EE281 EXPERIMENT 1

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22d of October 2020

1 Experimental Work: Theoretical solutions

1.1 Figure 1

Current of the figure 1 is 5A from the formula $\mathrm{V}_1 = I_1 * R_1$.

V_1 = 5V from the voltage supply
5V = $\mathrm{I}_1 * 1k\Omega$
$I_1 = 5mA$

1.2 Figure 2

To apply the formula V = IR, we should find R_{total}. Resistors are connected in series.

$\mathrm{R}_{total} = R_1 + R_2$
$R_{total} = 1k\Omega + 10k\Omega = 11k\Omega$
$5V = I_2 * 11k\Omega$
$I_2 = 0.45454545..m\Omega$
$V_2 = I_2 * R_1 \rightarrow V_2 = 0.\overline{45}mA * 1k\Omega = 0.\overline{45}V$
$V_3 = I_2 * R_2 \rightarrow V_3 = 0.\overline{45}mA * 10k\Omega = 4.\overline{54}V$

1.3 Figure 3

Potential difference between both two resistors are equal to 5V from the KVL.
$\mathrm{V}_4 = 5V$
$V_5 = 5V$
$I_3 = \frac{5V}{1k\Omega} = 5mA$
$I_4 = \frac{5V}{10k\Omega} = 0.5mA$

1.4 Figure 4

R$_{total} = R_1 + \frac{R_2 * R_2}{R_2 + R_2} = R_1 + \frac{R_2}{2} = 1k\Omega + 5k\Omega = 6k\Omega$
$I_5 = \frac{V_{total}}{R_{total}} = \frac{5V}{6\Omega} = 0.8\overline{3}mA$
$V_6 = I_5 * R_1 \rightarrow V_6 = 0.8\overline{3}mA * 1 = 0.8\overline{3}V$
Current will go through both R$'_2s$ equally since resistances of the resistors are the identical.
I$_6 = I_7 = I_{total}/2 = \frac{0.8\overline{3}}{2} = 0.41\overline{6}$
Voltages of the R$'_2s$ will be the same since their currents and resistances are the same from the formula V = IR
V$_7 = V_8 = I_6 * R_2 \rightarrow 0.41\overline{6}mA * 10k\Omega = 4.1\overline{6}V$

1.5 Figure 5

R$_{total} = R_1 + R_2//(R_2 + R_3) \rightarrow R_{total} = R_1 + \frac{R_2 * (R_2 + R_3)}{2R_2 + R_3}$
$R_{total} = 1k\Omega + \frac{10 * (13.3)k\Omega}{23.3} = 6.708k\Omega$
$I_8 = 25v/6.708k\Omega = 3.73mA \rightarrow V_9 = 3.73mA * 1k\Omega = 3.73V$

$After$R$_1$ our voltage drops to $V_{after} = 25V - 3.73V = 21.27V$. By KVL and because of parallel connection, potential difference is the same between R$_2//(R_2 + R_3)$ which is V_{after}.

$I_9 = \frac{V_{after}}{R_2} = \frac{21.27V}{10k\Omega} = 2.127mA \rightarrow$V$_{after} = V_{11} = 21.27V$ since there are no resistors on that branch other than R$_2$.

$I_{10} = \frac{V_{after}}{R_2 + R_3} = \frac{21.27V}{13.3k\Omega} = 1.59mA$

$V_{10} = I_{10} * R_3 = 1.59mA * 3.3k\Omega = 5.28V$

$V_{12} = I_{10} * R_2 = 1.59mA * 10k\Omega = 15.6V$

1.6 Figure 6

To transfer my solution properly I want to call the diamond's left point "c" and right point "d". I'll assign the letter "A" for the current between the nodes "a" and "c", and assign the letter "B" for the current between the nodes "c" and "d" (direction is to the right), and finally assign the letter "C" for the current between the nodes "a" and "d". In this situtation the $current_{cb}$ will be A-B, and the $current_{db}$ will be C+B by KCL.

I will use three loops in order to solve this problem. I will use KVL, hence I will write the equations regarding voltages of resistors. (V = IR) First loop will go through the nodes "a", "c", "b" by order. With this loop we can get this equation:

5 - A -3.3(A-B) = 0 $\rightarrow 4.3A + 3.3B = 5$

Second loop will go through the nodes "a", "d", "b" by order. With this loop we can get this equation:

5 - 10C - 10(C + B) = 0 $\rightarrow 20C + 10B = 5$

Third loop will go through the nodes "a", "c", "d", and "a" again by order. With this loop we can get this equation:

A + 10B - 10C = 0 $\rightarrow 10C = A + 10B$

We have three equations:

4.3A + 3.3B = 5

20C + 10B = 5

10C = A + 10B

After solving the algebraic equations we get:

A = 1.23

B = 0.86

C = 0.2

Since $I_{11} = A + CbyKCL, I_{11} = 0.2mA + 1.23mA = 1.43mA$

V = $I_{11} * Rtotal \rightarrow R_{total} = 5V/1.43mA = 3.49k\Omega$

1.7 Color Codes

Resistors	1st Band	2nd Band	3rd Band	Tolerance
22k	Red	Red	Orange	Silver
3.3k	Orange	Orange	Red	Silver
12k	Brown	Red	Orange	Silver
18k	Brown	Gray	Orange	Silver
1M	Brown	Black	Green	Silver

1.8 SMD Resistors

SMD Resistors	Resistor Value	Method
100	10 ohm	Three Digit Resistor
472	4.7 k ohm	Three Digit Resistor
00R1	0.1 ohm	Resistor with Radix Point
0R2	0.2 ohm	Resistor with Radix Point
1002	10 k ohm	Four-Digit Resistor

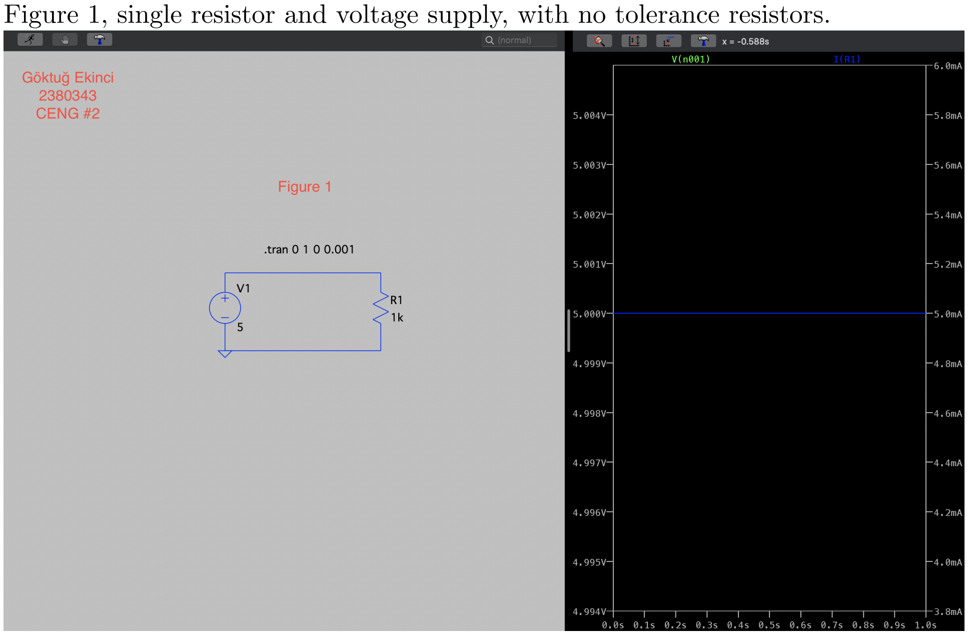
2 Experimental Work: Simulation Solutions

2.1 Figure 1

I set up the circuit with zero tolarence, 1%, 5%, 10% by order as said in the documentation. I set the stop time to 1 second and start time to 0 second, and timestep is 0.001 for all circuits.

2.1.1 (i)

Figure 1, single resistor and voltage supply, with no tolerance resistors.



2.1.2 (ii)

Figure 1 and tolerance is set to 1%

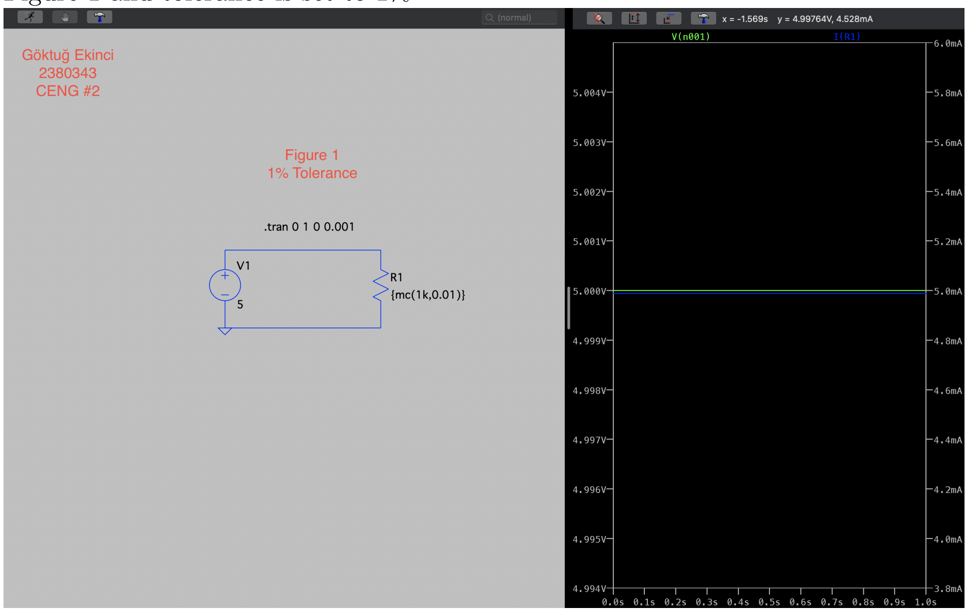


Figure 1 and tolerance is set to 5%

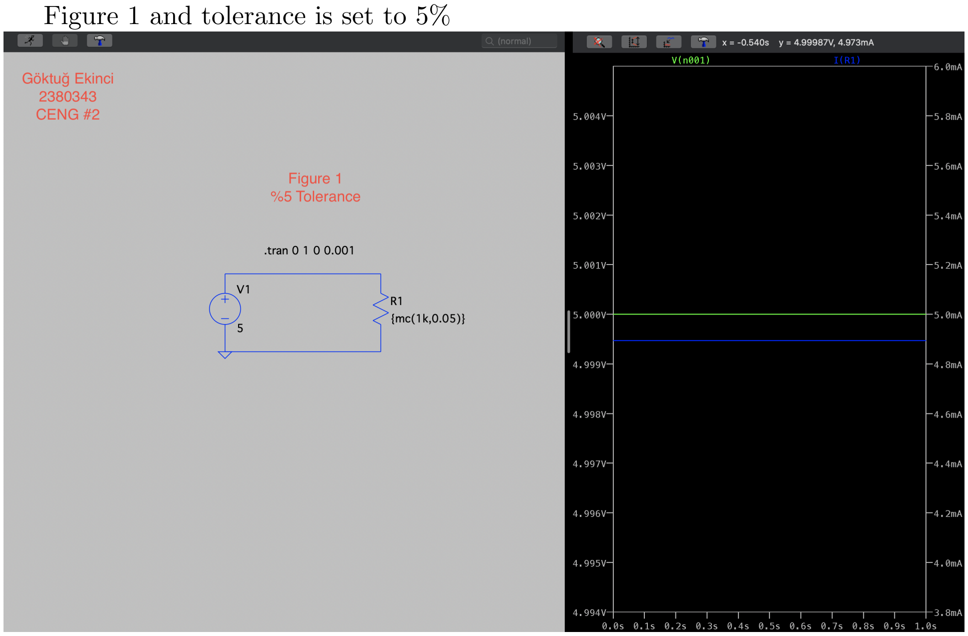
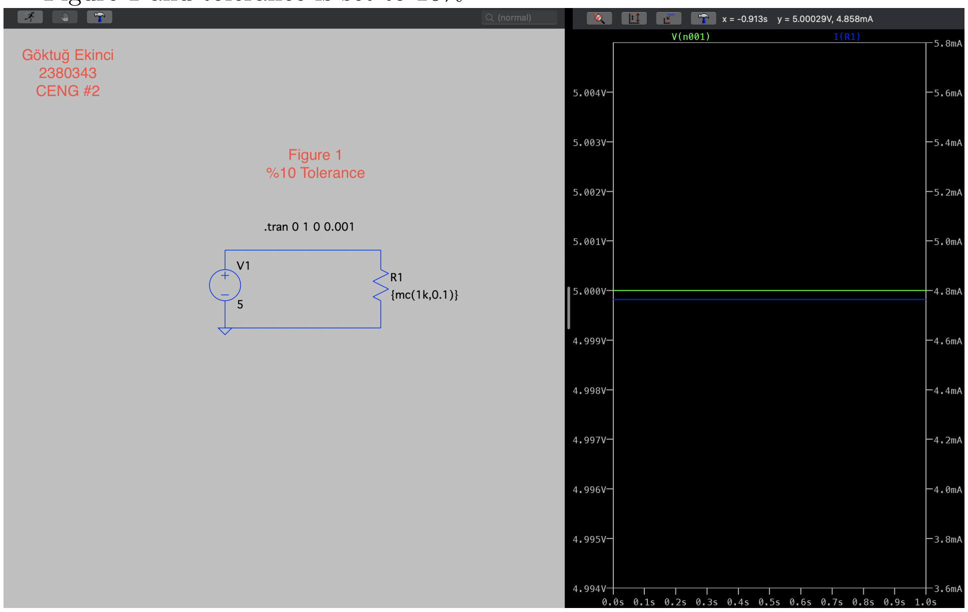
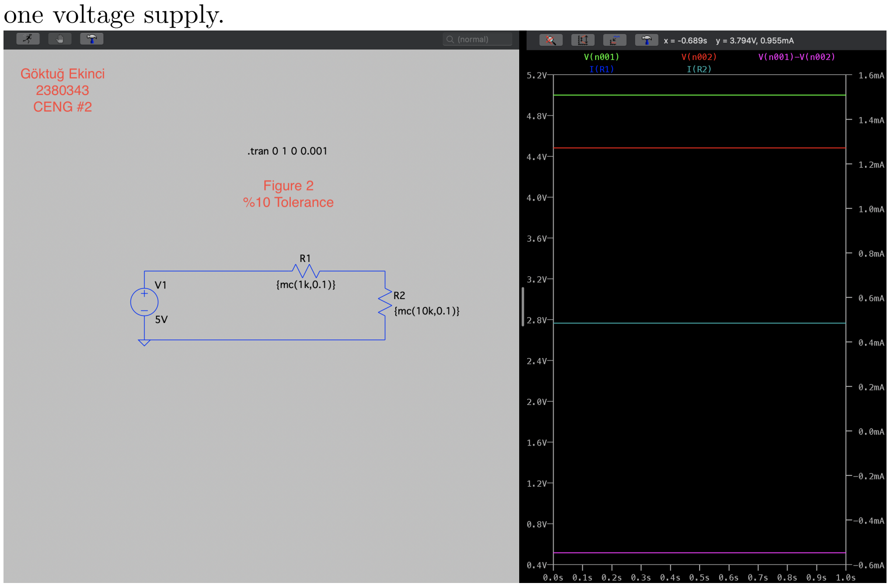


Figure 1 and tolerance is set to 10%



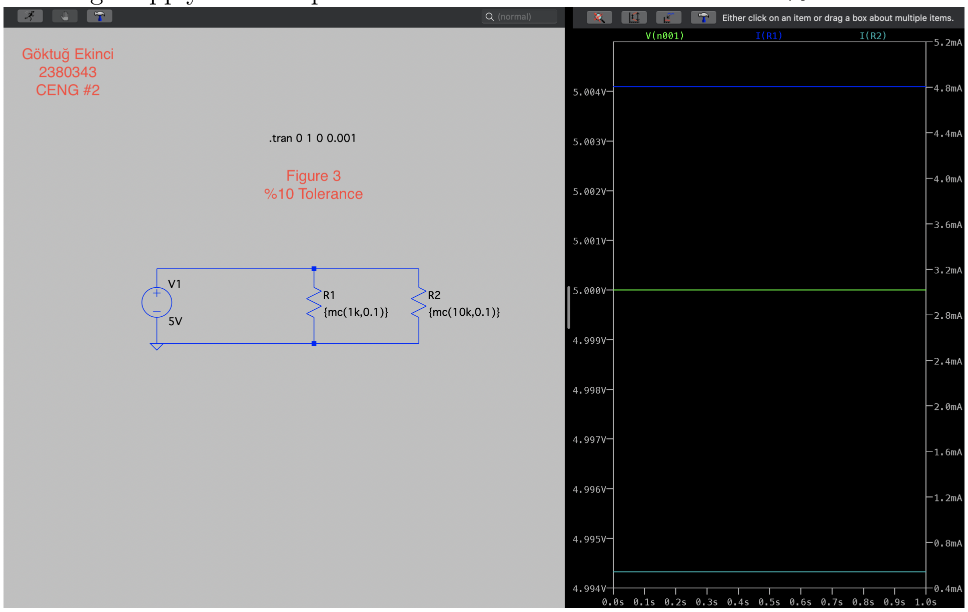
2.2 Figure 2

I used "Add Traces" command to add the plot of voltages of resistors to the graph. I measure the voltage just before the resistors and after the resistors and subtracted them. Tolerances of resistors set to 10%, two resistors in series and one voltage supply.



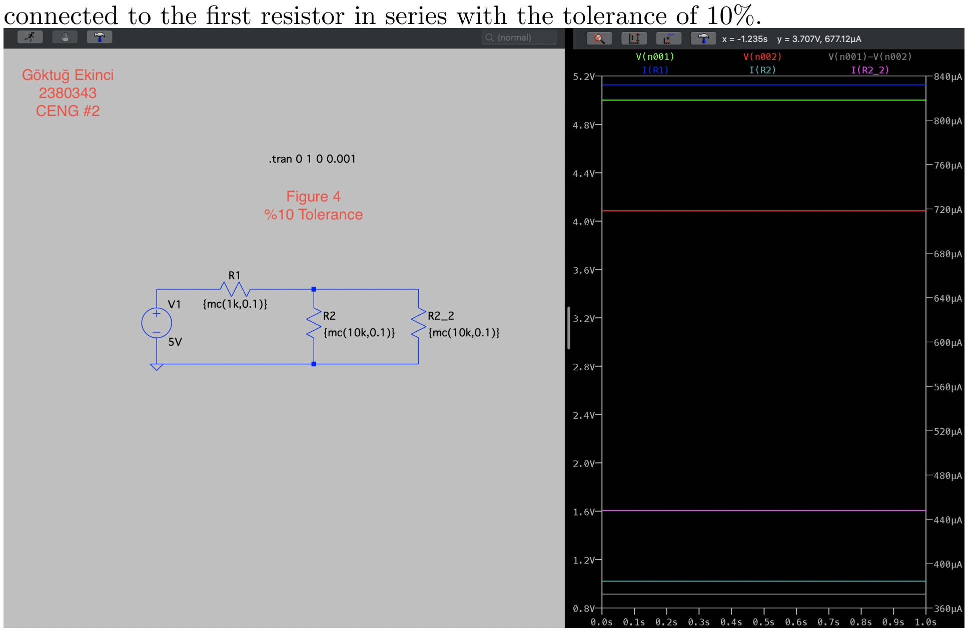
2.3 Figure 3

A voltage supply and two parallel resistors with the tolerance of 10%.



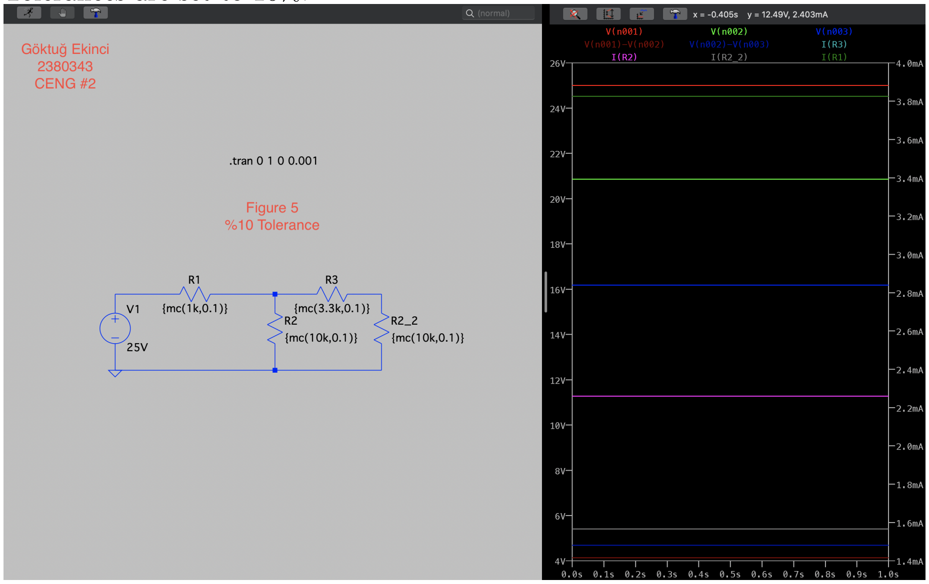
2.4 Figure 4

A voltage supply with 3 resistors which two are connected in parallel and they're connected to the first resistor in series with the tolerance of 10%.



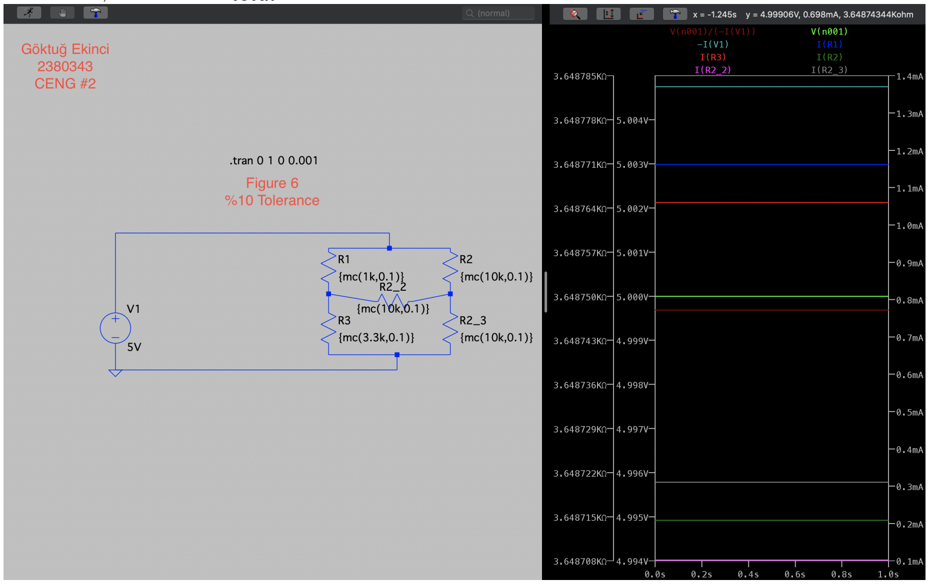
2.5 Figure 5

A voltage supply with 4 resistors their connections is like: $R1+((R3+R2_2)//R2)$. Tolerances are set to 10%.



2.6 Figure 6

The wheatstone bridge simulation circuit with 10% toleranced resistors.I used "Add Traces" method again to add the plotting of R_{total}. I divide the value of V to I11, which is I_{total}.



2.7 Simulation vs Calculated Results

	Voltages				Currents	
	Simulation	Calculated			Simulation	Calculated
V1	5V	5V		I1	4.6	5mA
V2	0.517V	0.46V		I2	0.484mA	0.45mA
V3	4.48V	4.55V		I3	4.81mA	5mA
V4	5V	5V		I4	0.541mA	0.5mA
V5	5V	5V		I5	0.832mA	0.84mA
V6	0.914V	0.84V		I6	0.384mA	0.417mA
V7	4.08V	4.17V		I7	0.448mA	0.417mA
V8	4.08V	4.17V		I8	3.83mA	3.73mA
V9	4.14V	3.73V		I9	2.26mA	2.13mA
V10	4.68V	5.28V		I10	1.57mA	1.59mA
V11	20.9V	21.27V				
V12	16.2V	15.9V				

2.8 Comments

Simulation results were really close to my calculated results. Simulated results are changing nearly in the range of 10% of calculated results since we adjust the tolerance of 10%. Simulations tolerance logic is completely random. Resistances can change randomly from run to run. It was a delightful experience to use LTspice. I had a chance to compare the theoretical and practical solutions of the circuits