Lab 3: Equivalent Networks and Superposition

ECEN 214 - 517
TA: Saad Muaddi
Date Performed: September 29, 2020
Due Date: September 30, 2020

Procedure

Task 1

For the first task, the students were asked to verify the Thévenin equivalent circuit that was developed based on the Prelab calculations. To successfully perform this part of the lab the students must take the measurement of the current through and the voltage across the load resistor. It also suggested we measure the open-circuit voltage and short circuit current of the circuit to find the equivalent resistance. We utilized the DMM to take the measurements and connected the meter in a parallel circuit for voltage measurement and in a series circuit for the measurement of the current. To calculate the circuit's current we can remove the load resistor.

Task 2 & 3

Starting with task 2, the students verified the superposition principle by taking the measurements that were analyzed in the prelab calculations and comparing the two results. First, we measured the current through a 1K-Ohm resistor to find I. Then by removing V_2, we were able to take another measurement of the current to find I_1. Repeating that step, we replaced V_2, then took the measurements of the second current I_2. Then for task 3, we were once again verifying the superposition principle but for non-linear devices, which was done using a diode. We began with measuring the current through the 1k-Ohm resistor, in order to find the current and both the voltages. Repeating the exact steps for task 2 we measure I_1 and I_2, with the absence of V_1 and V_2.

Data Tables

Task 1

	Measured Value	**Calculated Value**	**% Diff**
$\mathbf{I_L}$	1.14 A	1.12 A	1.77%
$\mathbf{V_L}$	2.41 V	2.37 V	1.67%
$\mathbf{V_{OC}}$	4.78 V	4.56 V	4.7%
$\mathbf{I_{SC}}$	2.35 A	2.19 A	7.04%
$\mathbf{R_{eq}}$	2.03 Ω	2.08 Ω	2.43%

Task 2 & 3

Parameter	Measured (V)	Calculated	% difference	Simulated (V)	% difference (Simulated to measured)
V_L	1.78	1.78	0	1.78	0
$V_{L,1}$	2.54	2.54	0	2.54	0
$V_{L,2}$	-0.76	-0.76	0	-0.76	0
$V_{L,1+L,2}$	1.78	1.78	0	1.78	0

Parameter	Measured (V)	Calculated	Simulated (V)	% Error
V_L	1.56	1.56	1.56	0
$V_{L,1}$	2.32	2.32	2.32	0
$V_{L,2}$	0.00	0.00	0.00	0
$V_{L,1+L,2}$	2.32	2.32	2.32	0

Sample calculations

Task 1

For the first task, we set up Kirchhoff's law equations to solve for the unknowns, and simply the circuit to its Thevenin's equivalent and then found the current by dividing V_2 by the series resistance. To solve for R_{eq} we used V_{OC} / I_{SC}, and we got 2.08 Ω.

Task 2 & 3

For the second and third tasks, we utilized the circuit without both voltage sources and, and them individually. To work through the circuit we utilize Kirchhoff's law equations to find the unknown currents. For the diode, the voltage drop can be the max value or no change in the voltage at all. In our case, the simulation showed that there is no voltage drop.

Formulas:

The % difference calculations:

%diff = |Pspice value - Measured value| / [(Pspice value + Measured value)/2]*100

The % error calculations:

% error = |Pspice value - Measured value| / (Pspice value) *100

Discussion

Task 1

The data, collected on multisim, between the measured values and calculated were somewhat close to each other, as the values were pretty close to each other. While the percent error wasn't super small, it was relatively low. Much of the error can be attributed to the voltage source, which was 3 V in the calculations and 2.93 V when measuring. We can infer based on these calculations, that the values from the measured values and calculated match to be $R_{eq}=R_{th}$.

Task 2 & 3

In Task 2, the total voltage V_L through the 1 kΩ resistor is shown to be the sum of the individual voltages through the resistor, as measured with each of the resources removed one at a time. In other words, it is equal to the sum of the voltage through it with the 9V source removed and the voltage through it with the 3V source removed.

The reason superposition works in Task 2 and not Task 3 is because the diode in Task 3 only allowed current to flow in one direction. In Task 2, without the diode, the current flows through the 1 kΩ resistor in both directions; however, with the introduction of the diode, the current can only flow one way, resulting in no current flowing through the 1 kΩ resistor when measured with only the 3V source. When measured with only the 3V source, the current flow in the opposite direction allowed by the diode, as shown in the equivalent part of Task 2.

It should be noted that Tasks 2 and 3 were performed entirely in Multisim due to a lack of the necessary parts. Therefore, the measured, simulated, and calculated values are identical because these tasks were performed in an ideal environment.