ساهر بكار

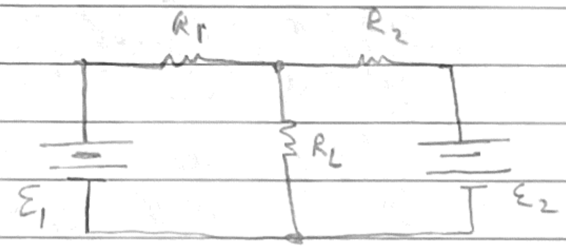
Experiment 4
Network Analysis II

The Thevenin and Norton Techniques

* kirchoff's laws and SPP are useful techniques for analyzing networks that contain a few circuit element

* complicated networks requires methods such as the equivalent circuit techniques of Thevenin and Norton

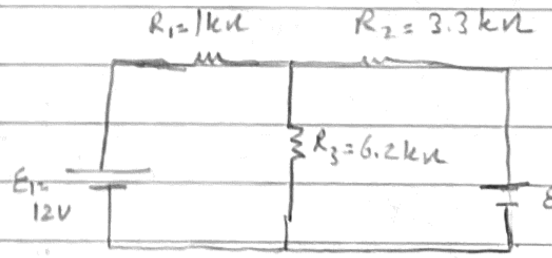
* Thevnin's theorem states that : any network of resistors and supplies having two output terminals can be replaced by a series combination of a voltage source (ε_{eq}) and a resistor (R_{eq})



$R_1 = 1k\Omega$
$R_2 = 3.3k\Omega$
$R_3 = 6.2k\Omega$
$\varepsilon_1 = 12$ volt
$\varepsilon_2 = 6$ volt

* Thevenin :

(A) Finding $I_3 \Rightarrow$ (So let $R_L = R_3$)



(1) Remove R_L (Which is R_3 in our case A), kill both sources and Find R_{eq} (by connecting ohmmeter or multimeter on ohm's mode)

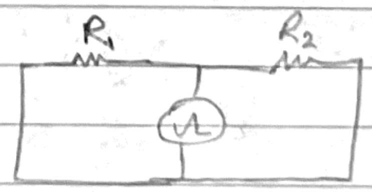
exp

calculator

$$R_{eq} = R_1 \parallel R_2$$

$$R_{eq} = \frac{R_1 R_2}{R_1 + R_2}$$

$$R_{eq} = \frac{1 \times 3.3}{1 + 3.3}$$



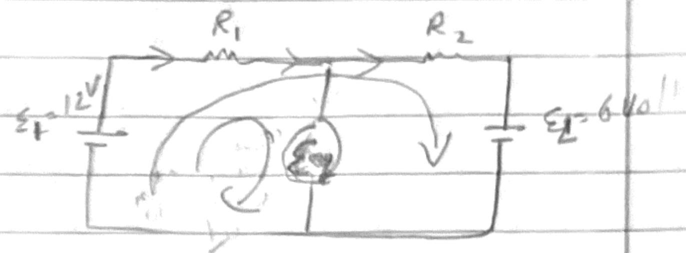
عادي بس حاطط [illegible] kΩ
والاجابة بـ kΩ

سابقا

$$\boxed{R_{eq} = 0.767\ k\Omega}$$

(2) Return both sources ($\mathcal{E}_1, \mathcal{E}_2$) and Find $\mathcal{E}_{eq}$, I_{eq}

- by connecting voltmeter or multimeter for $\mathcal{E}_{eq}$
- by connecting Ameter or multimeter for I_{eq}



From the large loop

$$\mathcal{E}_1 - IR_1 - IR_2 - \mathcal{E}_2 = 0$$

$$\mathcal{E}_1 - \mathcal{E}_2 - I(R_1 + R_2) = 0$$

$$I = \frac{\mathcal{E}_1 - \mathcal{E}_2}{R_1 + R_2} = \frac{12 - 6}{(1 + 3.3)\ k\Omega} = 1.395\ mA$$

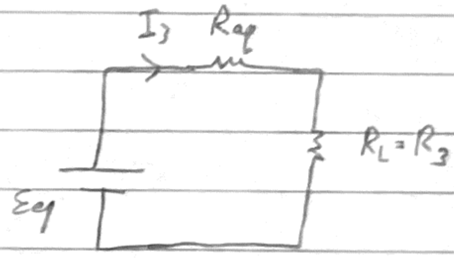
From the small loop

$$\mathcal{E}_1 - IR_1 - \mathcal{E}_{eq} = 0 \Rightarrow \mathcal{E}_{eq} = \mathcal{E}_1 - IR_1 = 12 - 1.395\ mA \times 1\ k\Omega = 10.605\ Volt$$

لكن ستخدمها في Norton لأنها تلزمك هناك

$$I_{eq} = \frac{\mathcal{E}_{eq}}{R_{eq}} = \frac{10.605}{0.767 \times 10^3} = 13.83\ mA$$

(3) construct Thevenin's circuit



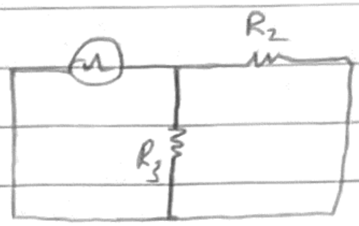
$$I_{L_3} = \frac{\mathcal{E}_{eq}}{R_{eq} + R_3} = \frac{10.605}{(0.767 + 6.2)\ k\Omega}$$

$$\boxed{I_3 = 1.522\ mA} \Rightarrow \boxed{I_{L_3} = 1.522\ mA}$$

بعيار

(B) Finding I_1 $\Rightarrow$ (so let $R_L = R_1$)

1. Remove R_L, kill both sources and find R_{eq}

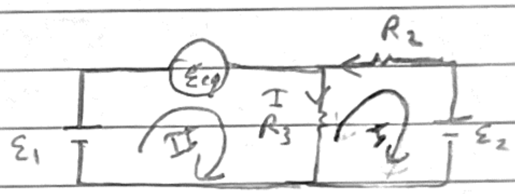


$$R_{eq} = R_2 \parallel R_3 = \frac{R_2 R_3}{R_2 + R_3} = \frac{3.3 \times 6.2}{3.3 + 6.2}$$

عوضت بـ kΩ فالجواب بطلع kΩ

$$\boxed{R_{eq} = 2.15\ k\Omega}$$

2. Return both sources and find ε_{eq}



(I)

$$IR_3 + IR_2 - \varepsilon_2 = 0$$

$$I(R_3 + R_2) - \varepsilon_2 = 0$$

$$I_2 = \frac{\varepsilon_2}{R_3 + R_2} = \frac{6}{(6.2+3.3)k\Omega} = 0.63\ mA$$

(II) $\varepsilon_1 - \varepsilon_{eq} - IR_3 = 0$

$$\varepsilon_{eq} = \varepsilon_1 - IR_3$$

$$= 12 - 0.63 \times 6.2$$

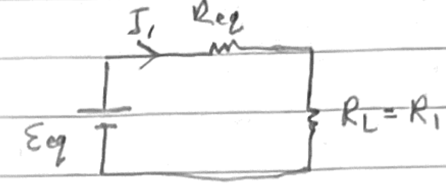
k x m بيروحوا بعض

$$\boxed{\varepsilon_{eq} = 8.094\ \text{Volt}}$$

$$I_{eq} = \frac{\varepsilon_{eq}}{R_{eq}} = 3.76\ mA$$

باختصار

③ construct Thevenin's circuit وصل المقاومة R_L و R_{eq} على التوالي مع مصدر الجهد E_{eq}



$$I_1 = \frac{E_{eq}}{R_{eq} + R_L}$$

$$I_1 = \frac{8.094}{(2.15+1)\,k\Omega}$$

$$\boxed{I_1 = 2.569\ mA} \Rightarrow I_{L_1} = 2.569\ mA$$

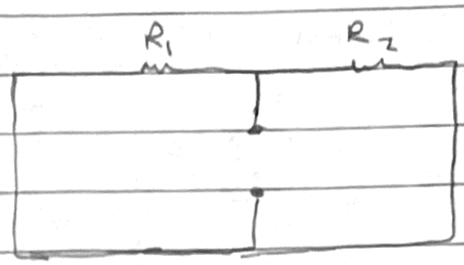
سارة مرجان

Norton's

Finding I_{L3} let $R_L = R_3$

① Remove $R_L \to (R_3)$, killing sources and find Req by connecting to ohmmeter

$\boxed{R_{eq} = R_1 \parallel R_3}$



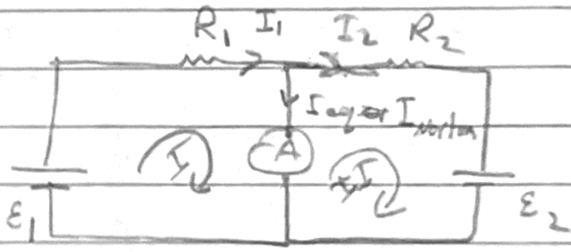
$$R_{eq} = \frac{R_1 R_3}{R_1 + R_3}$$

$\Rightarrow R_{eq} = 0.767\ k\Omega$

② Return both sources and calculate I_{eq} (by connecting Ammeter or multimeter) then find I_{eq} (I_{Norton})

$I_{eq} + I_2 = I_1$

$I_{eq} = I_1 - I_2$



I small loop

$\varepsilon_1 - I_1 R_1 = 0$

$I_1 = \frac{\varepsilon_1}{R_1} = \frac{12}{1k\Omega} = 12\ mA$

II

$-I_2 R_2 - \varepsilon_2 = 0$

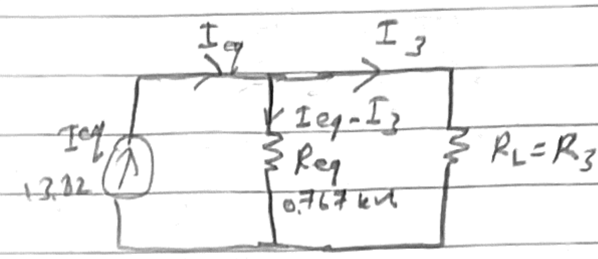
$I_2 = \frac{-\varepsilon_2}{R_2} = \frac{-6}{3.3k\Omega} = -1.82\ mA$

$I_{eq} = I_1 - I_2 = 12\ mA - -1.82$

$= 13.82\ mA$

(3) construct Norton circuit

وصل R_3 مع R_{eq} مع I_{eq} على التوازي



$$I_3 R_3 = I_{eq}(R_3 \parallel R_{eq})$$

$$I_3 R_3 = I_{eq} \frac{R_3 R_{eq}}{R_3 + R_{eq}}$$

$$I_3 = \frac{I_{eq}}{\cancel{R_3}} \frac{\cancel{R_3} R_{eq}}{R_3 + R_{eq}}$$

$$I_3 = \frac{I_{eq} \; R_{eq}}{R_3 + R_{eq}}$$

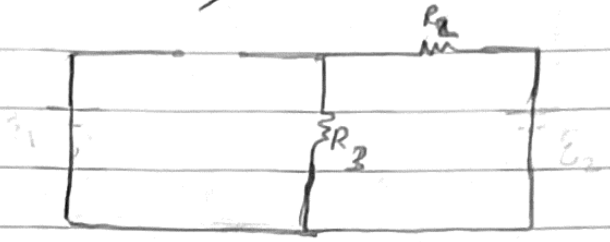
$$= \frac{13.82 \times 0.767}{6.2 + 0.767}$$

$$I_3 = 1.52 \text{ mA} \Rightarrow \boxed{I_{L_3} = 1.52 \text{ mA}}$$

Norton

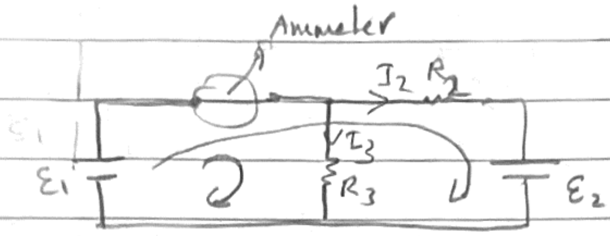
For $R_L = R_1$ Finding I_{L1}

① Remove $R_L (R_1)$, killing sources and Find Req



$$R_{eq} = R_2 \| R_3$$
$$= \frac{R_2 R_3}{R_2 + R_3} \Rightarrow R_{eq} = 2.15\ k\Omega$$

② Return both Sources and calculate I_{eq} (by connecting Ammeter or multimeter) then Find I_{eq} (I_{Norton})



$$I_{eq} = I_2 + I_3$$

From small Loop:

$$\varepsilon_1 - I_3 R_3 = 0$$
$$I_3 = \frac{\varepsilon_1}{R_3} = \frac{12}{6.2k\Omega} = 1.935\ mA$$

From the large loop:

$$\varepsilon_1 - I_2 R_2 - \varepsilon_2 = 0$$
$$I_2 R_2 = \varepsilon_1 - \varepsilon_2$$
$$I_2 = \frac{\varepsilon_1 - \varepsilon_2}{R_2} = \frac{12 - 6}{3.3k\Omega} = 1.82\ mA$$

$$\Rightarrow I_{eq} = I_3 + I_2 = 1.935 + 1.82 = 3.753\ mA$$

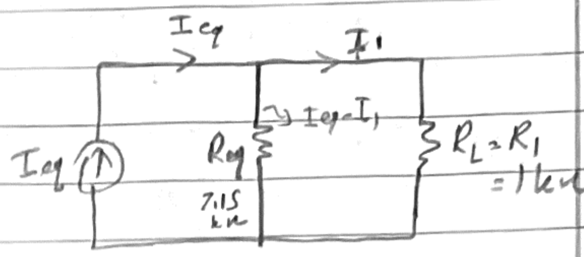
ساعد يا

3. construct Norton circuit — وصل R_1 مع R_{eq} مع I_{eq} على التوازي

او وحيد لمصدر I_{eq}

$V_{through\,R_1} = V_{through}(R_1 \parallel R_{eq})$

$I_1 R_1 = I_{eq}(R_1 \parallel R_{eq})$



$$I_1 R_1 = I_{eq} \frac{R_1 R_{eq}}{R_1 + R_{eq}}$$

$$I_1 = \frac{I_{eq}}{\cancel{R_1}} \; \frac{\cancel{R_1} R_{eq}}{R_1 + R_{eq}}$$

$$I_1 = \frac{I_{eq} R_{eq}}{R_1 + R_{eq}}$$

$$= \frac{3.753 \times 2.15}{(1 + 2.15)\,k\Omega}$$

$\cancel{\times 10^{3}} \; \cancel{\times 10^{-3}}$

$$\boxed{I_1 = 2.56\,mA}$$

or $I_{L_1} = 2.56\,mA$

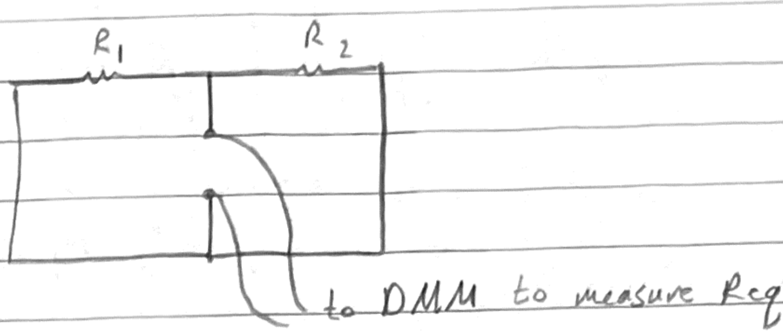
ابدأ

Thevinin

step 1

قم بإزالة المصادر $\varepsilon_1 , \varepsilon_2$

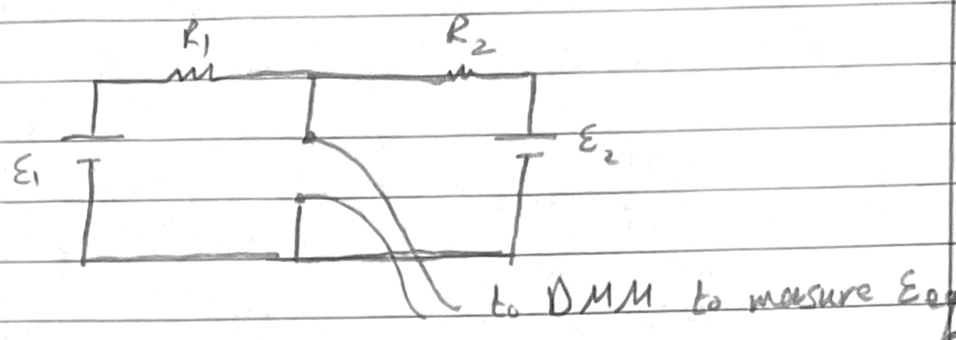
وضع DMM مكان R_3 لقياس R_{eq}



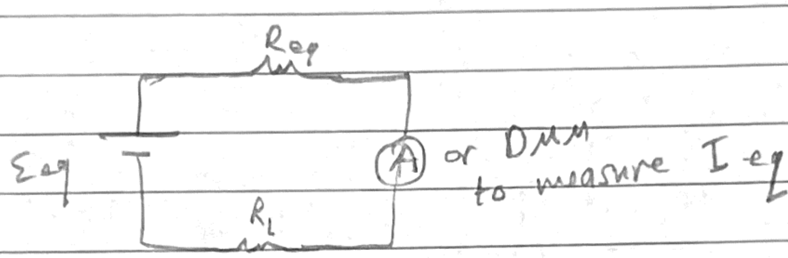
step 2

قم بإزالة R_3 وإعادة $\varepsilon_1 , \varepsilon_2$

ضع DMM مكان R_3 لقياس ε_{eq}



step 3



ثم يوصل الدارة R_{eq} ، R_L مع ε_{eq} على التوالي وقياس I_L

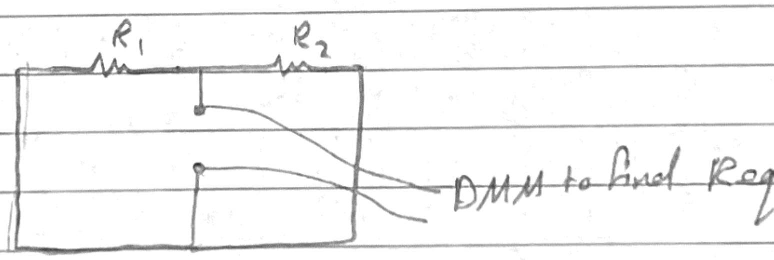
1

Norton

step 1

قم بإزالة المصادر $\varepsilon_1 , \varepsilon_2$

وضع DMM مكان R_3

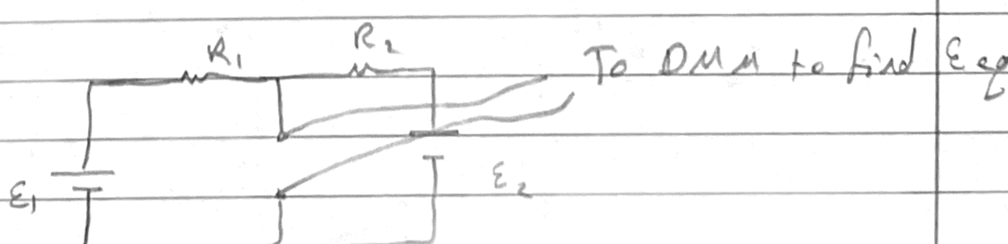


step 2

قم بإعادة المصادر $\varepsilon_1 , \varepsilon_2$

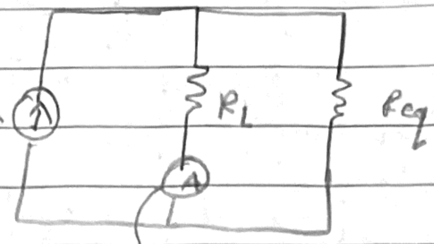
واستخدم DMM لقياس

R_{eq}



step (3)

supply the circuit with I_{eq}



measure I_3 or I_L using DMM or A

