Exp 3 : The Superposition prineiple anel Kirchhoff's Laws

- Kirchhoff's Law :

I. Loop theorem : The algebraic sum of the voltage anel (emf's) in a closed eleltric circuit is always zero [energy conservation]

- in other words, The power generated by Sources in a closed circuit is totally consumed by the circuit components.

$$\sum_i V_i = 0 \qquad \text{or} \qquad \sum_k \mathcal{E}_k = \sum_j I_j R_j$$

II. Junction theorem: The algebraic sum of the currents passing through any circuit junction is always zero

$$\sum_j I_j = 0$$

* the currents ~~passing through~~ entering a junction has opposite signs to those leaving it

** of equations = ** of currents

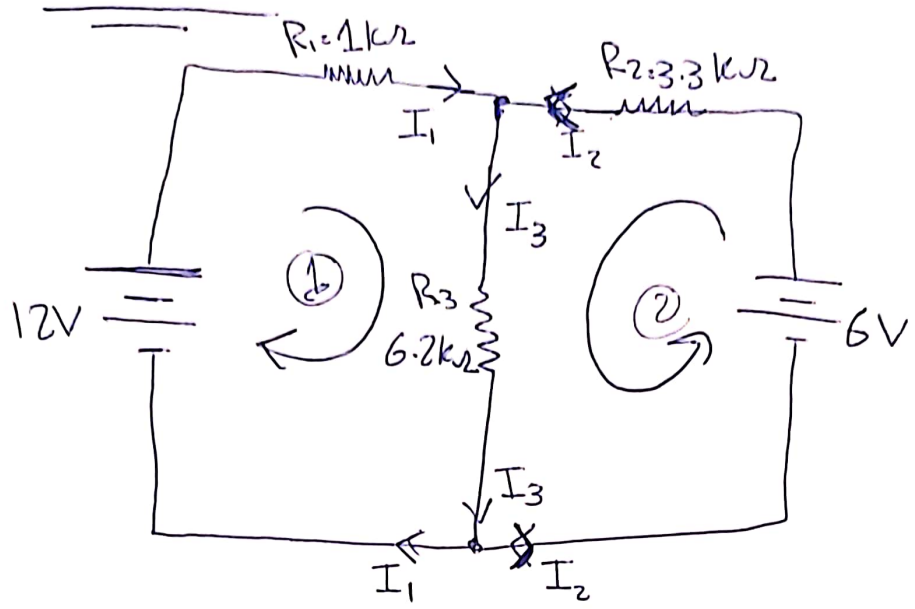
The Superposition principle (SPP)

* if circuit eq are linear ∴ the SPP states that :-

> The 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 is applicable.

* SPP can be applied on a circuit that contain 1. independent linear sources, 2. linear circuit components

- Analyze the circuit :-



- Using Kerchhoff's rules

$$I_1 + I_2 - I_3 = 0$$

- we have 2 junction but both give the same eq.

$$I_3 = I_1 + I_2$$

loop1

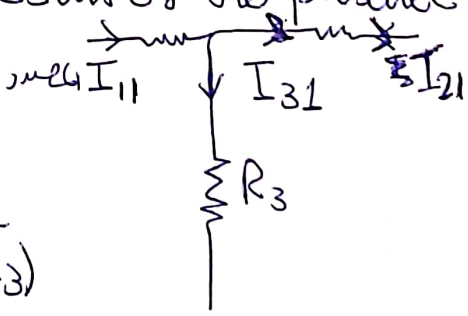
$$\mathcal{E}_1 = I_1 R_1 + I_3 R_3$$

$$\mathcal{E}_2 = -I_2 R_2 + I_3 R_3$$

- Using SPP

1. replace $\mathcal{E}_2$ by short.

I passing through R_3 as result of the presence of $\mathcal{E}_1$ alone



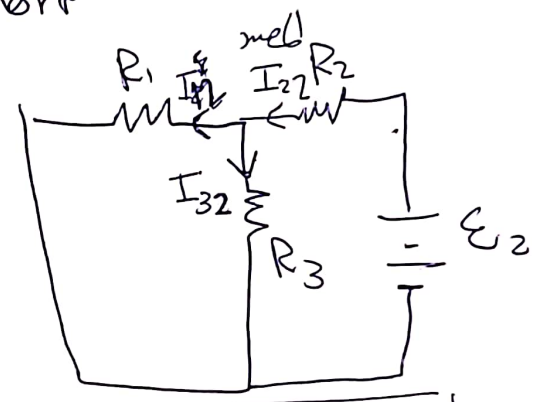
$$I_{11} = \frac{\mathcal{E}_1}{R_1 + (R_2 // R_3)}$$

$$I_{31} R_3 = (I_{11} - I_{31}) R_2$$

Thus

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

2. Keep $\mathcal{E}_2$, replace $\mathcal{E}_1$ by short



ohm's law $I_{22} = \frac{\mathcal{E}_2}{R_2 + (R_1 // R_3)}$ .. ①

Voltage in // equals

$V_{R_3} = V_{R_1}$

$I_{12} = I_{22} - I_{32}$

$$I_{32} R_3 = (I_{22} - I_{32}) R_1 \quad .. ②$$

① and ② gives

$$I_{32} = \frac{\mathcal{E}_2 R_1}{R_1 R_2 + R_2 R_3 + R_1 R_3}$$

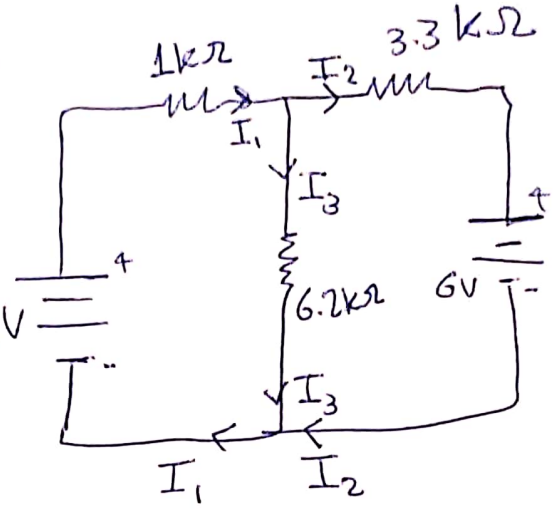
Finally

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

Should equal to that you find it by Kirchhoff's Law ?!

* procedure: الإجراءات

1. connect the circuit as shown.



Kerchhoffs

2. Measure the voltage differences for the 3 carbon resistor and the current passing through each of them.

SPP

3. replace $\mathcal{E}_2$ by a short and repeat (2)

4. connect $\mathcal{E}_2$ back, and replace $\mathcal{E}_1$ by a short and repeat (2)

* Analysis of results: تحليل النتائج

I. SPP:

analyze the circuit to find the value of the current passing through $R_3 = 6.2\ k\Omega$ when each source acting alone.
- compare with exp value.

II. Kerchhoff's Law:

analyze the circuit using Kerchhoff's rules find I in the 3 resistors, compare with exp value

Kirchhoff's

	Experiment	Calculation
I_1(mA)	2.55	
I_2(mA)	1.03	
I_3(mA)	1.52	

SPP

$\mathcal{E}_1$	exp	calc
I_{11}		
I_{21}		
I_{31}		

$\mathcal{E}_2$	exp	calc
I_{22}		
I_{12}		
I_{32}		

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

$$I_2 = I_{21} + I_{22}$$

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