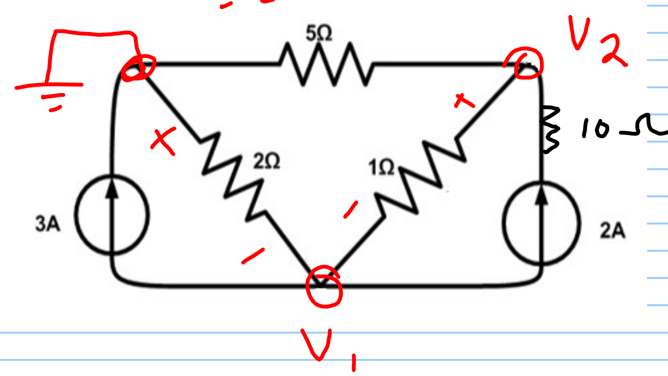
Note Title 9/30/2020

Ch 4

$\boxed{\text{Nodal method}}$

$V_2 - V_1$ 5 1 2.5
$-2.5 -$



@ node V_1

All currents are out
OR " " " IN

$\Sigma I_{out} = 0$ OR $\Sigma I_{IN} = 0$

I_{out}
$$3 + \frac{V_1}{2} + \frac{V_1 - V_2}{1} + 2 = 0$$

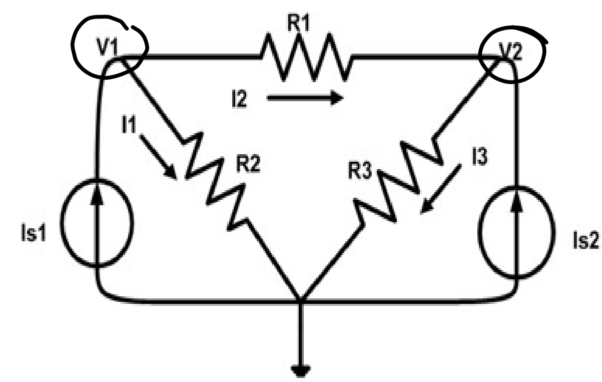
$$(1.5)\,V_1 - V_2 = -5 \quad \text{— (1)}$$

@ Node V_2

I_{out}
$$-2 + \frac{V_2 - V_1}{1} + \frac{V_2}{5} = 0$$

$$-V_1 + 1.2\,V_2 = 2 \quad \text{— (2)}$$

$$\boxed{\begin{aligned} V_1 &= -5\ V \\ V_2 &= -2.5\ V \end{aligned}}$$



@ node V_1

$$\left(\frac{1}{R_1} + \frac{1}{R_2}\right)V_1 - \left(\frac{1}{R_1}\right)V_2 = I_{s_1}$$

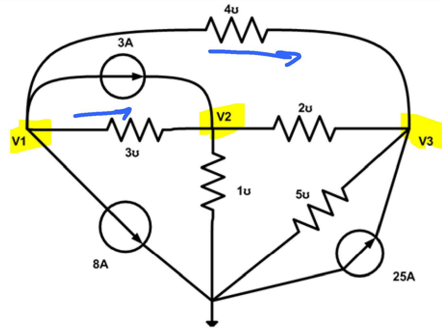
@ node V_2

$$-\left(\frac{1}{R_1}\right)V_1 + \left(\frac{1}{R_1} + \frac{1}{R_3}\right)V_2 = I_{s_2}$$

@ node 1

$$\sum I_{out} = \sum I_{in}$$

$$7V_1 - 3V_2 - 4V_3 = -11 \quad — ①$$



$$3(V_1 - V_2) + 4(V_1 - V_3) + 3 + 8 = 0$$

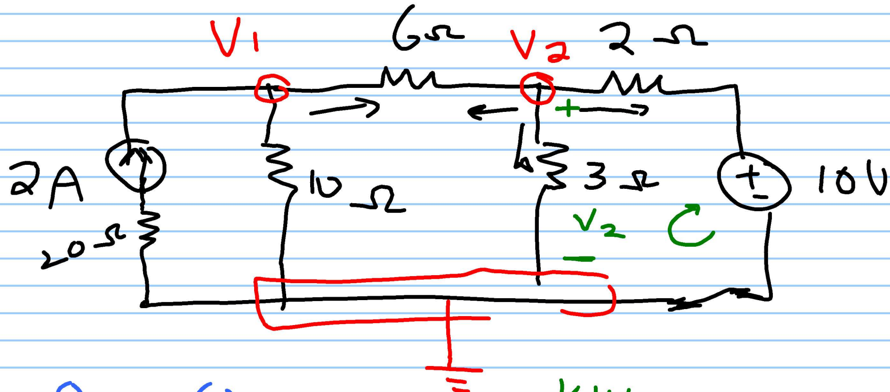
@ node V_2

$$-(3)V_1 + (3+2+1)V_2 - (2)V_3 = 3 \quad — ②$$

@ node V_3

$$-4V_1 - 2V_2 + (5+2+4)V_3 = 25 \quad — ③$$

Ex



$\sum I_{out} = zero$

KVL

node 1

$$-2 + \frac{V_1}{10} + \frac{V_1 - V_2}{6} = 0 \quad — ①$$

رتبها

$$-V_2 + 2I_x + 10 = 0$$

node 2

$$\sum I_{out} = 0$$

$$I_x = \frac{V_2 - 10}{2}$$

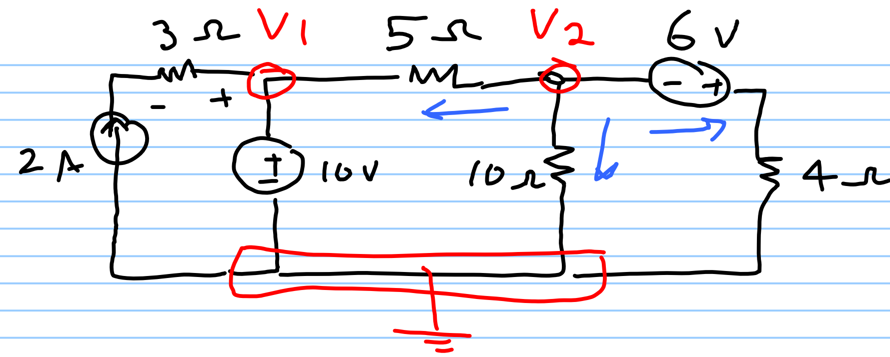
$$\frac{V_2 - V_1}{6} + \frac{V_2}{3} + \frac{V_2 - 10}{2} = 0 \quad — ②$$

رتبها

$V_1 =$ ——

$V_2 =$ ——

Ex



A V

$(-2) + (V_1 - 10)$ X

$V_1 = 10\ V$

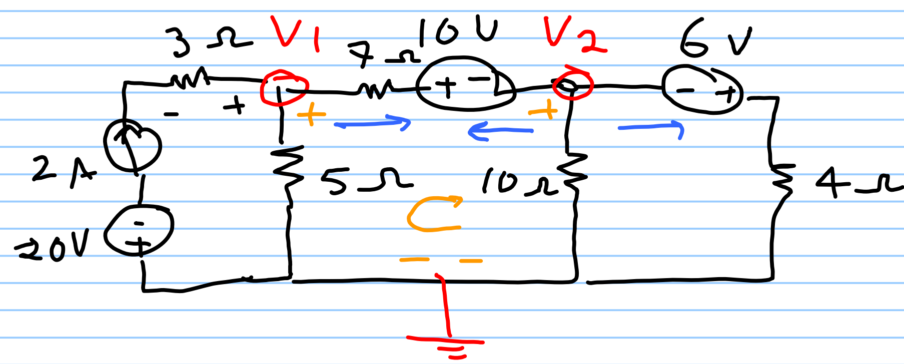
@ node V2

$$\frac{V_2 - \cancel{V_1}^{10}}{5} + \frac{V_2}{10} + \frac{V_2 + 6}{4} = 0$$

$$0.55 V_2 = 2 - 1.5$$

$$\boxed{V_2 = \frac{0.5}{0.55} = 0.909 \text{ Volt}}$$

Ex



$\Sigma I_{out} = \text{Zero}$

@ node V1

$$-2 + \frac{V_1}{5} + \frac{V_1 - 10 - V_2}{7} = 0 \quad \text{—(1)}$$

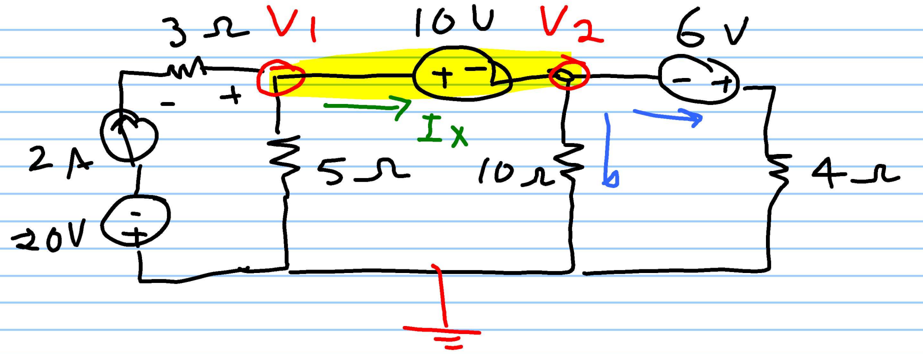
$$-V_1 + 7I_x + 10 + V_2 = 0$$

@ node V2

$$\frac{V_2 - V_1 + 10}{7} + \frac{V_2}{10} + \frac{V_2 + 6}{4} = 0 \quad \text{—(2)}$$

Special case

Ex



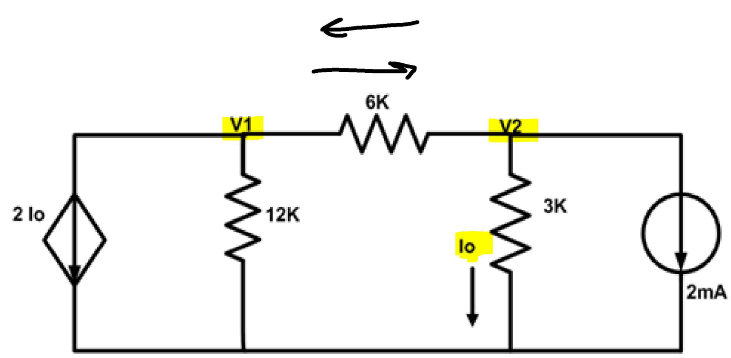
@node V_1

$$-2 + \frac{V_1}{5} + \underline{\underline{I_x}} = 0$$

$$-2 + \frac{V_1}{5} + \frac{V_2}{10} + \frac{V_2 + 6}{4} = 0 \quad \text{— (1) KVL}$$

$$V_1 - V_2 = 10 \quad \text{— (2) KVL @ supernode}$$

Ex



$$I_o = \frac{V_2}{3k} \quad \text{— (1)}$$

@ node V_1

$$2 I_o + \frac{V_1}{12k} + \frac{V_1 - V_2}{6k} = 0$$

$$2\left(\frac{V_2}{3K}\right) + \frac{V_1}{12k} + \frac{V_1 - V_2}{6k} = 0 \quad \text{— (1)}$$

@ node V_2

$$\frac{V_2 - V_1}{6k} + \frac{V_2}{3k} + 2mA = 0 \quad \text{— (2)}$$

$$V_1 = -\frac{24}{5} V, \quad V_2 = \frac{12}{5} V$$

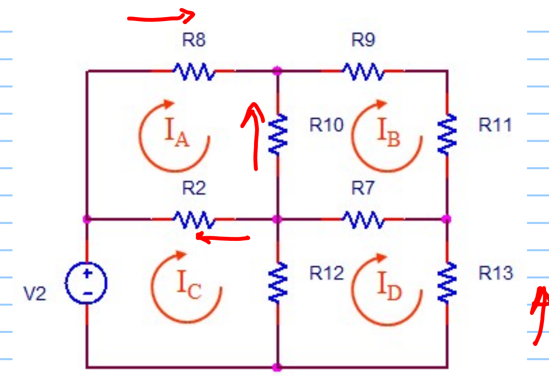
Mesh method

$I_{R_8} = I_A$

$I_{R_2} = I_A - I_C$

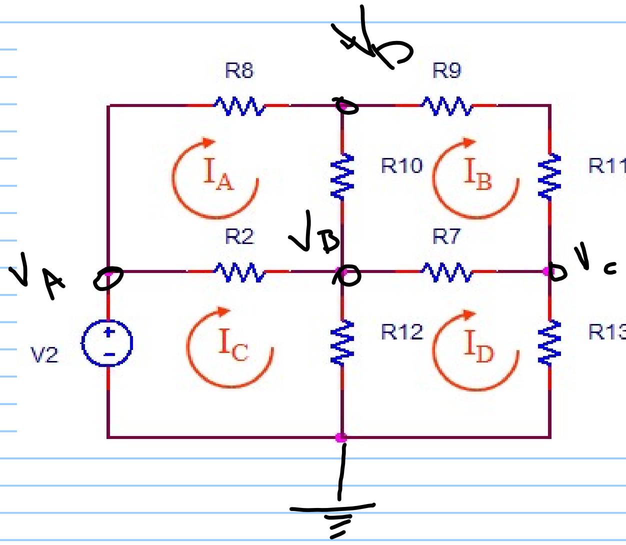
$I_{R_{13}} = -I_D$

$I_{R_{10}} = I_B - I_A$



4 equations

4 unknowns I_A, I_B, I_C & I_D



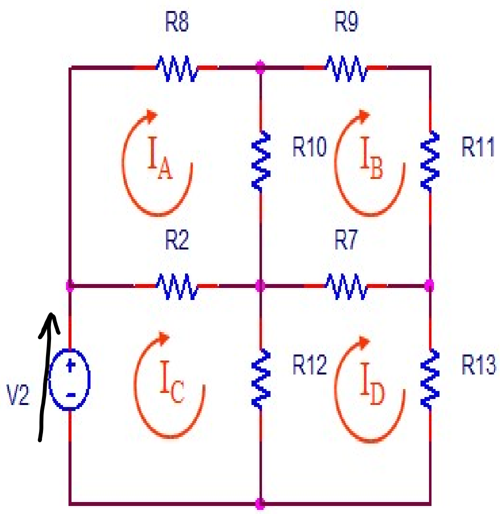
$V_A = V_2$

Nodal method

3 eqs

3 unknowns

V_{B}, C & D



Mesh KVL

$$R_8 I_A + R_{10}(I_A - I_B) + R_2(I_A - I_C) = 0$$

$$(R_8 + R_{10} + R_2) I_A - R_{10} I_B - R_2 I_C = 0 \quad (1)$$

$$-(R_{10}) I_A + (R_{10} + R_9 + R_{11} + R_7) I_B$$

$$-0 I_C - R_7 I_D = 0 \quad (2)$$

$$-V_2 + R_2(I_C - I_A) + R_{12}(I_C - I_D) = 0$$

$$(R_2 + R_{12}) I_C - R_2 I_A - R_{12} I_D = V_2 \quad (3)$$

$$(R_{12}+R_7+R_{13})I_D - 0I_A - R_7 I_B - R_{12} I_C = 0 \quad - \text{(4)}$$

EX

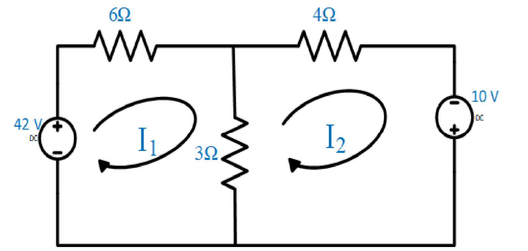


Figure3:example 1 of mesh analysis

$$-42 + 6I_1 + 3(I_1 - I_2) = 0$$

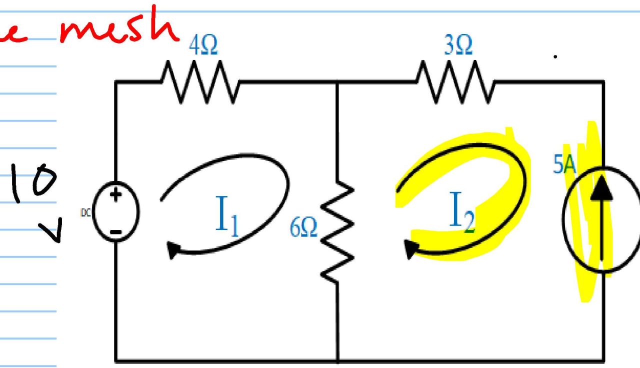
$$9I_1 - 3I_2 = 42 \quad \text{— (1)}$$

$$-3I_1 + 7I_2 = 10 \quad \text{— (2)}$$

6A, 4A

special case 1 | current source exists only in one mesh

EX



Figur6:mesh with current sourcee.

$$I_2 = -5\,A \checkmark$$

$$-10 + 4I_1 + 6(I_1 - 5) = 0$$

+

$$I_1 = -2A \checkmark$$

Case 2:

Current source exists between two meshes, a **Super mesh** is obtained

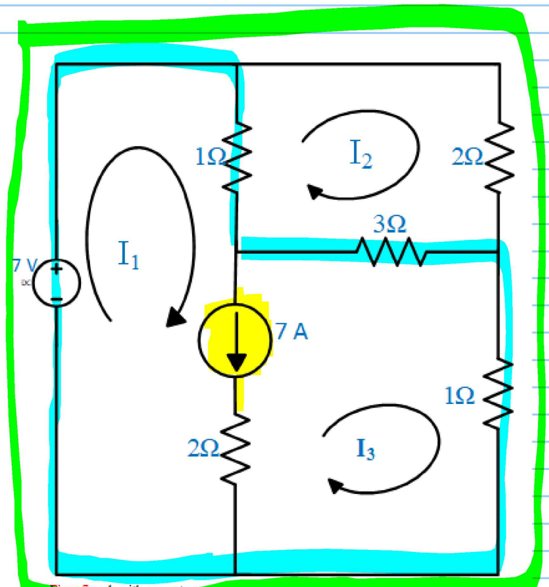


Figure 7 mesh with current sources

→ KVL for mesh (2)

$$(1+2+3)I_2 - (1)I_1 - (3)I_3 = 0 \quad (1)$$

→ constraint equation

$$I_1 - I_3 = 7 \quad (2)$$

→ super mesh equation

$$-7 + (1)(I_1 - I_2) + (3)(I_3 - I_2) + (1)I_3 = 0$$

$$I_1 - 4I_2 + 4I_3 = 7 \quad (3)$$

$I_3 = -7A$ X

OR

*

$$-7 + 2I_2 + I_3 = 0 \quad (3)$$

EX) Mesh Analysis with dependent sources

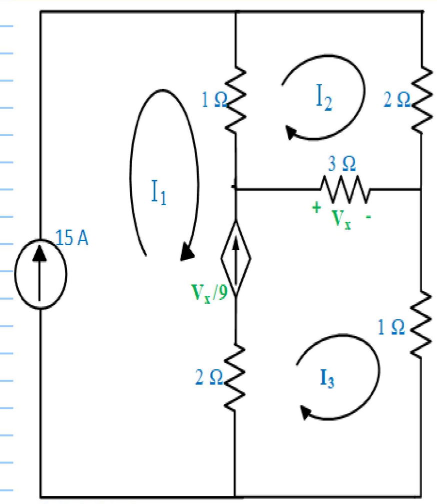


Figure 9 mesh with dependant current source.

→ $V_x = (3)(I_3 - I_2)$

$\boxed{I_1 = 15A}$ ✓

→ constraint equation

$$\frac{V_x}{9} = I_3 - I_1$$

$$\frac{3}{9}(I_3 - I_2) = I_3 - 15$$

$$\frac{3}{9}I_2 + \frac{2}{3}I_3 = 15$$

$$\boxed{I_2 + 2I_3 = 45} \quad (1)$$

$$(1)(I_2 - 15) + (2)I_2 + (3)(I_2 - I_3) = 0$$

$$\boxed{6I_2 - 3I_3 = 15} \quad (2)$$

$I_2 = 11A$ ✓

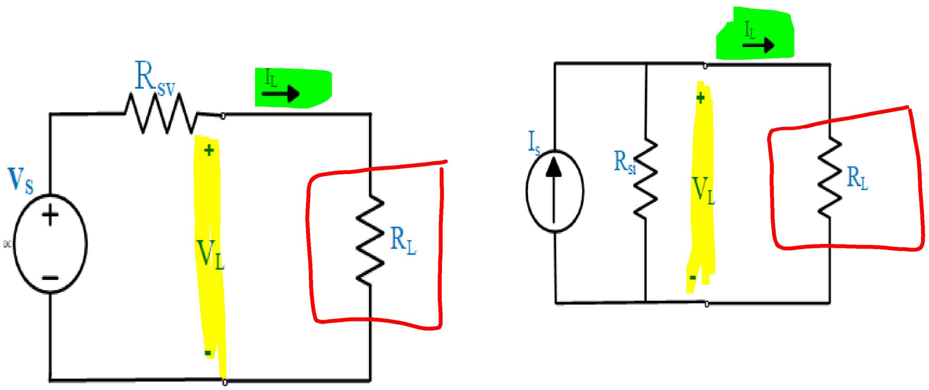
$I_3 = 17A$ ✓

Node or mesh: How to choose?

- Use the one with fewer equations.
- Use the method you like best.

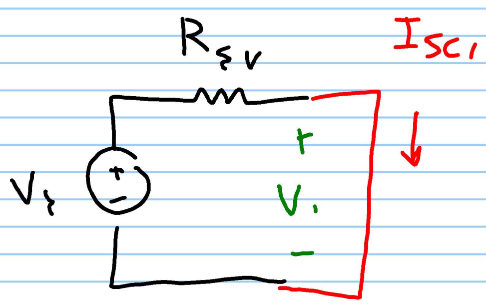
slides

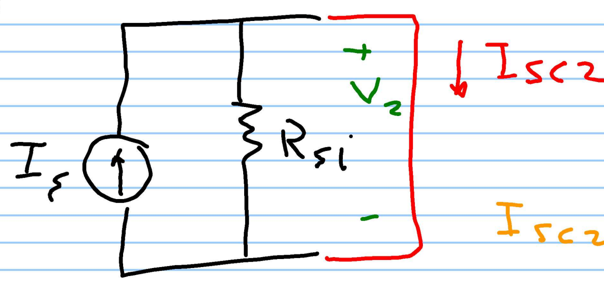
Source Transformation



Two sources are equivalent, if each produces identical current and identical voltage in any load which is placed across its terminal.

let $R_L = \text{Zero}$ (short circuit S.C.)





$$I_{sc2} = \frac{R_{si}}{R_{si} + 0} I_s$$

$$I_{sc1} = \frac{V_s}{R_{sv}}$$

$$I_{sc2} = I_s$$

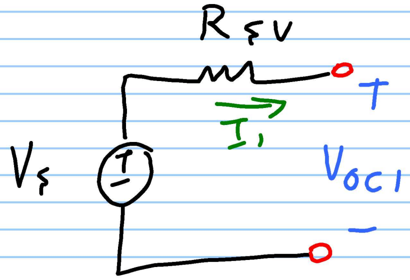
$$\boxed{V_1 = V_2 = \text{Zero}}$$

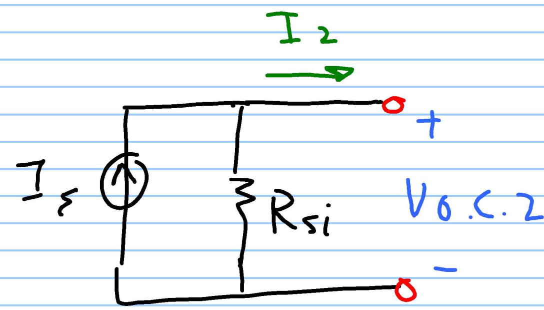
For $I_{sc1} = I_{sc2}$

$$\boxed{I_s = \frac{V_s}{R_{sv}}}$$ ⊕

↱ let $R_L = \infty$ (open circuit)

$\boxed{I_1 = I_2 = \text{Zero}}$





$V_{oc1} = V_s$ $\qquad$ $V_{oc2} = I_s R_{si}$

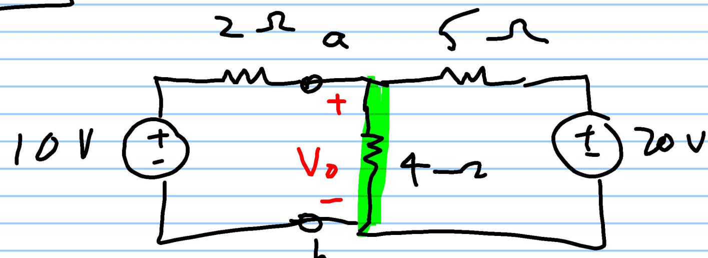
For $V_{oc1} = V_{oc2}$

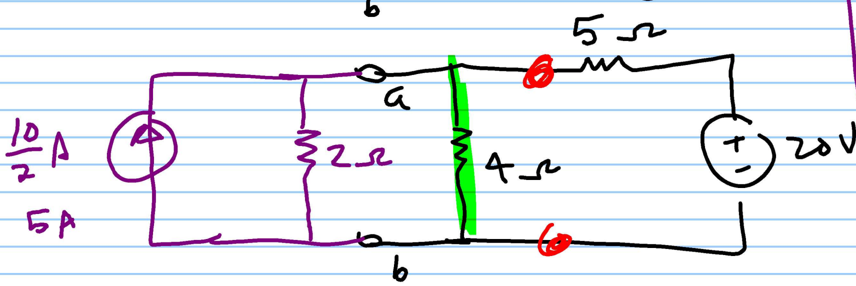
$V_s = I_s R_{si}$

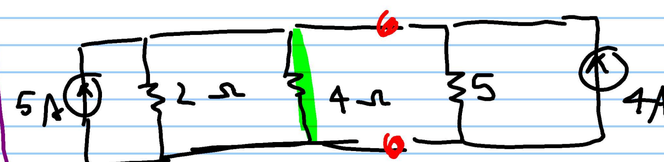
OR $\boxed{I_s = \dfrac{V_s}{R_{si}}}$ —— * * —— $\boxed{I_s = \dfrac{V_s}{R_{sv}}}$ —— ⊕

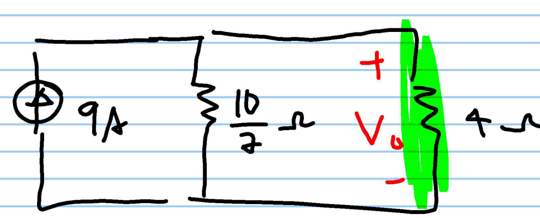
or $\boxed{R_{si} = R_{sv}}$

Ex 1 find V_o



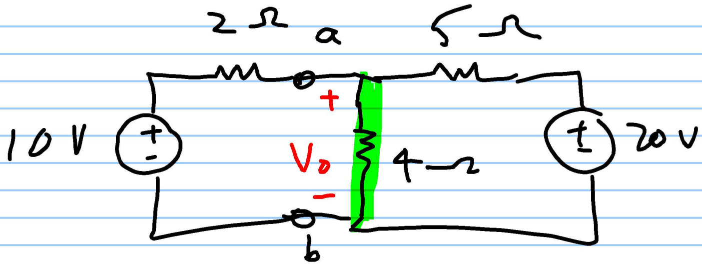






$$\left(\frac{10/7}{10/7+4}\cdot 9\right)(4) = V_o$$

$V_o = 9.47$ Volt. ✓



OR

Nodal

$$\frac{V_0 - 10}{2} + \frac{V_0}{4} + \frac{V_0 - 20}{5} = 0$$

$$V_0\left(\frac{1}{2} + \frac{1}{4} + \frac{1}{5}\right) = \frac{10}{2} + \frac{20}{5}$$

$$V_0(0.95) = 9$$

$$V_0 = 9.473 \text{ Volt.}$$