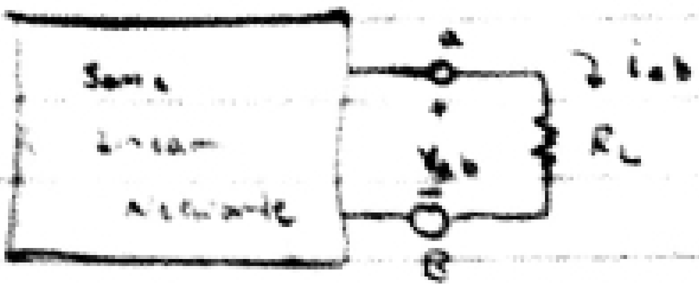
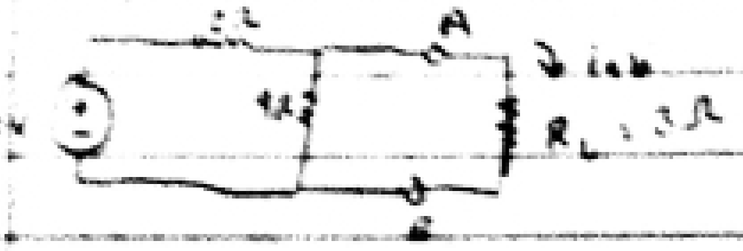
Thevenin and Norton Equivalent Circuits

1. Used to replace complex circuits
2. Equivalent circuits have equivalent terminal conditions
3. Terminal conditions matter as that we care about

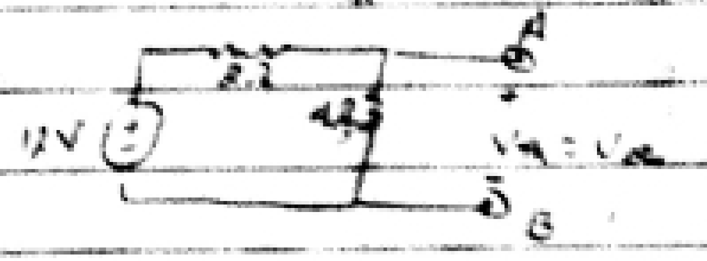


Example



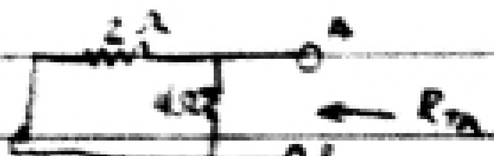
Need two things from the terminal conditions

1. $V_{oc} = V_{th}$

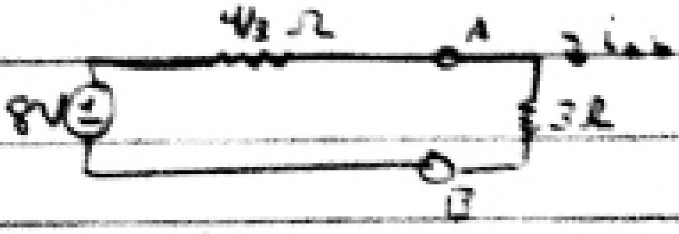


$V_{oc} = \left(\frac{4}{2+4}\right)(12V) = 8V$

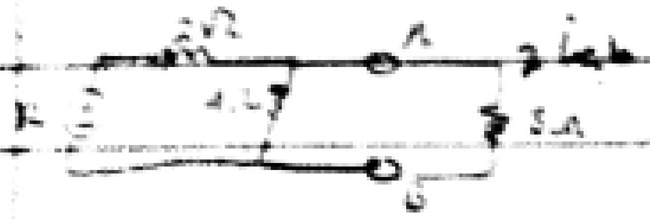
2. R_{Th} is the equivalent resistance of the Dead network



$R_{Th} = \frac{2(4)}{2+4} = \frac{8}{6} = 4/3\ \Omega$



$i_{ab} = \frac{8V}{4/3 + 3\Omega} = 24/13\ A$



$4 \parallel 3 = \frac{12}{7}$

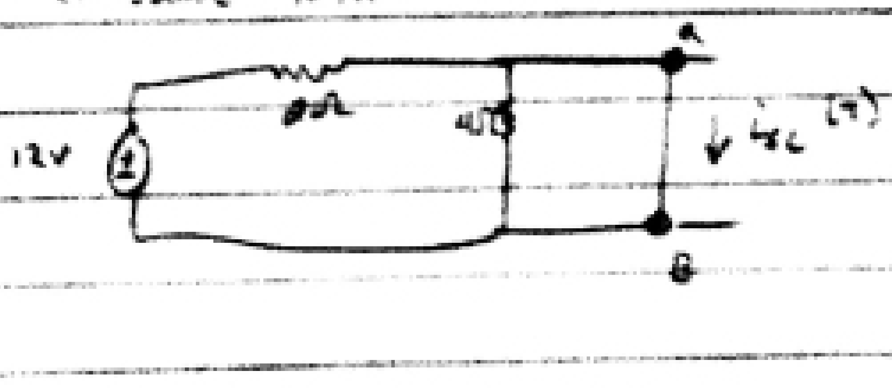
$12/7$ series $+ 2 = 26/7$

$i = \frac{12}{26/7} = \frac{12 \cdot 7}{26} = 42/13\ A$

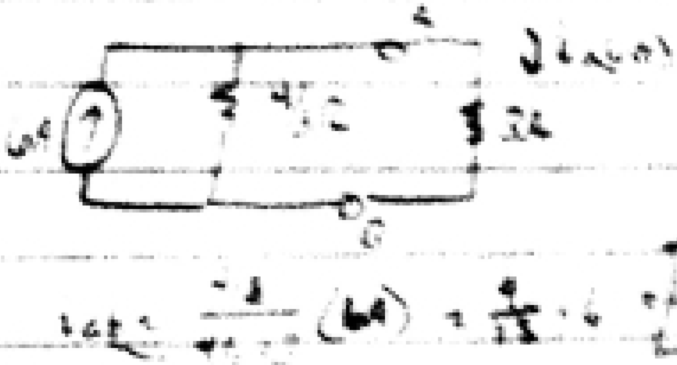
$i_{ab}(3) = \left(\frac{4}{4+3}\right)(42/13) = 24/13\ A$

Nort equivalent

1. The short circuit current
2. Same R_{th}



$i_{sc}(?) = \frac{12V}{2\Omega} = 6A$



$i_{ab} = \frac{4/3}{4/3 + 3}(6A) = \frac{4}{13} \cdot 6 = \boxed{\frac{24}{13} A}$

V_{TH}, R_{TH}, I_{SC}

$V_{TH} = R_{TH} \cdot I_{SC}$

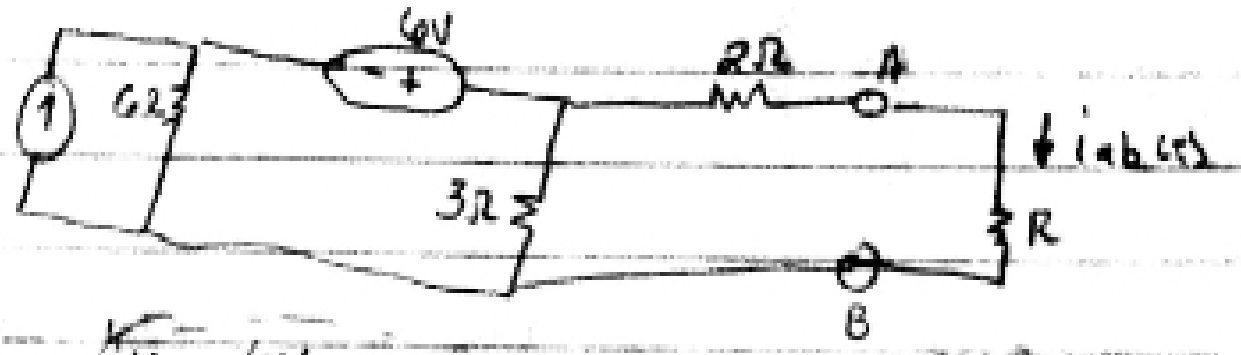
$V_{TH} = 8V$

$R_{TH} = 4/3 \Omega$

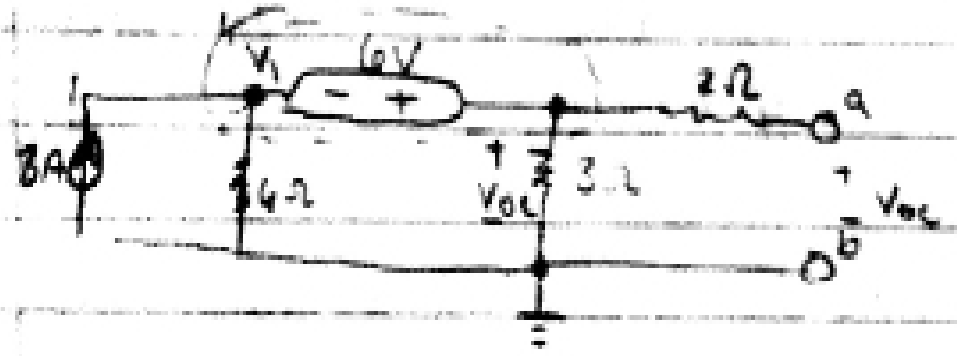
$I_{SC} = 6A$

$6A = \frac{8V}{4/3} = 24/4$

Example



Find $i_{ab}(t)$



SN: $-3 \quad \frac{V_1}{6} + \frac{V_{0c}}{3}$

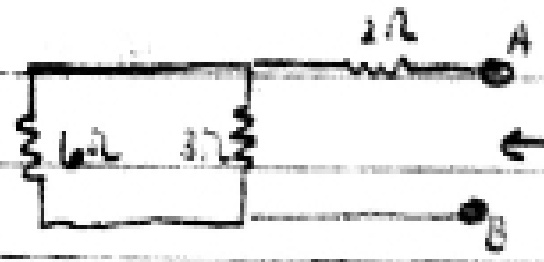
$V_1 = V_{0c} - 6$

$-3 + \frac{V_{0c}-6}{6} + \frac{V_{0c}}{3} = 0$

$-18 + V_{0c} - 6 + 2V_{0c} = 0$

$3V_{0c} = 24$

$V_{0c} = 8V$

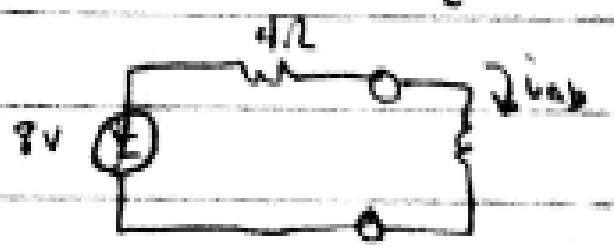


$\leftarrow R_{TH}$

$6 \| 3 = 2\Omega$

$2 + 2 = 4\Omega$

$R_{TH} = 4\Omega$



$i_{ab} = \frac{8V}{4\Omega + R}$

Another:

SN: $-3 + \frac{V_1}{6} + \frac{V_2}{3} + \frac{V_2}{2}$

$V_1 = V_2 - 6$

$-3 + \frac{V_2-6}{6} + \frac{V_2}{3} + \frac{V_2}{2} = 0$

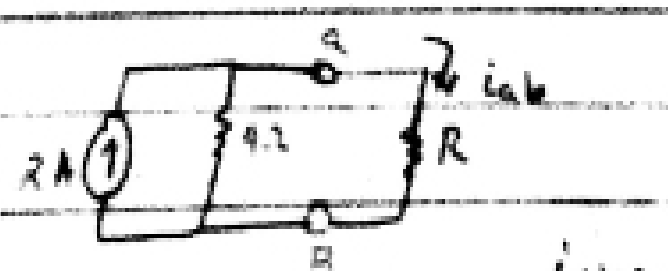
$-18 + V_2 - 6 + 2V_2 + 3V_2 = 0$

$6V_2 = 24$

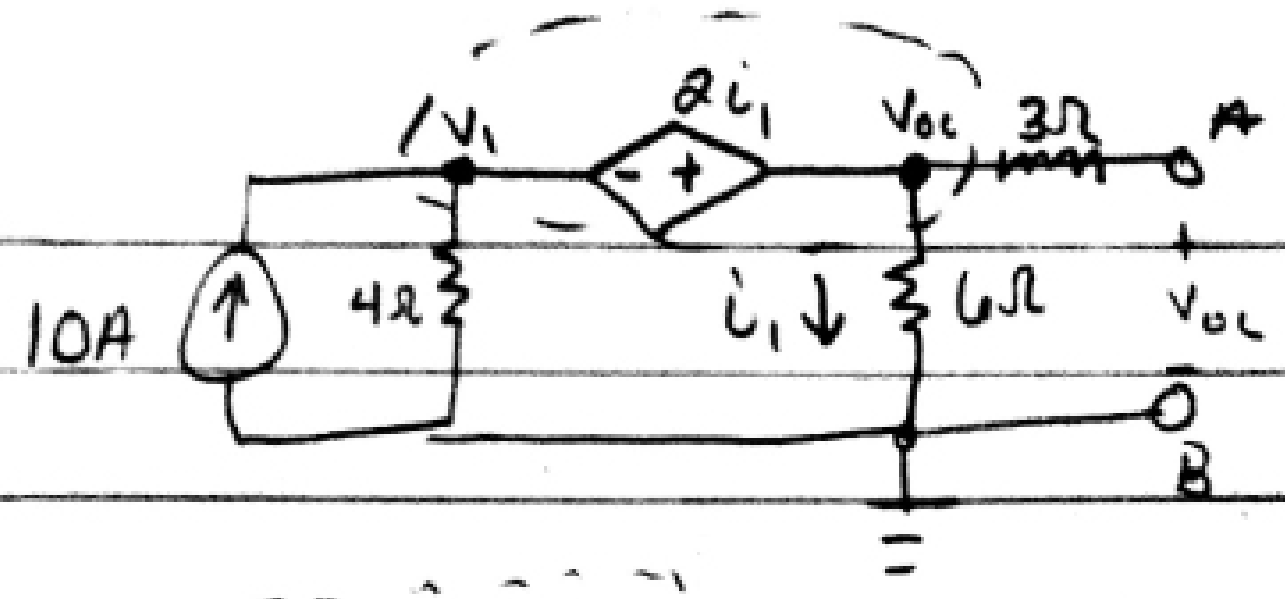
$V_2 = 4V$ $\quad \therefore i_{SC}(1) = \frac{4V}{2} = 2A$

$= 4\Omega$

$= 2A$



$i_{ab} = \frac{3}{3+R}(2A) = \frac{6}{3+R}$



$$-10 + \frac{V_1}{4} + \frac{V_{oc}}{6} = 0$$

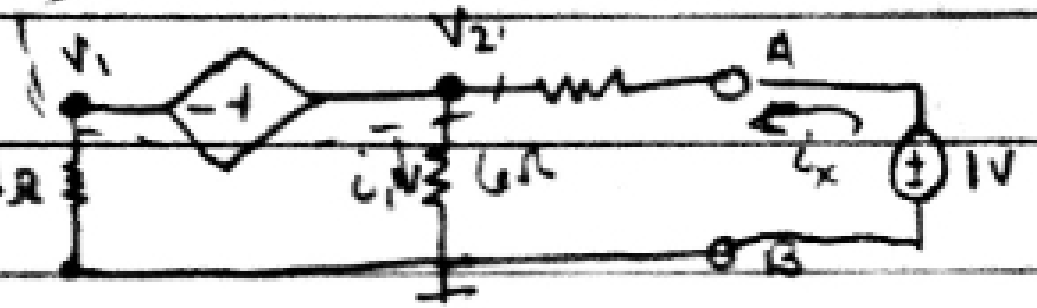
$$V_1 = V_{oc} - 2i_1$$

$$i_1 = \frac{V_{oc}}{6\Omega}$$

$$-10 + \frac{V_{oc}}{6} + \frac{V_{oc}}{6} = 0$$

$$2V_{oc} = 60$$

$$V_{oc} = 30V$$



$$SN = \frac{V_1}{4} + \frac{V_2}{6} + \frac{V_2 - 1}{3} = 0$$

$$V_1 = V_2 - 2i_1 = \frac{3}{3}V_2$$

$$i_1 = \frac{V_2}{6}$$

$$\frac{1}{6}V_2 + \frac{1}{6}V_2 + \frac{V_2}{3} - \frac{1}{3} = 0$$

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

$$V_2 = \frac{1}{2}$$

$1V \longrightarrow 2A$

$3V \longrightarrow 6A$

$$i_x = \frac{1V - 0.5V}{3} = \frac{0.5}{3} = \frac{1}{6}A$$

$$R_{TH} = \frac{1V}{\frac{1}{6}A} = 6\Omega$$

HW. 5.32, 5.34