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Section: CSE 10

Course: CSE 250

Lab: 1

# Lab - 01

**Objective:** The experiment is to acquaint the students with series-parallel circuits and to give them the idea about how to connect different circuits in bread board.

**APPARATUS:**

* DC Power supplies
* Resistors
* Bread Board / Trainer board
* Multimeter

Circuit:

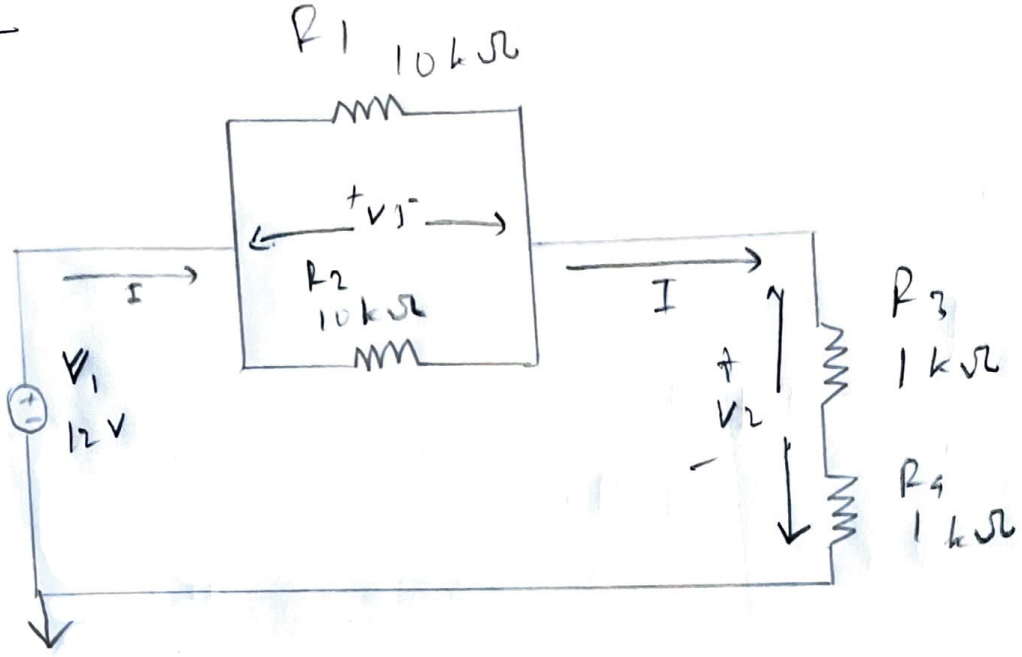



Figure: 01

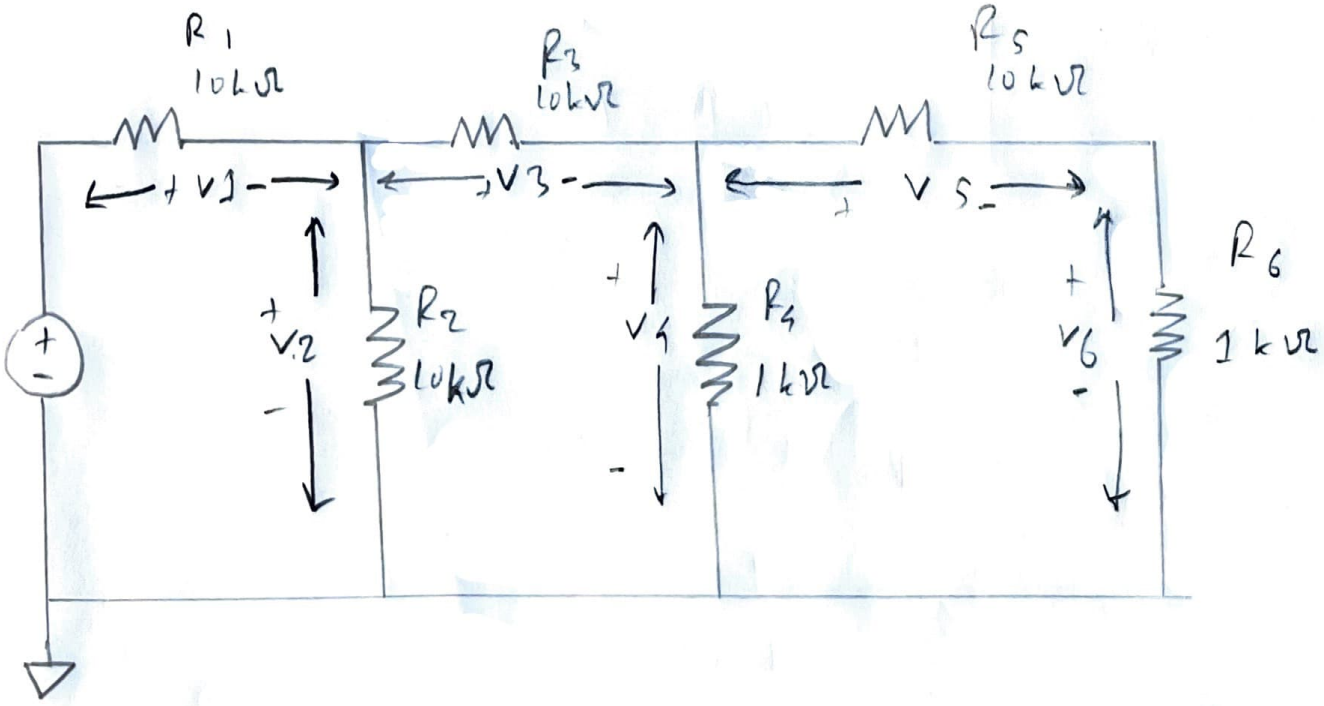



Figure 2

Analysis:

$R_1 = 10\ k\Omega$

$R_2 = 10\ k\Omega$

$R_3 = 1\ k\Omega$

$R_4 = 1\ k\Omega$.

$R_1$ and $R_2$ are in parallel.

$\therefore R_{12} = \left(\frac{1}{10} + \frac{1}{10}\right)^{-1}\ k\Omega$.

$= 5\ k\Omega$.

$\therefore R_{12}$, $R_3$ and $R_4$ are in series

$\therefore R = (R_{12} + R_3 + R_4)$

$= (5 + 1 + 1)\ k\Omega$

$= 7\ k\Omega$.

$\therefore$

$I = \frac{V}{R} = \frac{12}{7}\ mA = 1.7143\ mA$

Here,

$R_1 = R_2$

$\therefore I_1 = I_2 = \frac{I}{2} = \frac{1.7143}{2} = 0.857\,mA$

$R_3$ and $R_4$ are in series.

$\therefore I_3 = I_4 = 1.7143\,mA$

$V_2 = I R_{34} = 1.7143 (1+1)$

$= 3.428\,V$

$V_1 = (12 - 3.428)V$

$= 8.572\,V$

Data Table:

| $V_1(V)$ | $V_2(V)$ | $V_1+V_2(V)$ | $I_1(mA)$ | $I_2(mA)$ | $I(mA)$ |
|---|---|---|---|---|---|
| 8.572 | 3.428 | 12 | 0.857 | 0.857 | 1.7142 |

Figure 2:

$R_1 = R_3 = R_5 = 10k\Omega$

$R_2 = R_4 = R_6 = 1k\Omega$

$V_1 = 12V$

$R_5$ and $R_6$ are in series.

$\therefore R_{56} = R_5 + R_6$

$= (10 + 1)k\Omega$

$= 11 k\Omega$

$R_4$ and $R_{56}$ are in parallel.

$\therefore R_{456} = \left(\frac{1}{11} + 1\right)^{-1}$

$= 0.91667 k\Omega$

$R_2$ and $R_{456}$ are in series.

$\therefore R_{3456} = (10 + 0.91667)k\Omega.$

$= 10.91667 k\Omega$

$R_{3456}$ and $R_2$ are in parallel.

$$\therefore R_{23456} = \left(\frac{1}{10.91667} + 1\right)^{-1}$$

$$= 0.916\ k\Omega$$

$R_1$ and $R_{23456}$ are in series.

$$\therefore R = R_{123456} = (10 + 0.916)\ k\Omega$$

$$= 10.916\ k\Omega$$

$$\therefore I = \frac{V}{R} = \frac{12}{10.916}$$

$$= 1.0993\ mA$$

$$V_1 = (1.099 \times 10)\ V$$

$$= 10.993\ V$$

$$V_2 = (12 - 10.$$

$$= 1.007\ V$$

$I_1 = I = 1.0993 \text{ mA}$

$I_2 = \frac{V_2}{R_2} = 1.007 \text{ mA}$

$\therefore I_3 = I - I_2$

$= (1.0993 - 1.007) \text{ mA}$

$= 0.0923 \text{ mA}$

$V_3 = I_3 R_3$

$= (0.0923 \times 10) \text{ V}$

$= 0.923 \text{ V}$

$V_4 = (1.007 - 0.923) \text{ V}$

$= 0.0845 \text{ V}$

$= 84.55 \text{ mV}$

$$I_4 = \frac{V_4}{R_4} = \frac{0.0845}{1}$$

$$= 0.0845 \text{ mA}$$

$$I_5 = I_3 - I_4$$

$$= (0.0923 - 0.0845) \text{ mA}$$

$$= 7.8 \times 10^{-3} \text{ mA}$$

$$V_5 = I_5 \times R_5$$

$$= (7.8 \times 10^{-3} \times 10) \text{ V}$$

$$= 0.078 \text{ V}$$

$$V_6 = V_4 - V_5$$

$$= (0.0845 - 0.078)\ V$$

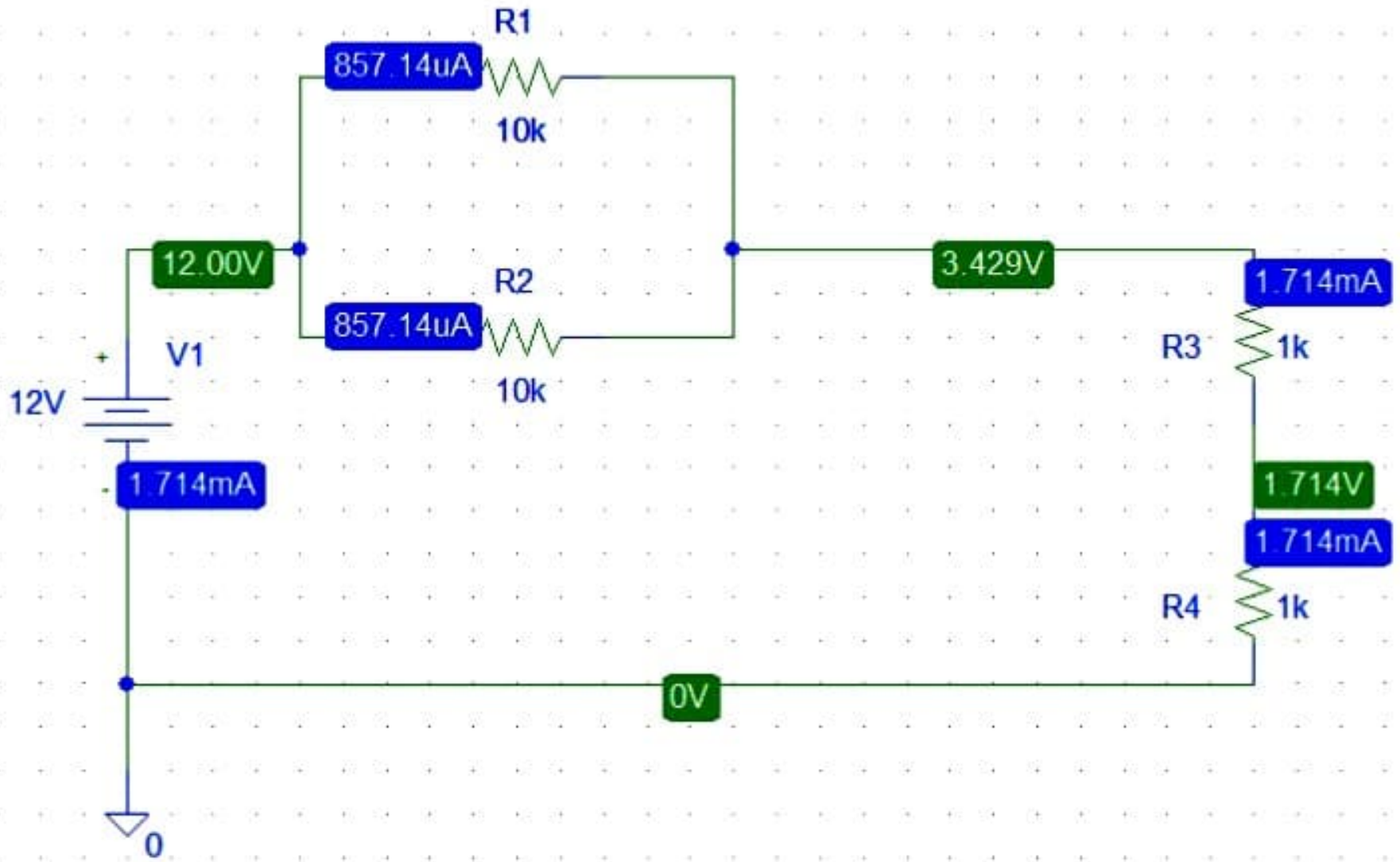
$$= 6.5 \times 10^{-3}\ V$$

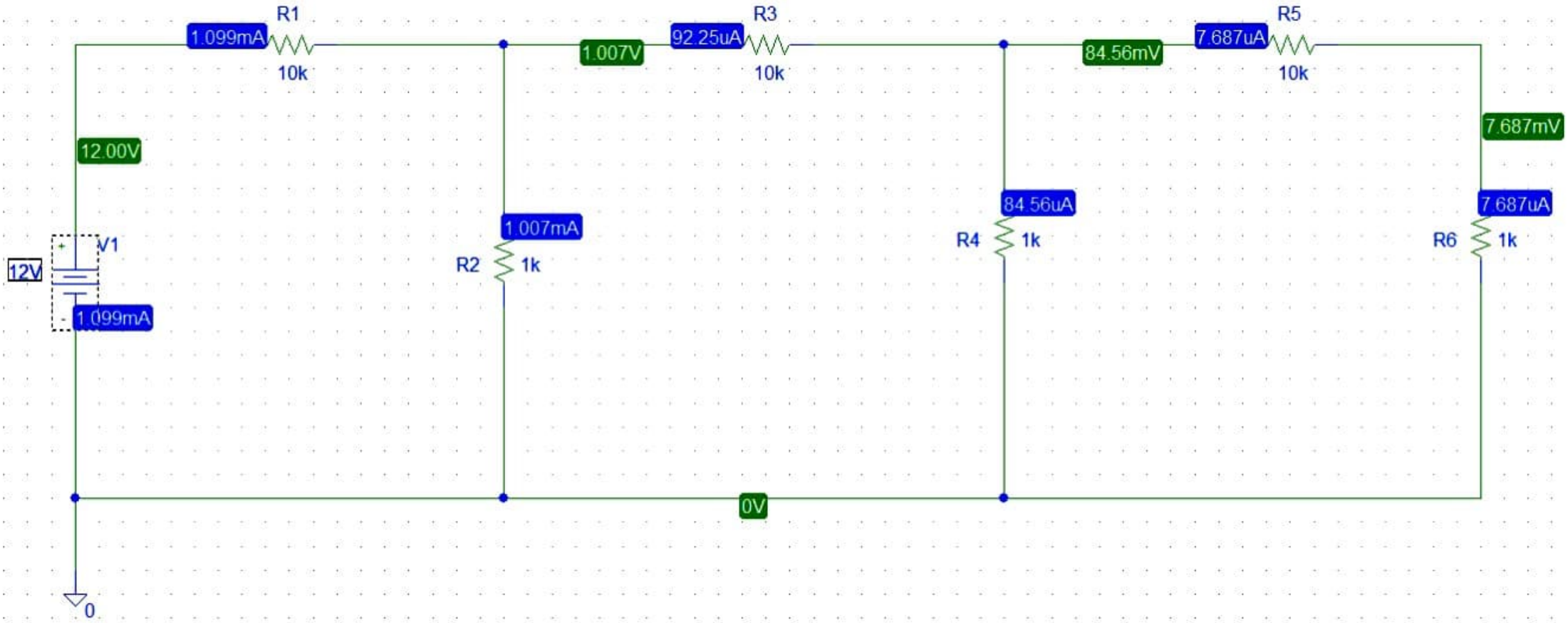
$$I_6 = I_5 = 7.8 \times 10^{-3}\ mA$$

Data table:

| $V_1$ (V) | $V_2$ (V) | $V_3$ (V) | $V_4$ (V) | $V_5$ (V) | $V_6$ (V) | $I_1$ | $I_2$ | $I_3$ | $I_4$ | $I_5$ | $I_6$ | $I$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 10.993 | 1.007 | 0.923 | 0.0845 | 0.078 | $6.5 \times 10^{-3}$ V | 1.0993 mA | 1.007 mA | 0.0923 mA | 0.0845 mA | $7.8 \times 10^{-3}$ mA | $7.8 \times 10^{-3}$ mA | 1.0993 mA |

(iv) Result verification using Pspice simulation:


R1
857.14uA
10k
12.00V
R2
857.14uA
10k
3.429V
1.714mA
R3
1k
V1
12V
1.714mA
1.714V
1.714mA
R4
1k
0V
0


R1
1.099mA
10k
1.007V
R3
92.25uA
10k
84.56mV
R5
7.687uA
10k
7.687mV
12.00V
1.007mA
R2
1k
84.56uA
R4
1k
7.687uA
R6
1k
V1
12V
1.099mA
0V
0

Both results are almost same. There are slight differences in the Pspice values and our values as there are decimal values in most of the voltage and currents.

Questions and answers:

1. There are small discrepancies. It happened because Pspice takes the exact values after decimals. But we have taken those differently. These small changes made the $V_6$ look a lot different than Pspice value as we have written it with an exponent of 10.

2. We are given six 100 Ω resistors and we have to make an effective resistance of 300 Ω.

If we set two 100 Ω parallelly,

$$R_0 = \left(\frac{1}{100} + \frac{1}{100}\right)^{-1}$$

$$= 50$$

∴ So, we need two resistors parallelly like these twice and keep two 100 Ω in series.

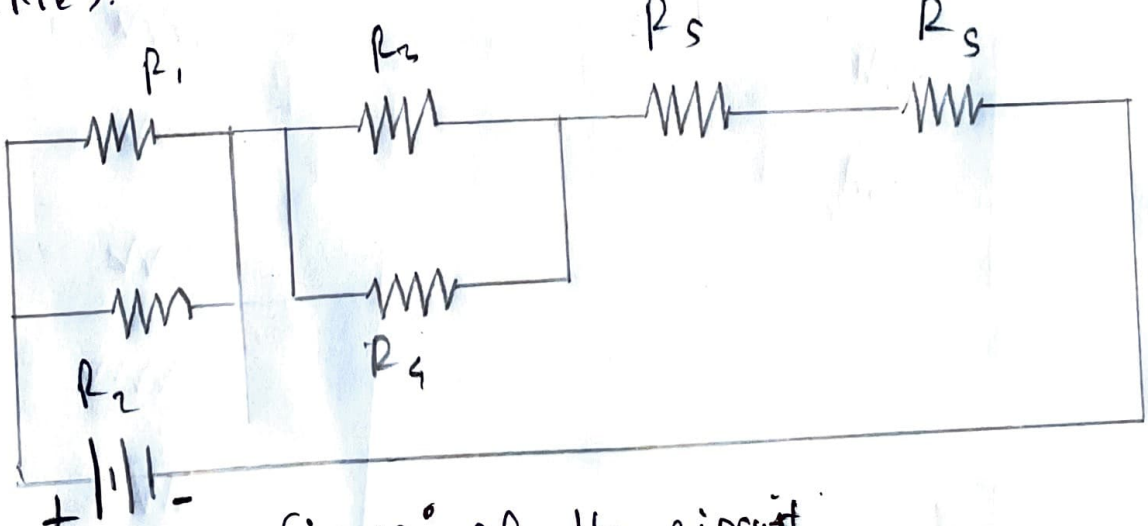



Figure of the circuit

$$R_{Total} = \left(\frac{1}{R_1 + R_2}\right)^{-1} + \left(\frac{1}{R_3} + \frac{1}{R_4}\right)^{-1} + R_5 + R_6$$

$$= \left(\frac{1}{100} + \frac{1}{100}\right)^{-1} + \left(\frac{1}{100} + \frac{1}{100}\right)^{-1} + 100 + 100$$

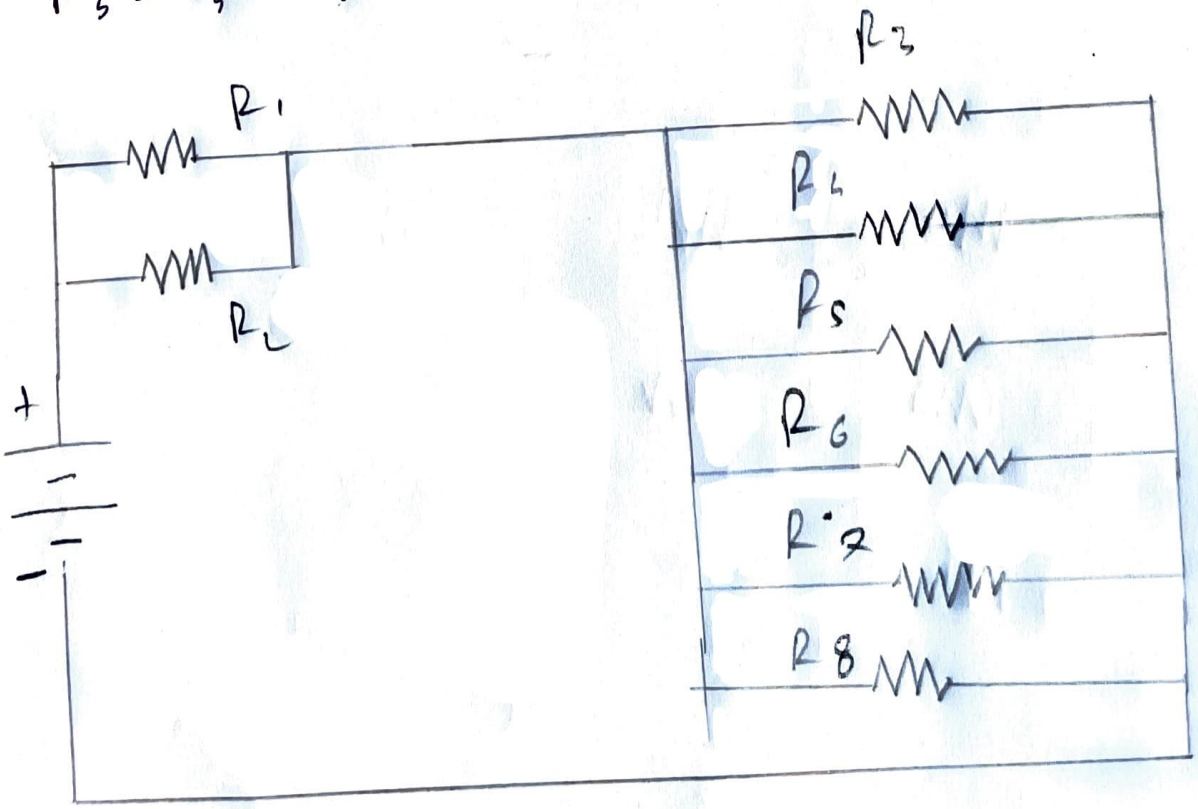
$$= 300\ \Omega$$

3.

Given,

$R_1 = R_2 = 1.5\ k\Omega$

$R_3 = R_4 = R_5 = R_6 = R_7 = R_8 = 15\ k\Omega$



If we use all 1.5 k ohm resistors parallelly and all 15 k ohm resistors parallelly, then we get 3.25 k ohm.

$$R = \left(\frac{1}{R_1} + \frac{1}{R_2}\right)^{-1} + \left(\frac{1}{R_3} + \frac{1}{R_4} + \frac{1}{R_5} + \frac{1}{R_6} + \frac{1}{R_7} + \frac{1}{R_8}\right)^{-1}$$

$$= \left(\frac{1}{1.5} + \frac{1}{1.5}\right)^{-1} + \left(\frac{1}{15} + \frac{1}{15} + \frac{1}{15} + \frac{1}{15} + \frac{1}{15} + \frac{1}{15}\right)^{-1}$$

$$= 3.25 \text{ k ohm}$$

Discussion: From this lab, we learned to build circuits. We also learned calculating the value ~~from~~ of current, voltage, resistors by formula and also with Pspice design margin. We learned that in case of series connection, current is same but voltage is different.

But for Parallel connection, voltage is same

but current is different.