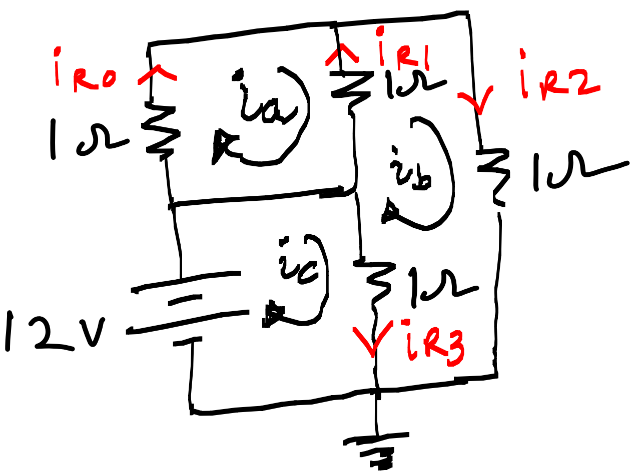
Extra Practice Questions.

Note Title 2/5/2013

Q.1



KVL for mesh a:

$$i_a \cdot 1 + (i_a - i_b)\cdot 1 = 0$$

$$2 i_a - i_b = 0 \quad \text{——} \ (1)$$

KVL for mesh b:

$$(i_b - i_a)\cdot 1 + i_b \cdot 1 + (i_b - i_c)\cdot 1 = 0$$

$$-i_a + 3 i_b - i_c = 0 \quad \text{——} \ (2)$$

KVL for mesh c:

$$-12 + (i_c - i_b)\cdot 1 = 0$$

$$-i_b + i_c = 12 \quad \text{——} \ (3)$$

The equations can be put in matrix form

$$\begin{bmatrix} 2 & -1 & 0 \\ -1 & 3 & -1 \\ 0 & -1 & 1 \end{bmatrix} \begin{bmatrix} i_a \\ i_b \\ i_c \end{bmatrix} = \begin{bmatrix} 0 \\ 0 \\ 12 \end{bmatrix}$$

Solution: $i_a = 4\,A$, $i_b = 8\,A$, $i_c = 20\,A$.

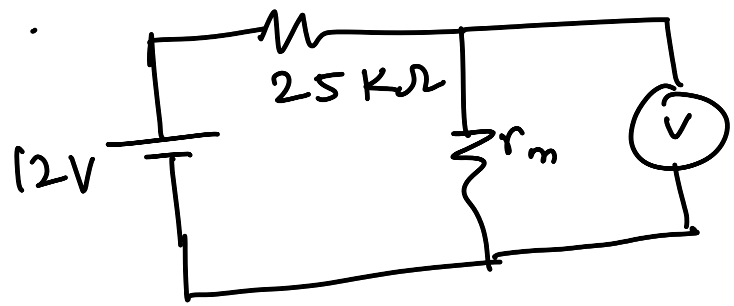
$i_{R0} = i_a = 4\,A$.

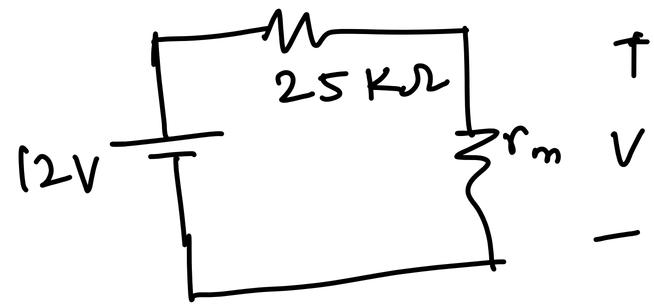
$i_{R1} = i_b - i_a = 8 - 4 = 4\,A$.

$i_{R2} = i_b = 8\,A$.

$i_{R3} = i_c - i_b = 20 - 8 = 12\,A$.

Q.2 .





(volt-meter represented by its equivalent resistance)

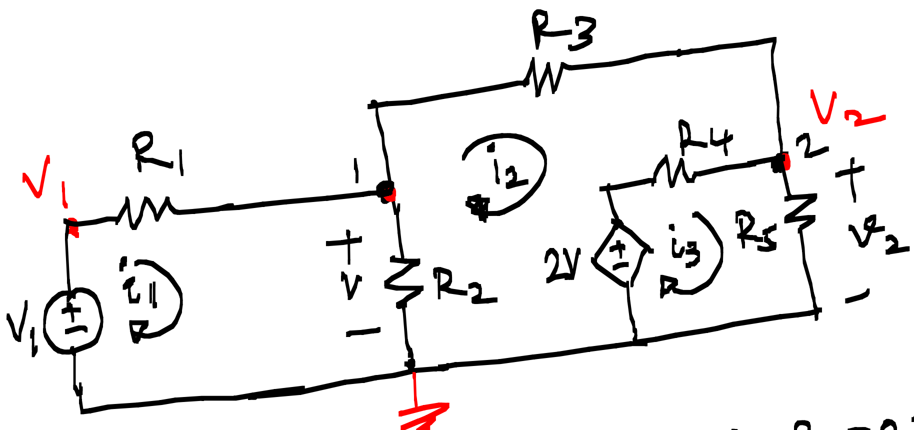
Given $v = 11.81\,V$.

Voltage divider rule $\Rightarrow$ $v = 12 \times \dfrac{r_m}{25K + r_m} = 11.81$

$$12\, r_m = 25000 \times 11.81 + 11.81\, r_m$$

$$r_m = \frac{25 \times 11.81}{0.19}\,K = \underline{\underline{1554\,K\Omega}}\,.$$

Q.3



$R_1 = 1\Omega$, $R_2 = 0.5\Omega$, $R_3 = 0.25\Omega$, $R_4 = 0.25\Omega$, $R_5 = 0.25\Omega$

we can use either node voltage or mesh current analysis method. In mesh current analysis method, we have to solve for 3 unknown variables. In node voltage analysis method, we need to solve for 2 unknowns only.

Voltage gain $A_v = \frac{V_2}{V_1}$

Let us try node voltage analysis:

(unknowns V, V_2).

KCL at node 1

$$\frac{V-V_1}{R_1} + \frac{V}{R_2} + \frac{V-V_2}{R_3} = 0 \quad \text{— (1)}$$

$$\frac{V-V_1}{1} + \frac{V}{0.5} + \frac{V-V_2}{0.25} = 0$$

$$(V-V_1) + 2V + 4(V-V_2) = 0$$

$$7V - 4V_2 = V_1 \quad \text{— (1)}$$

contd.

→ contd..

KCL at node 2

$$\frac{V_2-2V}{R_4} + \frac{V_2}{R_5} + \frac{V_2-V}{R_3} = 0 \quad \text{— (2)}$$

$$\frac{V_2-2V}{0.25} + \frac{V_2}{0.25} + \frac{V_2-V}{0.25} = 0$$

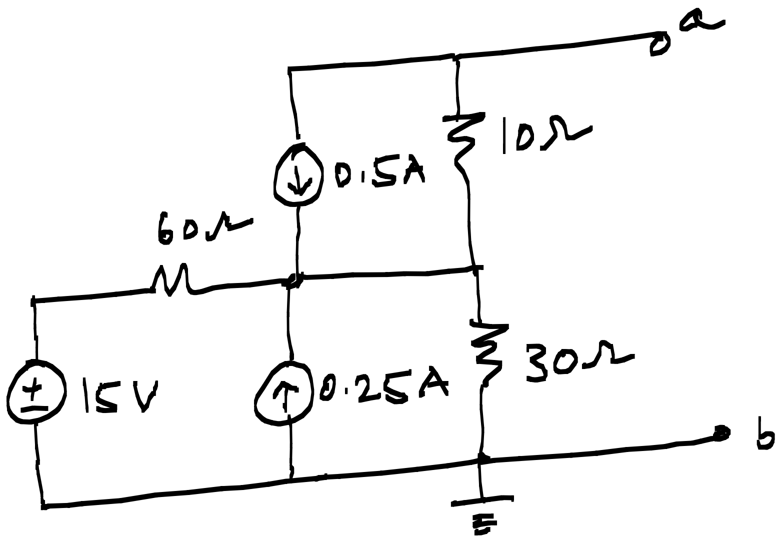
$$V_2 - 2V + V_2 + V_2 - V = 0$$

$$3V_2 - 3V = 0 \Rightarrow V_2 = V.$$

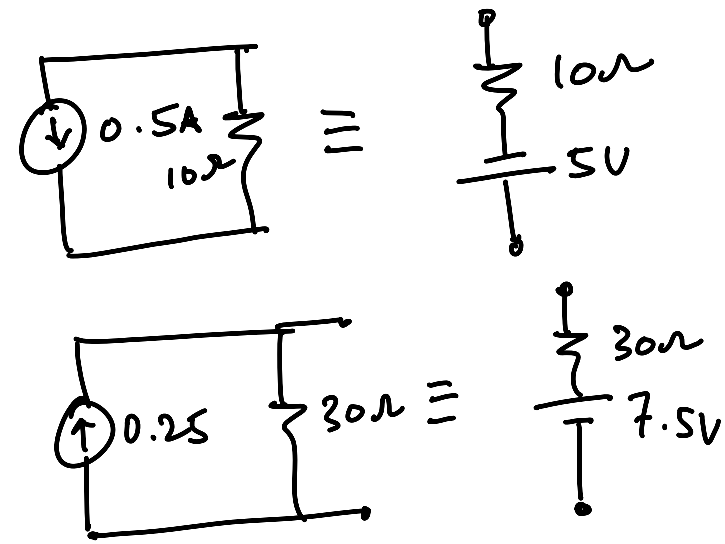
$$\therefore 7 \cdot V_2 - 4V_2 = V_1 \Rightarrow 3V_2 = V_1,$$

$$\therefore A_v = \frac{V_2}{V_1} = \frac{1}{3} = 0.33.$$

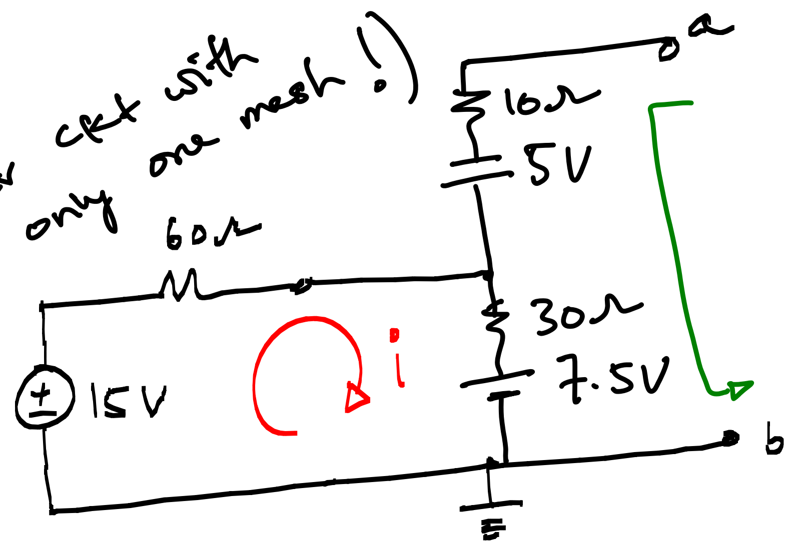
Q.4.



- The ckt has 3 meshes.
- However, if we do source conversion it will be simpler.
- Let us convert current source with parallel resistor to voltage source with series resistor.



(simpler ckt with only one mesh!)



KVL around the only mesh: $-15 + 60i + 30i + 7.5 = 0$

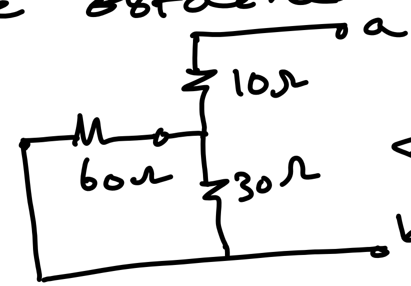
$90i = 7.5\,V \Rightarrow i = \frac{7.5}{90}\,A$.

Voltage V_{ab} (Find a path from a to b and add the voltage falls along the way!) =

$= -5 + 30 \times i + 7.5 = -5 + \cancel{30}^{\,} \times \frac{\cancel{7.5}^{2.5}}{\cancel{90}_{3}} + 7.5 = 5\,V.$

$\therefore\ \underline{\underline{V_{oc} = V_t = 5V}}.$

Thevenin resistance can be obtained by killing all the independent sources:



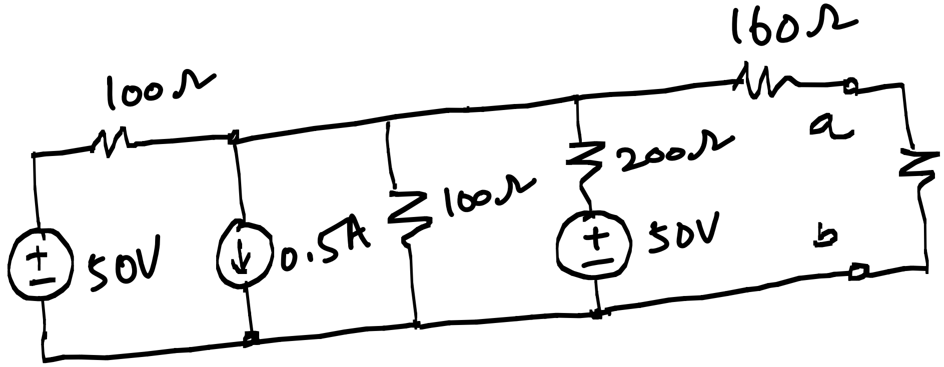
$\Leftarrow R_{eq} = 10 + \frac{30 \times 60}{30 + 60}$

$= 10 + 20 = 30\Omega$

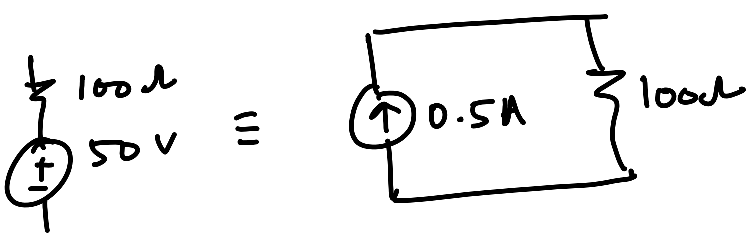
$= R_t$.

$\therefore\ \underline{\underline{V_t = 5V,\ R_t = 30\Omega}}.$ Ans.

Q.5



We shall convert voltage source with series resistance to current source with parallel resistance.



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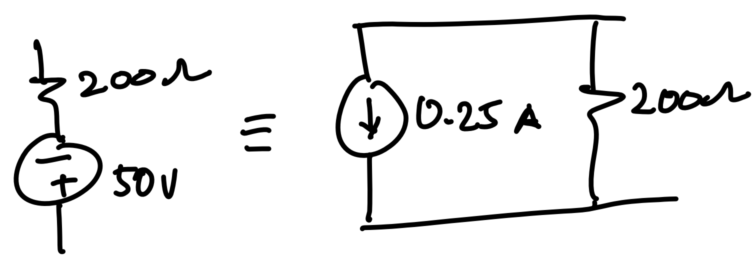
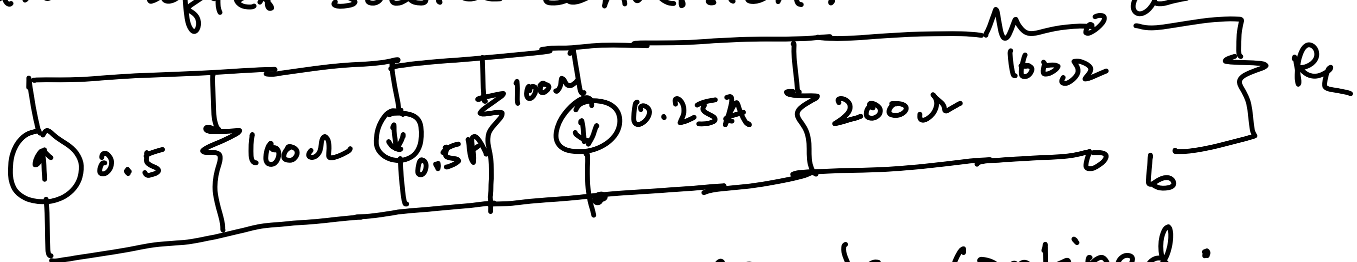
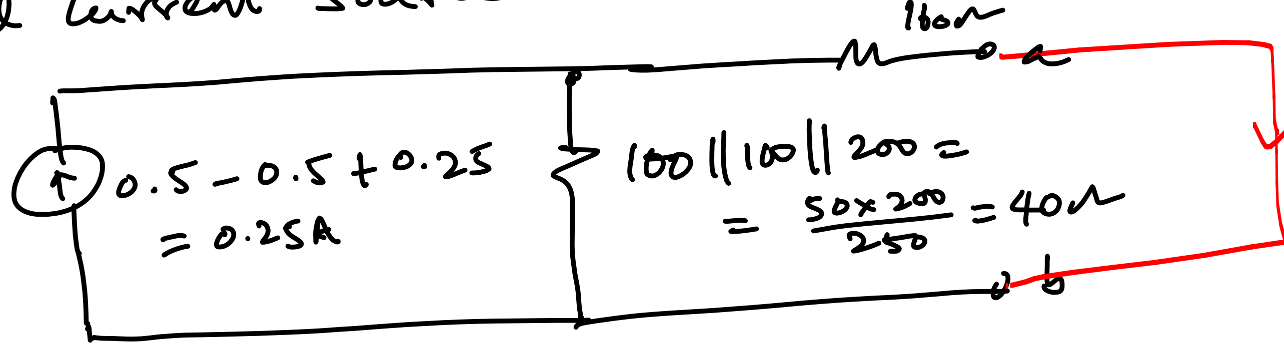


Circuit after source conversion:



Parallel current sources can be combined:



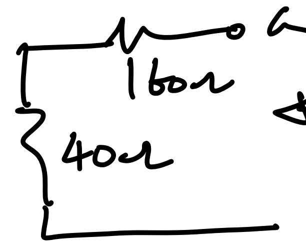
Current divider rule

$I_{sc} = 0.25 \times \frac{40}{200}$

$= 0.05A$

$= I_N.$

R_t : killing the current source

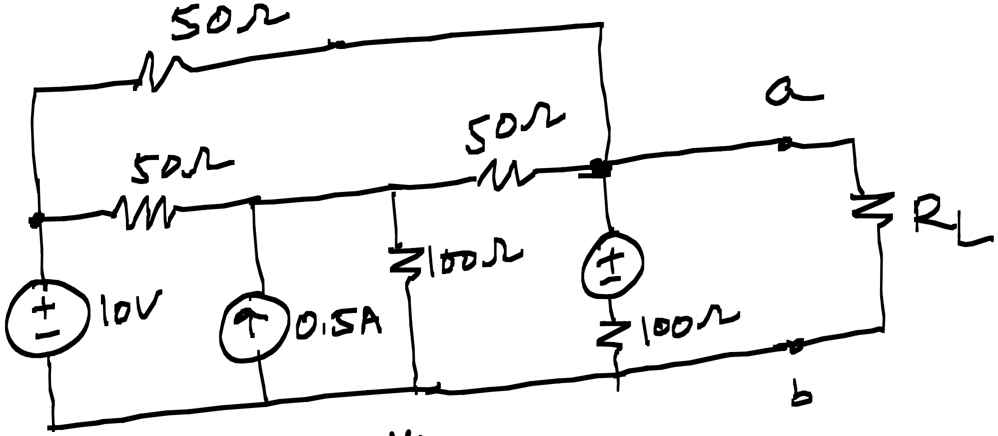


$R_{eq} = 200\Omega$

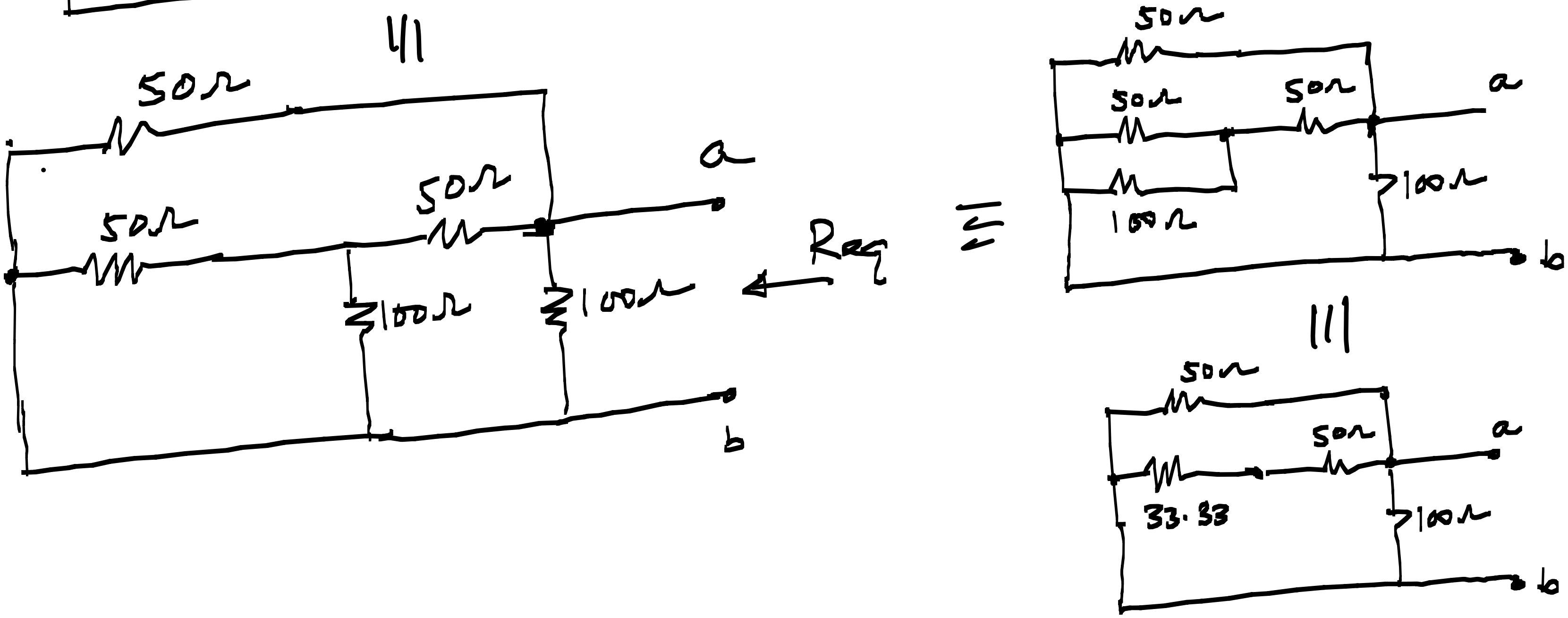
$= R_t$

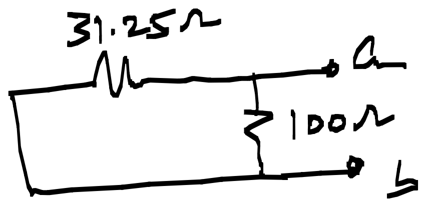
$I_N = 0.05A, \quad R_t = 200\Omega$

Q.6



- All sources are independent
- We can kill these sources and then find R_{eq}.





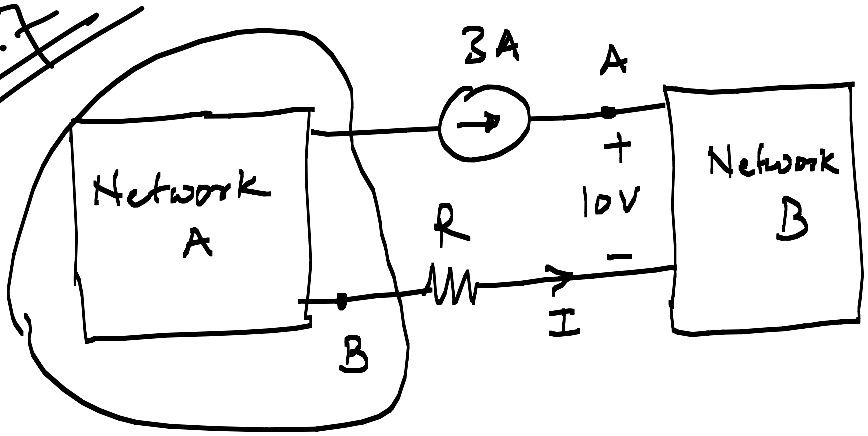
$$50 \parallel (33.33 + 50) = 50 \parallel 83.33$$

$$= \frac{50 \times 83.33}{133.33} = 31.25\,\Omega.$$

$$R_{eq} = \frac{31.25 \times 100}{131.25} = 23.81\,\Omega.$$

$$R_t = 23.81\,\Omega$$

Q.7



KCL at the supernode:

$$3 + I = 0 \Rightarrow I = -3\ A.$$

KVL around the loop:

As we have to find V_{AB}, let us start from point A and go counter clockwise
$V_{AB} = V_A - V_B$ i.e. the voltage fall from point A to point B.

$$\therefore \quad V_{AB} + R \times I - 10 = 0$$

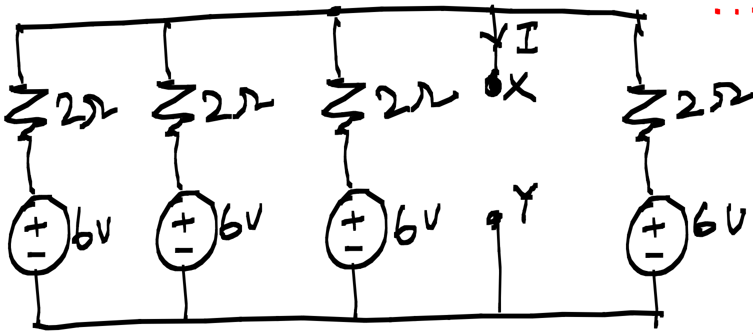
$$\therefore \quad V_{AB} = 10 - R \cdot I.$$

When $R = 2\,\Omega$, $V_{AB} = 10 - 2 \times (-3) = 16\ V$

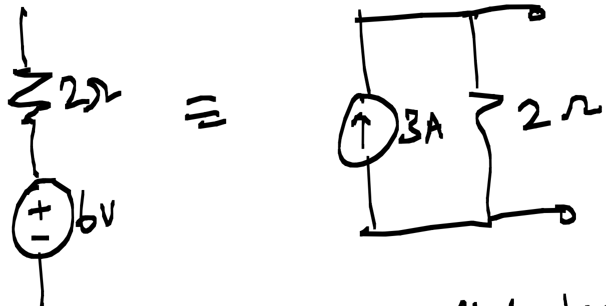
When $R = 0\,\Omega$, $V_{AB} = 10 - 0 \times (-3) = 10\ V$

When $R = 6\,\Omega$, $V_{AB} = 10 - 6 \times (-3) = 28\ V.$

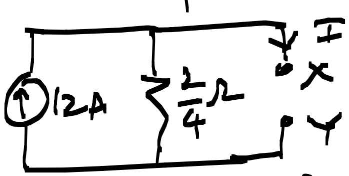
Q.8



We can do source conversion:



∴ with 4 such parallel branches, we get:



(Norton's equivalent)

... Contd

(a) when open circuited:

$I = 0$, $V_{XY} = 12 \times \frac{2}{4} = 6V$.

(b) when short circuited:

$I = 12A$, $V_{XY} = 0$.

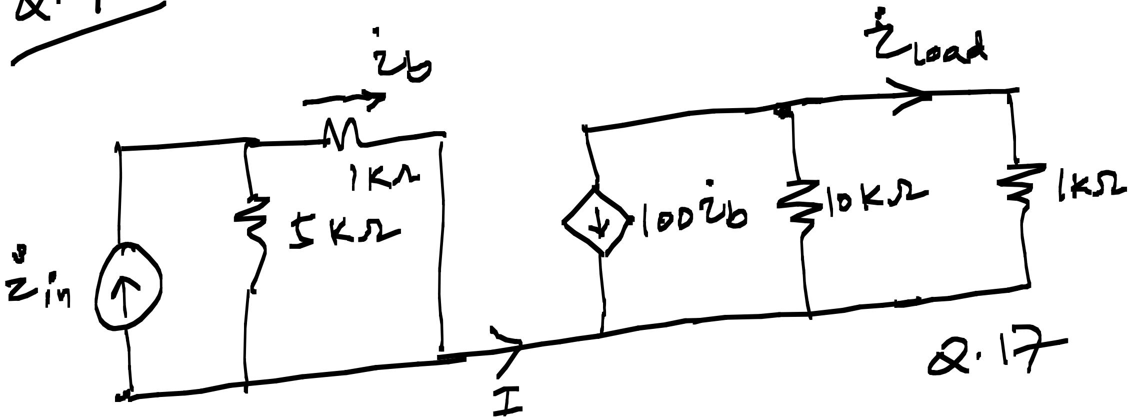
(c) when 1Ω is connected across them,

$$I = \frac{2/4}{1 + 2/4} \times 12 = \frac{2}{4+2} \times 12 = \frac{24}{4+2}$$

$$= 4A.$$

$V_{XY} = 1 \times 4 = 4V$

Q.9



Q.17

We can show That $I = 0$.

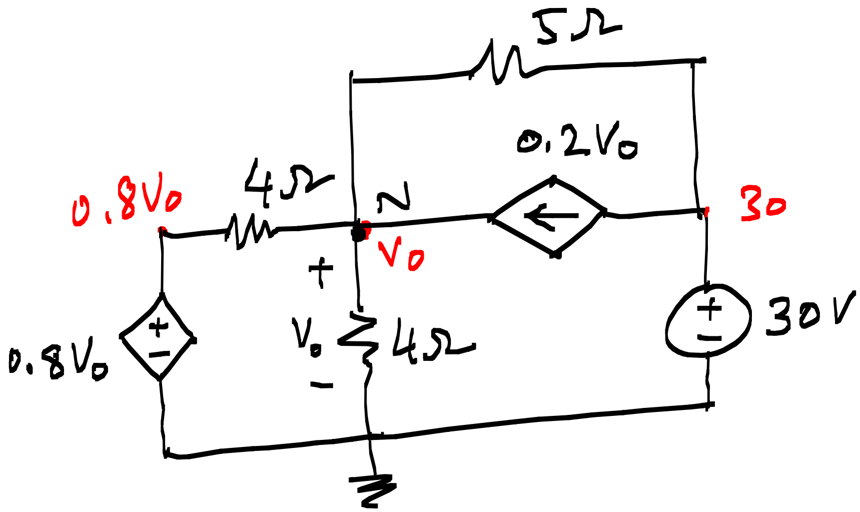
$\therefore \quad i_b = i_{in} \times \frac{5}{5+1} = i_{in} \times \frac{5}{6}$ (Current divider rule)

$i_{Load} = -100\, i_b \times \frac{10}{10+1} =$

$= -100 \times i_{in} \times \frac{5}{6} \times \frac{10}{11}$

$\therefore \quad A_i = \frac{i_{Load}}{i_{in}} = -100 \times \frac{50}{66}$

Q.10



KCL at node N.

$$\frac{V_0 - 0.8V_0}{4} + \frac{V_0}{4} + \frac{V_0 - 30}{5} - 0.2V_0 = 0$$

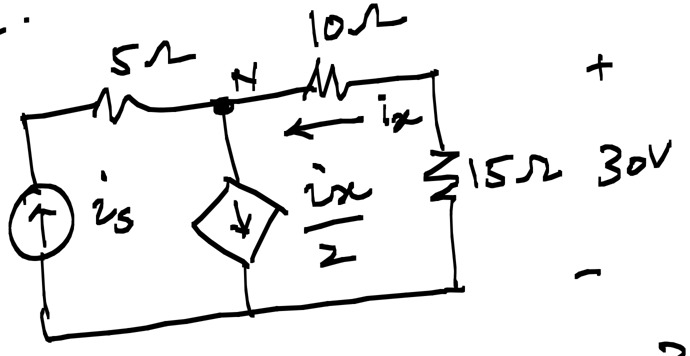
multiplying by 20:

$$5 \times 0.2V_0 + 5V_0 + 4(V_0 - 30) - 20 \times 0.2V_0 = 0$$

$$V_0 + 5V_0 + \cancel{4V_0} - 120 - \cancel{4V_0} = 0$$

$$6V_0 = 120 \Rightarrow V_0 = 20\text{ V}.$$

2.11.



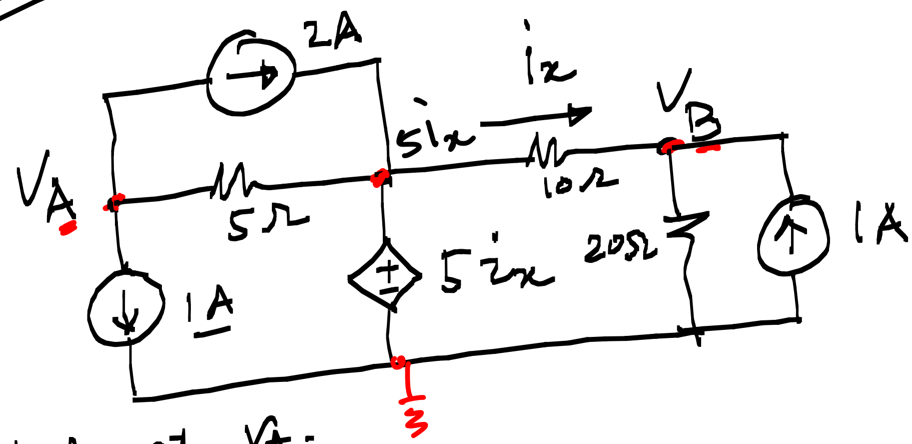
$$30V = 15\,i_x \Rightarrow i_x = \frac{30}{15} = 2\,A.$$

KCL at node N.

$$-i_s - i_x + \frac{i_x}{2} = 0$$

$$\therefore -i_s = i_x/2 \Rightarrow i_s = -\frac{i_x}{2} = -1A.$$

Q.12



- Node voltage analysis
- Unknowns V_A and V_B.

$$i_x = \frac{5i_x - V_B}{10}$$

$$\Rightarrow 10 i_x = 5i_x - V_B \Rightarrow \underline{i_x = -0.2V_B}$$

<u>KCL at V_A:</u>

$$1 + 2 + \frac{V_A - 5i_x}{5} = 0 \Rightarrow 3 + \frac{V_A - 5(-0.2V_B)}{5} = 0 \Rightarrow V_A + V_B = -15 \quad (1)$$

<u>KCL at V_B:</u>

$$-i_x + \frac{V_B}{20} - 1 = 0 \Rightarrow 0.2V_B + \frac{V_B}{20} - 1 = 0 \Rightarrow 4V_B + V_B - 20 = 0$$

$$\Rightarrow V_B = 4V.$$

$$\therefore V_A = -15 - V_B = -19V.$$

$$\therefore V_{AB} = V_A - V_B = -19 - 4 = -23V. \quad \underline{\text{ANS}}$$