Lab Final Project

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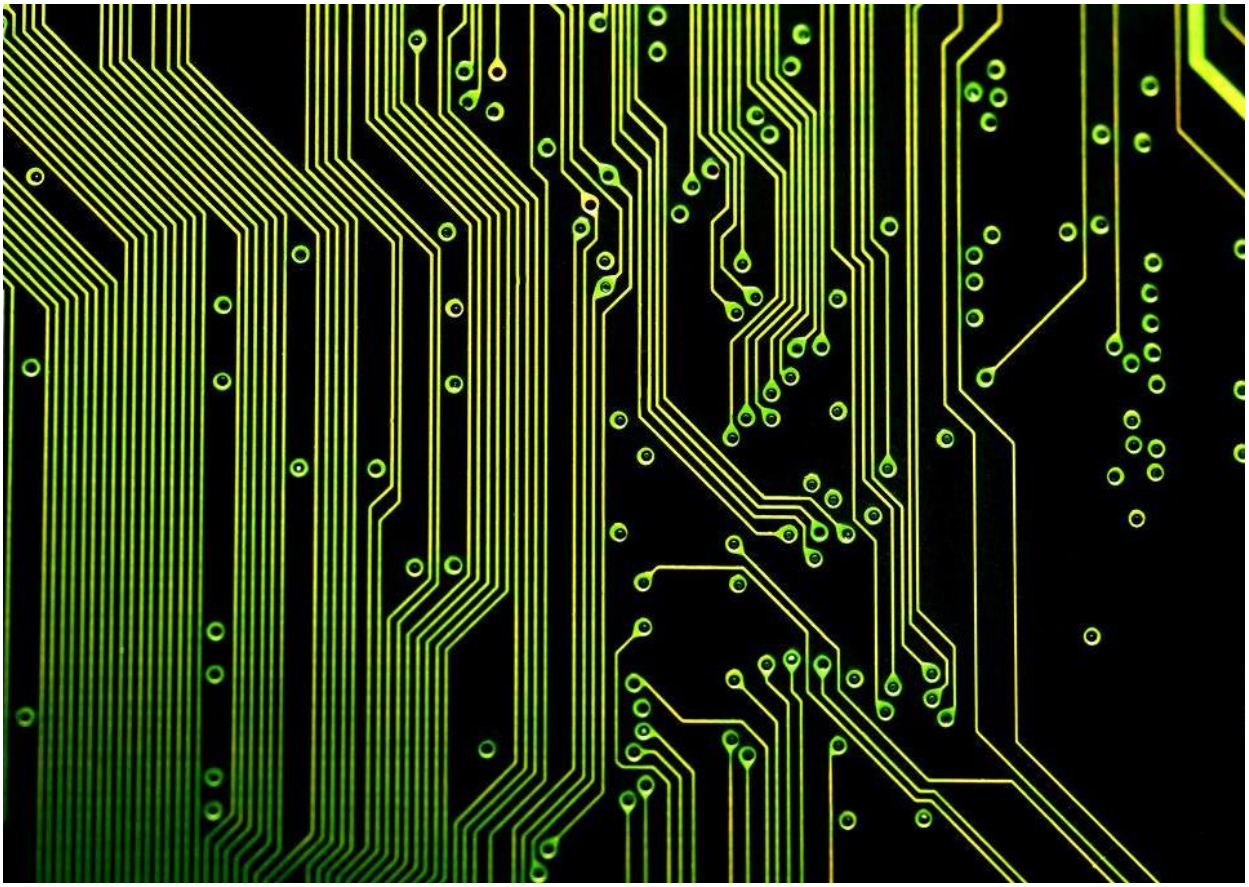
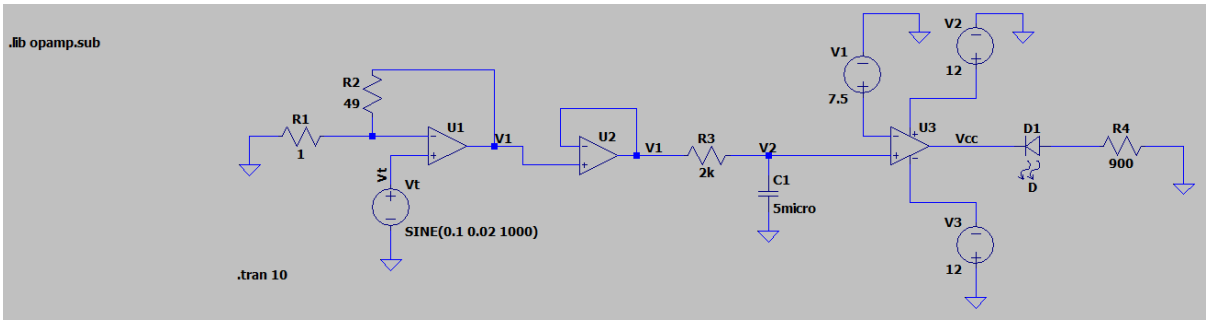


Project 4

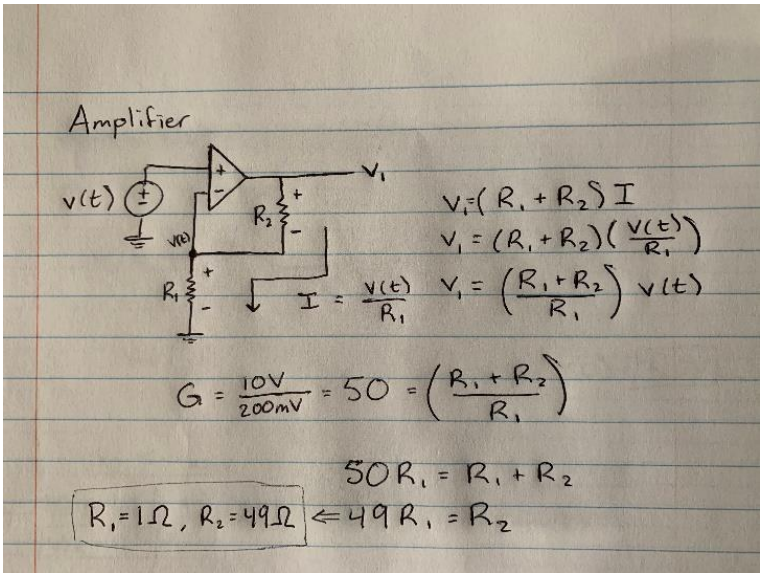
Group Code: M2-4

CIRCUIT DIAGRAM



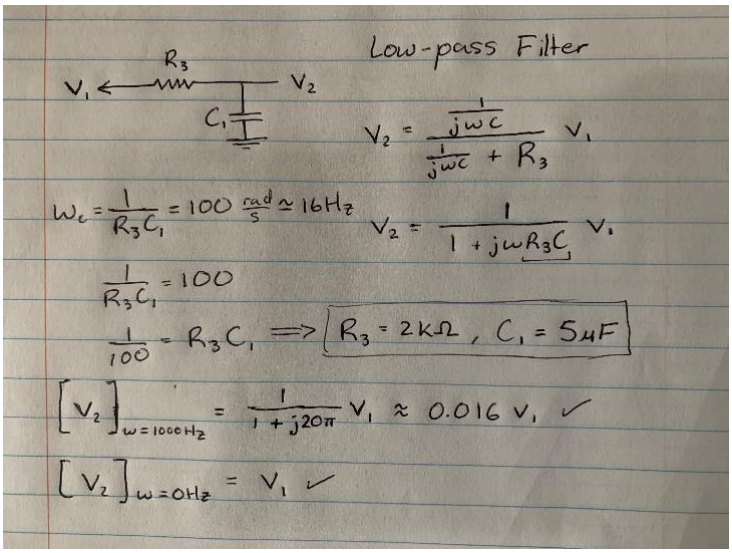
THEORETICAL DERIVATIONS

1. First we calculated what the gain of the amplifier should be and chose values of R1 and R2 based on this.



We decided to have R1 = 1 ohm and R2 = 49 ohms.

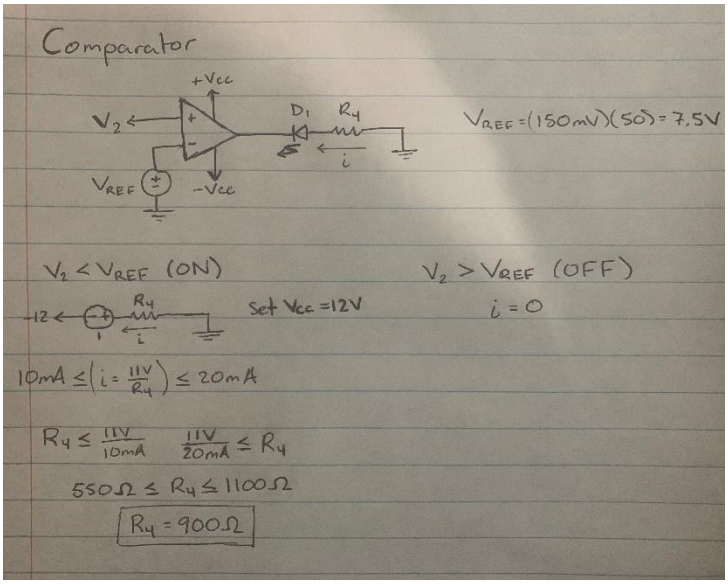
2. Next, we knew we needed to use a low-pass filter to get rid of the AC component with 1000Hz frequency. We knew that a relatively small corner frequency would result in a smaller gain for higher frequencies, so we decided to go with an angular frequency of 100 rad/s (~16 Hz). We deemed the gain of the circuit at 1000Hz to be satisfactory. To find the ratio of R3 to C1, the resistance and capacitance of the filter, respectively, we used the formula w=1/RC.



We decided to have R3 = 2 kilo-ohms and C = 5 micro-Farads.

3. To find the reference voltage of the comparator, we multiplied 150 mV by 50 (gain of amplifier). We got Vref = 7.5 V.

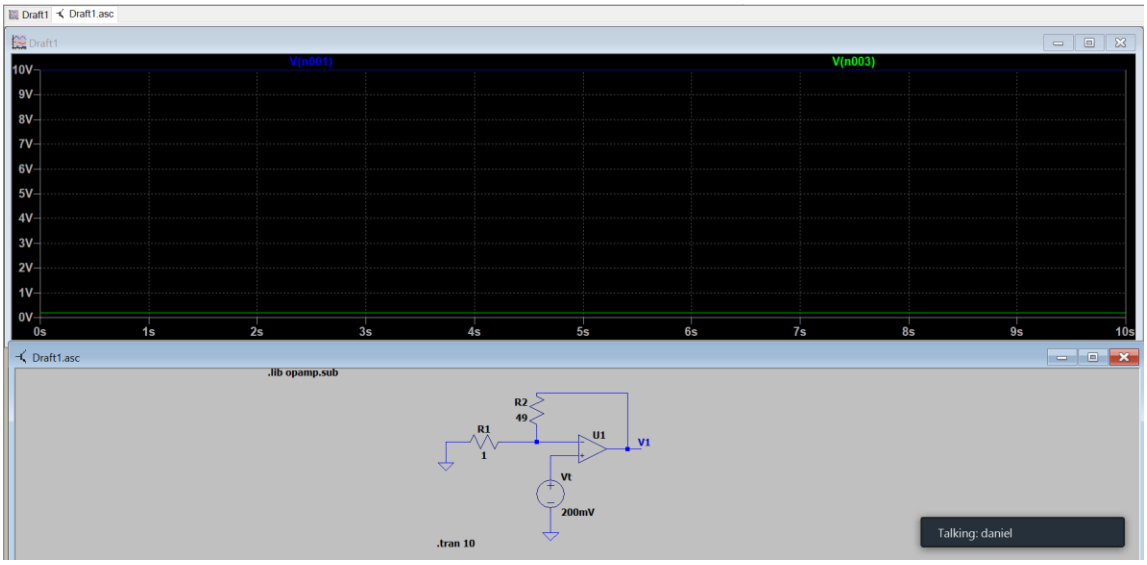
4. Finally, based on the given bounds for the current through the diode (between 10 mA and 20 mA) and the output voltage of the comparator (we set Vcc= 12V based on common practice), we established bounds for the resistor value to connect in series with the diode (the direction of which was designed to allow current under a negative output voltage, V2 < Vref).



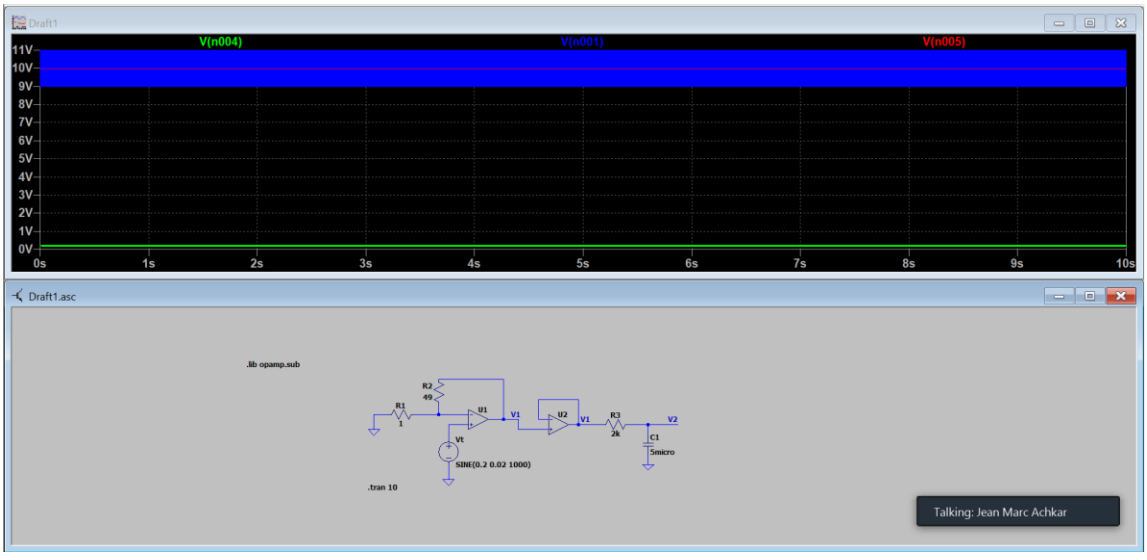
We opted for a 900 Ohm resistor (R4).

CIRCUIT SIMULATION

1. We first checked if the amplifier was working with the resistors we chose by testing the circuit under 200mV DC offset (green line), which yielded the correct 10V output (blue line).

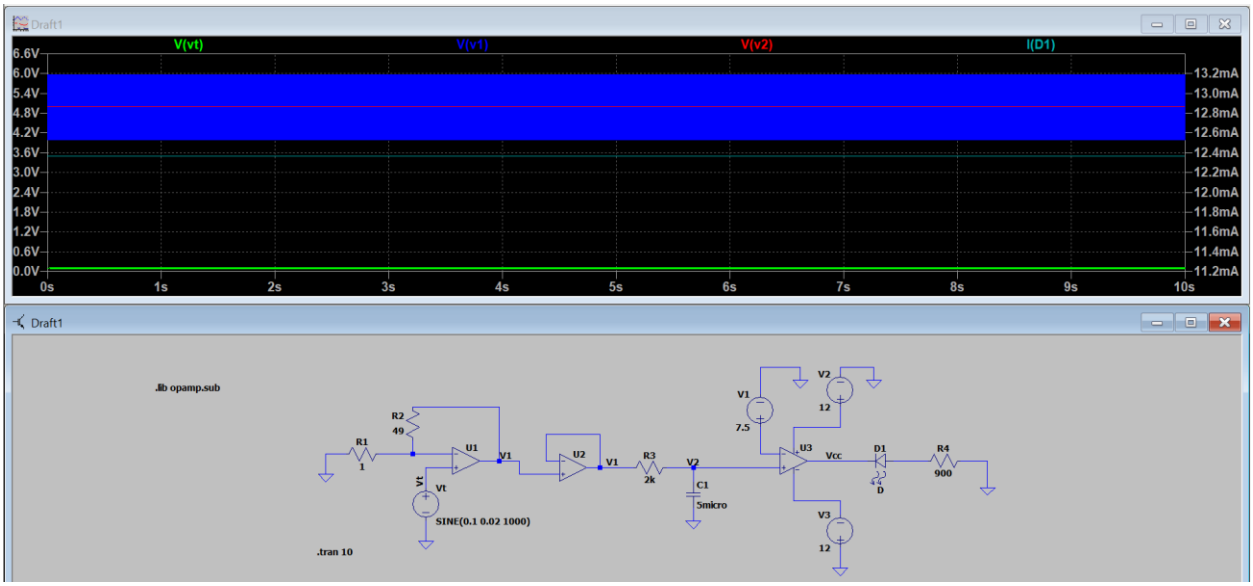


2. We then added the low pass filter and tested whether it was removing the AC signal by inputting a sinusoidal voltage with an offset of 200mV (0.2V), an amplitude of 20mV (0.02V), and a frequency of 1000 Hz (green line). Pictured below is the amplified signal (blue) and the filtered output (red). Note that the output actually has an approximate amplitude of 0.000015V (apparent under a zoomed-in scale), but is reasonably close to the desired DC output.



3. Finally, we added the comparator and checked that the circuit was working as intended.

We tested the circuit under an input of Vt = 0.1 V DC offset, 0.02 V Peak Amplitude, 1000Hz (green) and observed a correct output current I(D1) (light blue). The output current was approximately 12.4mA, which was within the specified bounds, which means the diode was “on” (as it should have been because the input offset was below 150mV).



We then tested an input (green) of V(t) = 0.2 Volt DC offset, 0.02 V Peak Amplitude, 1000Hz. As expected, the output current (light blue) was zero and the LED was “off” because the input offset was above 150mV).