Frank Martino - Proof of Skills Day 4

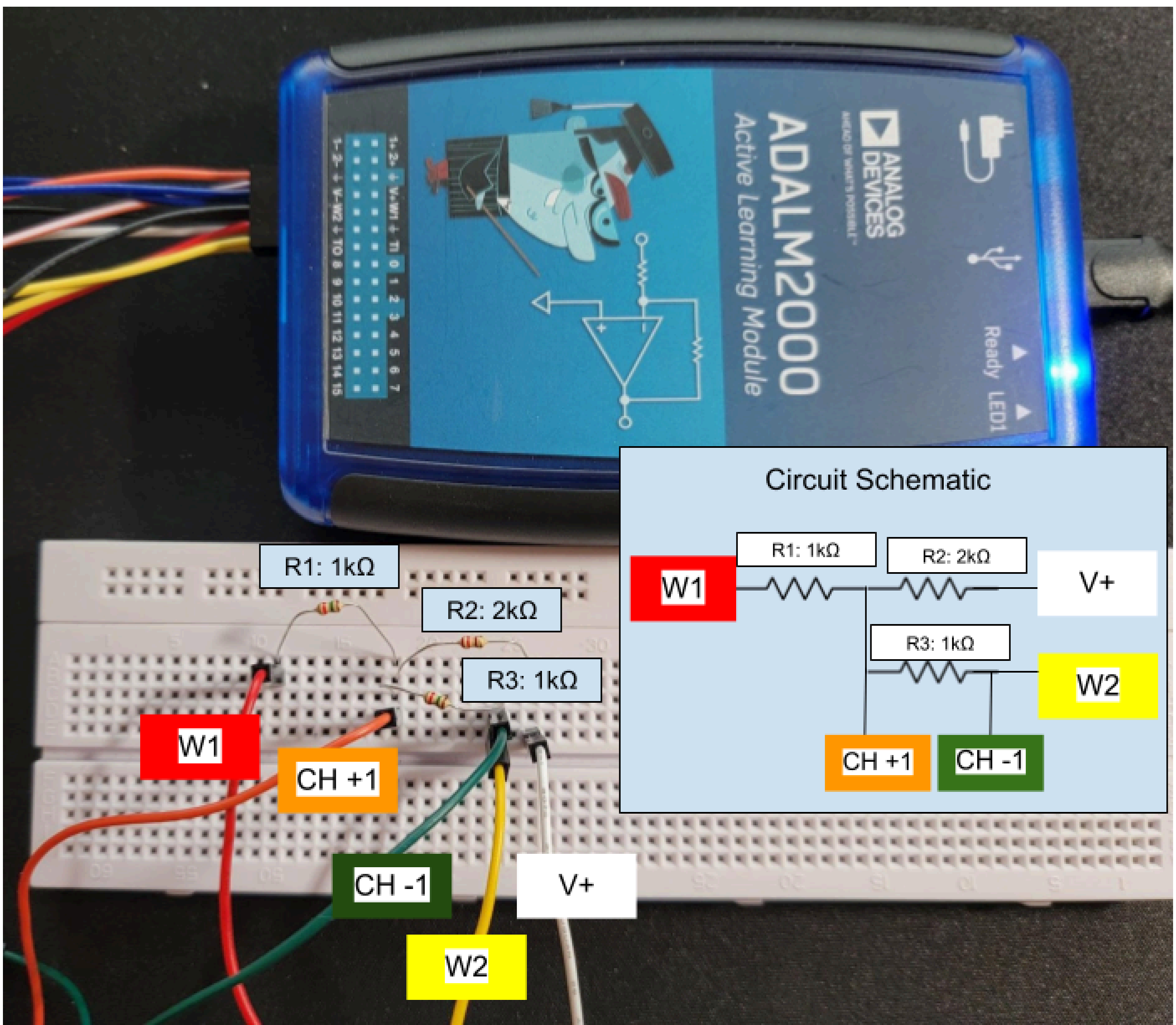
Q4 Community, communication, asking for help, helping others and answering for yourself “Is this right?’

Giving and getting answers is a skill set we strongly encourage as engineers. Practice here!

Q4.5 MAX LEVEL PROOF OF SKILLS- FULL INTEGRATION!

I can clearly document and compare a calculated, simulated, and experimental result to answer the question “Is this right?” for myself

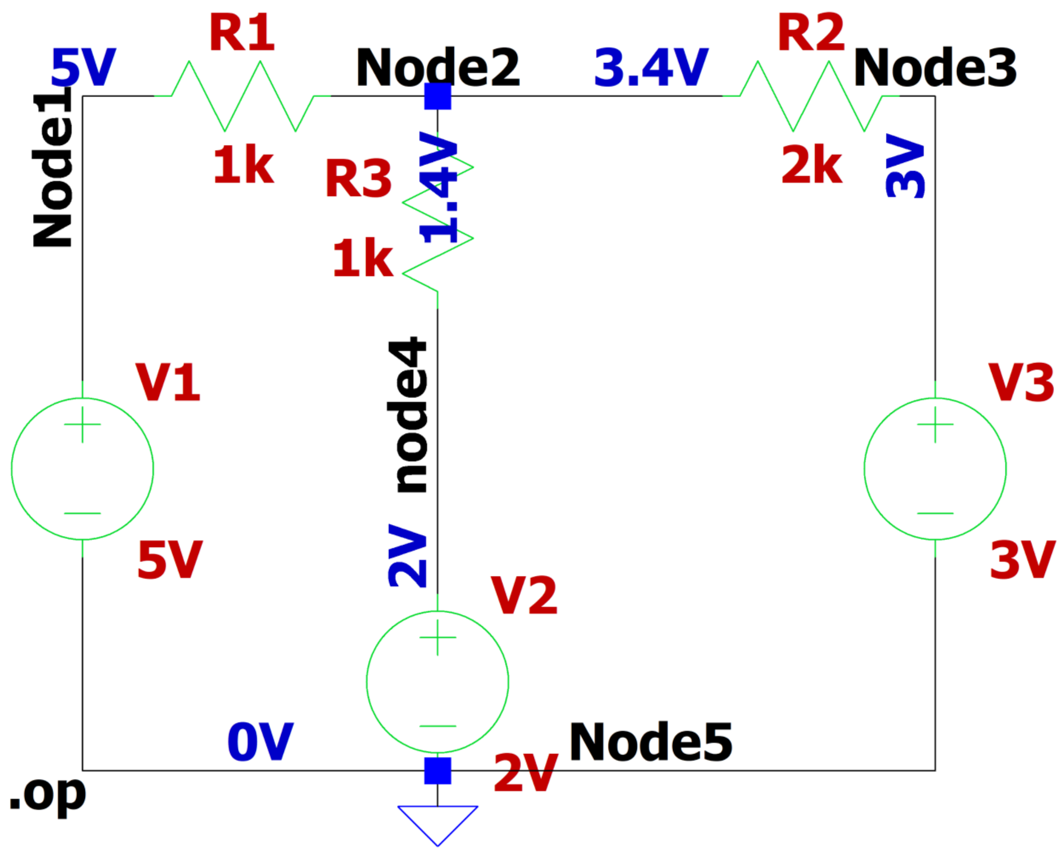
I can prove my skills in the full integration problem by making a circuit with unknowns in it and solving for the voltage across a component. I can calculate this by hand using circuit analysis and a TI-84 ce and by comparing my solutions to an LTspice simulation, building the circuit and measuring the voltage using Scopy and the ADALM2000, and measuring the voltage using a multimeter. The circuit I created is shown below.

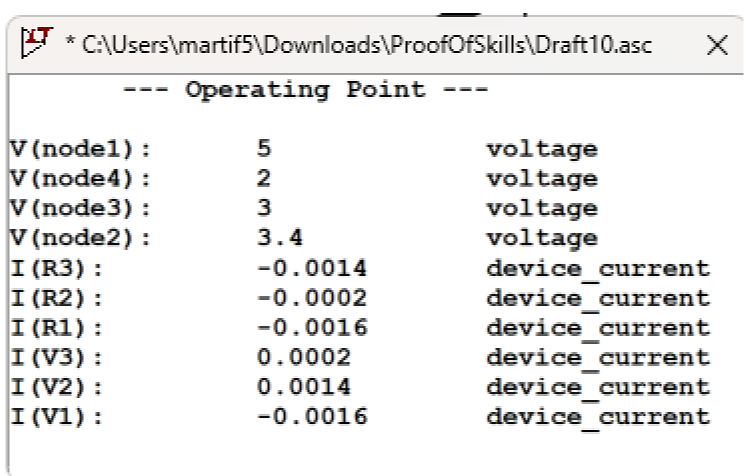


The above circuit contains a voltage source from channel 1 W1 that is in series with a resistor R1(1kΩ); it is then connected to two branches. One is connected with resistor R2(2kΩ) and a voltage source from channel V+, 3 volts and another with resistor R3(1kΩ) and 2 volts from channel W2 on the ADALM2000. I then used channels +1 and -1 on either side of R3 to read its voltage on scopy. There is no ground in the above circuit that can connect directly to the resistors because the channels may have built in grounds.

Simulated:

Below shows the circuit built in LTspice and simulated output created to find the voltages at the nodes and across R3. The estimated voltage across R3 is 1.4 volts.




* C:\Users\martif5\Downloads\ProofOfSkills\Draft10.asc

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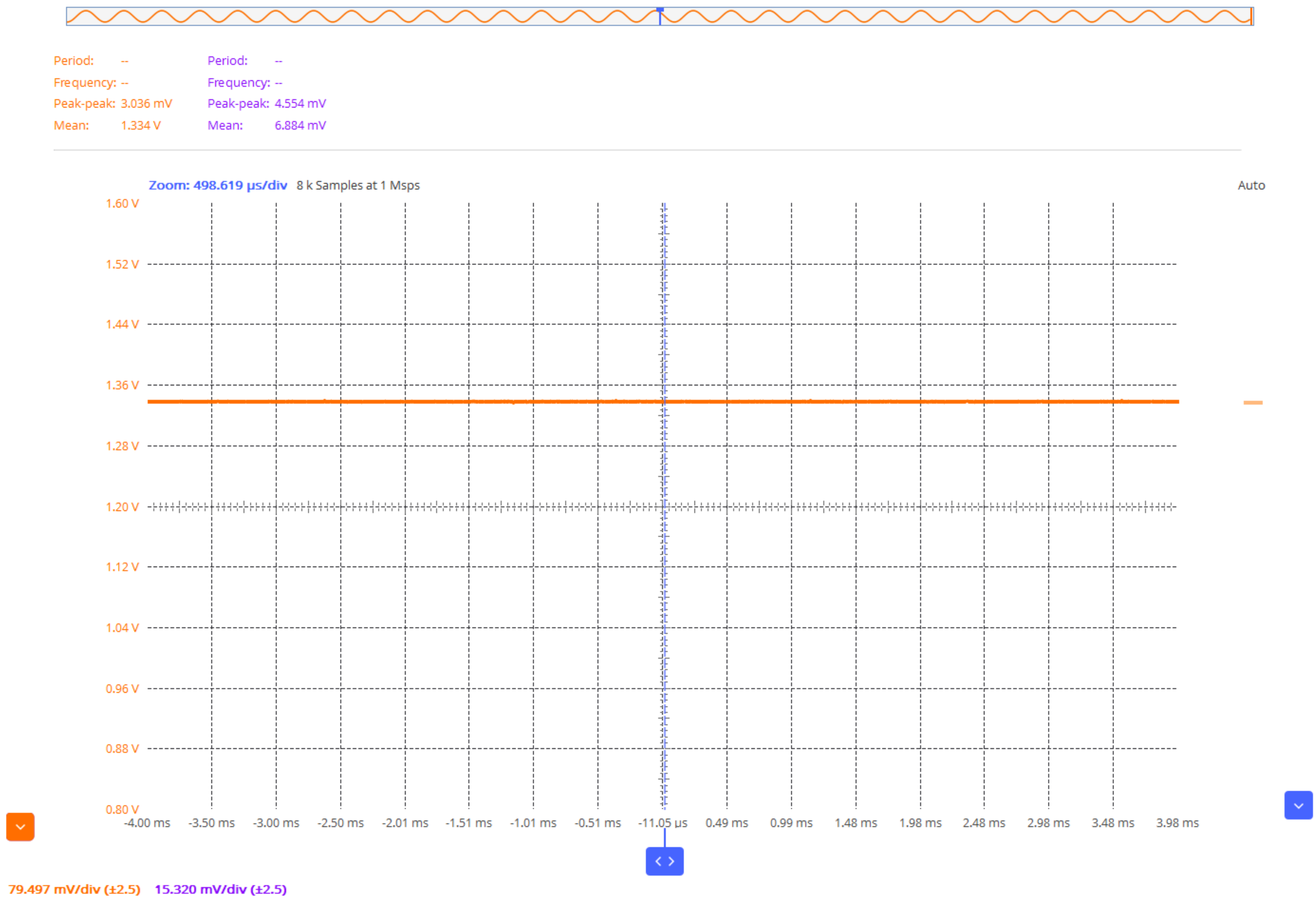
--- Operating Point ---

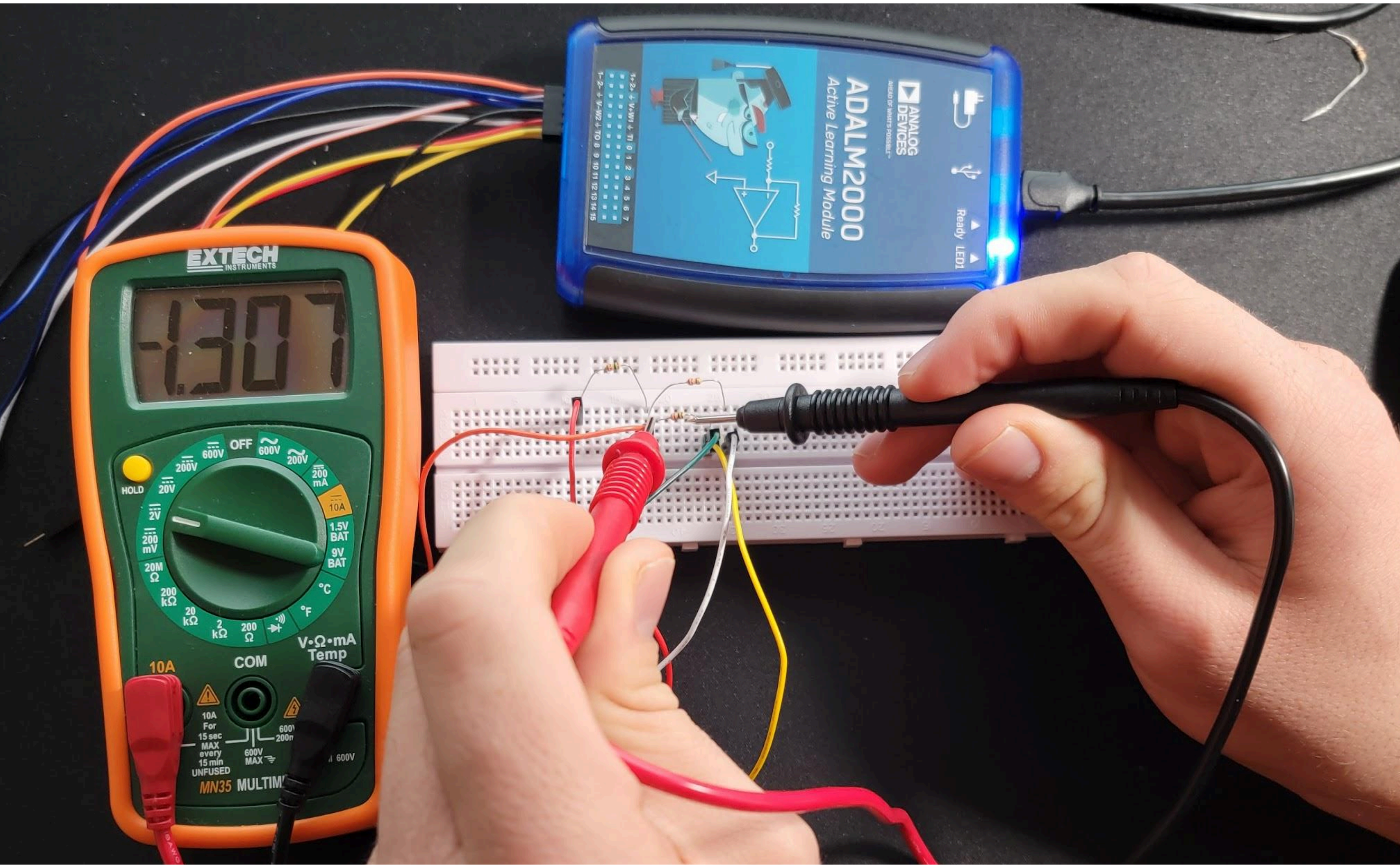
V(node1):     5          voltage
V(node4):     2          voltage
V(node3):     3          voltage
V(node2):     3.4        voltage
I(R3):        -0.0014    device_current
I(R2):        -0.0002    device_current
I(R1):        -0.0016    device_current
I(V3):        0.0002     device_current
I(V2):        0.0014     device_current
I(V1):        -0.0016    device_current
```

Experimental Result:



After using Scopy and the ADALM2000 I was able to measure the voltage across R3. I found it somewhat matched the voltage found in LTspice at 1.334 volts. To continue testing the experimental result of the created circuit, I used a multimeter across R3 and got 1.307 volts which is close to the output of both LTspice, Scopy, and my hand calculations. While both my hand calculations and the LTspice circuit simulation showed the voltage should be 1.4 volts, the discrepancy in voltage is likely due to not having a ground and measuring with an oscilloscope/ multimeter which could be using up voltage. Another contributing factor could be due to the fact that my hand calculations and LTspice view the resistors and other components as ideal, meaning there is no loss in voltage; however, there are manufacturing tolerances that the resistors have meaning more or less voltage could be used up by the resistor than advertised. Below is an image of testing the circuit with a multimeter and its output.

Please note the leads of the multimeter were switched which is why the output is negative.



Calculated Result:

Below I included my hand calculations where I solved the same circuit using nodal and mesh analysis. In both analyses I got 1.4 volts across R2 matching the previous forms of solving the problem. I also included the matrix and solution using the rref function on my TI-84 ce.