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BE 4355

Senior Design II

Notebook #1-2-3-4-5

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Objective: Building adjustable square wave generator circuit with a 555 timer

Approach for activity: Learn about 555 timer as much as possible

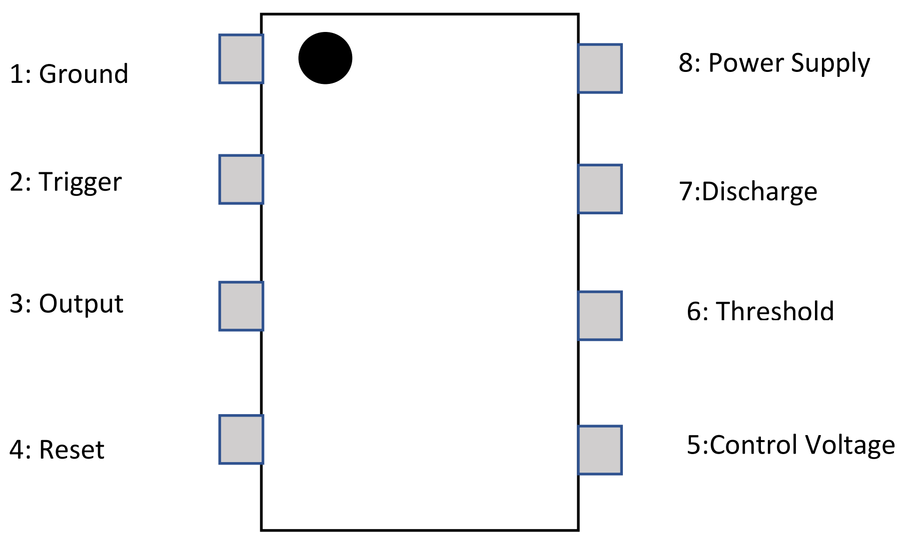
Outcome of activity: Found one circuit to try out later

Impact of activity on the project: Very important with waveform generator task

Assessment of the importance of activity: Important in continuing the project

Tips to improve the approach for doing the activity for iterations: Find the datasheet first

555 Timer Pins

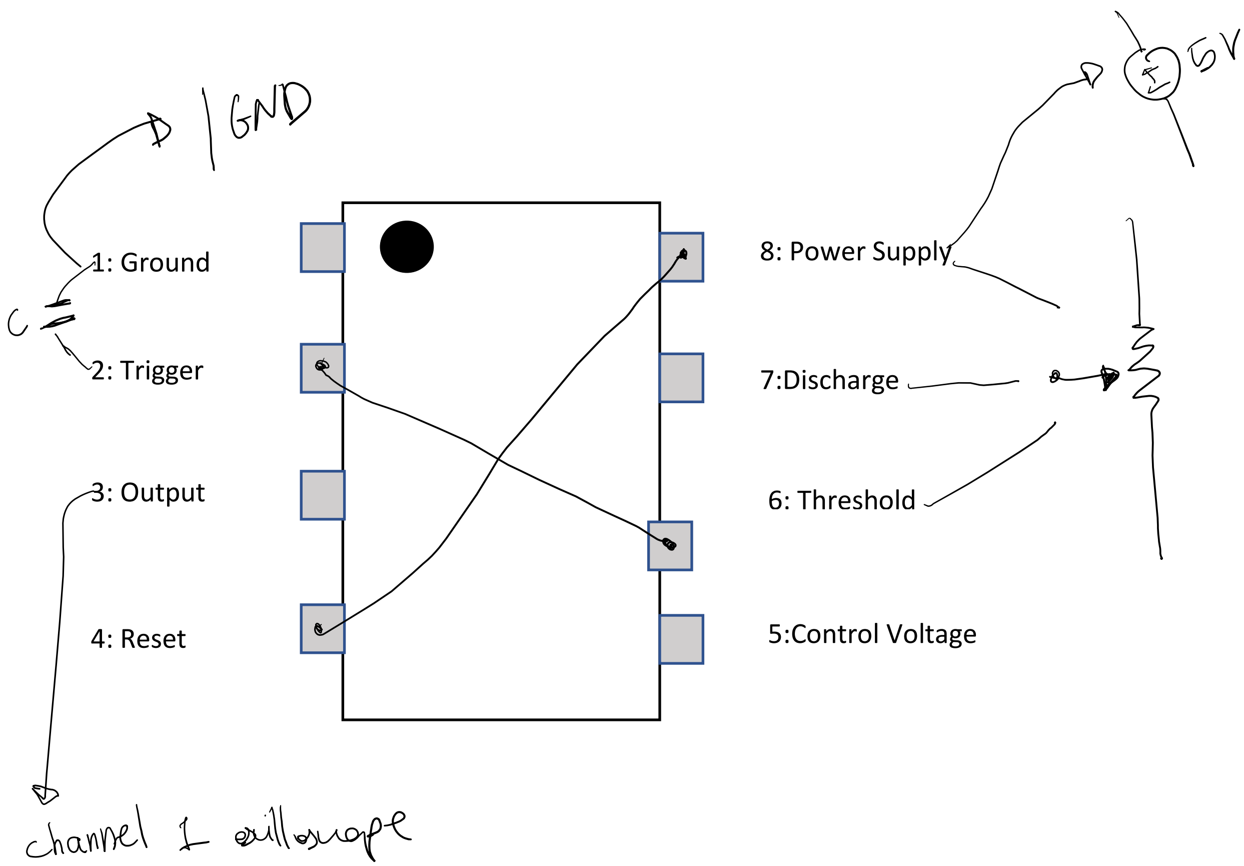


$f_c = \frac{1.44}{(R_1+R_2)*C}$

Example:

- R_1= 100Ω
- R_2=100 Ω
- C_1=0.15 uF
- f_c=48 kHz

Circuit 1 connections



January 19th Senior Design Task

Objective: Building adjustable square wave generator circuit with a 555 timer

Approach for activity: Find the right circuit and try to copy it

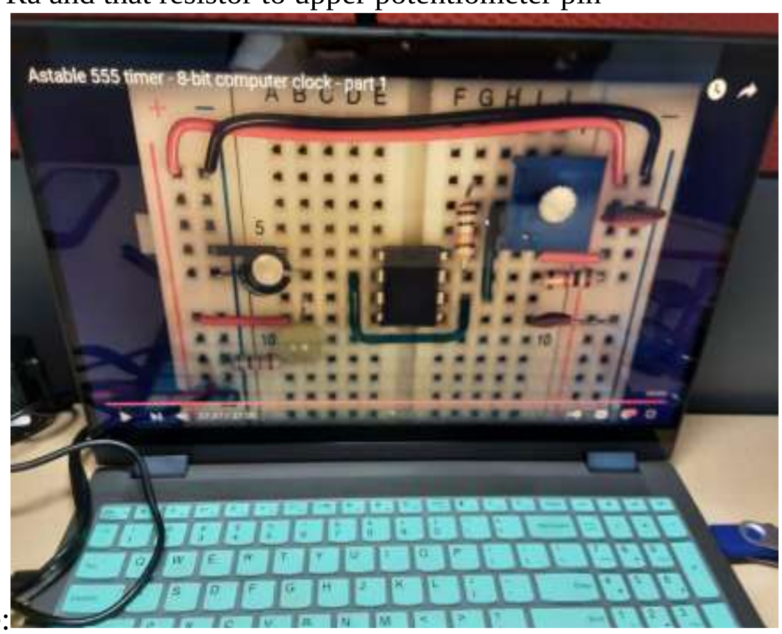
Outcome of activity: Circuit was found and created

Impact of activity on the project: Important in completion of the waveform generator task

Assessment of the importance of activity: Very important to continue the project

Tips to improve the approach for doing the activity for iterations: Find datasheet first next time

Datasheet has the formulas for astable waveforms

- Pin 3 : output and ground for oscilloscope channel 1
  - Capacitor and ground (?) for oscilloscope channel 2
- Multimeter to measure capacitance values
- Pin 5 to ground to reduce noise
  - 0.01 uF capacitor
- Pin 4: connected to voltage
- Potentiometer instead of Rb resistor
  - Pin 6 and 7
  - Pin 6 to middle pin of potentiometer
  - Pin 7 to resistor Ra and that resistor to upper potentiometer pin
  - Circuit to create: 

555 timer tutorial

- Pin 1 to ground

- Pin 2 to Pin 6
- Pin 3 to resistor for LED resistor R_l
    - Connect LED to that resistor in series
    - Resistor in series and to ground
- Pin 4 to positive voltage pin
- Pin 5 to nothing
- Pin 6 to resistor Rb
    - R_b to pin 7
- Pin 7 to resistor R_a
    - Resistor R_a to positive voltage source pin
- Pin 8 to positive voltage source

Without capacitor LED doesn't do anything

Capacitor:

- Negative side to the negative voltage source (aka ground)
- Positive side of capacitor to pin 2

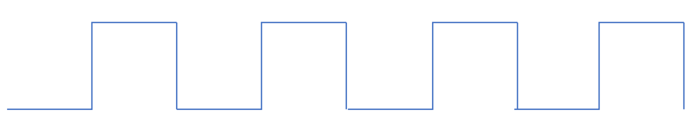
LED will start blinking with capacitor.

Adjustable flashing/blinking LED

555 timer across the breadboard:

- Pin 1 to negative voltage source
- Pin 8 to positive voltage source
- Pin 6 to pin 2
- Pin 4 to pin 8
- Pin 7 and pin 8 to R_a=1 kΩ
- Pin 6 and pin 7 to R_b=100 kΩ
- Capacitor C_1= 10uF
    - Pin 1 to negative capacitor pin
    - Pin 2 to positive capacitor pin
- Extend pin 3 with jumper wire and put the LED in series with the jumper wire and the resistor R_l=220 Ω. Connect them to negative voltage source (aka ground)
- ↓resistance value flashing rate/blinking increases
- ↓ capacitor value flashing rate/ blinking increases

Low Frequency Pulse Generator Circuit



T_C

Pulse width

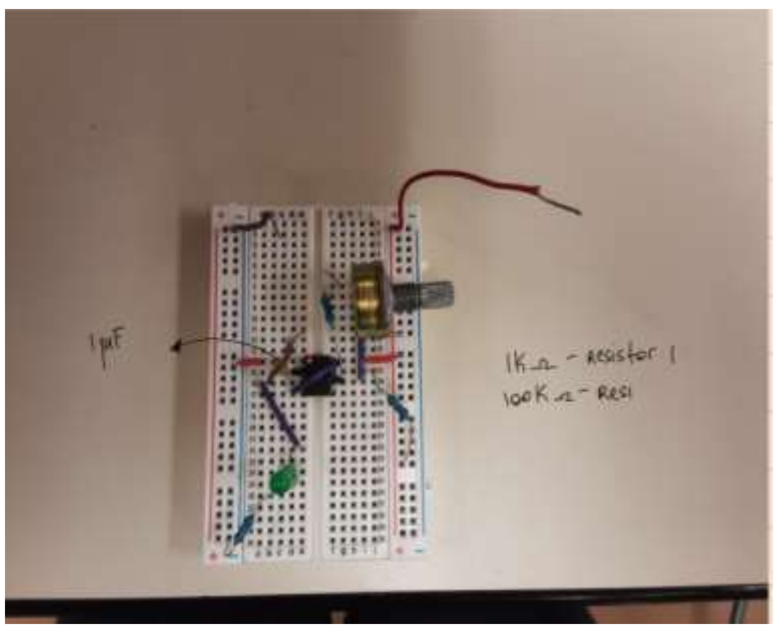
$\uparrow R_1 \downarrow F$

$\uparrow C_1 \downarrow F$

$f = 1/T_C$

$$f = \frac{1.44}{(R1 + 2 * R2) * C}$$

Practice

Created circuit: 

Frequency generated: 8Hz

January 20th Senior Design Task

Objective: Building adjustable square wave generator circuit with a 555 timer

Approach for activity: Build circuits and test for correctness

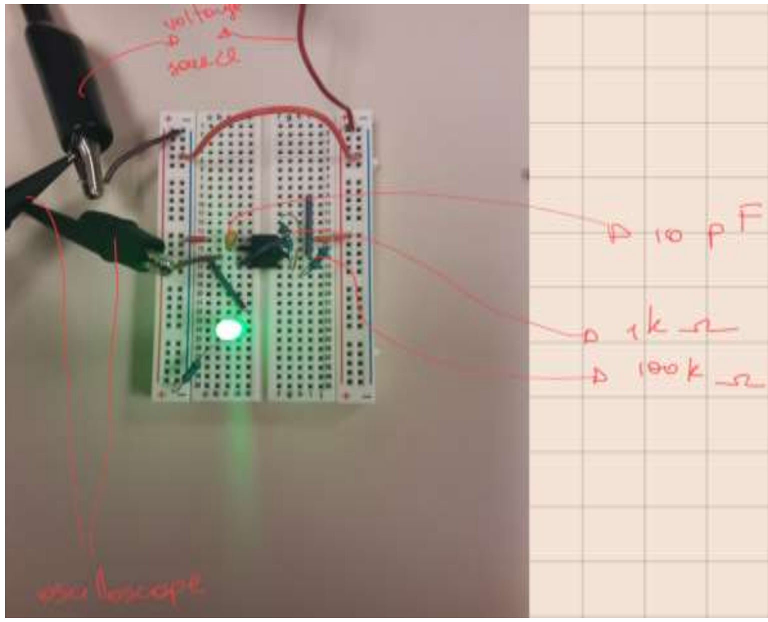
Outcome of activity: Oscilloscope square waveform was generated

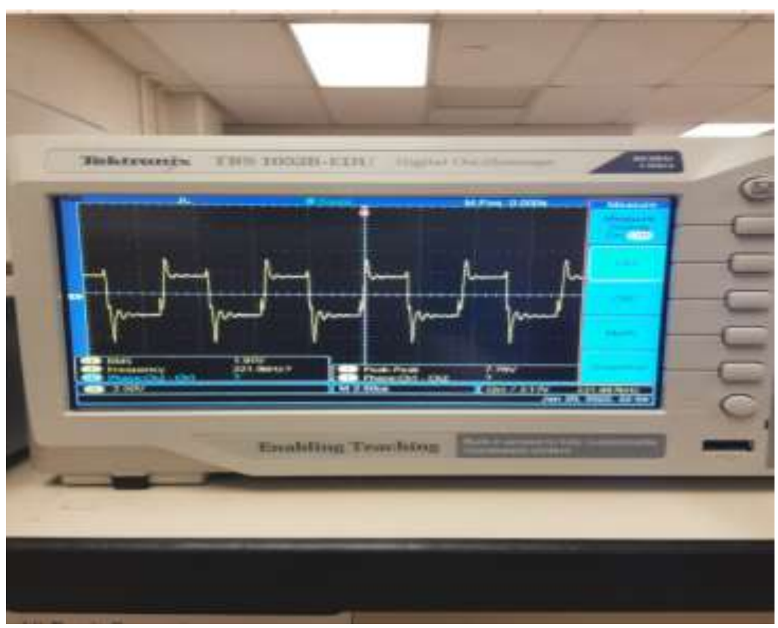
Impact of activity on the project: Important in progress of waveform generator task

Assessment of the importance of activity: Very important in continuing project

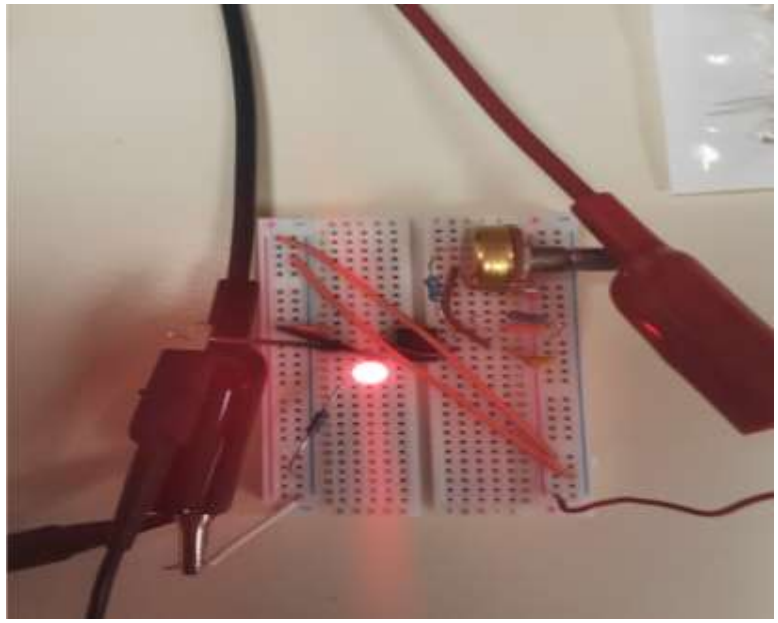
Tips to improve the approach for doing the activity for iterations: Find the datasheet next time

Practice

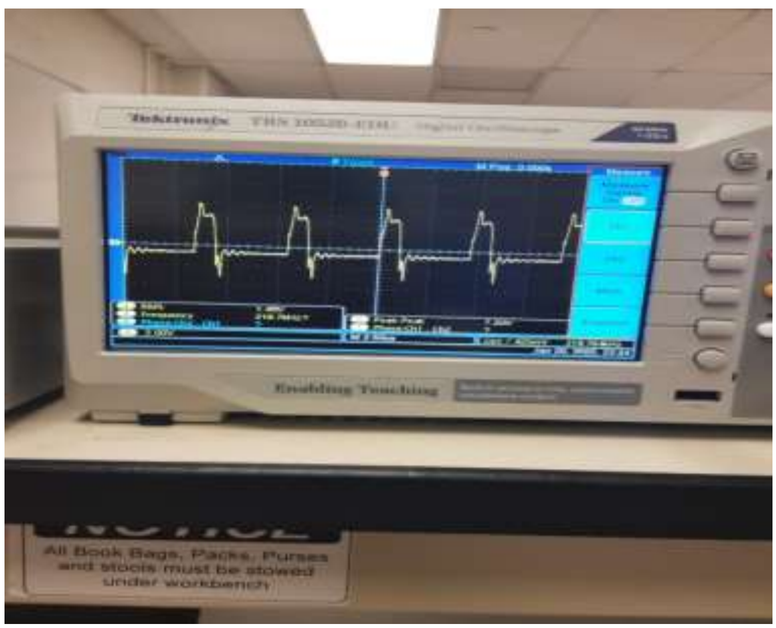
Created circuit: 

Oscilloscope results: 

Created circuit:



Oscilloscope results:

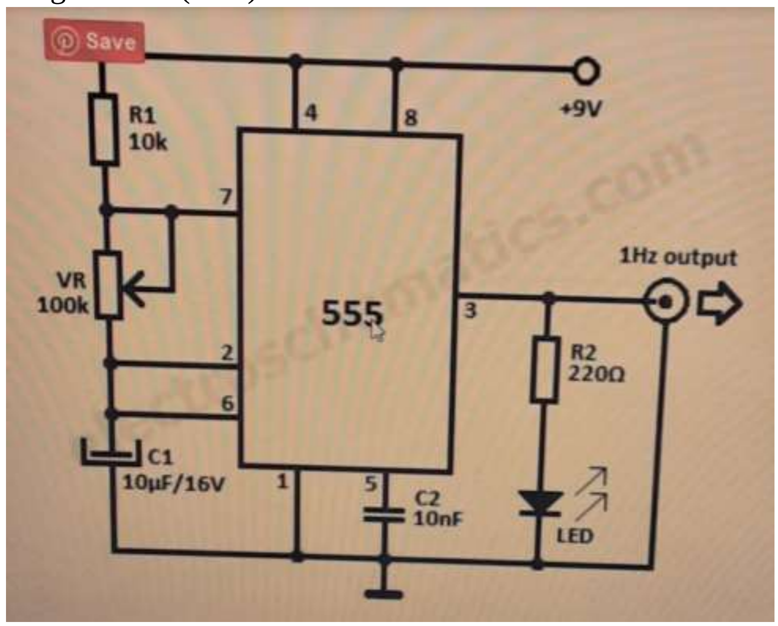


1 Hz Pulse Frequency Generator with 555 Timer

Circuit connections of 555 timer:

- Pin 1 to ground
- Pin 3 connected to R_2 = 220 Ω and that resistor connected to LED in series
- Pin 5 to C_2=10nF
    - C_2 to ground
- Pin 2 connects to V_R=100 kΩ
- Pin 7 connects to R_1=10 kΩ

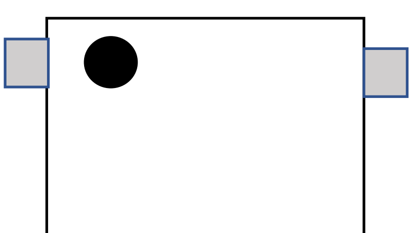
- Pin 4 connects to R_1=10kΩ
- Pin 8 connects to positive voltage source (+9V)
  - Circuit Diagram:



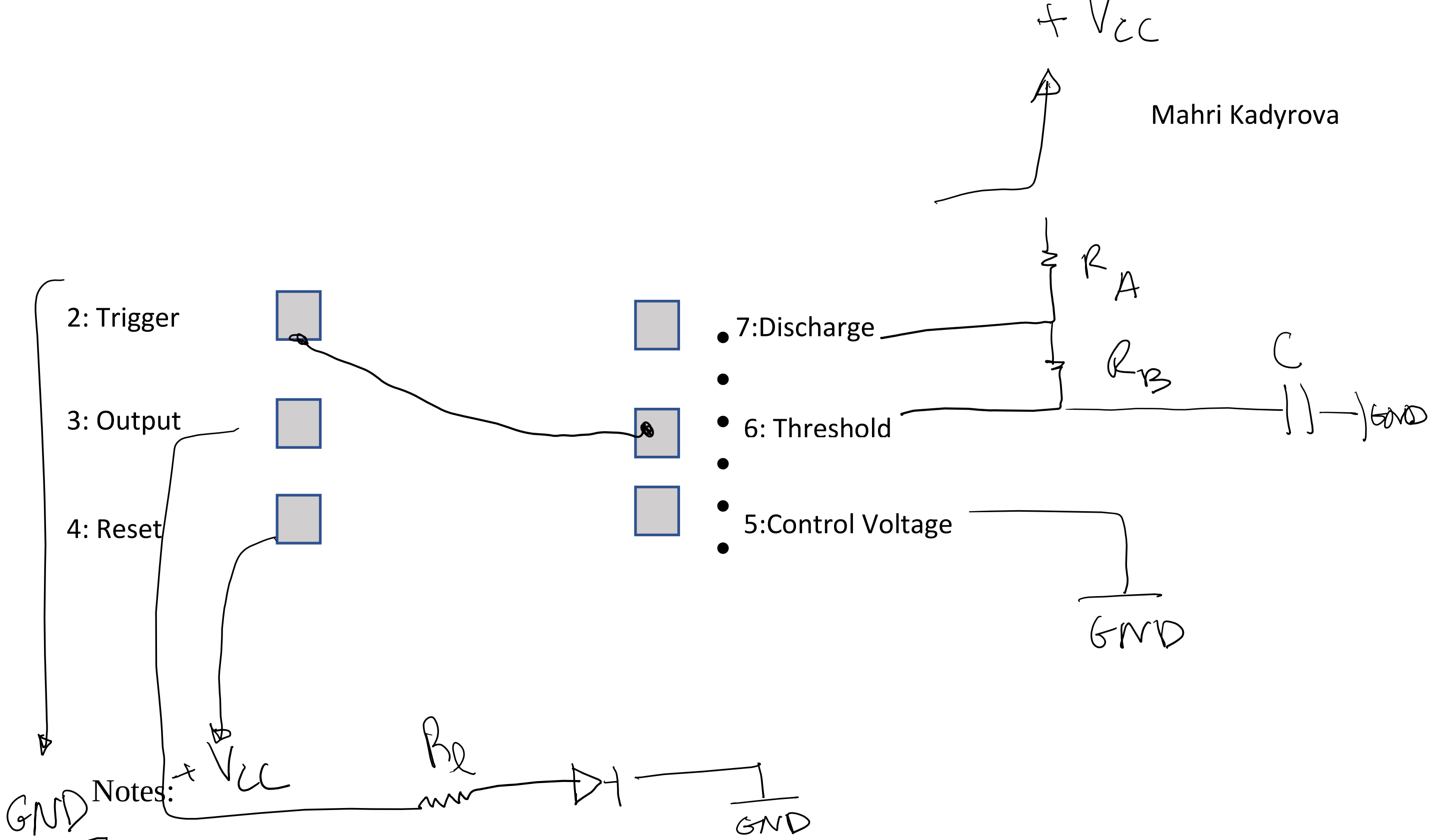
IC- integrated circuit

- 555 timer IC
  - Oscillating circuit
  - Astable
    - Pin 3- output: is where oscillations are
    - Astable mode voltage circuit:

1: Ground



8: Power Supply



Notes:

- R_l has to be larger when using bigger voltage source.

January 21st Senior Design Task

Objective: Building adjustable square wave generator circuit with a 555 timer

Approach for activity: To build circuits from tutorials and make sure components work

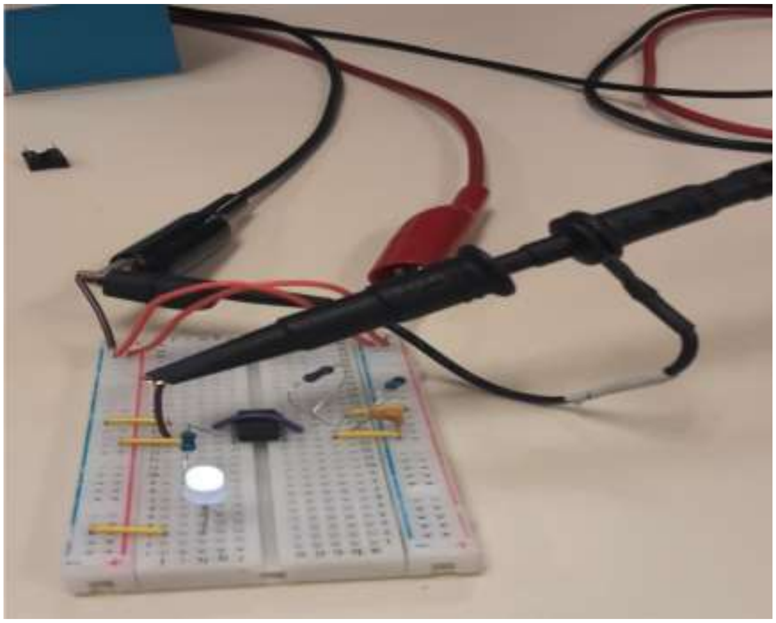
Outcome of activity: Circuit and square waveform was generated

Impact of activity on the project: Important in progress of the waveform generator task

Assessment of the importance of activity: very important to continue the project

Tips to improve the approach for doing the activity for iterations: Find the Datasheet first next time

Practice

Created circuit: 

Connections on breadboard:

- Pin 8-7: R_a=100 kΩ
- Pin 7-6: R_b=100 kΩ
- Pin 6-GND: C=1nF
- Pin 3 connected to resistor R_l= 330 Ω which is in series connected to LED and ground

Measuring resistors using multimeter

Connections on breadboard

- R_L=230 Ω
- Pin 8-7 resistor R_a=106 kΩ
- Pin 7-6 resistor R_b=100 kΩ
- Pin 3 reading:
    - Peak to peak : 3.92-4.16 V [fluctuates]
    - Frequency ~ 1.3 kHz
    - RMS ~ 9.16 mV

New Circuit Diagram from Texas Instruments Datasheet

Connections on breadboard:

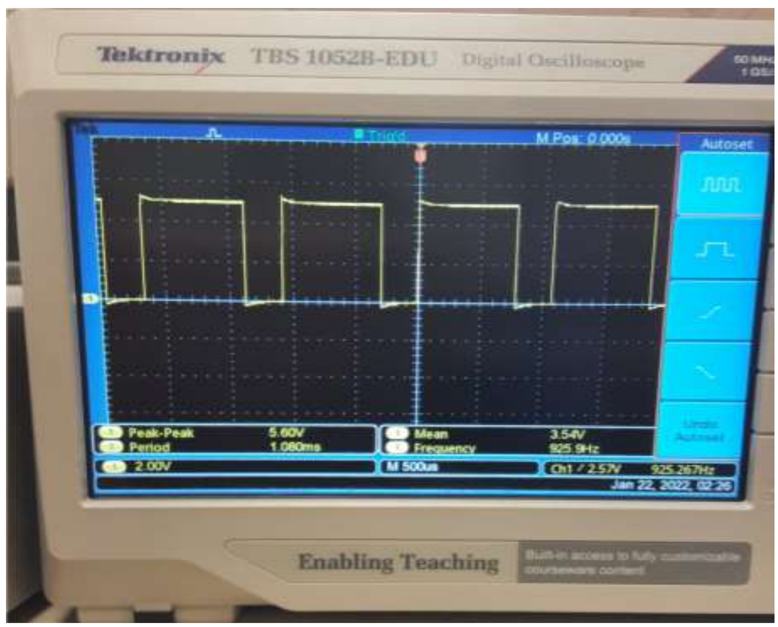
- Pin 1 to ground
- Pin to pin 6
- Pin 2 to capacitor C_1

  - Capacitor C_1 to ground
- Resistor R_b to pin 6 and pin 7
- Resistor R_a to pin 7 and pin 8
- Pin 4 to pin 8
- Pin 5 to nothing
- Pin 4 to C 2= 0.01 uF
  - C2 connected to pin 4 and then to ground
- Pin 8 to 5 V voltage source
- R_l connects pin 3 and pin 8

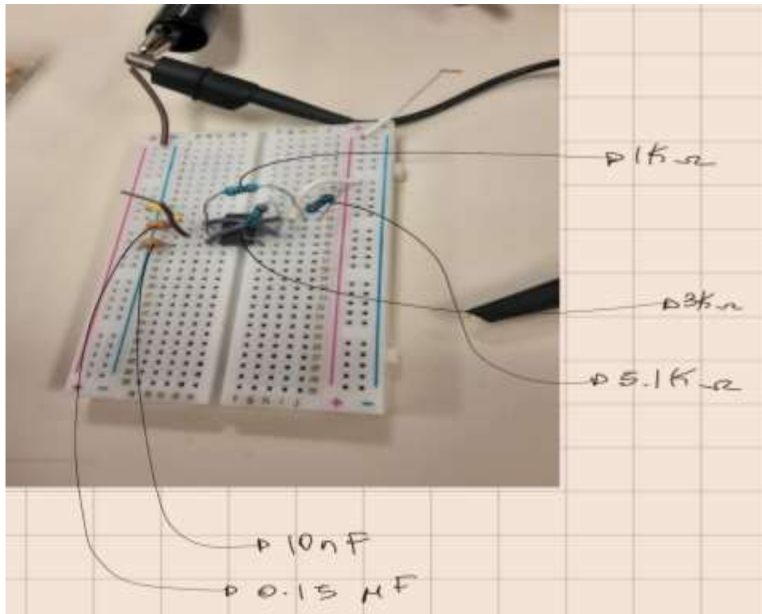
Experiment test

Findings include:

- R_a= 5.1 kΩ
- R_b= 3 kΩ
- C_1=0.15 uF
- R_l=1 kΩ
- Oscilloscope results :



- Circuit created :



Testing with C_1= 10pF

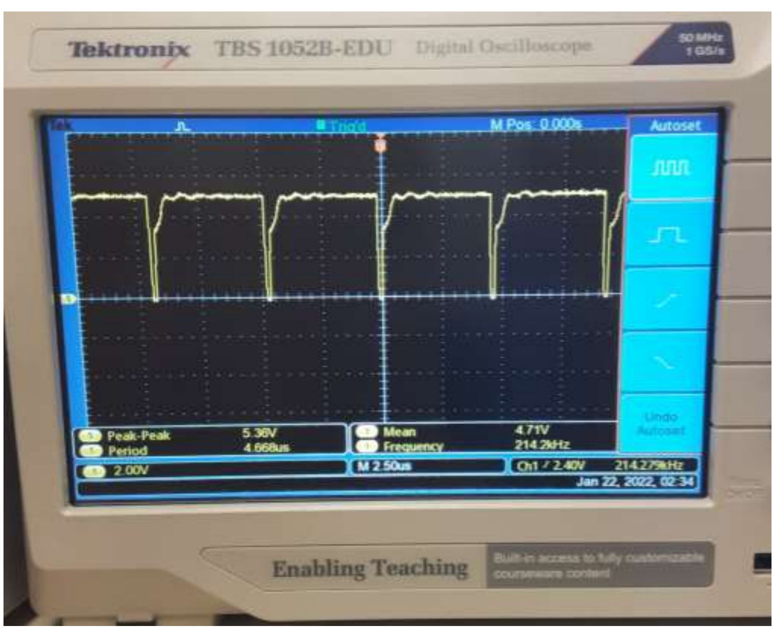
New components include:

- C_1=10 pF
- R_a=5.1 kΩ
- R_b= 3kΩ

Calculated frequency using above formulas: 12,972 kHz

Oscilloscope given frequency: 214.279 kHz

Oscilloscope square waveforms:



January 25st Senior Design Task

Objective: Generating 38 kHz oscillator

Approach for activity: Use the circuit diagram from Texas Instruments Datasheet for NE555+ timer

Outcome of activity: 2 circuits have been generated with 38 kHz and 56 kHz

Impact of activity on the project: Helped progress on the waveform generator task

Assessment of the importance of activity: Very important to see if the waveform generator is possible

Tips to improve the approach for doing the activity for iterations: Next time use multimeter for all the components to acquire as accurate resistor values as possible

Experimenting with previous circuit

R_l= 1 kΩ

C_2=0.01 uF=10nF

Entry	R_a [connected to pin 8 and pin 7] (kΩ)	R_b [connected to pin 6 and pin 7] (kΩ)	C_1 [changing capacitor value while C_2 is set] (nF)	Oscilloscope frequency (kHz)	Calculated frequency [using formula] (kHz)
1	5.1	3	10^(-2)	~214.8	
2	5.1	3	1	~ 89.35	
3	5.1	5.1	1	~70.2	
4	5.1	33	1	~18.82	20.253
5	5.1	22	1	~26.3	29.327
6	5.1	15	1	~35.2	41.026
7	4.7	15	1	~35.6	41.499
8	3	15	1	~37.4	43.636
9	2.2	15	1	~38.2	44.720

Table 1

Notes:

- ↓R_b ↑F_{osc}
- ↓R_a ↑F_{osc}

Entry from Table 1	Ratios of Freq calculated/Freq oscilloscope	Difference: Freq calculated – Frew oscilloscope (kHz)
4	1.076	1.433
5	1.115	3.027
6	1.1655	5.826
7	1.156	5.899
8	1.166	6.236
9	1.17	6.52

Table 2

Generating 56 kHz oscillator

Entry	Ra (kΩ)	Ra from multimeter (kΩ)	Rb (kΩ)	Rb from multimeter (kΩ)	C1 (nF)	Freq oscilloscope (kHz)
1	5.1	5.125	5.1	5.066	1	~ 70.8
2	5.1	5.125	5.6	5.582	1	~67.3
3	5.1	5.125	7.5	7.429	1	~57.16
4	5.6	5.582	7.5	7.429	1	~56.12

Table 3

January 31st Senior Design Task

Objective: Learning how to solder to

Approach for activity: Use NH 148A lab to learn how to solder

Outcome of activity: Learned how to use solder wire and solder iron

Impact of activity on the project: Will let us connect header wires to the SMD phototransistor

Assessment of the importance of activity: Very important to take care of our experiments

Tips to improve the approach for doing the activity for iterations: Invite other teammates next time because one person can’t solder header wires onto an SMD component

Tools used:

- Solder iron set at 600 F
- Tip cleaning sponge and metal brass wool
- Tweezers
- Soldering wire
- Soldering practice kit

January 28th Senior Design Task

Objective: Creating the phototransistor-waveform generator circuit

Approach for activity: Creating a phototransistor circuit and putting two circuits together

Outcome of activity: Were able to see some data

Impact of activity on the project: Big impact

Assessment of the importance of activity: Very important

Tips to improve the approach for doing the activity for iterations: Maybe buy a full size phototransistor to experiment with or solder better

I put the phototransistor in series with a resistor with various values. The phototransistor was soldered to two wires and it doesn't work properly most of the time.

February 2nd Senior Design Task

Objective: Learning op amp to create a hardware filter

Approach for activity: Googled the information

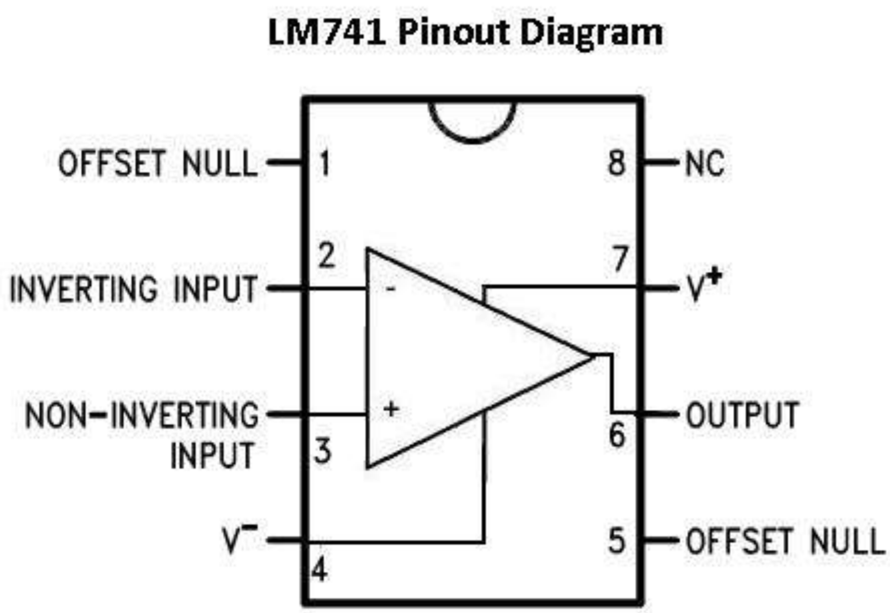
Outcome of activity: Learned a little about the pinout of op amp

Impact of activity on the project: Very big

Assessment of the importance of activity: Quite important

Tips to improve the approach for doing the activity for iterations: Make sure to learn the pinout of the op amp we actually have

The following pinout was studied:



Notes taken:

- We need active bandpass filter and for that we need op amp

February 4th Senior Design Task

Objective: Learning about bandpass filter

Approach for activity: Googling and recreating

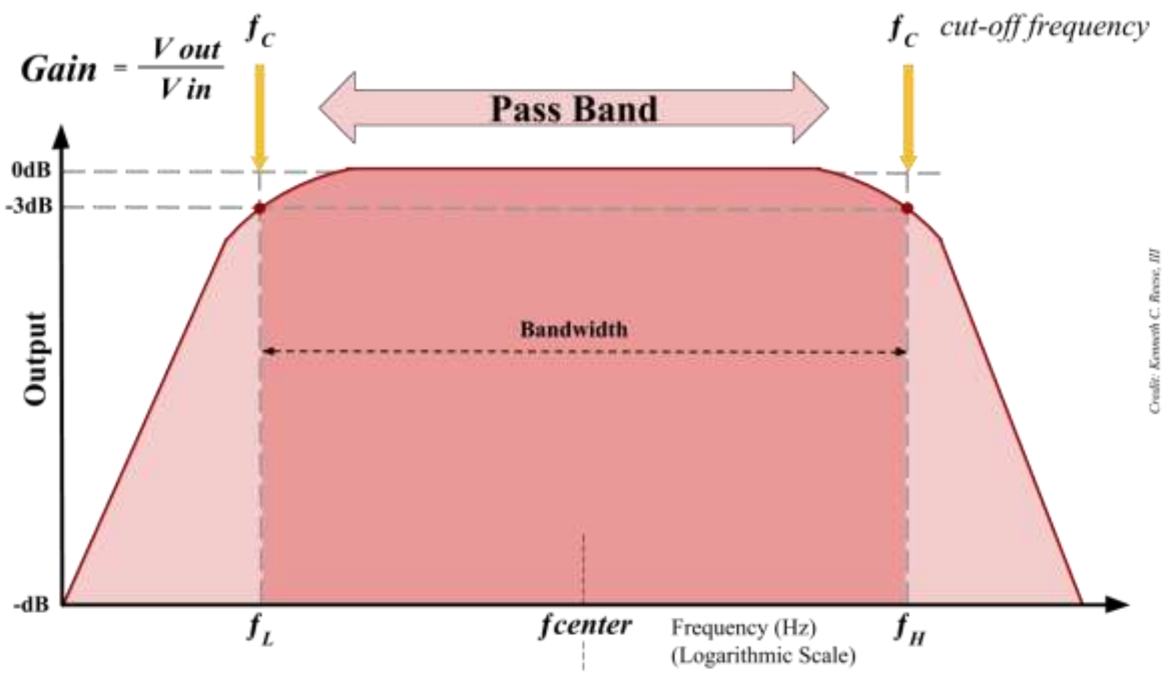
Outcome of activity: Learned a little about the concept

Impact of activity on the project: Very important to be completed soon

Assessment of the importance of activity: Important to get completed

Tips to improve the approach for doing the activity for iterations: Maybe reach out to other engineers beforehand

Following was studied:



Active bandpass filter notes:

- Amplifies input signal
- Needs transistors or op amps
- Combination of high and low pass filers

The first filter we need to create:

- f_1=35 kHz [low cutoff frequency]
- f_2=41 kHz [high cutoff frequency]

Using LM741 op amp notes:

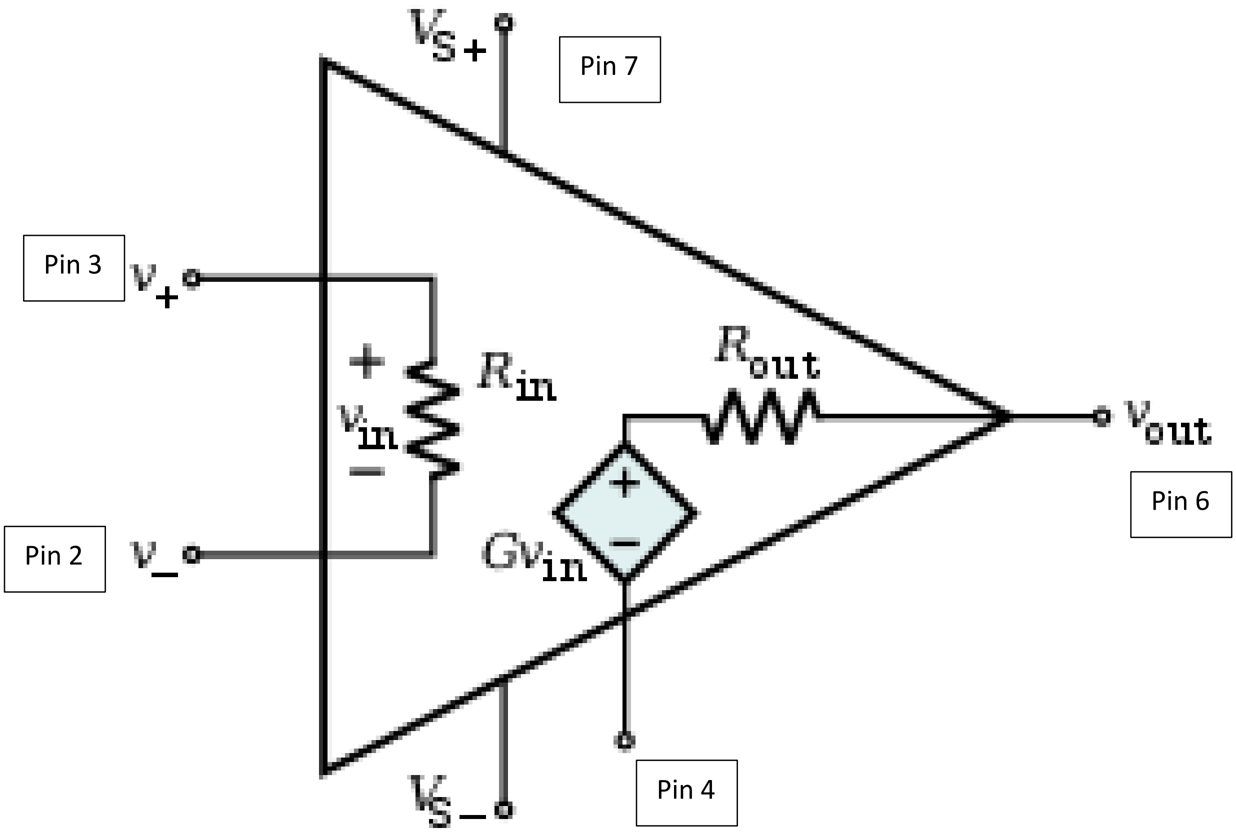
- pin 7 and pin 4 are power pins
- pin 7 gets +DC voltage
- pin 4 gets -DC voltage
- pin 2 and 3 are input pins to op amp
- pin 2 is the inverting terminal
- pin 3 is the noninverting terminal
- pin 6 is the output

Active inverting op amp bandpass filter circuit notes: **[insert the circuit]**

- op amps needs DC power
- output AC voltage signal will only be as high as ceiling and floor
- pin 4 is connected to negative voltage and cant be connected to ground
- pin 7 is connected to positive voltage
- High pass filter:
  - R1 and C1 are responsible for it
  - Passes all frequencies above the point is it desifned to pass
  - Creates lower cutoff frequency point
  - 1kHz in this circuit
  - Calculating cutoff frequency:
  - $Frequency_{Low\ cutoff} = \frac{1}{2*pi*R1*C1} = \frac{1}{2*pi*1.5kohm*100nF} = 1\ kHz$
- Low pass filter:
  - R2 and C2 form low pass filter
  - LPF passes all frequencies below the frequency cutoff it was designed to
  - Forms the upper cutoff frequency point
  - 3.2 kHz in this circuit
  - Calculating higher cutoff frequency
  - $Frequency_{High\ cutoff} = \frac{1}{2*pi*R2*C2} = \frac{1}{2*pi*15kohm*3.3nF} = 3.2\ kHz$
- Gain of op amp
  - $gain(A_v) = -\frac{R2}{R1} = -\frac{15}{1.5} = -10$
  - negative means that voltage output is inverted from voltage input
- it is important to follow max voltage guidelines
- for high frequency signals, it is best to use much higher speed op amp than LM741

Electronics Tutorials notes:

- understanding the op amp circuit
- Pin Out on Op Amp LM741



- Figured out that we need active band pass filter because passive band pass filter doesn't amplify

February 7th Senior Design Task

Objective: Recreate an active bandpass filter

Approach for activity: Creating a circuit on breadboard

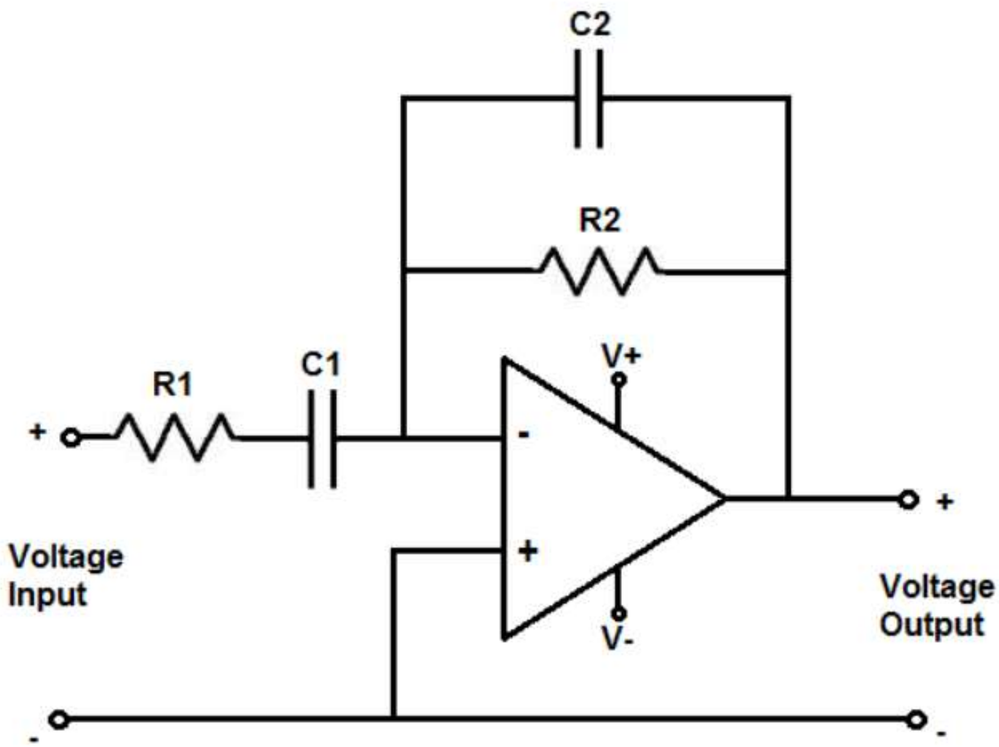
Outcome of activity: It didn't work as we thought it did

Impact of activity on the project: Very big

Assessment of the importance of activity: Quite important

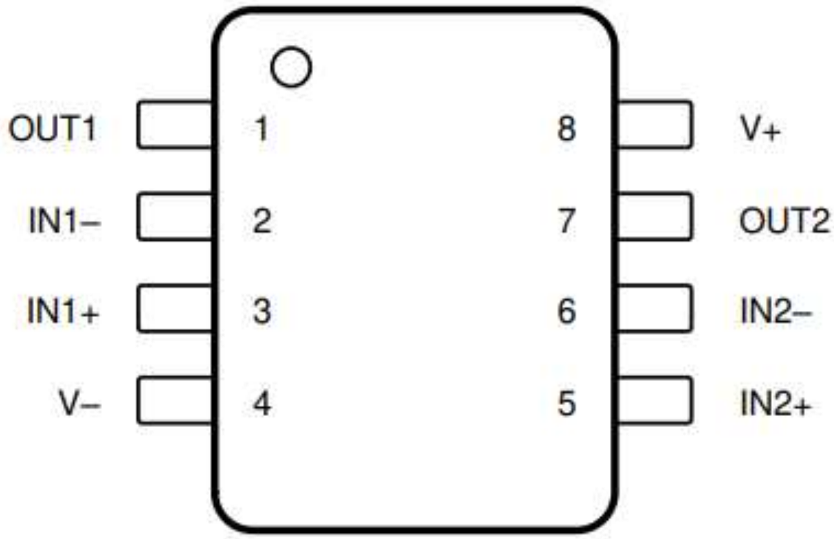
Tips to improve the approach for doing the activity for iterations: Make sure to learn the pinout of the op amp we actually have. Because we have dual op amp

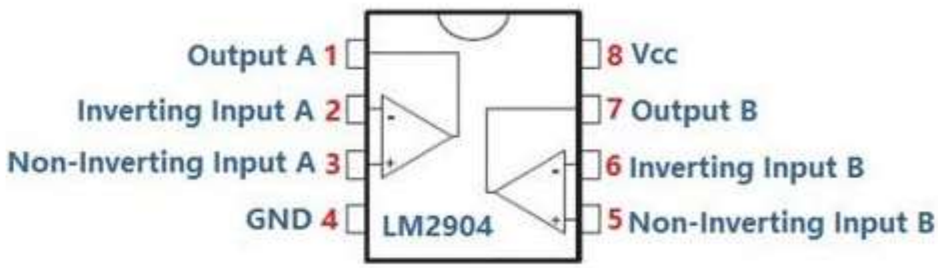
Active inverting op amp bandpass filter:



- Circuit is using op amp LM358P which is a dual op amp and has a different pin out
- C1=10 nF
- C2=1 nF
- R1= 1 kohm
- R2= 7.5 kohm
- $f_{c_1} = \frac{1}{2*\pi*R_1+C_1}$=16 kHz
- $f_{c_2} = \frac{1}{2*\pi*R_2+C_2} = 21\ kHz$

- LM358P pinout:





- Simulation was performed on Falstad Simulation Lab using the above circuit and values
- The results included output voltage of 15V for input voltage of 5V and every frequency that was set
- Dr. Yetkin agreed that simulation will be a waste of time with such high frequencies but said that simulation using NI Multisim is optional

Trial and error tips:

- If trying to see if phototransistor is working, flash an LED on it and see if the output on oscilloscope changes
- Connect phototransistor circuit onto Arduino and run AnalogReadSerialFast code; Look at the plot

February 8th Senior Design Task

Objective: To try create a 38 kHz active bandpass filter

Approach for activity: Simulated the circuit first which was Savannah's work

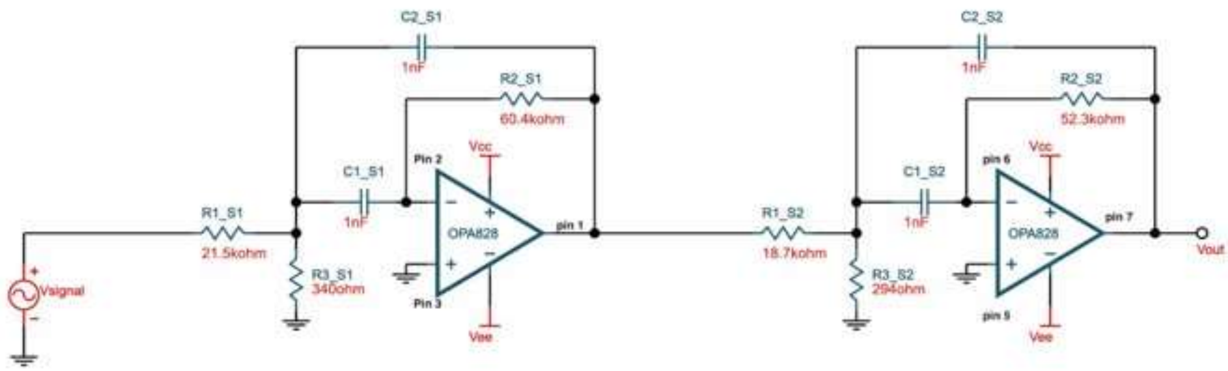
Outcome of activity: It didn't work out as we thought

Impact of activity on the project: Very big

Assessment of the importance of activity: Quite important

Tips to improve the approach for doing the activity for iterations: Make sure to learn the pinout of the op amp we actually have because we have dual op amp and we needed to use both sides

Testing simulated circuit:



Element w/ different value	New value
R1-S1	22 kohm
R3-S1	330 ohm
R2-S1	56 kohm
R1-S2	22 kohm
R3-S2	330 ohm
R2-S2	56 kohm

Table 4

February 18th Senior Design Task

Objective: Perform more testing using testing tools

Approach for activity: Connect to oscilloscope, multimeter, voltage source, Arduino etc to analyze the waveform generated

Outcome of activity: Had hard time analyzing the signal

Impact of activity on the project: Very big

Assessment of the importance of activity: Quite important

Tips to improve the approach for doing the activity for iterations: Make sure to have all the needed components like banana wires, oscilloscope wires etc

Test the following circuits together: 38 kHz waveform generator circuit and phototransistor circuit

- Channel 1 [yellow] : phototransistor circuit
  - Fluctuating frequency
- Channel 2 [blue] : 38 kHz waveform generator circuit
- Results included the following measurements and waves:

February 21st Senior Design Task

Objective: Meet up with Dr. Yetkin and trouble shoot

Approach for activity: Scheduled a meeting with Dr. Yetkin and setup the circuits

Outcome of activity: Troubleshooted some part of it but still faced many challenges

Impact of activity on the project: Very big

Assessment of the importance of activity: Quite important

Tips to improve the approach for doing the activity for iterations: Make sure to setup the circuits and troubleshoot the whole setup beforehand

Tasks performed:

- Set up the same procedure with 38 kHz waveform generating circuit and phototransistor circuit
- Performed testing with Dr Yetkin
- Feedback:
  - Waveform generator output was very noisy on oscilloscope this time
    - We tried changing the probe, switching the parameters, applying trigger function but Dr. Yetkin believes it might be oscilloscope problem because the circuit was working before perfectly
    - Need to find a better oscilloscope
- Phototransistor circuit problems include:
  - Very low voltage output
  - Has a lot of noise and we tried using two ways of looking at the output:

        - Using Arduino, we were able to see some function waveforms
        - Using oscilloscope, the output was very noisy and didn't give much
    - Feedback:
        - We need to find a better oscilloscope
        - We probably need to solder a new phototransistor with header wires
- Waveform generator function
    - The waveform generator machine does not give out enough voltage
    - Feedback:
        - We need wires dedicated for the waveform generator machine
- Tips:
    - On the oscilloscope probe, we switched the switch from 10K to 1K
    - We need batteries, banana wires and other connecting wires, jumper wire kit
    - Make sure to do sanity checks using multimeter and Arduino graphing

February 25th Senior Design Task

Objective: Soldering IR LED

Approach for activity: Soldered two jumper wires onto each side of the SMD IR LED

Outcome of activity: Was able to create an SMD IR LED that works

Impact of activity on the project: Very big

Assessment of the importance of activity: Quite important

Tips to improve the approach for doing the activity for iterations: Obtain all the components from the ERB lab before starting

Steps taken to solder IR LED:

- Use the tweezers in the NH 241 to put the SMD IR LED in between
- Turn on the soldering iron and smoke absorber
    - Set the heating temperature at 350 C
- Heat one side of the SMD model for 2-3 sec
- Add some solder onto the heated part of the SMD model
- Have the jumper wire ready and heat up the jumper wire ending after placing it on one side of the SMD model
- Make sure the wire is not moving and that it is connected correctly
    - If there is too much of wire sticking out, the SMD model may not work due to short circuitry
- Repeat the same steps for the other side of the SMD IR LED

February 26th Senior Design Task

Objective: Test the waveform generator with the phototransistor

Approach for activity: Setup the 38 kHz waveform generator with the phototransistor circuit

Outcome of activity: The phototransistor and waveform generator worked but amplifier didn't

Impact of activity on the project: Very big

Assessment of the importance of activity: Quite important

Tips to improve the approach for doing the activity for iterations: Make sure to simulate the amplifier circuit before building it , because it didn't work this time

Task 1: testing the 38 kHz waveform generator circuit

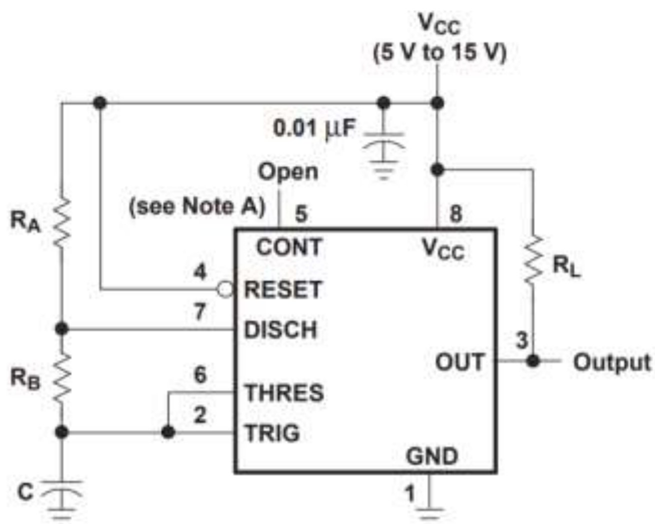
The following circuit was built and analyzed with following components:

- RA=5.1 kohm
- RB=33 kohm
- C1=10 nF
- C=1 nF
- Vin=3V
- RL=1 kohm
- SMD IR LED was connected to the output of the 555 timer and was used to transmit signals to the phototransistor

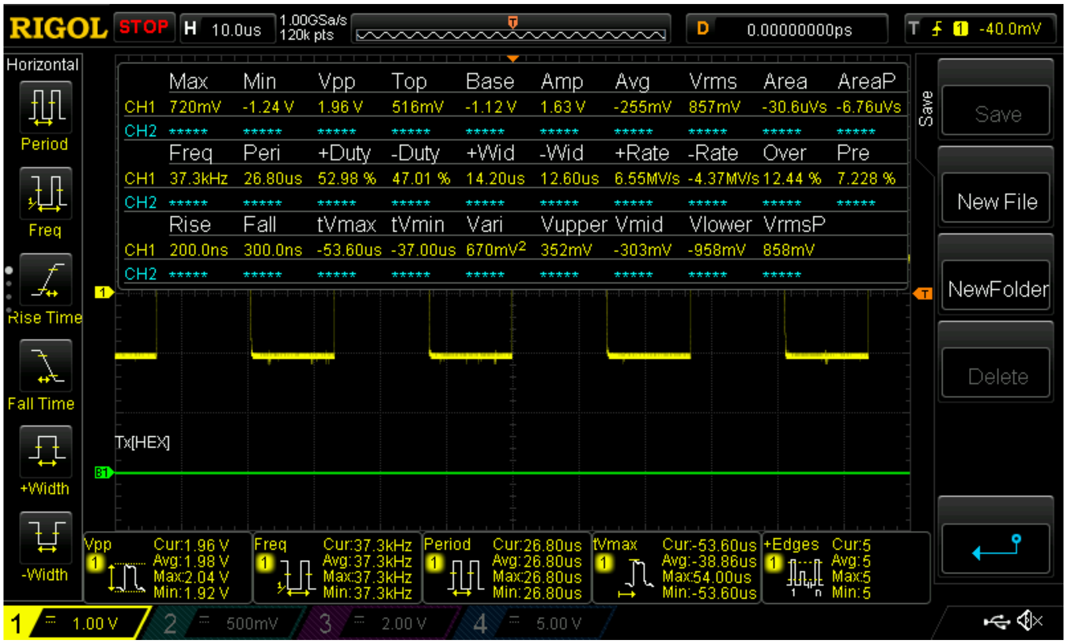
The following results were crucial to obtain:

- Vout=1.96 V
- Frequency: 37.3 kHz
    - The frequency was oscillating within the range of ±2 kHz

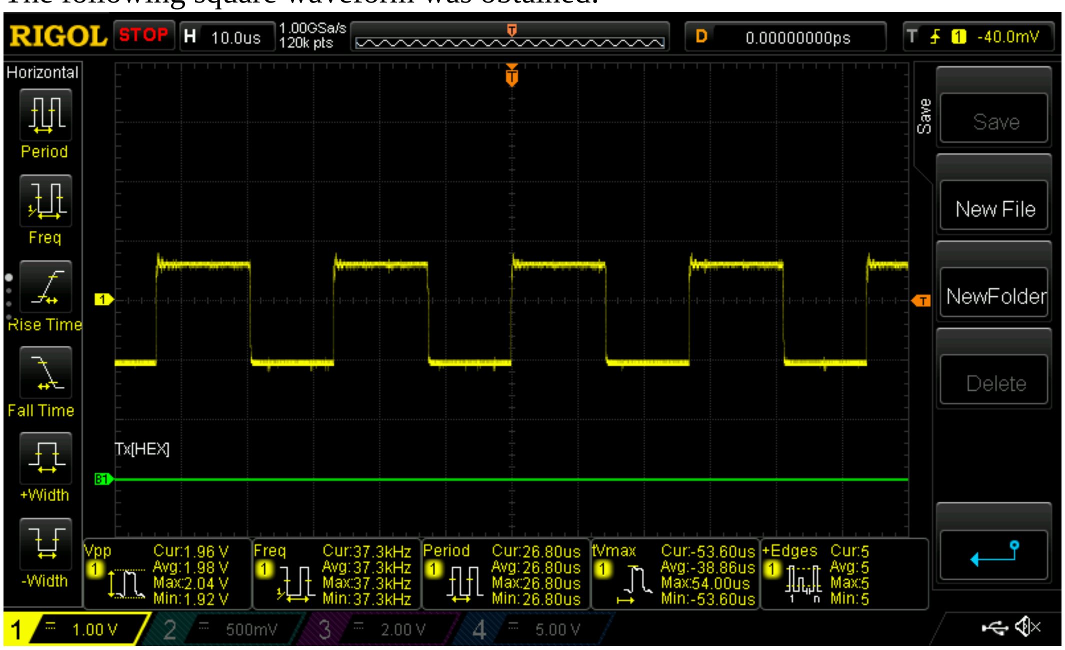
Following was the circuit built:



The following measurements were obtained:

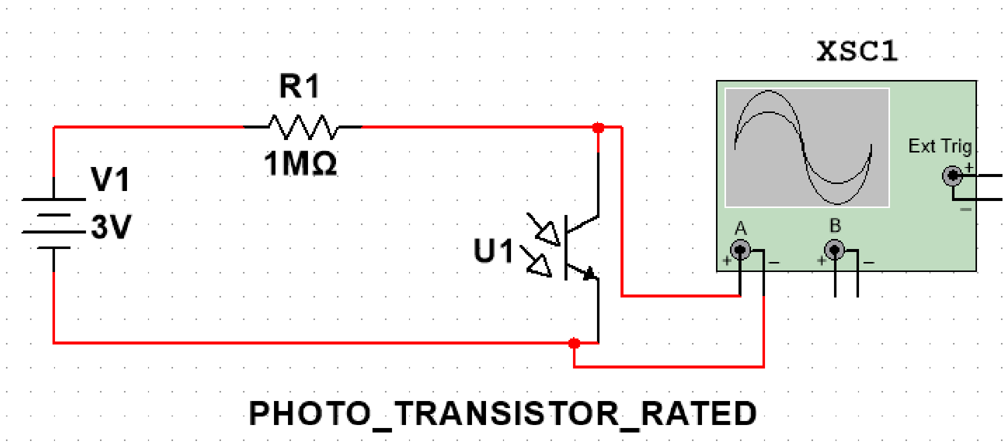


The following square waveform was obtained:



Task 2: using the above circuit with the phototransistor circuit and obtaining the results.

The phototransistor circuit is following:



The following components were used for the phototransistor circuit:

- R1=1Mohm
- Vin=3V

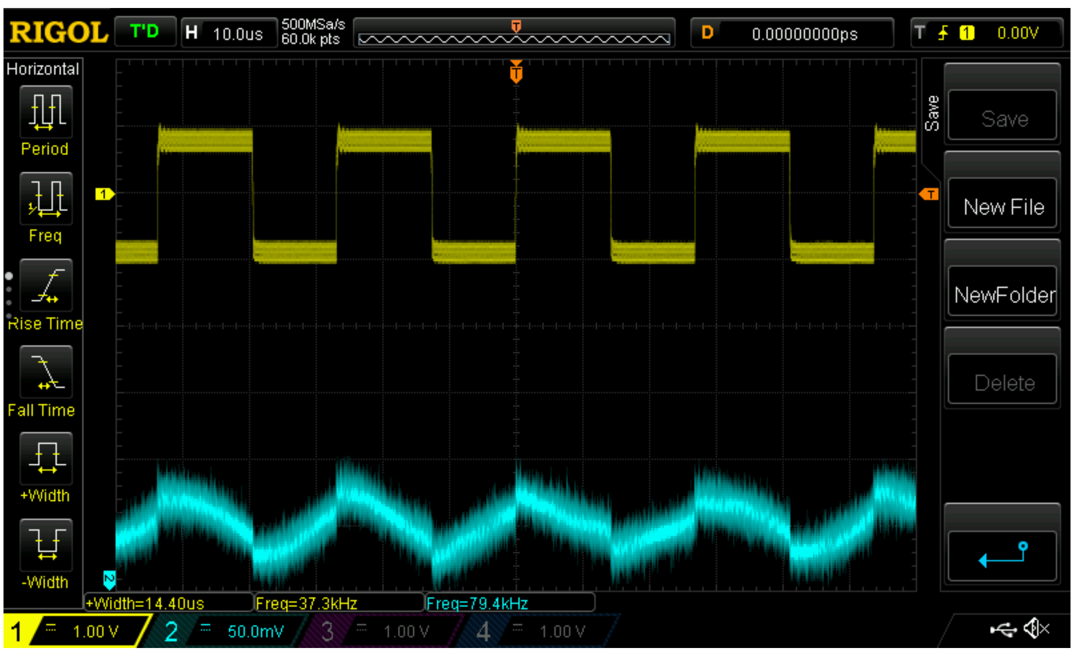
Following critical results were obtained:

- Vout= 150 mV
    - This is very small for the input of 3V
    - We used a very high resistor value but it still is very high
- Frequency=35.2 kHz
    - This frequency kept oscillating as well

Important notes:

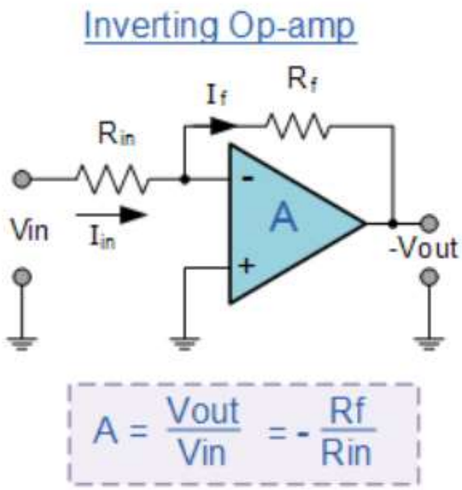
- Yellow line corresponds to the 38 kHz waveform generator signal
- Blue line corresponds to the phototransistor signal
- The IR LED that was used was soldered SMD model with two jumper wires
    - IR LED and phototransistor were positioned facing up very close to each other

The following measurements were obtained:



Task 3: Creating amplifier and feeding phototransistor results into it to amplify its output voltage

The following circuit was tried but failed:



Components:

- R1=Rin=1 kohm
- R2=Rf=10 kohm

Calculated gain=-1K

The results include:

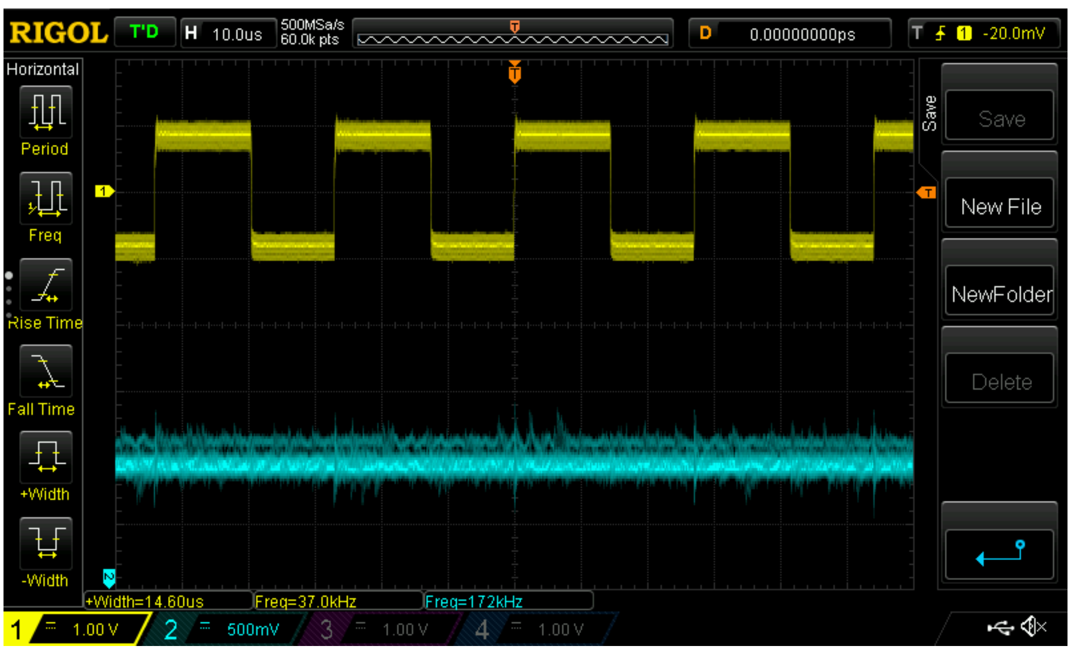
- Vout=560 mV
  - This is the voltage after amplifying the output of the phototransistor circuit
- Vout_before=150 mV
  - This is the voltage before amplifying and this voltage is of phototransistor circuit
- Voltage gain= 560 mV/ 150 mV= 3.733
  - The voltage gain is not high enough

Notes:

- Yellow line corresponds to the waveform generator signal
- Blue line corresponds to the amplifier output signal
- The phototransistor signal was not shown here

The following measurements were obtained:

The following waveforms were obtained:



February 27th Senior Design Task

Objective: Learn NI Multisim and simulate the needed circuits

Approach for activity: Obtained a license and started using NI Multisim

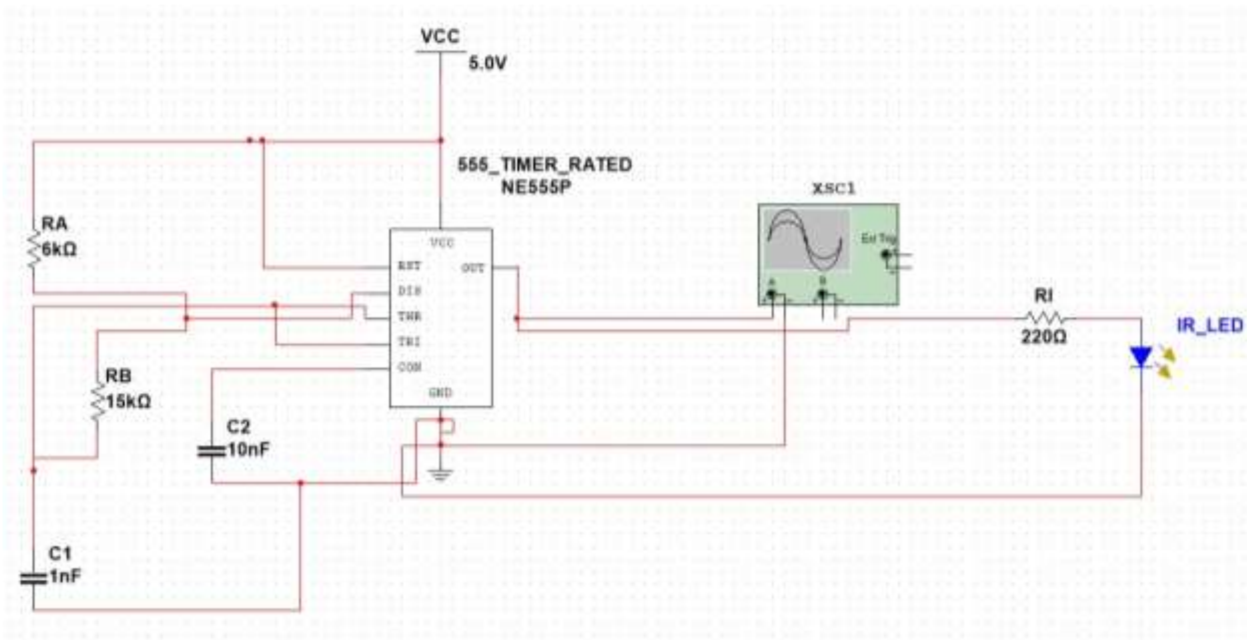
Outcome of activity: Found out the better waveform generating circuit

Impact of activity on the project: Very big

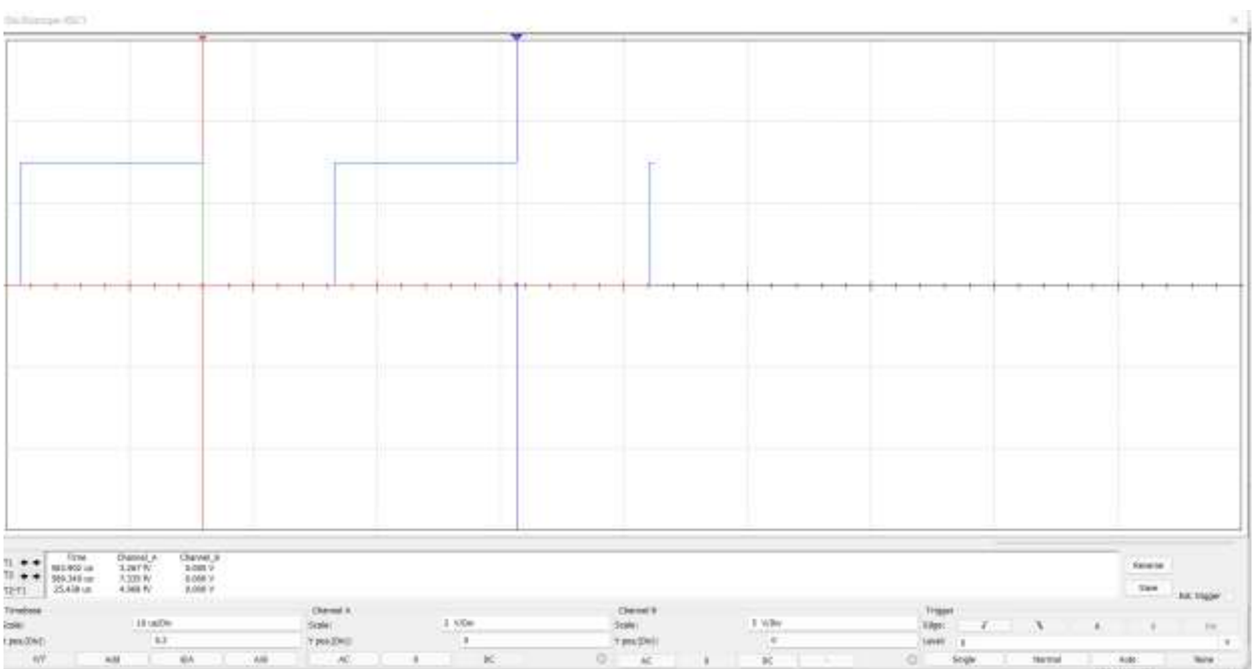
Assessment of the importance of activity: Quite important

Tips to improve the approach for doing the activity for iterations: Search YouTube videos for the needed circuits and compare them to circuits on datasheet

Waveform generator circuit:

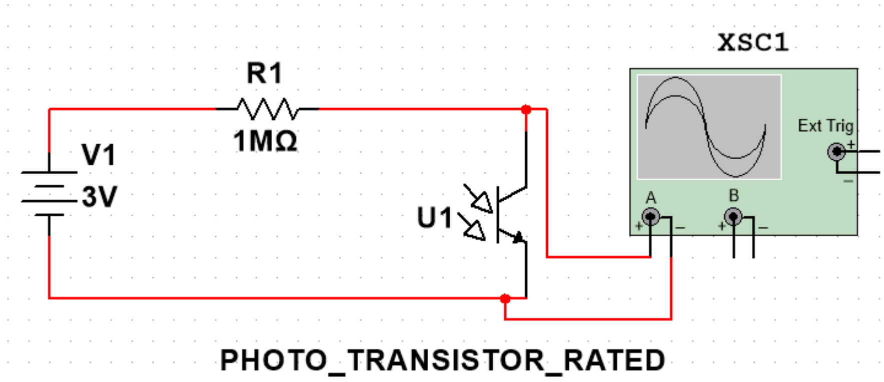


Simulation of waveform generating circuit:

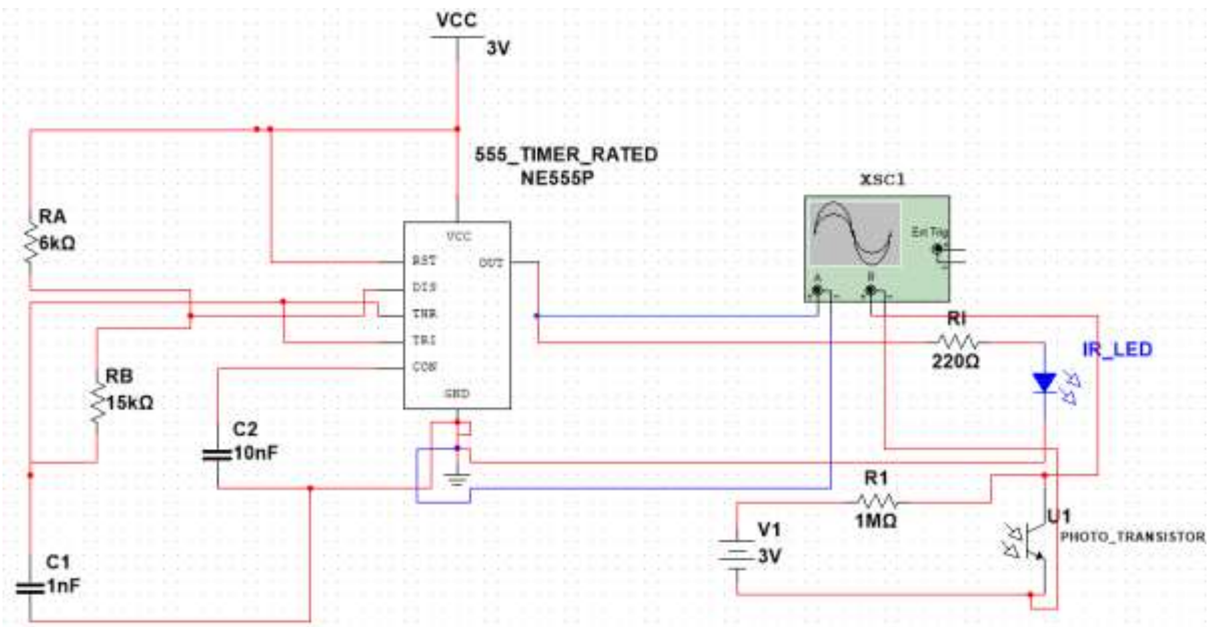


Obtained frequency: 39.3 kHz

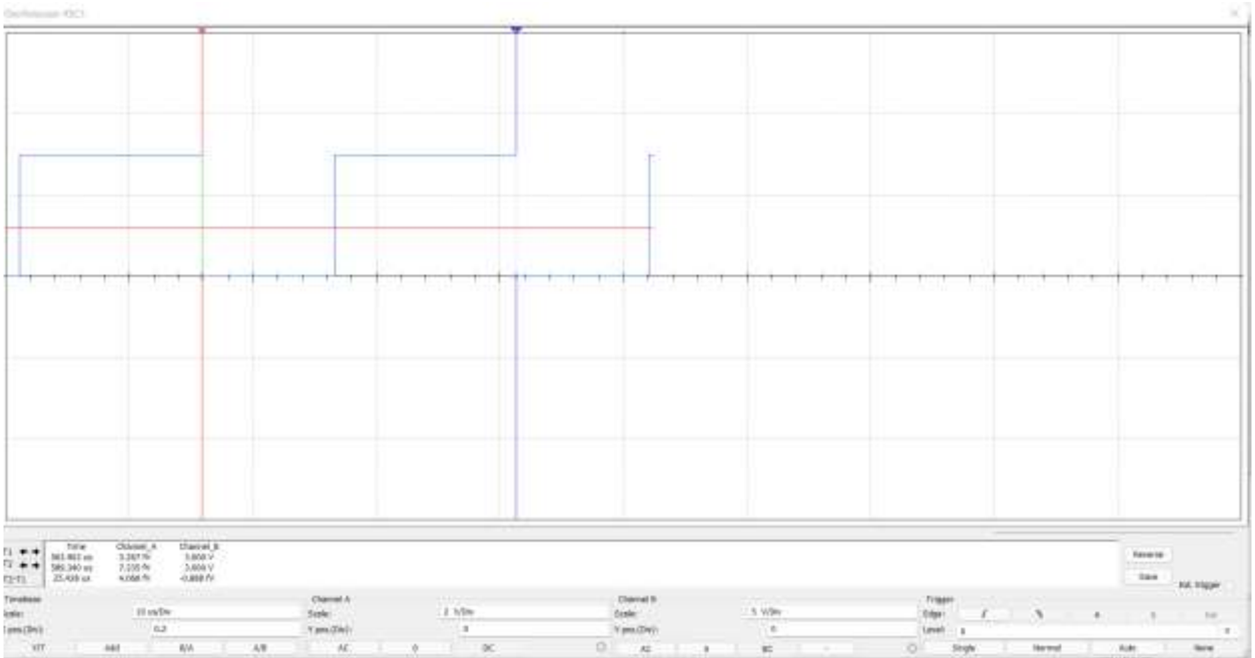
Phototransistor circuit:



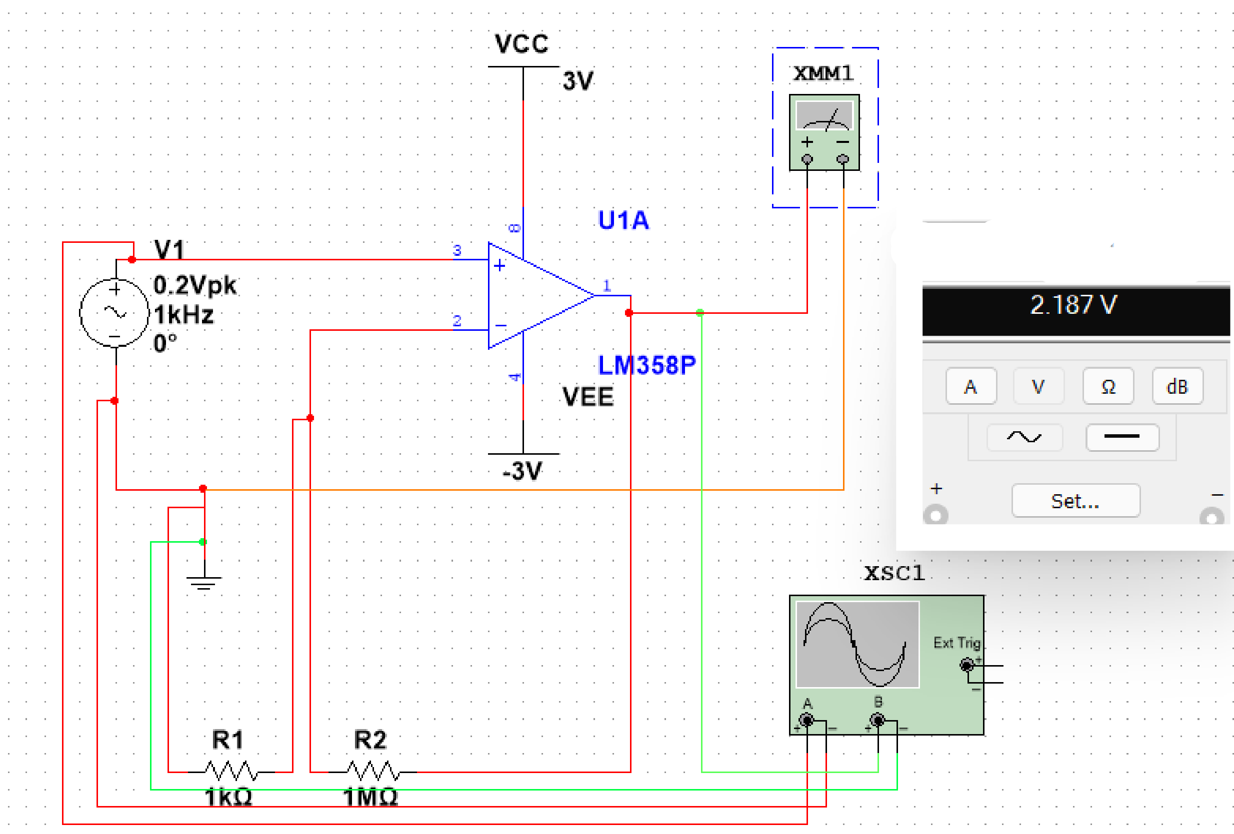
Phototransistor & waveform generator circuits:



Simulation of phototransistor and waveform generator circuits:



Amplifier circuit:



Next steps will be to test them on breadboard and using oscilloscope.

February 28th Senior Design Task

Objective: Simulate the frequencies we need for the ring and fingernail transponders

Approach for activity: Use NI Multisim to simulate the desired frequencies and find out the resistor and capacitor values

Outcome of activity: Was able to come up with close enough frequencies for the desired frequencies

Impact of activity on the project: Very big

Assessment of the importance of activity: Quite important

Tips to improve the approach for doing the activity for iterations: The simulated frequency setup is not the same on real breadboard. The resistors values change

It was decided on the following 15 unique frequencies for 15 total transponders (may change depending on our research): 18 kHz, 38 kHz, 56 kHz, 77 kHz, 98 kHz,114 kHz,132 kHz,154 kHz,166 kHz,186 kHz,205 kHz, 228 kHz,245 kHz,260 kHz,278 kHz

The following frequency values were known:

Frequency (kHz)	RA (kohm) (connects pins 7 & 8)	RB (kohm) (connects pins 6 & 7)	C1 (nF)	C2 (nF)
~18	5.1	33	1	10
~38	2.2	15	1	10

The following frequency values needed to be simulated:

$$f = \frac{1.44}{(R_A + R_B) * C_2} \Omega$$

Frequency (kHz)	RA (kohm) (connects pins 7 & 8)	RB (kohm) (connects pins 6 & 7)	C1 (nF)	C2 (nF)
~8	5.1	33	1	10
~16.4	4.7	3	1	10
~25.5	4.7	22	1	10
~72.5	4.7	4.7	1	10
~89.3	4.7	3	1	10
~104	3	3	1	10
~101	4.7	2.2	1	10
~121	3	2.2	1	10

March 7th Senior Design Task

Objective: Create couple waveform generators with unique frequencies and solder a new IR LED

Approach for activity: Simulated the circuits to be created first and then created them on breadboard

Outcome of activity: The desired frequency was reached even though it wasn't the exact frequency that we needed but close enough. SMD IR LED was also successfully soldered with two jumper wires

Impact of activity on the project: Very big

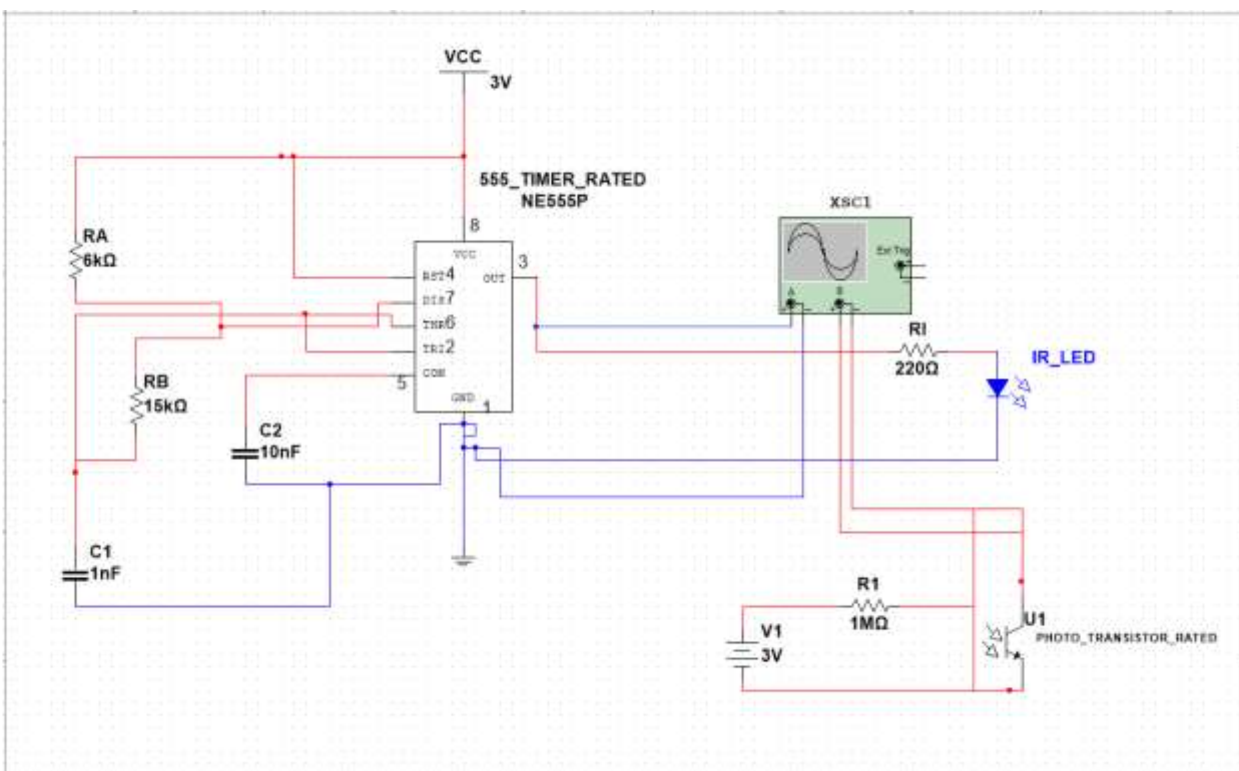
Assessment of the importance of activity: Quite important

Tips to improve the approach for doing the activity for iterations: Make sure to take notes and record data even if it takes longer than scheduled; Make sure to prepare everything when soldering and turn on the smoke absorber

Tasks performed:

Task 1: creating 38 kHz waveform generator

The following circuit was used to create a 38 kHz waveform generator:



The simulated values included:

- RA= 2.2 kohm
- RB=15 kohm
- C1= 1nF
- C2= 10 nF

The actual values that gave the target frequency were:

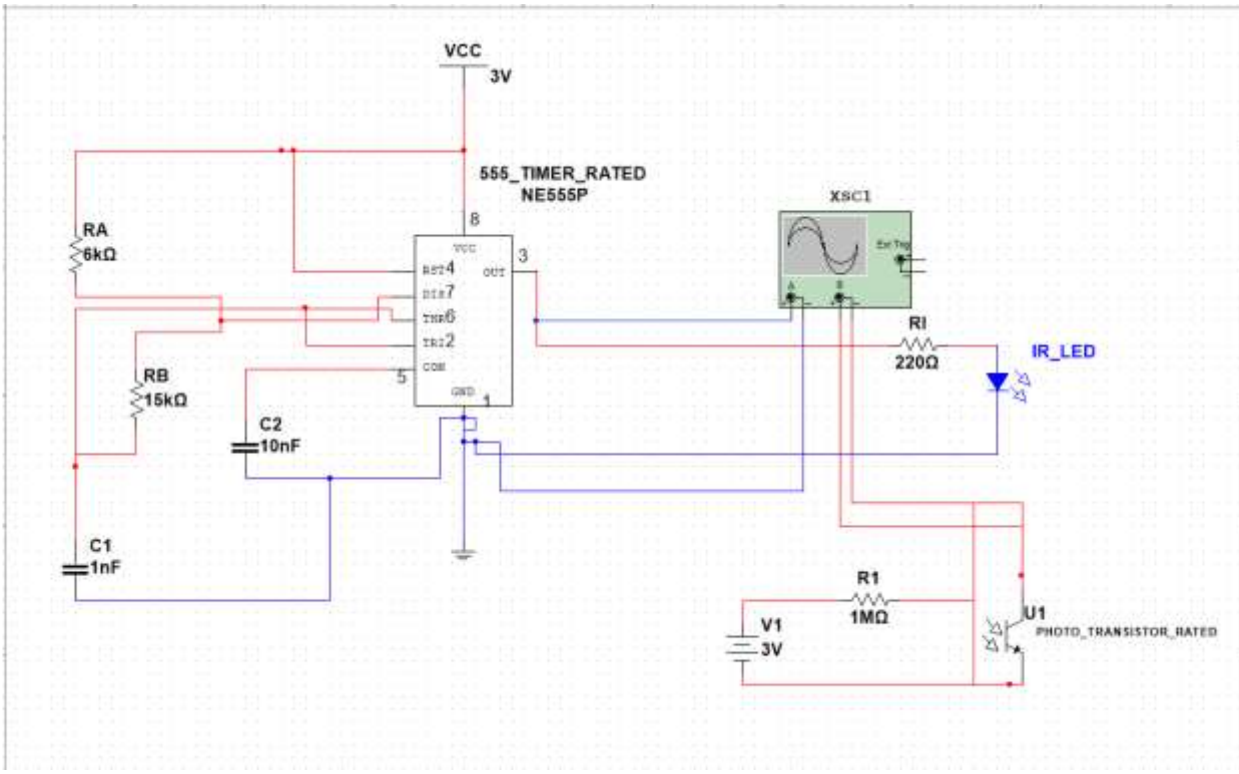
- RA= 3 kohm
- RB=15 kohm
- C1= 1nF
- C2= 10 nF

Results included:

- The waveform generator signal was less unstable
    - The frequency was oscillating less
    - The emitted square waves from the IR LEDs that is in parallel with the phototransistor are detected better by the phototransistor
- The phototransistor circuit was able to output more pronounced waves
    - The output waves had some amplitude unlike the previous results
    - Each cycle matched the cycle of the waveform generator signal and was somewhat synchronized

Task 2: creating an 18 kHz waveform generator that will be tested in the 18 kHz filter:

The following circuit was used to build the 18 kHz function generator:



The simulated values included:

- RA= 4.7 kohm
- RB=33 kohm
- C1= 1nF
- C2= 10 nF
- Vin= 3V

The actual values that gave the target frequency were:

- RA= 5.1 kohm
- RB=33 kohm
- C1= 1nF
- C2= 10 nF

The results included:

- The filter was able to output some of the wave like signal which may mean that it is working
  - This happened only when the phototransistor circuit's voltage input was increased to 5 V
- The output signal of the filter had a very small amplitude
  - Thus we need to work on the amplifier at the moment
- Vout=200 mV from the phototransistor output while the Vin= 3V
  - We tried to use Vin=5 V which gave us the Vout ~ 500 mV

Vin	**Vout**
3 V	200 mV
5 V	500 mV

Task 3: soldered new IR LED

Steps taken to solder IR LED:

- Use the tweezers in the NH 241 to put the SMD IR LED in between
- Turn on the soldering iron and smoke absorber
    - Set the heating temperature at 350 C
- Heat one side of the SMD model for 2-3 sec
- Add some solder onto the heated part of the SMD model
- Have the jumper wire ready and heat up the jumper wire ending after placing it on one side of the SMD model
- Make sure the wire is not moving and that it is connected correctly
    - If there is too much of wire sticking out, the SMD model may not work due to short circuitry
- Repeat the same steps for the other side of the SMD IR LED

March 8th Senior Design Task

Objective: Meet up with Dr. Yetkin and trouble shoot bandpass filter circuit and phototransistor circuit

Approach for activity: Scheduled a meeting with Dr. Yetkin and setup the circuits

Outcome of activity: Troubleshooted some part of it but still faced many challenges and found out new ways to optimize circuitry analysis

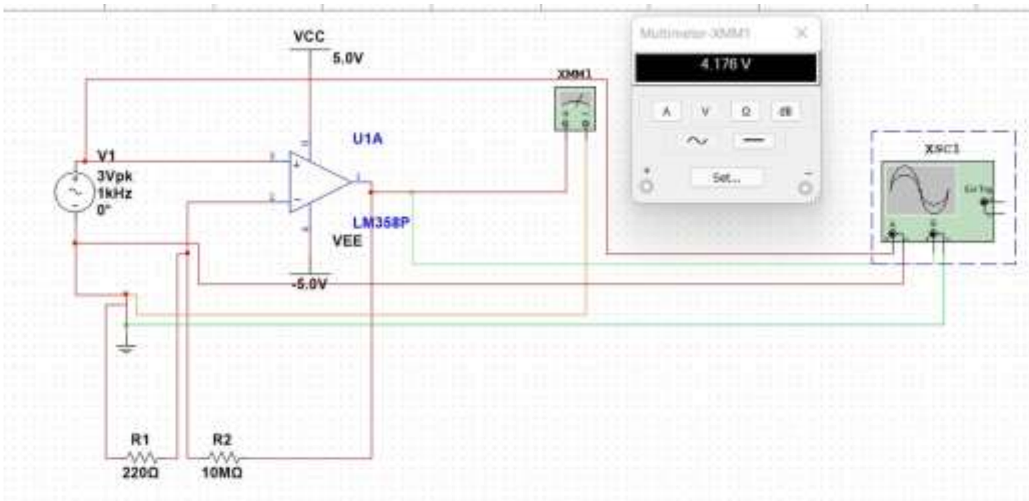
Impact of activity on the project: Very big

Assessment of the importance of activity: Quite important

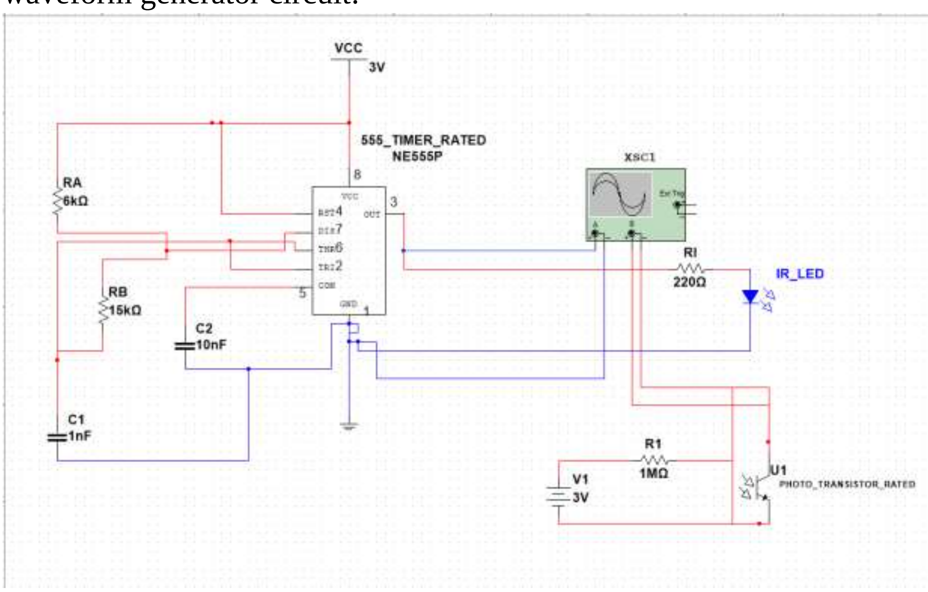
Tips to improve the approach for doing the activity for iterations: Phototransistor needs to be pointed upside down at the IR LED; We need to buy single rail op amp if we proceed with PCBs

Tasks performed:

- Tried the amplifier circuit
    - Did not work because there was no signal when we tried to measure it
    - The following circuit was created :

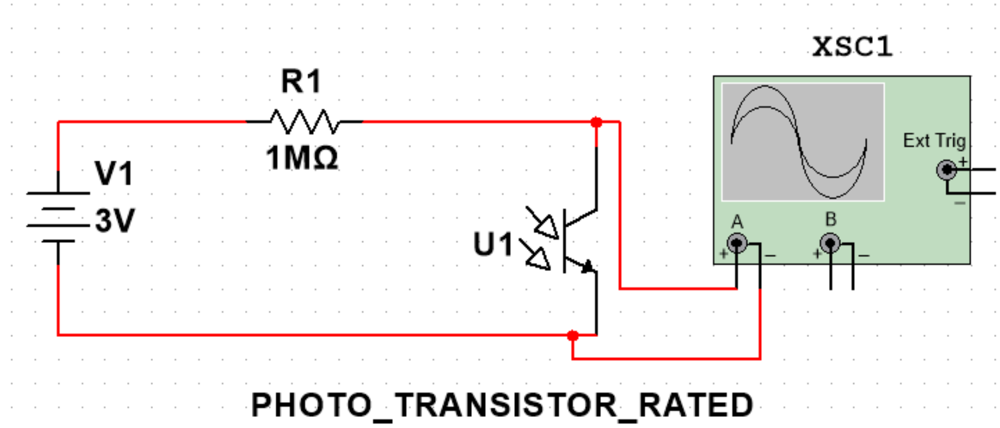
- 

- I am thinking that it might be the op amp that we have or maybe the way I connected the parts on the breadboard

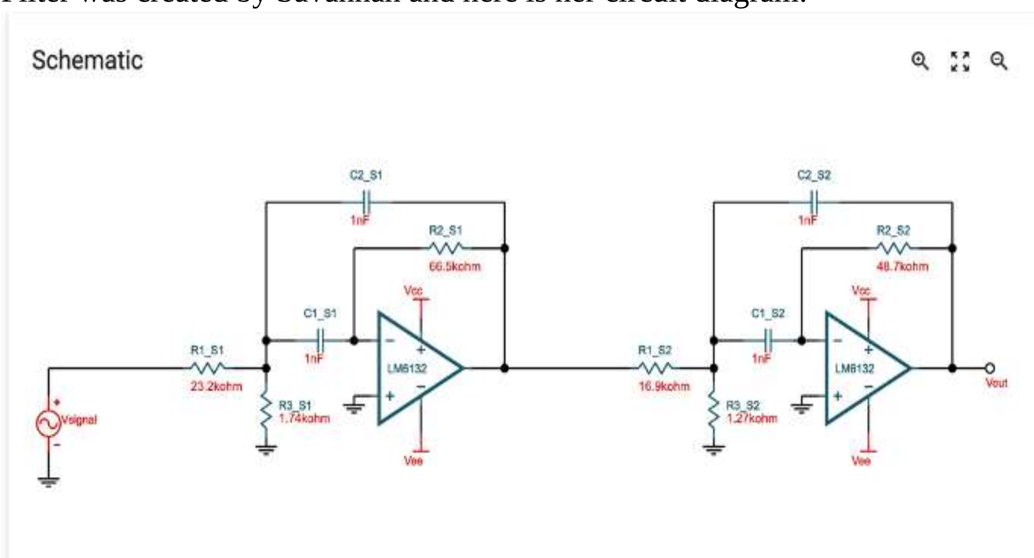
* Created a 10 kHz waveform generator circuit and tested it with the 18 kHz filter
  - 10 kHz waveform generator circuit had following components:
    - RA=4.7 kohm
    - RB=330 kohm
    - C1=1 nF
    - C2=10 nF
    - Vin=3V
      * The Vin might have been increased up to a 5V to increase the amplitude of the waves detected by the phototransistor
    - The following was the circuit that was used to create the 10 kHz waveform generator circuit:
    - 

  - Phototransistor circuit:
    - Vin= 3V
    - R1= 1Mohm

        - Performs detection of signal emitted by the IR LED
        - IR LED and the phototransistor were positioned within 1 cm parallel to each other
        - The following was the circuit that was used :



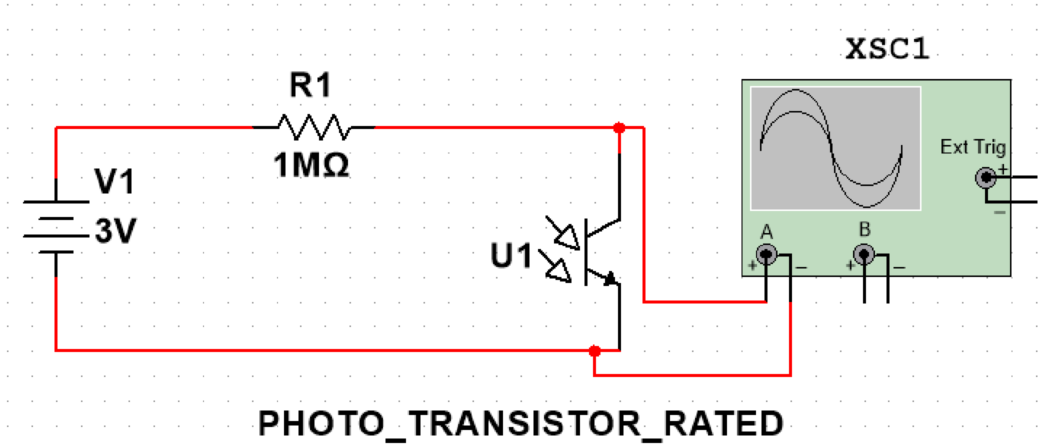
    - 18 kHz bandpass filter circuit
        - Filter was created by Savannah and here is her circuit diagram:



- The overall setup included having the IR LED signal being detected by the phototransistor. Phototransistor output was connected to the bandpass filter circuit as the input. And the output measurements and waveform of the filter was obtained below:
    - Yellow line is the 18 kHz waveform generator signal
    - Blue line is the phototransistor's detected signal plotted as a waveform
    - Purple line is the output of the bandpass filter

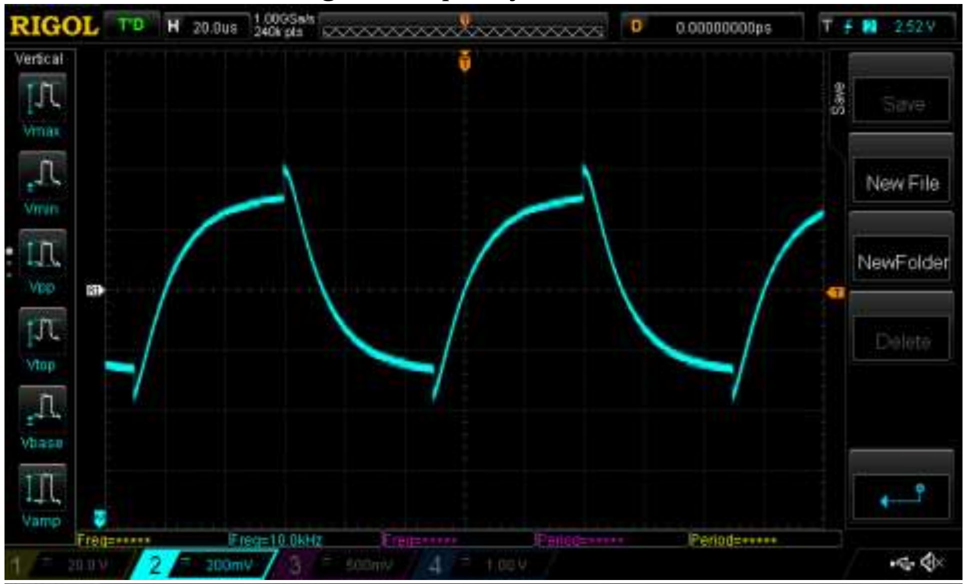
- 

- Created a simple circuit with the IR LED, 220 ohm and waveform generator machine and phototransistor circuit
  - Waveform generator circuit:
    - We placed 220 ohm resistor in series with IR LED and powered the circuit by the waveform generator machine
  - Phototransistor circuit:
    - It was the same circuit that was used in the above experiment:



- Notes:
  - In this case we pointed the phototransistor upside down while the IR LED was facing up
  - The main purpose of this was to see if the phototransistor can pick up enough signal from the IR LED to results in a waveform that has big enough peak to peak voltage
- We tested 10 Hz, 10 kHz, 20 Khz, 38 Khz square waveform functions that we generated thru the waveform generator machine
  - The voltage was set to 3 VPP
  - The following were the output voltages of the phototransistor circuits' voltage output:
    - 10 Hz gave the voltage output of ~1.6 V
    - 10 kHz gave the voltage output of ~800 mV
    - 20 kHz gave the voltage output of ~600 mV
    - 38 kHz gave the voltage output of ~400 mV
- The following pictures show how the wave looked like:
  - This wave is the detected signal from the blinking IR LED by the phototransistor

- The IR LED was blinking at a frequency of 10 kHz



March 9th Senior Design Task

Objective: Simulating amplifier circuit

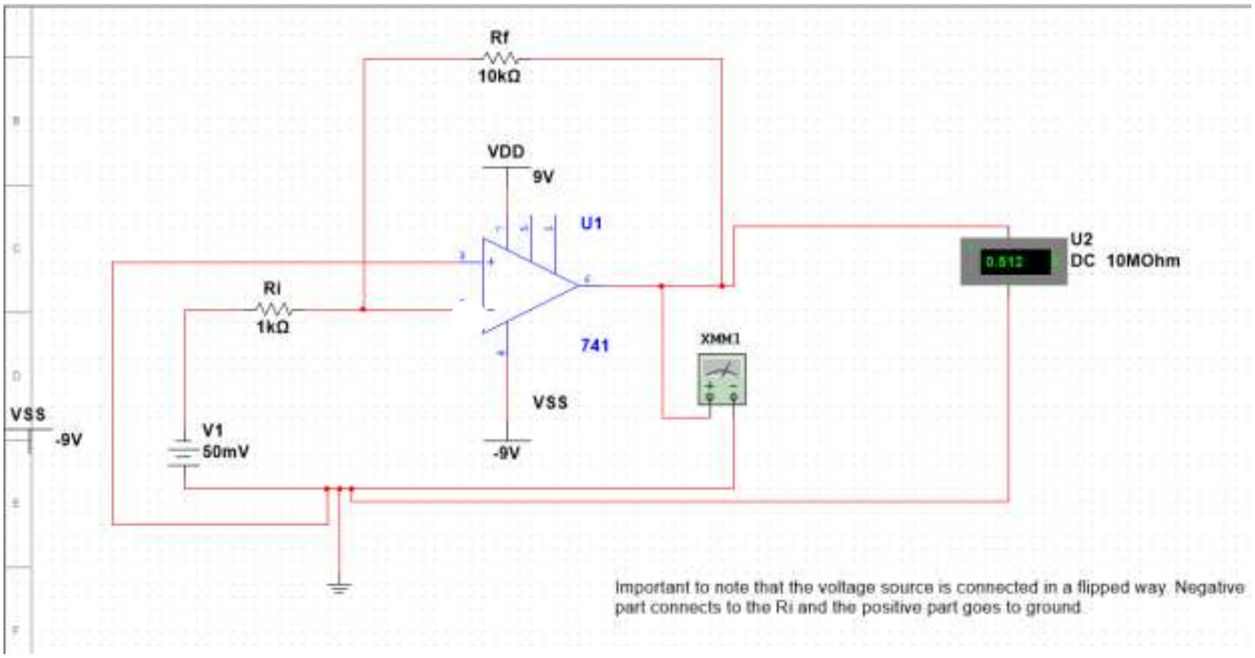
Approach for activity: Use NI Multisim for simulation

Outcome of activity: As can be seen from the image, it didn’t work

Impact of activity on the project: Very important because one of the problems we have is voltage attenuation

Assessment of the importance of activity: Important in continuing the project

Tips to improve the approach for doing the activity for iterations: Try various combinations for the resistor, op amp voltage, and input voltage values.



The above circuit was simulated using NI Multisim and the input of 50 mV produced 0.512 V. The circuit didn't give the desired result so I tried finding different active amplifier circuits online.

March 15th Senior Design Task

Objective:

Approach for activity: Watched youtube video to find new circuit for amplifier

Outcome of activity: In the long run, it didn't work in real life

Impact of activity on the project: Very important because we can't work with very low voltage values

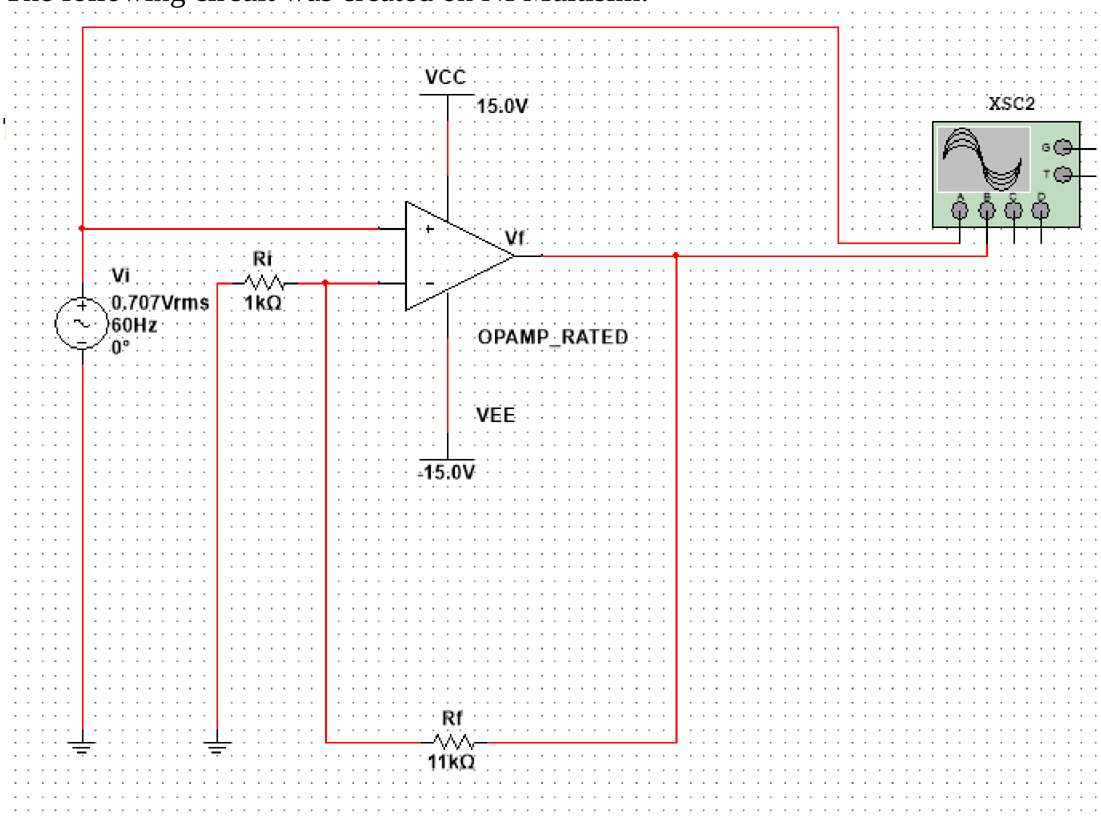
Assessment of the importance of activity: Important in continuing the project

Tips to improve the approach for doing the activity for iterations: Ask for advices from people that know signal processing

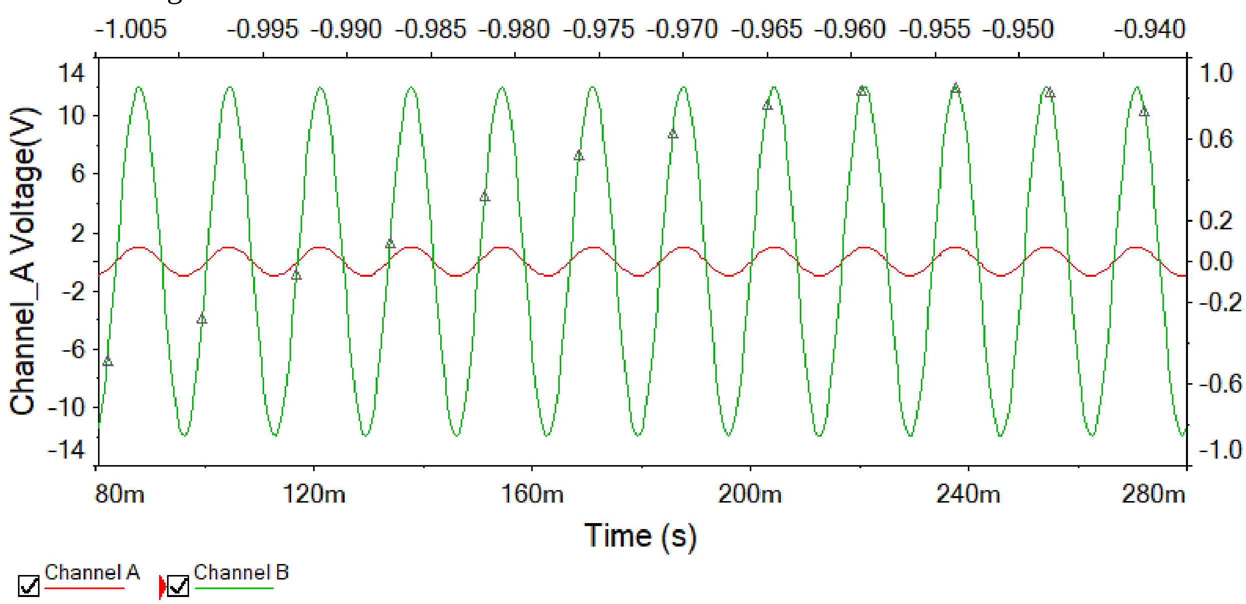
- Wacthed the following video to recreate non inverting amplifier using op amp: https://www.youtube.com/watch?v=vfhwAHGJgl8

Important notes :

- Vo=(1+Rf/Ri)*Vi
- The following circuit was created on NI Multisim:



-
- The following simulation was obtained:



-
- Where the red line is the voltage input Vi and the green line is the voltage output Vf
- It is worthy to mention that both Vi and Vf are in the same phase

*Unfortunately, when tested in real life, it didn't work

March 22nd Senior Design Task

Objective: Trying to create a better bandpass filter

Approach for activity: Building circuit and using NH 148 library to test

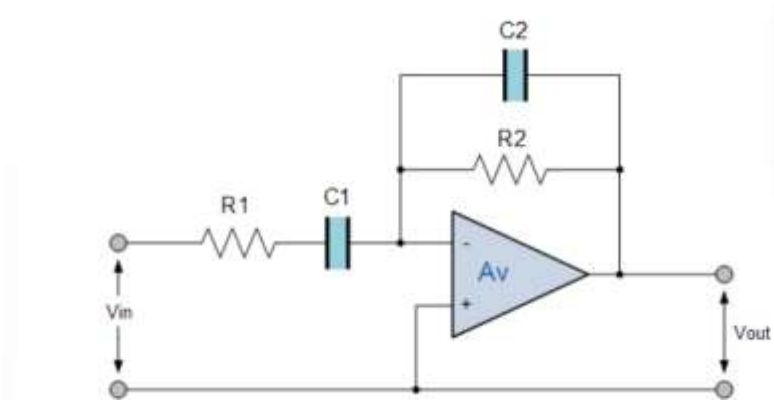
Outcome of activity: I believe nothing worked so we went back to previous circuit and tried to troubleshoot it

Impact of activity on the project: Very important because we can't move on without having a working active bandpass filter

Assessment of the importance of activity: Important in continuing the project

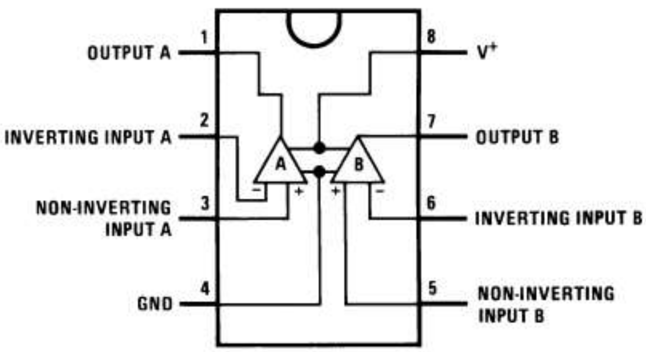
Tips to improve the approach for doing the activity for iterations: Troubleshoot earlier to find out what needs to be bought or done to fix some bugs

- I couldn't find a Multisim stimulation video on youtube to recreate a new filter so will try to recreate the following bandpass filter that is active and inverting with operational amplifier



- Voltage gain here is -R2/R1
- Cutoff frequency #1 is 1/(2*pi*R1*C1)
- Cutoff frequency #2 is 1/(2*pi*R2*C2)

The pinout of the op amp that we are using is LM358P which is the dual op amp and has the following diagram:



- Here position 2 will serve as the connection where C1 and R1 will be connected in series
- Pin 3 will go to ground because circuit is inverting circuit
- Pin 4 will go to ground
- Pin 8 will be fed 3 V
- Pin 1 will be measured with oscilloscope
- Pin 2 will also have the waveform input that will need to be filtered

To calculate the cutoff frequency:

- The lower cutoff frequency is decided to be 34 kHz
- The upper cutoff frequency is decided to be 42 kHz
- To calculate for the lower cutoff frequency:

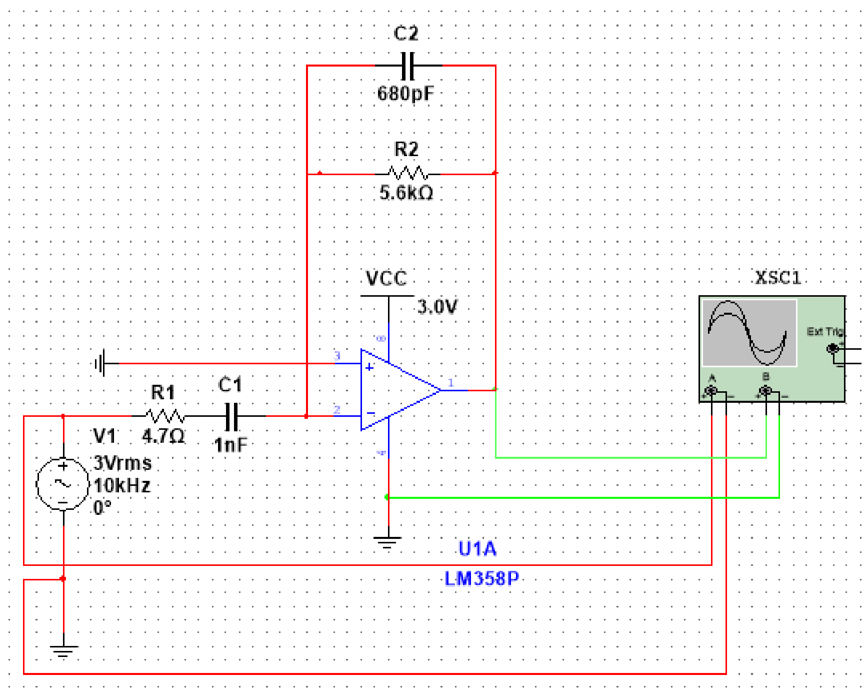
Index	R1	C1	Theoretical f_{c1}
1	4.7 ohm	1 uF	33.863 kHz
2	46.810 ohm	0.1 uF	34 kHz
3	2.128 ohm	2.2 uF	34 kHz
4	0.468 ohm	10 uF	34 kHz
5	4.681 ohm	1 nF	34 kHz
6	4.7 ohm	1 nF	33.863 kHz

- To calculate for the upper cutoff frequency:

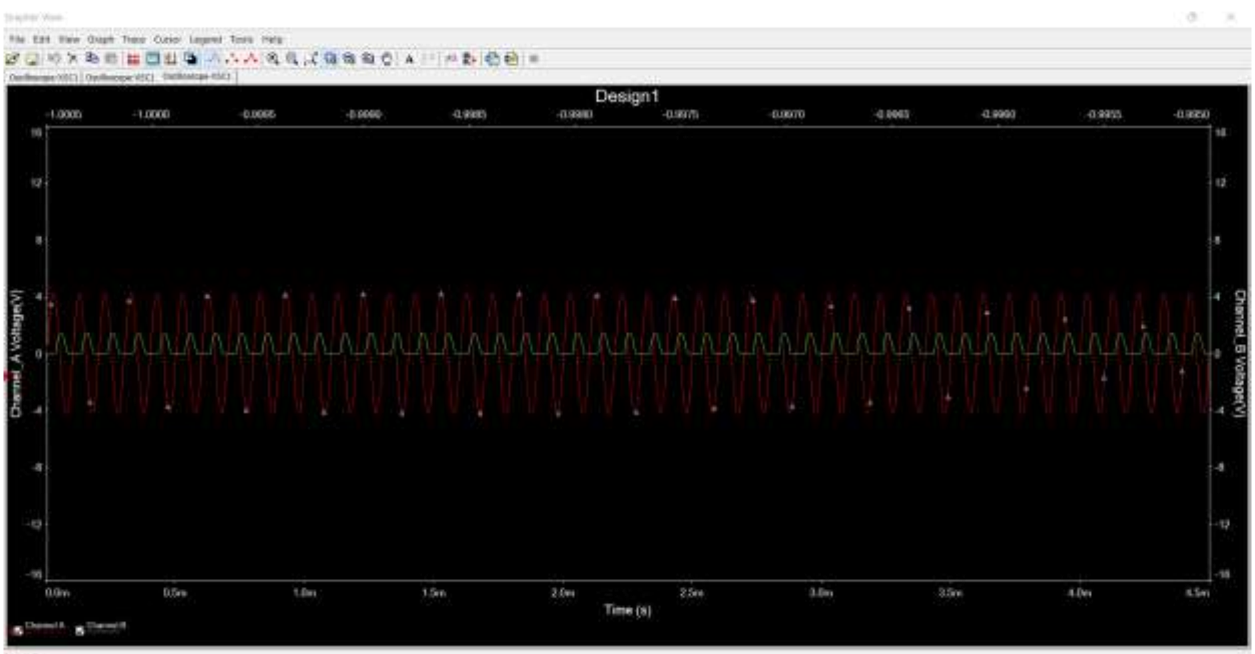
Index	R2	C2	Theoretical f_{c1}
1	3.789 kohm	1 nF	42 kHz
2	806.256 ohm	4.7 nF	42 kHz
3	80.625 ohm	47 nF	42 kHz
4	5.573 kohm	680 pF	42 kHz
5	5.6 kohm	680 pF	41.795 kHz

- The main reason of choosing the resistor and capacitor values above is because we have the actual resistors to test the circuit with

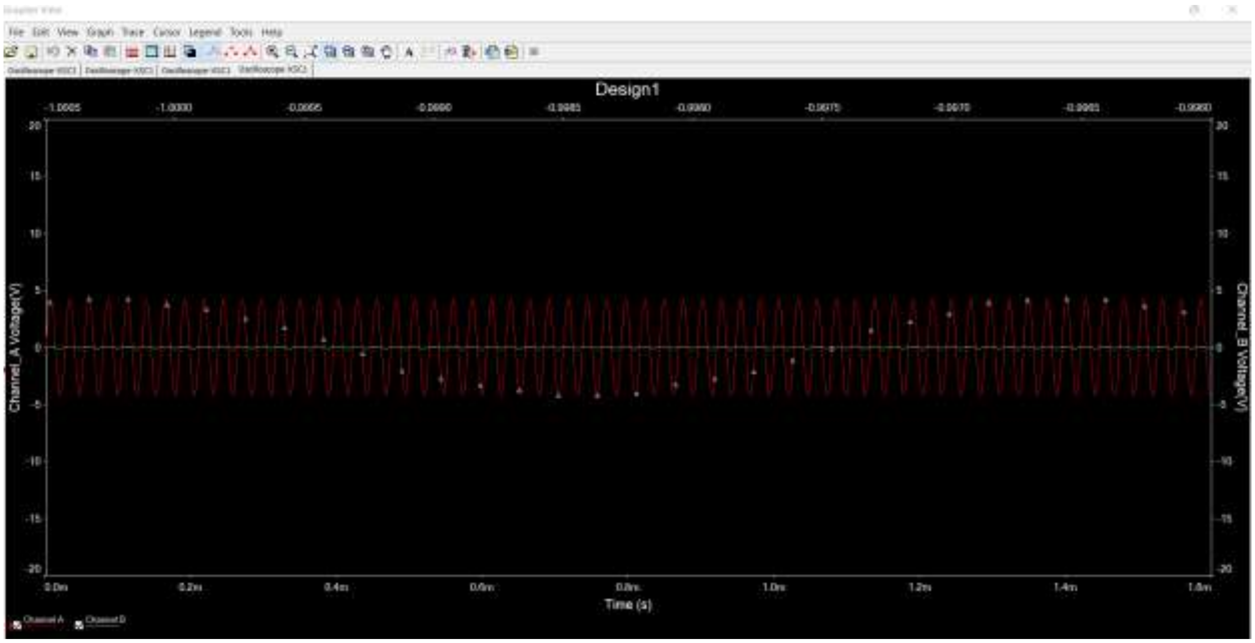
Testing out on NI Multisim:



Results include the following:

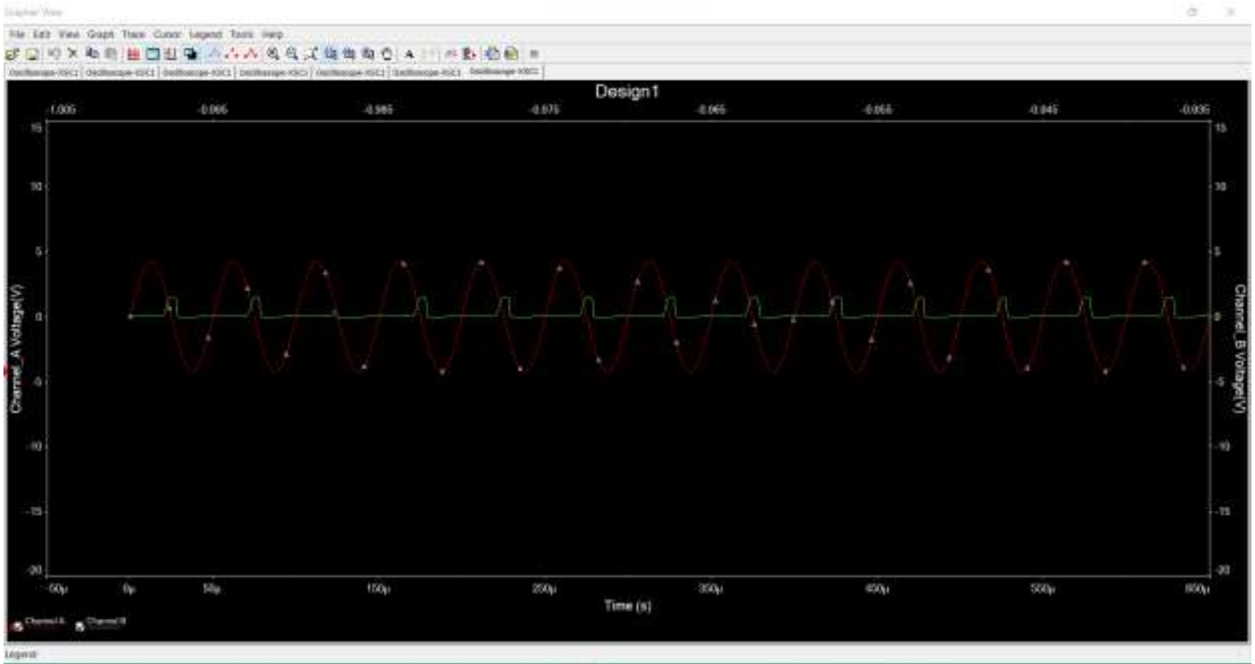


- This is for the 10kHz input signal
- Here the green wave is the output and the red wave is the input

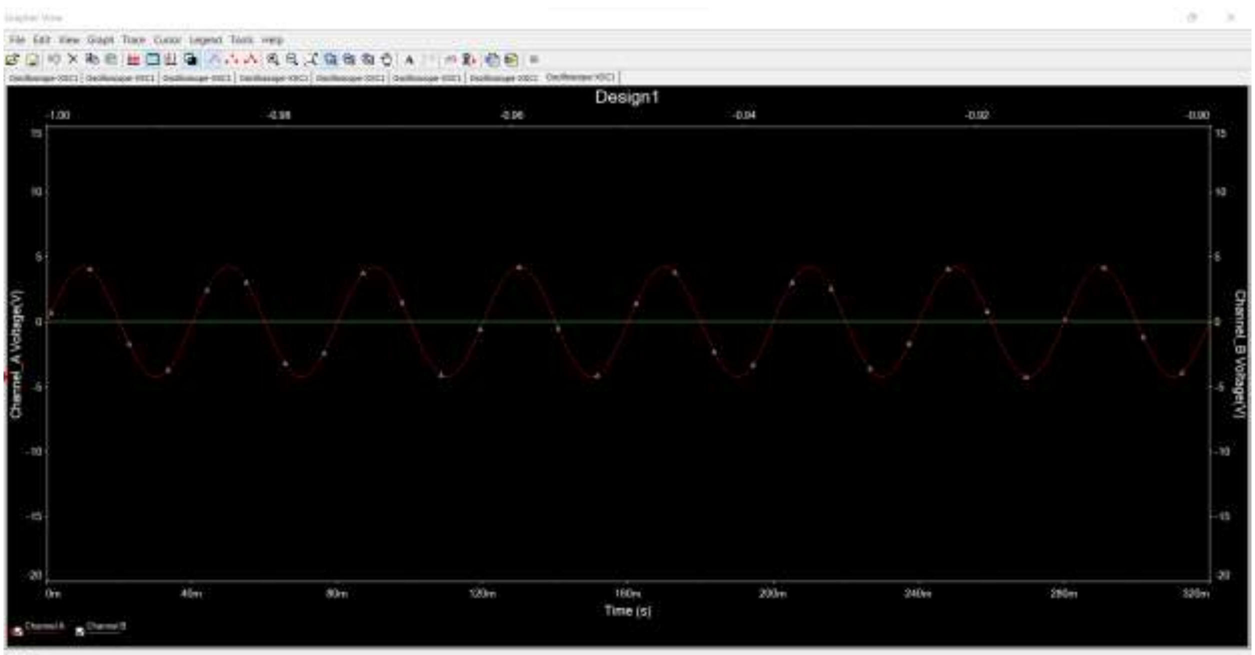


- these are the results for 38kHz and the output wave is very small

- These are the results for the 15 kHz input signal



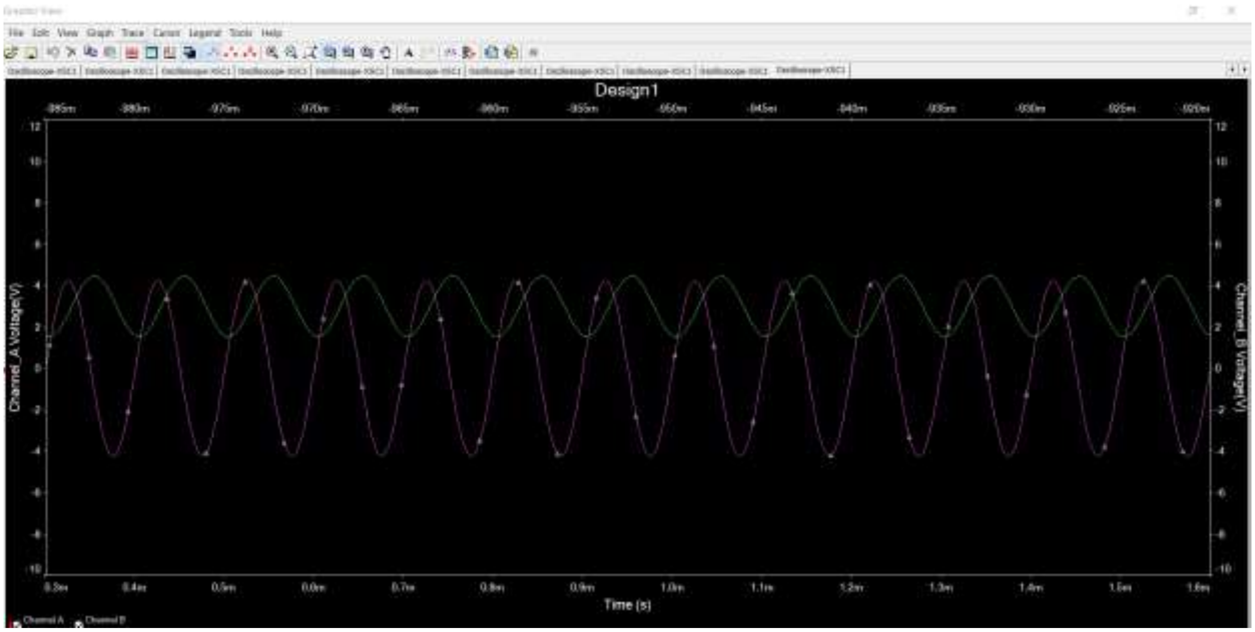
- These are the results for 20 kHz



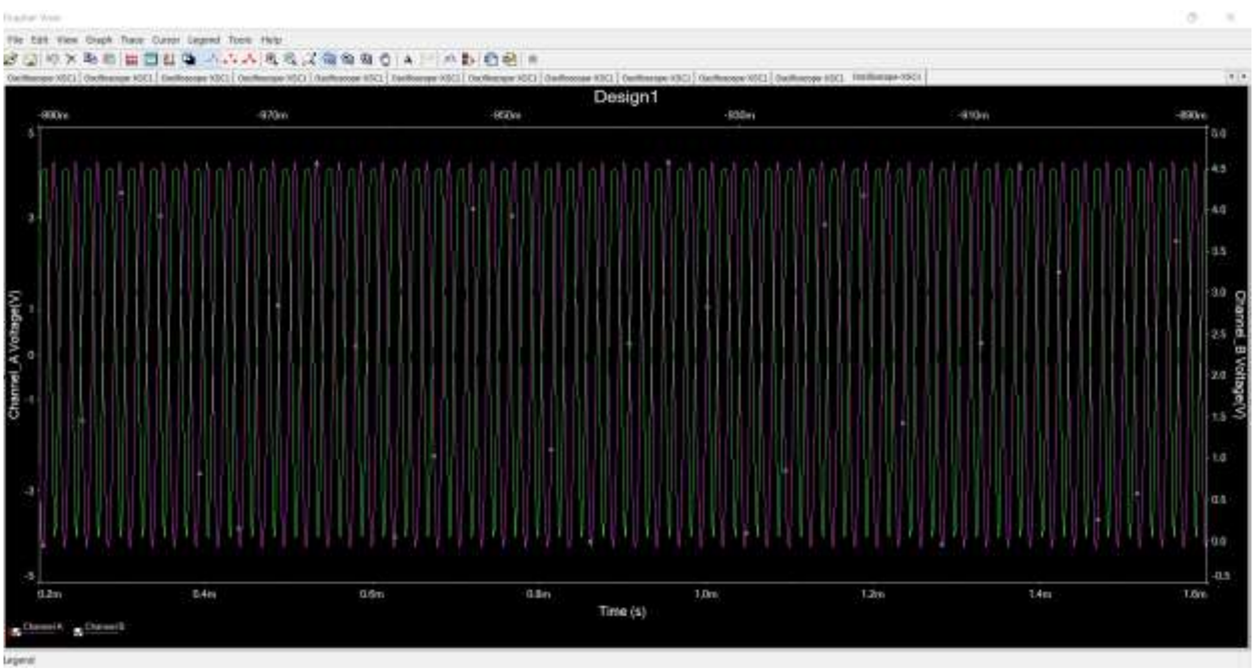
- These are the results for the 25 kHz

The following change was made:

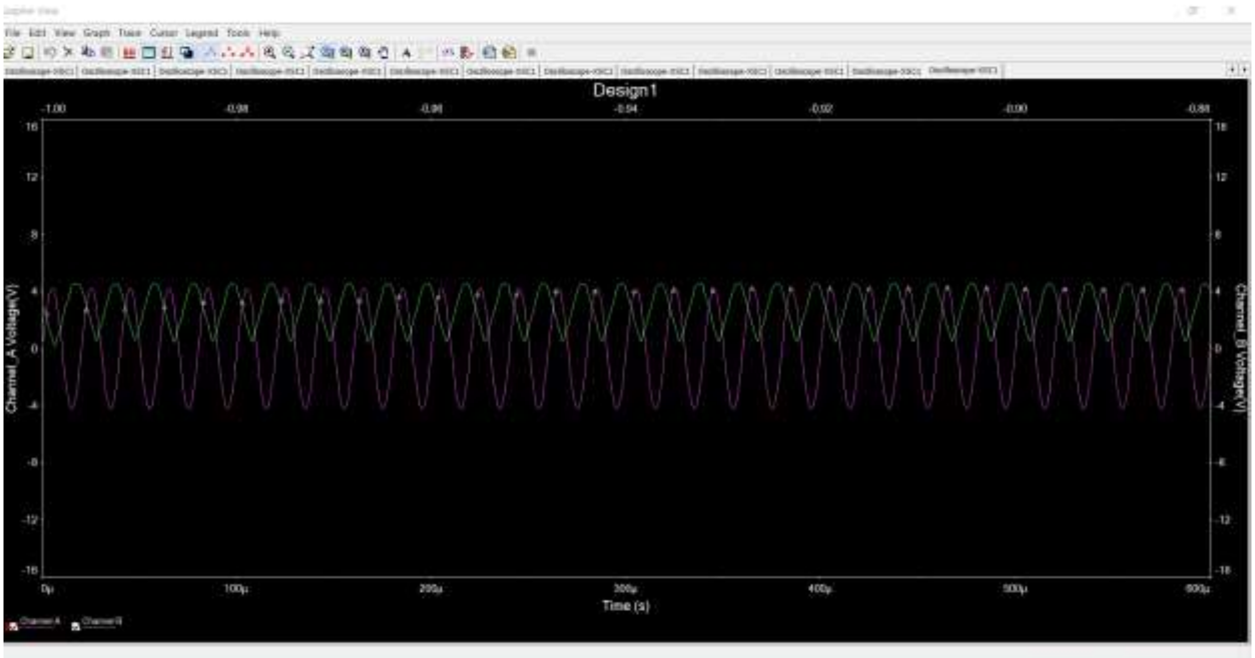
- The pin 2 of the circuit was connected to VEE with a value of -3V and the following is the diagram:



- This is the result for 10 kHz input signal

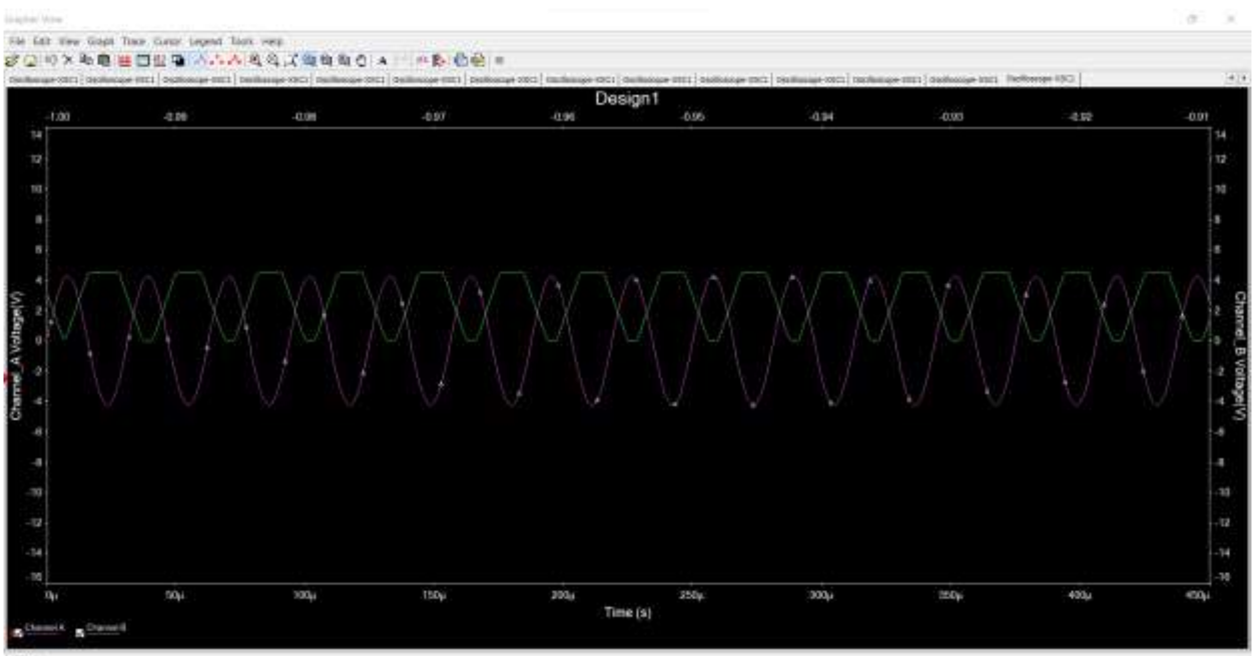


- This is for the 38 kHz input signal

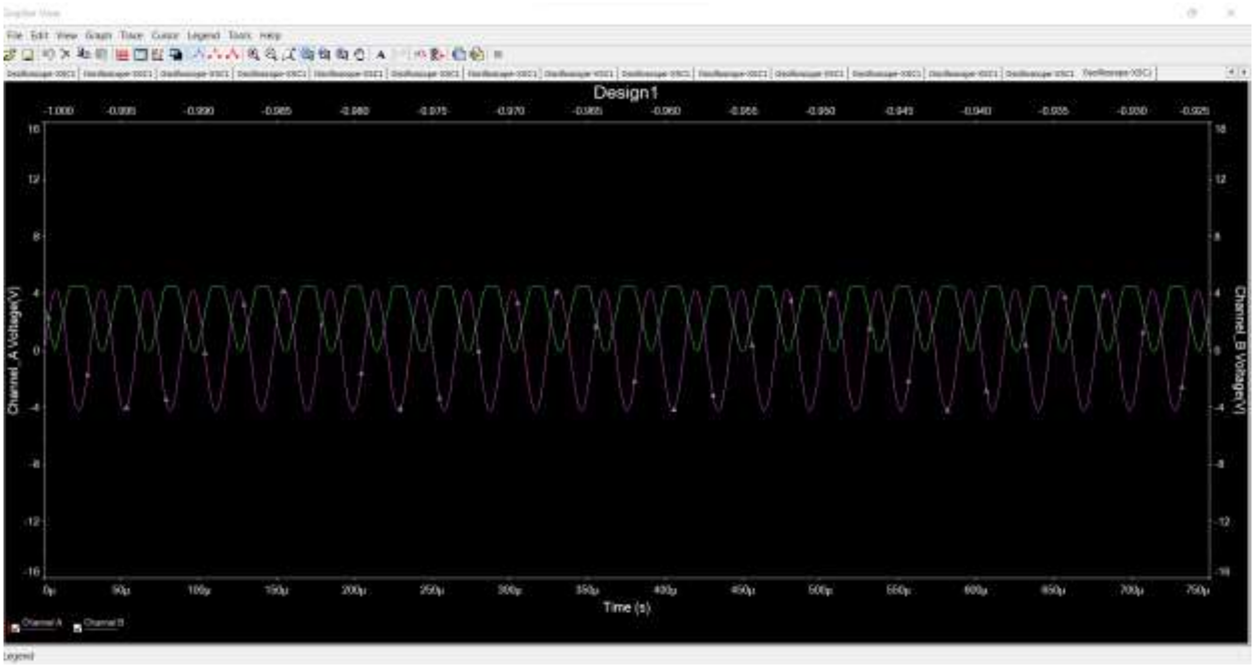


- This is for the 50 kHz input signal

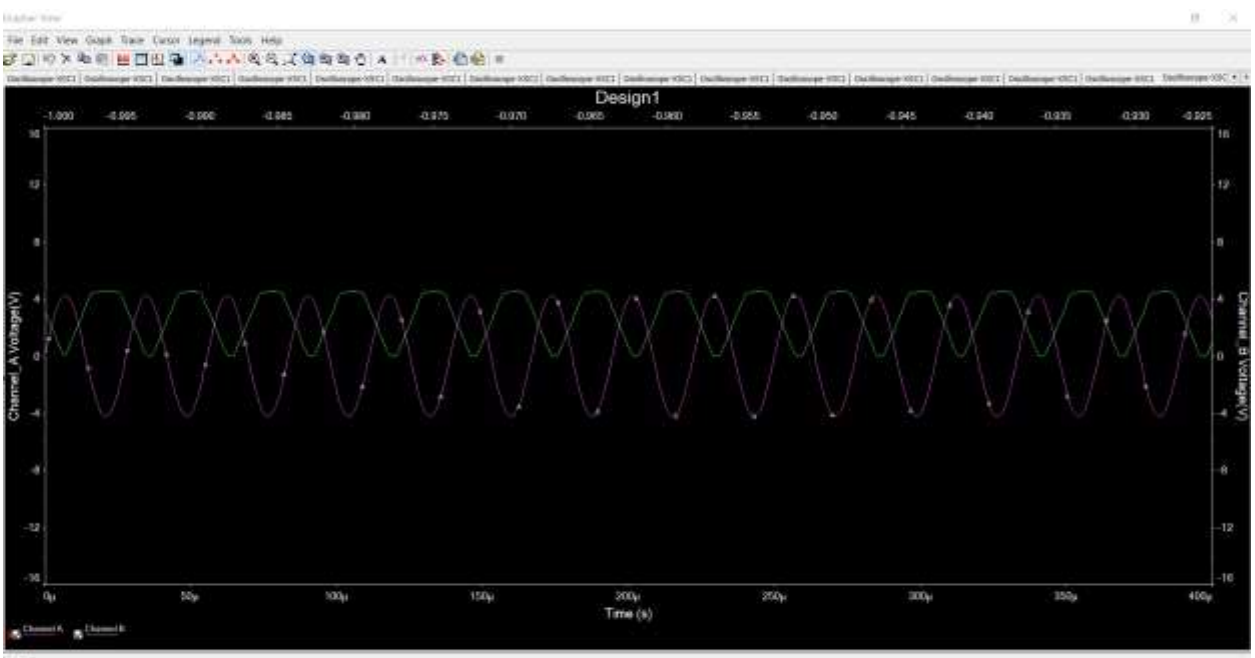
The problem that we have that needs to be addressed is not being able to acquire a bandwidth with small enough range. The above has the range of the 10-50 kHz. We need the bandwidth of 33.9 kHz to 41.8 kHz.



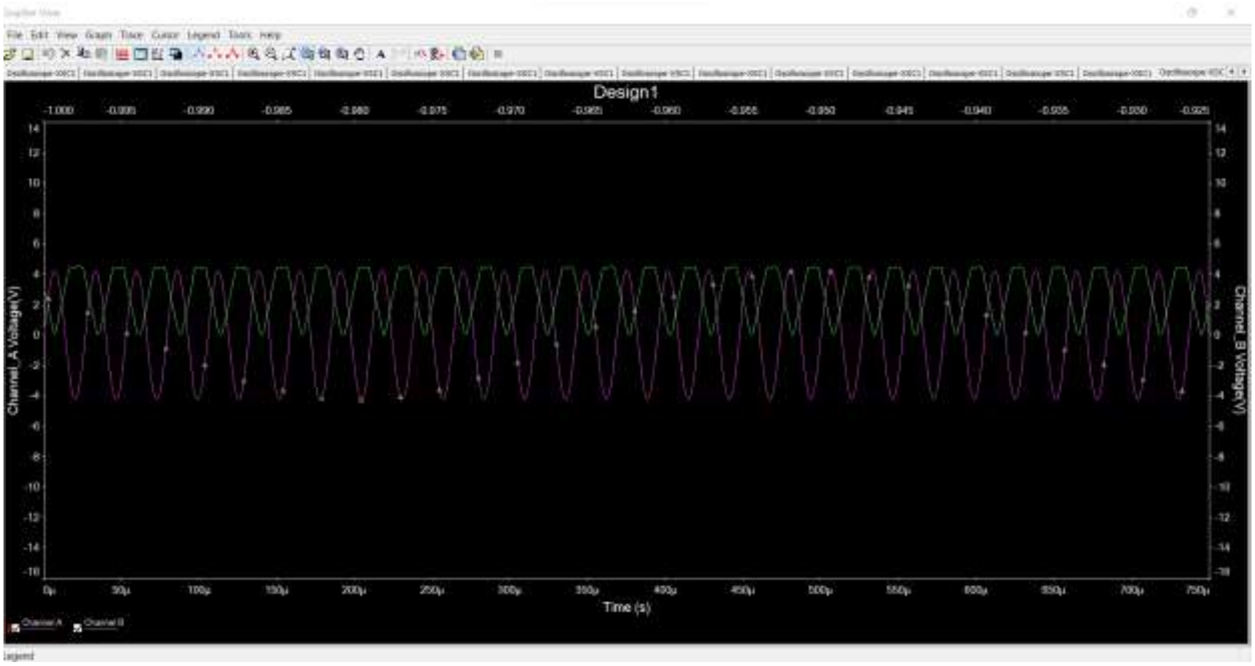
- This is the 32 kHz input signal's output



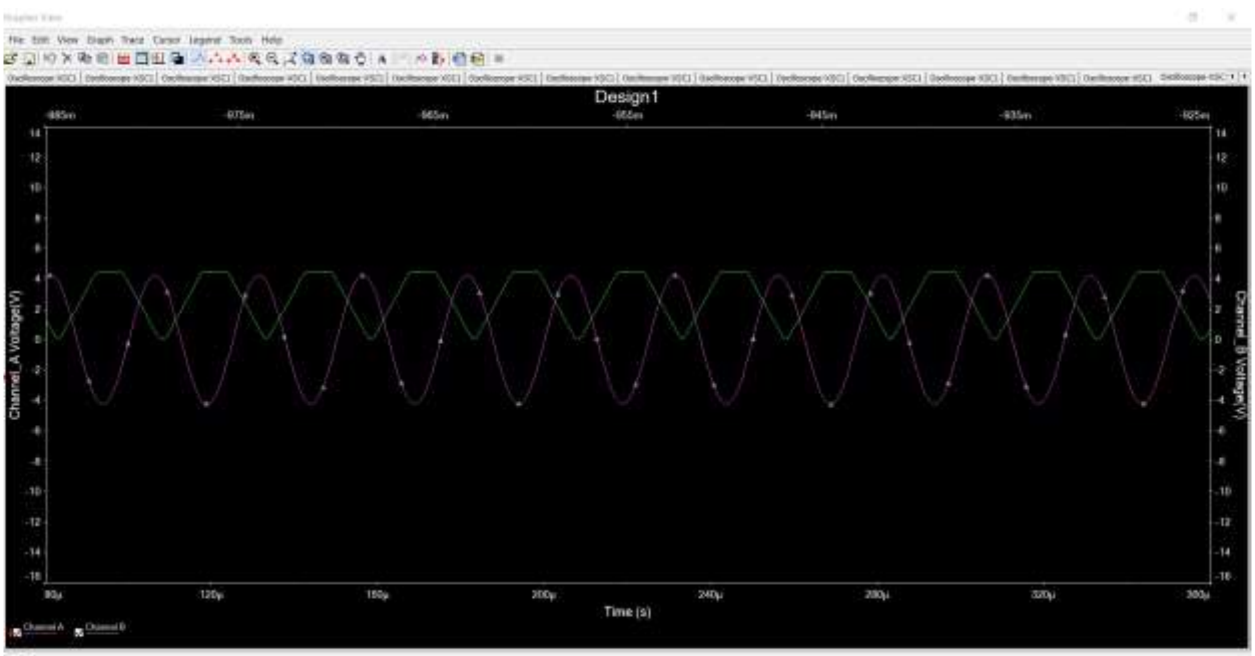
- This is for the 34 kHz input signal



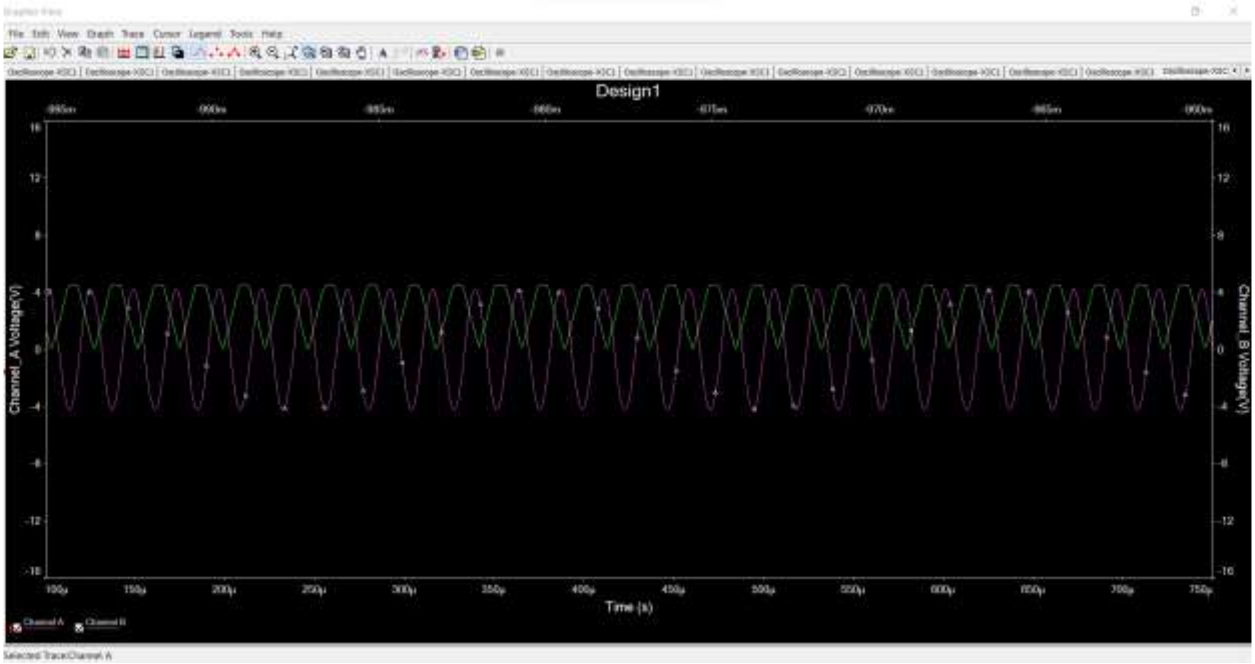
- This is for the 36 kHz input signal



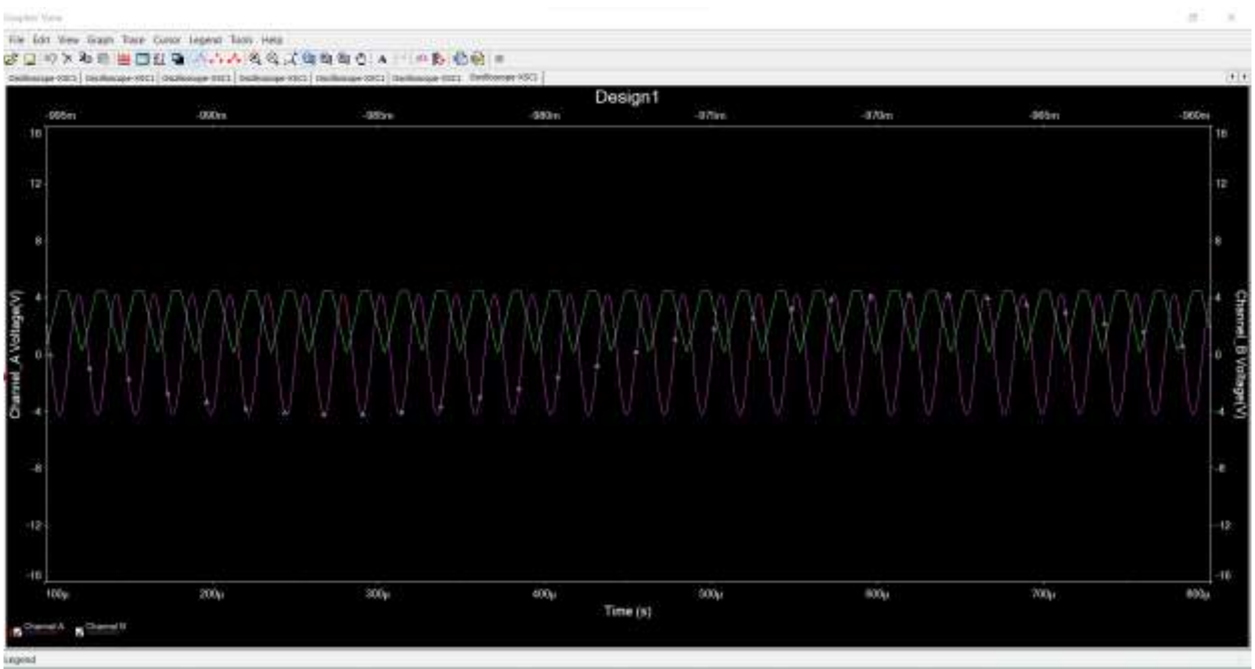
- This is for the 38 kHz input signal



- This is for the 40 kHz input signal



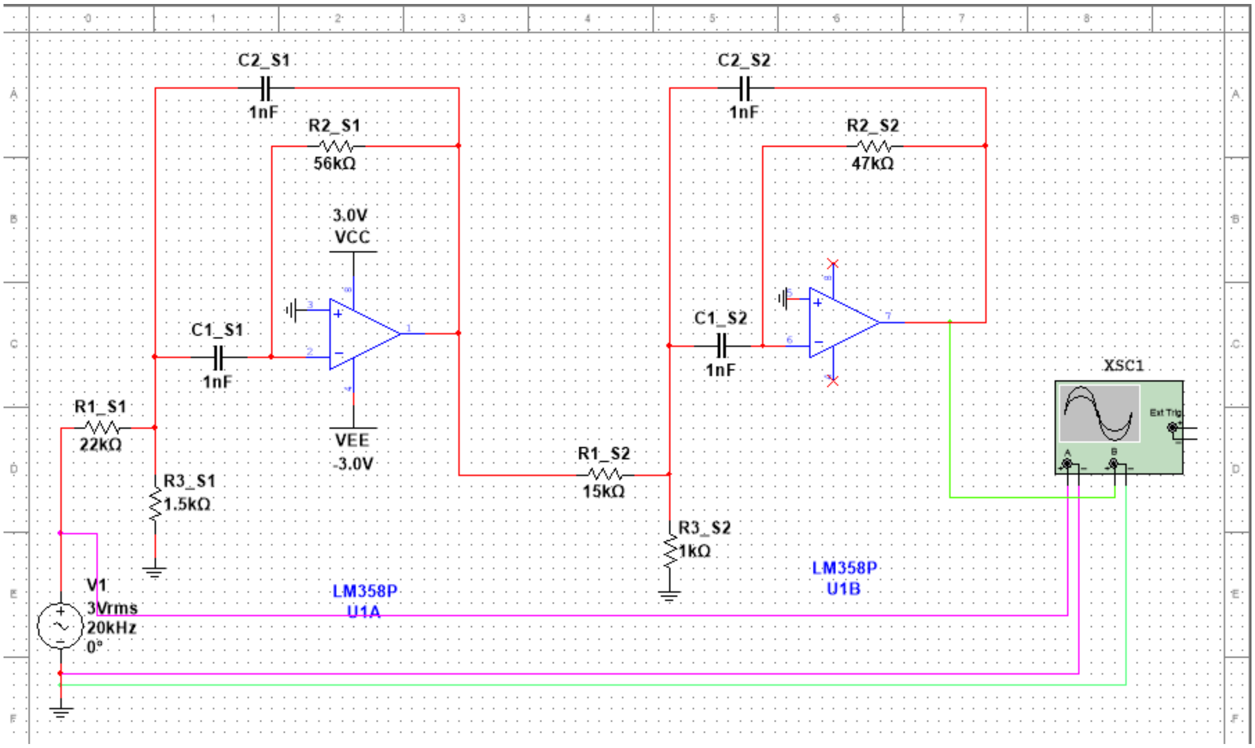
- This is for the 42 kHz input signal



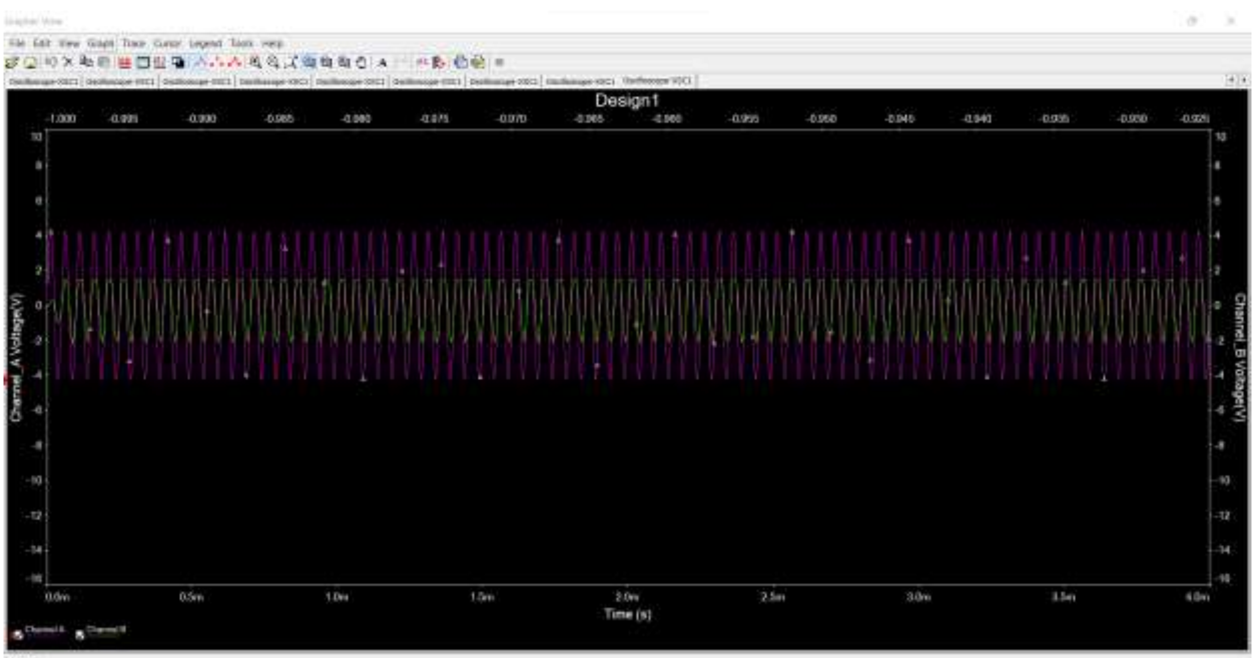
- This is for the 44 kHz input signal

The following changes were made since the upper results didn't give much:

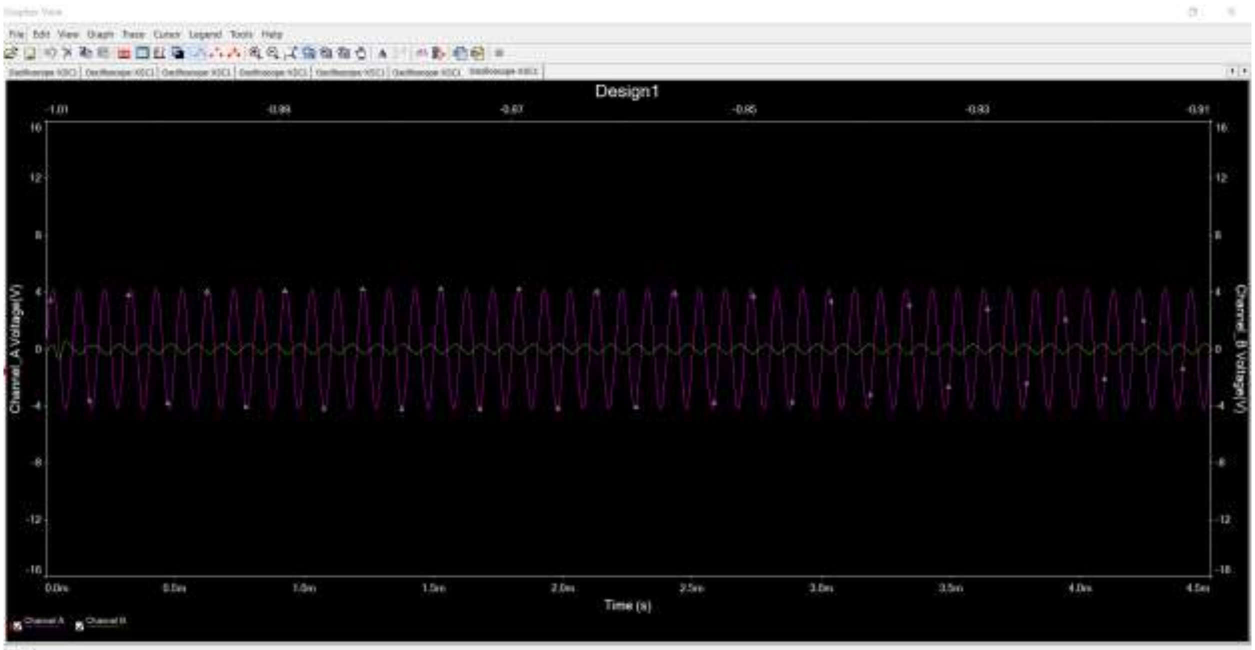
- New circuit tested from Texas Instruments Software



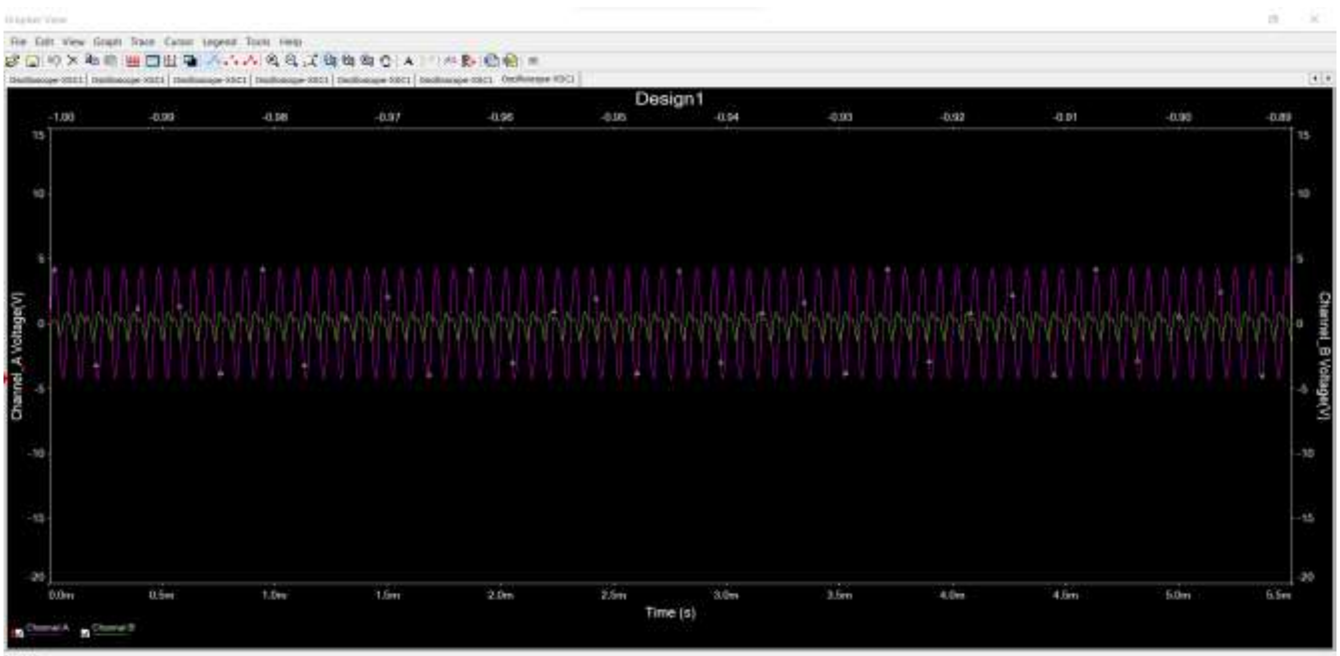
- According to Savannah this is the circuit for the 14-22 kHz bandwidth active bandpass filter
- The results include:



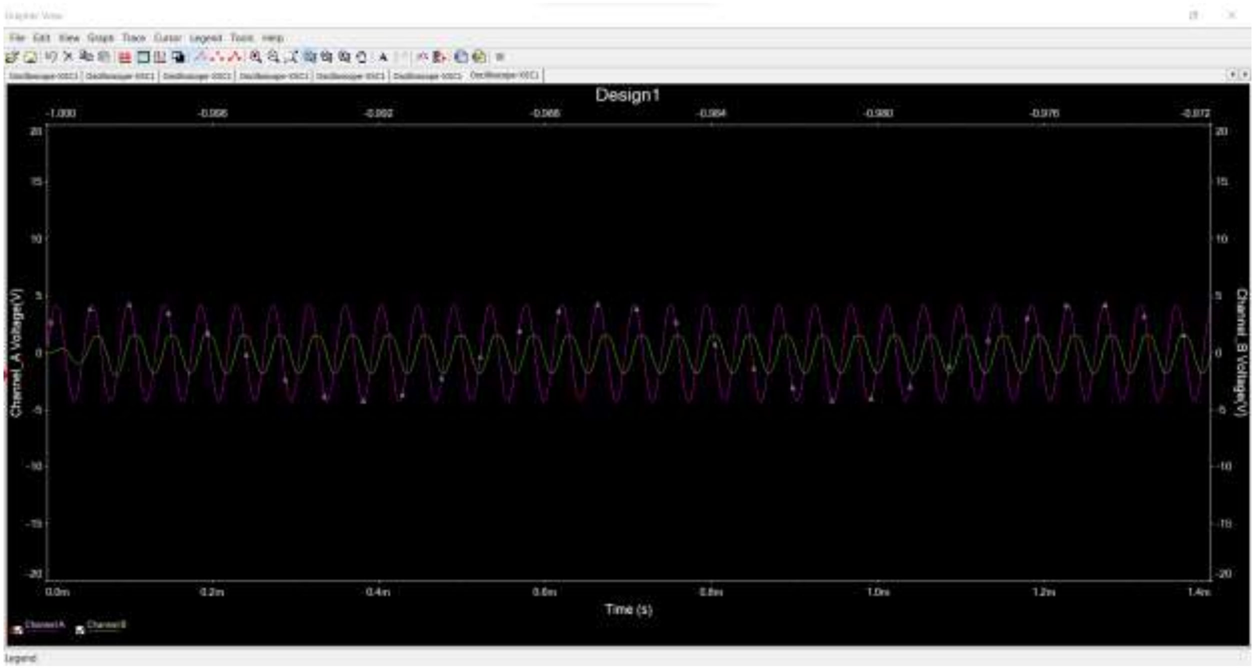
- This is at the 20 kHz input signal



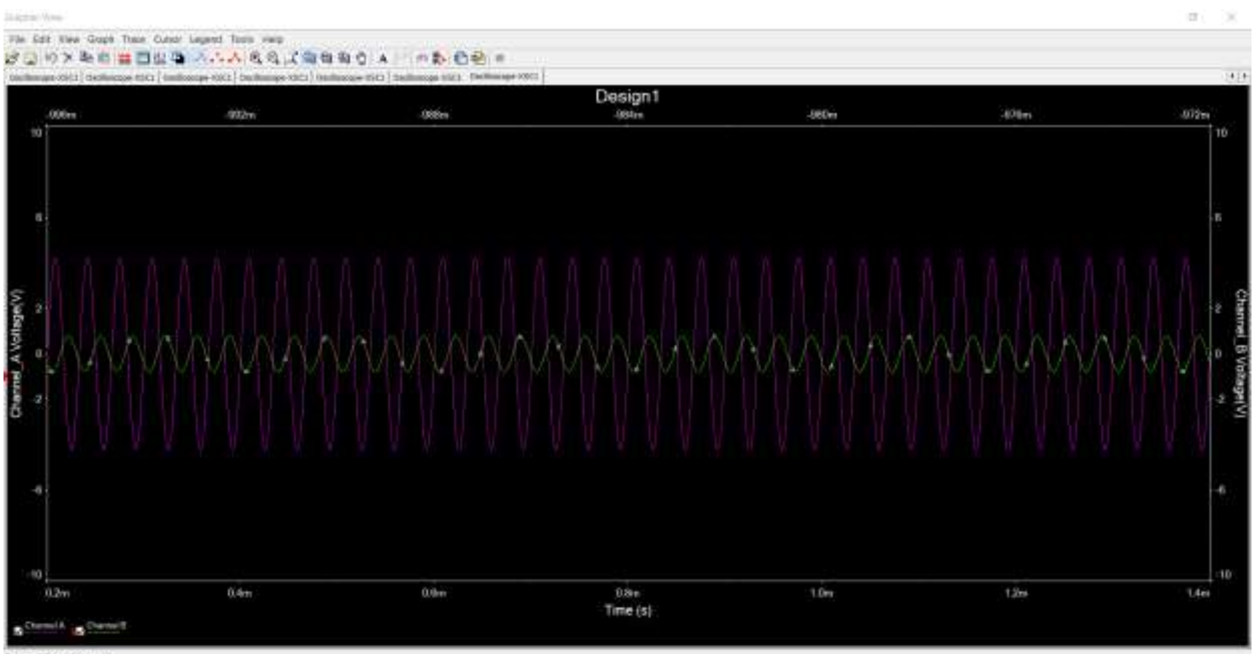
- This is at the 10 kHz input signal



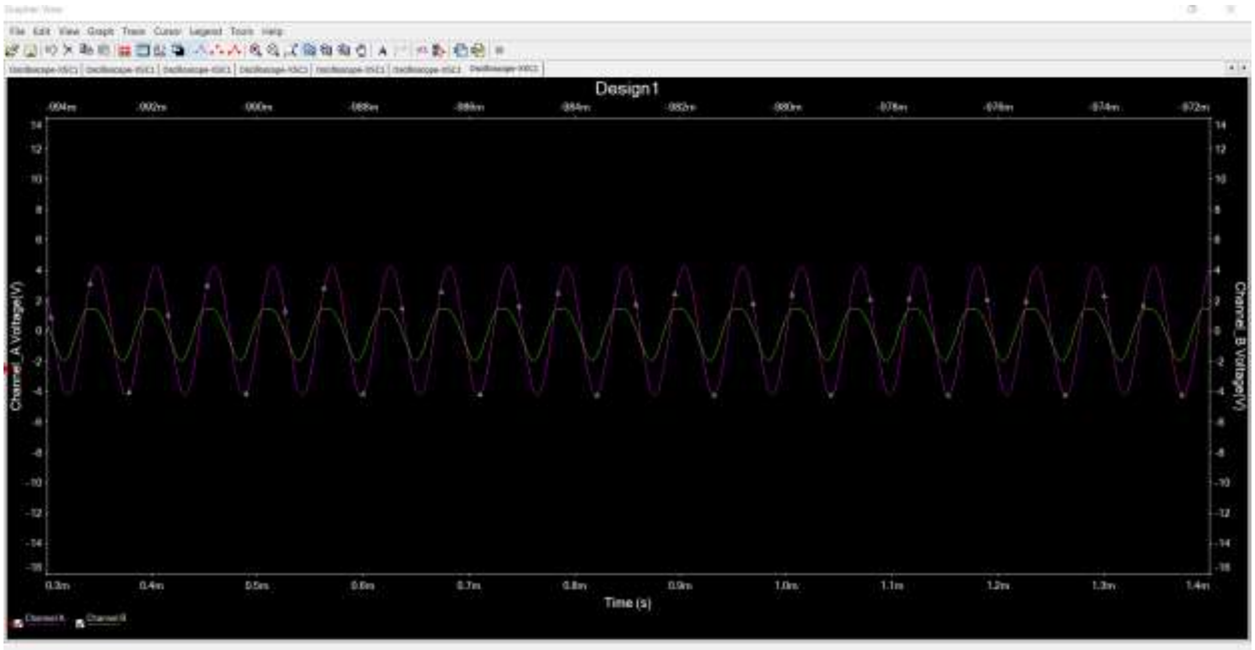
- This is at the 13 kHz input signal
- As can be seen the waveform starts fluctuating the closer it gets to the bandwidth range



- This is at the 23 kHz input signal



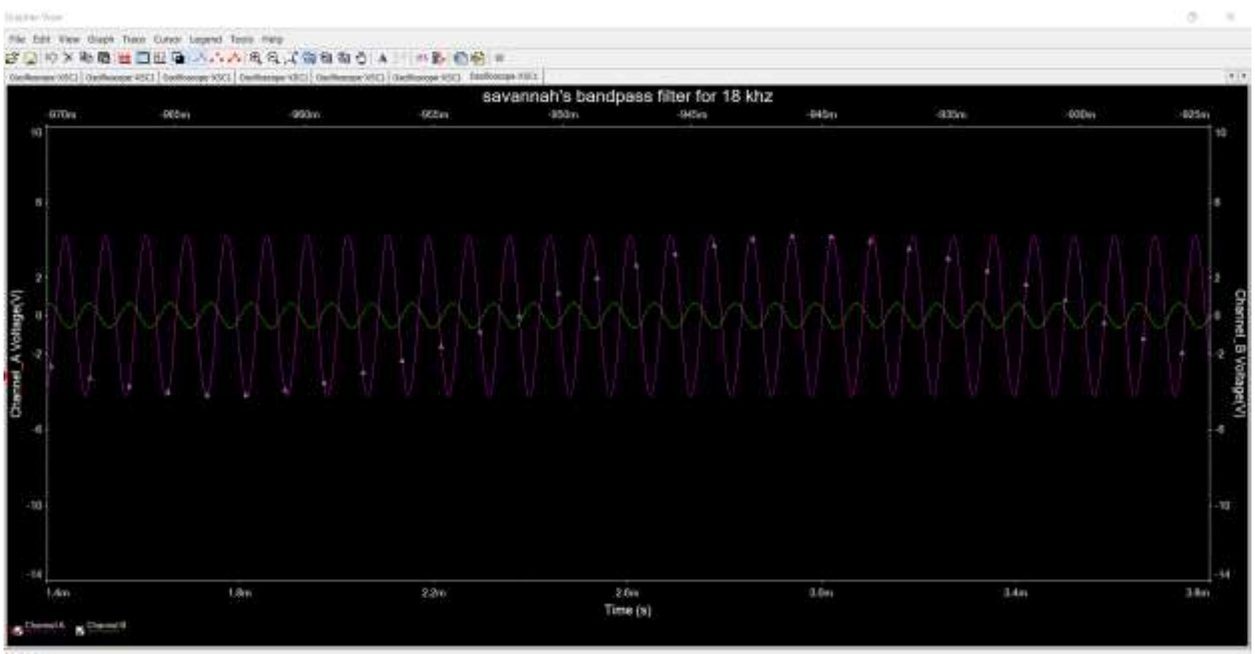
- This is at the 30 kHz input signal



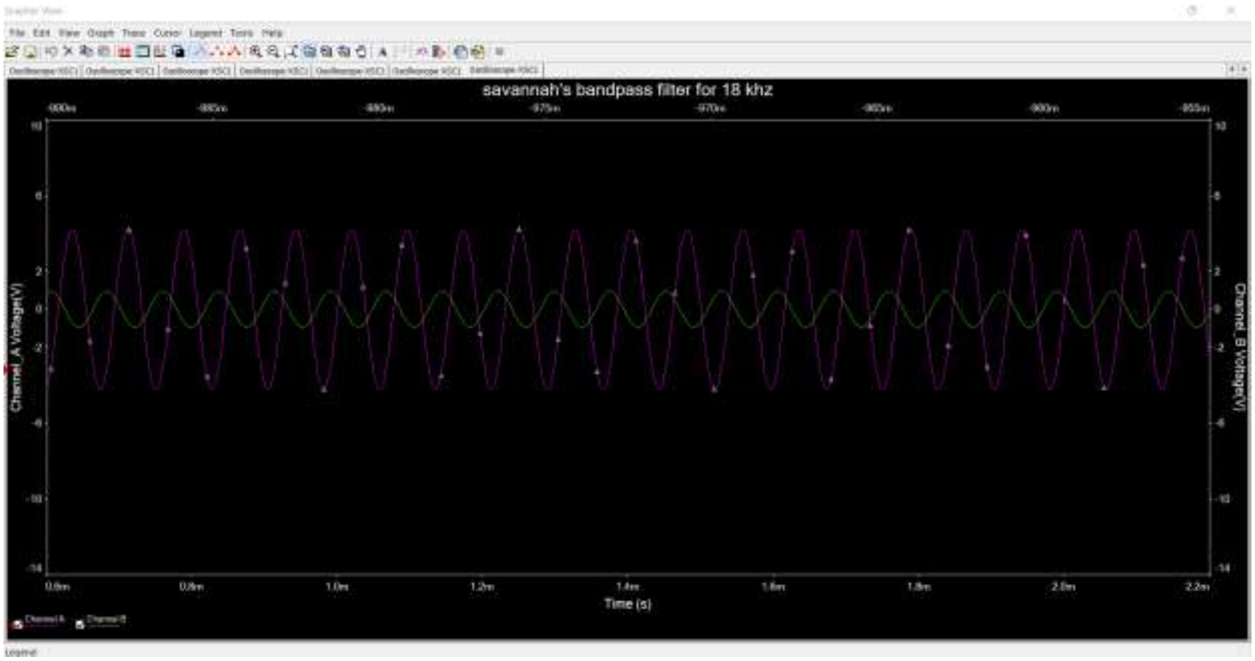
- This is at the 18 kHz input signal

The following changes were made:

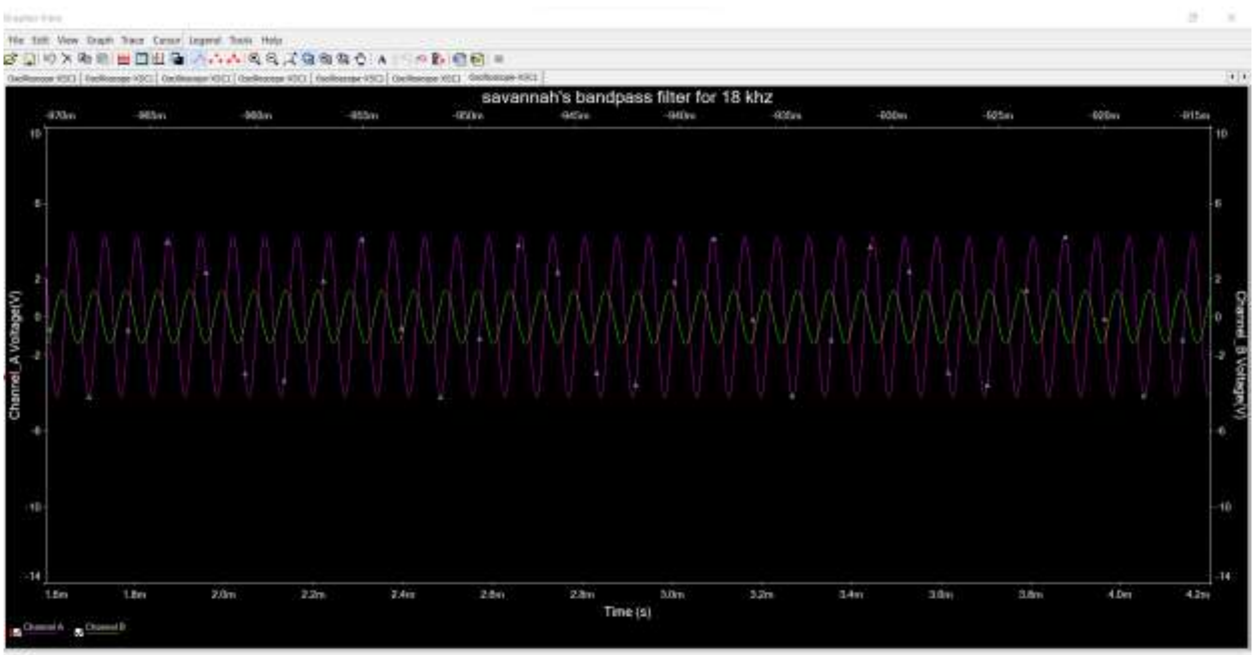
- Next I changed the VCC and VEE of the op amp to 5 V and -5 V, respectively so that the gain will have bigger range



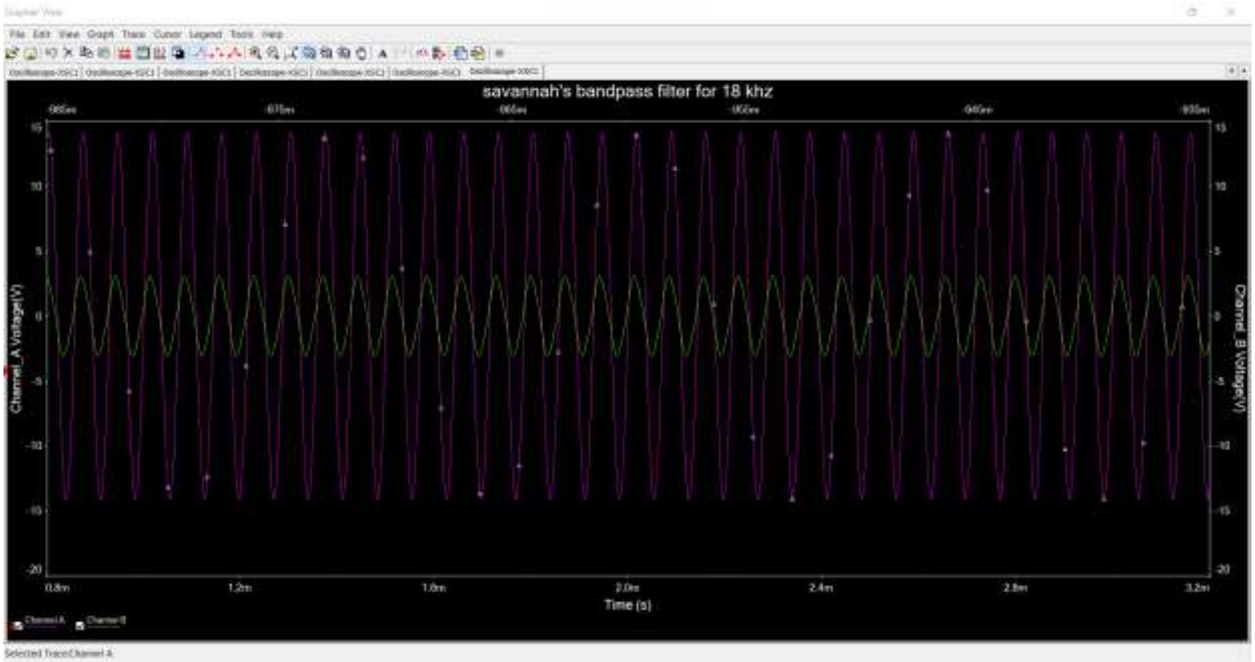
- This is at the 12 kHz input signal



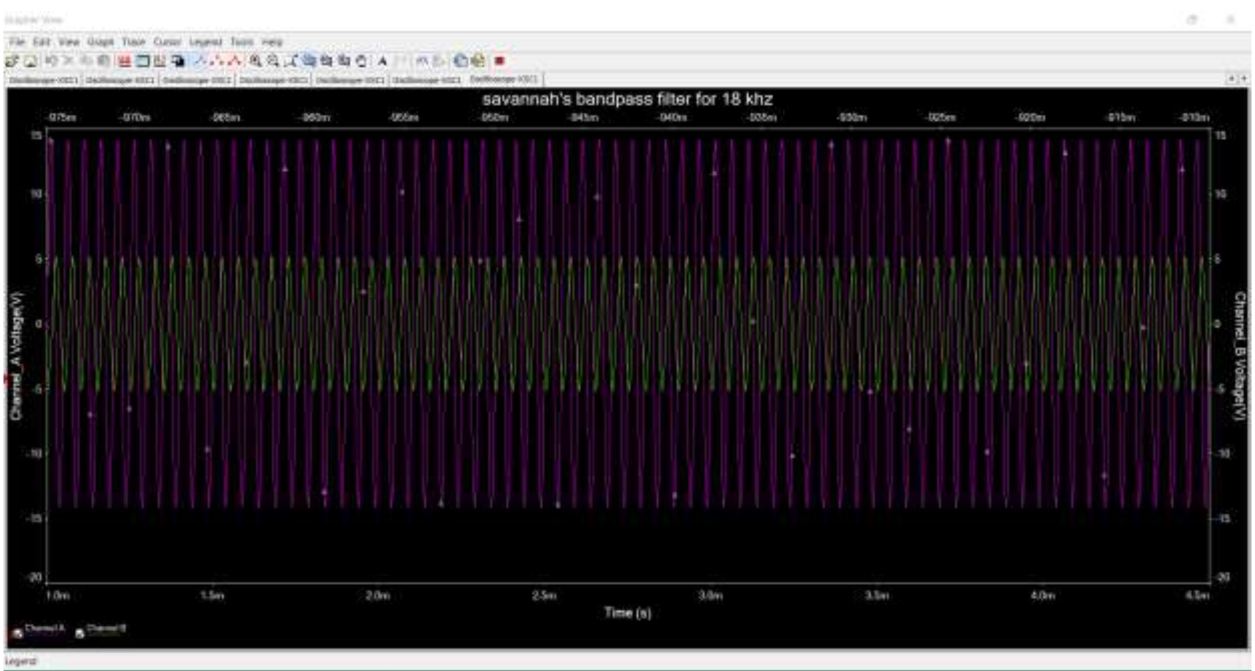
- This is at the 13 kHz input signal



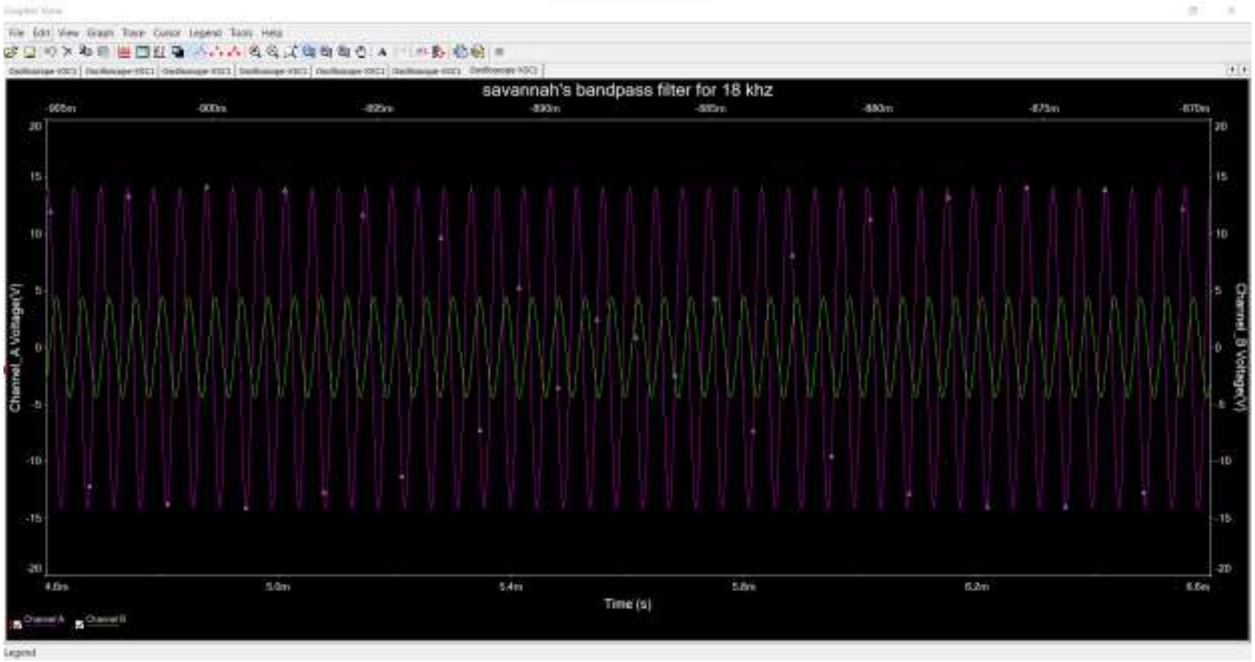
- This is at the 14 kHz input signal
- The problem have been identified : when setting the input voltage at 10 V and having op amp voltage of -10 V to 10 V, the gain within the bandwidth results in a waveform with max voltage of 2.5 V when the input frequency is 14 kHz as can be seen below:



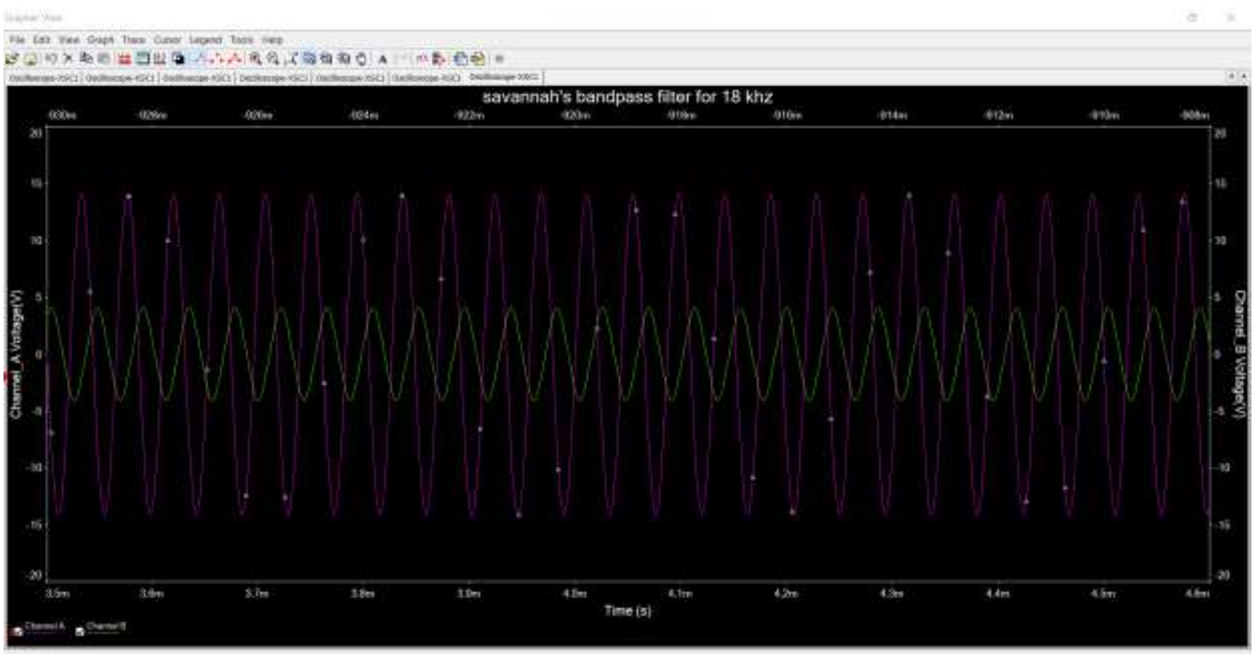
- This is at the 14 kHz input signal
- Input voltage of waveform generator input is 10V
- VCC of op amp is 10V and VEE of op amp is -10



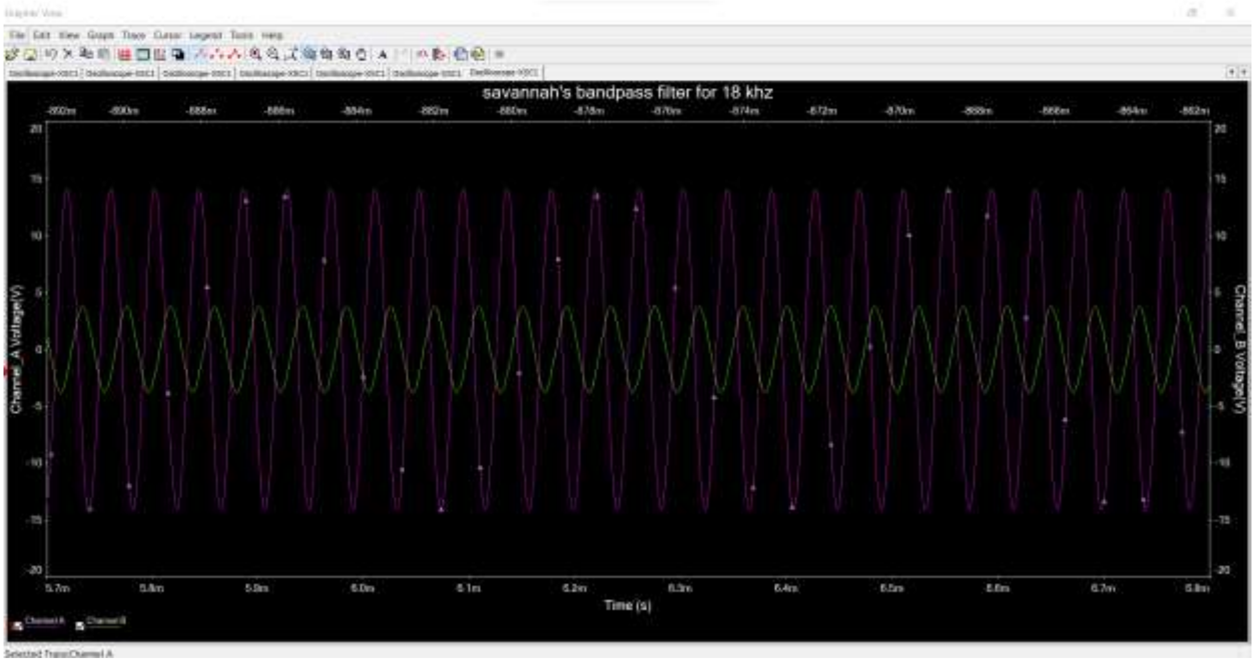
- This is at the 20 kHz input signal



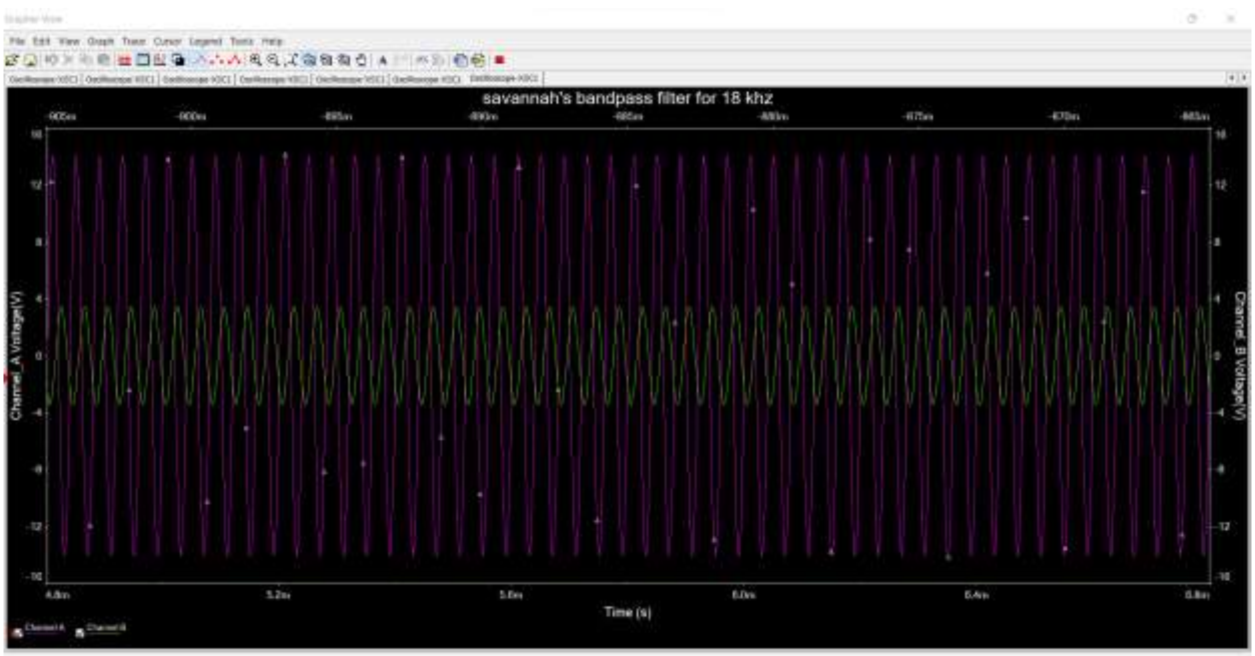
- This is at the 22 kHz input signal



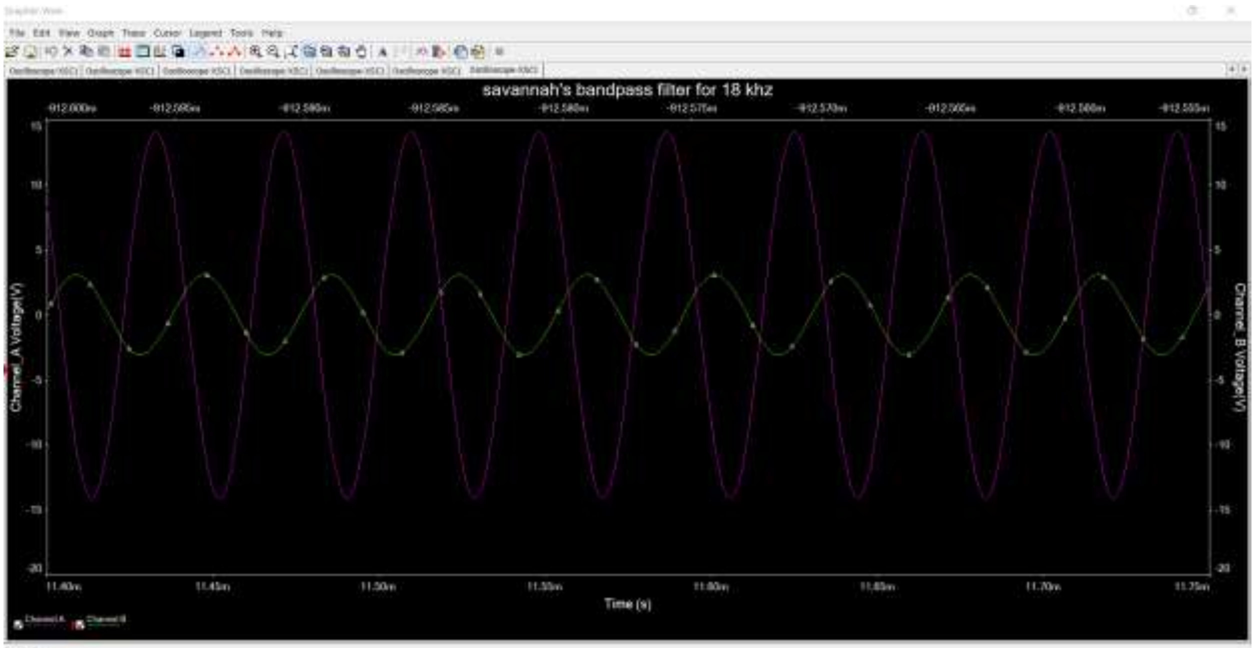
- This is at the 23 kHz input signal



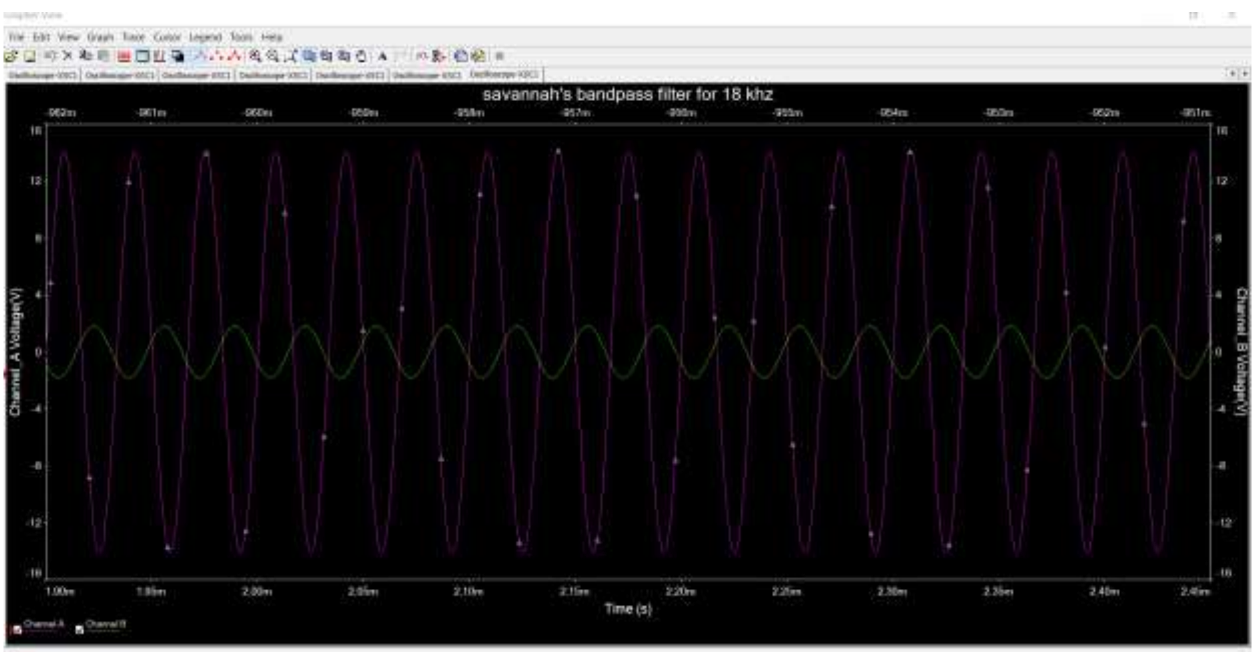
- This is at the 24 kHz input signal



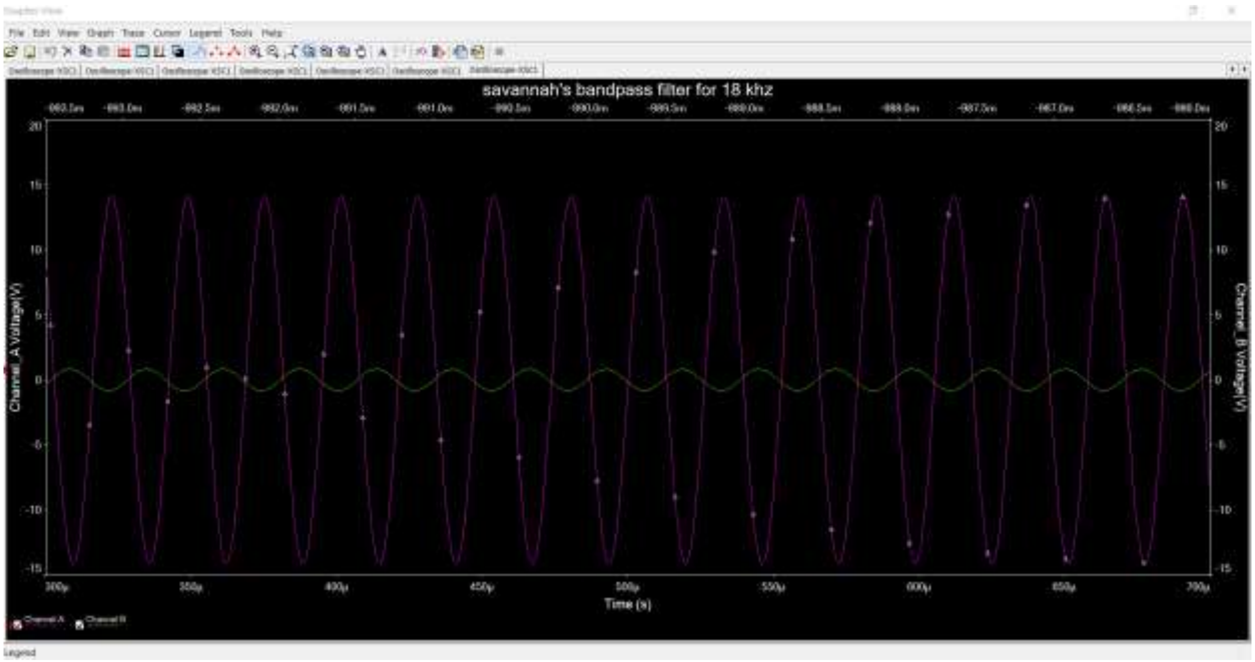
- This is at the 25 kHz input signal



- This is at the 26 kHz input signal



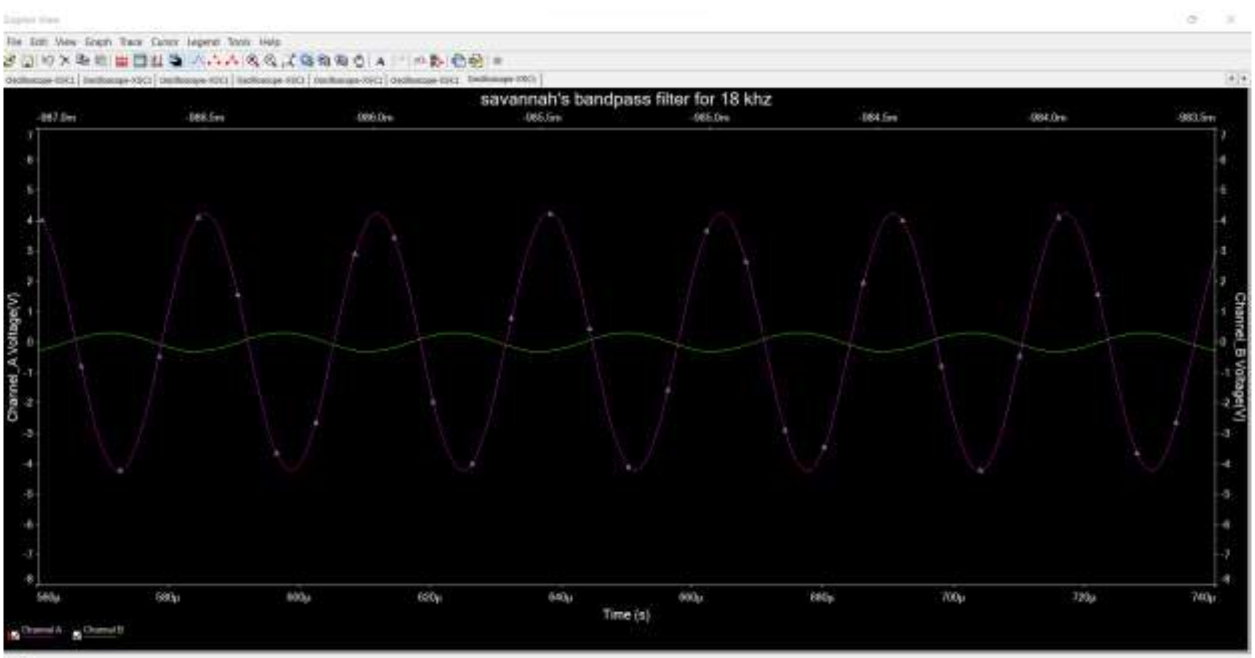
- This is at the 30 kHz input signal



- This is at the 38 kHz input signal

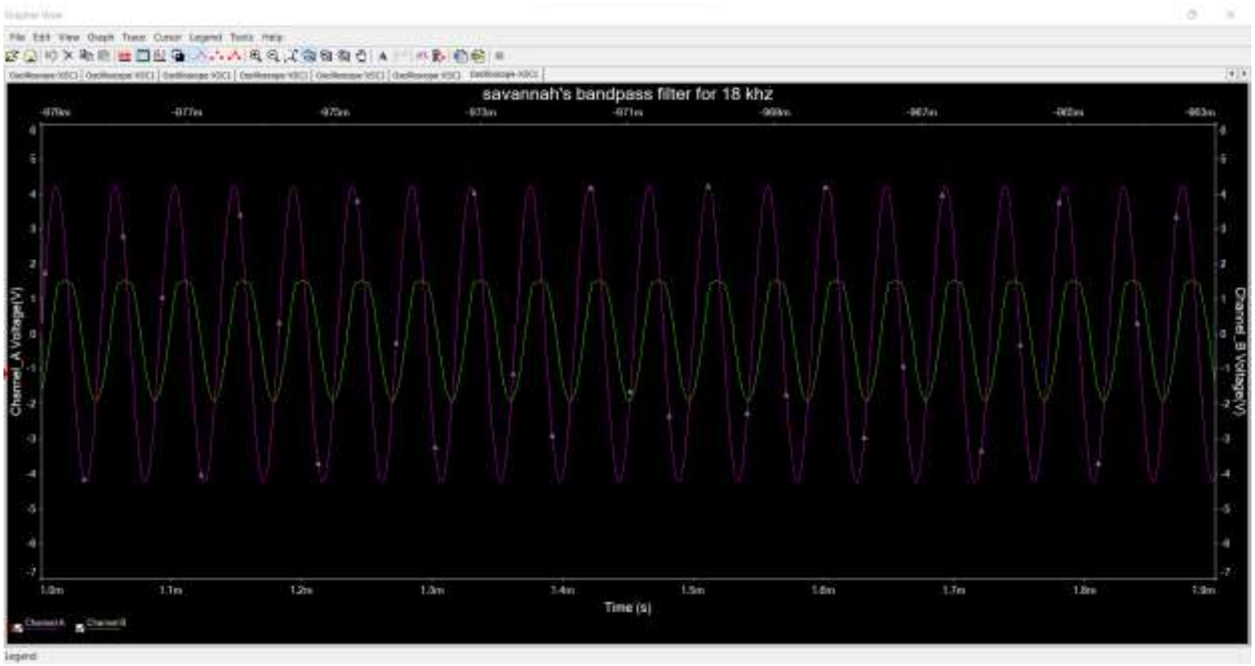
The following changes were made:

- I went ahead and changed the input voltage of the waveform generator machine to 3V and changed the VCC and VEE voltages of op amp to 3V and -3V respectively, and following is the result for the 38 kHz which I believe is the upper cutoff frequency instead of the 22 kHz:



- Here the voltage of the input signal is 4V was decreased to ~0.5 V

- Using the same setup as above, I tested the 22 kHz which I believe has one of the highest gains within the bandwidth range:



These tests didn't give much to proceed with so it was decided to test the system in lab.

March 24th Senior Design Task

Objective: Testing and troubleshooting Savannah's filter

Approach for activity: Used NH 148 lab space for testing

Outcome of activity: We were able to progress in troubleshooting a little

Impact of activity on the project: Very important because one of the big problems we have is voltage attenuation

Assessment of the importance of activity: Important in continuing the project

Tips to improve the approach for doing the activity for iterations: Try various combinations for the resistor and capacitor values

- We tested the existing active bandpass filter to try to find the problems of the circuit and obtained the following results

Index	Frequency of Waveform Generator	Amplitude of Waveform Generator	Input Voltage of Op Amp	Frequency from Channel 1	Frequency from Channel 2	VPP of channel 1	Vpp of channel 2	Amplitude of Channel 1	Amplitude of Channel 2
1	10 kHz	3 Vpp	3 V	~10 kHz	~10 kHz	3.4 V	640 mV	3.2 V	640 mV
2	11 kHz	3 Vpp	3 V	~ 11	~11	3.4 V	1.280 V	3.2 V	1.280 V
3	12 kHz	3 Vpp	3 V	~12	~12	3.4 V	1.640 V	3V	1.640V
4	13 kHz	3 Vpp	3 V	~13	~13	3.6 V	1.680 V	3V	1.680 V
5	14 kHz	3 Vpp	3 V	~14	~14	4 V	1.720 V	3 V	1.720 V
6	15 kHz	3 Vpp	3 V	~~15	~15	3.4 V	1.760 V	3 V	1.760 V
7	16 kHz	3 Vpp	3 V	~16	~16	3.4 v	1.8 v	3.2 V	1.8 V
8	17 kHz	3 Vpp	3 V	~17	~17	3.6 V	1.84 V	3.2 V	1.840 V
9	18 kHz	3 Vpp	3 V	~18	~18	3.4 V	1.840 V	3.2 V	1.480 V
10	19 kHz	3 Vpp	3 V	~19	~19	4.2 V	1.8 V	3.2 V	1.640 V
11	20 kHz	3 Vpp	3 V	~20	~20	3.6 V	1.640 V	3.2 V	1.480 V
12	21 kHz	3 Vpp	3 V	~21	~21	4.0 V	1.6 V	3.2 V	1.480 V
13	22 kHz	3 Vpp	3 V	~22	~22	3.8 V	1.6 V	3.2 V	1.240 V
14	23 kHz	3 Vpp	3 V	~23	~23	4 V	1.6 V	3.2 V	1.6 V
15	24 kHz	3 Vpp	3 V	~24	~24	4.2 V	1.560 V	3.2 V	1.560 V
16	25 kHz	3 Vpp	3 V	~25	~25	3.4 V	1.560 V	3.2 V	1.560 V
17	26 kHz	3 Vpp	3 V	~26	~26	3.4 V	1.440 V	3 V	1.440 V
18	27 kHz	3 Vpp	3 V	~27	~27	4 V	1.320 V	3.2 V	1.320 V
19	28 kHz	3 Vpp	3 V	~28	~28	4.0 V	800 mV	3.2 V	800 mV
20	29 kHz	3 Vpp	3 V	~29	~29	3.8 V	520 mV	3.2 V	520 mV
21	30 kHz	3 Vpp	3 V	~30	~30	3.8 V	640 mV	3.2 V	640 mV

- Channel 1 is measuring waveform generator signal

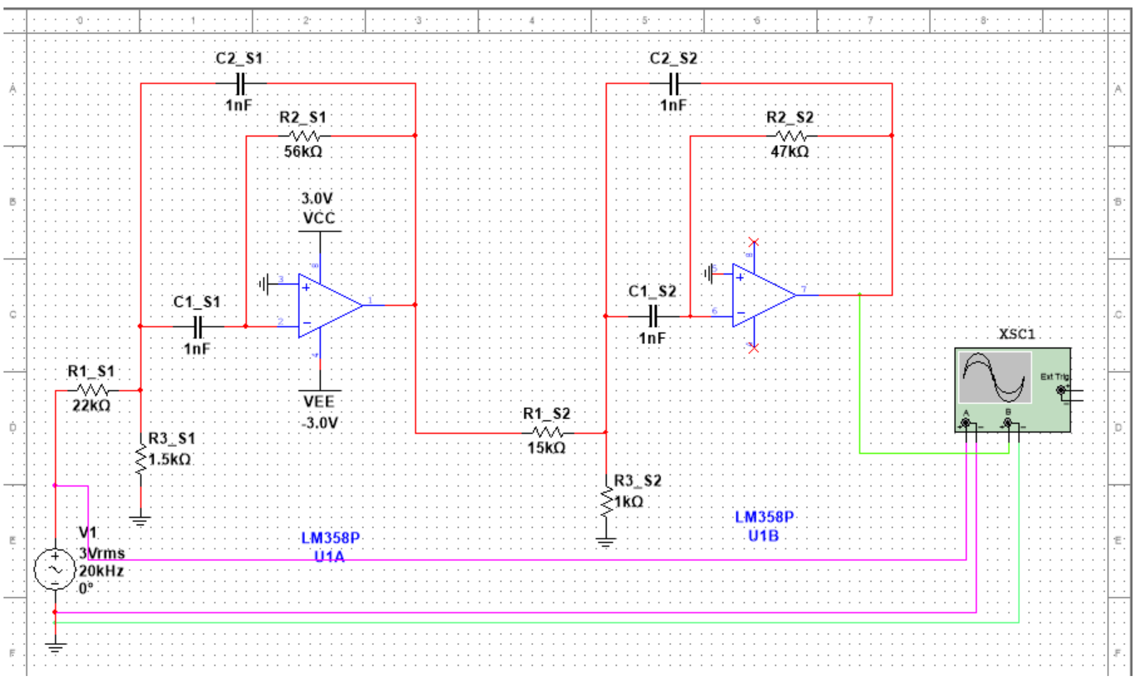
- Channel 2 is measuring the output of op amp from pin 7

Following problems were identified:

- Bandwidth range is too big
    - Lower cutoff frequency is about 10 kHz but we need it to be about 14 kHz so we will have to decrease the resistor and capacitor values [high pass filter = lower cutoff frequency]
    - Upper cutoff frequency is about 30 kHz but we need it to be about 22 kHz so we will have to increase the resistor and capacitor values [low pass filter = upper cutoff frequency]
- Very low voltage output

Following changes were made to decrease the bandwidth range:

- R2_S1 was decreased from 56 kHz to 47 kHz
- R2_S2 was increased from 47 kHz to 56 kHz
- Here is the circuit from above for reference:



- The following results were obtained after changes were made:

Index	Frequency of Waveform Generator	Amplitude of Waveform Generator	Input Voltage of Op Amp	Frequency from Channel 1	Frequency from Channel 2	VPP of channel 1	Vpp of channel 2	Amplitude of Channel 1	Amplitude of Channel 2

1	10 kHz	3 Vpp	3 V	~10 kHz	~10 kHz	3.4V	1.4V	3.2V	1.4V
2	11 kHz	3 Vpp	3 V	~ 11	~11	3.4V	1.28V	3.2V	1.28V
3	12 kHz	3 Vpp	3 V	~12	~12	3.4V	1.76V	3.2V	1.76V
4	13 kHz	3 Vpp	3 V	~13	~13	3.8V	1.8V	3.2V	920mV
5	14 kHz	3 Vpp	3 V	~14	~14	3.8V	1.8V	3.2V	1.8V
6	15 kHz	3 Vpp	3 V	~~15	~15	3.4V	1.88V	3.2V	1.88V
7	16 kHz	3 Vpp	3 V	~16	~16	4.2V	1.84V	3.2V	1.84V
8	17 kHz	3 Vpp	3 V	~17	~17	3.6V	1.88V	3.2V	1.8V
9	18 kHz	3 Vpp	3 V	~18	~18	3.4V	1.88V	3.2V	1.68V
10	19 kHz	3 Vpp	3 V	~19	~19	4.0V	1.72V	3.2V	1.52V
11	20 kHz	3 Vpp	3 V	~20	~20	3.8V	1.64 V	3.0V	1.48V
12	21 kHz	3 Vpp	3 V	~21	~21	3.4V	1.68V	3.2V	1.68V
13	22 kHz	3 Vpp	3 V	~22	~22	4.2V	1.68V	3.2V	1.68V
14	23 kHz	3 Vpp	3 V	~23	~23	3.6V	1.64V	3.2V	640mV
15	24 kHz	3 Vpp	3 V	~24	~24	4.2V	1.52V	3.2V	1.52V
16	25 kHz	3 Vpp	3 V	~25	~25	3.4V	1.64V	3.2V	1.64V
17	26 kHz	3 Vpp	3 V	~26	~26	4.0V	1.64V	3.2V	1.64V
18	27 kHz	3 Vpp	3 V	~27	~27	3.6V	1.32V	3.2V	1.32V
19	28 kHz	3 Vpp	3 V	~28	~28	4.0V	1.52V	3.2V	1.52V
20	29 kHz	3 Vpp	3 V	~29	~29	3.8V	1.08V	3.2V	1.08V
21	30 kHz	3 Vpp	3 V	~30	~30	3.4V	1.0V	3.2V	1.0V

Following changes were made to decrease the bandwidth range further:

- R1_S1 was decreased from 22kHz to 15 kHz
- R1_S2 was increased from 15 kHz to 22 kHz

Index	Frequency of Waveform Generator	Amplitude of Waveform Generator	Input Voltage of Op Amp	Frequency from Channel 1	Frequency from Channel 2	VPP of channel 1	Vpp of channel 2	Amplitude of Channel 1	Amplitude of Channel 2
1	10 kHz	3 Vpp	3 V	~10 kHz	~10 kHz	3.4V	320mV	3.2V	320mV
2	11 kHz	3 Vpp	3 V	~ 11	~11	4.0V	264mV	3.2V	264mV
3	12 kHz	3 Vpp	3 V	~12	~12	3.6V	280mV	3.2V	152mV
4	13 kHz	3 Vpp	3 V	~13	~13	4.0V	288mV	3.0V	176mV
5	14 kHz	3 Vpp	3 V	~14	~14	3.4V	336mV	3.2V	248mV

6	15 kHz	3 Vpp	3 V	~~15	~15	3.4V	1.64V	3.2V	840mV
7	16 kHz	3 Vpp	3 V	~16	~16	4.0V	1.68V	3.2V	1.68V
8	17 kHz	3 Vpp	3 V	~17	~17	4.2V	1.72V	3.0V	1.72V
9	18 kHz	3 Vpp	3 V	~18	~18	4.2V	1.76V	3.2V	1.76V
10	19 kHz	3 Vpp	3 V	~19	~19	4.0V	1.72V	3.2V	1.64V
11	20 kHz	3 Vpp	3 V	~20	~20	3.6V	1.68V	3.2V	1.56V
12	21 kHz	3 Vpp	3 V	~21	~21	3.6V	1.56V	3.2V	1.44V
13	22 kHz	3 Vpp	3 V	~22	~22	4.8V	1.6V	3.2V	1.6V
14	23 kHz	3 Vpp	3 V	~23	~23	3.4V	1.52V	3.0V	1.52V
15	24 kHz	3 Vpp	3 V	~24	~24	3.4V	1.48V	3.2V	1.48V
16	25 kHz	3 Vpp	3 V	~25	~25	3.4V	920mV	3.2V	920mV
17	26 kHz	3 Vpp	3 V	~26	~26	4.4V	800mV	3.2V	800mV
18	27 kHz	3 Vpp	3 V	~27	~27	3.8V	680mV	3.2V	600mV
19	28 kHz	3 Vpp	3 V	~28	~28	3.8V	560mV	3.2V	560mV
20	29 kHz	3 Vpp	3 V	~29	~29	4.4V	520mV	3.2V	520mV
21	30 kHz	3 Vpp	3 V	~30	~30	3.8V	480mV	3.2V	480mV

- Savannah was able to find a way to improve the bandwidth range and shorten it a little after performing the above tests

March 28th Senior Design Task

Objective: Testing and troubleshooting some challenges

Approach for activity: Simulated circuit on NI Multisim

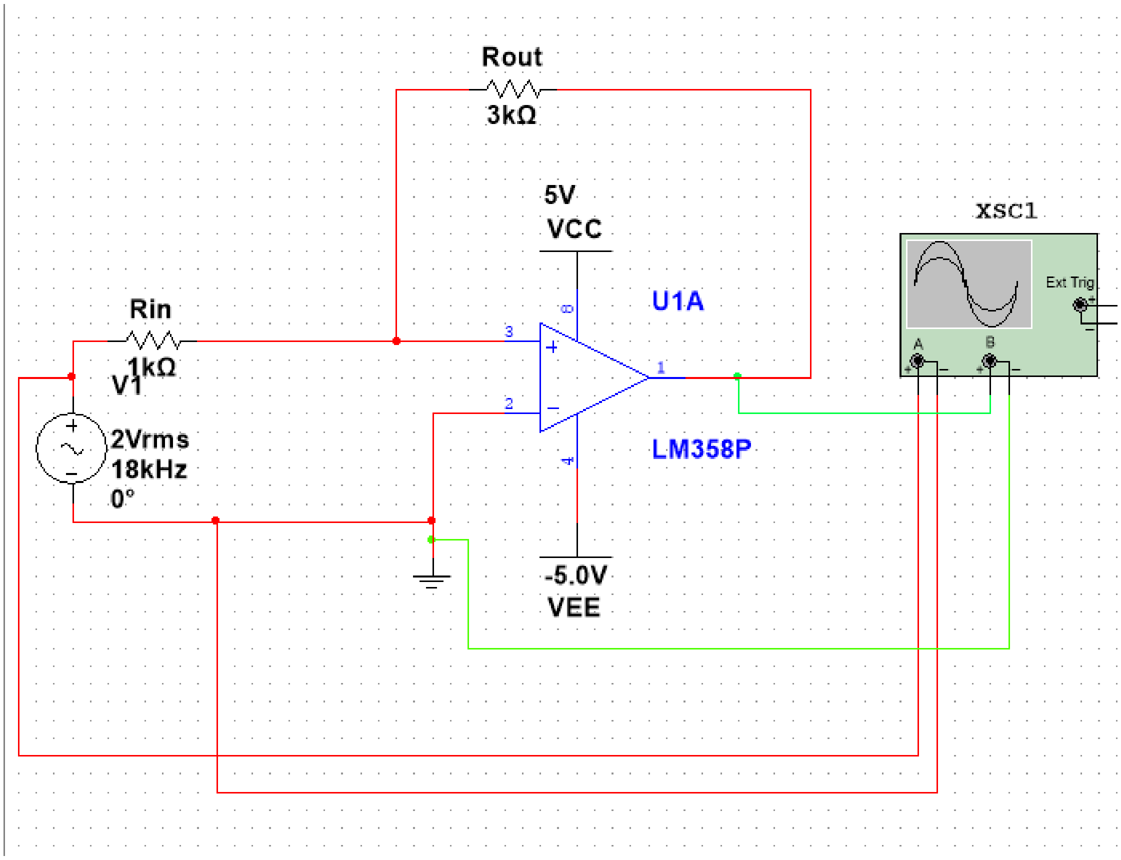
Outcome of activity: Unfortunately the circuit didn’t work in the long run

Impact of activity on the project: Very important because one of the big problems we have is voltage attenuation and we need amplifier that was built in this task

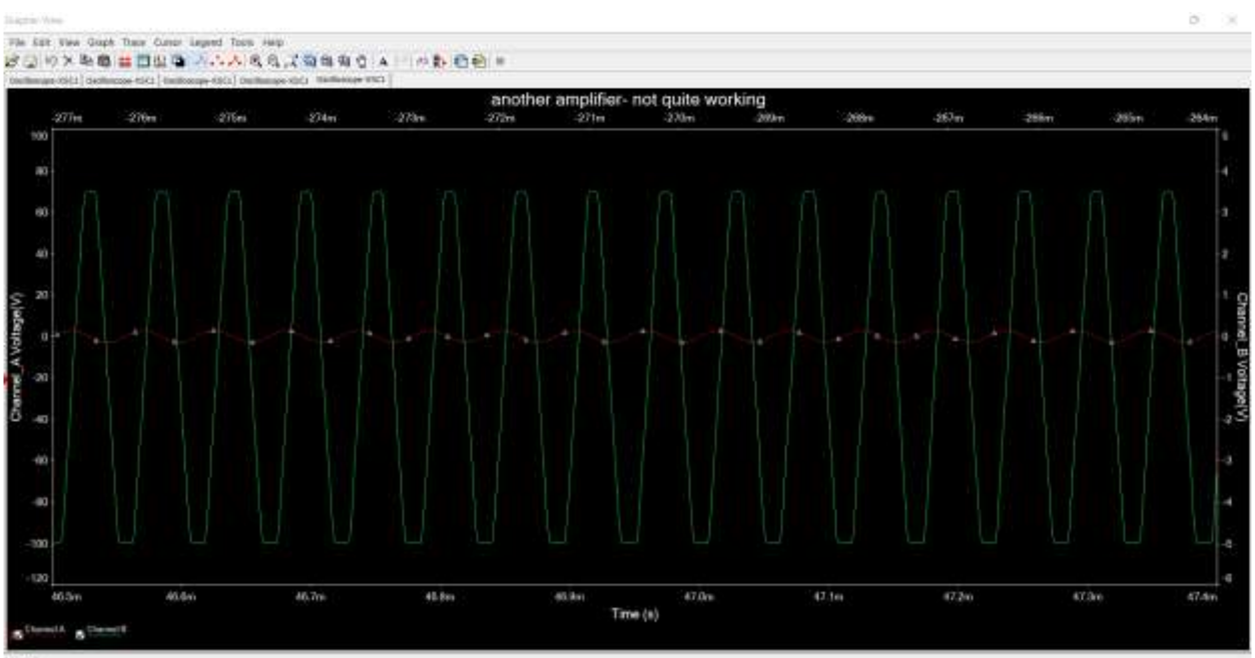
Assessment of the importance of activity: Important in continuing the project

Tips to improve the approach for doing the activity for iterations: Try various combinations for the resistor and capacitor values

- The following circuit was found online and simulated on NI Multisim



- It is an amplifier circuit with the same gain properties that were described above
- Here are some of the obtained results:



- Red lines are the input signal, and the green signal is the output

March 30th Senior Design Task

Objective: Testing the above amplifier circuit in lab

Approach for activity: Used NH 148 lab space to test

Outcome of activity: Unfortunately, the circuit didn’t work and almost burned

Impact of activity on the project: Very important because one of the big problems we have is voltage attenuation and we need amplifier that was built in this task

Assessment of the importance of activity: Important in continuing the project

Tips to improve the approach for doing the activity for iterations: Take better precautions

- The above circuit was built and was connected to voltage supply, waveform generator, and oscilloscope
- The circuit didn’t give any results because I needed to disconnect it from voltage supply because it almost burned

April 4th Senior Design Task

Objective: Simulating active bandpass filter circuit with single rail op amp

Approach for activity: Simulated circuit on NI Multisim

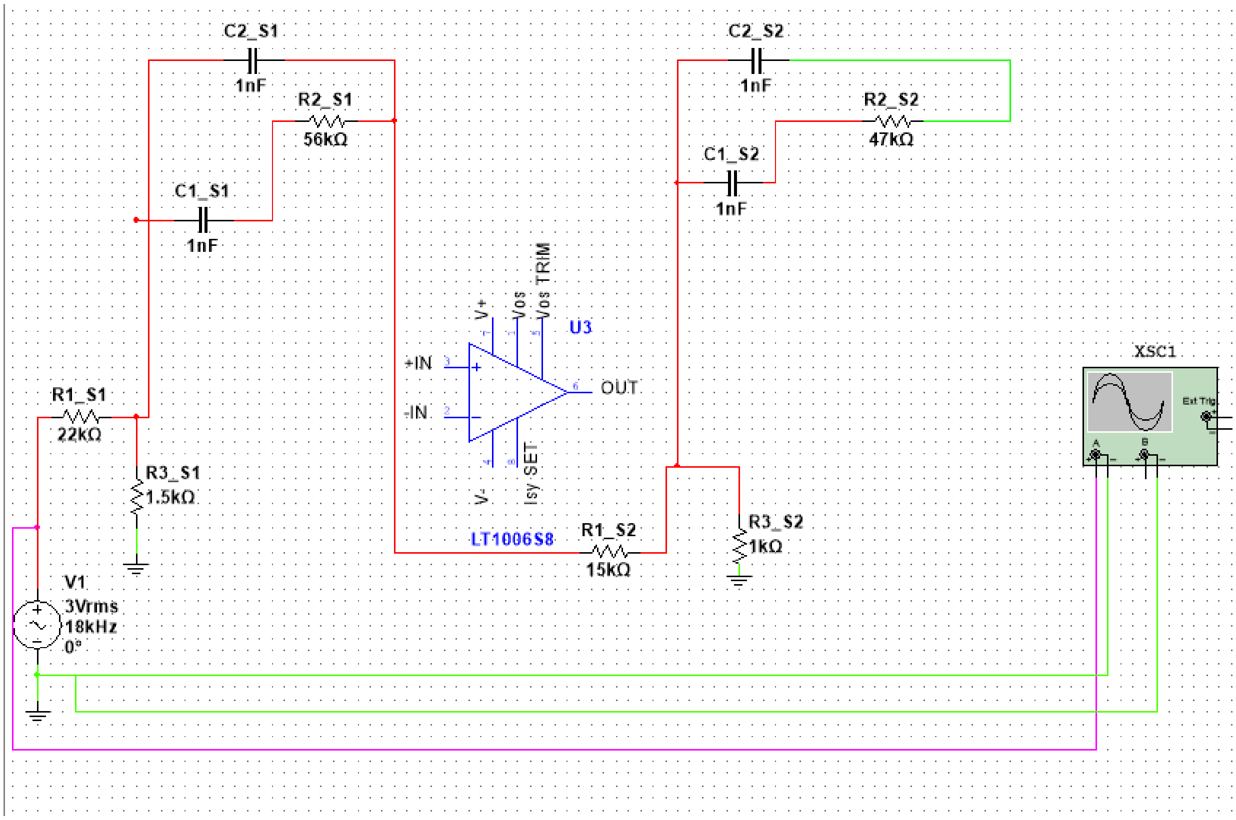
Outcome of activity: We didn’t need the simulation because another solution was found

Impact of activity on the project: Very important because we thought our op amp was dual rail and could only be powered by negative and positive voltages

Assessment of the importance of activity: Important in continuing the project

Tips to improve the approach for doing the activity for iterations: Try researching and finding TI op amps with specifications in data sheet that op amps are single rail/ single supply

- The following op amp was found to be tested but I learned that the op amp LM358P that we were using had properties of both single and double supply
- The main reason we needed to find single supply op amp was because Arduino doesn’t support dual supply and our system was powered by Arduino
- This was the circuit that I was to simulate and didn’t



April 6th Senior Design Task

Objective: Trying to miniaturize the system we have

Approach for activity: Solder components onto perforated boards

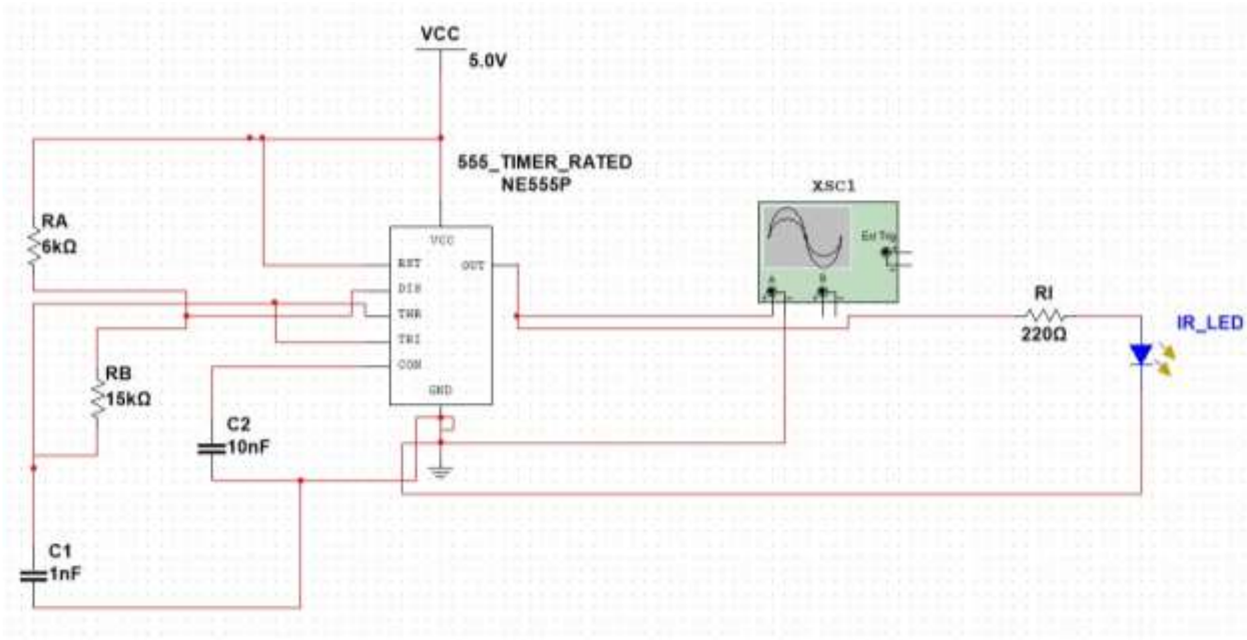
Outcome of activity: Waveform generator and phototransistor boards do work

Impact of activity on the project: Important to see if the miniaturized system works as good as the system that was built on breadboard

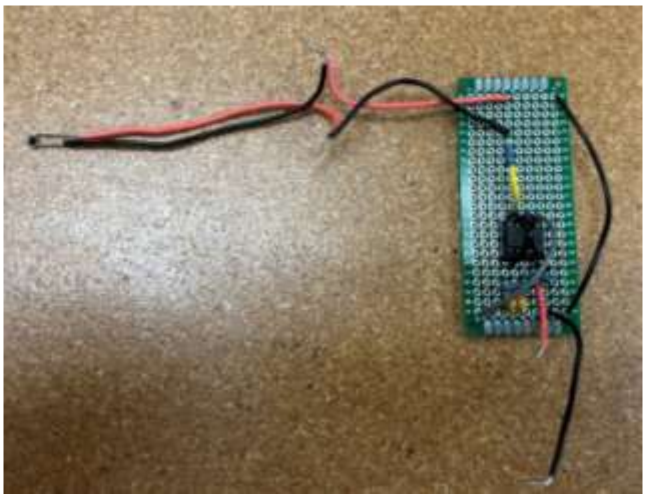
Assessment of the importance of activity: Important in continuing the project

Tips to improve the approach for doing the activity for iterations: Learn how to solder on perforated boards beforehand

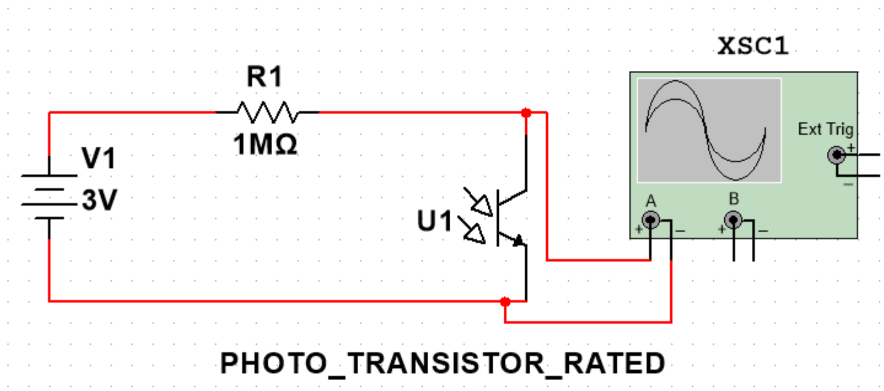
- Soldered circuits included:
  - 18 kHz waveform generating circuit
    - Components used included the components on the following circuit but the resistor values were different to create an 18 kHz waveform generating circuit



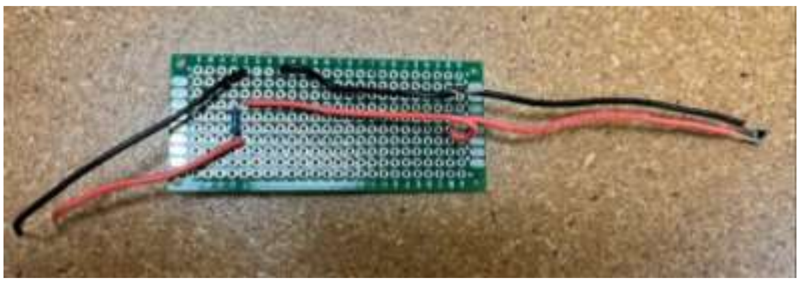
- The results included the following circuit:



- Phototransistor circuit
  - The following circuit was soldered but resistor value chosen was 1Mohm to increase the voltage input to phototransistor component



- The results included the following circuit:



April 7th

Objective: Troubleshoot the system

Approach for activity: Troubleshoot with Dr. Yetkin

Outcome of activity: The perforated boards did not work properly

Impact of activity on the project: Important to see if the miniaturized system works as good as the system that was built on breadboard

Assessment of the importance of activity: Important in continuing the project

Tips to improve the approach for doing the activity for iterations: Make sure the SMD models work beforehand

April 10th

Objective: Work on an innovation day poster

Approach for activity: split the work among teammates and complete the poster

Outcome of activity: Poster was printed

Impact of activity on the project: Important to see earn a good grade

Assessment of the importance of activity: Important in completing the class

Tips to improve the approach for doing the activity for iterations: Adjust the font and font size correctly

April 12th

Objective: Continue to troubleshoot the system using Arduino

Approach for activity: Setup the system and connect to Arduino

Outcome of activity: Some results were obtained but desired results were not obtained

Impact of activity on the project: Important to see if the miniaturized system works as good as the system that was built on breadboard

Assessment of the importance of activity: Important in continuing the project

Tips to improve the approach for doing the activity for iterations: Make sure to record the data obtained

April 25th

Objective: Test the system for new experiments and record the video for final presentation

Approach for activity: Setup the system and test the three procedures

Outcome of activity: Desired results were obtained for the presentation

Impact of activity on the project: Important to see if the miniaturized system works as good as the system that was built on breadboard

Assessment of the importance of activity: Important in continuing the project and completing the class

Tips to improve the approach for doing the activity for iterations: Make sure to record the data obtained on flash drive

The three procedures included setting up the perforated boards and testing them, setting up unmodulated frequency for the filter, and shining an IR LED on phototransistor and passing the output of detection subsystem to filter.