Proof of Concepts

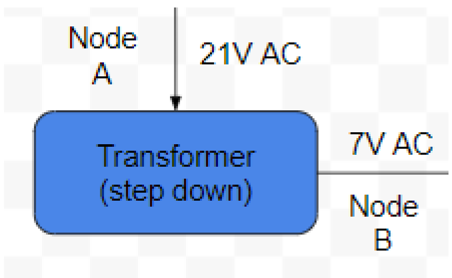
You will have an entry with the following format for each of the required concepts.

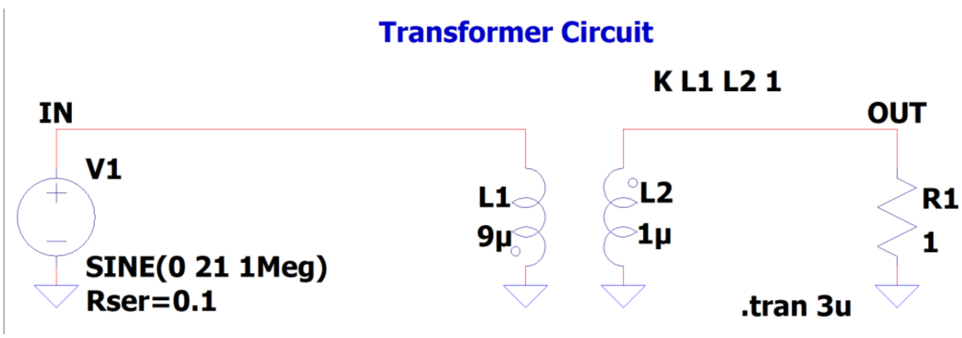
Note: we're a group of two. Our lab partner dropped the class and we never got another assigned...

1. Transformer (Ideal, Step Down)

Building Block: Short description and schematic

An ideal transformer being used to step down high voltage input.





Analysis:

Equation and short description.

$$V_{out} = N \cdot V_{in}$$

$$N = \frac{1}{3}, \; V_{in} = 21, \; V_{out} = 7V\, peak$$

$$V_{in\,RMS} = \frac{21}{\sqrt{2}} = 14.8V_{RMS}$$

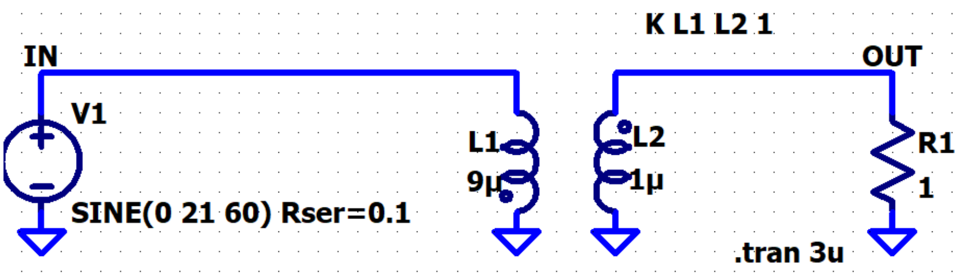
$$V_{out\,RMS} = \frac{7}{\sqrt{2}} = 4.95V_{RMS}$$

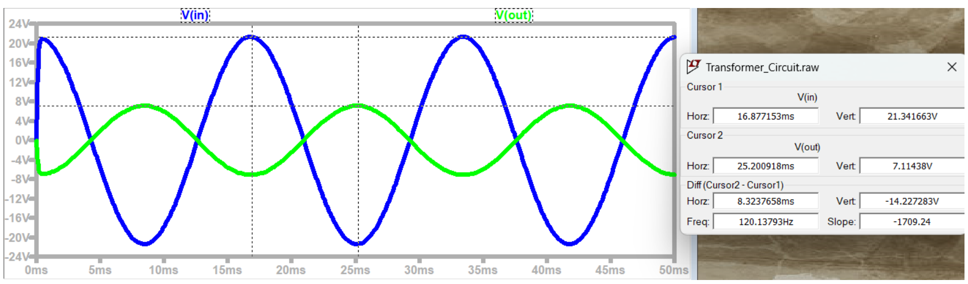
An ideal transformer that we are using to step down high voltage input. In a real-world setting this system would be fed a high and unsafe voltage value, however, experimentally, we are stepping 21V down to 7V. The 7V will then feed the rest of the later circuit.

Simulation:

Screenshot of simulation

Clearly labeled with nodes and/or input/output that matches with schematic above. Any important portions of output are identified (i.e. the point at which a comparator switches is circles and/or point to with labeled arrow for easy identification).





Measurement:

Screenshot of Waveforms output from circuit above. Remember to clearly show all axes in a measurement plot. Also identify any important portions of the output.

We were told by TA Saad that if we are unable to get a transformer before the necessary due date for this lab, we were told that we only had to simulate the transformer.

Discussion (and answer related questions in Alpha Lab):

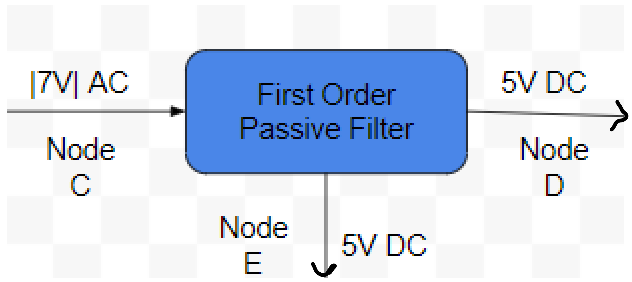
Comparison of Analysis, Simulation and Measurement results. Both a simple summary of results (like a numerical chart of values) and a simple description that details if the results are as you expect. Also include any speculation as to why they may be different from one another if they are different. What variation is too much for example…explore this.

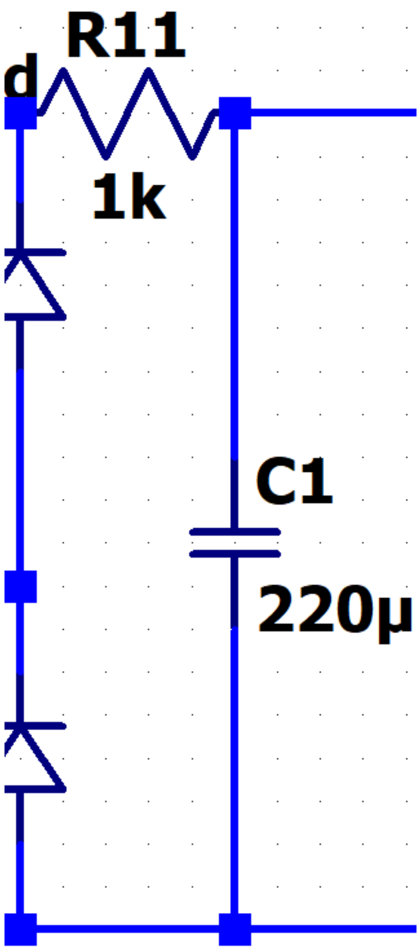
The analysis and simulation results agree that by using an ideal transformer, we are able to take 21V and step it down to 7V. Notably, LTSpice does not have a transformer component or a turns counter for inductors, but we are able to simulate one a transformer by including the square of the turns ratio in the inductive values. So, since we want a 3:1 turns ratio, our first inductor has a value of 9µH, and our second inductor has a value of 1µH.

2. First Order Passive Filter

Building Block: Short description and schematic

Clearly label all nodes you will reference





Takes our rectified 60Hz AC signal (now 120Hz) and filters it into a flat DC signal

Analysis:

Equation and short description.

Describe clearly how you are applying the concept

$\omega_c = \frac{1}{RC}$

C=220µF, R=1000Ω

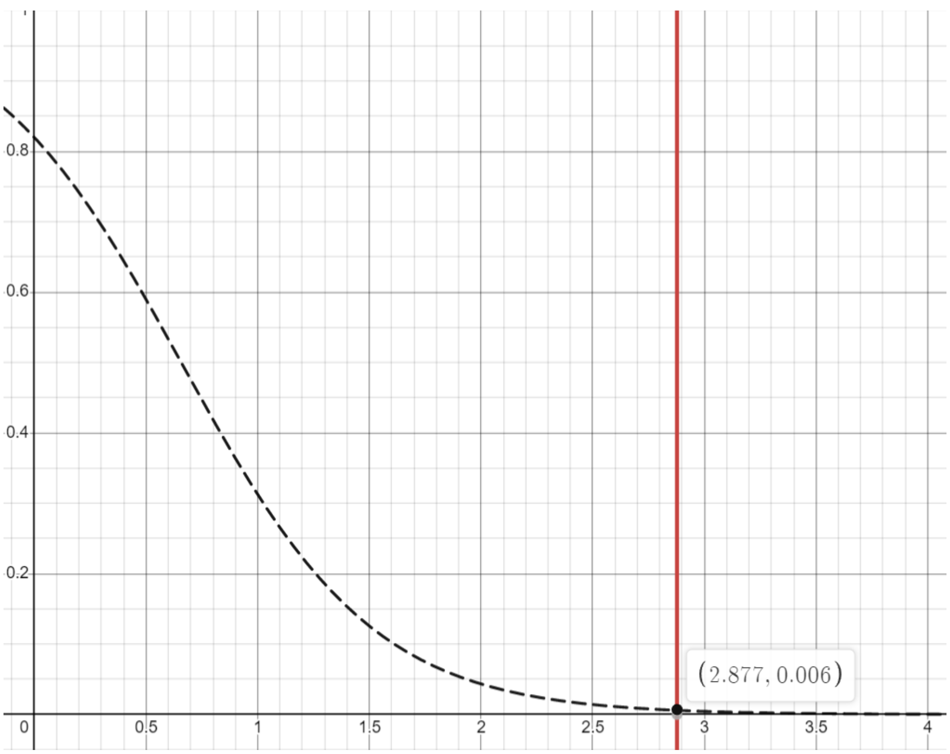
$\omega_c = \frac{1}{1k \cdot 220\mu} = 4.545$ rad/s

$$H(s) = \frac{\omega_c}{s + \omega_c}$$

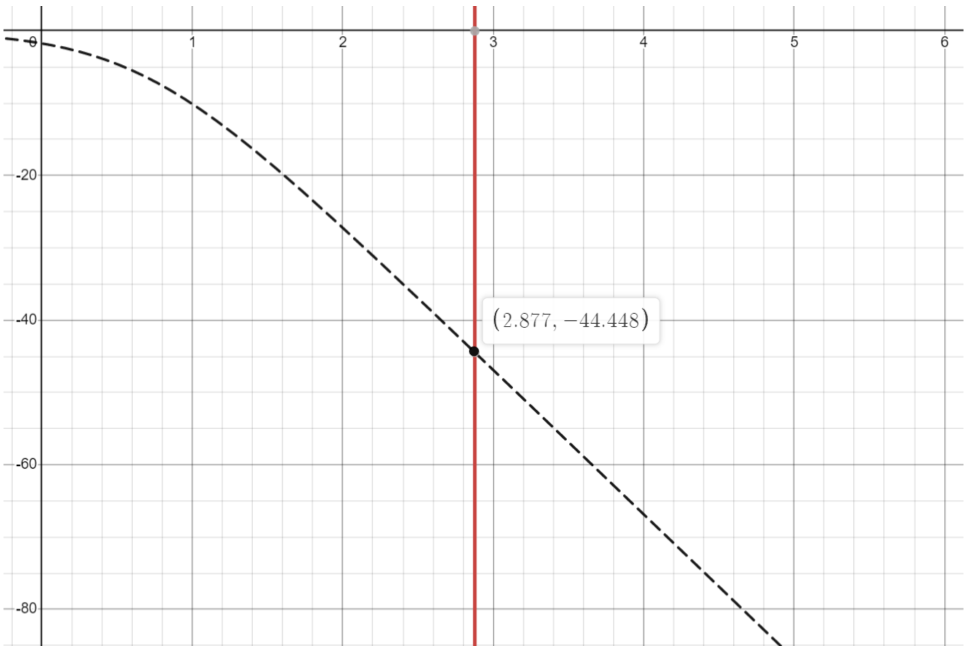
f=120Hz ω=240π

$H(s) = \frac{\omega_c}{s+\omega_c} = \frac{4.545}{240\pi + 4.545} = 0.00599$, basically flat, almost everything is filtered out and we're left with nice flat DC.

H(s): (x is log scale)



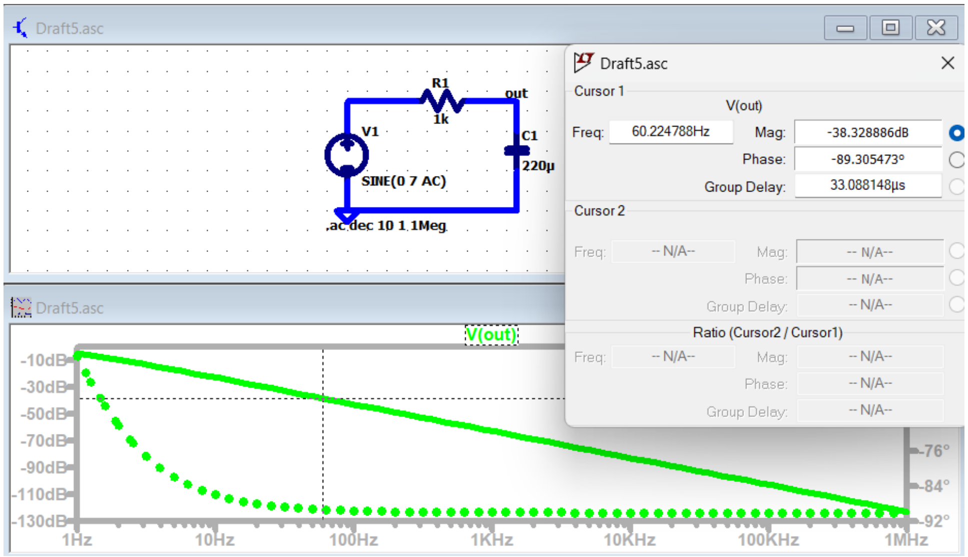
Bode plot = 20log(H(60))=-44.448dB



Simulation:

Screenshot of simulation

Clearly labeled with nodes and/or input/output that matches with schematic above. Any important portions of output are identified (i.e. the output of the point at which the bridge is balanced in a parameter sweep).



Much less curvature

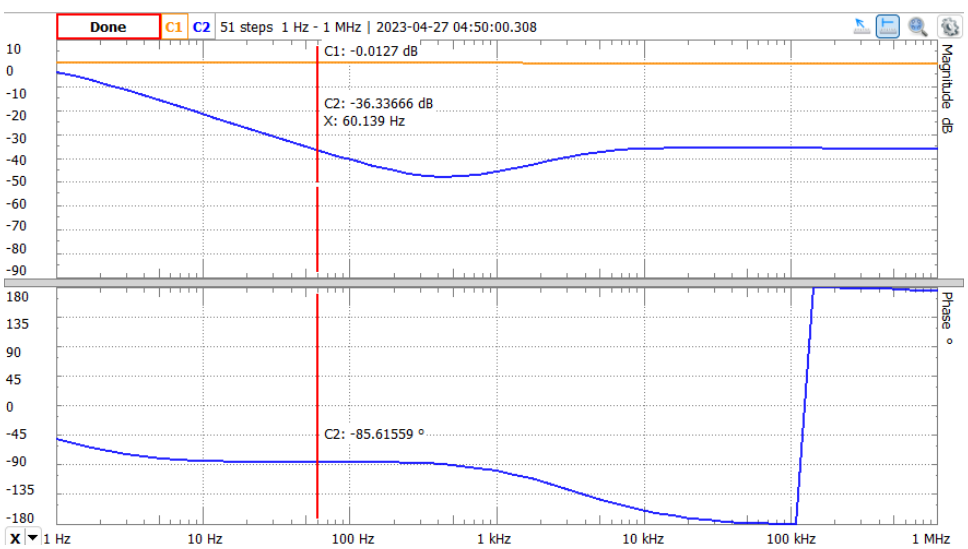
At 60Hz, -38.3dB

Picking some random points on the bottom half, slope is $\frac{-70.727773+86.226059}{\log(2.4924324)-\log(14.970295)} = -19.9051467435$

Measurement:

Screenshot of Waveforms output from circuit above.

Remember to clearly show all axes in a measurement plot. Also identify any important portions of the output.



It acts as expected around the 60Hz frequency we use, actual –36.33dB

Discussion:

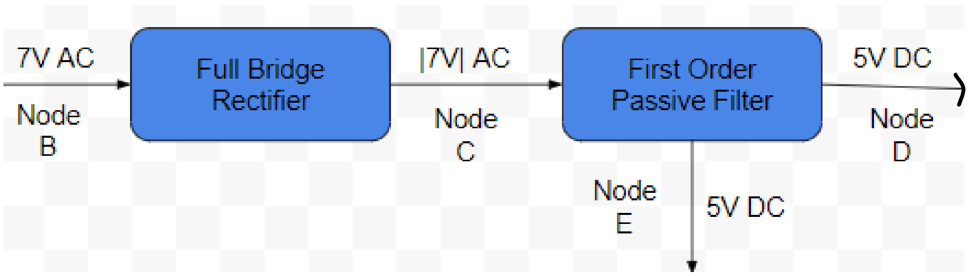
Comparison of Analysis, Simulation and Measurement results. Both a simple summary of results (like a numerical chart of values) and a simple description that details if the results are as you expect. Also include any speculation as to why they may be different from one another if they are different. How different is too much for example…explore this.

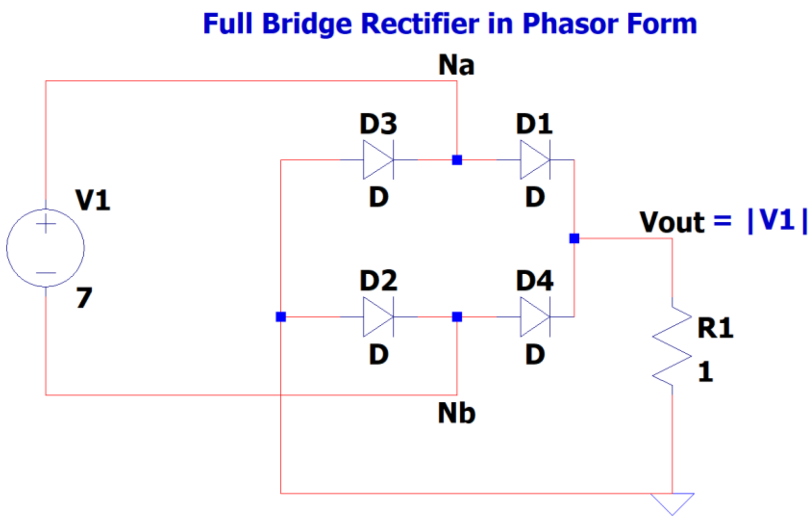
Our analytical, simulation, and experimental measurement results all approximately agreed. Simulated gave only 2dB more reduction than expected, but the calculation gave a full 8dB more reduction. This is insignificant for our purposes, but could be significant in certain applications.

3+4. Phasors + Complex Power

Building Block: Short description and schematic

Clearly label all nodes you will reference





Analysis:

Equation and short description.

We are using phasors to find the voltage output from the full bridge rectifier, which restricts every wave from the AC input, to be positive only. There is an input voltage of about $\sim 5V_{rms}$ coming from the transformer.

$5V\angle 0$

$5 + 0j\,V$

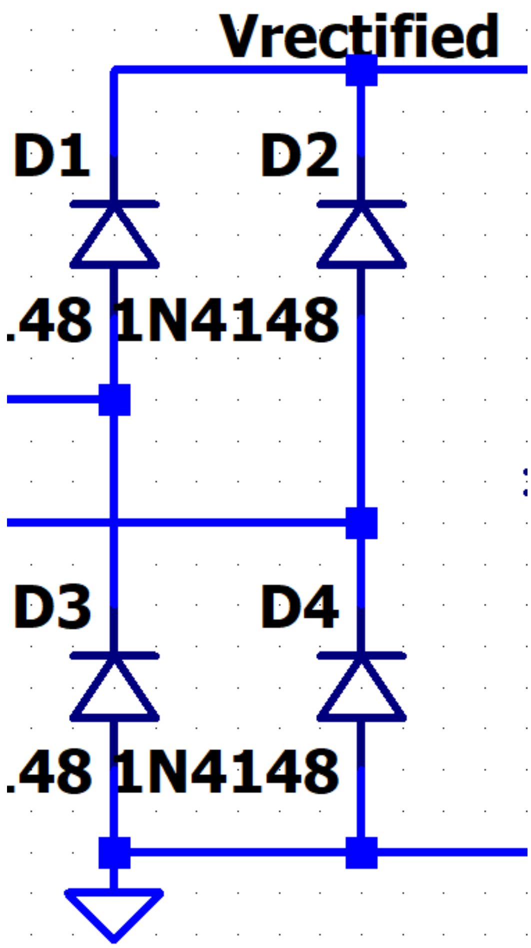
Diodes take the absolute value

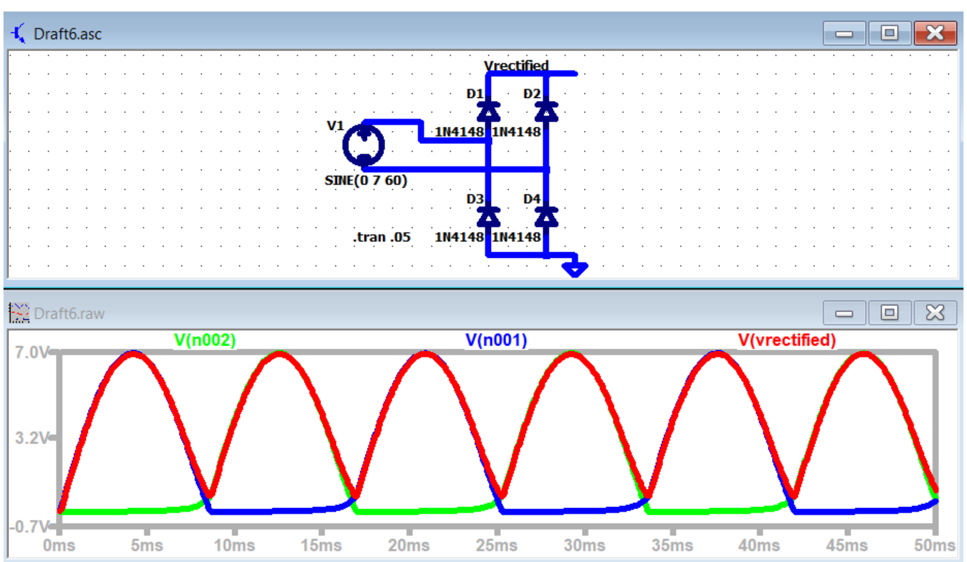
$$|5| + |0|j\,V$$

Simulation:

Screenshot of simulation

Clearly labeled with nodes and/or input/output that matches with schematic above. Any important portions of output are identified (i.e. the output of the point at which the bridge is balanced in a parameter sweep).





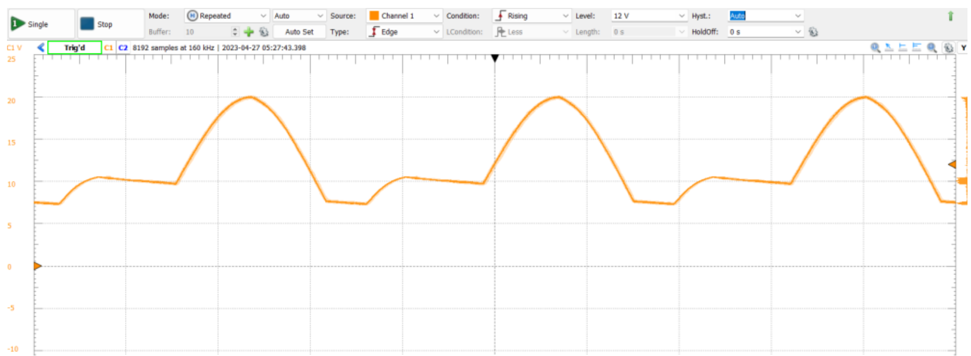
Measurement:

Screenshot of Waveforms output from circuit above.

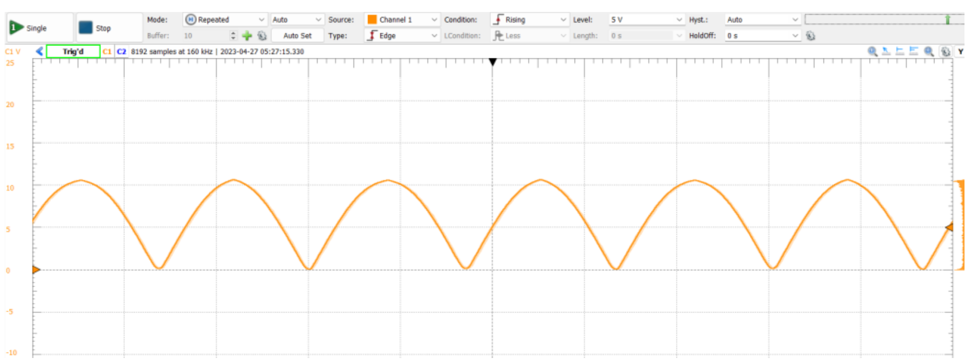
Remember to clearly show all axes in a measurement plot. Also identify any important portions of the output.

This is where there are lots of issues with shared ground for measurement. It works fine - until you measure it and accidentally ground something via little to no resistance (measured to be 0.3Ω between our function generator and oscilloscope)

Here's waveforms with my laptop plugged in to charge: can't really make any sort of phasor out of this



Here's waveforms with my laptop unplugged. $|5|VAC$



Discussion:

Comparison of Analysis, Simulation and Measurement results. Both a simple summary of results (like a numerical chart of values) and a simple description that details if the results are as you expect. Also include any speculation as to why they may be different from one another if they are different. How different is too much for example…explore this.

Firstly, this has been an issue all day, I didn't have my laptop with me to test this until now, so I could only speculate (as was shown in our video presentation). Now to look into any good ways of isolating grounds? Anyway, once solved, our calculations, simulation, and experiment all agree and we get the absolute value of the real component of the voltage, all the regular math applies to complex power and phasors too.