FinalProjectWeek2

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1 Final Project Week 2

Written by: Percy Nizamova
Lab Partner: Thomas Whitehead

[2]:
```
from PIL import Image
from IPython.display import display

def displayImage(fileName, width):
    img = Image.open(fileName)

    base_width = width
    w_percent = base_width / float(img.size[0])
    new_height = int(float(img.size[1]) * w_percent)
    img_resized = img.resize((base_width, new_height))
    display(img_resized)
```

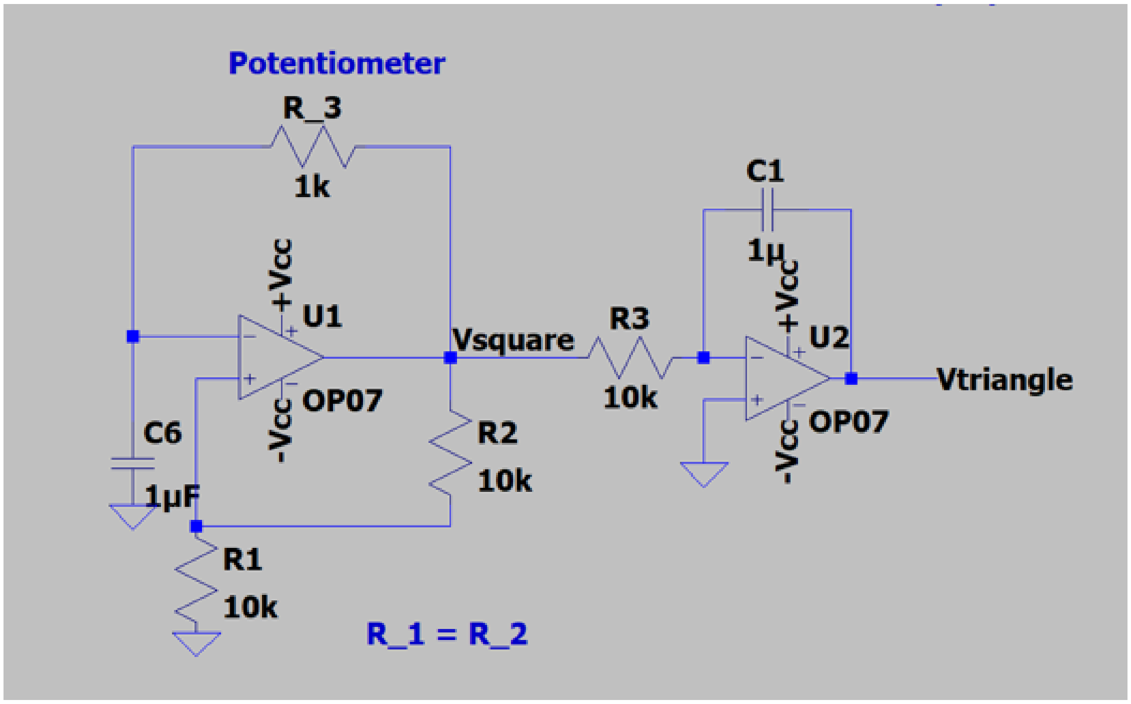
2 Abstract

For this lab today, we have two objectives. Our first objective is to set our Op-Amp circuts for making a sine wave and a triangle wave using our previous findings/setups, since we found last week that our Op-Amp circuts worked out the best - despite the limited frequency range. For the second half of the lab, we are going to test and figure out how to use our IC3038 chip. (**Reword**)

3 Triangle wave Generator:

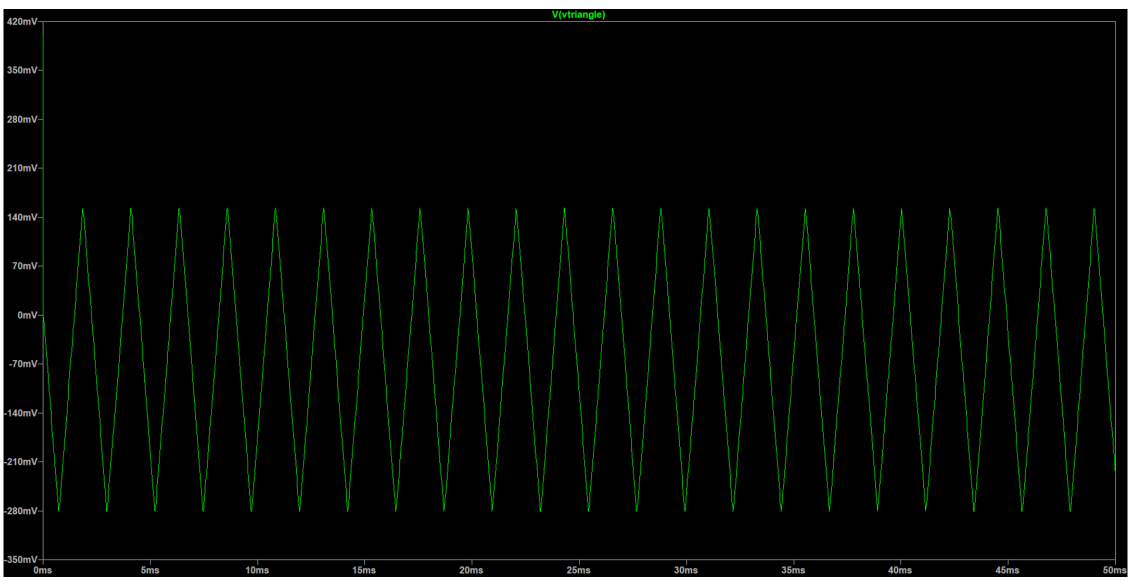
We started off this process by building our diagram in LT Spice. Below is an image of our diagram:

[5]:
```
displayImage("Final_Proj_2_1.png", 600)
```



As we can see here, we have any square wave circut, where our square wave circut is going to be inputted into an inverting integrator, which should transform our wave into a triangular wave.

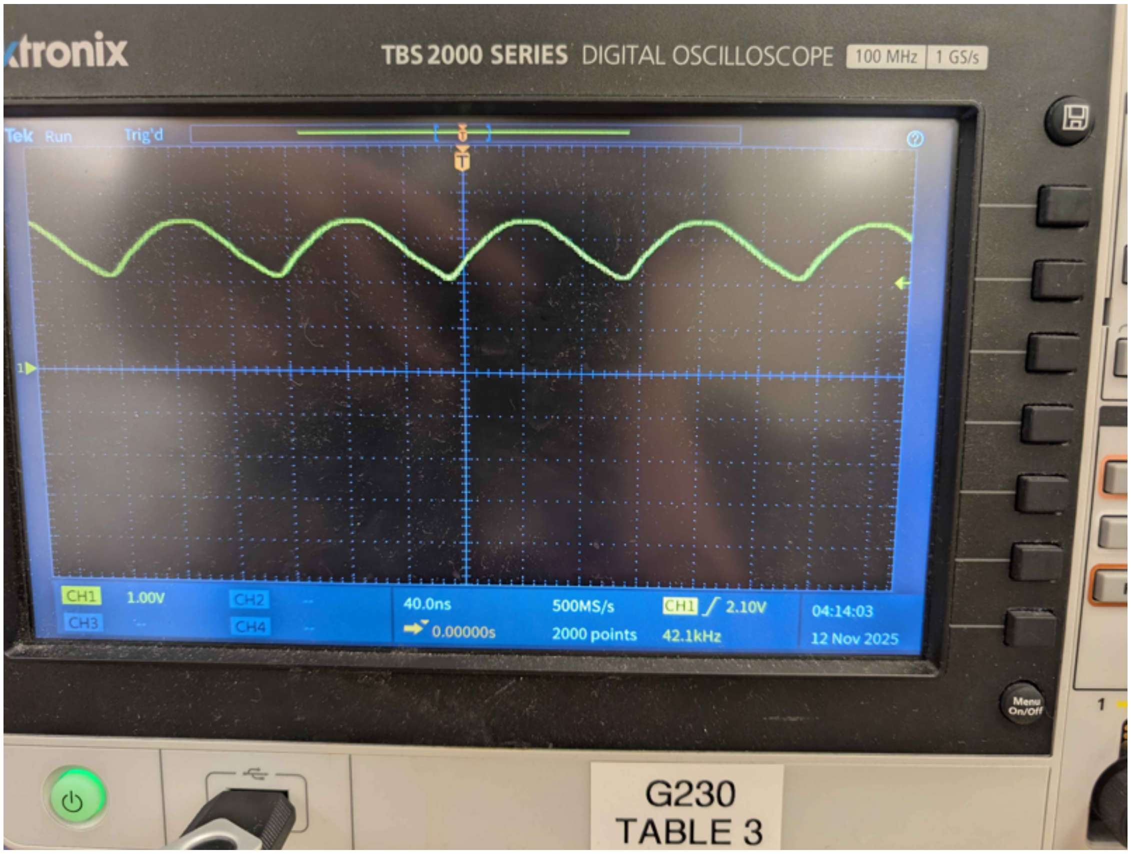
[8]:
```
displayImage("Final_Proj_2_2.png", 2160)
```



Now we are going to measure our values, for our resistor we got a value of 10.05 kΩ, and for our capacitor we got that it was about 0.948 uF.

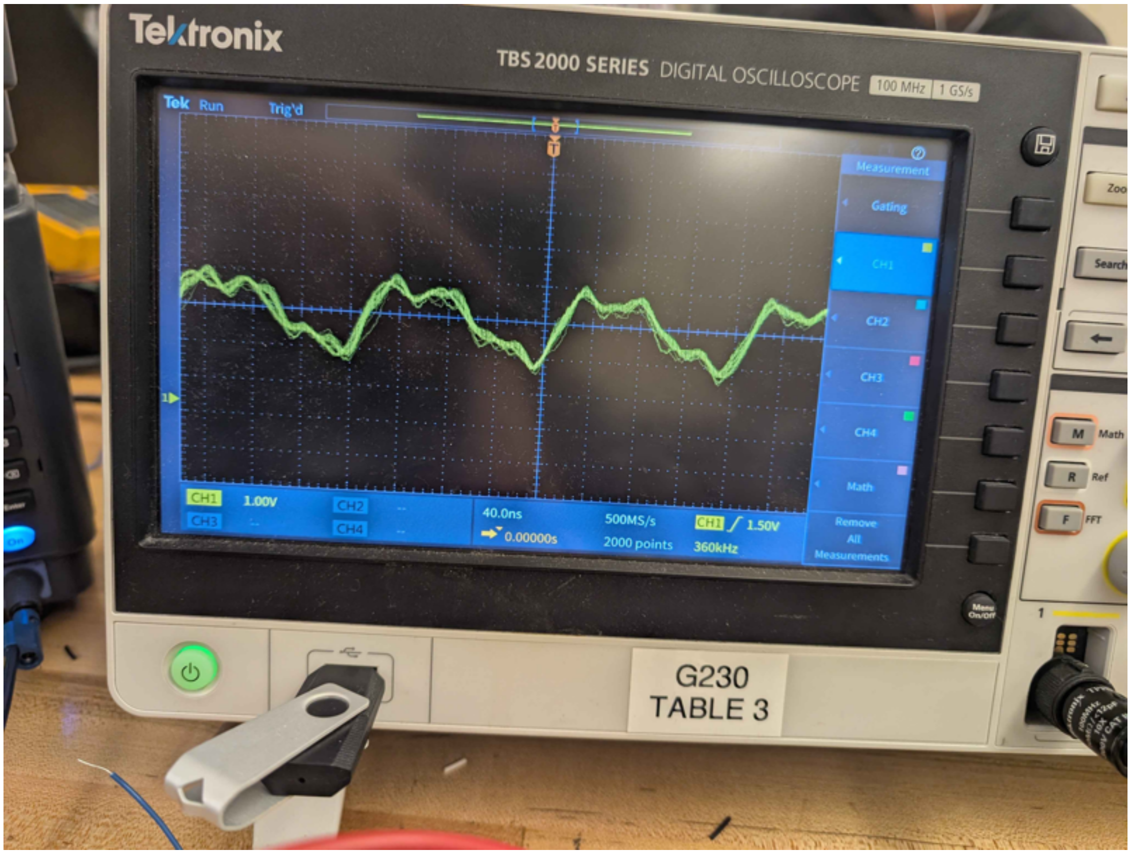
Below is an image of what our first iteration of our circut looks like:

[11]:
```
displayImage("Final_Proj_2_3.jpg", 800)
```



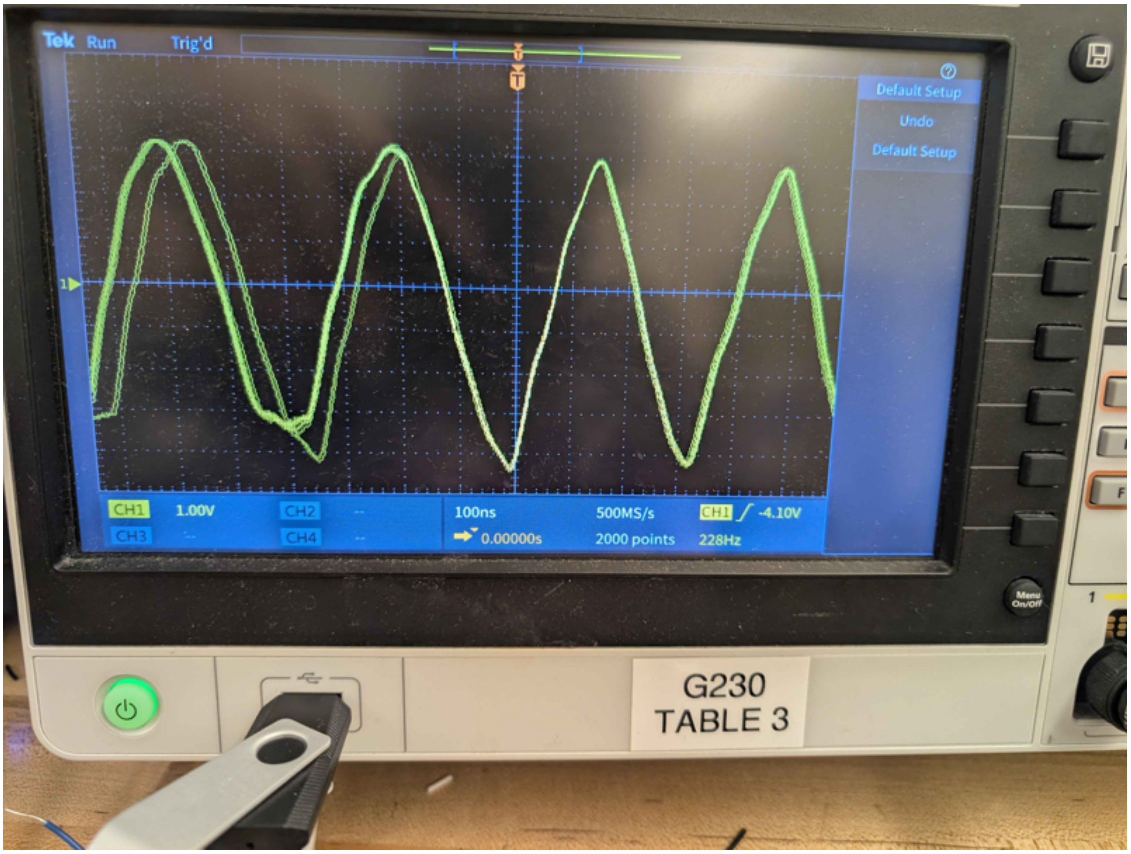
As we can see there is a 5V D.C offset which is not something we expected. We can see that forour wave form as well, we can see a curved peak instead of a square peak which is not what we should expect. Right now we are goung to test the hypothesis that the issues from our square wave generator are propogated into our triangle wave generator. We swapped the value of our resistor to a $1k\Omega$ resistor and we connected our function generator to test if it was an issue with our circut or if there was an issue with the way our waveform propogates.

[12]:
```
displayImage("Final_Proj_2_4.jpg", 800)
```



This is not our intended behavior. However, when I connected back our Op-Amp circut, and measured the waveform with our new resistor. This is what our wave form looked like:

[13]:
```
displayImage("Final_Proj_2_5.jpg", 800)
```



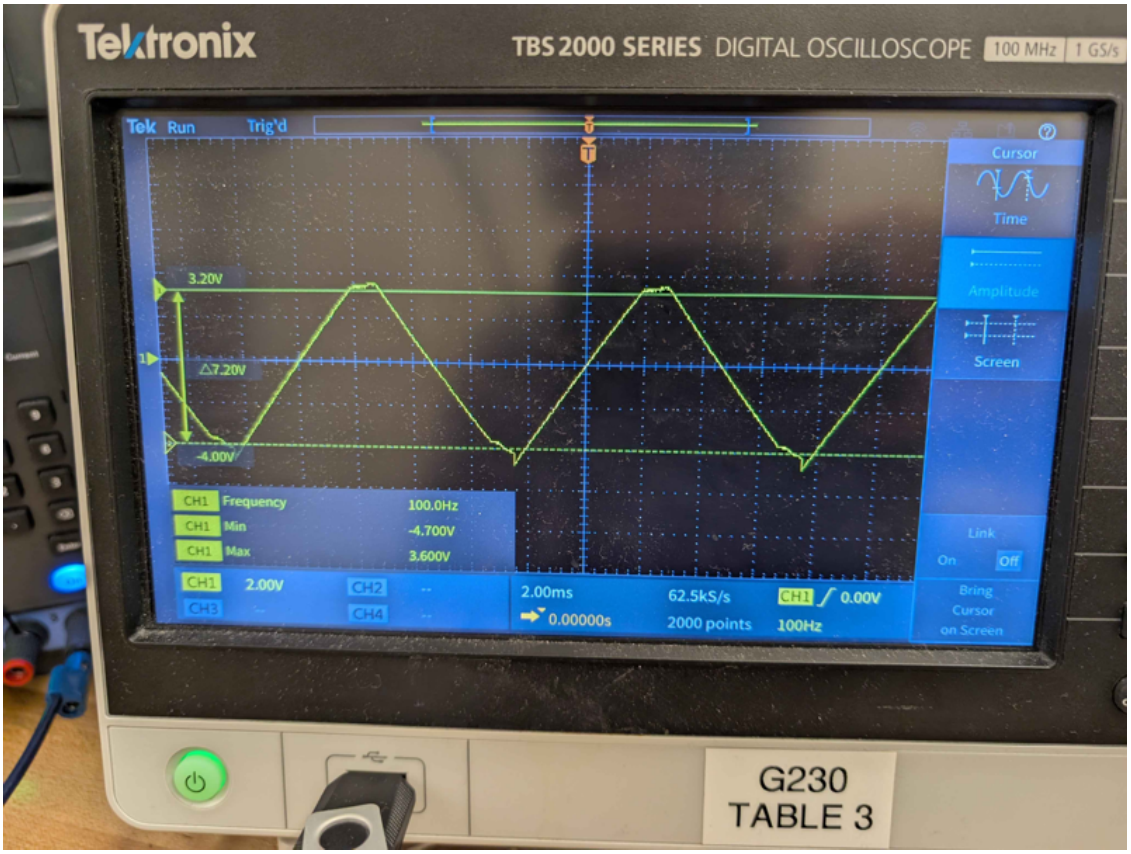
Although our wave form is generally correct, we are having an issue with our minimum and maximum voltage, where our minimum voltage is -4.3 V and our maximum voltage is 3.25 V.

There are a few issues with our components, where in order to counter the DC offset of our integrator - we needed to add an extra resistor. Since our Capacitor in our lab doesn't act like an "ideal capacitor" compared to our real value capacitor. This means we need to add a resistor in parallel to counter this DC offset. Now that we've confirmed that our wave is generally a square wave we will do calculations to figure out how to counter the DC offset.

Since we do not have an ideal capacitor - we used the methodology used in our Lab 4 to see if that was the issue that was causing the DC offset. We used our LCR bridge and we set the parameter is set to C+R and our Equiv Circut was set to parallel, where for our equivilant resitance we got a resistance if 139.58 $k\Omega$. We grabbed a resistor with a resistance of 118$k\Omega$ and put it in series with our circut.

We did a sanity check to confirm if the issue was with our wave square wave or with our integrator circut. I used a frequency of 100 Hz and we found that our triangle wave still has the behavior where the minimum and maximim voltages are different. I also replaced our Op-Amp with the LF365, rather than the NTE937 since I found there were much better results. Below is a screenshot of what it looks like:

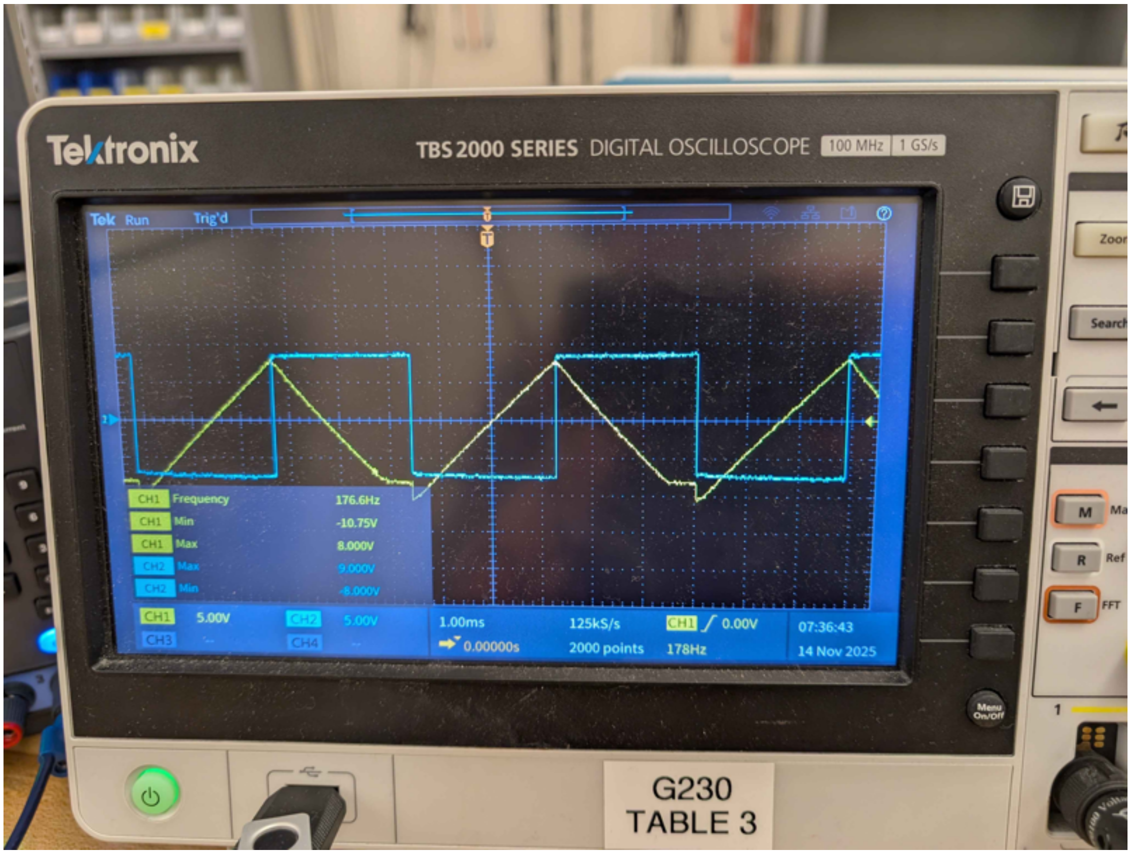
[4]:
```python
displayImage("Final_Proj_2_6.jpg", 800)
```



Next we decided to test if this was a result of the slew rate limits of our Op-Amp, and by increasing the voltage to 10 V on our function generator, we found that this made our minimum and maximum voltage more even. Our maximum voltage is now 4.770 V and our minimum voltage is 4.500 V. This is way better than our prior results. Our wave is also a perfect triangle wave with our function generator, now we just need to iron out any kinks with our square wave. Now let us start by replugging in our values into the square wave.

Below is an image of what our wave looks like with our square wave:

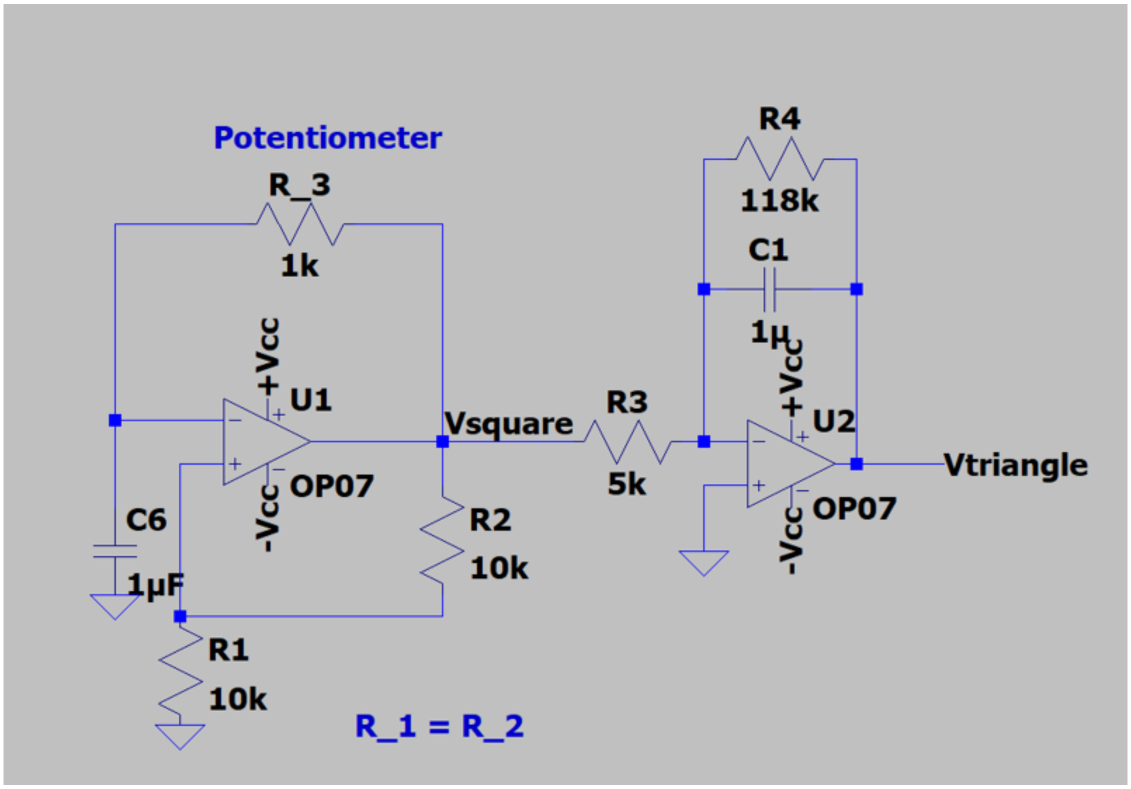
[10]:
```
displayImage("Final_Proj_2_8.jpg", 800)
```



As we can see down below, our triangle wave has a slight imperfection which occurs when our square wave hits it's minimum. The maximum value of our triangle corresoponds to our top of our square wave and the bottom corresponds with the flat part of our triangle wave. In order to compensate this, we incresed our resistor that inputs into our circut to $5k\Omega$ and we found that it helped with the clipping since it reduces transient current into the integrator, allowing us to get an even wave form. This worked, and we finally have a triangular wave form that is variable with our turn of our potentiometer. I will attach a youtube video since this is pretty cool: https://www.youtube.com/shorts/TQWqijuCMGI.

Below is our final circut diagram:

[11]:
```
displayImage("Final_Proj_2_9.png", 800)
```


Potentiometer
R_3
1k
+Vcc
U1
OP07
-Vcc
C6
1µF
R2
10k
R1
10k
R_1 = R_2
Vsquare
R3
5k
R4
118k
C1
1µ
+Vcc
U2
OP07
-Vcc
Vtriangle

[ ]: