PHY405 Lab 5

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Collaborators for all questions: none. Partner (for Lab 1-10): Jacob Villasana.

R-1 / R-2

If one were to consider the circuit created by the inputs at both voltages of the op-amp, and the current being supplied to the LED (the outermost loop), one has $V_{\text{set}} = R_{\text{sense}} I_{\text{LED}}$, hence $I_{\text{LED}} = \dfrac{V_{\text{set}}}{R_{\text{sense}}}$.
For R-2, we noticed that the V_{set} and V_{sense} voltages were proportional:

V_{set} (± 0.001)	V_{sense} (± 0.001)
0	0
0.514	0.518
1.007	1.024
1.517	1.550
2.503	1.570

We noticed the proportionality of V set stopped around the 1.6V input mark. This was assumed to be because the diode limited voltage up to a certain value, or something to do with the op-amp/transistor (I couldn't figure this out).

R-3

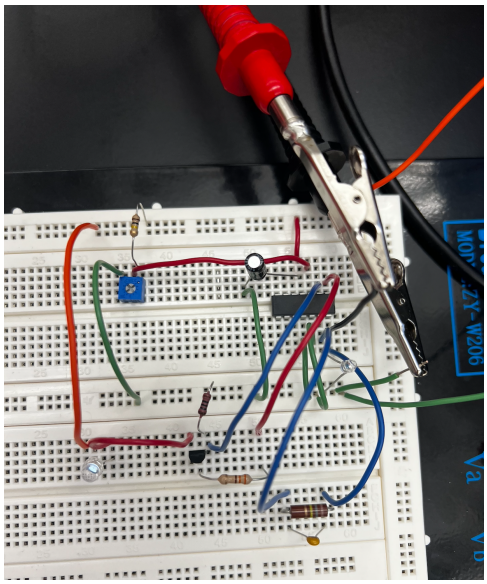

Figure 1: voltage controlled current source circuit. Input and ground were taken from Arduino Uno analog pins. Green wires represent common ground connections. Orange wires represent voltage in. Blue and red wires represent internal connections.

R-4

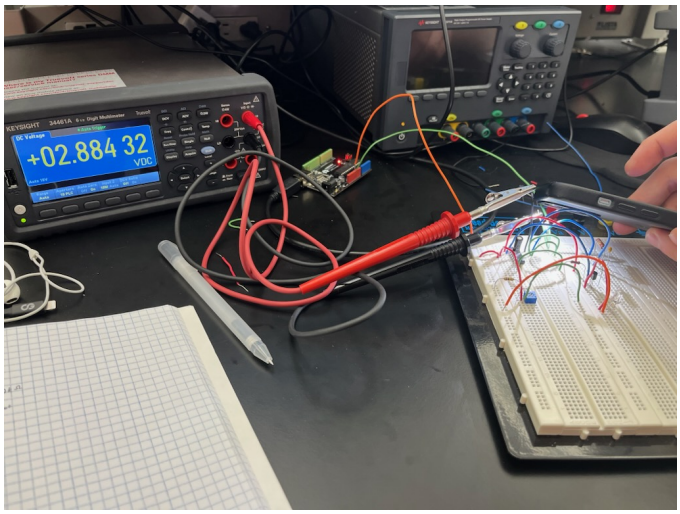

Figure 2: Voltage reading from V_{sense} with an uncovered photodiode (+ external light source for emphasis). Measured using the multimeter and alligator pins with reference to the common ground.

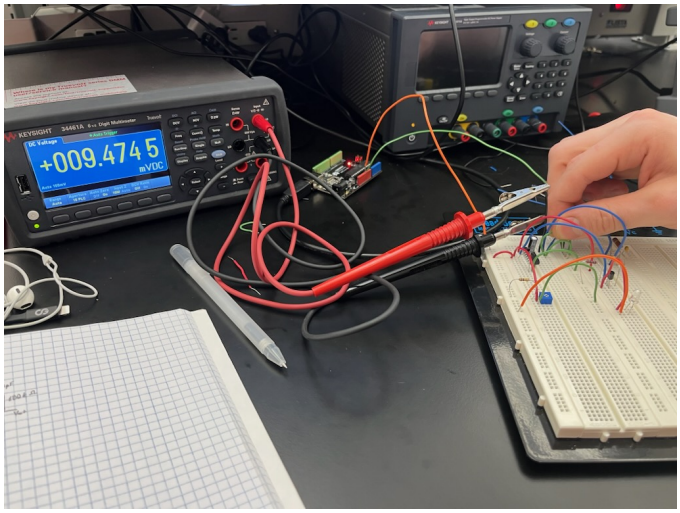

Figure 3: Voltage reading from V_{sense} with a covered photodiode (my fingers). Note that the multimeter reads millivolts.

R-5

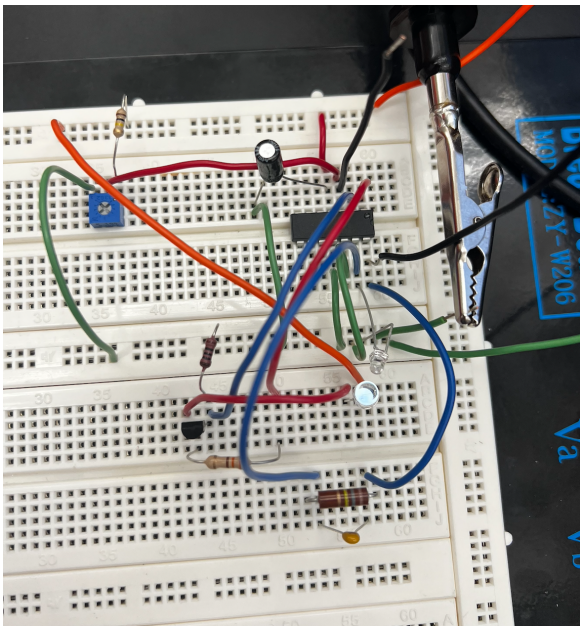

Figure 4: photo of circuit with the photodiode/LED very close together. This was later refined so that the two were touching (this is an older image and did not have time to return to the lab). Wire colors are identical to those described in R-3.

R-6

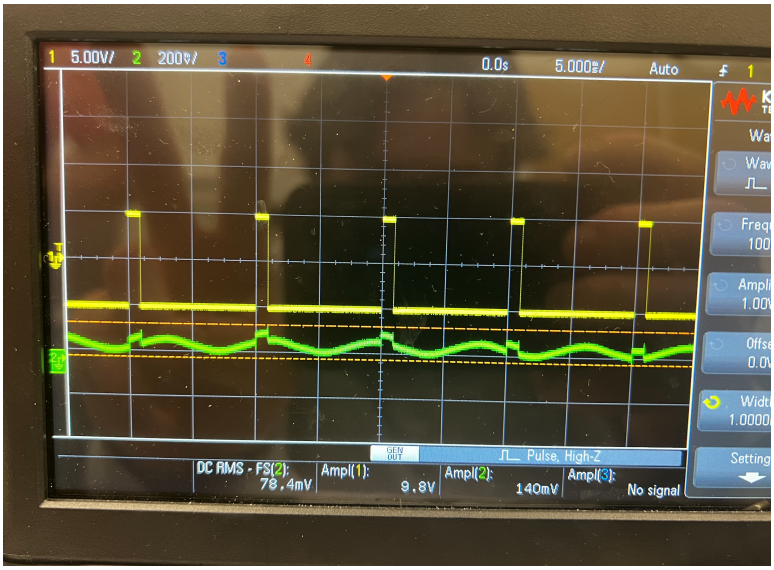

Figure 5: Screen capture of wavegen in/out signals from the oscilloscope. The yellow pulse wave is the input given to the LED circuit. The green wave is the measured response from the photodiode circuit. The sine wave in the background of the pulse is due to external room lighting.

R-7

Using the wavegen VPP setting, adjusting it up/down, there was a degree of proportionality be-

tween the wave 1 and wave 2 measured VPP's:

$V_{\text{pulse, in}}$ (± 0.1)	$V_{\text{pulse, out}}$ $(\pm 10\text{m})$
10.1	110m
17.5	165m
23.3	210m
28.5	257m
33.8	300m

From the table one may observe that the V in and V out measurements were proportional, but with a roughly-consistent 3V/30mV voltage decrease between the two.

R-8

The chosen resistor and capacitor for the circuit was a *nominal* $180k\Omega$ resistor and a 33pF capacitor. Using $f_c = \frac{1}{2\pi RC}$, the expected cutoff frequency should be $\sim$ 26.7 kHz. The observed cutoff was around 20kHz. This was attributed to either (a) external lighting picked up from the photodiode, (b) having a decreased voltage input from the voltage-controlled current source, or (c) the resistor and capacitor being imposters and having a higher/lower capacitance/resistance than described (we didn't measure them...).

Figure 6: Bode plot of the frequency analysis given to the circuit via the oscilloscope. The -3db cutoff was located around 20kHz. The screen capture instead of actual plot is a result of running out of time (we messed up the first plot).

R-9

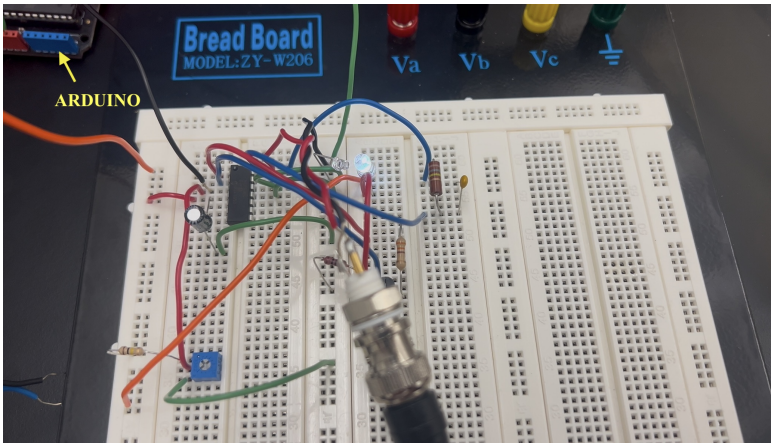

Figure 7: Photo of total working circuit, including the LED flashing. The wire connection labels are identical to that of those described in R-3. The BNC wavegen input is shown in the middle and the arduino is located in the top left corner, using the ground and analog output pins. The capacitor and resistor were chosen to me 33pF and 180kΩ and are located on the right of the circuit in parallel.

R-10

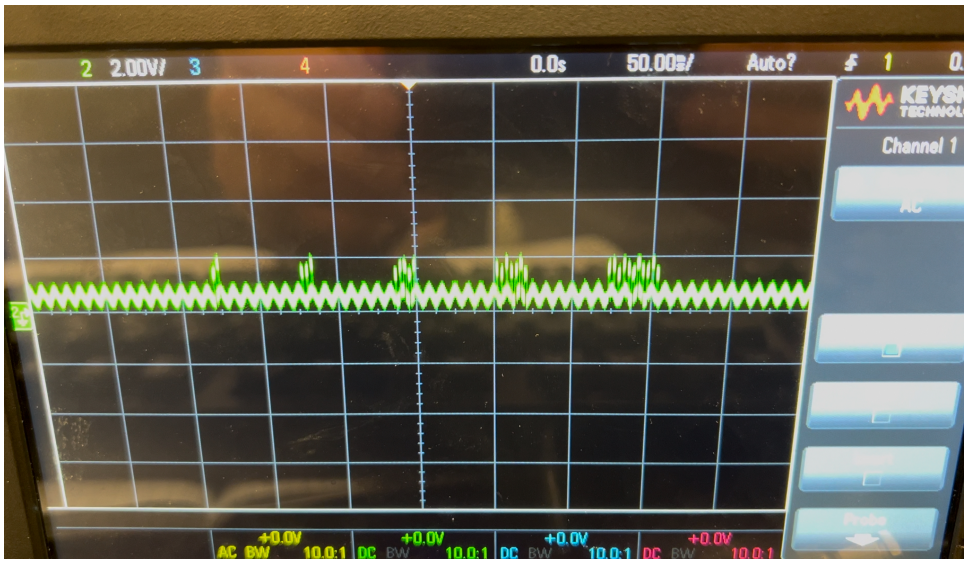

Figure 8: screen capture from the oscilloscope input from the photodiode / LED circuit with the voltage input to the LED being provided by the Arduino. The prime number sequence was given as 2-3-5-7-11, as shown above.