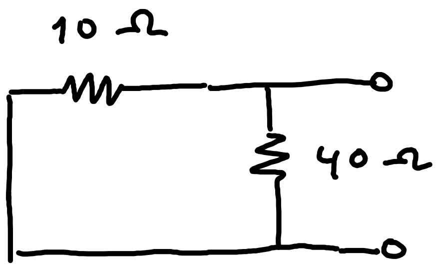
[Alexander and Sadiku, 2009, Q4.33]: V_{Th} & R_{Th}

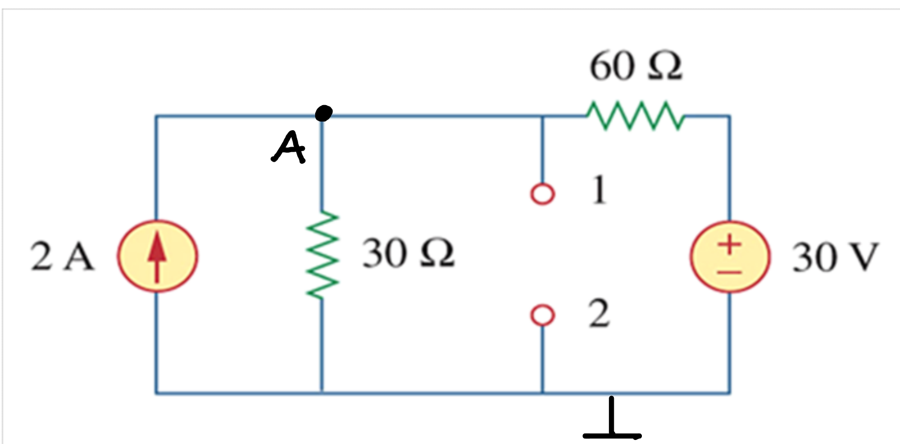
Monday, July 1, 2013 3:56 PM

(a) $V_{TH} = \dfrac{4\cancel{0}}{1\cancel{0}+4\cancel{0}} \times 20 = \dfrac{4}{5} \times 20 = \boxed{16\text{ V}}$

$R_{TH} = 10 // 40 = \dfrac{10 \times 40}{10+40} = \boxed{8\ \Omega}$



(b)



(b)

At node A

$$-2 + \frac{v_A}{30} + \frac{v_A - 30}{60} = 0$$

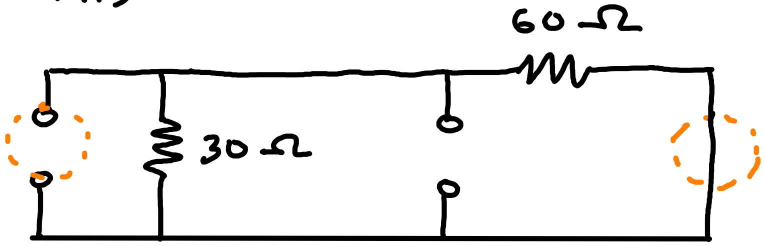
$$-120 + 2v_A + v_A - 30 = 0$$

$$3v_A = 150\,V$$

$$v_A = 50\,V$$

$$V_{TH} = v_A = \boxed{50\,V}$$

For R_{TH}, we deactivate all the sources:



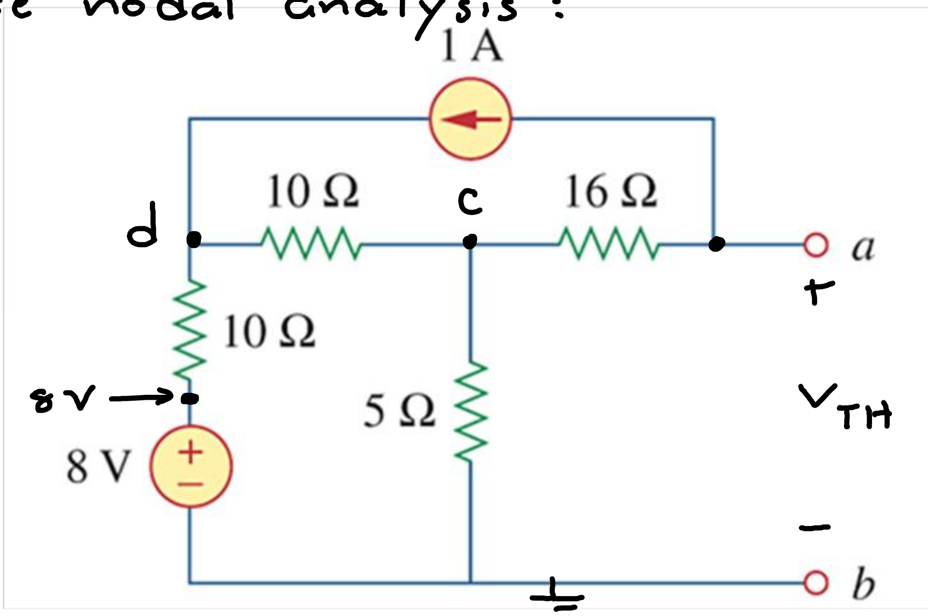
$$R_{TH} = 30 // 60 = \frac{30 \times 60}{30 + 60} = \frac{\cancel{30}^{10} \times \cancel{60}^{2}}{\cancel{90}_{3}} = \boxed{20\,\Omega}$$

[Alexander and Sadiku, 2009, Q4.39]: VTh & RTh

Monday, July 1, 2013 4:02 PM

First we find V_{TH}

Use nodal analysis :



KCL @ a:

$$1 + \frac{V_a - V_c}{16} = 0$$

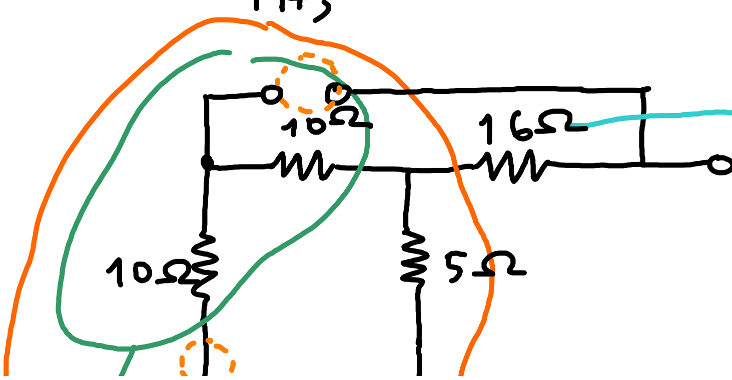
$$\frac{V_c - V_a}{16} = 1$$

Maple

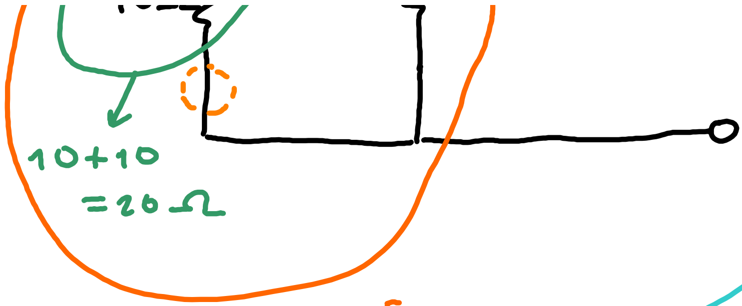
$$\left.\begin{aligned} &\text{KCL @ c: } \underbrace{\frac{V_c - V_a}{16}}_{=1} + \frac{V_c - V_d}{10} + \frac{V_c}{5} = 0 \\ &\text{KCL @ d: } \frac{V_d - 8}{10} + \frac{V_d - V_c}{10} - 1 = 0 \end{aligned}\right\} \Rightarrow \begin{aligned} V_c &= -\frac{2}{5} \\ V_d &= \frac{44}{5} \end{aligned}$$

$$V_a = V_c - 16 \times 1 = -\frac{2}{5} - 16 = -16.4 \text{ V} = V_{TH}$$

For R_{TH}, we deactivate all the sources :

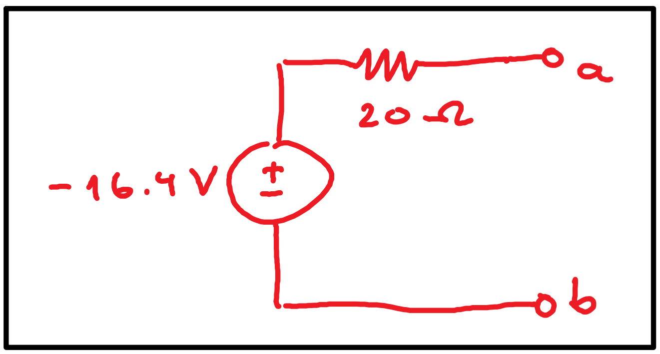


$$R_{TH} = 4 + 16 = 20\,\Omega$$



$$20 /\!/ 5 = \frac{20 \times 5}{20+5} = 4\ \Omega$$

The Thevenin equivalent at terminal a-b is

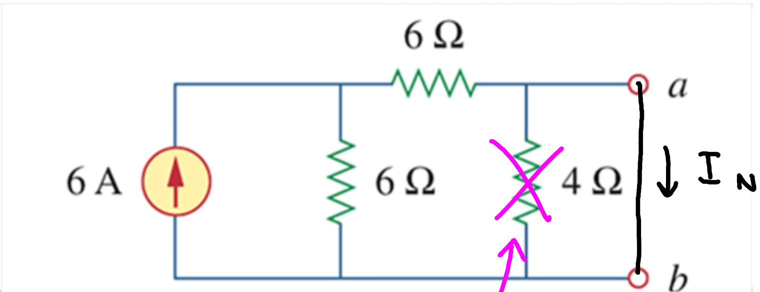


[Alexander and Sadiku, 2009, Q4.45]

Monday, July 1, 2013 4:02 PM

First, we find I_N.

Recall that I_N = short-circuit current



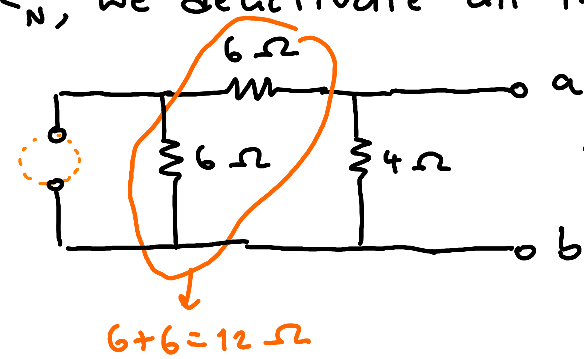
Alternatively, we see that the voltage across this 4Ω resistor is $V_a - V_b = 0$.
same because they are shorted together.
By ohm's law, there can't be any current through this 4Ω resistor.

The 4 Ω resistor is gone because it is shorted out.

By the current divider formula, the 6 A from the current source is split equally between the two 6 Ω resistors.

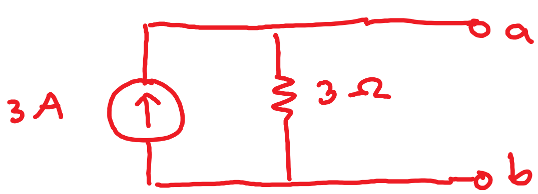
Hence, $I_N = 3\,A$.

For R_N, we deactivate all the sources:

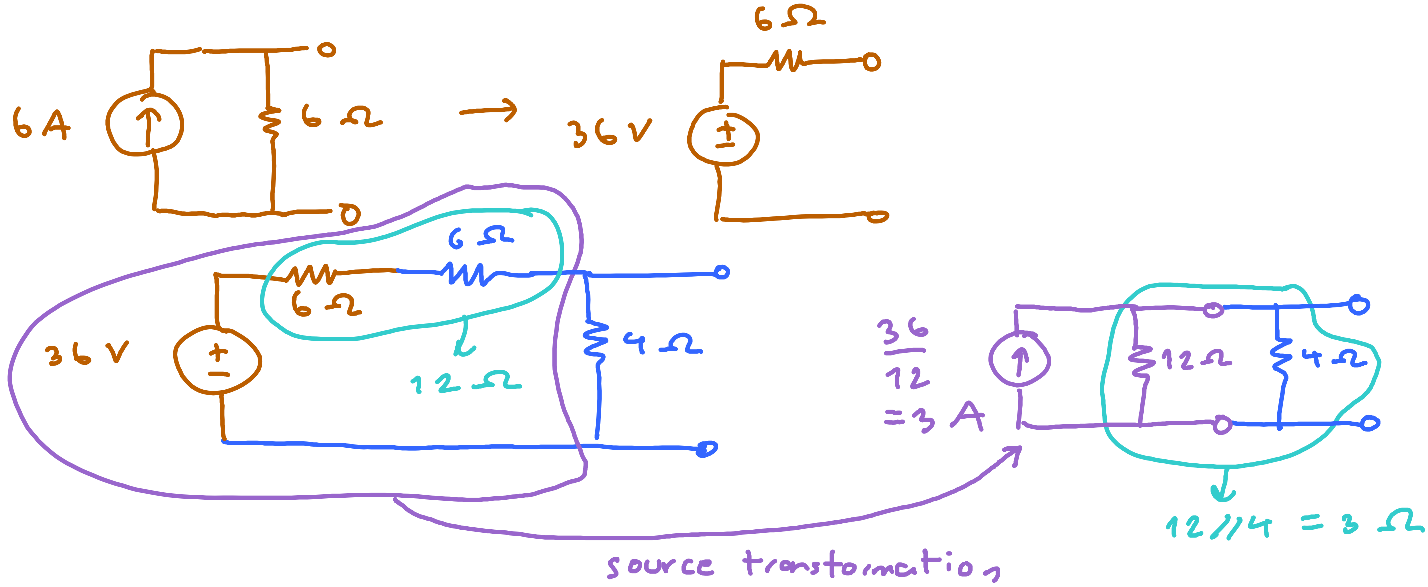


$$R_N = 12 // 4 = \frac{12 \times 4}{12+4} = 3\ \Omega$$

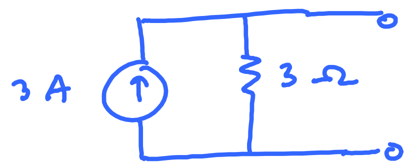
The Norton equivalent is given by



Alternatively, because the question does not specify that we have to find the value of I_N and R_N from their definitions, we may choose to use source transformation.



This gives

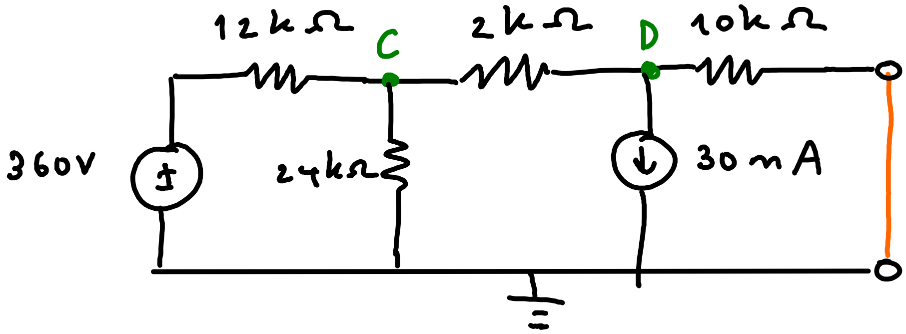


which is the same as what we got from Norton's theorem above.

[Alexander and Sadiku, 2009, Q4.56]

Monday, July 1, 2013 4:02 PM

Note that the question specifies that we have to use the Norton theorem. Hence we will first need to find Norton equivalent of the following circuit



Find I_N, the short-circuit current.

Use Nodal analysis:

$$\text{KCL@c} \quad \frac{V_c - 360}{12k} + \frac{V_c}{24k} + \frac{V_c - V_D}{2k} = 0$$

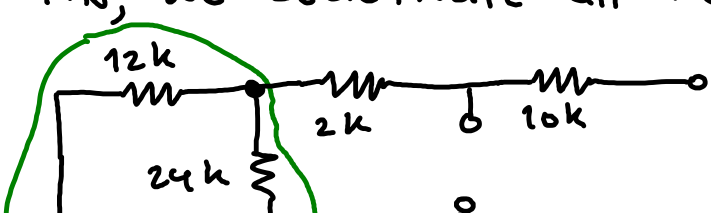
$$\text{KCL@d} \quad 30m + \frac{V_D - V_c}{2k} + \frac{V_D}{10k} = 0$$

$$\Rightarrow \quad V_c = 24\text{ V}, \quad V_D = -30\text{ V}$$

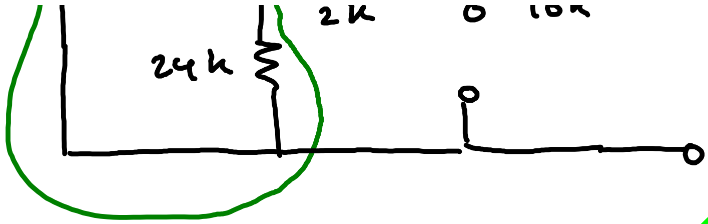
Note that if I multiply these two equations by 1,000, the m and k will magically disappear. So, I don't really have to care about them.

$$I_N = \frac{V_D}{10k} = \frac{-30}{10k} = -3\text{ mA}$$

For R_N, we deactivate all the source and get



$R_{TH} = 8 + 2 + 10$

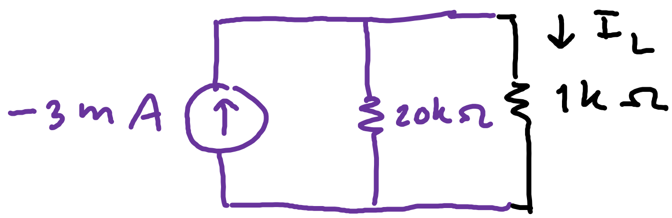


$$R_{TH} = 8+2+10 = 20k\Omega$$

$12k \,//\, 24k$

$$= \frac{\cancel{12}^{1} \times 24}{\cancel{12}_{1} + \cancel{24}_{2}}\, k = 8k$$

Now, we connect the Norton equivalent back to the load resistor:



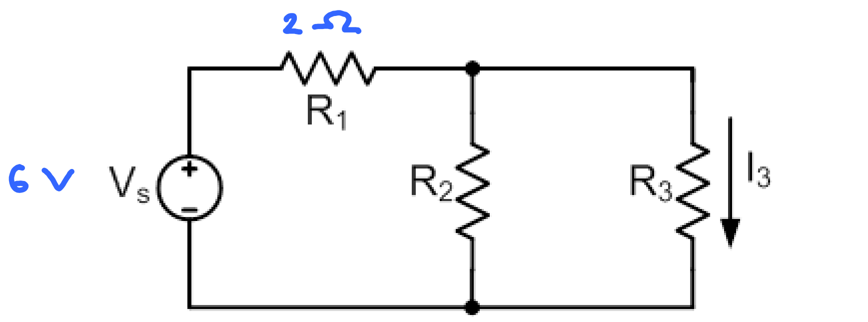
The current I_L is $= -3m \times \dfrac{\frac{1}{1k}}{\frac{1}{1k} + \frac{1}{20k}} = -3 \times \dfrac{20}{21}\ mA$

current divider

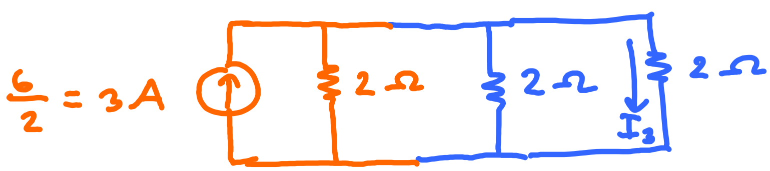
$$V_o = I_L \times R_L = -3\cancel{m} \times \frac{20}{21} \times 1\cancel{k} = \boxed{-\frac{60}{21}\ V \approx -2.86\ V}$$

[ECS203, Midterm Exam, 2009-2, Q1]

Monday, July 08, 2013 7:40 PM



(a) we transform V_s and R_1



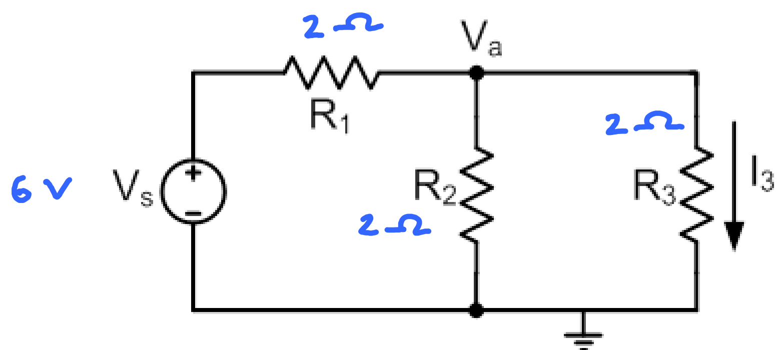
current divider

$$I_3 = \frac{\frac{1}{2}}{\frac{1}{2}+\frac{1}{2}+\frac{1}{2}} \times 3\text{ A}$$

$$= \frac{1}{3} \times 3\text{ A}$$

$$= \boxed{1\text{ A}}$$

(b)



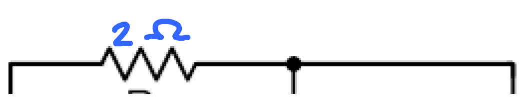
$$\frac{V_a - 6}{2} + \frac{V_a}{2} + \frac{V_a}{2} = 0$$

$$3V_a - 6 = 0$$

$$V_a = \frac{6}{3} = 2\text{ V}$$

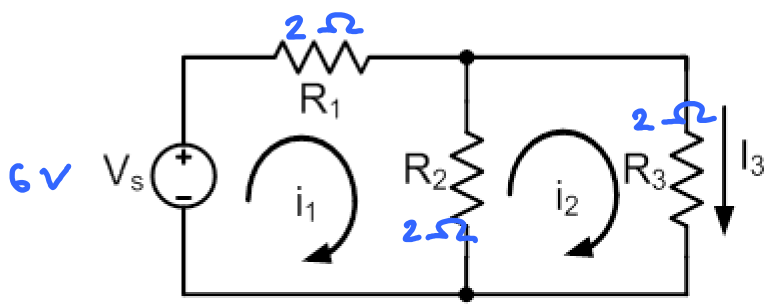
$$I_3 = \frac{V_a}{R_3} = \frac{2}{2} = \boxed{1\text{ A.}}$$

(c)



note that

(c)



Note that $I_3 = i_2$.

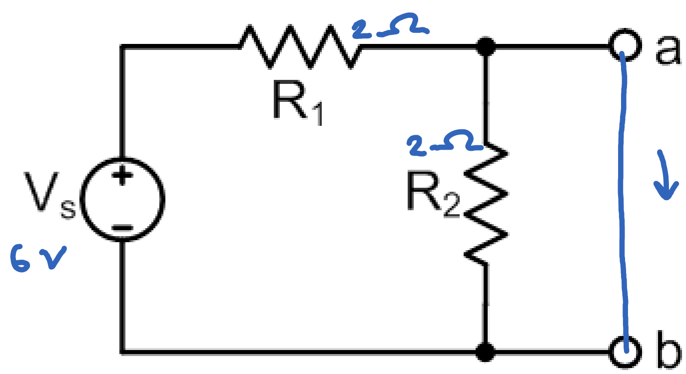
$$\left.\begin{array}{l} 6 - i_1 \times 2 - (i_1 - i_2)\times 2 = 0 \\ -(i_2 - i_1)\times 2 - i_2 \times 2 = 0 \end{array}\right\} \Rightarrow$$

$$2i_1 - i_2 = 3$$
$$i_1 - 2i_2 = 0$$
$$i_1 = 2i_2$$
$$4i_2 - i_2 = 3$$
$$3i_2 = 3$$
$$i_2 = \frac{3}{3} = 1\ A$$
$$i_1 = 2 \times i_2$$
$$i_1 = 2\ A$$

$$\boxed{\begin{array}{l} i_1 = 2A \\ i_2 = 1A \\ I_3 = 1A \end{array}}$$

(d)

(i)

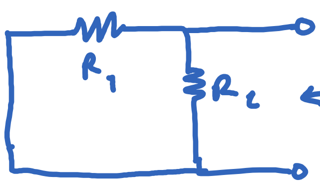


To find I_N, we add this short-circuit connection.

$$I_N = \frac{V_s}{R_1} = \frac{6}{2} = 3\ A$$

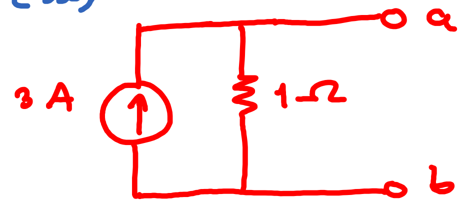
(ii)

To find R_N, we deactivate the source.

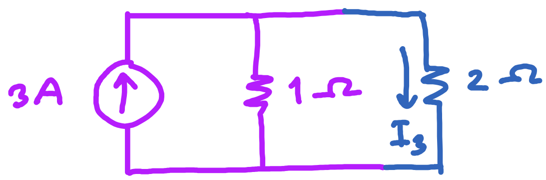


$\leftarrow R_N = R_1 // R_2 = 2//2 = 1\ \Omega$

(iii)



(e)



$$I_3 = \frac{\frac{1}{2}}{\frac{1}{1}+\frac{1}{2}} \times 3$$

$$= \frac{1}{3} \times 3 = \boxed{1A}$$