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LAB-2

Monday, 28 February 2022 11:00 PM

Spring 2022 EEE/ETE 141L Electrical Circuits-I Lab(Sec-10) Faculty : Md. Abu Obaidah (AbO) Instructor: Farhana Atuyar Saleh
Lab No.: 02

Date of Performance :23/02/2022 Date of Submission :2/01/2022	**Name:** 1. **Bushra Hossain** 2. **Md. Ishtiaq Ahamed Fahim** 3. **Tajrian Al Israq** **ID:** 1. **2031346642** 2. **2012518642** 3. **2021536643**

Lab 2 : KCL, Current Divider Rule with Parallel and Ladder Circuit.

Objectives :

① We have to learn how to connect a parrallel circuit on a breadboard.

② We have to validate the current divider rules.

③ We have to verify Kirchhoff's current flow.

④ We have to verify KCL and KVL in Ladder circuit.

List of Components :

① Trainer board.

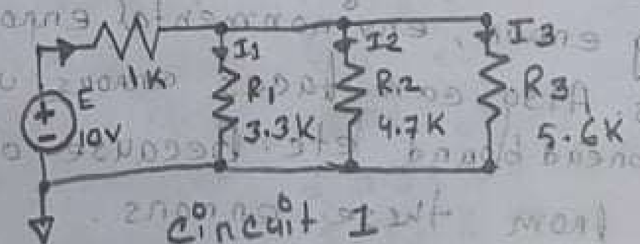
② Resistors [1 KΩ, 3.3 KΩ, 4.7 KΩ, 5.6 KΩ, 10 KΩ)

③ Digital Multimeter (DMM)

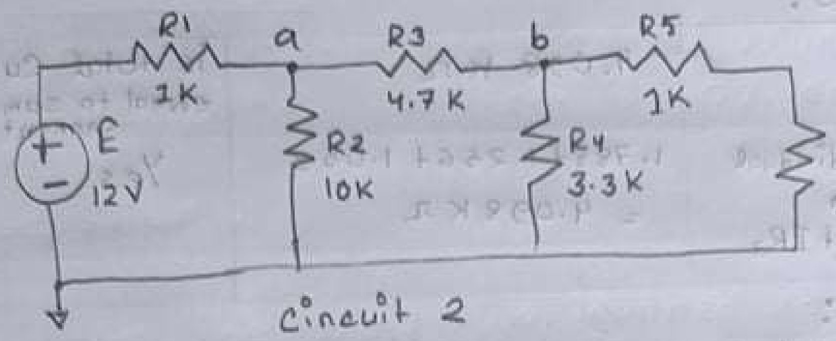
④ connecting wire.

⑤ Multisim.

Circuit Diagram :



Circuit 1



Circuit 2

Data Table:

Table 1:

Resistance using colour coding					Resistance using DMM	% Error
Band 1	Band 2	Band 3	Band 4	Resistance ± tol		
Brown	Black	Red	Gold	1kΩ ± 5%	1 KΩ	0%
Orange	Orange	Red	Gold	3.3kΩ ± 5%	3.3KΩ	0%
Yellow	violet	Red	Gold	4.7kΩ ± 5%	4.7KΩ	0%
Green	Blue	Red	Gold	5.6kΩ ± 5%	5.6kΩ	0%
Brown	Black	Orange	Gold	10KΩ ± 5%	10KΩ	0%

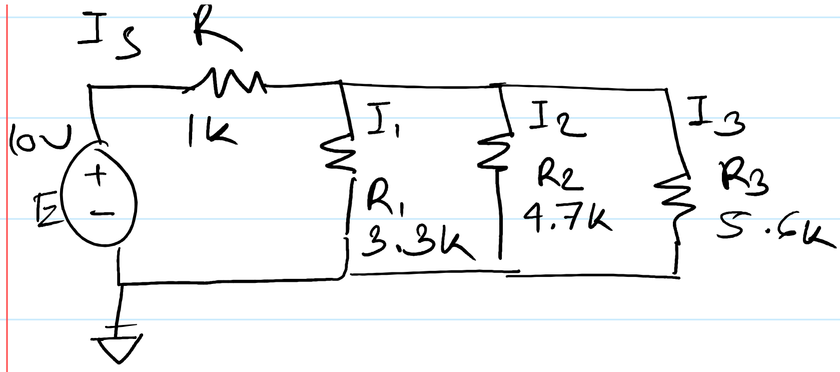
Table 2:

Experimental readings				Theoretical values			
I_s (mA)	I_{R1} (mA)	I_{R_2} (mA)	I_{R_3} (mA)	I_s (mA)	I_{R_1} (mA)	I_{R_2} (mA)	I_{R_3} (mA)
4.098	1.788	1.256	1.054	4.1	1.8	1.26	1.054

% Error

I_s	I_{R_1}	I_{R_2}	I_{R_3}
0.0488% or 0.05%	0.67%	0.317%	0%

React:



$$R_{eq} = 1k + (R_1 \parallel R_2 \parallel R_3)$$

$$= 1 + \left(\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}\right)^{-1}$$

$$= 1 + \left(\frac{1}{3.3} + \frac{1}{4.7} + \frac{1}{5.6}\right)^{-1}$$

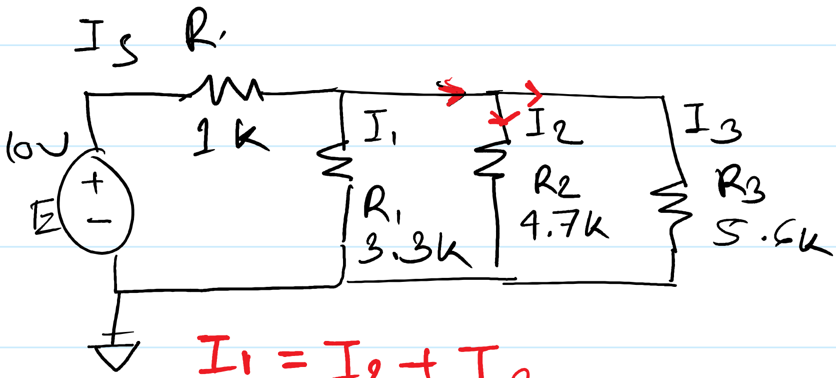
$$= 1 + 1.4$$

$$= 2.4\ \Omega$$

$$E = I_T R_{eq}$$

$$10 = I_T R_{eq}$$

$$I_T = \frac{10}{2.4} = 4.1\ mA$$



$$I_1 = I_2 + I_3$$

$$I_1 = \frac{R_1 \parallel R_2 \parallel R_3}{R_1} I_T$$

$$= 1.8$$

$$I_2 = \frac{R_1 \parallel R_2 \parallel R_3}{R_2} I_T$$

$$= 1.26$$

$$I_3 = \frac{R_1 \parallel R_2 \parallel R_3}{R_3} I_T$$

$$= 1.054$$

$$I_s = \%\ \text{error} = \left| \frac{4.1 - 4.098}{4.1} \right| \times 100\%$$

$= 0.05\%$

$I_1 = \%\text{error} = \left| \dfrac{1.8 - 1.788}{1.8} \right| \times 100\%$

$= 0.67\%$

$I_2 = \%\text{error} = \left| \dfrac{1.26 - 1.256}{1.26} \right| \times 100\%$

$= 0.314\%$

$I_3 = \%\text{error} = \left| \dfrac{1.054 - 1.054}{1.059} \right| \times 100$

$= 0\%$

Table 3:

Is	4.098 KΩ	is total current equal to sum of individual current?
Sum of individual current ($IR_1+IR_2+IR_3$	1.788+1.256+1.053 = 4.098 KΩ	Yes

Table 4:

Experimental Req	Theoretical Req	% Error
2.44 KΩ	2.44 KΩ	0%

Table 5:

Component	Voltage (V)	Current (mA)
E	12	2.538
R_1	2.53	2.538
R_2	9.46	0.946
R_3	7.48	1.592
R_4	1.98	0.601
R_5	0.99	0.991
R_6	0.99	0.991

Table 3 Result:

Sum of indivual current = (1.788 + 1.256 + 1.054)
= 4.098

Table 4 Result:

$$R_{eq} = 1k + (R_1 \parallel R_2 \parallel R_3)$$
$$= 1 + \left(\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}\right)^{-1}$$
$$= 1 + \left(\frac{1}{3.3} + \frac{1}{4.7} + \frac{1}{5.6}\right)^{-1}$$
$$= 1 + 1.44$$
$$= 2.44\Omega$$

Table 5 Result:

$$I_1 = I_2 + I_3$$

$$I_3 = I_4 + I_5$$

we get

$$I_1 = I_2 + I_4 + I_5$$

$$V_1 = \frac{R_1}{R_{eq}} \times 12 = 2.538\ V$$

$$I_1 = \frac{V_1}{R_1} = \frac{2.538}{1} = 2.538\,A$$

$$V_2 = E - V_1 \quad [\text{voltage rule}]$$

$$= 12 - 2.538\,V = 9.46\,V$$

$$I_2 = \frac{V_2}{R_2} = \frac{9.46}{10} = 0.946\,A$$

$$V_3 = \frac{R_3}{((R_5 + R_6) \parallel R_4) + R_3} \times V_2$$

$$= \frac{4.7}{((1+1)^{-1} + 3.3^{-1})^{-1} + 4.7} \times 9.46$$

$$= 7.478\,V$$

$$I_3 = \frac{V_3}{R_3} = \frac{7.478}{4.7} = 1.592\,I$$

$$V_4 = 9.46 - 7.478 = 1.982\,V \quad [\text{voltage rule}]$$

$$I_4 = \frac{V_4}{\ } = \frac{1.982}{\ } = 0.601\,I$$

$$R_4 = \frac{\quad}{3.3} = \ldots$$

$$V_5 = \frac{R_5}{R_5 + R_6} \times V_4$$

$$= \frac{1}{1 + 1} \times 1.982$$

$$= 0.991$$

$$I_5 = \frac{V_5}{R_5} = \frac{.991}{1} = 0.991 \text{ A}$$

$$V_6 = V_5 - V_4 = 1.982 - 0.991 = 0.0991 \text{ V}$$

$$I_6 = \frac{R_6}{R_5 + R_6} \times V_4$$

$$I_6 = \frac{1}{1+1} \times 1.982 = 0.991 \text{ A}$$

Question / Answer :

① State the current division rule.

Ans: Current division rule states that the entire current separated into either of the parallel combination of two resistance or impedance is conversely corresponding to the esteem of resistance. It tells us how the current is isolated within the parallel associated resistance.

② State the Kirchhoff's current law (KCL).

Ans: Kirchhoff's current law states that " the algebraic sum of the currents entering and leaving a node is equal to zero". This law is utilized to depict how a charge enters and takes off a wire junction point or node on a wire.

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③ With the experimental data, verify Kirchhoff's voltage Law in circuit 1 within each independent closed loop of the circuit.

Ans: We have to use Kirchhoff's voltage law in circuit 1 within each independent closed loop of the circuit.

Given, $V = 10\,V$

Now,

$$\frac{10 - V_x}{1\,K\Omega} = \frac{V_x}{3.3\,K\Omega} + \frac{V_x}{4.7\,K\Omega} + \frac{V_x}{5.6\,K\Omega}$$

$$\Rightarrow 10 - V_x = V_x \left(\frac{1}{3.3} + \frac{1}{4.7} + \frac{1}{5.6} \right) K\Omega^{-1}$$

$$\Rightarrow 10V = V_x + (0.694)\,V_x$$

$$\Rightarrow 10V = V_x (1 + 0.694)$$

$$\Rightarrow 10V = 1.694$$

$$\Rightarrow V_x = \frac{10V}{1.694}$$

$$\therefore V_x = 5.901\,V$$

$\therefore V_x = \cancel{5.09}\ 5.901\ V$

Now, $I_s = \dfrac{(10 - 5.901)\,V}{1\,K\Omega}$

$= \cancel{4.098\ mA}$

$= 4.098\ mA$

Now, Again $I_{R_1} = \dfrac{V_x}{R_1}$

$= \dfrac{5.901\,V}{3.3\,K\Omega}$

$= 1.788\ mA$

$I_{R_2} = \dfrac{V_x}{R_2} = \dfrac{5.901\,V}{4.7\,K\Omega}$

$= 1.256\ mA$

$I_{R_3} = \dfrac{V_x}{R_3} = \dfrac{5.901\,V}{5.6\,K\Omega}$

$= 1.053\ mA$

So the experimental values are same as the kirchhoff's voltage law

$I_s = I_{R_1} + I_{R_2} + I_{R_3}$

$= (1.788 + 1.256 + 1.053)\ mA$

$\therefore I_s = 4.098\ mA$

It proves the kirchhnoff's law.

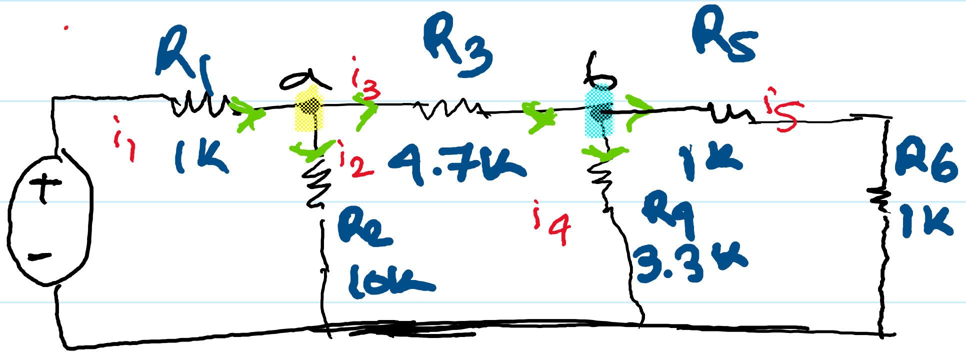
(4)

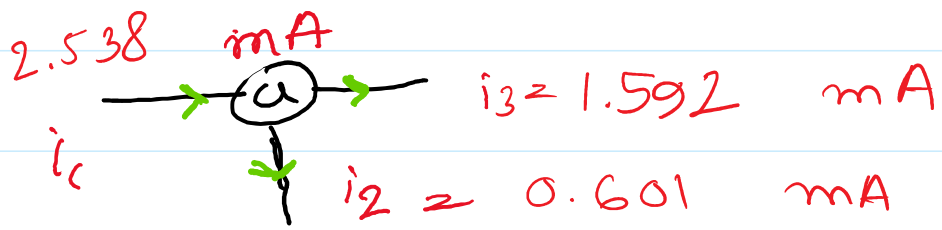
With the experimental data, verify Kirchhoff's current law at nodes a and b of circuit 2.

We know Karroff current law states that the summation of all current entering and leaving a junction is equal to zero

$$\sum_{k}^{n} I_k = 0$$

at point ab





As Kirchhoff's current law states we can derive this formula form it,

$$\sum_{k=1}^{n} \text{Current}_{\underline{in}} = \sum_{k=1}^{n} \text{Current}_{\underline{out}}$$

at point a,

$$I_{in} = I_{out}$$

$$i_1 = i_2 + i_3$$

$$2.538\ mA = (1.592 + 0.601)\ mA$$

2.538 = 2.538 mA

2.538 mA = 2.538 mA

Proven

Alternatively:

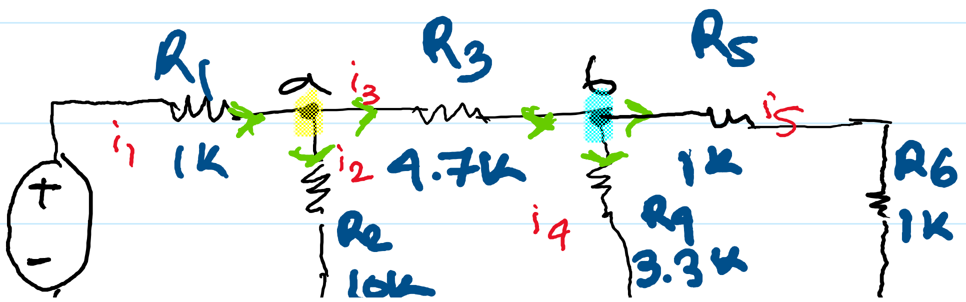
$$\sum_{k=1}^{n} i_k = 0$$

$$\sum_{k=1}^{n} I_{in} + \sum_{k=1}^{n} I_{out} = 0$$

$$2.538 - 2.538 = 0$$

$$0 = 0$$

Proven



at b $i_3 = 1.592mA$

$i_4 = 0.601mA$

$i_5 = 0.991mA$

at b point

$I_{in} = I_{out}$

$i_3 = i_4 + i_5$

$1.592 = 0.601 + 0.991$

$1.592 = 1.592$

Proven

Alternatively,

$$\sum_{k=1}^{n} i_k = 0$$

$I_{in} + I_{out} = 0$

$1.592 - 1.592 = 0$

$0 = 0$

proven

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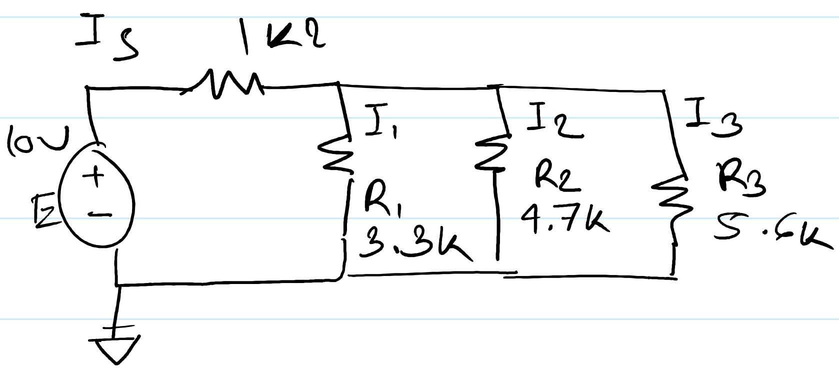
Showing all steps, calculate the theoretical values in Table 2. Compare theoretical values
to your experimental values and explain whether your circuit follows KCL or not



$$R_{eq} = 1k + (R_1 \| R_2 \| R_3)$$

$$= 1 + \left(\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}\right)^{-1}$$

$$= 1 + \left(\frac{1}{3.3} + \frac{1}{4.7} + \frac{1}{5.6}\right)^{-1}$$

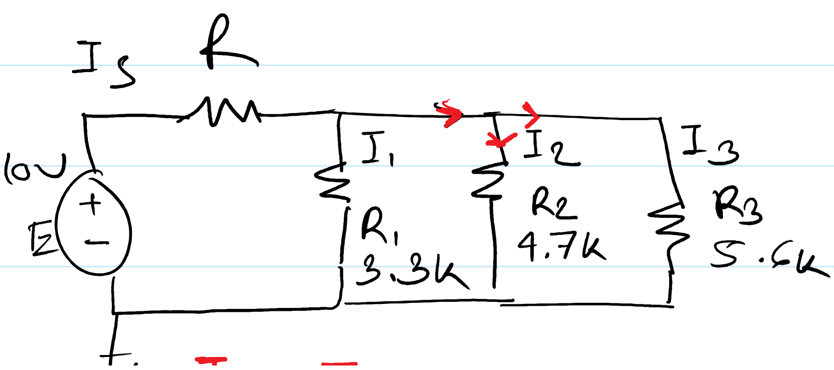
$$= 1 + 1.44 = 2.44$$

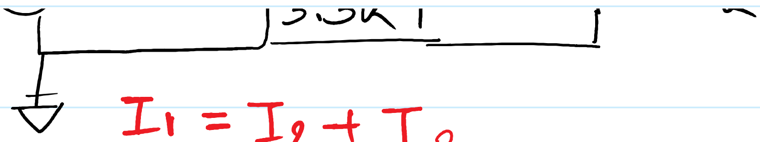
$$\simeq 2.4\ \Omega$$

$$E = I_T R_{eq}$$

$$10 = I_T R_{eq}$$

$$I_T = \frac{10}{2.4} = 4.1\ mA$$





$$I_1 = I_2 + I_3$$

$$I_1 = \frac{R_1 \parallel R_2 \parallel R_3}{R_1} I_T$$

$$= 1.74$$

$$I_2 = \frac{R_1 \parallel R_2 \parallel R_3}{R_2} I_T$$

$$= 1.22$$

$$I_3 = \frac{R_1 \parallel R_2 \parallel R_3}{R_3} I_T$$

$$= 1.03$$

$$I_S = \%\,\text{error} = \left| \frac{4.1 - 4.098}{4.1} \right| \times 100\%$$

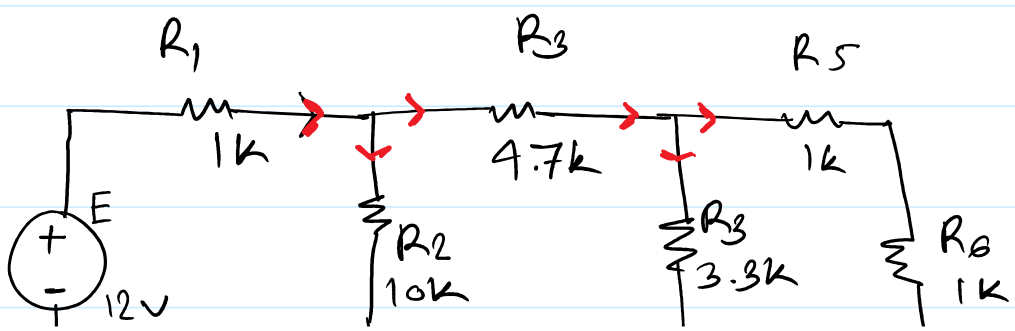
$$= 0.05\%$$

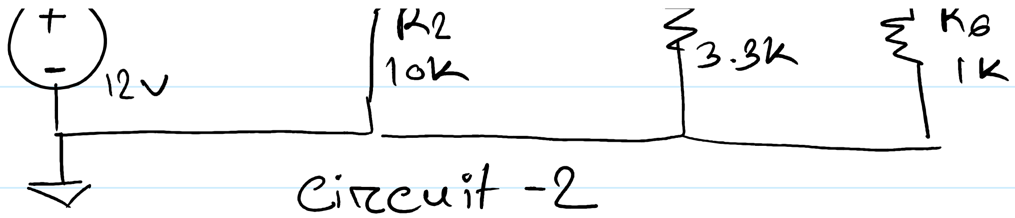
Table 2:

Experimental readings				Theoretical values			
I_S	I_{R1}	I_{R2}	I_{R3}	I_S	I_{R1}	I_{R2}	I_{R3}
4.098mA	1.788mA	1.256mA	1.054mA	4.1mA	1.74mA	1.22mA	1.03mA
% Error							
I_S		I_{R1}		I_{R2}		I_{R3}	
0.05		0.016		0.016		0.017	

Table 4:

Experimental Req	Theoretical Req	% Error
2.44k	2.44k	0





Circuit -2

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Showing all the steps, theoretically calculate Req of circuit 1.
Compare with the
experimental value.

Table 2:

Experimental readings				Theoretical values			
I_S	I_{R1}	I_{R2}	I_{R3}	I_S	I_{R1}	I_{R2}	I_{R3}
4.098mA	1.788mA	1.256mA	1.054mA				

% Error			
I_S	I_{R1}	I_{R2}	I_{R3}

We gather the data from multisim using a multimeter and setting its reading mode to Amp.

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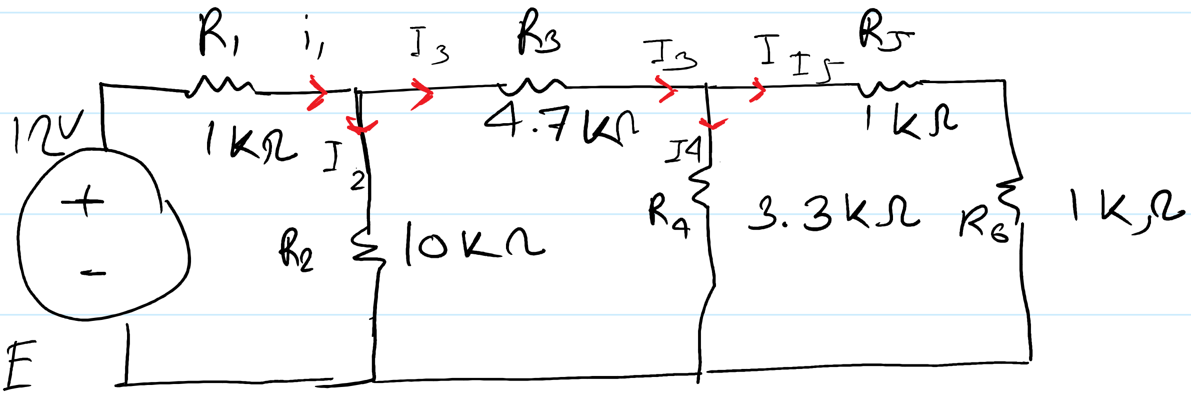
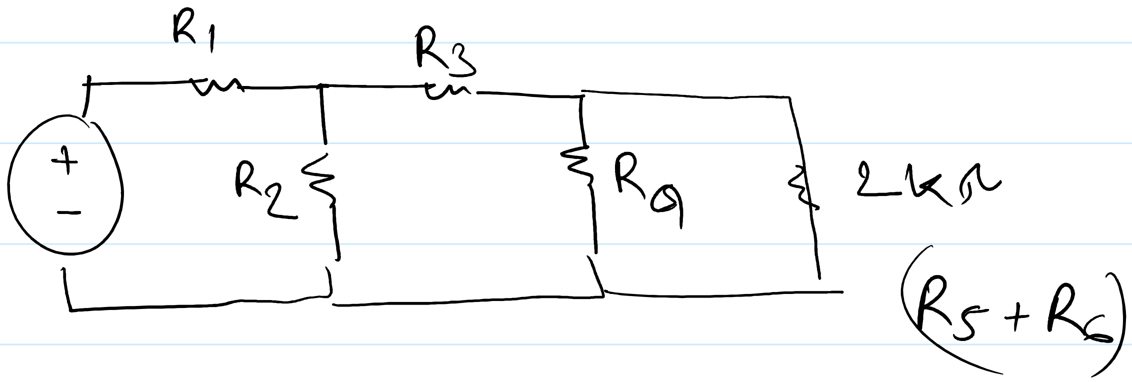
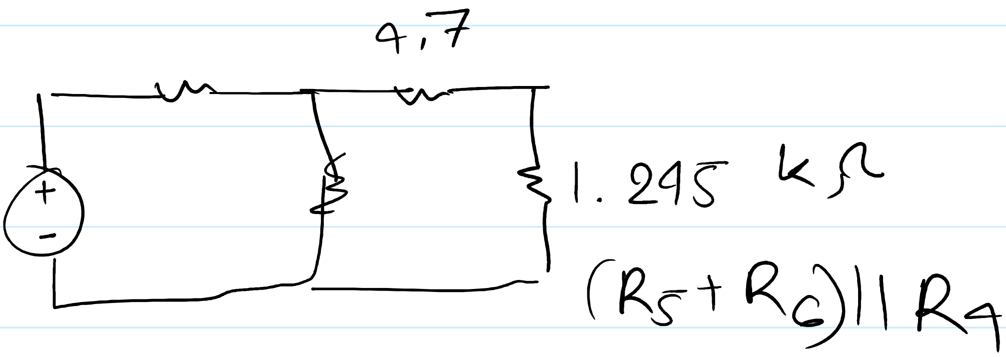
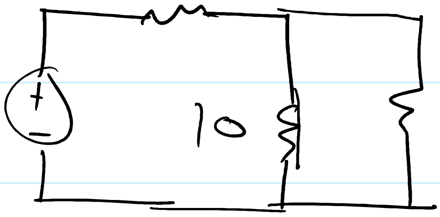
Calculate all the theoretical values for Table 5. Show all steps



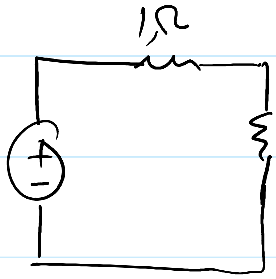






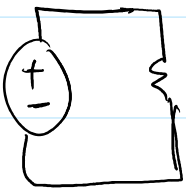
5.945 kΩ

$((R_5+R_6)\,\|\,R_4)+R_3$



3.728Ω

$(((R_5+R_6)\,\|\,R_4)+R_3)\,\|\,R_2$



4.728Ω

$R_{eq} = 4.728\,k\Omega$

$I_1 = I_2 + I_3$

$I_3 = I_4 + I_5$

we get

$I_1 = I_2 + I_4 + I_5$

$$V_1 = \frac{R_1}{R_{eq}} \times 12 = 2.538\,V$$

$$I_1 = \frac{V_1}{R_1} = \frac{2.538}{1} = 2.538\,A$$

$v_2 = E - v_1$ [voltage rule]

$= 12 - 2.538\,v = 9.46\,V$

$$I_2 = \frac{v_2}{R_2} = \frac{9.46}{10} = 0.946\,A$$

$$v_3 = \frac{R_3}{((R_5+R_6) \parallel R_4) + R_3} \times v_2$$

$$= \frac{4.7}{((1+1)^{-1}+3.3^{-1})^{-1}+4.7} \times 9.46$$

$= 7.478\,V$

$$I_3 = \frac{v_3}{R_3} = \frac{7.478}{4.7} = 1.592\,I$$

$v_4 = 9.46 - 7.478 = 1.982\,V$ [voltage rule]

$$I_4 = \frac{v_4}{R_4} = \frac{1.982}{3.3} = 0.601\,I$$

$$V_5 = \frac{R_5}{R_5 + R_6} \times V_4$$

$$= \frac{1}{1+1} \times 1.982$$

$$= 0.991$$

$$I_5 = \frac{V_5}{R_5} = \frac{.991}{1} = 0.991 \text{ A}$$

$$V_6 = V_5 - V_4 = 1.982 - 0.991 = 0.0991 \text{ V}$$

$$I_6 = \frac{R_6}{R_5 + R_6} \times V_4$$

$$I_6 = \frac{1}{1+1} \times 1.982 = 0.991 \text{ A}$$

Table 5:

Component	Voltage	Current mA
E	12	2.538
R1	2.53	2.538
R2	9.46	0.946
R3	7.48	1.592
R4	1.98	0.601
R5	0.99	0.991
R6	0.99	0.991

Discussion:

Form this lab-2 we can have learn How current division rule works Also How kirchhoff's voltage law work, checked its validity with hands on experment. Stated proff form expermental data, and How get voltage and current rating form diagram.

As, it was an online lab, we had to

we multisim to do the experiments. So, we didn't have to face many error

theore...

formulas.
If, we had done the labs offline then we could have faced errors like human errors, lose wiring error, environmental errors, mechanical errors. Also can faces errors using DMM, cables and bread board etc. Because of online we are