CE211-L Circuit Analysis Lab

Lab Report # 5

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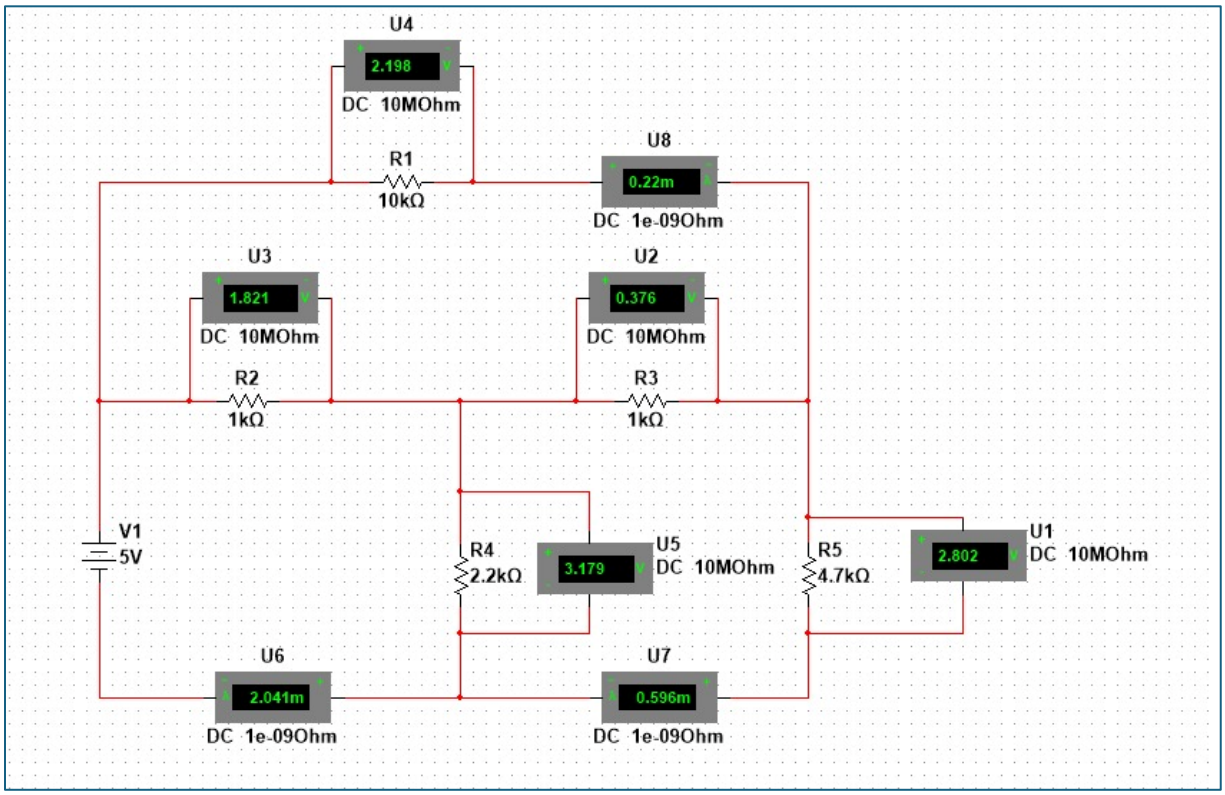
Task Statement:

1. Assemble the circuit in Figure with the component values shown in Table. Take measurements to complete the entries corresponding to the experimental values. (Hardware + Software)



Solution:

Resistor	Parameter	Theoretical	Experimental	% Error
10 kΩ	V_{r1}	2.200 V	2.196 V	0.18 %
1 kΩ	V_{r2}	1.821 V	1.843 V	1.19 %
1 kΩ	V_{r3}	0.376 V	0.38 V	1.05 %
2.2 kΩ	V_{r4}	3.179 V	3.19 V	0.32 %
4.7 kΩ	V_{r5}	2.802 V	2.812 V	0.36 %

Workings:

$$V = IR$$

$$\begin{bmatrix}5\\0\\0\end{bmatrix} = \begin{bmatrix}3.2 & -2.2 & -1\\-2.2 & 7.9 & -1\\-1 & -1 & 12\end{bmatrix}\begin{bmatrix}I_1\\I_2\\I_3\end{bmatrix}$$

Det =

$$\Delta = 3.2 \begin{vmatrix}7.9 & -1\\-1 & 12\end{vmatrix} - (-2.2) \begin{vmatrix}-2.2 & -1\\-1 & 12\end{vmatrix} - 1 \begin{vmatrix}-2.2 & 7.9\\-1 & -1\end{vmatrix}$$

$$\Delta = 3.2[(7.9)(12) - (-1)(-1)] + 2.2[(-2.2)(12) - (-1)(-1)] - 1[(-2.2)(-1) - (7.9)(-1)]$$

$$\Delta = 229.78$$

$$\Delta x = 469.0$$
$$\Delta y = 137.0$$
$$\Delta z = 50.5$$

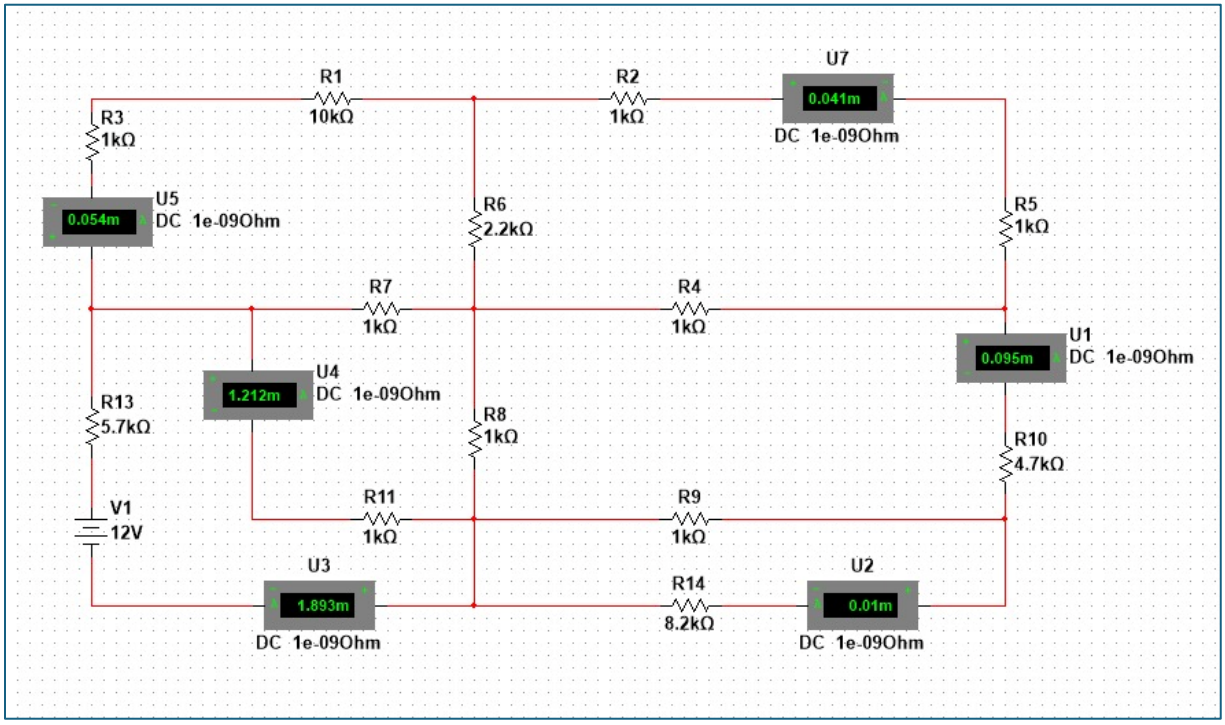
$$x = \frac{\Delta x}{\Delta} = 2.041$$
$$y = \frac{\Delta y}{\Delta} = 0.596$$
$$z = \frac{\Delta z}{\Delta} = 0.220$$

$$I_1 = 2.041,\ I_2 = 0.596,\ I_3 = 0.220$$

Apply Ohm's Law (V=IR)

V_{r1} = 10k (0.220) = **2.20 V**
V_{r2} = 1k (2.041 - 0.220) = **1.821 V**
V_{r3} = 1k (0.596 - 0.220) = **0.376 V**
V_{r4} = 2.2k (2.041 - 0.596) = **3.179 V**
V_{r5} = 4.7k (0.596) = **2.802 V**

2. **Calculate and measure the all-loop currents in the figure below. (Software)**



Solution:

Parameter	Theoretical	Experimental	% Error
I_1	0.051 mA	0.053 mA	3.9%
I_2	0.04 mA	0.041 mA	2.5%
I_3	0.093 mA	0.095 mA	2.1%
I_4	0.01 mA	0.01 mA	0
I_5	1.94 mA	1.893 mA	2.4%
I_6	1.2 mA	1.212 mA	1%

Working:

The equations for the six meshes based on Kirchhoff's Voltage Law (KVL) are as follows:

- 1) $12 + 6.7I_1 - I_3 = 0$
- 2) $9.2I_2 - I_4 = 0$
- 3) $8I_3 - I_1 - I_6 = 0$
- 4) $7.7I_4 - I_2 - I_3 - I_5 = 0$
- 5) $5.2I_5 - I_4 - 2.2I_6 = 0$
- 6) $14.2I_6 - 2.2I_5 - I_3 = 0$

A =
[6.7 0 −1 0 0 0]
[0 9.2 0 −1 0 0]
[−1 0 8 0 0 −1]
[0 −1 −1 7.7 −1 0]
[0 0 0 −1 5.2 −2.2]
[0 0 −1 0 −2.2 14.2]

B = $[12, 0, 0, 0, 0, 0]^T$.

Calculated determinants:
$|A| = 55627.9744$
$|A_1| = -108029.184$
$|A_2| = -8472.884$
$|A_3| = -56259.84$
$|A_4| = -8688.48$
$|A_5| = -3581.856$
$|A_6| = -4516.896$

- $I_1 = |A_1| / |A| = (-108029.184) / 55627.9744 = -1.94$ A
- $I_2 = |A_2| / |A| = (-8472.884) / 55627.9744 = -0.1$ A
- $I_3 = |A_3| / |A| = (-56259.84) / 55627.9744 = -1.2$ A
- $I_4 = |A_4| / |A| = (-8688.48) / 55627.9744 = -0.093$ A
- $I_5 = |A_5| / |A| = (-3581.856) / 55627.9744 = -0.04$ A
- $I_6 = |A_6| / |A| = (-4516.896) / 55627.9744 = -0.05$ A