**Datasheet for Lab 5: Nodal and Mesh Analysis**

Name(s): \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Date: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_  
  
Approximate time to complete:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Lab Kit: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Watch the video [Lab 5 Overview](https://youtu.be/9D7c5riABoc)

**Part 1 – Build a Circuit Model**

Step 1 – Paste a Screenshot of your Circuit Simulation Here

Make sure you are also showing the values of node voltages V1, V2 and V3, and currents through R1 - R4. If it’s possible in your simulation software, use a positive current reference direction of rightward and downward. If not, just be aware of possible current sign discrepancies.

**Part 2 – Build the Circuit on your Breadboard**

Steps 2 and 3 – Before building the circuit, measure your resistor and voltage supply values and record in table 1.

**Table 1 – Measured values of Resistors and Voltage Sources**

|  |  |  |
| --- | --- | --- |
| Item | Nominal | Actual |
| R1 | 470 Ohms |  |
| R2 | 220 Ohms |  |
| R3 | 100 Ohms |  |
| R4 | 1000 Ohms |  |
| Vx | 12 V |  |
| Vz | 12 V |  |

Step 4 – Paste your modified circuit simulation (adjusted with actual resistor and voltage values from your actual components) here, still showing V1 – V3 and currents through R1-R4. Whenever we refer to **predicted** values, this is where you should look.

Step 7 – Paste a photo of your actual circuit showing the voltage at V2 here:

Now paste a second photo showing a close-up of your wiring here:

Step 8 – Record the actual node voltages from your breadboard circuit and compute the percent error from the predicted values from your second simulation in Step 4.

**Table 2 – Predicted vs Measured Node Voltages and their Percent Error**

[In the prediction column please enter your modified simulation results from step 4]

|  |  |  |  |
| --- | --- | --- | --- |
| Node Voltage | [from Step 4]  Prediction | Measured in Your circuit | % Error |
| V1 |  |  |  |
| V2 |  |  |  |
| V3 |  |  |  |

If any of your %Errors exceed 2%, please go back and make sure you entered the values from Step 4 in your prediction column (not the original simulation in step 1)

**Table 3 – Predicted vs Inferred Actual Resistor Currents and their Percent Error**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Resistor | Actual R in Table 1 | Voltage Across R in circuit | Calculated  Current from data at left | Predicted Current  from Step 4 | % Error |
| R1 |  |  |  |  |  |
| R2 |  |  |  |  |  |
| R3 |  |  |  |  |  |
| R4 |  |  |  |  |  |

**Part 3 – [OPTIONAL] Build the Circuit on a Virtual Breadboard using TinkerCad**

**You can skip this step. It provides another way to practice breadboarding which may be helpful for those who have issues with the process of laying out a circuit.** If you haven’t used TinkerCad Circiuts yet, you may refer to this brief [video](https://www.youtube.com/watch?v=FNdOJCKoi7Q&feature=youtu.be&t=417) which shows how to build the circuit from Lab 2, and also shows how to measure voltage and current.

Step 11 – Paste your virtual breadboard simulation from TinkerCad Circuits, with a virtual voltmeter showing the voltage at Node 1 and a virtual ammeter showing the current through R4.

**Part 4 – Derive the Circuit Variables using Nodal and Mesh Analysis**

Step 12 and 13 – show your matrices derived from Nodal and Mesh solutions of the circuit. A work area to develop these solutions is provided in Part 4 of the Lab 05 handout.

**Table 4 – Nodal and Mesh Analysis Results**

|  |  |
| --- | --- |
| Nodal Analysis  A Matrix  b Matrix  V1 =  V2 =  V3 = | Mesh Analysis  A Matrix  b Matrix  Ia =  Ib =  Ic = |

Step 14 – **Postlab Questions**

1. Nodal Analysis involves computing the voltage potential of a node *relative to a chosen reference node, which is assigned the value 0V*. It’s important to realize that the choice of reference node is arbitrary – choosing a different reference node will result in a different set of node voltages. That’s because the + and – we use to label any voltage always refers to a *difference in voltage* between the + and – terminals.

For example, suppose we had chosen V1 to be the reference node. The new node voltage for V1 would now be 0V. But what would the new node voltage for V2 be? (Hint - Think about what the voltmeter would read if you connected the common (black) lead to V1 and the red lead to V2.)

What would we have determined the new V2 to be?

What would we have determined the new V3 to be?

What would the voltage of our previous reference node now be?

You don’t have to redo the nodal analysis to answer these questions.

1. Which resistor is dissipating the most power, and how much power is it dissipating?

If all of the resistors are rated for ½ W, are we exceeding the power limit of any of the resistors?

1. Suppose we had only performed mesh analysis. Show at least 2 ways that we could derive the node voltage V2, using KVL and your mesh currents.

1. We can measure the current Ic using an ammeter in series with R4. Is there any way we can physically measure the mesh current Ib? If so, how? If not, why not?
2. Which was easier to perform on this circuit, nodal, or mesh analysis?
3. What is a node voltage?
4. What is a mesh current?

When you are finished, please estimate the time it took to complete Parts 1-4 of this lab to the nearest 0.1 hours and enter this at the top of the datasheet.

**Part 5 – [Optional] Challenge**

Insert a circuit simulation showing the node voltages for the challenge circuit here.

Insert your derived Nodal and Mesh results here.

|  |  |
| --- | --- |
| Nodal Analysis  A Matrix  b Matrix  Vx =  V1 =  V2 = *[should be -162.78 V]* | Mesh Analysis  A Matrix  b Matrix  Ia = *[should be -12.52 mA]*  Ib =  Ic = |