# Voltage and current division as an application of KVL and KCL.

Report 2

P.Srijith Reddy,
EE19BTECH11041,
J.Eshwari
EE19BTECH11042
Department of Electrical Engineering
IIT Hyderabad

February 25, 2020

**Abstract**

In this experiment we studied the behaviour of voltage division and current division rule as an application of KCL and KVL in reality which turns out to be close to ideal behaviour using ammeter and voltmeter.

## 1 Introduction

The very important physical effect has applications to chip manufacturing ,electric appliances ,almost every aspect of modern world.

## 2 Theoretical Background

Voltage division is used to calculate the voltage drop across a resistor (impedance) as a fraction of total voltage across a series string of resistors (impedances).

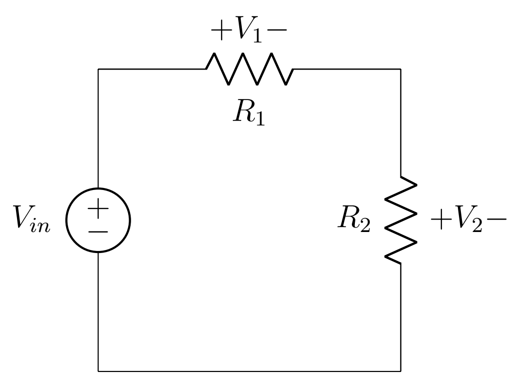

Figure 1: Voltage Divider

Current Division is used to calculate the fraction of the total current into a parallel string of resistors flows through any one of the resistors.

$$V_1 = V_{in}\frac{R_1}{R_1 + R_2} \tag{1}$$

$$V_2 = V_{in}\frac{R_2}{R_1 + R_2} \tag{2}$$

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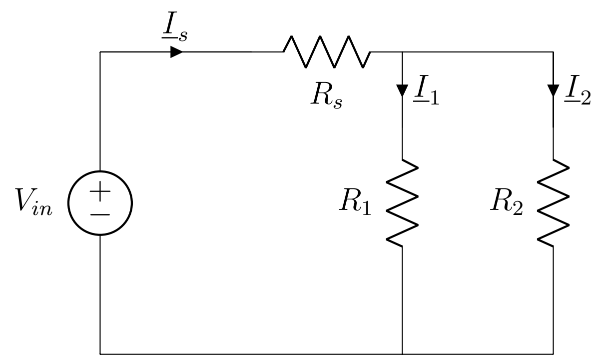


$$I_1 = I_s\frac{R_2}{R_1 + R_2} \tag{3}$$

$$I_2 = I_s\frac{R_1}{R_1 + R_2} \tag{4}$$

# 3 Procedures

Connect the circuit as shown in Fig. 3 and determine the value of I1 and I2. In Fig. 3, add one more resistor in parallel with R1 and R2 and check the variation in I1, I2 and Is.

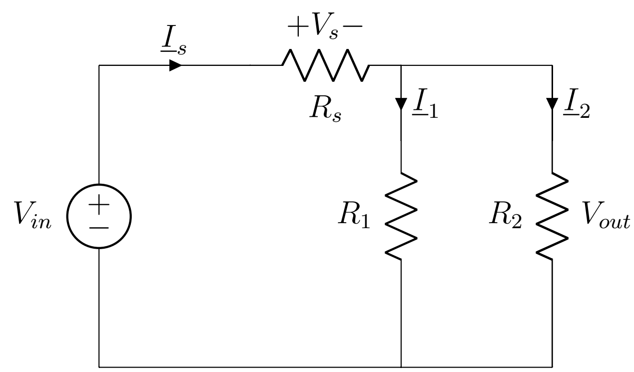


Figure 3:Circuit 1

Now we verify volatage division rule and current division rule using the practical values obtained by placing ammeter and voltmeter .

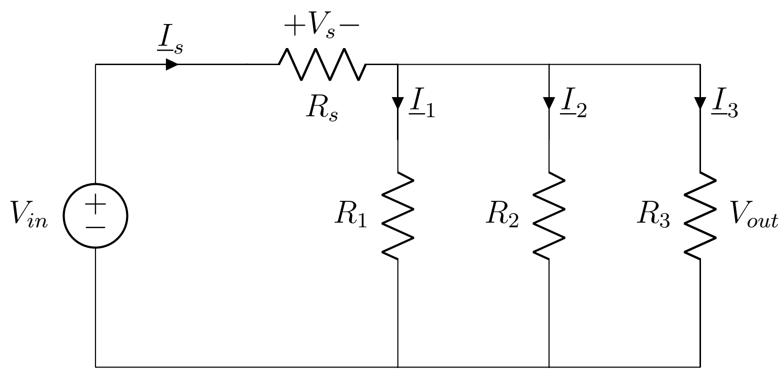


Figure 4: After adding resistor to the circuit 1

Now we should repeat the experiment for circuit below and also make sure that the power in resistor does not exceed it's limit.

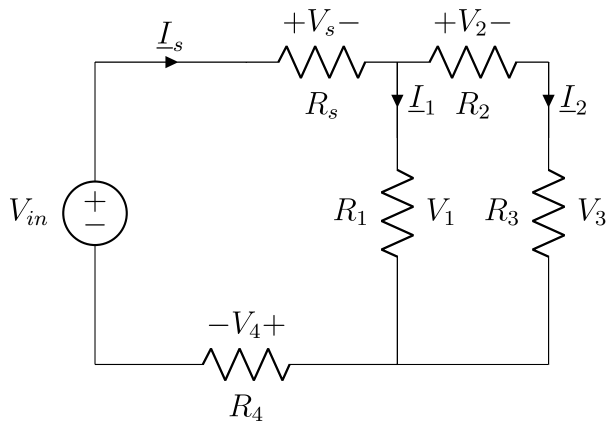


Figure 4 :Circuit 2

# 4 Analysis

**Experiment 1** components

$V_{in} = 24.7\text{V}$
$R_s = 47\Omega$
$R_1 = 220\Omega$
$R_2 = 1K\Omega$
**Theoretical values** Using KCL

$$I_s = I_1 + I_2 \tag{5}$$

Using KVL

$$V_{in} = I_s R + I_1 R_1 \tag{6}$$

$$I_1 R_1 = I_2 R_2 \tag{7}$$

We find the values of $I_s$,$I_1$,$I_2$ using the above equations.

| Element | Theoretical value | Experimental value |
|---|---|---|
| $I_s$ | 108.6 mA | 106 mA |
| $I_1$ | 89.06 mA | 87 mA |
| $I_2$ | 19.59 mA | 19.56 mA |
| $V_s$ | 5.10 V | 5.13 V |
| $V_{out}$ | 19.59 V | 19.52 V |

**After adding resistor in parallel to circuit 1**
$R_3 = 1K\Omega$
**Theoretical values**
Using KCL

$$I_s = I_1 + I_2 + I_3 \tag{8}$$

Using KVL

$$V_{in} = I_s R + I_1 R_1 \tag{9}$$

$$I_1 R_1 = I_2 R_2 = I_3 R_3 \tag{10}$$

| Element | Theoretical value | Experimental value |
|---|---|---|
| $I_s$ | 123 mA | 121 mA |
| $I_1$ | 85.86 mA | 83 mA |
| $I_2$ | 18.88 mA | 19 mA |
| $I_3$ | 18.88 mA | 19 mA |
| $V_s$ | 5.81 V | 5.86 V |
| $V_{out}$ | 18.88 V | 18.85 V |

**Experiment 2**
components
$V_{in} = 24.7$V
$R_s = 47\Omega$
$R_1 = 220\Omega$
$R_2 = 1K\Omega$
$R_3 = 1K\Omega$
$R_4 = 47\Omega$
**Theoretical values**
Using KCL

$$I_s = I_1 + I_2 \tag{11}$$

$$V_{in} = I_s R_s + I_1 R_1 + I_s R_4 \tag{12}$$

$$I_1 R_1 = I_2 (R_2 + R_3) \tag{13}$$

| Element | Theoretical value | Experimental value |
|---|---|---|
| $I_s$ | 84.5 mA | 83.5 mA |
| $I_1$ | 76.15 mA | 75 mA |
| $I_2$ | 8.37 mA | 8.4 mA |
| $V_s$ | 3.97 V | 3.97 V |
| $V_1$ | 16.75 V | 16.7 V |
| $V_2$ | 8.37 V | 8.35 V |
| $V_3$ | 8.37 V | 8.35 V |
| $V_4$ | 3.97 V | 3.98 V |

# 5 Conclusions

• The table shows that theoretical values and experimental values are close and so we have felt the power of voltage and current division rule in reality.
• We should also note that KCL and KVL doesn't hold good all the time .
• KCL doesn't hold good when there is a leakage of charge or accumulation of charge at node.
• KVL is also invalid when the electric field within a loop is not conservative. Based on the laws of physics (Maxwells equations), this occurs in the presence of a changing magnetic field within the circuit, which can certainly arise within high-frequency AC circuits

**Thank you**