Is this Right?

As you know from the Professional Accountability max-level skill and as you have heard us (Prof. Sawyer and Prof. Patterson) say multiple times during lecture, being able to answer the question "Is this right?" for yourself is a necessary skill as an engineer. The process to check your work typically consists of three major steps, in a cycle:

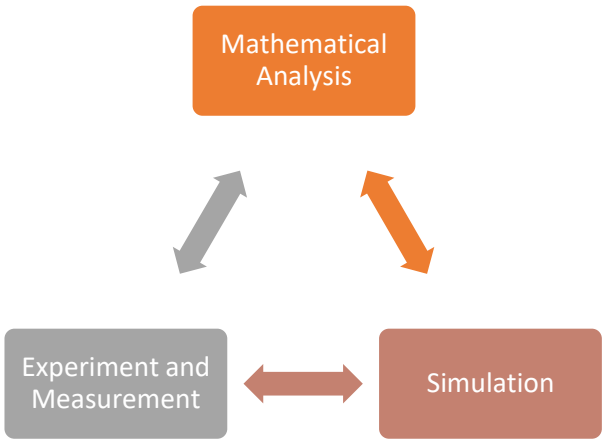


Figure 1 – Cyclical design process

Design Process

1. **Mathematical Analysis**
   - Hand-draw and label circuit diagram.
   - Calculate all quantities important for the design (voltage, current, resistance, etc.).
   - Ensure that your circuit functions as intended (meets design specifications) via these calculations.

2. **Simulation**
   - Create a model of the circuit in LTspice, enter component values, label all relevant voltage nodes, simulate circuit, and probe all relevant quantities that were calculated in the *Mathematical Analysis* step. Ensure that the waveforms are able to be read easily.
   - Confirm that the simulation results agree with calculations of the *Mathematical Analysis* step.
   - If they do not, check the simulation and/or return to *Mathematical Analysis*.

3. **Experiment and Measurement**
   - Hand-draw the diagram of the circuit to be built, including any design changes required for implementing it on a protoboard.
   - Label the diagram with all wire names (for example the channels on the M1K), colors (M1K wires and other wires), and voltage node names (Vin, Vout, VR1, etc.).
   - Build the circuit, measure all relevant quantities, and take a clear picture of the circuit on the protoboard. Ensure that the saved waveform of the measurements is easily readable.
   - Confirm that the measurements agree with the simulation results and mathematical analysis results.
   - If not, check to see that the circuit is built correctly and that the simulation is correct (agrees with mathematical analysis).

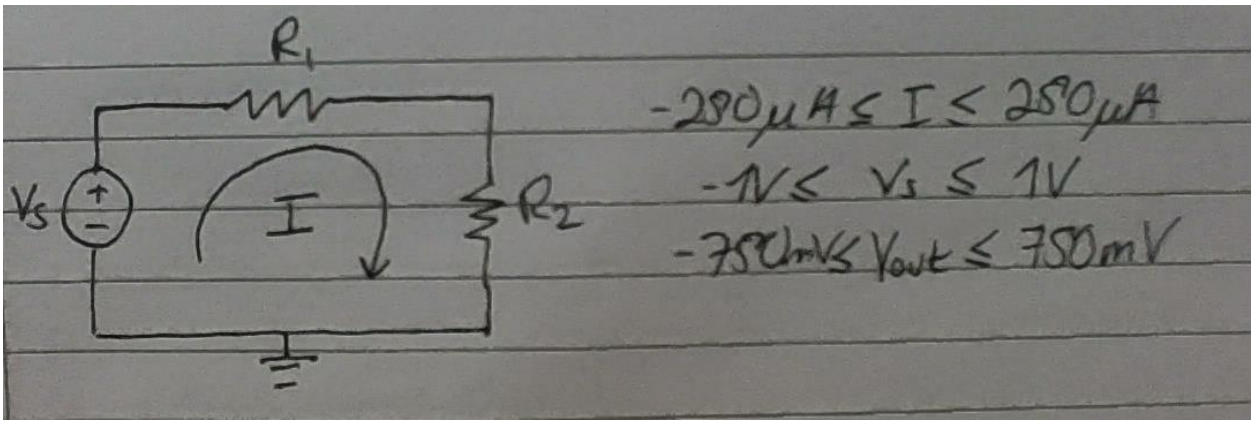
Practice checking “Is this right?” for yourself

Here’s the situation: about six months ago, your boss asked you to design a simple circuit for a customer, but at the last minute the customer decided they didn’t need it, so you documented your work and filed it away for later. Just now, your boss came to your desk and told you that the customer now urgently needs the circuit you designed six months before. You need to send the circuit design and the accompanying documentation to your boss within the next 30 minutes; it will be presented in a meeting with the customer later today.

Specifically, the customer requested the following: i) a circuit design that supplies an output voltage ranging between -750mV and +750mV; ii) an LTspice model of the circuit; and iii) experimental proof that the circuit meets the design specifications above.

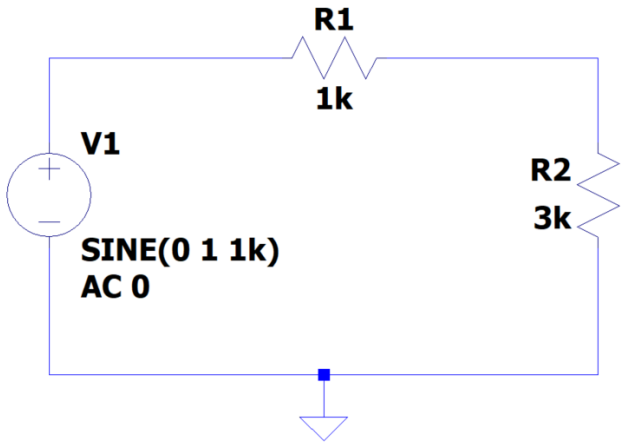
You open up your documentation to check the design before sending it to your boss. The images below are what you find. So, is this right? Does the circuit meet the design specifications? Would you send this circuit design to your boss to present to the customer? Why or why not? Use the steps of the Design Process as a guideline. What could you have done better when you documented your work to make it easier or quicker for you to answer questions like this in the future?

Mathematical Analysis

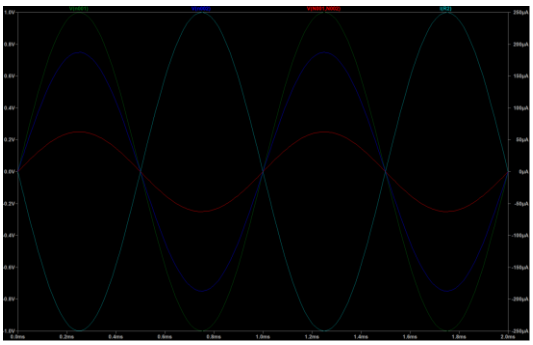


Hand-drawn circuit diagram

Simulation

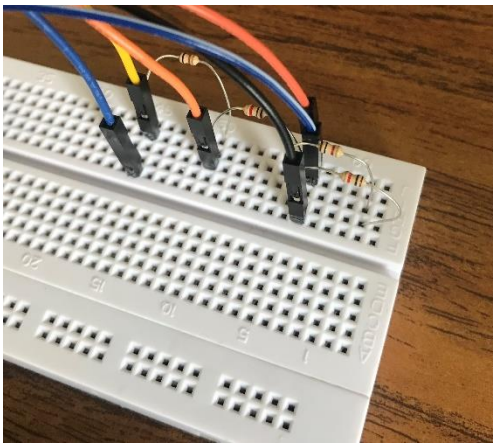


LTspice circuit schematic

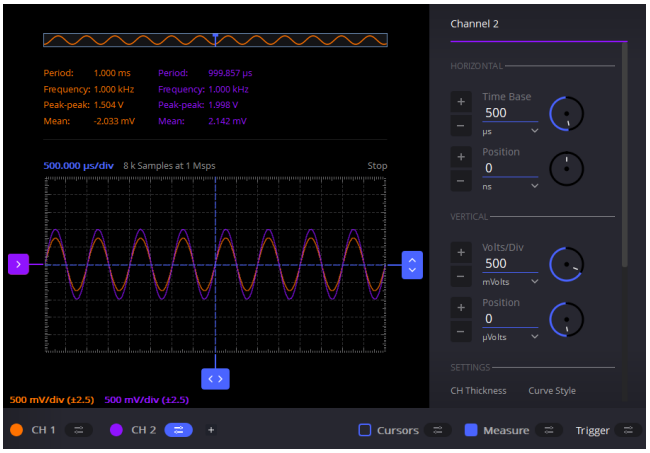


LTspice probed waveforms

Experiment and Measurement



Implemented circuit on breadboard



Measurements from implemented circuit