CS 20 Laboratory 2: Application of Kirchhoff’s Laws

1. KCL and KVL Exercise
2. Enumerate all effective nodes of the circuit; include all components connected to each node.

Let us denote the effective nodes in the circuit as follows:

Node A

Node B

Diagram

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Node D

Node C

*Figure 1: Visualization of effective nodes*

The components of each node are:

* Node A – 5V voltage source, 100 Ω resistor, and 270 Ω resistor
* Node B – 270 Ω resistor, 470 Ω resistor, 220 Ω resistor, 390 Ω resistor, and 560 Ω resistor
* Node C – 5V voltage source, 100 Ω resistor, 220 Ω resistor, and 180 Ω resistor
* Node D - 180 Ω resistor and 390 Ω resistor

1. Fill up the table below. Show relevant equations as well as screenshots from Falstad showing that your calculations are correct:

|  |  |  |
| --- | --- | --- |
| **Element** | **Voltage across** | **Current through** |
|  | 5V |  |
|  |  |  |
|  |  |  |
|  |  |  |
|  |  |  |
|  | 0 V | 0 A |
|  | 0 V | 0 A |
| Source | 5V |  |

Solutions:

In order to obtain the desired quantities, we must simplify the circuit. We can neglect and already because they do not affect the circuit and have no current.

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As shown in figure 1,  and are in series so we can simplify their resistance. Let be their simplification given by

Furthermore, and are in parallel so we can further simplify them. Let be their simplification given by

Now and are in series so we can further simplify them. Let be their simplification given by

Finally, and will be left in parallel with the source. This is the simplified version of the circuit.

* For and source

Since it is in parallel with the voltage source, by KVL, the voltage is also 5V. Using Ohm’s Law,

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Furthermore, by KCL, we can add the current of and

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* For

Similarly, is in parallel with the voltage source so by KVL, its voltage is also 5V. Since it is the simplification of and in series, we can use voltage division such that

Using Ohm’s Law,

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* For

is in series with so by KCL, they have the same current. Furthermore, it is also the simplification of and in parallel, so by KVL, both have the same voltage as , which can be obtained using Ohm’s Law

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* For and

is in parallel with so by KVL, they have the same voltage. Furthermore, it is also the simplification of and in series, so by KCL, both have the same current as , which can be obtained using Ohm’s Law

Since they are in series, they will have different voltages

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1. Are there any resistors in which no current passes through? Identify which resistor(s), if any. Why is there no current passing through the said resistor(s)?

Yes, and does not have any current passing. As shown in figure 1, is connected to a single node such that both its terminals are connected to only one node. This is also the case for . Since these resistors just loop at a single node, and is neither in parallel nor in series, we can neglect them as they do not affect the circuit.

1. Equivalent Resistors exercise
2. Show a screenshot of your implementation of the circuit in Falstad.

Graphical user interface

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*Figure 2: New Circuit Implemented in Falstad*

1. Prove using resistor collapsing that your implementation has an equivalent resistance of about 88.7Ω. Include step-by-step equations and screenshots.

Diagram

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*Figure 3: Visualization of nodes of new circuit*

As shown in the figure above (fig 3), and are in series while and are in parallel. We can get the equivalent of these resistors as and , respectively.

A picture containing line chart

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and are in series so we can get their equivalent

Diagram

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and are in series so we can get their equivalent

Chart, line chart

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and are in series so we can get their equivalent

Diagram

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Finally, and are in series so we can get their equivalent which is the equivalent resistance of the whole circuit

Therefore, the equivalent resistance of the circuit is about

Q.E.D.

1. From the equations gathered in the previous item, show that the current supplied by the 5V source is about

To get the current supplied by the source voltage, we use Ohm’s law

where is the equivalent resistance of the circuit computed from the previous item,