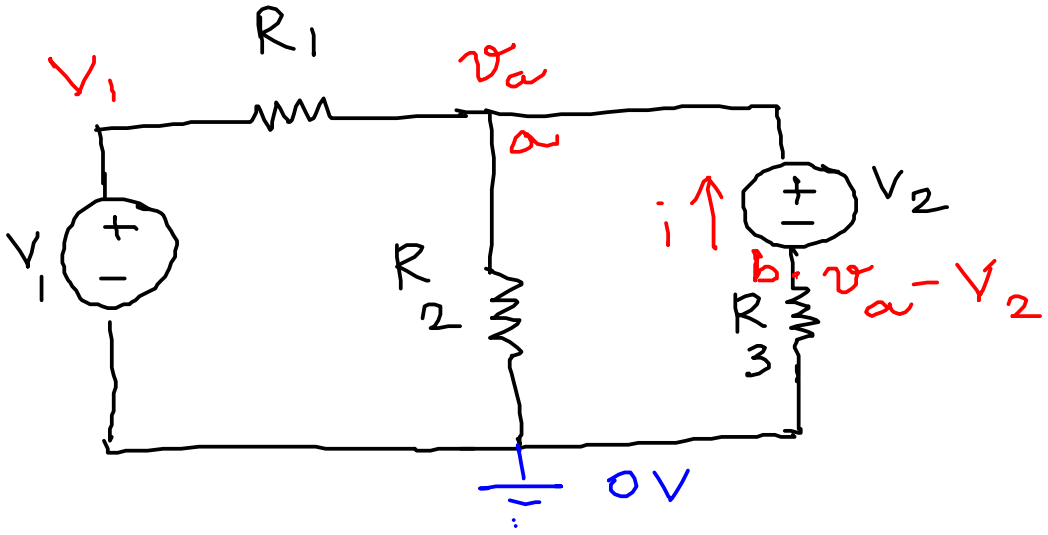
$$3: \quad i + \frac{v_1 - v_2 + 3V}{2\Omega} + \frac{0 - v_2 - 3V}{3\Omega} = 0$$

solution

$$v_1 = -5.64V$$

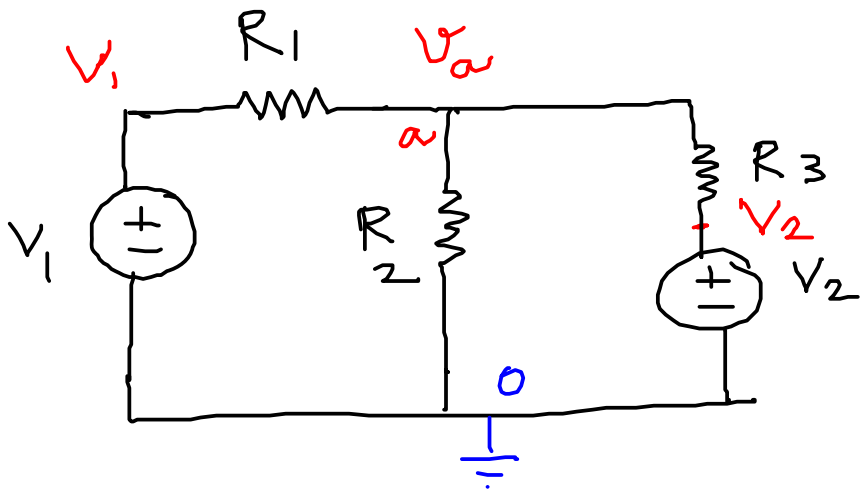
$$v_2 = -5.14V$$

$$i = 1.04A$$



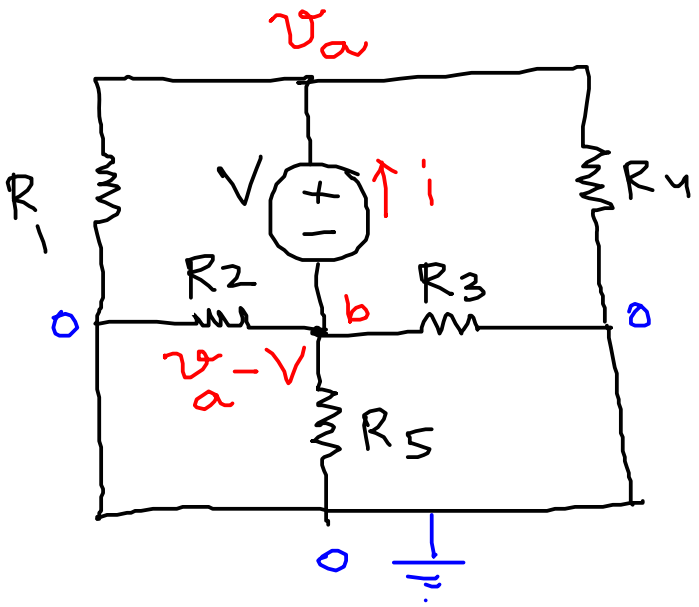
$$a: \quad \frac{V_1 - v_a}{R_1} + \frac{0 - v_a}{R_2} + i = 0$$

$$-i + \frac{0 - v_a + V_2}{R_3} = 0$$



$$a: \quad \frac{V_1 - v_a}{R_1} + \frac{0 - v_a}{R_2} + \frac{V_2 - v_a}{R_3} = 0$$

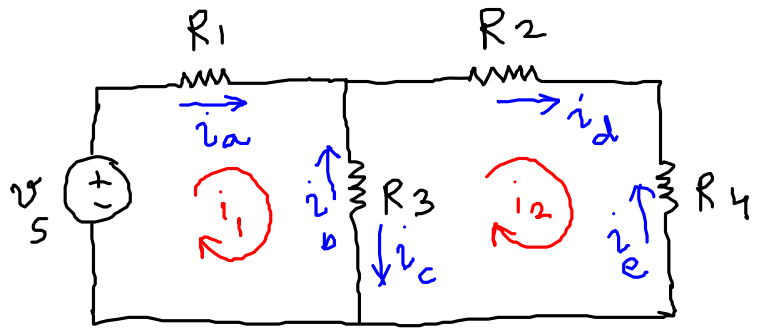
One unknown, one equation



$$a: \quad \frac{0 - v_a}{R_1} + i + \frac{0 - v_a}{R_4} = 0$$

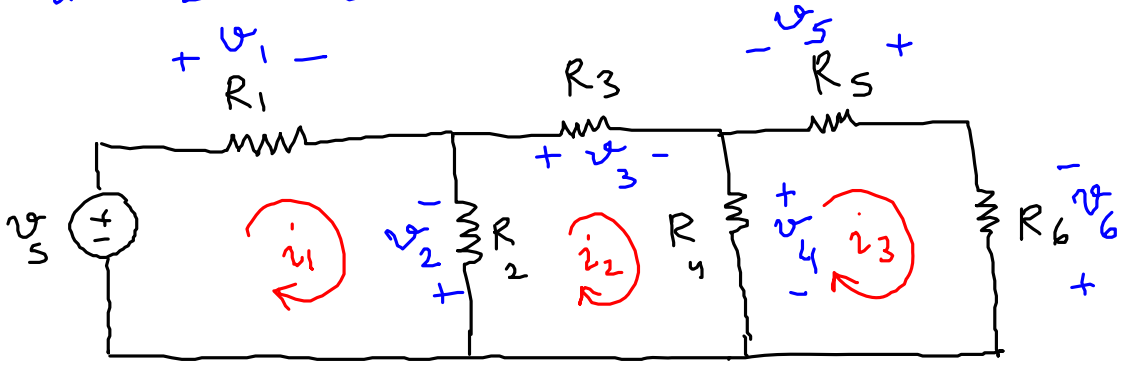
$$b: \quad -i + \frac{0 - v_a + V}{R_2} + \frac{0 - v_a + V}{R_5} + \frac{0 - v_a + V}{R_3}$$

Mesh Current Analysis



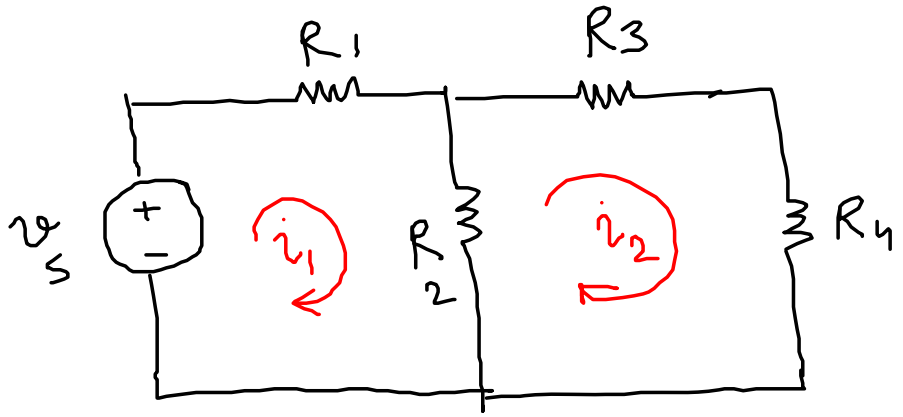
$i_a = i_1 \qquad i_b = i_2 - i_1 \qquad i_c = i_1 - i_2$

$i_d = i_2 \qquad i_e = -i_2$



$v_1 = i_1 R_1 \qquad v_2 = (i_2 - i_1) R_2 \qquad v_3 = i_2 R_3$

$v_5 = -i_3 R_5 \qquad v_4 = (i_2 - i_3) R_4 \qquad v_6 = -i_3 R_6$

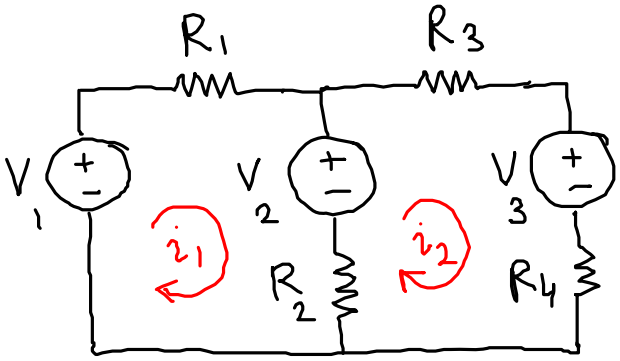


KVL: i_1 $\quad -v_s + R_1 i_1 + R_2 (i_1 - i_2) = 0$

$$R_3 i_2 + R_4 i_2 + R_2 (i_2 - i_1) = 0$$

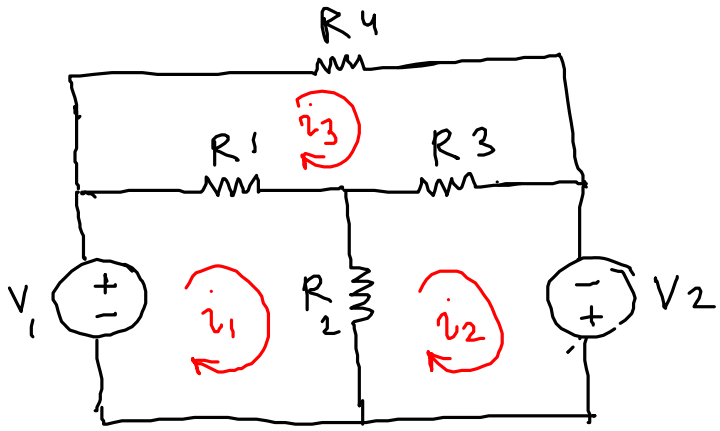
$$(R_1 + R_2) i_1 - R_2 i_2 = v_s$$

$$- R_2 i_1 + (R_2 + R_3 + R_4) i_2 = 0$$



Mesh i_1: $-V_1 + R_1 i_1 + V_2 + R_2(i_1 - i_2) = 0$

Mesh i_2: $-V_2 + R_3 i_2 + V_3 + R_4 i_2 + R_2(i_2 - i_1) = 0$

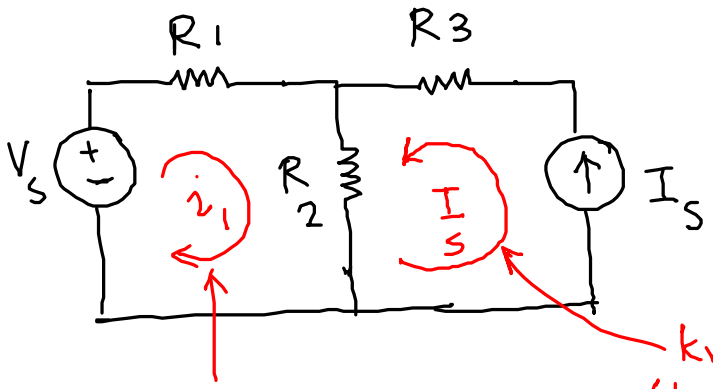


Mesh i_1: $-V_1 + R_1(i_1 - i_3) + R_2(i_1 - i_2) = 0$

Mesh i_2: $-V_2 + R_2(i_2 - i_1) + R_3(i_2 - i_3) = 0$

Mesh i_3: $R_4 i_3 + R_3(i_3 - i_2) + R_1(i_3 - i_1) = 0$

Mesh Analysis with current sources



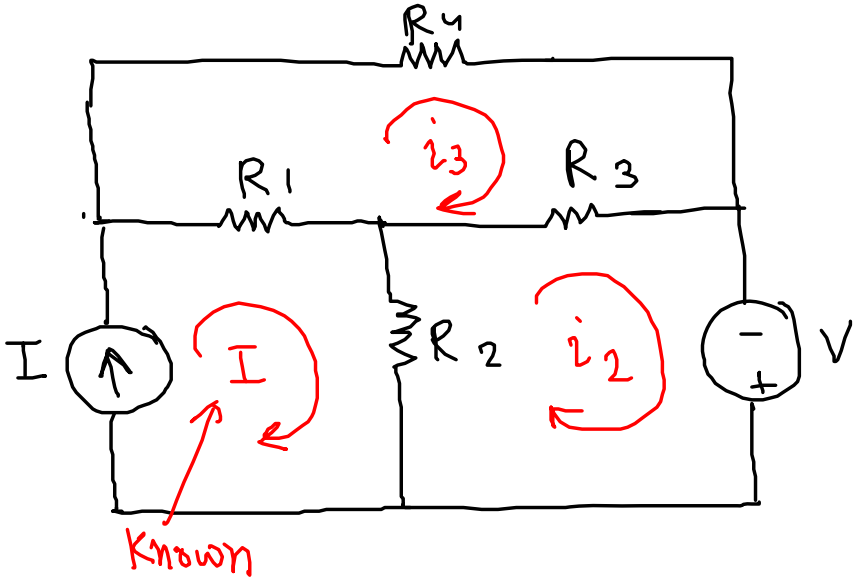
unknown mesh current (always anticlockwise)

known mesh current (in the direction of the current source)

Mesh i_1: $-V_S + R_1 i_1 + R_2 (i_1 + I_S) = 0$

I_S is known, no need to write a mesh equation for I_S

one equation in one unknown



Mesh i_2: $-V + R_2(i_2 - I) + R_3(i_2 - i_3) = 0$

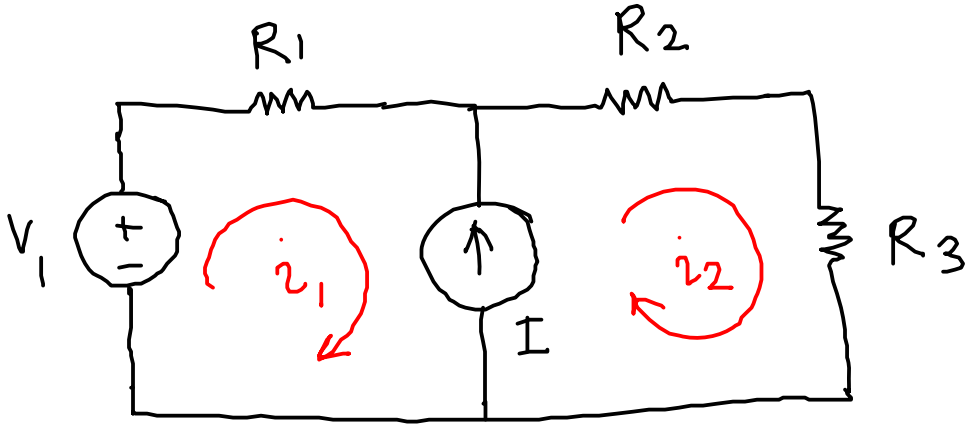
Mesh i_3 $R_1(i_3 - I) + R_4 i_3 + R_3(i_3 - i_2) = 0$

two equations in two unknowns

Unknown mesh currents = m − n

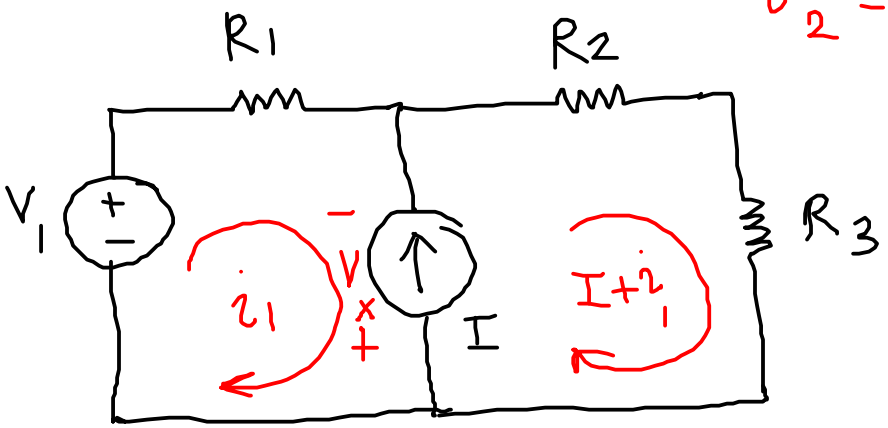
\# of mesh

\# of current sources



$I = i_2 - i_1$

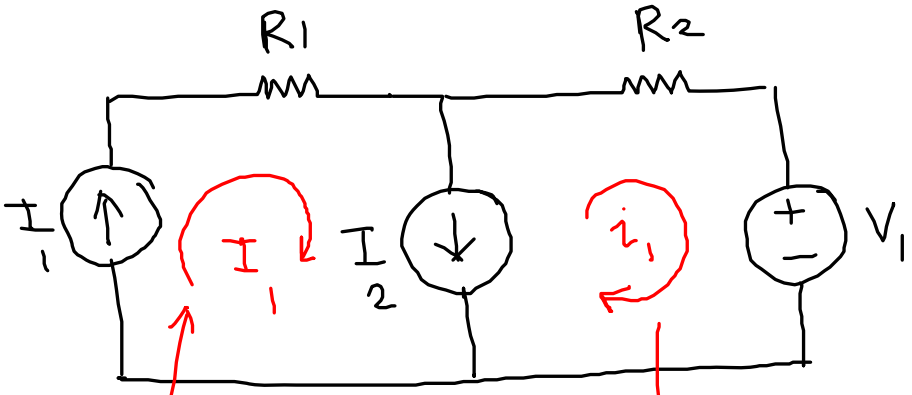
$i_2 = I + i_1$



Mesh i_1: $-V_1 + R_1 i_1 - V_x = 0$

$+V_x + R_2(I + i_1) + R_3(I + i_1) = 0$

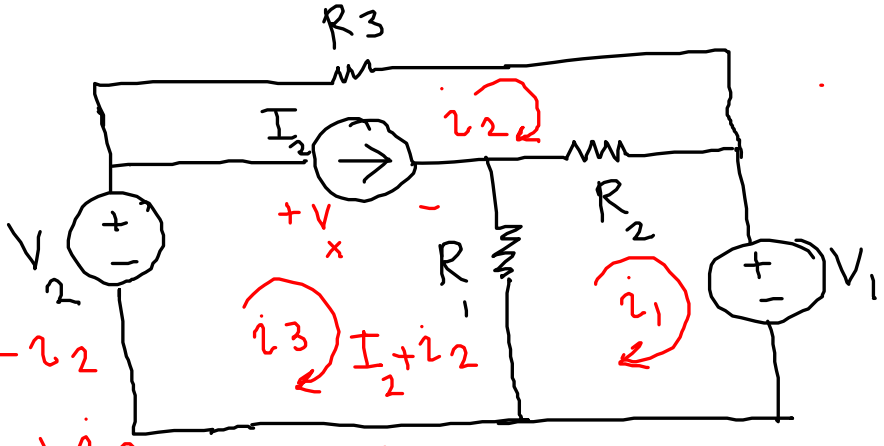
one equation in one unknown



$I_2 = I_1 - i_1$

$i_1 = I_1 - I_2$ (known)

problem is already solved



$I_2 = i_3 - i_2$

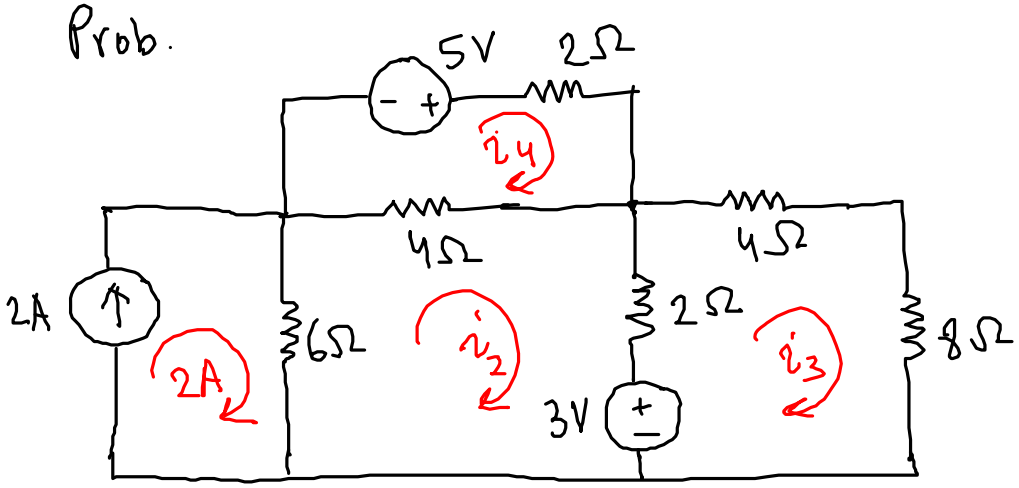
$i_3 = I_2 + i_2$

i_1: $V_1 + R_1(i_1 - I_2 - i_2) + R_2(i_1 - i_2) = 0$

i_2: $-V_x + R_3 i_2 + R_2(i_2 - i_1) = 0$

$V_x + R_1(I_2 + i_2 - i_1) - V_2 = 0$

Prob.



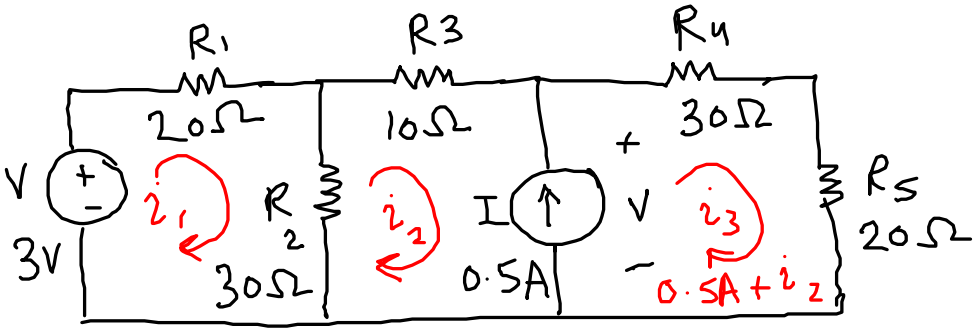
i_2: $6\Omega(i_2 - 2A) + 4\Omega(i_2 - i_4) + 2\Omega(i_2 - i_3) + 3V = 0$

i_3: $-3V + 2(i_3 - i_2) + 4\Omega i_3 + 8\Omega i_3 = 0$

i_4: $-5V + 2\Omega i_4 + 4\Omega(i_4 - i_2) = 0$

3 equations, 3 unknowns

Problem



find V

$0.5A = i_3 - i_2$

$i_3 = 0.5A + i_2$

i_1: $-3V + 20\Omega i_1 + 30\Omega(i_1 - i_2) = 0$

i_2: $V + 30\Omega(i_2 - i_1) + 10\Omega i_2 = 0$

$-V + 30\Omega(0.5A + i_2) + 20\Omega(0.5A + i_2) = 0$

two equations in two unknowns