Experiment # 1 **Date(s):**

Verification of Kirchhoff's Laws

Aim:

To verify Kirchhoff's Voltage Law (KVL) and Kirchhoff's Current Law (KCL) for the given electrical network by making the circuit on a breadboard and using simulation.

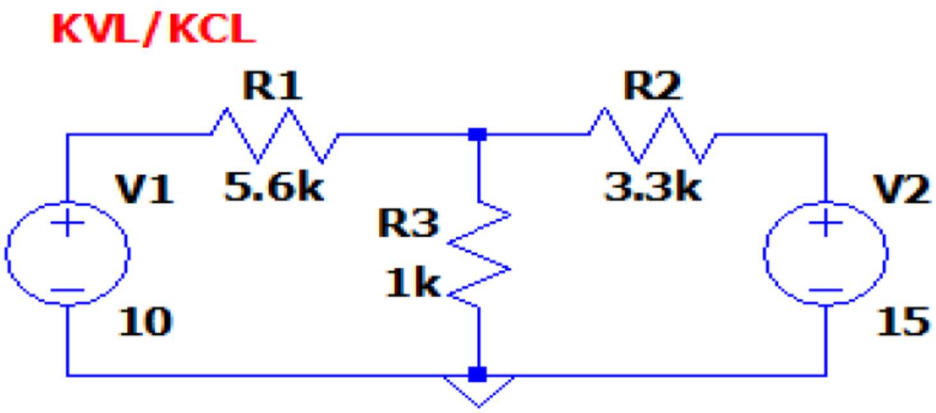
Apparatus Required(software):

LTspice software

Apparatus Required(hardware):

Sl. No.	Components Name	Range	Quantity
1	Resistor	5.6 kΩ, 1 kΩ, 3.3 kΩ	Each 1 No.
2	Voltmeter	0-30 V (DC)	3 Nos.
3	Ammeter	0-25mA (DC)	3 Nos.
4	RPS	0-32 V (DC)	2 Nos.
5	Connecting Wires	-	Few
6	Bread Board	-	1 No.

Circuit Diagram:



Theoretical Calculations:

By KCL, for 'N' currents meeting at a node

$$\sum_{n=1}^{N} i_n = 0$$

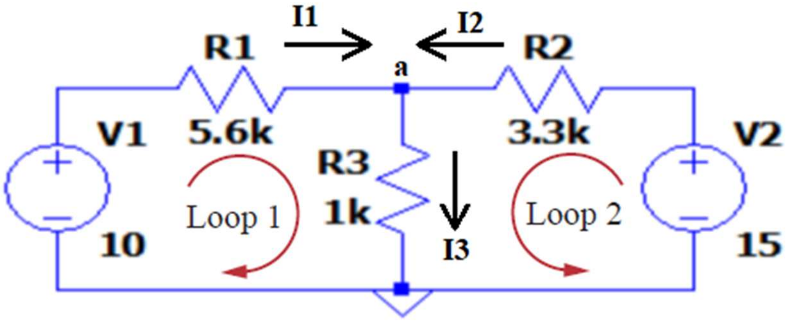
Let I_1 = current through R_1,
I_2 = current through R_2,
I_3 = current through R_3

Assuming I_1 and I_2 flow from V_1 and V_2 respectively, towards the node 'a' while I_3 flows from the node 'a' to the ground, by KCL

$$I_1 + I_2 - I_3 = 0 \qquad (1)$$

If V_{R1} = voltage across R_1,
V_{R2} = voltage across R_2,
V_{R3} = voltage across R_3

Then by Ohm's law,
$V_{R1} = I_1 * R_1$; $V_{R2} = I_2 * R_2$; $V_{R3} = I_3 * R_3$



By KVL, for 'M' voltages in a closed loop

$$\sum_{m=1}^{M} v_m = 0$$

Applying KVL to loop 1, $-V_1 + V_{R1} + V_{R3} = 0$
In terms of currents, $-V_1 + I_1 * R_1 + I_3 * R_3 = 0$ (2)

Applying KVL to loop 2, $-V_2 + V_{R2} + V_{R3} = 0$
In terms of currents, $-V_2 + I_2 * R_2 + I_3 * R_3 = 0$ (3)

For R_1 = 5.6 kΩ, R_2 = 3.3 kΩ, R_3 = 1 kΩ, and V_1 = 10 V, V_2 = 15 V, we have

$$I_1 + I_2 = I_3 \quad (4)$$
$$-10 + I_1 * 5600 + I_3 * 1000 = 0 \quad (5)$$
$$-15 + I_2 * 3300 + I_3 * 1000 = 0 \quad (6)$$

Substituting eq.(4) in eq.s (5) and (6), we get

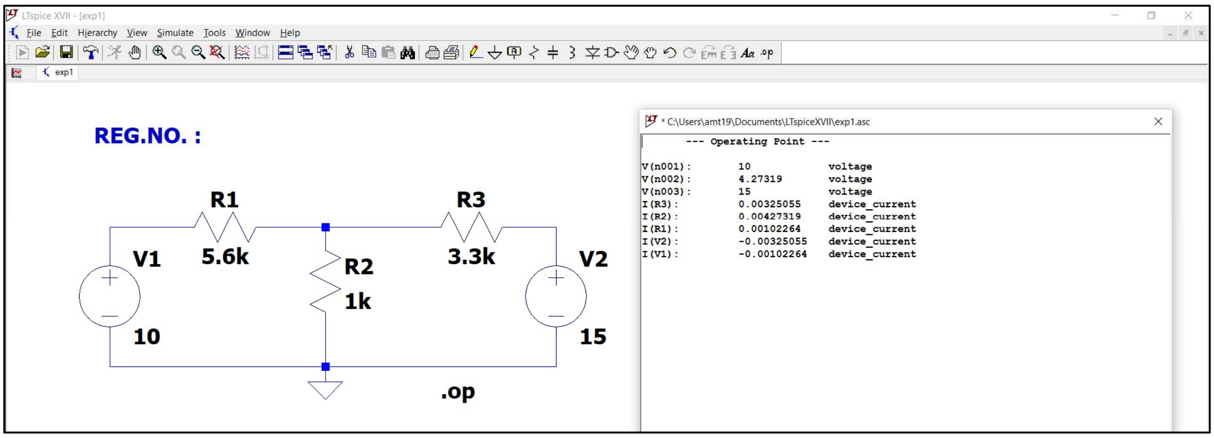
$$I_1 * 5600 + (I_1 + I_2) * 1000 = 10 \rightarrow I_1 * 6600 + I_2 * 1000 = 10 \quad (7)$$
$$I_2 * 3300 + (I_1 + I_2) * 1000 = 15 \rightarrow I_1 * 1000 + I_2 * 4300 = 15 \quad (8)$$

Solving eq.s (7) and (8), we get
Branch currents, I_1 = 1.022 mA, I_2 = 3.25 mA, $I_3 = I_1 + I_2$ = 4.27 mA
Nodal voltages $V_{R1} = I_1 * R_1$ = 5.72 V, $V_{R2} = I_2 * R_2$ = 10.73 V, $V_{R3} = I_3 * R_3$ = 4.27 V.

<u>A. Software Experiment</u>

Procedure:

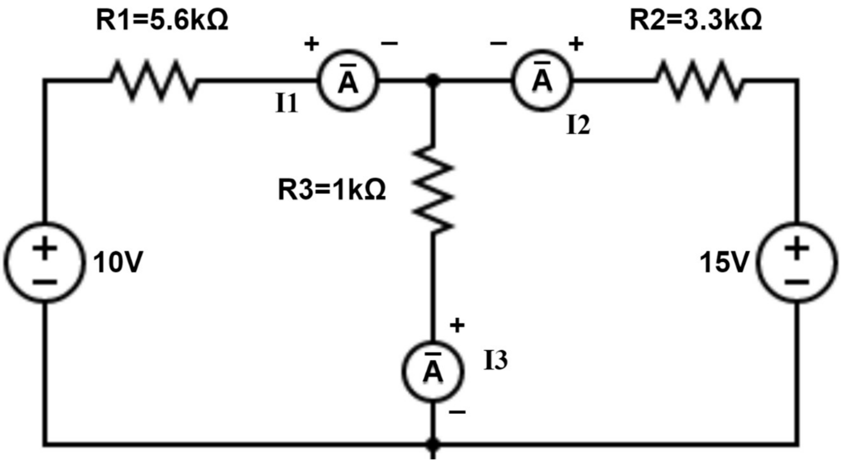
- Open a new file.
- Select dc voltage source from components list. Track and paste it. Right click to feed voltage value.
- Take resistor from the components list. Right click to feed resistor value and rename the components as per the components name in circuit diagram.
- Connect the components using connector.
- Save the file.
- Edit simulate cmd. Choose dc op ppt.
- Run the file
- Results will be displayed. Verify it with theoretical value



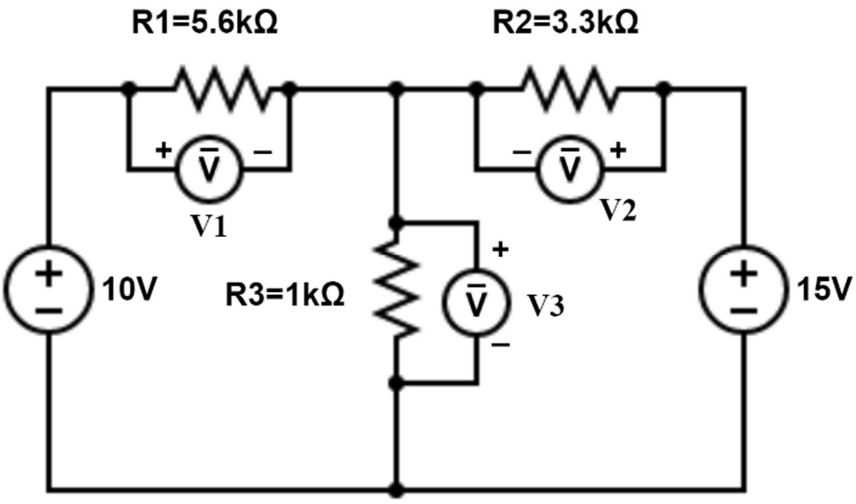
<u>B. Hardware Experiment</u>

Connection Diagram:

<u>1) KCL</u>



<u>2) KVL</u>



Procedure:

<u>KCL</u>

- Connections are given as per circuit diagram.

• Supply voltage is given using regulated power supply.
• The ammeter readings are noted and tabulated.
KVL
• Connections are given as per circuit diagram.
• Supply voltage is given using regulated power supply.
• The voltmeter readings are noted and tabulated.

Observations:

S. No	**Parameter to be measured**	**Value Measured with Units (Theoretical)**	**Value Measured with Units (Simulation)**	**Value Measured with Units (Practical)**
1	Branch Current through 5.6 kΩ			
2	Branch Current through 1 kΩ			
3	Branch Current through 3.3 kΩ			
4	Summation of currents at the junction of R1, R2 and R3			
5	Voltage across 5.6 kΩ			
6	Voltage across 1 kΩ			
7	Voltage across 3.3 kΩ			
8	Algebraic sum of voltages in Mesh 1			
9	Algebraic sum of voltages in Mesh 2			

Result:
Thus, Kirchhoff's Laws were verified for the given electrical network using hardware and software setup.