PS2: More Resistors

Tuesday, February 16, 2021 4:23 PM

PS2_ More Resistors

PSet 2: Resistors in Series and Parallel

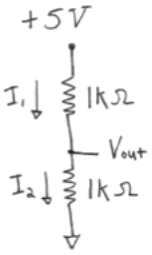
Goal: Learn how the total resistance changes when resistors are wired in series and in parallel.

Learning objectives

- Use your power supply and breadboard to construct resistor circuits;
- Apply Ohm's law to a DC circuit;
- Contrast theoretical voltages with measured values;
- Compute the equivalent resistance of resistors wired in series and parallel;
- Operate a potentiometer

Just fill in your results on this worksheet (or rewrite) and scan your handwritten work in. Again, these types of assignments are simply checked for completeness.

1) For the following circuit,



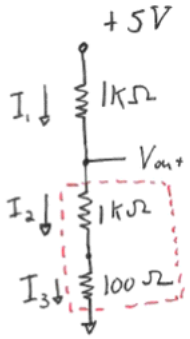
What kind of circuit is this?

Series Voltage Divider

Please list the following (with units). V_{out} should be measured* relative to ground.

- Vout (theory) = 5V
- Vout(measured) = 2.57V
- I_1 (calculated)= I_2
- I_2 (calculated)= $\frac{V}{R_{total}} = \frac{5V}{2000\Omega} = 0.0025A$

2) For the following circuit,



Please list the following (with units).

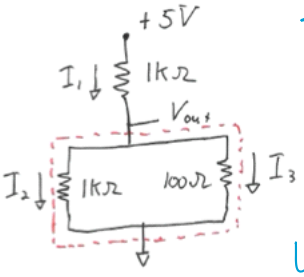
- Vout (theory) = $5V \cdot \frac{1.1k\Omega}{2.1k\Omega} = 2.619V$
- Vout(measured) = $\rightarrow 2.69V$
- I_1 (calculated)= $I_2 = I_3$
- I_2 (calculated)= $I_1 = I_3$
- I_3 (calculated)= $\frac{5V}{100\Omega} = 0.0238A$

3) For the previous circuit, we redraw with an equivalent circuit as follows:

What is the value of a resistor that is the equivalent to the resistors in series (the red branch in question 2), R_{eq}?

1100Ω

4) For the following circuit,



$I_1 = 0.0046A$

$R = \frac{1}{\frac{1}{1000} + \frac{1}{100}} = 90.90\Omega$

$V_{out} = 5V \cdot \frac{90.90\Omega}{1090.90\Omega} = 0.42V$

- Vout (theory) = 0.42V
- Vout(measured) = 0.413V
- I_1 (calculated)= 0.0046A
- I_2 (calculated)= 0.00042A
- I_3 (calculated)= 0.0042A

$I_2 = \frac{0.42V}{1000\Omega} = 0.00042A$

$I_3 = \frac{0.42V}{100\Omega} = 0.0042A$

5) For the circuit in 4), we redraw with an equivalent circuit as in 3). What is the value of R_{eq} that replaces these resistors in parallel (i.e., those in the red, dashed box)?

90.90Ω

6) Redo problem 4 replacing the 100 ohm resistor with 100 K.

- Vout (theory) = 2.49V
- Vout(measured) = 2.56V
- I_1 (calculated)=
- I_2 (calculated)= 2.49e-3
- I_3 (calculated)= 2.49e-5

$5V \cdot \frac{990.099}{1990.099}$

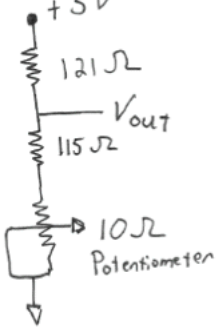
$R = \frac{1}{1/1000 + 1/100000} = 990.099$

$\frac{5V}{1990.099} = 0.0025$

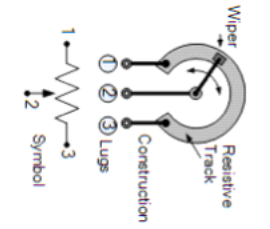
$I_2 = \frac{2.49V}{1000\Omega} = 0.00249A$

$I_3 = \frac{2.49V}{100K} = 2.49e-5$

7) Build the following circuit using a 10 ohm potentiometer (variable resistor). Note that the potentiometer has three terminals and we are connecting 2 to 3.



The potentiometer resistance from pin 1 to 3 is 10 Ohms.



Schematic: https://www.electronics-tutorials.ws/resistor/potentiometer.html

What are the minimum and maximum values for $R_{1\ to\ 2}$?

Min: 0, Max: 10Ω

What is the maximum and mininum value of V_{out}?

Schematic: https://www.electronics-tutorials.ws/resistor/potentiometer.html

- V_{out} (theory) maximum = 2.54V minimum = 2.44V
- V_{out} (measured) maximum = 2.62V minimum = 2.52V

Max R:

$V_{out} = 5V \frac{125}{246} = 2.54V$

Min R:

$V_{out} = 5V \frac{115}{236} = 2.44V$