**ECEN 214 - 302**

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1. **Procedure**

Create the circuit shown in Figure 3.3. With the AD2 as the a voltage source and two 1.5 V AA in series as the other voltage source, measure the voltage across the 1 kilo ohm resistor using the AD2. Once this value is recorded remove the second voltage source and use a jumper wire to short the circuit leaving only the first voltage source active. Remeasure the voltage across the 1 kilo ohm resistor and record the value. Connect the second voltage source and remove the first voltage source. Shorting the circuit with a jumper wire, measure the voltage across the 1 kilo ohm resistor and record the value.

With the values for the linear circuit found, construct circuit 3.4, by adding the 1N4148 diode to the circuit in Figure 3.3. With this new circuit repeat the step of measuring the voltage across the 1 kilo ohm resistor when both voltages are present, when only first voltage is present, and finally when only the second voltage is present. Record all three of these values.

1. **Data tables with results**

| Parameter | Measured | Calculated | % Diff (Calc to Measured) | Spice | % Diff (Spice to Measured) |
| --- | --- | --- | --- | --- | --- |
| VL | -0.692 V | -0.265 V | 89.237 % | -0.265 V | 89.237 % |
| VL,1 | 0.137 V | 0.291 V | 71.963 % | 0.291 V | 71.963 % |
| VL,2 | -0.751 V | -0.556 V | 29.769 % | -0.556 V | 29.769 % |
| VL,1+VL,2 | -0.614 V | -0.265 V | 79.408 % | -0.265 V | 79.408 % |

**Figure 1: Task 1 Data**

| Parameter | Measured | Calculated | Spice | % Error |
| --- | --- | --- | --- | --- |
| VL | 0.008 V | 0.001 V | 0.001 V | 700 % |
| VL,1 | 0.086 V | 0.161 V | 0.161 V | 46.716 % |
| VL,2 | **-**0.004 V | -0.002 V | -0.002 V | 100 % |
| VL,1+VL,2 | 0.509 V | 0.671 V | 0.671 V | 24.143 % |

**Figure 2: Task 2 Data**

1. **Sample calculations**

**Equation 1**

The above equation was used to calculate the % Difference in the tables above.

**Equation 2**

The above equation was used to calculate the % Error Figure 2.

1. **Discussion**

As one can tell from the data table for task 1, the measured data does not have a strong correlation with the calculated and spice data. This can be due to the fact that the two 1.5V AA in series did not provided a constant 3V input. Both batteries ranged from approximately 2.8 V to 3.1 V. However, to test if superposition applied to the measure circuit one can compare the VL and the VL1+ VL2 values for the measured data. When finding the difference between these two value one gets: 11.944%. The low difference value shows that superposition applies to the circuit designed in Task 1. Using the calculated and Spice values show this principle better as the 3V voltage source is constant. According to this data whether you analyze the circuit with both voltage sources together or sum the voltages across the resistor from each voltage source separately, the same voltage appears. This is because all elements in the circuit are linear, so the circuit is linear.

As one can tell from the data table for task 2, the superposition principle does not work for task 2. The 1 kilo ohm resistor has a voltage of 0.008 V when both voltage sources are present. However, the voltage that results from analyzing both voltage sources separately and adding the contributions together is 0.509 V, which is a significantly different result. Superposition does not work because the diode is a non-linear element, which means the circuit is not linear.

A resistor is a linear element because the current is always linearly related to the voltage by a slope that is equal to (1/R), where R is the resistance of the resistor. However, the diode does not exhibit the same linear relationship between current and voltage. An ideal diode allows current to flow in one direction only. This results in the diode have two modes depending on the voltage. The diode must have a voltage applied across it equal to or greater than the forward-bias voltage. Any voltage below the diode’s forward bias voltage will either cause no current through the diode or a very small negative current. However, once the forward-bias voltage is exceeded, there is an exponential relationship between the diode current and voltage. Thus, there is not a linear relationship between the diode’s current and voltage, so the diode is a nonlinear element.