**Datasheet for Lab 3: Series and Parallel Circuits**

Name(s): \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Date: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Approximate time to complete (to 0.1 hours):\_\_\_\_ Lab Kit: \_\_\_\_\_\_\_\_\_

**PRELAB** – Watch the Video: *Overview* which you can find in the [Lab 3 Video Playlist](https://www.youtube.com/playlist?list=PLhNcB8XKcGiK0EjZa2sFA9lJIPvmzUbcr)

**Part 1 - Voltage Divider**

**Two-Resistor Voltage Divider**
Watch the Videos*Measuring Your Skin Resistance*, and *Two-Resistor Voltage Divider*

**Table 1. Resistor Measurements**

|  |  |  |  |
| --- | --- | --- | --- |
| **Name** | **R1** | **R2** | **R3** |
| **Nominal** | **4.7** kΩ | **10** kΩ | **100** kΩ |
| **DMM Ohmmeter** |  |  |  |

 **DMM-Measured value of VIN \_\_\_\_\_\_\_\_\_\_\_**

**Use this value of VIN in your theoretical calculations for Table 2 below.

Table 2. Voltage Divider Theory vs Experiment**

|  |  |  |
| --- | --- | --- |
| **Value Determination** | **VR1** | **VR2** |
| Voltage Divider Formula (use measured VIN & R’s) |  |  |
| DMM Measured |  |  |
| Percent Error (Δ%) |  |  |

Use this formula to compute the percent error:

Δ% = 100x(Valuecalc – Valuemeas)/Valuemeas

If any of your Table 2 percent errors are larger than 5 % you likely have an error in your theoretical predictions or your circuit. Please check your work for errors and correct.

**Lie Detector Circuit**

Resistance of Lab Partner 1\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Resistance of Lab Partner 2\_\_\_\_\_\_\_\_\_\_\_\_\_\_ (or test subject if online)

Resistance of Lab Partner 3\_\_\_\_\_\_\_\_\_\_\_\_\_\_ (if present)

**Table 3. Lie Detector Voltage Measurements**

*Make sure you use R1 =* ***100*** *kΩ for this experiment*

|  |  |  |  |
| --- | --- | --- | --- |
| Test Case | Partner 1Vout | Partner 2Vout | Partner 3 (optional) |
| Open circuit (no hands connected)  |  |  |  |
| Subject connected to circuit (with foil wrapped around first finger of both hands and held with clothespins) |  |  |  |
| Subject telling the truth |  |  |  |
| Subject telling a lie |  |  |  |
| After doing 20 pushups or burpees |  |  |  |

Can you feel the current in your fingers or hands during the test?

**Circuit Verification**

Either have the instructor check off your circuit (classroom) \_\_\_\_\_\_\_\_

Or insert a photo here of your circuit in operation (online)

 **Lie Detector Concept Questions**

1. Describe how the voltage changed during the last three measurements:
2. Why do you think these changes, if any, occurred?
3. Given that Vin = 12V, R1 = 100 kΩ, and R2 = 300 kΩ,
what would be the expected value of Vout?
4. Suppose we hook a subject up to the circuit at R2. What would their skin resistance have to be to get a voltage reading Vout of 5V? Express your work in finding the answer.
5. Apply your formula from 4) to calculate your approximate skin resistance based on the voltage reading you got during your test. What is your calculated resistance?
6. How does your calculated resistance compare to your resistance as measured with the ohmmeter at the start of the lab? What factors can you think of that could explain the difference, if any?
7. Based on your answer for 5, approximately how much current was passing through your body during the test?

**Open and Short Circuits**

1. An open circuit is essentially an air gap between two nodes of a circuit, such that no matter how high the voltage gets (v🡪 ∞), no current flows between the nodes (i=0). According to Ohm’s law, what resistance would this be equivalent to? *(If you’re stuck on how to deal with infinity, use a voltage of a billion volts.)*
2. When nobody is touching the foil pads, we have an OPEN CIRCUIT (air gap) between the pads, shown in the figure below left. Based on your understanding of the resistance of an open circuit, what would the voltage divider formula indicate for Vout in this case? Express your work in finding the answer. *(If you’re stuck on how to deal with infinity, use a resistance R2 of a billion ohms.)*

Confirm whether this is correct by comparing to the Vout measurement in Table I when no one is touching the foil pads. Was the voltage divider formula correct?

  

1. A short circuit is often indicated by a wire connecting two nodes, such that no matter how much current travels through the wire (i🡪 ∞), the difference in voltage potential between the two nodes remains at zero (v=0). According to Ohm’s law, what resistance would this be equivalent to?
2. Suppose we accidentally allow the two foil pads to touch each other. This turns R2 into a SHORT CIRCUIT. Based on your understanding of the resistance of a short circuit, what would the voltage divider formula indicate for Vout in this case? Express your work in finding the answer.

Confirm whether this is correct by measuring Vout when the two foil pads are touching each other. Was the voltage divider formula correct?

1. In your own words, describe how the lie detector circuit works.

**Part 2 - Current Dividers**

1. For the circuit we are simulating, calculate the effective resistance of the three resistors in parallel: \_\_\_\_\_\_\_\_\_\_\_
2. Calculate Is using Ohm’s law: \_\_\_\_\_\_\_\_\_\_\_
3. Use your calculated Is in the current divider equation to find the current in each branch, and enter in the table below. Then confirm your calculations using the ammeter tool in the simulation.

**Table 4. Current Divider Theory vs Experiment**

|  |  |  |  |
| --- | --- | --- | --- |
| **Value Determination** | **IR1** | **IR2** | **IR3** |
| Current Divider Formula |  |  |  |
| Simulation Measured |  |  |  |
| Δ% |  |  |  |

If any of your percent errors are anything other than 0% you likely have an error in your theoretical predictions or your circuit simulation. Please check your work for errors and correct.

1. Comment on the reasonableness of the general pattern of results for all the values:
2. Use the voltmeter to measure the voltage from the top node to the bottom. Why does the simulation show the current flowing up through the resistors when the high potential side (i.e., 10V) is on top ?
3. Add a short circuit to the simulation in parallel to the three resistors and describe the results you get:
4. Why do you think that happens?
5. What does the current divider equation predict for the current through the resistors when there is a short across the circuit?

**Part 3**

**Insert screen captures from your simulated light bulb circuit here.**

1. SWITCH OPEN and Vs ≤2V
2. SWITCH CLOSED and Vs = 1.5V

When you are finished, please estimate the time it took to complete this lab to the nearest 0.1 hours and enter this at the top of the datasheet.