Basic Electrical and electronic Engineering (EEE1001)

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LAB EX: 2

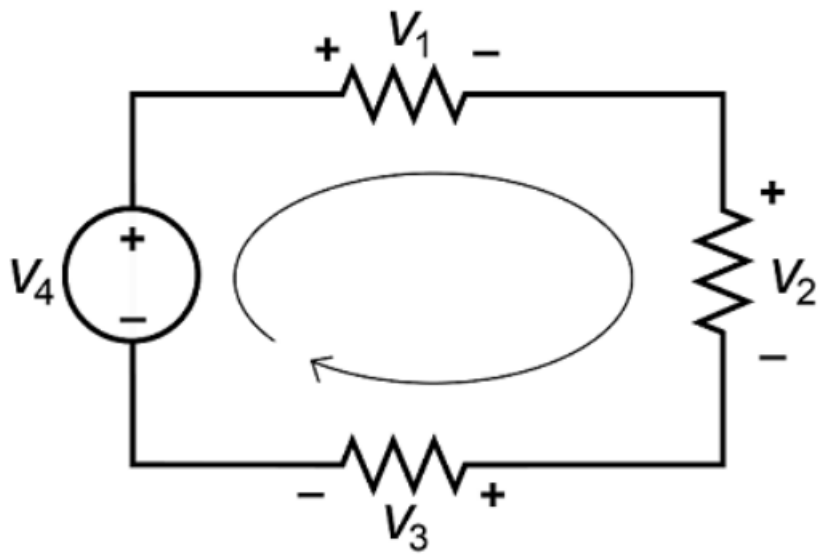
TITLE: Verification of Kirchhoff's Voltage law

Aim:

To verify Kirchhoff's voltage law by Simulation by using LT spice simulation and by conducting experiment.

Theory:

Kirchhoff's voltage law states that the algebraic sum of all the potential differences around a closed network must be equal to zero.

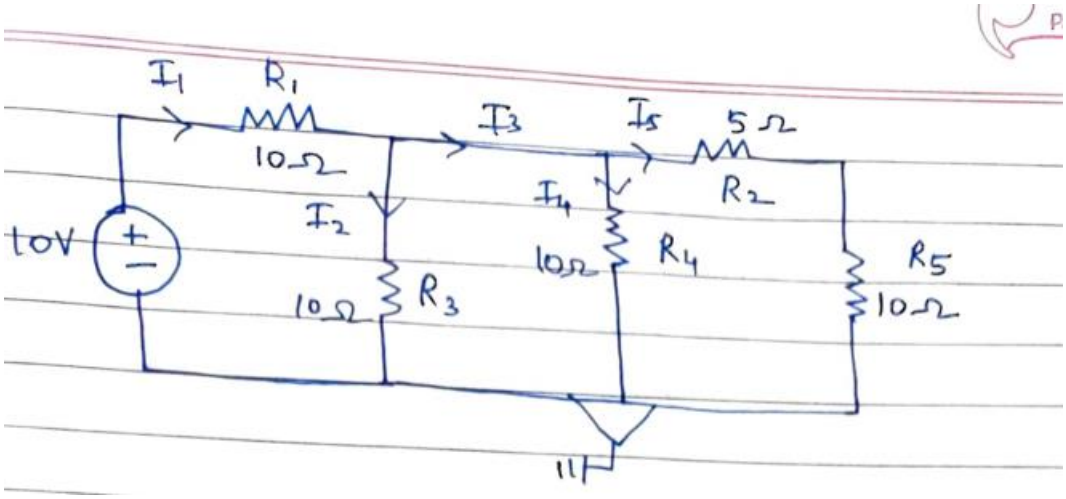


Formula:

$$v_1 + v_2 + v_3 - v_4 = 0, \text{ or } v_1 + v_2 + v_3 = v_4.$$

I. **Simulation verification**

Circuit Diagram:



Theoretical calculation:

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Resistance:

$R_{eq1} = R_2 + R_5 = 5 + 10 = 15\Omega$

$R_{eq2} = R_{eq1} \parallel R_4 = 15\Omega \parallel 10\Omega$

$\Rightarrow \frac{15 \times 10}{15+10} = \frac{150}{25} = 6\Omega$

$R_{eq3} = R_{eq2} \parallel R_3 = 6\Omega \parallel 10\Omega$

$\Rightarrow \frac{6 \times 10}{6+10} = \frac{60}{16} = 2.5\Omega$

$R_{eq4} = R_1 + R_{eq3}$

$= 2.5 + 10$

$= 12.5\Omega$

$\therefore \boxed{R_{eq} = 12.5\Omega}$

Current :

$I_1 = \frac{V}{Req} = \frac{10}{12.5} = 0.8A$

$I_2 = 0.8 \times \frac{6}{16} = 0.3A$

$I_3 = 0.8 \times \frac{10}{16} = 0.5A$

$I_4 = 0.5 \times \frac{15}{25} = 0.3A$

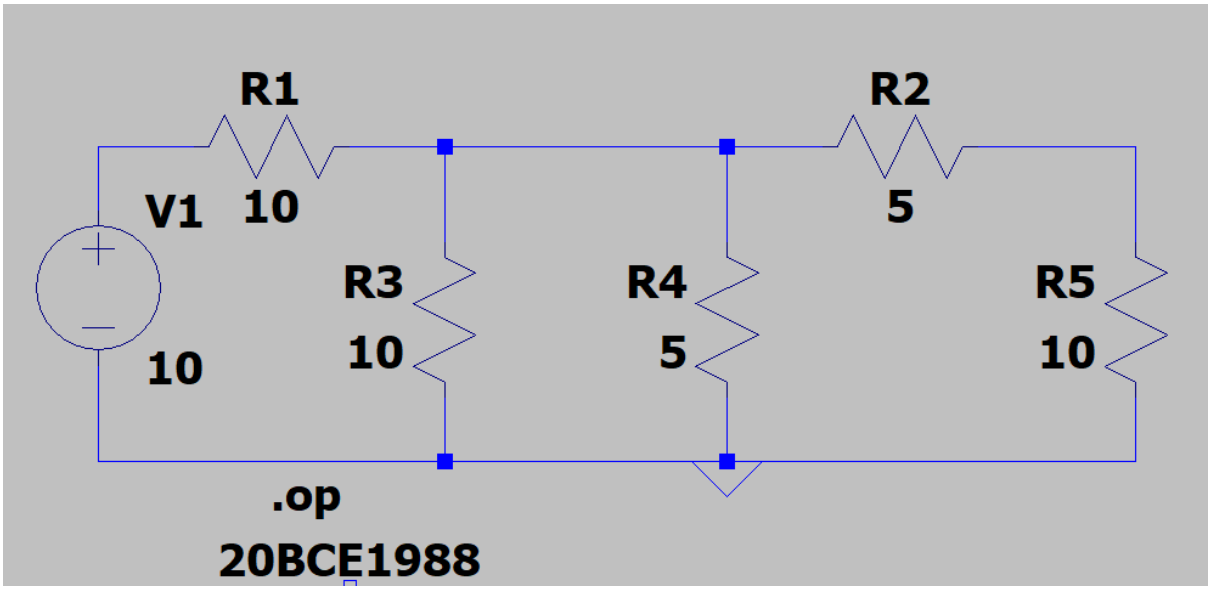
$I_5 = 0.5 \times \frac{10}{25} = 0.2A$

$\therefore V_1 = I_1 \times R_1 = 10V$

$\therefore V_2 = I_3 \times R_2 = 0.3 \times 10 = 3V$

$V_4 = 10V$; $V_5 = 3.33V$; $V_6 = 6.67V$

Simulation diagram:



Simulation Result:

* C:\Users\ragav\OneDrive\Documents\LTspiceXVII\Draft1.asc

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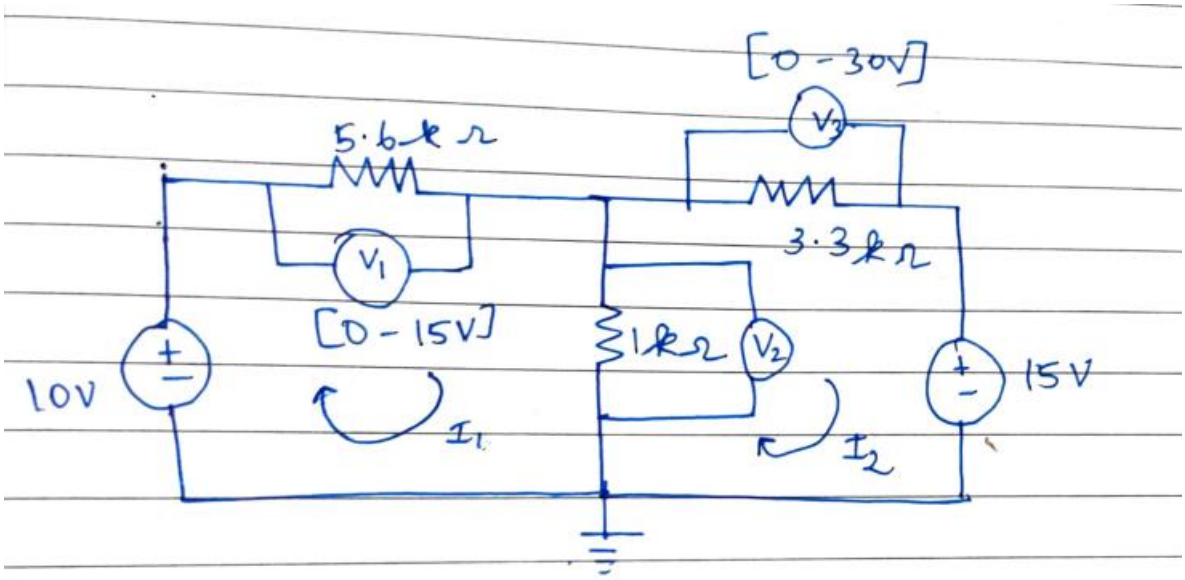
        --- Operating Point ---

V(n001):        10              voltage
V(n002):        2.14286         voltage
V(n003):        1.42857         voltage
I(R5):          -0.142857       device_current
I(R4):          -0.428571       device_current
I(R3):          -0.214286       device_current
I(R2):          -0.142857       device_current
I(R1):          -0.785714       device_current
I(V1):          -0.785714       device_current
```

2.Experiment

Circuit Diagram:



Theoretical calculation:

Theoretical calculation :

$$5.6k I_1 + 1k(I_1 - I_2) = 10V$$
$$3.3k I_2 + 1k(I_2 - I_1) = -15V$$

$$\Rightarrow \quad 6.6k I_1 - 1k I_2 = 10V \quad \rightarrow (1)$$
$$-1k I_1 + 4.3k I_2 = -15V \quad \rightarrow (2)$$

$(2) \times 6.6 \Rightarrow (4)$

$$\Rightarrow \quad 6.6k I_1 - 1k I_2 = 10V$$
$$-6.6k I_1 + 28.38k I_2 = -99V$$

$$27.38k I_2 = -89V$$

$$\therefore \boxed{I_2 = -3.251 mA}$$

$$I_1 = \frac{10 + 1k I_2}{6.6k} = \frac{10 - 3.251}{6.6 \times 10^{-3}}$$

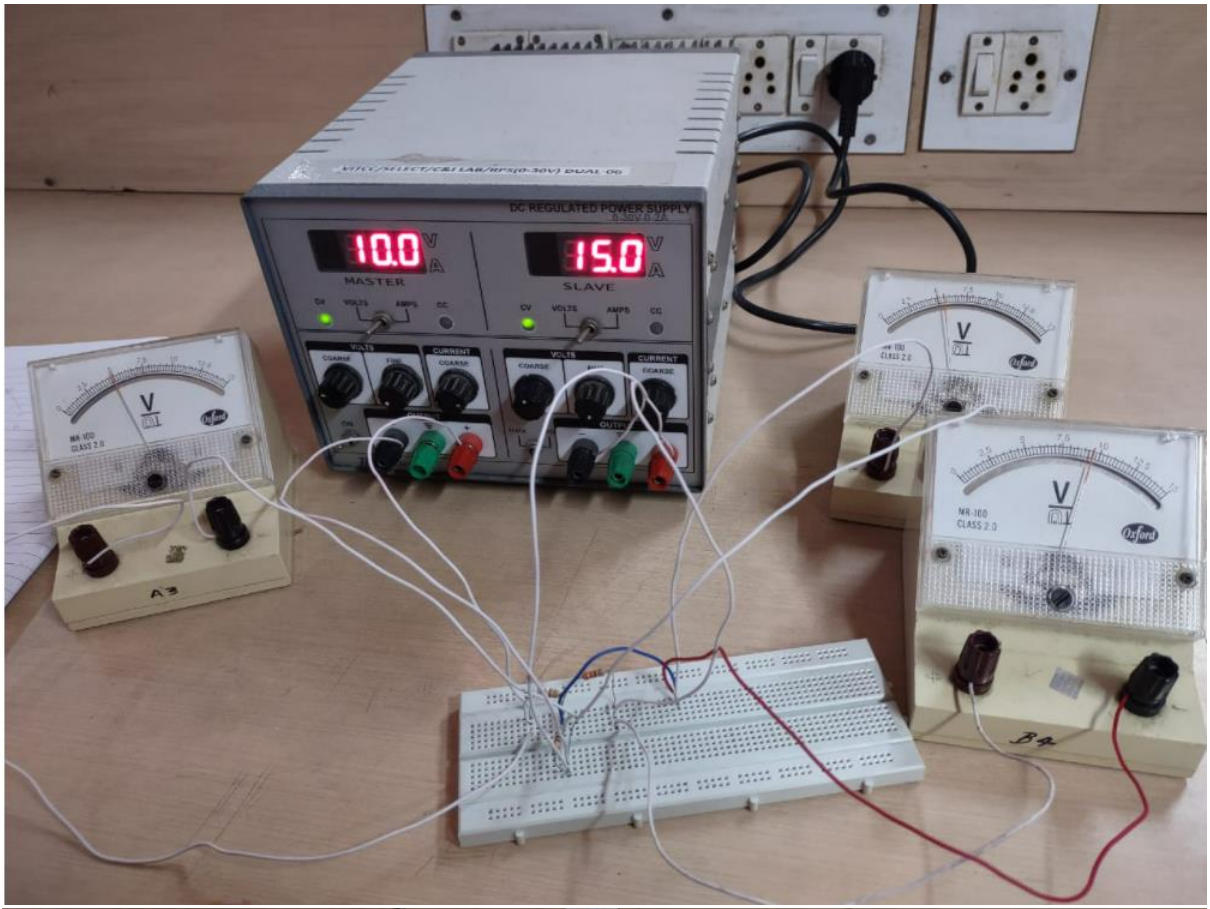
$$= 1.023 mA$$

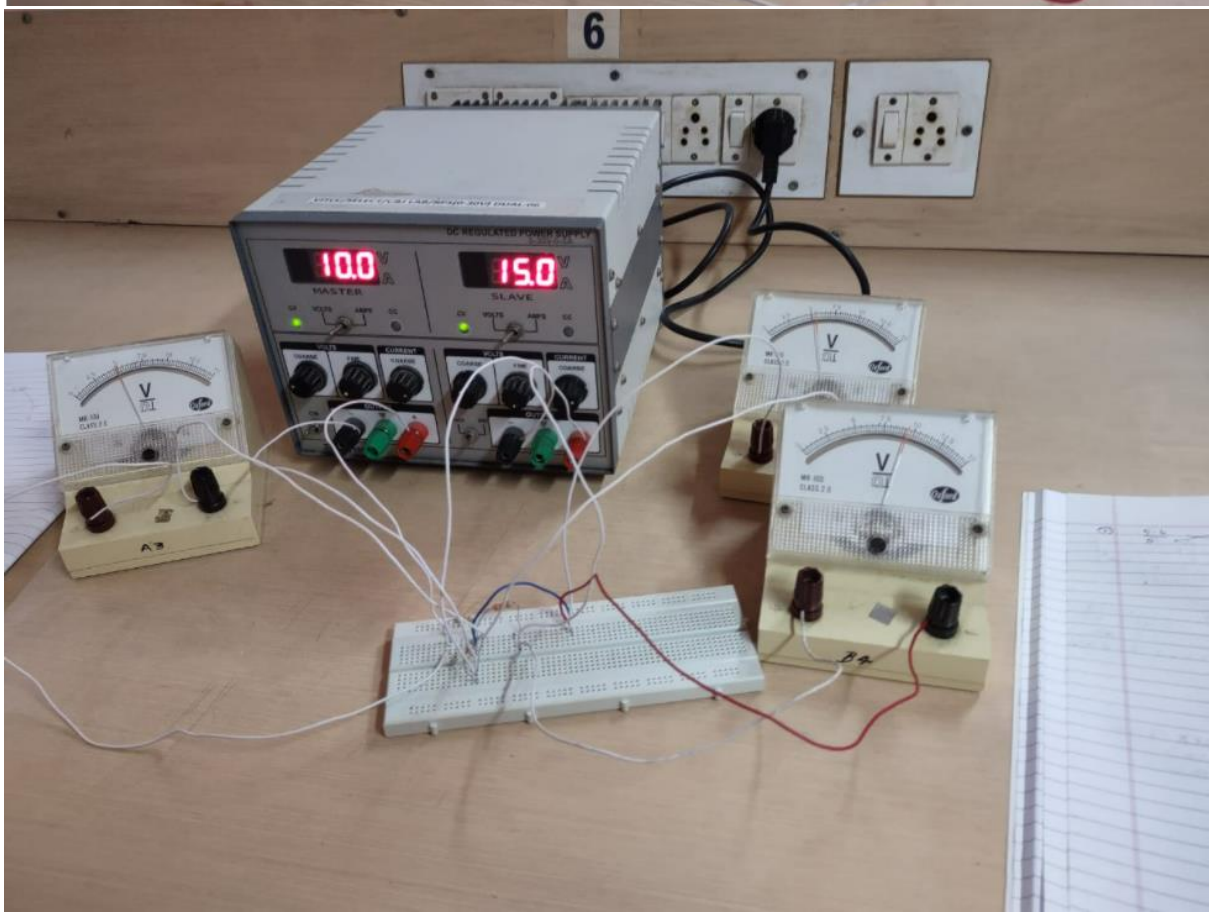
$$\therefore \boxed{I_1 = 1.023 mA}$$

$$\Rightarrow V_1 = 5.6k I_1 = 5.73V$$
$$V_2 = 1k(I_1 - I_2) = 1k \times 4.273mA = 4.27V$$

Experiment Result:

The voltages calculated manually in the experiment matched the voltages observed.


DC REGULATED POWER SUPPLY
10.0
MASTER
15.0
SLAVE
Oxford
NR-100
CLASS 2.0


6
DC REGULATED POWER SUPPLY
10.0
MASTER
15.0
SLAVE
Oxford
NR-100
CLASS 2.0

Result:

The Kirchhoff's voltage law is verified using LTSpice.