ساره جابر

Experiment 3
Network Analysis 1

The superposition principle and kirchhoff's law's

* Electric networks : circuits that include many elements such as resistors , Voltage sources and current sources that are connected together in arather complecated way.

* Applying ohm's law and simple parallel and series c... Connection rules is of no practical help for the Electric networks

* kirchhoff's lows and the supperposition principle is used for our case

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kirchhoff's low's

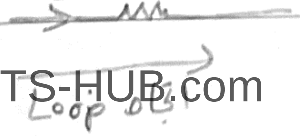
① Loop theorem : (conservation of energy)

The algebraic sum of the voltage drops and electromotive forces (emf's) in a closed electric circuit is always zero. In other words , the power generated by sources in a closed circuit is totally consumed by the circuit components

$$\boxed{\sum_i V_i = 0} \qquad \boxed{\sum_k \varepsilon_k = \sum_j I_j R_j}$$

* Voltage drops (IR) and emf's (ε) are opposite signs

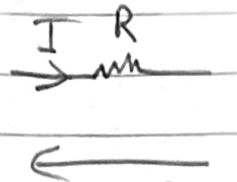
* If any current is found to be negative, its assigned must be reversed
  * Some rules

*


$-IR$

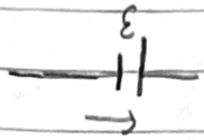
لانه مع التيار

[illegible]

* 

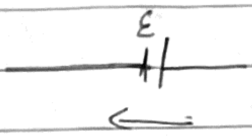
$+IR$

Loop اتجاه

* 

Loop

$+\varepsilon$



Loop

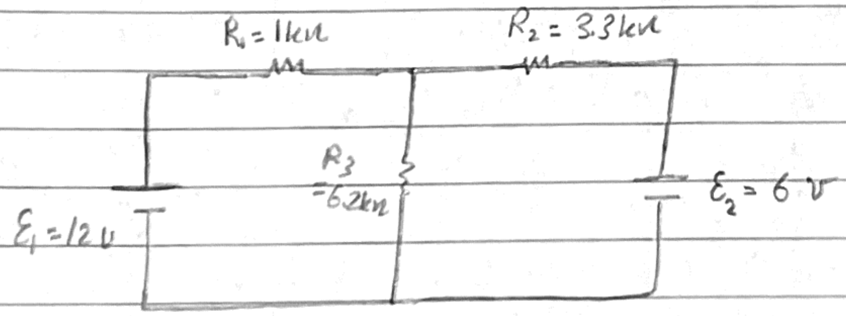
$-\varepsilon$

② Junction theorem : (conservation of charge)

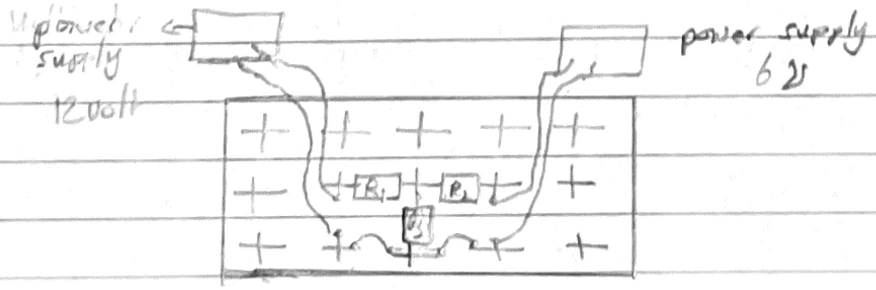
The algebraic sum of the currents passing through any circuit junction is always zero.

$$\boxed{\sum_j I_j = 0}$$

- the currents entering a junction have opposite signs to those leaving it

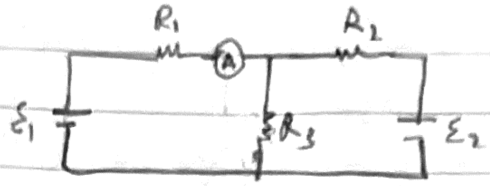


connect the circuit as the following

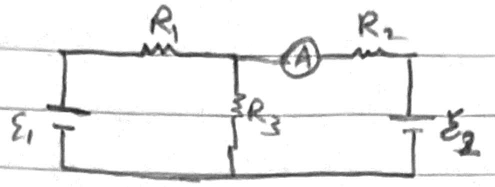


ساعتار

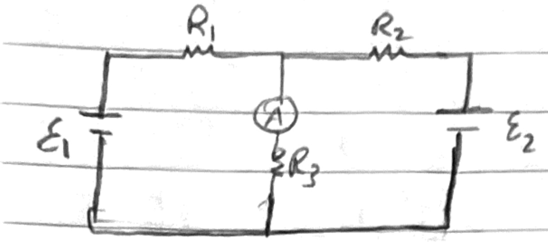
- you put the digital multimeters in each branch to measure I



⇒ To measure I_1



⇒ To measure I_2

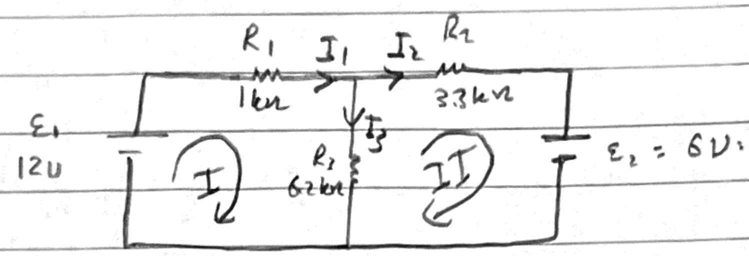


⇒ To measure I_3

$\Sigma I_i = 0$

$I_1 = I_2 + I_3 \rightarrow ①$

$\Sigma_i V_i = 0$



for (I) : $\mathcal{E}_1 - I_1 R_1 - I_3 R_3 = 0 \longrightarrow ②$

for (II) : $I_3 R_3 - I_2 R_2 - \mathcal{E}_2 = 0$

$\boxed{6.2 I_3 - 3.3 I_2 - 6 = 0} \longrightarrow ③$

لاحظ اننا عوضنا قيم R د kΩ (لا تنسى ان تأخدها بعين الاعتبار بالحسابات)

sub ① in ②

$\mathcal{E}_1 - (I_2 + I_3) R_1 - I_3 R_3 = 0$

$12 - (I_2 + I_3) - 6.2 I_3 = 0$

$12 - I_2 - I_3 - 6.2 I_3 = 0$

$12 - I_2 - 7.2 I_3 = 0$

اضرب ب -3.3 طرفي المعادله

$\boxed{-39.6 + 3.3 I_2 + 23.76 I_3 = 0} \longrightarrow ④$

حل المعادلتين ③ و ④ بالحذف

④

$-45.6 + 29.96 I_3 = 0$ سامبار

$45.6 = 29.96 I_3 \Rightarrow I_3 = \frac{45.6}{29.96} = 1.52$

$\Rightarrow \boxed{I_3 = 1.52 mA}$

sub I_3 in eq 3 عوض I_3 في المعادله 3

$6.2 (1.52) - 3.3 I_2 - 6 = 0$

$9.424 - 6 - 3.3 I_2 = 0$

$3.424 = 3.3 I_2$

$\Rightarrow I_2 = \frac{3.424}{3.3} = 1.037 \simeq 1.04 mA$

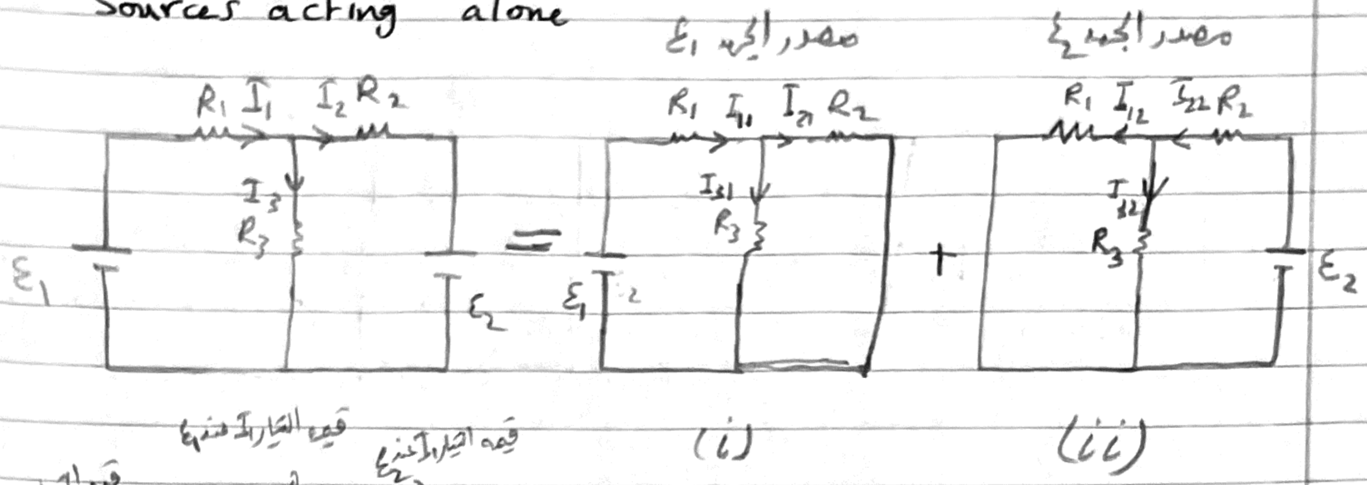
$\boxed{I_2 = 1.04 mA}$

$I_1 = I_2 + I_3 = 1.52 + 1.04 = 2.56 mA$

ساره ملا

The superposition principle (SPP)

The response "a desired current or voltage" at any point in a linear circuit having more than one source can be obtained as the sum of the responses caused by each of the independent sources acting alone



قيم التيار المار R1 عن ε1 ، ε2

قيمة التيار I1 عند ε1 — قيمة التيار I1 عند ε2

$I_1 = I_{11} + I_{12} \Rightarrow \textcircled{a}$

$I_2 = I_{21} + I_{22} \Rightarrow \textcircled{b}$

$I_3 = I_{31} + I_{32} \Rightarrow \textcircled{c}$

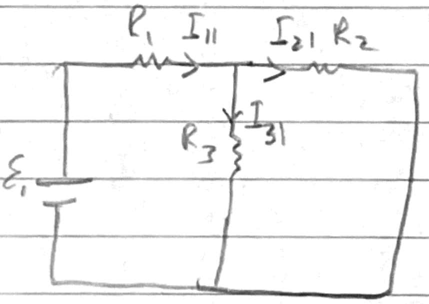
* يجب الانتباه للاتجاهات
اذا كانت بنفس الاتجاه جمع
اذا كانت بعكس الاتجاه طرح

* To find I_1
  * we should find I_{11} from (i)
  * we should find I_{12} from (ii)

  and sub in eq ⓐ

(i) $R_2 // R_3$ ([//] parallel)
R_1 wit $(R_2 // R_3)$ series

$I_{11} = \frac{\varepsilon_1}{R_1 + (R_2 // R_3)}$

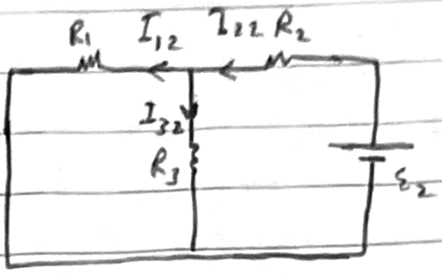


$$I_{11} = \frac{\varepsilon_1}{R_1 + \frac{R_2 R_3}{R_2 + R_3}} = \frac{12}{1 + \frac{3.3 \times 6.2}{3.3 + 6.2}} = 3.8 \text{ mA} \ (\rightarrow)$$

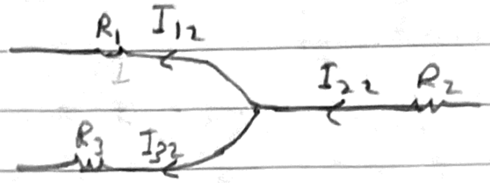
ساروجار

(ii) $R_1 \parallel R_3$

R_2 , $(R_1 \parallel R_3)$ series



لان I_{12} اصبحت فرع في دارة وليست التيار
الكلي فنعتمد على فكرة تساوي الجهد



$$I_{22} = \frac{\mathcal{E}_2}{R_2 + (R_1 \parallel R_3)} = \frac{\mathcal{E}_2}{R_2 + \left(\frac{R_1 R_3}{R_1 + R_3}\right.}$$

$$I_{22} = \frac{6}{3.3 + \left(\frac{1 \times 6.2}{1 + 6.2}\right)} = 1.44 \text{ mA}$$

$$V_{\text{through} R_1} = V_{\text{through} R_3} = V_{\text{through}} (R_1 \parallel R_3)$$

$$I_{12} R_1 = I_{32} R_3 = I_{22} (R_1 \parallel R_3)$$

$$\Rightarrow \quad I_{12} R_1 = I_{22} (R_1 \parallel R_3)$$

$$I_{12} R_1 = I_{22} \frac{R_1 R_3}{R_1 + R_3}$$

$$I_{12} = I_{22} \frac{\cancel{R_1} R_3}{R_1 + R_3} \frac{1}{\cancel{R_1}} = I_{22} \frac{R_3}{R_1 + R_3}$$

$$I_{12} = 1.44 \left(\frac{1 \times 6.2}{1 + 6.2}\right) \frac{1}{1}$$

$$I_{12} = 1.24 \text{ mA} \quad (\leftarrow)$$

سـارة نجار

from eq (a)

$I_1 = I_{11} + I_{12}$ مع مراعاة الاتجاهات

$= 3.8 - 1.24$ لازم عكس اتجاه بعض

$= 2.56\,mA\ (\leftarrow)$ الاجابة باتجاه الأعلى

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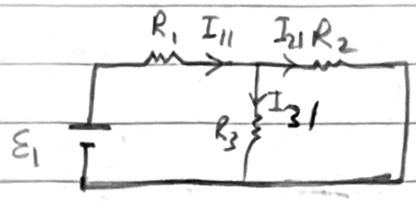
* To Find I_3

(i) $I_{11} = \frac{\varepsilon_1}{R_1 + R_2 // R_3} = 3.8\,mA$ حسبناها قبل



$V_{through}\,R_2 = V_{through}\,R_3 = V_{through}\,(R_2 // R_3)$

نأخذ الطرفين اللذان يفيدان في الحصول على المطلوب

$$V_{through}\,R_3 = V_{through}\,(R_2 // R_3)$$

$$I_{31} R_3 = I_{11}\,(R_2 // R_3)$$

$$I_{31} R_3 = I_{11} \frac{R_2 R_3}{R_2 + R_3}$$

$$I_{31} = I_{11} \frac{R_2 R_3}{R_2 + R_3} \frac{1}{R_3}$$

$$I_{31} = 3.8 \times \frac{3.3 \times 6.2}{3.3 + 6.2} \times \frac{1}{6.2}$$

$$I_{31} = 3.8 \times 2.15 \times \frac{1}{6.2}$$

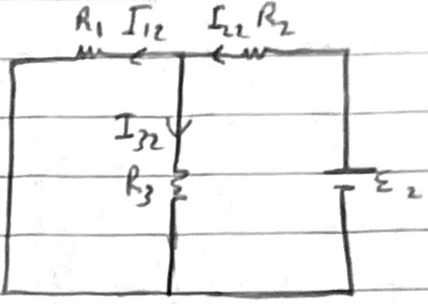
$$\boxed{I_{31} = 1.32\ mA}\ \downarrow$$

(ii) سابقا

$$I_{22} = \frac{\varepsilon_2}{R_2 + (R_1 \parallel R_3)} = \frac{\varepsilon_2}{R_2 + \frac{R_1 R_3}{R_1 + R_3}}$$

$$I_{22} = 1.44 \text{ mA}$$

حسبناها قبل ص6



$$V_{\text{through} R_1} = V_{\text{through} R_3} = V_{\text{through}} (R_1 \parallel R_3)$$

$$\Rightarrow V_{\text{through} R_3} = V_{\text{through}} (R_1 \parallel R_3)$$

$$I_{32} R_3 = I_{22} (R_1 \parallel R_3)$$

$$I_{32} R_3 = I_{22} \frac{R_1 R_3}{R_1 + R_3}$$

$$I_{32} = I_{22} \frac{R_1 R_3}{R_1 R_3} \frac{1}{R_3}$$

$$I_{32} = 1.44 \times \frac{1 \times 6.2}{1 + 6.2} \times \frac{1}{6.2}$$

$$\boxed{I_{32} = 0.2 \text{ mA}} \downarrow$$

sub I_{31}, I_{32} in eq c

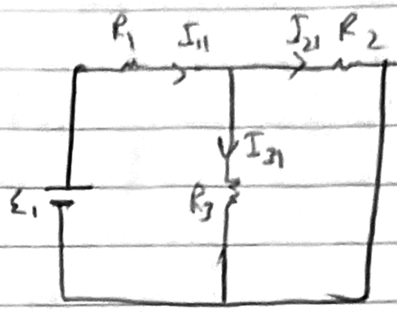
$$I_3 = I_{31} + I_{32}$$ لانهم بنفس الاتجاه نجمع

$$= 1.32 + 0.2$$

$$= 1.52 \text{ mA} (\downarrow)$$

سابقا

To find I_2 $\left(I_2 = \overset{\text{from i}}{I_{21}} + \overset{\text{from ii}}{I_{22}}\right)$



(i) $I_{11} = \dfrac{\mathcal{E}_1}{R_1 + R_2 // R_3} = 3.8\ mA$

$V_{through}\ R_2 = V_{throug}\ R_2 // R_3$

$$I_{21} R_2 = I_{11} \frac{R_2 R_3}{R_2 + R_3}$$

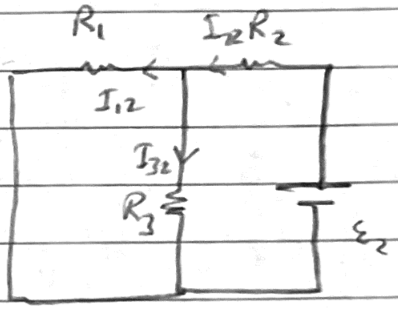
$$I_{21} = I_{11} \frac{R_2 R_3}{R_2 R_3} \frac{1}{R_2}$$

$$= 3.8 \times \frac{3.3 \times 6.2}{3.3 + 6.2} \times \frac{1}{3.3}$$

$I_{21} = 2.48\ mA$ →

(ii) $I_{22} = \dfrac{\mathcal{E}_2}{R_2 + R_1 // R_3}$

$$= \frac{\mathcal{E}_2}{R_2 + \frac{R_1 \cancel{\times} R_2}{R_1 + R_2}} =$$



$I_{22} = 1.44\ mA$ →

sub in eq ⑥

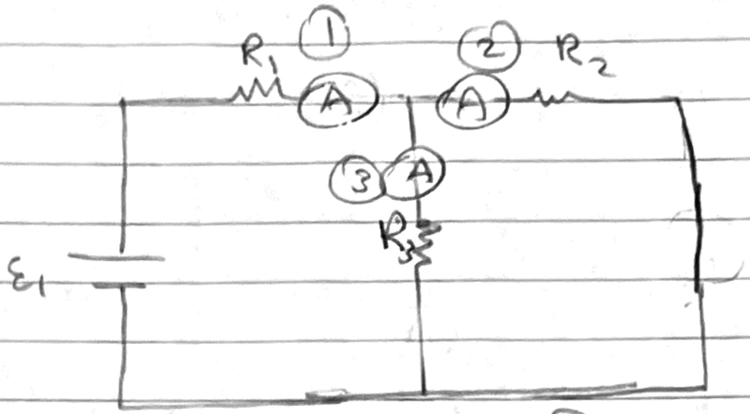
$I_2 = I_{21} \cancel{+} I_{22}$ لانهم عكس بعض

$= 2.48 \cancel{+} 1.44$

$= 1.04\ mA$

سابقاً
بالمختبر نزّل ε_2

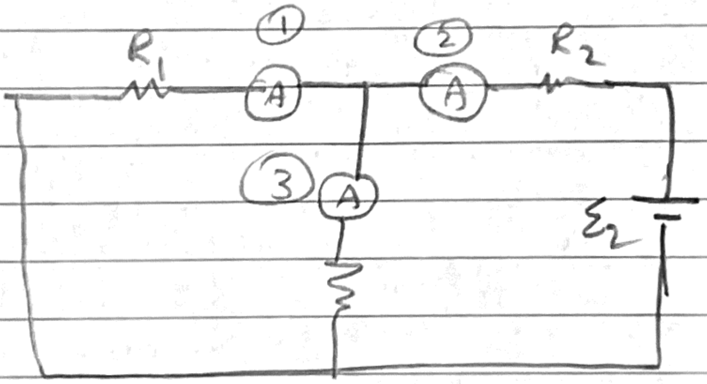
① Taking off ε_2



① I_{11} ② I_{21} ③ I_{31}

حيث نضع الاميتر عند كل فرع

② Taking off ε_1



① I_{12} ② I_{22} ③ I_{32}

حيث نضع الاميتر عند كل فرع

ثم نجمع التيار الذي حصلنا عليه في خطوة 1 وخطوة 2
للحصول على I_1 ، I_2 ، I_3 عملياً