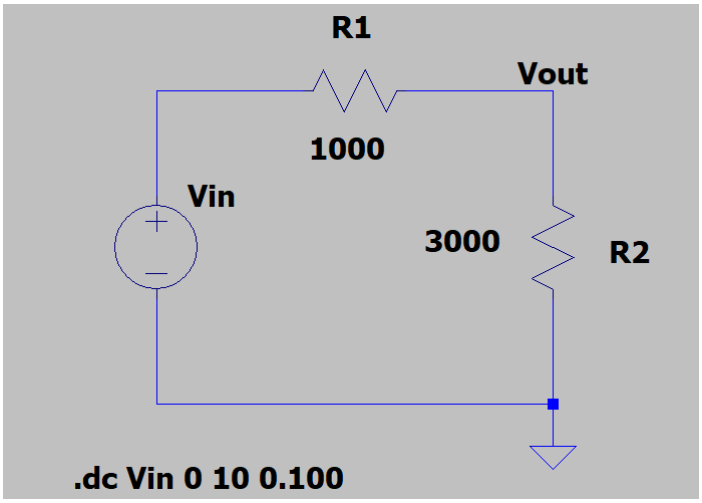
ELEN 115L Lab Report 1: Circuit Analysis using LTSpice

Matt Tognotti
Mulia Widjaja
5 April 2023
ELEN 115L Section Wednesday 2:15 pm

Lab objectives

- Become familiar with LTSpice
- Use LTSpice to simulate and analyze a voltage and current divider
- Construct a voltage divider and take measurements

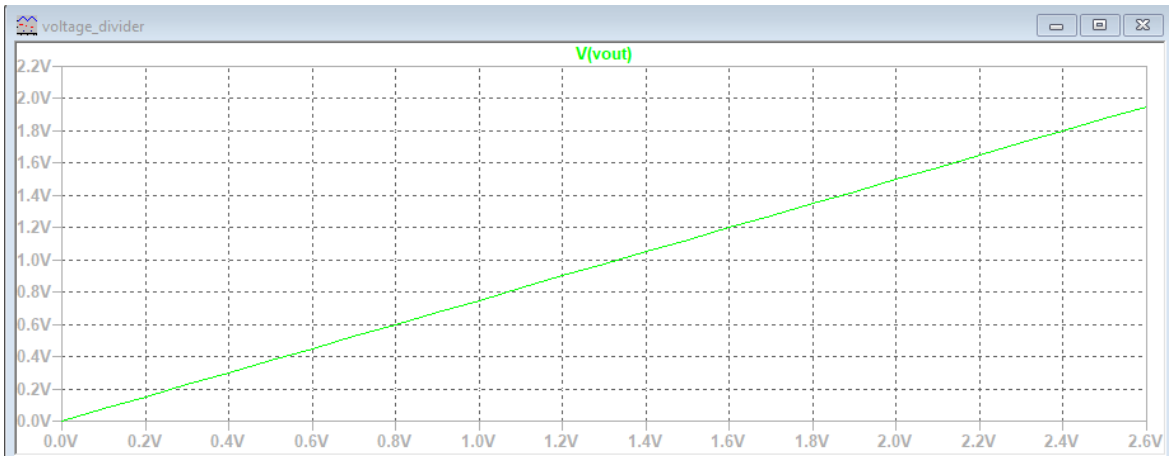
Part 1: Schematic



Voltage Divider

Part 2: DC Analysis

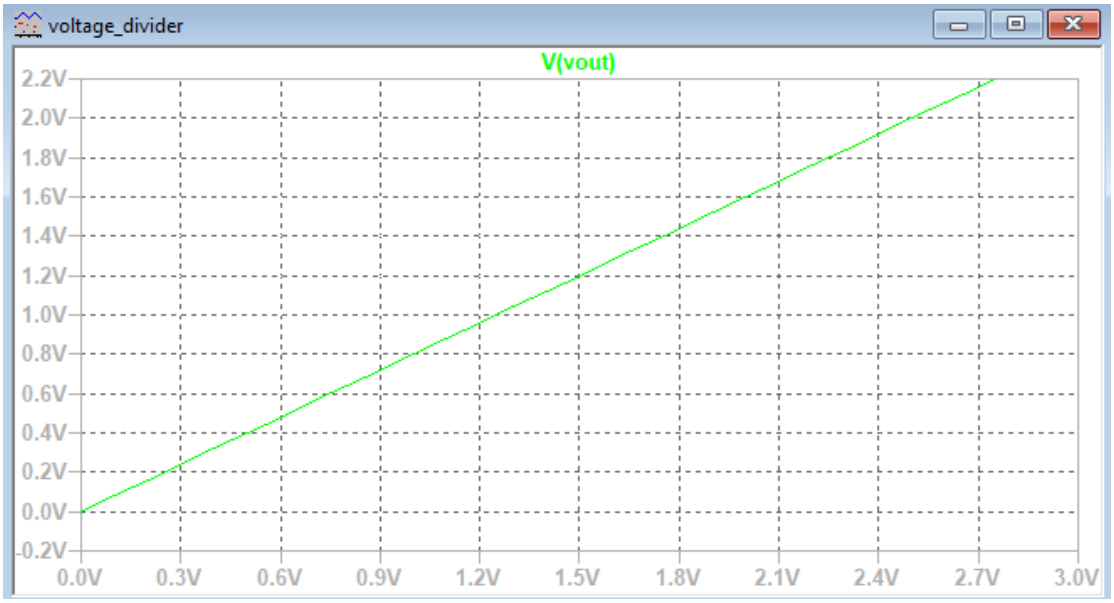
- DC Sweep simulation on Vin from 0V to 10V in 100mV increments shown below.
- The plot is of Vin on the x-axis and Vout on the y-axis



Vin vs Vout for voltage divider

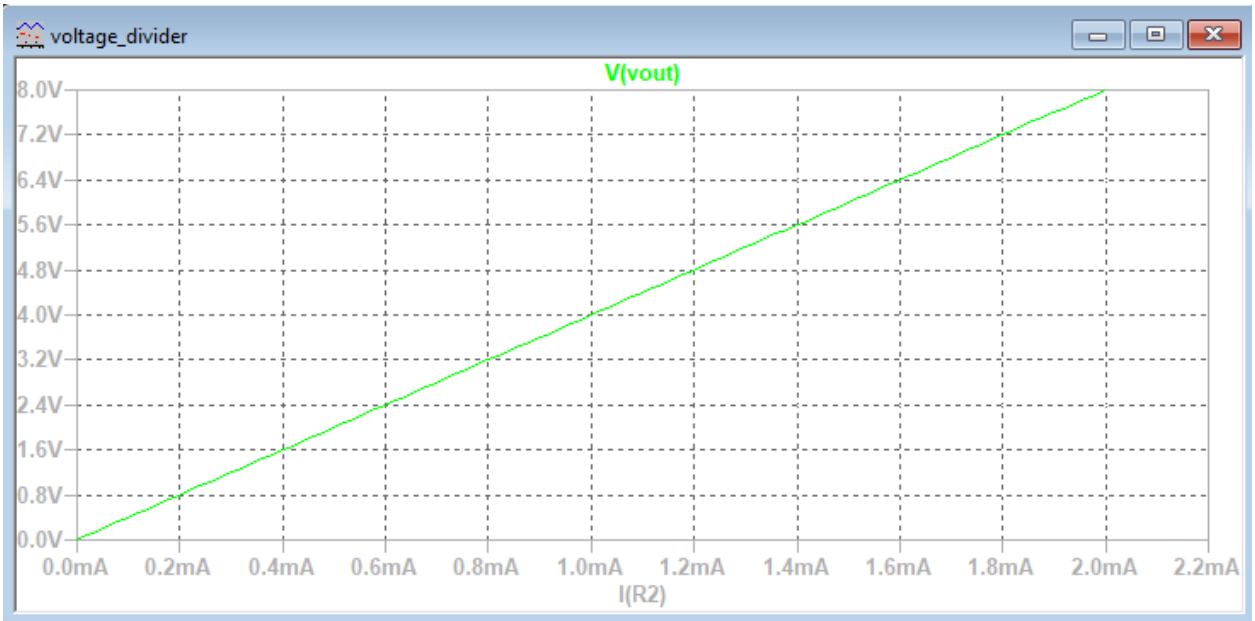
- Vout = (R2/(R1+R2))*Vin is the equation for the voltage across resistor 2.
- Therefore the slope is (R2/(R1+R2)) = 3000/4000 = 0.75
- This is a linear relationship as expected

- Now changing R2 to 4000 ohms the slope will slightly increase to (R2/(R1+R2)) = 4000/5000 = 0.8, using the voltage divider equation. The plot is shown below.



Vin vs Vout for voltage divider with R2 increased

- Now plotting Vout vs Iout for the same voltage divider



Vout vs Iout for Voltage divider

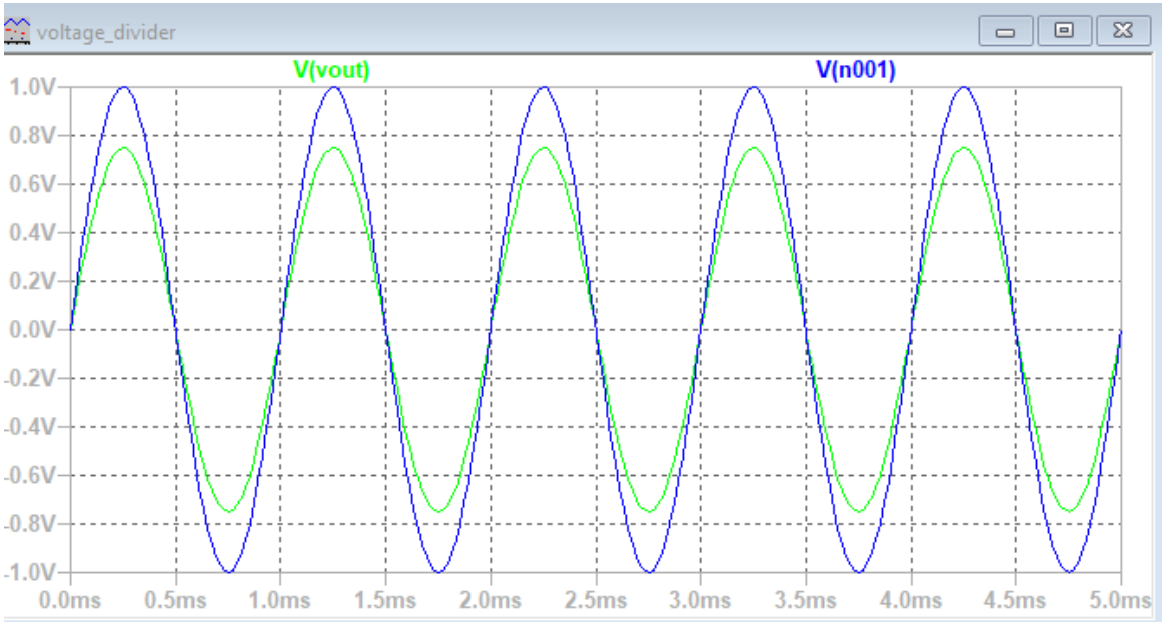
- This plot makes sense because as the voltage increases as the current increases (V=IR)

Part 3: Transient Analysis

- Now we plot Vout and Vin as a function of time for a sinusoidal source with the same voltage divider with R1 = 1k ohm and R2 = 3k ohm

- We use a sinusoidal source with 1V amplitude and 1kHz frequency
- We run a transient analysis for 5ms, using 10us time steps

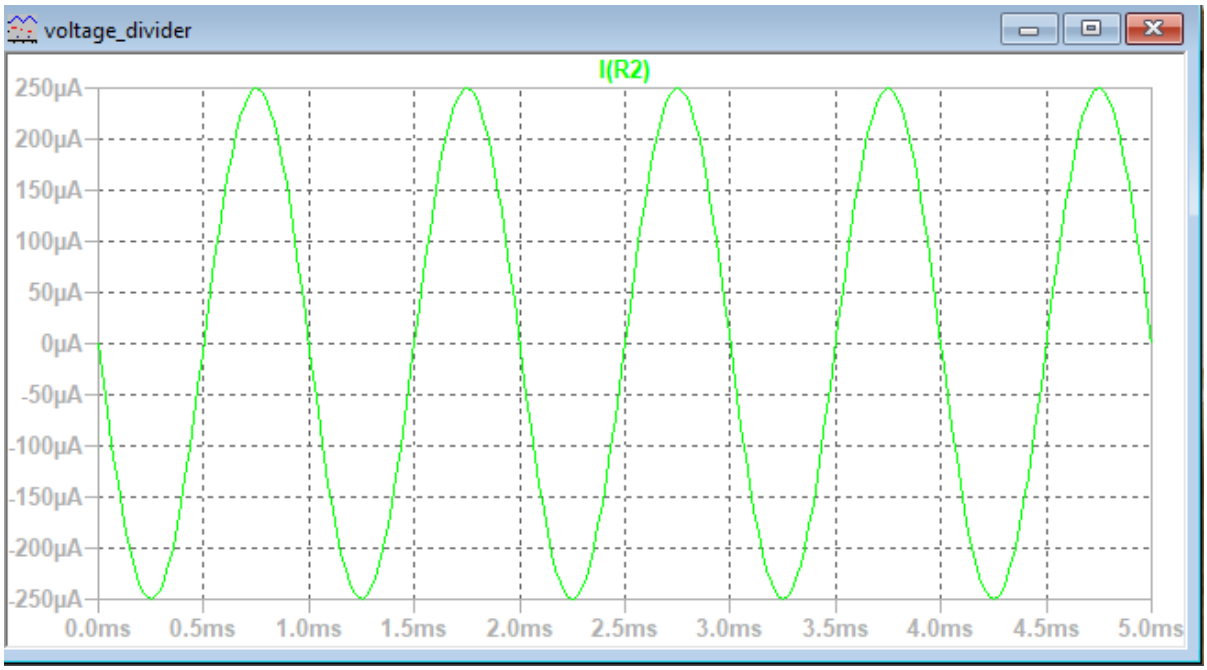
- Below, we plot Vin and Vout as a function of time



Vin and Vout as a function of time for voltage divider

- The result looks as expected, since the voltage amplitude is smaller due to the voltage divider (voltage was reduced).
- The voltage at the two nodes have the same frequency, as expected. However, their voltage amplitudes are different.

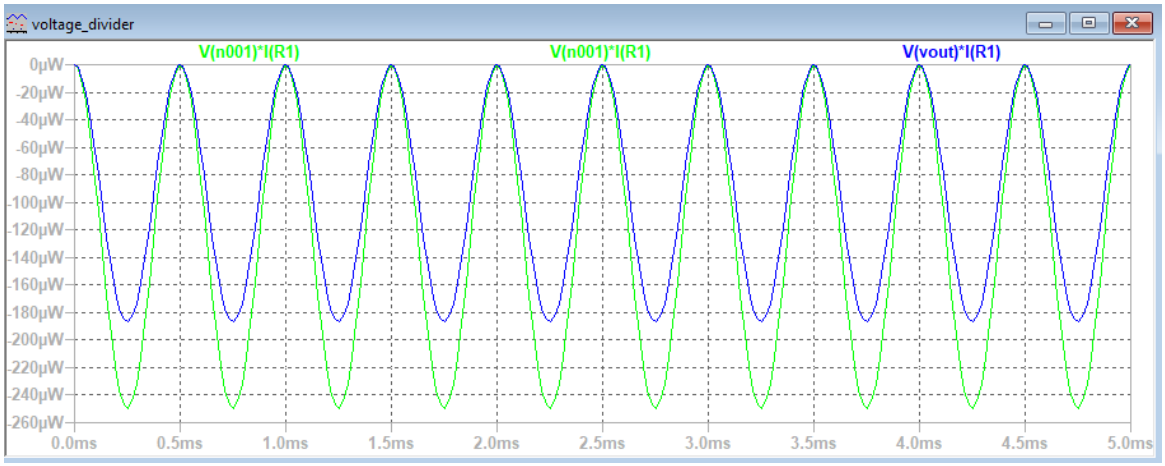
- Now we plot the current Iout as a function of time as shown below for the same circuit (voltage divider)



Iout as a function of time for voltage divider

- The plot shows the current changing direction as expected for a sinusoidal source.

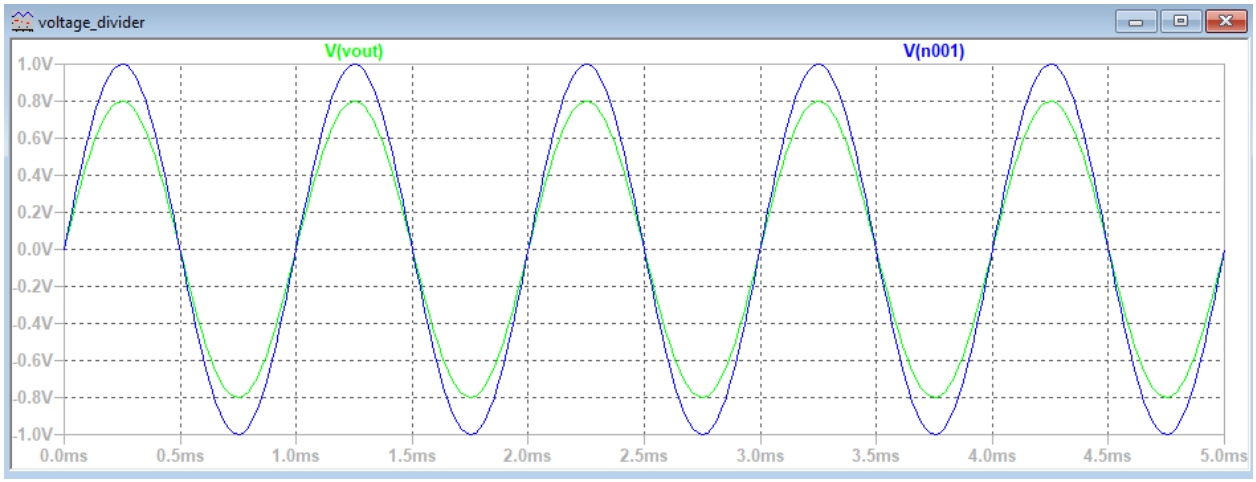
- Now we plot the power delivered by Vin and power delivered to R2 as a function of time



Power delivered by Vin and Power delivered to R2 as a function of time for the voltage divider

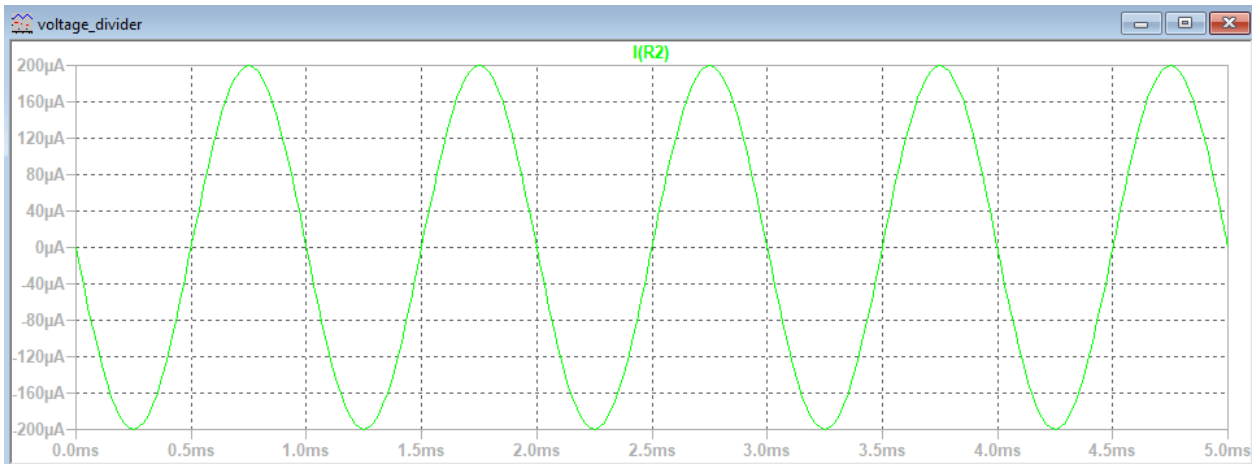
Now we change R2 to 4000 ohms

- We plot Vin and Vout as a function of time with the new R2 value of 4000 ohms



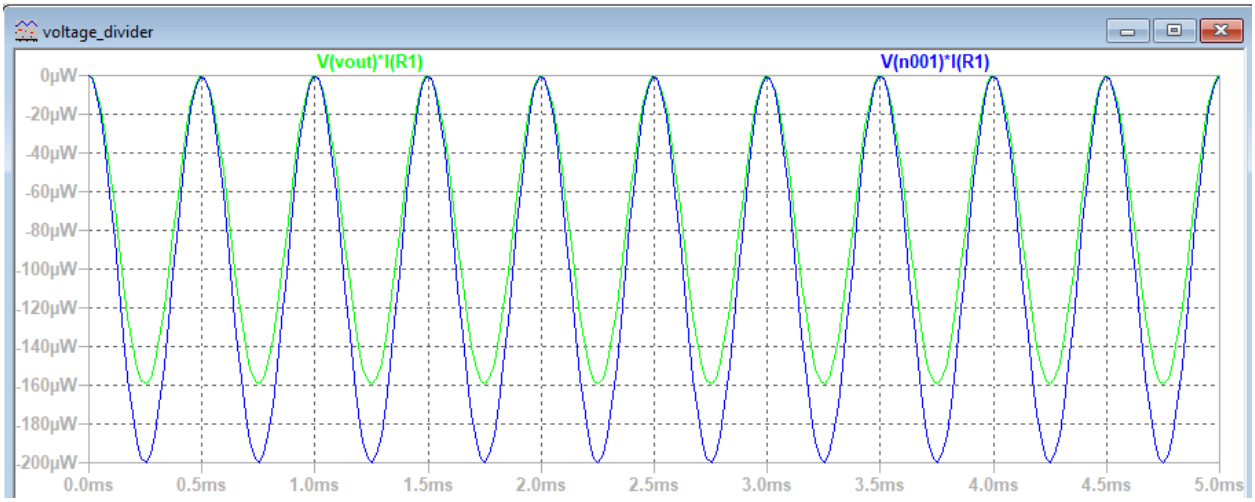
Vin and Vout as a function of time for voltage divider

- Next, we plot Iout as a function of time shown below with the new R2



Iout as a function of time for the voltage divider

- Next, we plot the power delivered by Vin and power delivered, with now R2 = 4000 ohms, as a function of time.



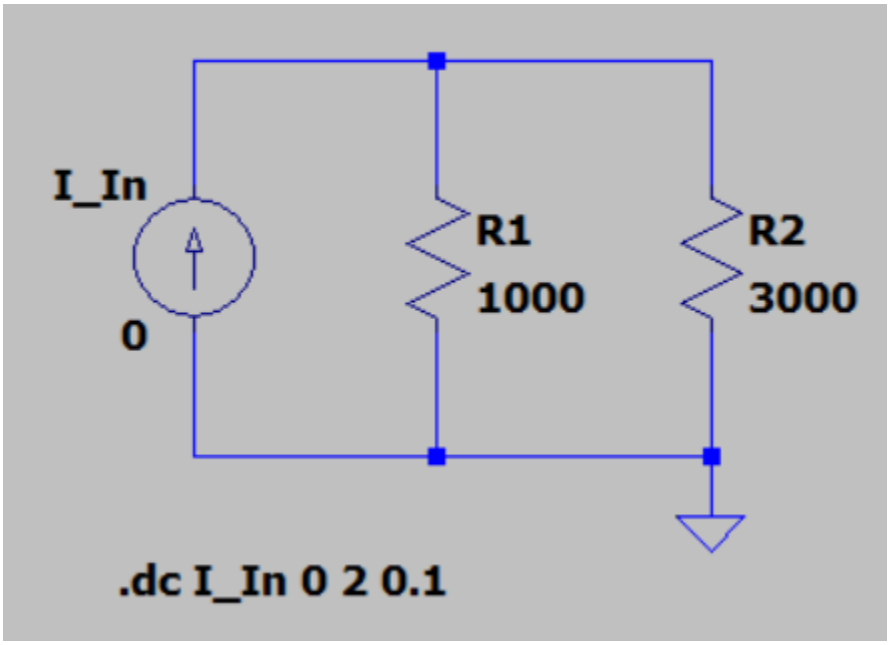
Power delivered by Vin and Power delivered to R2 as a function of time for the voltage divider

How did the waveforms change after R2 was increased?

- The output voltage increased when we changed R2 to 4000 ohms, as expected per the voltage divider equation
- Additionally, the output current through R2 decreased to a peak-to-peak of 200 uA (250 uA before with 3000 ohms resistor), which checks out with ohms law.
- The power delivered to R2 was decreased when we increased the resistor to 4000 ohms.

Part 4: Parallel Circuit

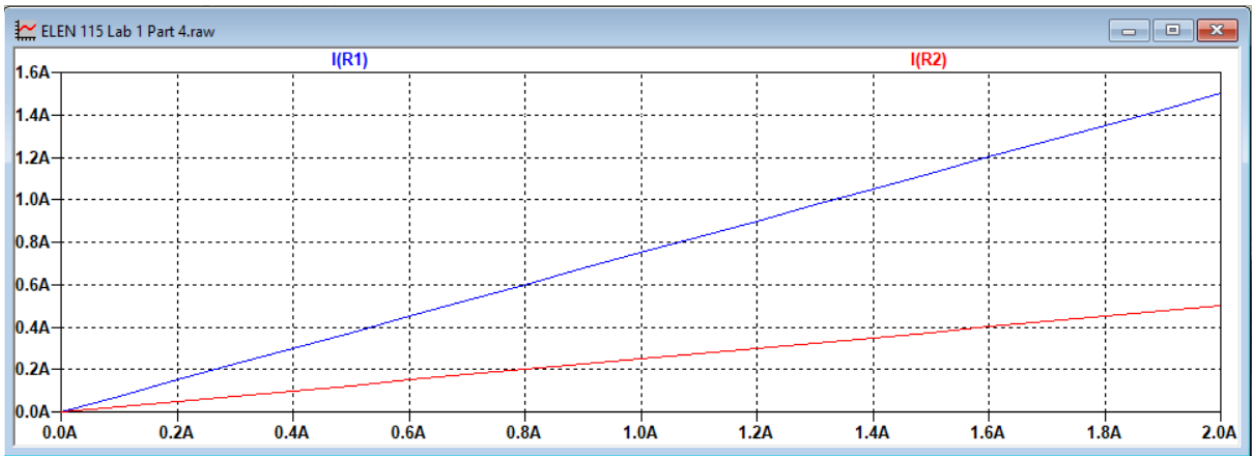
- Now we build a current divider as shown below



Current divider

- We run a DC sweep simulation on Iin from 0A to 2A in 100mA increments.

- We plot IR1 and IR2 with Iin on the x-axis as shown below

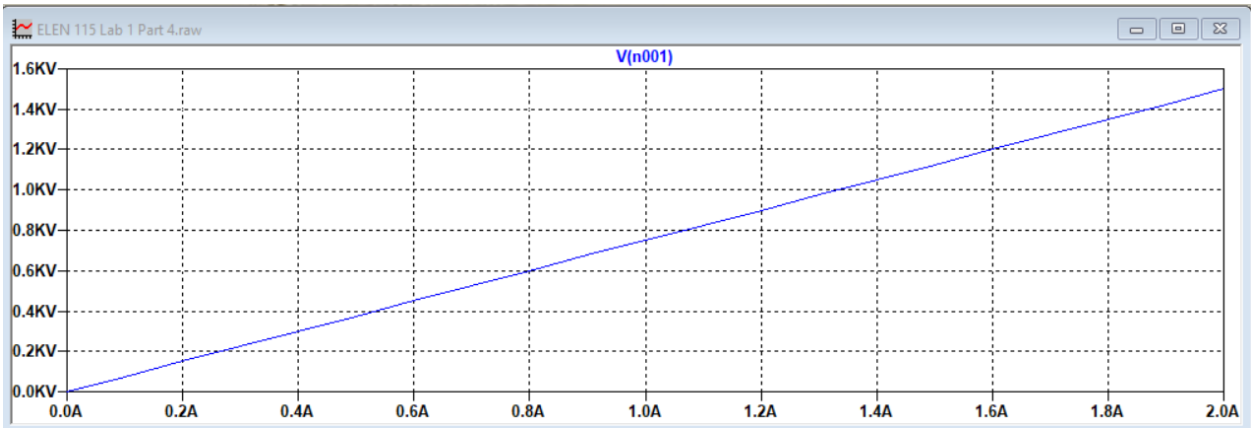


IR1 and IR2 with Iin on the x-axis for current divider

Using the current divider equations:

- The slope for IR1 is R2/(R1+R2) = ¾ = 0.75

- The slope for IR2 is R1/(R1+R2) = ¼= 0.2
- Now we plot Vout
- Vout = I * (R1 || R2) therefore the slope is (R1 || R2) = 750



Vout vs Iout for current divider

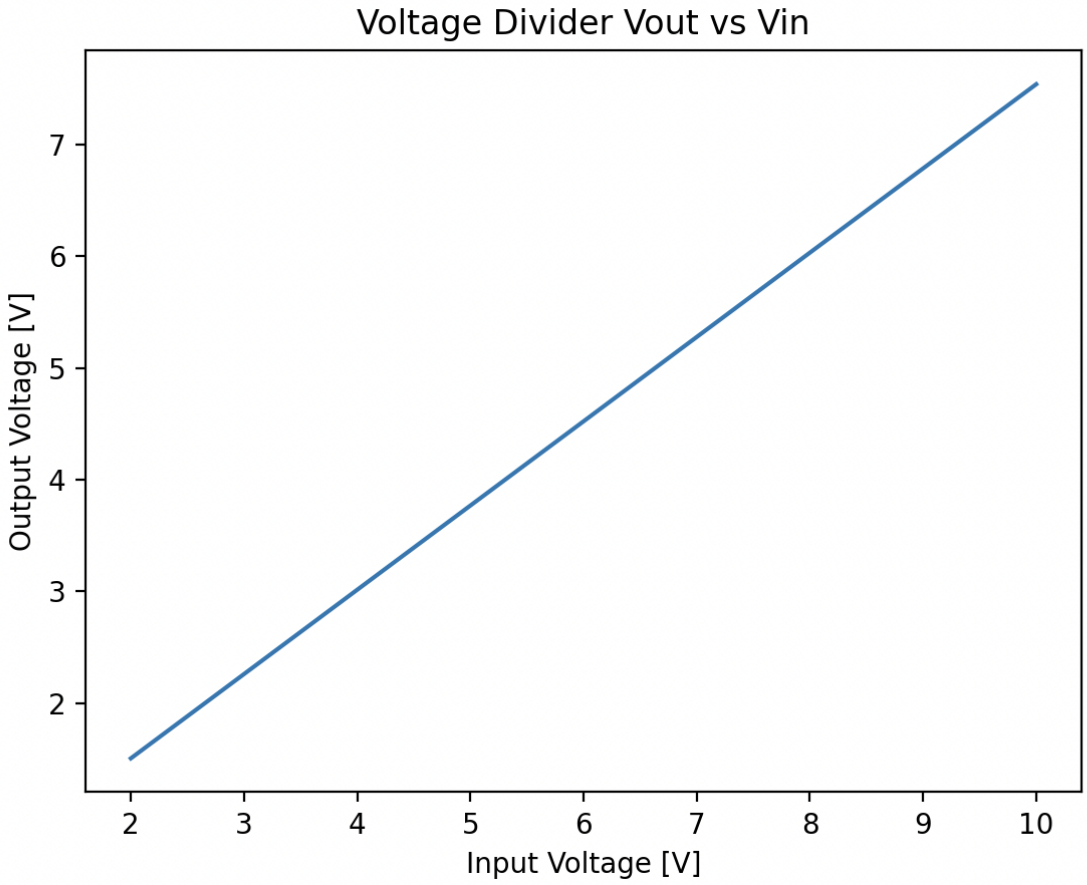
- This represents the voltage and current direct proportionality. As the current increases the voltage increases (V = IR).

Part 5: Circuit Build

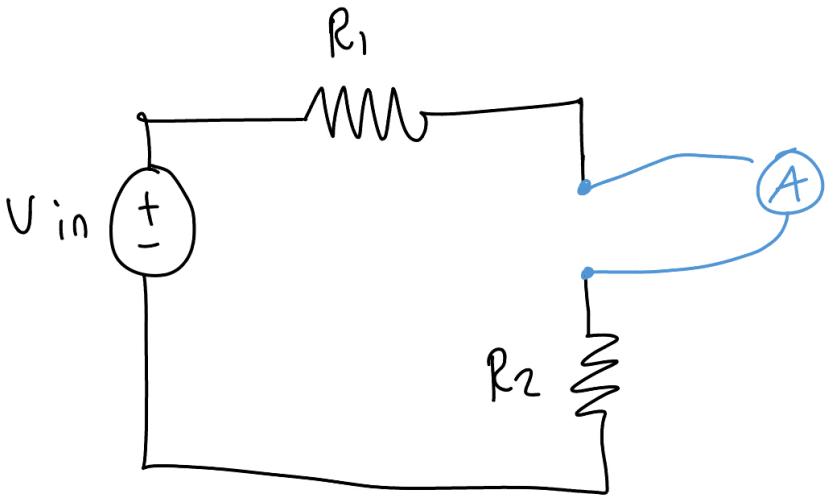
Now we build the voltage divider from part 1

Vin (V)	Vout (V)
2	1.507
4	3.015
6	4.522
8	6.031
10	7.538

The slope is about 0.75 just like the simulation.
We plot the data from the circuit build below.



- We place the ammeter in series with the resistor R2 to measure the current through R2.

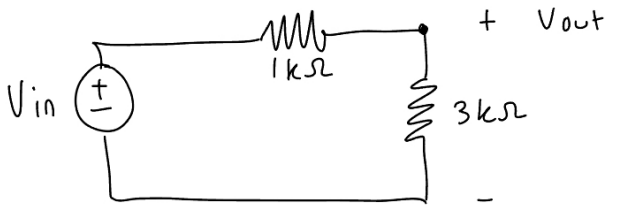


Measuring the current through R2

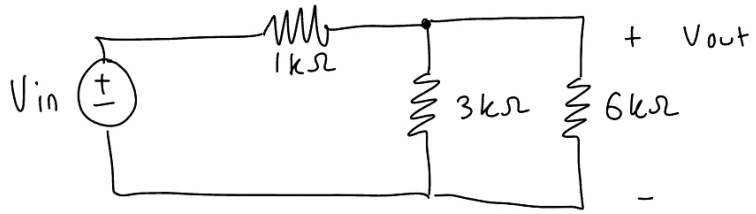
Part 6 Lab Extension

1.

Adding a resistor in Parallel to voltage divider

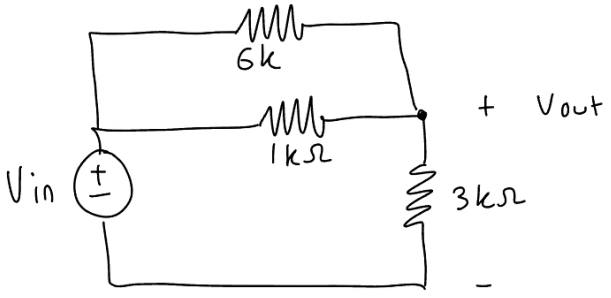


$$V_{out} = V_{in} \times \frac{3k}{1k+3k} = \frac{3}{4} V_{in} = \boxed{0.75\ V_{in}}$$



$6k \| 3k = 2k\Omega$

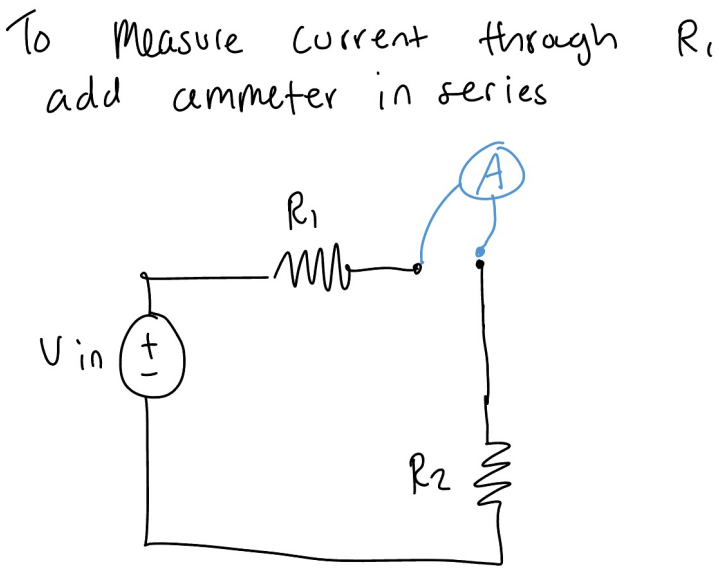
$$V_{out} = V_{in} \frac{2k}{2k+1k} = \frac{2}{3} V_{in} = \boxed{0.66\ V_{in}}$$



$6k \| 1k = 857\ \Omega$

$$V_{out} = \frac{3k}{3k+857} V_{in} = \boxed{0.77\ V_{in}}$$

2.



Conclusion

We became more familiar with constructing and analyzing circuits in LTSpice. We collected data from a current divider and a voltage divider. For the voltage divider, we built the circuit physically and compared our results. They were very similar.