CS 20 Laboratory 1: Introduction to Electric Circuits

Department of Computer Science
College of Engineering
University of the Philippines - Diliman

1 Using the Falstad Circuit Simulator

For this lab exercise, we will be using a circuit simulator that can be found at `https://www.falstad.com/circuit/circuitjs.html`. This will allow us to create and analyze circuits without having a physical setup.

When you open the website, your browser will look like Figure 1. The menu bar is located at the top. This is where you can access the different commands available in the simulator such as moving, deleting, and adding components. Details about the circuit can be found at the bottom. When you hover over a wire or a component, its properties such as current and voltage will appear. To delete a component, simply hover over it and press `backspace`.

This time, go to the menu bar at the top. Click `Circuits > Basics > Ohm's Law`. Your browser window should look like Figure 2. Try hovering over the resistor at the left. Its properties should appear at the bottom. Here we can see that 50 mA of current is flowing through it and the voltage across the two ends of the resistor is 5 V.

This `video` shows the example circuit being modified to add one more resistor in parallel, as well as connect all the resistors to a single ground. A component can be added by simply selecting it from the `Draw` menu and doing a click and drag across the simulation space. There are also keyboard shortcuts for certain components such as `r` for a resistor and `w` for a wire.

In order to make a connection between wires and components, you need to start from a node and end with a node. This is important as it is a common mistake when using the simulator that you would start a new wire/component in the middle of another wire. This connection will be invalid and will be indicated by a red dot across the ends of the component.

You can also change the values of the resistors. This can be done by double-clicking one of them. A window should appear that lists the resistance value. Finally, try hovering over the 5 V source to see the properties of the circuit as a whole. 35 mA of current flows through a parallel circuit with two $1k\Omega$ and one 200Ω resistors with a 5 V supply voltage.

Finally, you can save a circuit by going to `File > Save As`. A link to download a text file describing the circuit will appear. In the future, if you want to open the circuit again, just load the text file by going to `File > Open File`.

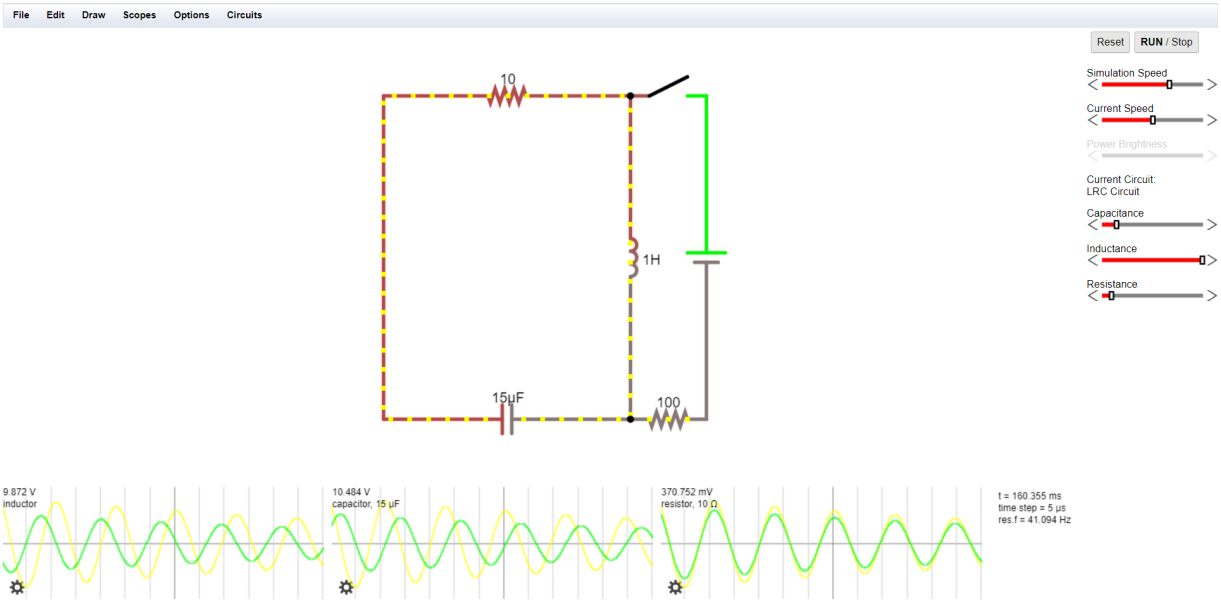

Figure 1: A newly opened simulation

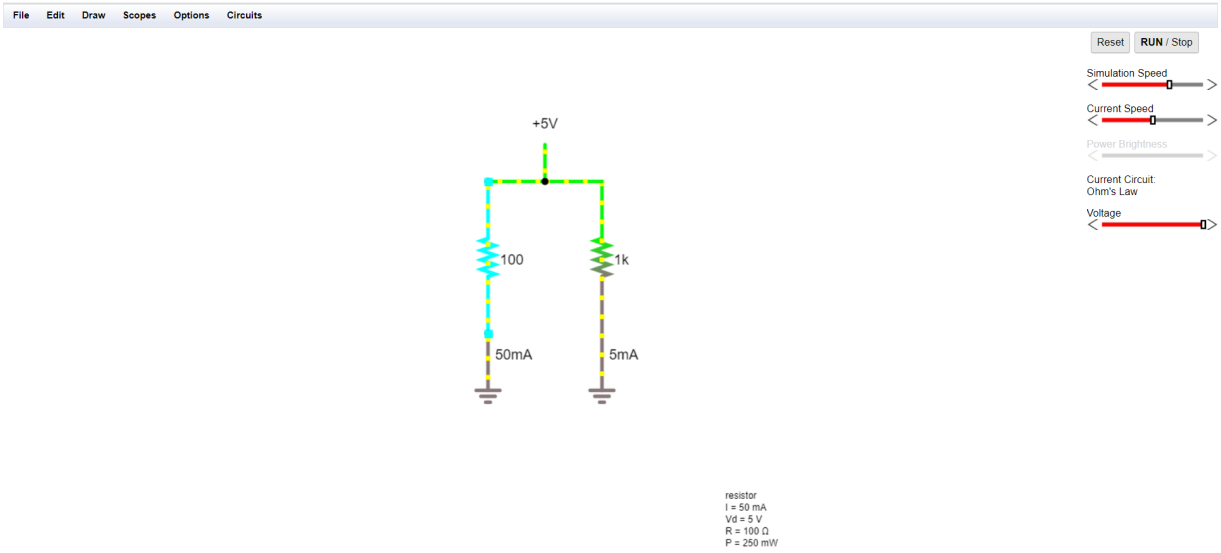

Figure 2: Example circuit

2 Laboratory Exercises

Work on the following laboratory exercises individually.

2.1 Resistor Color Bands

Resistor values are specified via color bands. Each band stands for a numeric digit - the digit then has an interpretation based on its position (first, second, or third). In addition, there are silver and gold bands for specifying tolerance. Identify the theoretical value of a resistor with a given set of color bands in the table below. Refer to Figure 3 for a chart of resistor color bands.

Label	**Resistor Color Bands**	**Computed Resistance**
R1	Brown, Orange, Brown, Gold	
R2	Red, Red, Brown, Gold	
R3	Green, Blue, Brown, Gold	
R4	Brown, Red, Red, Gold	

2.2 Series Circuits

Given the series circuit diagram shown in Figure 4, do the following exercises below. Use $5V$ and the resistor values above for $R1$, $R2$, and $R3$.

1. Compute for the equivalent/effective resistance (R_{eff}) of the resistor network.
2. Compute for the current (i) passing through the entire network.
3. Compute for the voltage across $R1$, $R2$, and $R3$.
4. Implement the given circuit diagram on Falstad.
5. Determine the voltage across each resistor using the simulator.
6. Using the simulator, show that the current passing through each of the resistors are the same.

2.3 Parallel Circuits

Given the parallel circuit diagram shown in Figure 5, do the following exercises below. Use $5V$ and the resistor values above for $R1$, $R2$, and $R3$.

1. Compute for the equivalent/effective resistance (R_{eff}) of the resistor network.
2. Compute for the current passing through $R1$, $R2$, and $R3$.
3. Implement the given circuit diagram on Falstad.
4. Determine the current passing through each resistor using the simulator.
5. Using the simulator, show that the voltage across each of the resistors are the same.

Figure 3: Guide to resistor colors bands

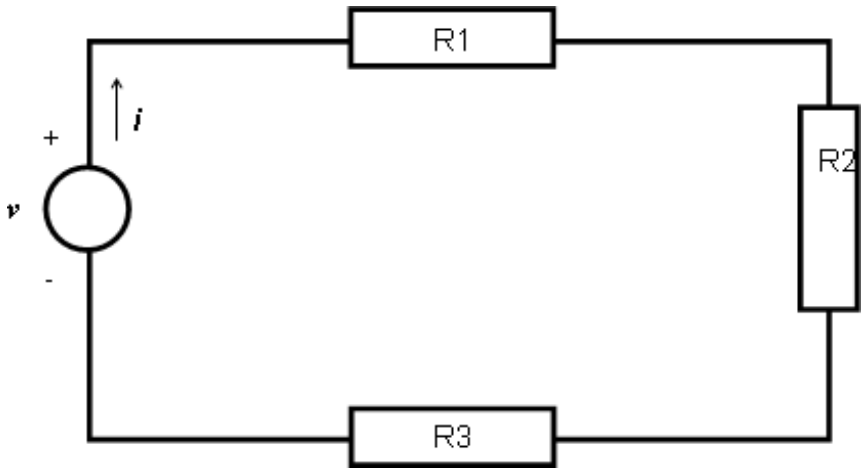

Figure 4: Series circuit

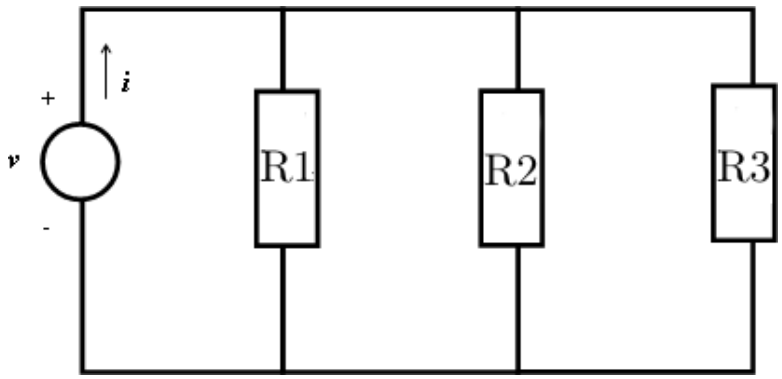

Figure 5: Parallel circuit

3 Laboratory Report

Create the lab report following the specified format and submit it through the UVLê submission module as **cs20labrep1.pdf**. Also include in your submission the text files for both series and parallel circuits as **cs20lab1_2.txt** and **cs20lab1_3.txt**, respectively. **Incomplete submissions will not be checked.** You may submit multiple times before the specified deadline.

Maximum score: 12/12

1. *(2pts)* For the **Resistor Color Bands** exercise, give the *theoretical resistance values* for $R1$, $R2$, $R3$, and $R4$ (0.5 point for each value).
2. *(5pts)* For the **Series Circuits** exercise:
   (a) *(1pt)* Solve for the *effective/equivalent resistance* of the resistor network. Show complete solution. Take a screenshot of the simulator showing that the computed value is correct. (Hint: instead of using individual source and ground components, use the 2-terminal voltage source component in order to be able to get the effective resistance of the entire circuit)
   (b) *(3pts)* Solve for the *theoretical voltage drops* across resistors R1, R2, and R3. Show complete solutions. Take screenshots of the simulator showing that the computed values are correct. (1pt for each resistor)
   (c) *(1pt)* Solve for the *theoretical current through the circuit*. Show complete solution. Take a screenshot of the simulator showing that the computed value is correct.
3. *(5pts)* For the **Parallel Circuits** exercise:
   (a) *(1pt)* Solve for the *effective/equivalent resistance* of the resistor network. Show complete solution. Take a screenshot of the simulator showing that the computed value is correct.
   (b) *(3pts)* Solve for the *theoretical current values* through resistors R1, R2, and R3. Show complete solutions. Take screenshots of the simulator showing that the computed values are correct. (1pt for each resistor)
   (c) *(1pt)* Solve for the *theoretical voltage across the circuit*. Show complete solution. Take a screenshot of the simulator showing that the computed value is correct.

4 Learnings Checklist

In this session you should have learned...

- how to use the Falstad circuit simulator
- how to get the value of a resistor based on its color bands
- how to implement series and parallel circuits