EE1002 Lab 1: Kirchhoff's Law (Online)

I.OBJECTIVES

1. To get familiar with the online simulator.
2. To build and simulate the basic DC circuits with the simulator.
3. To find the voltages of a circuit using the Kirchhoff's Voltage Law.
4. To find the currents of a circuit using the Kirchhoff's Current Law.

II. EQUIPMENT AND MATERIALS REQUIRED

1. Computer
2. Browser
3. Online simulator: Circuit-Sandbox (https://spinningnumbers.org/circuit-sandbox/index.html)

III. PROCEDURES

Part A: Kirchhoff's Voltage Law

The Kirchhoff's Voltage Law (KVL) states that the algebraic SUM of the potential differences in any closed loop must be equal to zero, i.e.,

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

1. First pick the resistors and a voltage source from the right column.

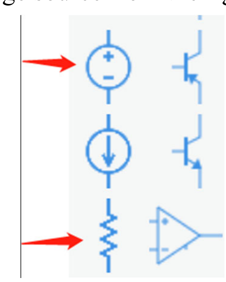
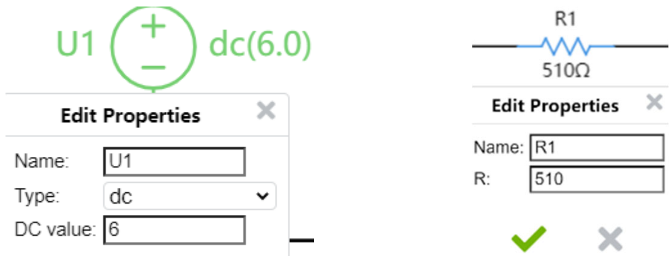


Fig. 1. Voltage source and resistor in the component list.

2. You can rotate the components by using the tool on the left. Double-click them and then you can change their names and values.



(a) (b)

Fig. 2. Settings of (a) voltage and (b) resistor.

3. Place the cursor at the terminal of the components and draw lines to connect the components to the circuit as shown in Fig.3. Remember to include the "ground" which can be found from the right column (see Fig. 4).

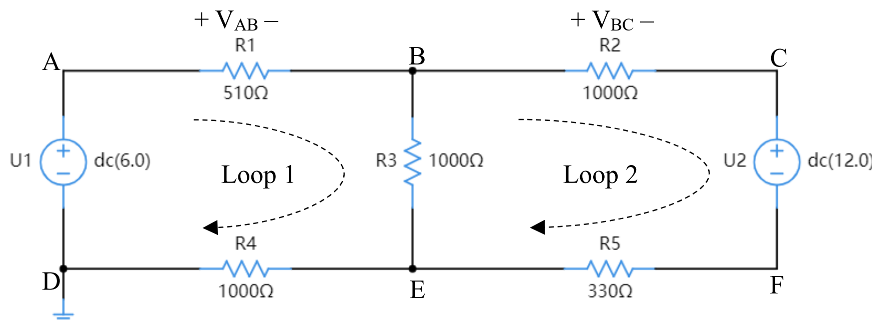


Fig.3. Circuit configuration for the KVL simulation.

Fig. 4. Ground in the component list.

4. Now you can run the simulation by clicking the "DC" icon (see Fig. 5). In the "DC" solver, the simulated results are shown in the circuit directly. Please be careful about the voltage direction in the circuit, e.g., $V_{BE} \neq V_{EB}$.

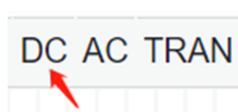


Fig. 5. Start the simulation.

5. Fill in Tables I, II, and III with the calculated and simulated data.

Table I. Loop-1

Voltages (V)	V_{AB}	V_{BE}	V_{ED}	V_{DA}	ΣV
Calculation*					
Simulation**					

Table II. Loop-2

Voltages (V)	V_{BC}	V_{CF}	V_{FE}	V_{EB}	ΣV
Calculation*					
Simulation**					

Table III. Loop-3 (outer loop ABCFEDA)

Voltages (V)	V_{AB}	V_{BC}	V_{CF}	V_{FE}	V_{ED}	V_{DA}	ΣV
Calculation*							
Simulation**							

* *In your Lab Report, you should give full derivations of the calculations.*

** *The simulated results should be shown in the report.*

Part B: Kirchhoff's Current Law

Kirchhoff's Current Law (KCL) states that the algebraic sum of ALL the currents entering or leaving a node must be equal to zero, i.e.,

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

1. Current probes are used to measure the current through the resistors.

Fig. 6. Current probe in the component list.

2. Build the circuit of Fig.7 in the simulator.

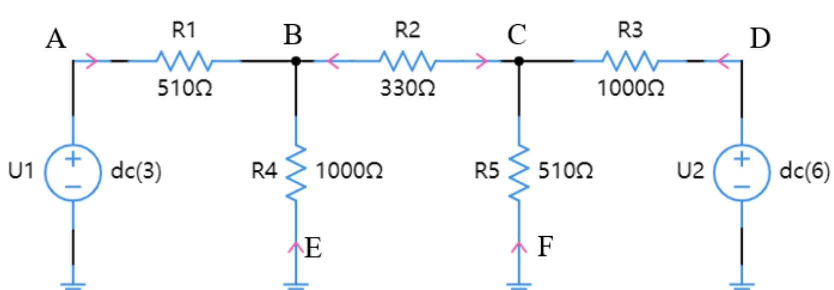


Fig.7. Circuit configuration for the KCL simulation.

3. Run the simulation by clicking the "DC" icon. Please be careful about the current direction in the circuit, e.g., $I_{CB} \neq I_{BC}$

4. Fill in Tables IV and V with the calculated and simulated data.

Table IV. Currents at Node B.

Currents (mA)	I_{AB}	I_{EB}	I_{CB}	ΣI
Calculation*				
Simulation**				

Table V. Currents at Node C.

Currents (mA)	I_{BC}	I_{FC}	I_{DC}	ΣI
Calculation*				
Simulation**				

5. Replace the constant voltage source U2 with a constant current source (see Fig.8), which provides a current of 10mA flowing from the ground to Node D, as shown in Fig. 9. Fill in Tables VI and VII with the new calculated and simulated data.

Fig. 8. Current source in the component list.

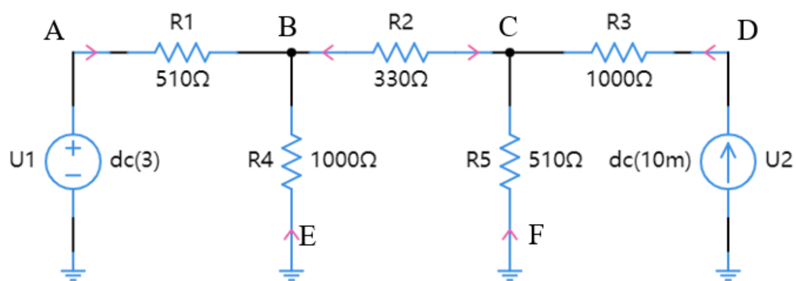


Fig.9. Circuit configuration for the KCL simulation.

Table VI. Currents at Node B.

Currents (mA)	I_{AB}	I_{EB}	I_{CB}	ΣI
Calculation*				
Simulation**				

Table VII. Currents at Node C.

Currents (mA)	I_{BC}	I_{FC}	I_{DC}	ΣI
Calculation*				
Simulation**				

* *In your Lab Report, you should give full derivations of the calculations.*

** *The simulated results should be shown in the report.*

IV. DISCUSSION

1. If you do a real measurement for Part I, should the measured voltages across the resistors be lower or higher than the calculated result? Explain your answer.
2. In Part II, what will happen to the currents of the resistors if the internal resistance of the voltage sources is considered?

V. REFERENCES

1. C. K. Alexander and M.O. Sadiku, Fundamentals of Electric Circuits, 7th Edition, McGraw Hill, 2020.
2. M. O. Sadiku, S. M. Musa and C. K. Alexander, Applied Circuit Analysis, McGraw Hill, 2012.