Exp 3: Network Analysis I

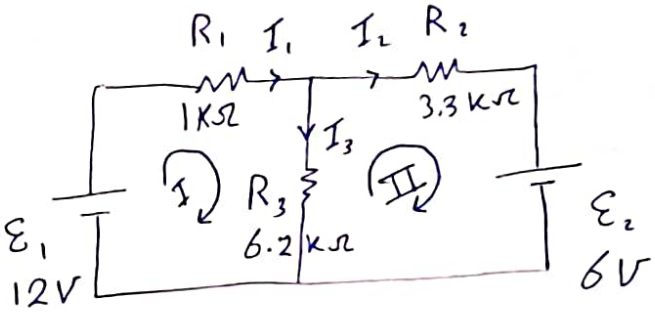
Kirchhoff's Laws & Superposition principle

① Kirchoff's laws:

i) Junction theorem

$$\sum_i I_i = 0$$

$$I_1 = I_2 + I_3 \quad \cdots ①$$



ii) Loop theorem:

$$\sum_i V_i = 0 \qquad \text{(in a closed loop)}$$

loop I :- $\varepsilon_1 - R_1 I_1 - R_3 I_3 = 0 \quad \cdots ②$

$$I_3 R_3 - I_2 R_2 - \varepsilon_2 = 0 \quad \cdots ③$$

To solve for I_1, I_2, I_3 ??

sub. ① in ②

$$\varepsilon_1 - R_1 (I_2 + I_3) - R_3 I_3 = 0 \quad \cdots ②$$

$$12 - (I_2 + I_3) - 6.2\, I_3 = 0 \quad \cdots ②$$

$$6.2\, I_3 - 3.3\, I_2 - 6 = 0 \quad \cdots ③$$

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eq ②: $(12 - I_2 - 7.2\, I_3 = 0) * (-3.3) \quad \cdots ②$

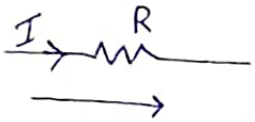
$$+/ \quad -39.6 + 3.3\, I_2 + 23.76\, I_3 = 0 \quad \cdots ②$$
$$-6 - 3.3\, I_2 + 6.2\, I_3 = 0 \quad \cdots ③$$

$$-45.6 + 29.96\, I_3 = 0$$

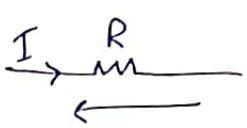
$$I_3 = 1.52 \text{ mA}$$

Find I_1 , I_2 ??

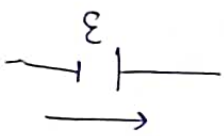
Some Ruls :



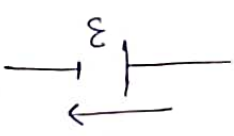
$-IR$,



$+IR$

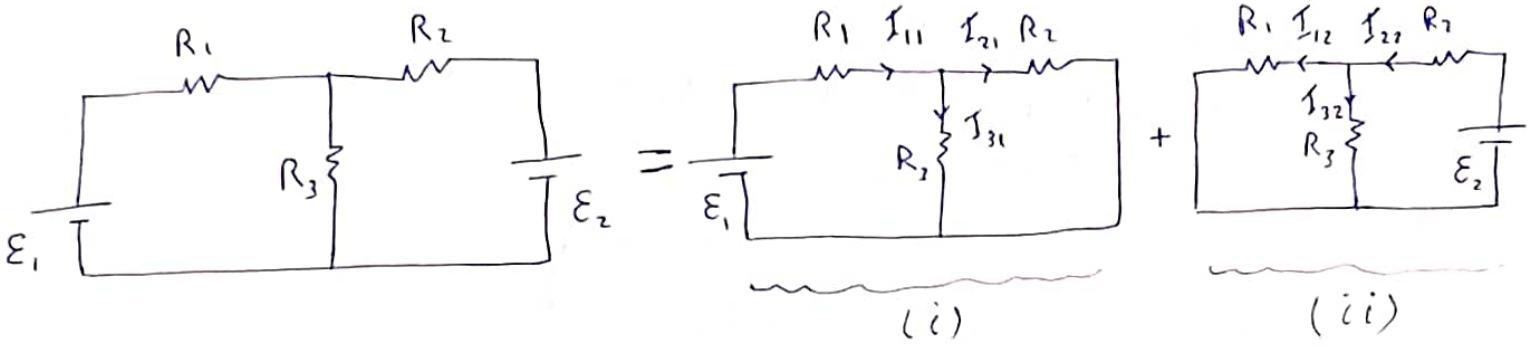


$+\varepsilon$,



$-\varepsilon$

② Superposition principle :



To find I_1, I_2, I_3 using the superposition principle we must find :

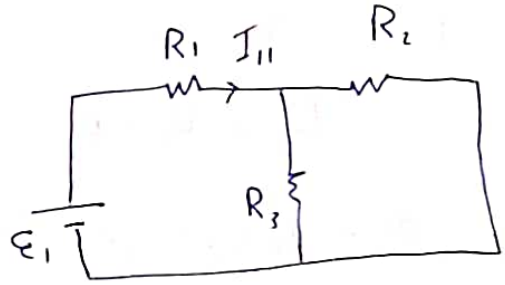
$$I_1 = I_{11} + I_{12}$$ (الانسياب للاتجاهات)

$$I_2 = I_{21} + I_{22}$$ ← نفس الاتجاه مع ε2

$$I_3 = I_{31} + I_{32}$$ ← عكس الاتجاه مع ε2

* Finding I_1 :

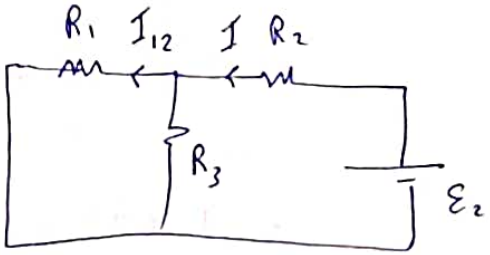
(i) $R_2 // R_3$

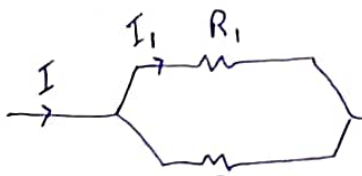


$$I_{11} = \frac{\varepsilon_1}{R_1 + R_2 // R_3}$$

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

(ii) $I = \frac{\varepsilon_2}{R_2 + R_1 // R_3}$





جهد الفرع = الجهد قبل التفرع

$I_1 R_1 = I (R_1 // R_3)$ → R_{eq}

$$R_1 I_{12} = I (R_1 // R_3)$$

$$I_{12} = \frac{\mathcal{E}_2}{R_2 + \frac{R_1 R_3}{R_1 + R_3}} \cdot \frac{R_1 R_3}{R_1 + R_3} \left(\frac{1}{R_1}\right)$$

$$= \frac{6}{3.3 + \frac{1 \times 6.2}{1 + 6.2}} \times \frac{1 \times 6.2}{1 + 6.2} \left(\frac{1}{1}\right)$$

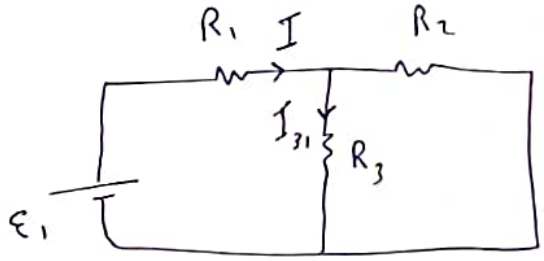
$$= 1.24 \text{ mA} \quad (\leftarrow)$$

$$I_1 = I_{11} - I_{12}$$

$$= 3.8 - 1.24 = 2.55 \text{ mA} \ (\rightarrow)$$

Finding I_3:

(i) $$I = \frac{\mathcal{E}_1}{R_1 + R_2 // R_3}$$



مجموع التفرع = المجموع بين التفرع R_3

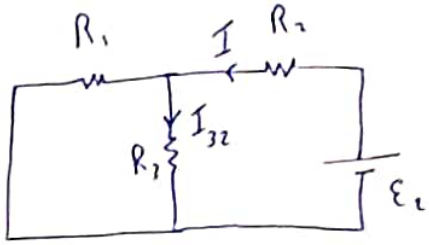
$$I_{31} R_3 = I (R_2 // R_3)$$

$$I_{31} = \frac{\mathcal{E}_1}{R_1 + R_2 // R_3} \frac{(R_2 // R_3)}{R_3}$$

$$= \frac{12}{1 + \frac{3.3 \times 6.2}{3.3 + 6.2}} \left(\frac{3.3 \times 6.2}{3.3 + 6.2}\right)\left(\frac{1}{6.2}\right)$$

$$= 1.32 \text{ mA} \ (\downarrow)$$

(ii) $I = \dfrac{\mathcal{E}_2}{R_2 + R_1 // R_3} = \dfrac{6}{3.3 + \frac{1 \times 6.2}{1+6.2}} = 1.44 \text{ mA}$



$I_{32} R_3 = I (R_1 // R_3)$

$I_{32} = \dfrac{1.44}{6.2}\left(\dfrac{1 \times 6.2}{1+6.2}\right) = 0.2 \text{ mA } (\downarrow)$

$I_3 = I_{31} + I_{32}$

$= 1.32 + 0.2 = 1.52 \text{ mA } (\downarrow)$

In the same way find I_2 !!