ECE132: Basic Electrical and Electronics Engineering Lab

Experiment 1: The verification of Kirchhoff's voltage law and Kirchhoff's current law

Introduction

In complex circuits such as bridge or T networks, we can not simply use Ohm’s Law alone to find the voltages or currents circulating within the circuit. For these types of calculations we need certain rules which allow us to obtain the circuit equations and for this we can use **Kirchhoffs Circuit Law**.

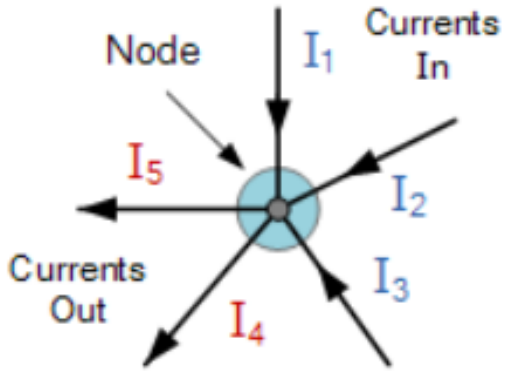
It states that, "In any network of conductors, the algebraic sum of currents meeting at a point (or junction) is zero".

In other words the algebraic sum of ALL the currents entering and leaving a node must be equal to zero, I(exiting) + I(entering) = 0

Kirchhoffs Circuit Law

Kirchhoffs Current Law

Currents Entering the Node
Equals
Currents Leaving the Node



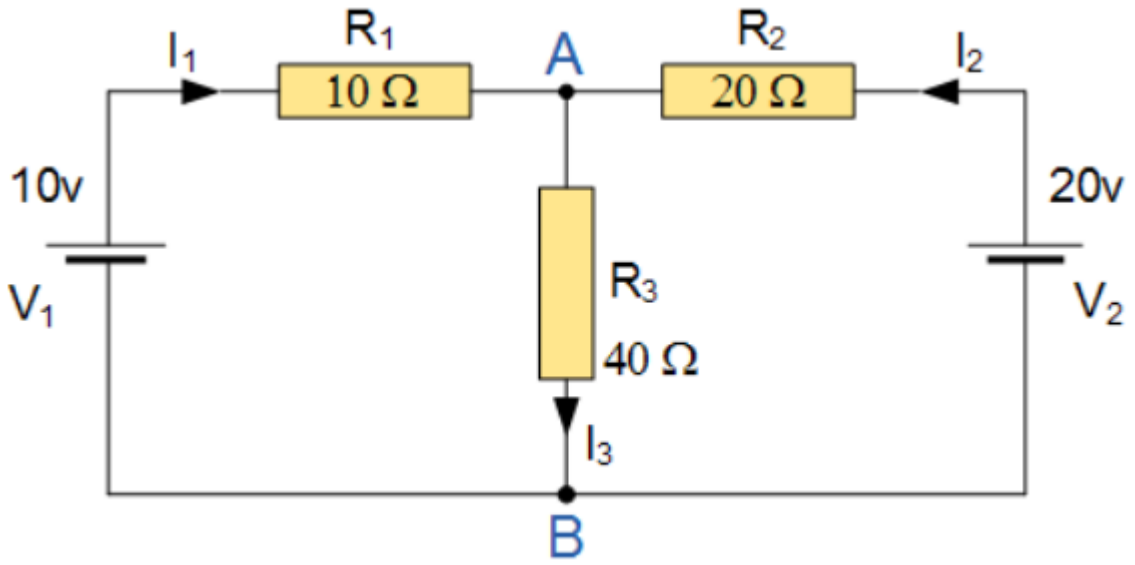
$$I_1 + I_2 + I_3 + (-I_4 + -I_5) = 0$$

Kirchhoffs Circuit Law

Using **Kirchhoffs Current Law**, **KCL** the equations are given as:

At node A : $I_1 + I_2 = I_3$

At node B : $I_3 = I_1 + I_2$



Kirchhoffs Circuit Law

$I_1 + I_2 = I_3$

$I_1 = \frac{V_1 - V_A}{R_1}$ $\quad I_3 = \frac{V_A - V_B}{R_3}$

$I_2 = \frac{V_2 - V_A}{R_2}$ $\quad$ Assume $V_B = 0$

$$\frac{V_1 - V_A}{R_1} + \frac{V_2 - V_A}{R_2} = \frac{V_A}{R_3}$$

$$\frac{V_1}{R_1} + \frac{V_2}{R_2} - V_A\left[\frac{1}{R_1} + \frac{1}{R_2}\right] = \frac{V_A}{R_3}$$

$$\frac{V_1}{R_1} + \frac{V_2}{R_2} = \frac{V_A}{R_3} + V_A\left[\frac{1}{R_1} + \frac{1}{R_2}\right]$$

$$\frac{V_1}{R_1} + \frac{V_2}{R_2} = V_A\left\{\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}\right\}$$

$$\frac{V_1}{R_1} + \frac{V_2}{R_2} = V_A\left\{\frac{R_2R_3 + R_1R_3 + R_1R_2}{R_1R_2R_3}\right\}$$

$$\frac{10}{10} + \frac{20}{20} = V_A\left\{\frac{800 + 400 + 200}{8000}\right\}$$

$$2 \times \frac{8000}{1400} = 11.428 = V_A$$

$$I_1 = \frac{10 - 11.428}{10} = -0.1428$$

$$I_2 = \frac{20 - 11.428}{20} = 0.4286$$

$$I_3 = \frac{11.428}{40} = 0.2857$$

Kirchhoffs Circuit Law

Using **Kirchhoffs Current Law**, **KCL** the equations are given as:

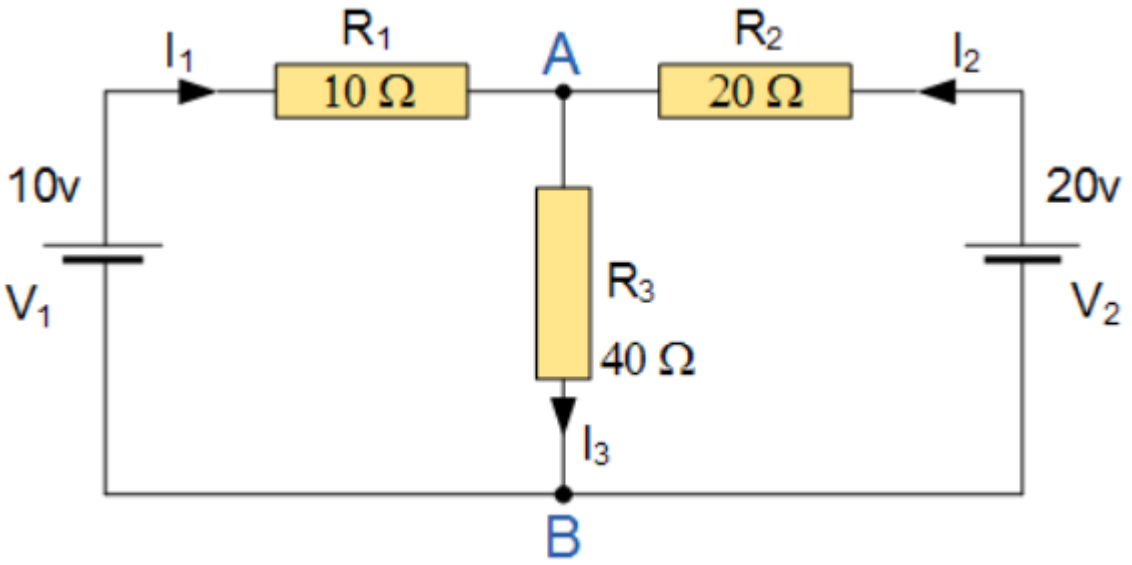
At node A : $I_1 + I_2 = I_3$

At node B : $I_3 = I_1 + I_2$

I_1 = -0.1428 amp

I_2 = 0.4286 amp

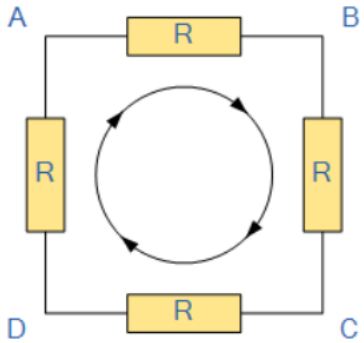
I_3 = 0. 2857 amp



Kirchhoffs Voltage Law

Kirchhoffs Voltage Law or KVL, states that "*in any closed loop network, the total voltage around the loop is equal to the sum of all the voltage drops within the same loop*" which is also equal to zero. In other words the algebraic sum of all voltages within the loop must be equal to zero.

The sum of all the Voltage Drops around the loop is equal to Zero

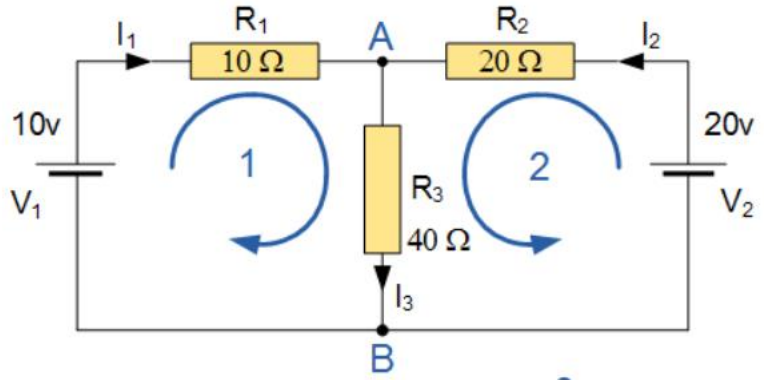


$V_{AB} + V_{BC} + V_{CD} + V_{DA} = 0$

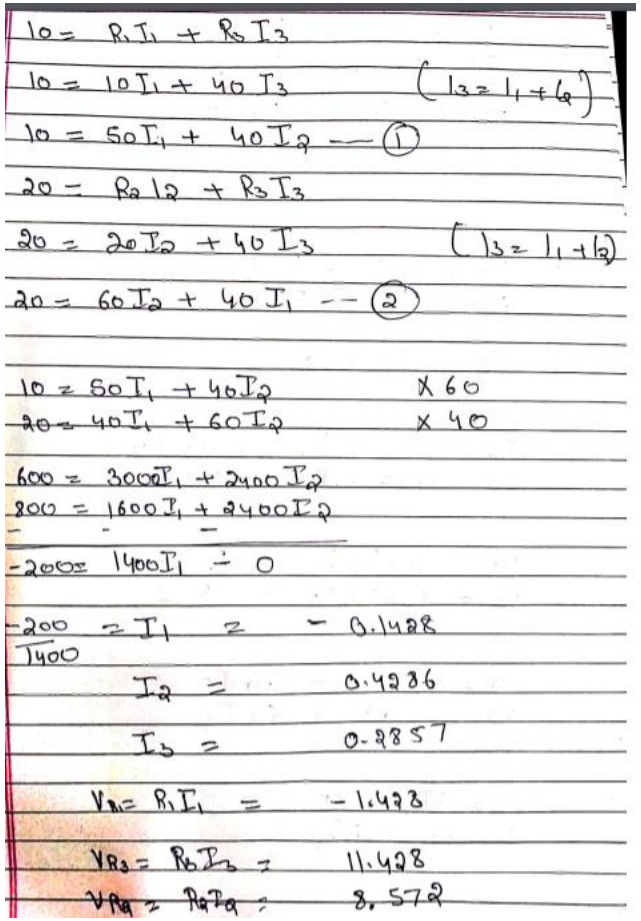
Kirchhoffs Voltage Law

Using **Kirchhoffs Voltage Law**, **KVL** the equations are given as:

- Loop 1 is given as : $10 = R_1 I_1 + R_3 I_3 = 10I_1 + 40I_3$
- Loop 2 is given as : $20 = R_2 I_2 + R_3 I_3 = 20I_2 + 40I_3$



Kirchhoffs Voltage Law

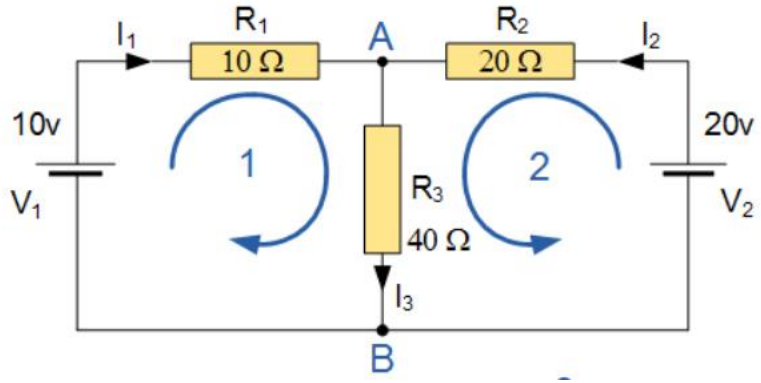


Kirchhoffs Voltage Law

Using **Kirchhoffs Voltage Law**, **KVL** the equations are given as:

- Loop 1 is given as : $10 = R_1 I_1 + R_3 I_3 = 10I_1 + 40I_3$
- Loop 2 is given as : $20 = R_2 I_2 + R_3 I_3 = 20I_2 + 40I_3$

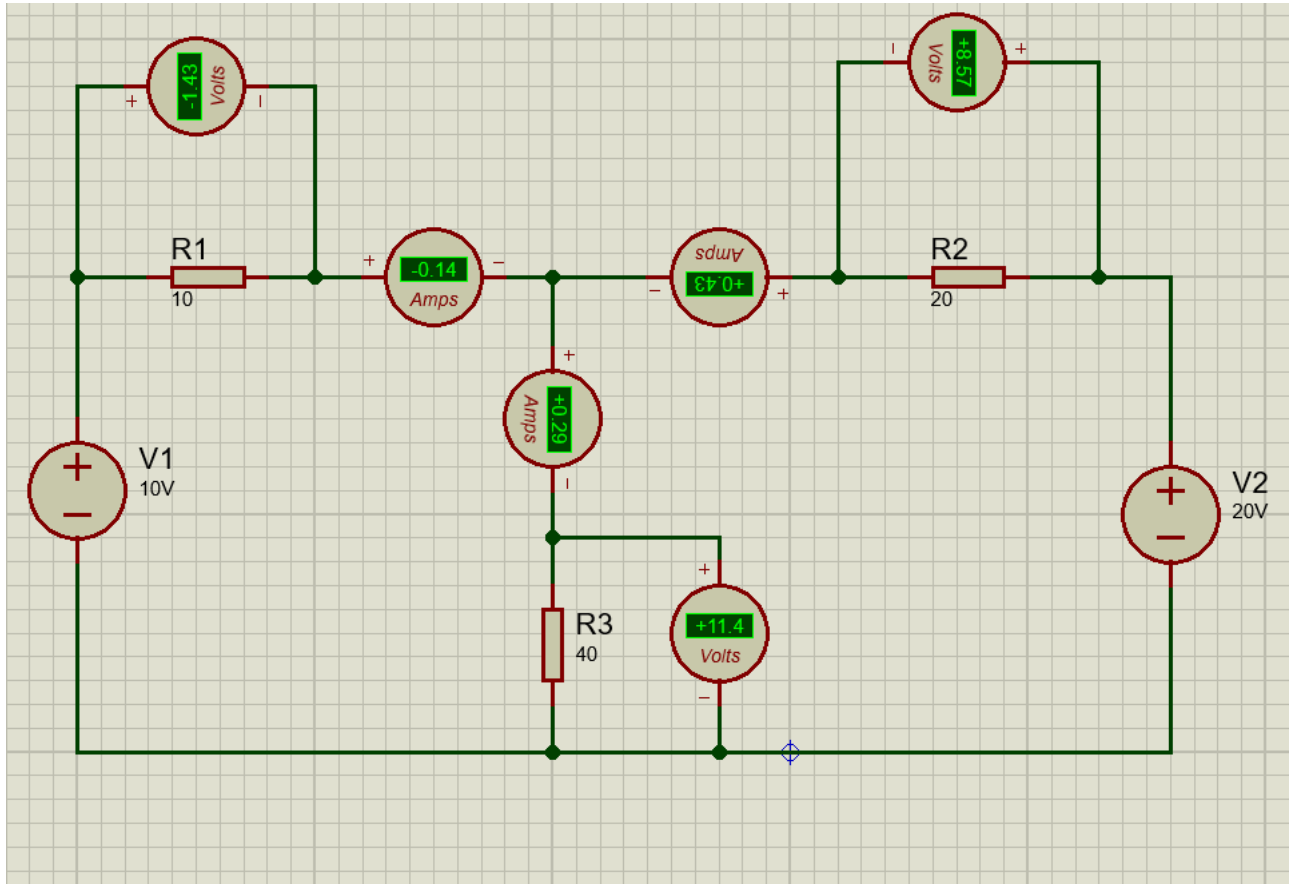
- VR1 = -1.428
- VR2 = 8.572
- VR3 = 11.428



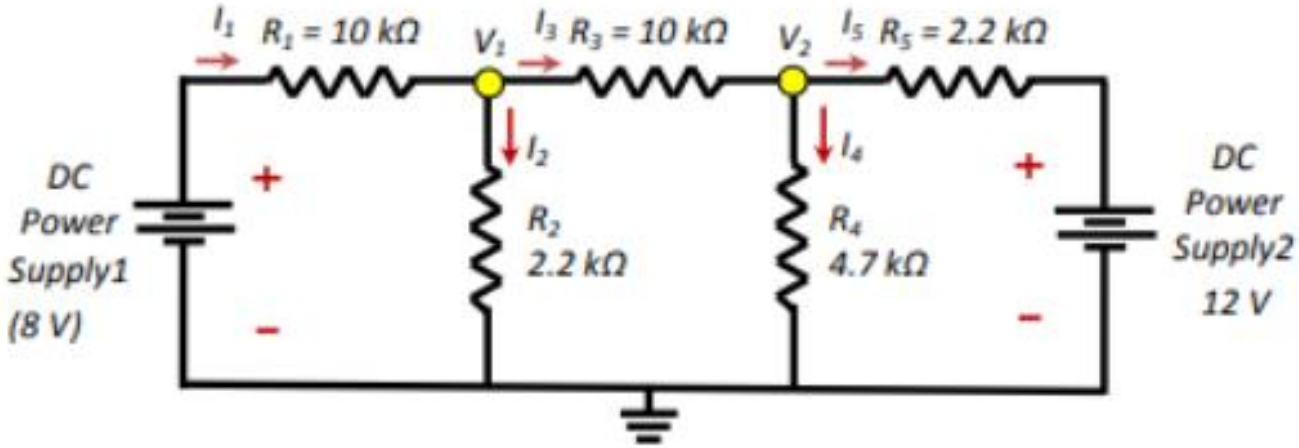
Let Verify using Proteus

- I_1 = -0.1428 amp
- I_2 = 0.4286 amp
- I_3 = 0. 2857 amp

- VR1 = -1.428
- VR2 = 8.572
- VR3 = 11.428



Problem to be solved



Thanks You