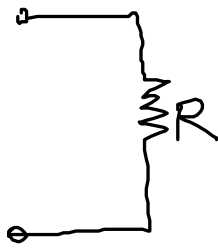


Resistance & ohms law



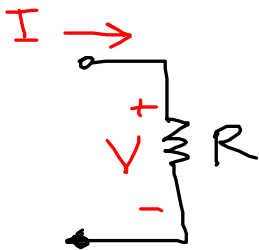
ohms (Ω) resistance

$$G = \frac{1}{R} \text{ siemens (S)}$$

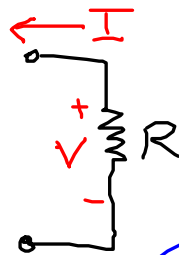
↑
conductance

mho

Ohms Law



$$V = IR$$



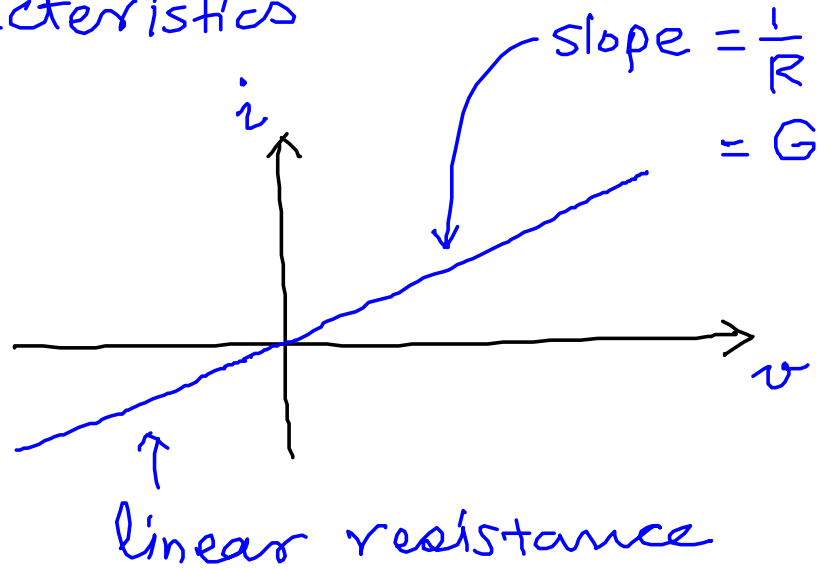
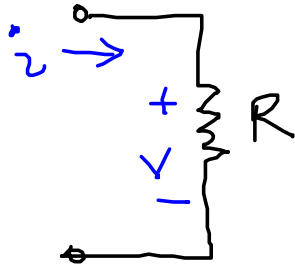
$$V = -IR$$

ohms Law

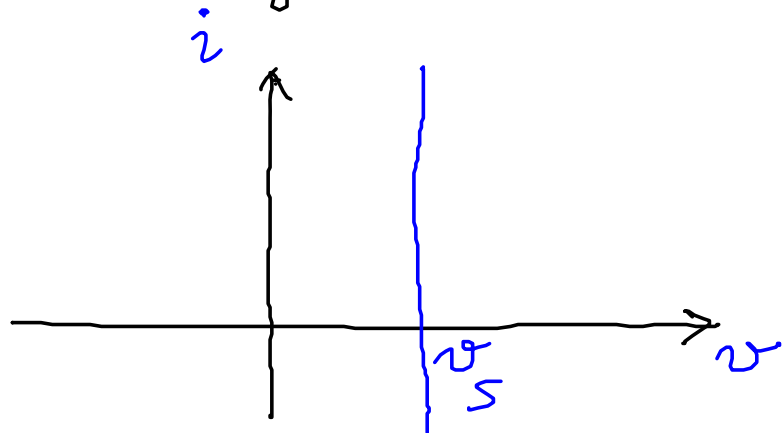
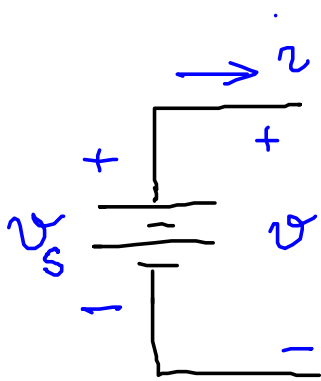
$$I = GV$$

$$I = -GV$$

1-V Characteristics

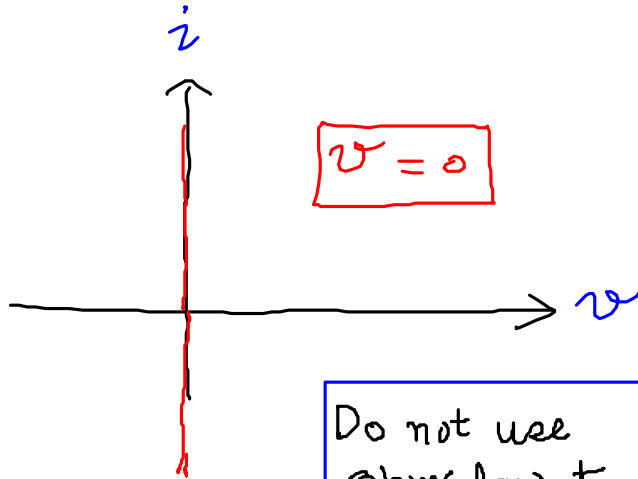
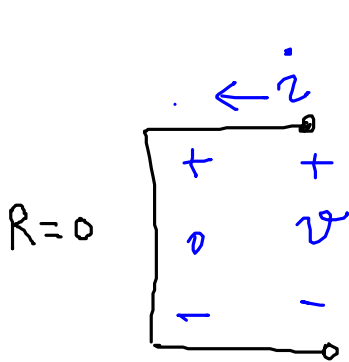


Independent voltage source



current is determined by the circuit the voltage source is connected to

short circuit (resistance $R = 0$)



$$v = iR = 0$$

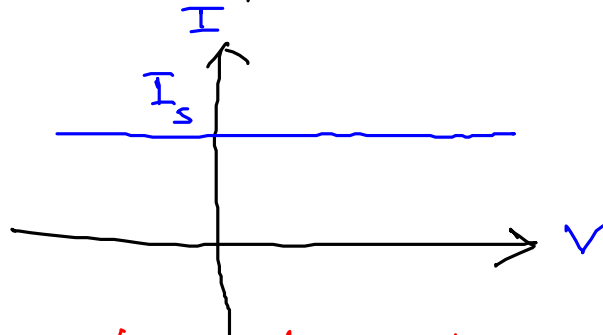
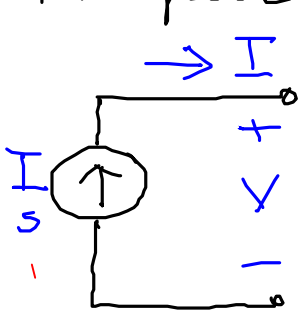
$$i = \left(\frac{1}{R}\right)v = \infty \times 0 = ?$$

Do not use Ohms law to determine i !

current i is determined by the rest of the circuit

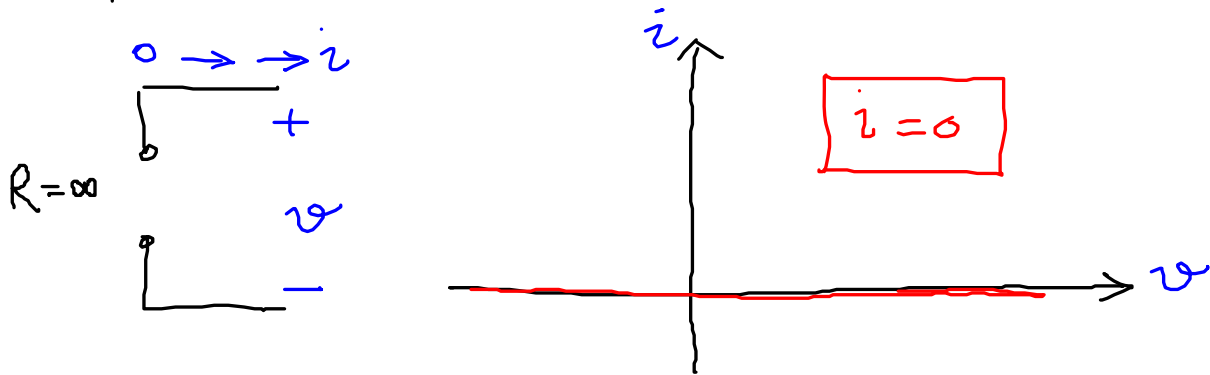
short circuit = independent ideal zero voltage source

Independent current source



voltage v is determined by the rest of the circuit

Open circuit (resistance $R = \infty$)



$$i = \frac{1}{R} v = \frac{1}{\infty} v = 0 v = 0$$

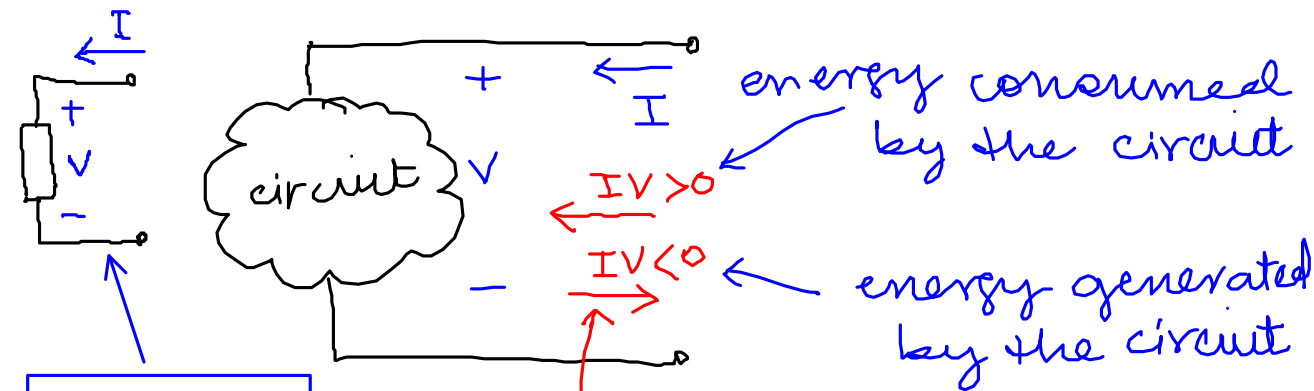
$$v = R i = \infty \times 0 = ?$$

voltage v is determined by the rest of the circuit

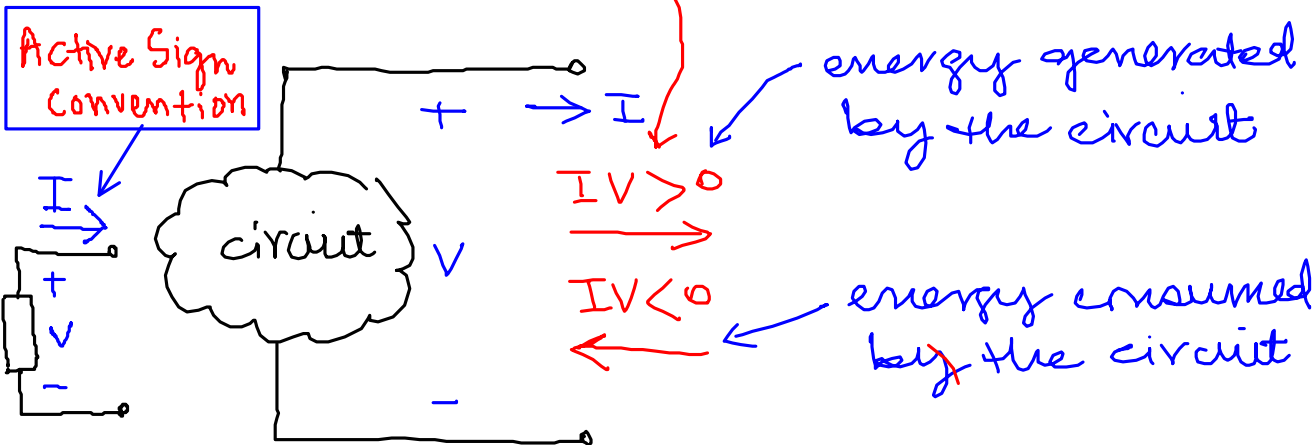
Do not use ohms law to determine v !

Electric Power

Power = $\frac{\text{work}}{\text{time}}$ $J/s = W$ (watts)

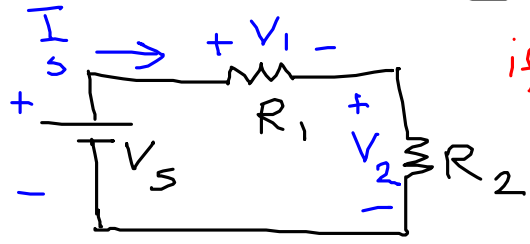


Passive Sign Convention



Active Sign Convention

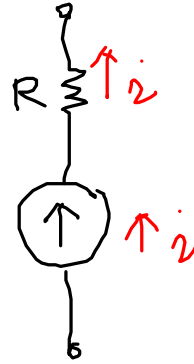
flow of energy



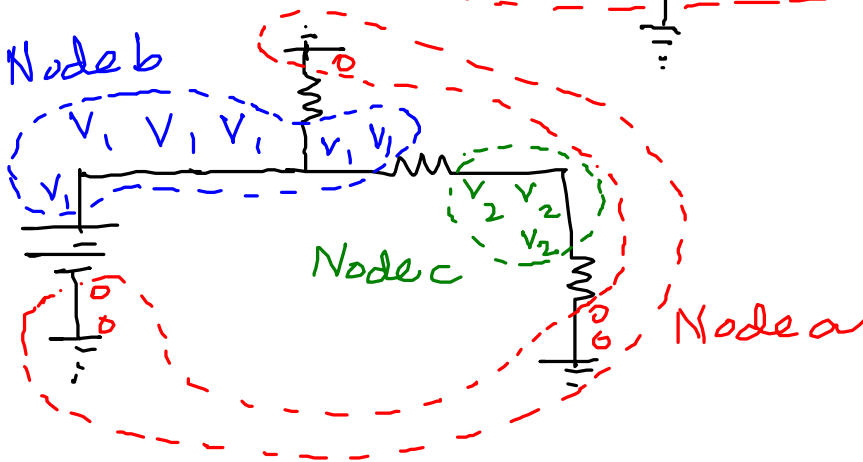
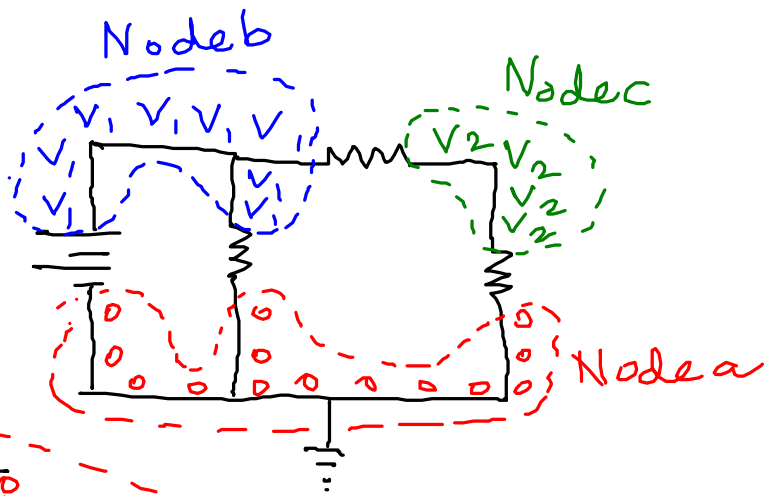
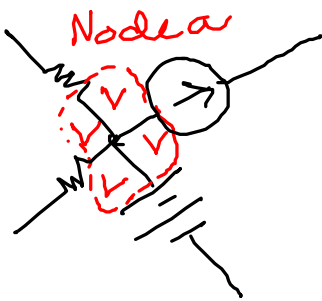
if $V_s I_s > 0$
battery generating energy

if $I_s V_{R1} > 0$
resistance R_1 consuming energy

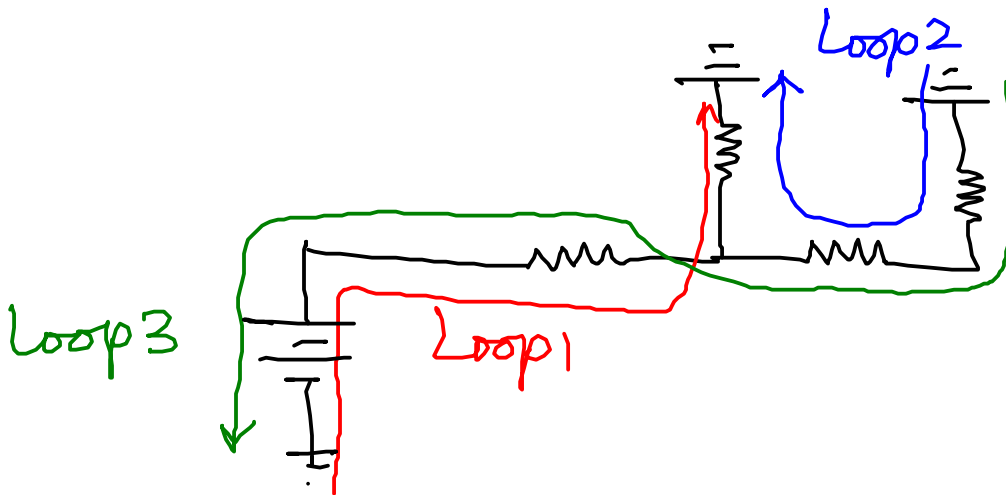
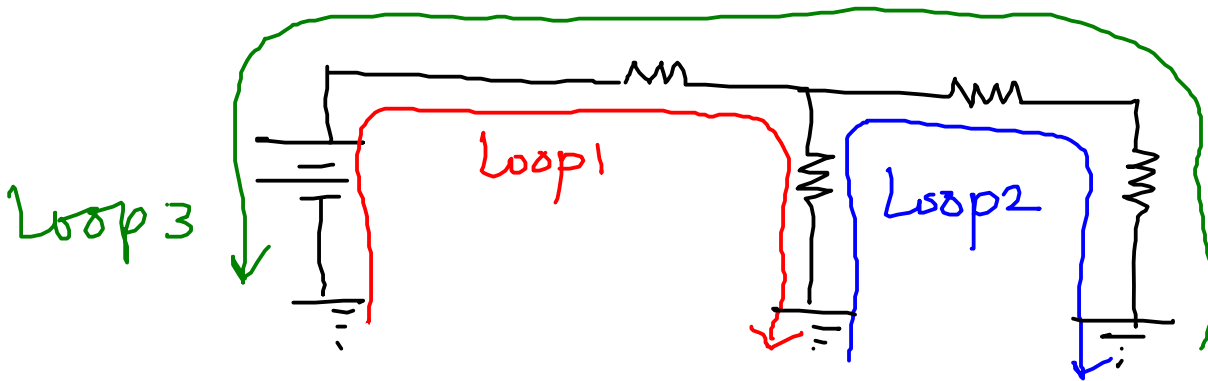
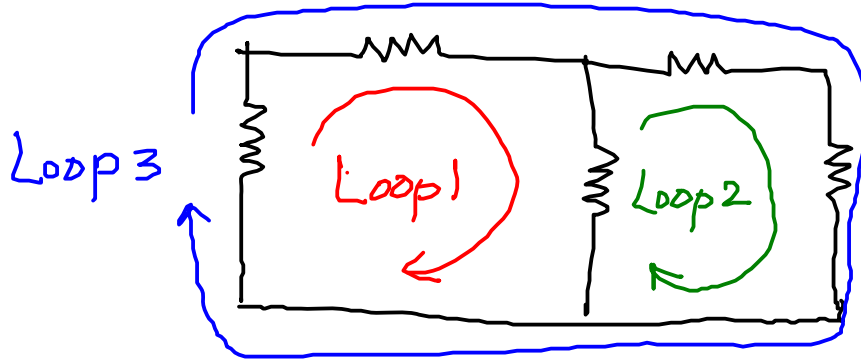
Branch



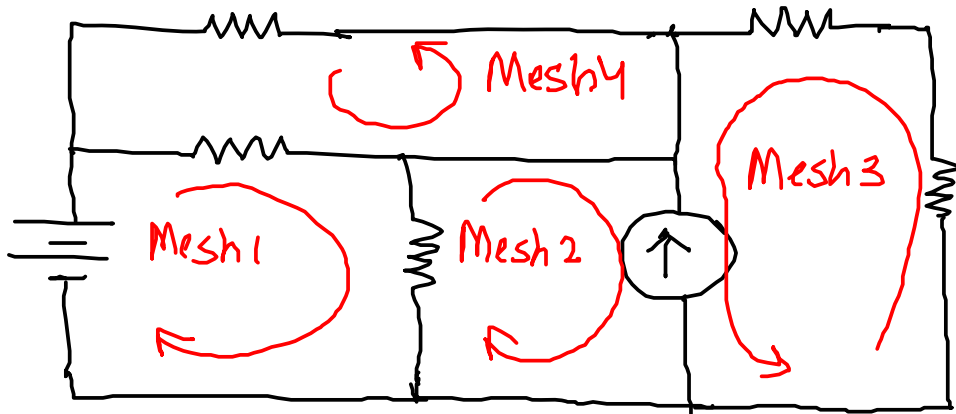
Node



Loop



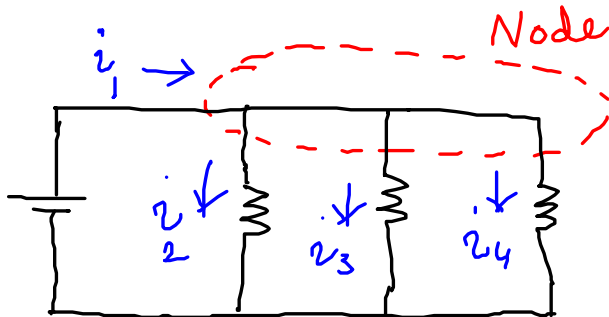
Mesh (a loop that does not contain other loops)



Kirchoff's current law (KCL)

Sum of currents at a node must equal to zero

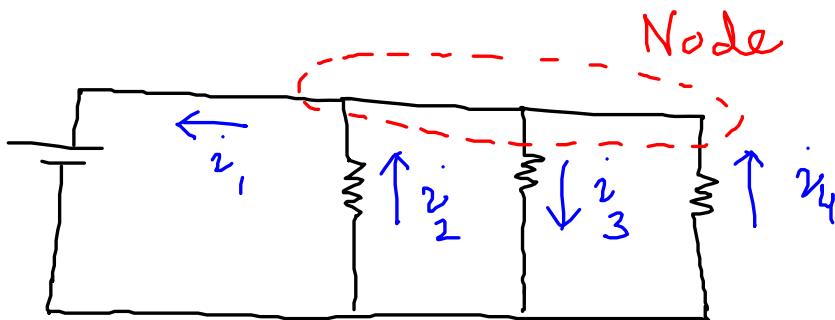
$$\sum_{n=1}^N i_n = 0$$



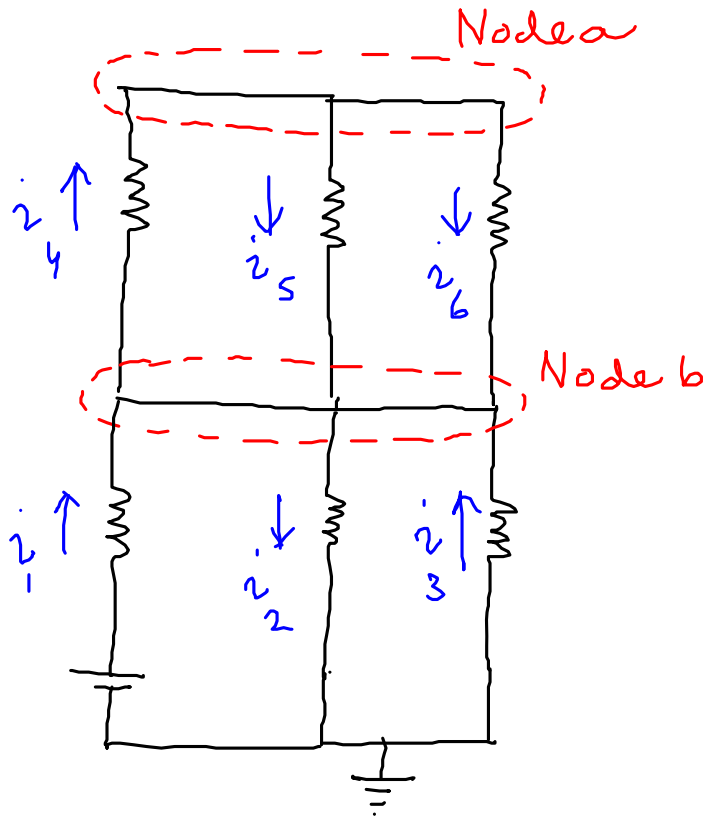
$$i_1 - i_2 - i_3 - i_4 = 0$$

or

$$-i_1 + i_2 + i_3 + i_4 = 0$$

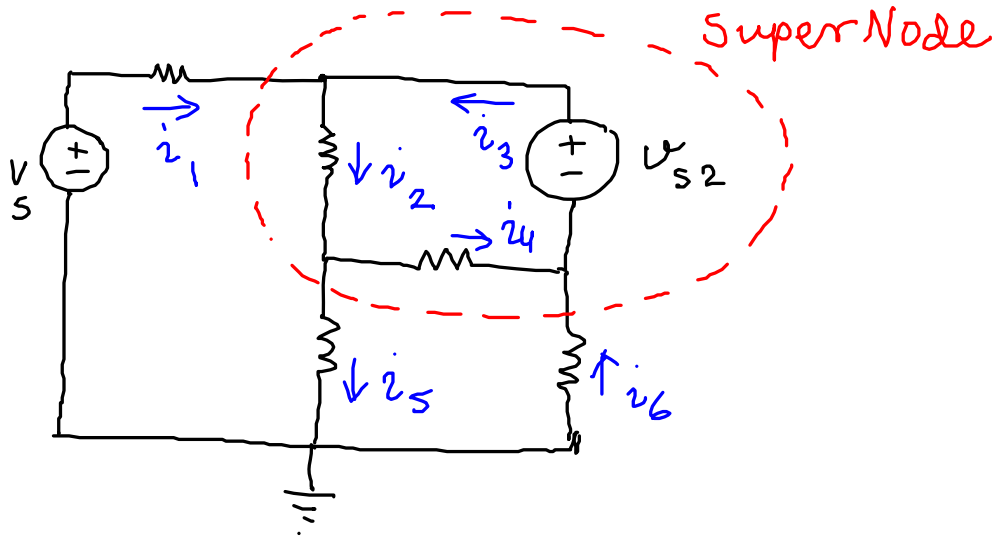


$$-i_1 + i_2 - i_3 + i_4 = 0$$



Node a: $i_4 - i_5 - i_6 = 0$

Node b: $-i_4 + i_5 + i_6 + i_1 - i_2 + i_3 = 0$

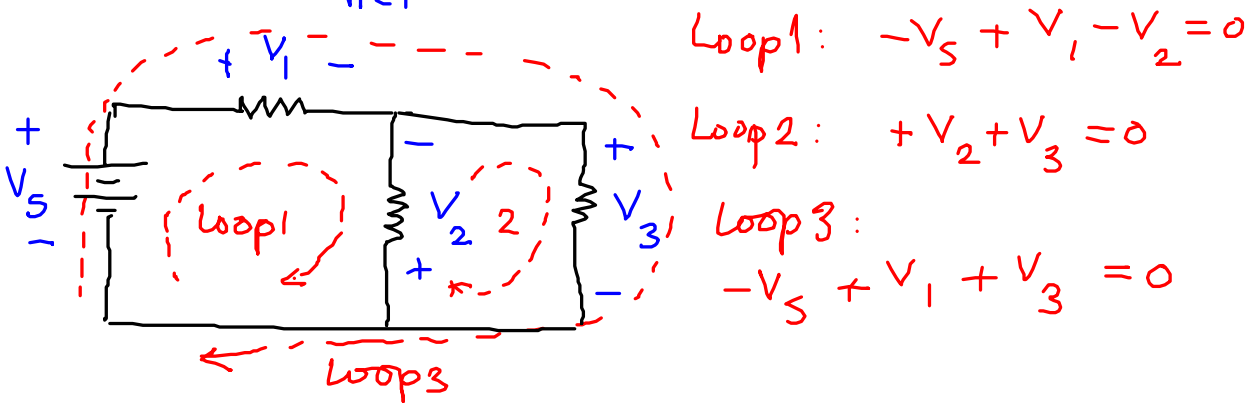


$$i_1 - i_5 + i_6 = 0$$

Kirchhoff's Voltage Law (KVL)

The sum of voltages around a closed loop must be equal to zero

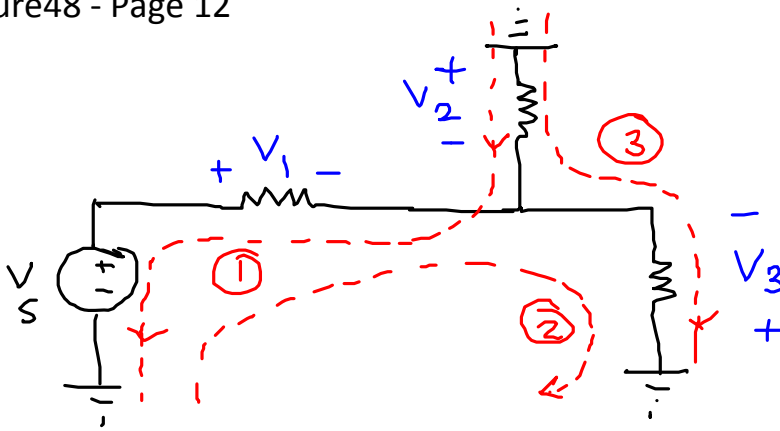
$$\sum_{n=1}^n v_n = 0$$



Loop 1: $-V_S + V_1 - V_2 = 0$

Loop 2: $+V_2 + V_3 = 0$

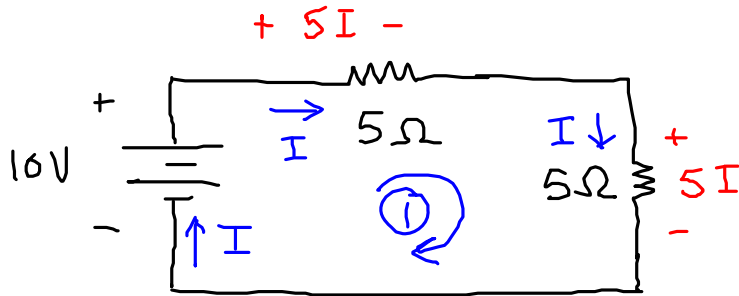
Loop 3: $-V_S + V_1 + V_3 = 0$



$$\textcircled{1} \quad V_2 - V_1 + V_S = 0$$

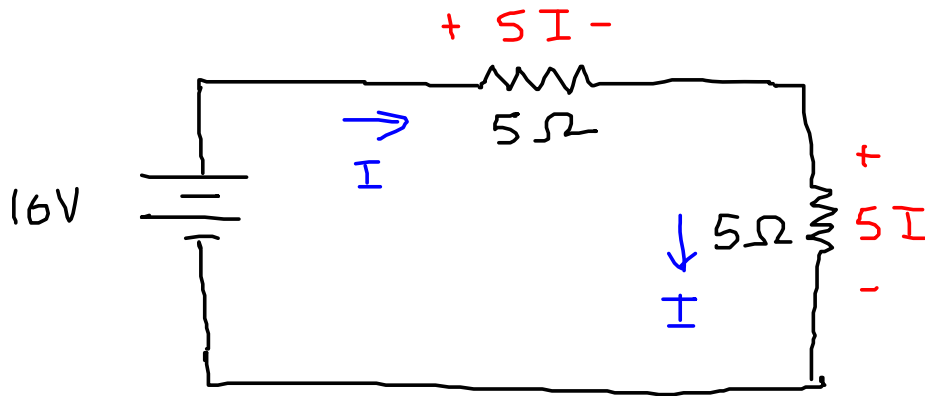
$$\textcircled{2} \quad -V_S + V_1 - V_3 = 0$$

$$\textcircled{3} \quad V_2 - V_3 = 0$$



$$\textcircled{1} \text{ KVL: } -10 + 5I + 5I = 0$$

$$\therefore I = \frac{10V}{10\Omega} = 1A$$



$I = 1A$

