ECE 65 – Components and Circuits Lab

Lab 4 Report – Circuit Simulations

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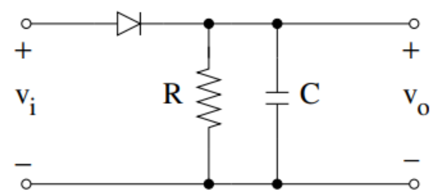
Abstract

The purpose of this lab is to further expand our knowledge of diodes beyond the experiments of lab 3 and explore various diode circuits. Throughout this lab we conducted various experiments. The first experiment encouraged us to switch around the circuit by removing/including a resistor from the circuit, transforming it from a rectifier to a peak detector. The second experiment we conducted was creating another peak detector circuit but this time with an op-amp to which we analyzed and compared with the peak detector circuit from experiment one whilst documenting their behaviors. Lastly, in the third experiment we created a clamp circuit where we tested different capacitance values to see how the output changed in regards to different time constants. All the results obtained from this lab further reinforced our knowledge of diodes and their applications in real life circuit implementations.

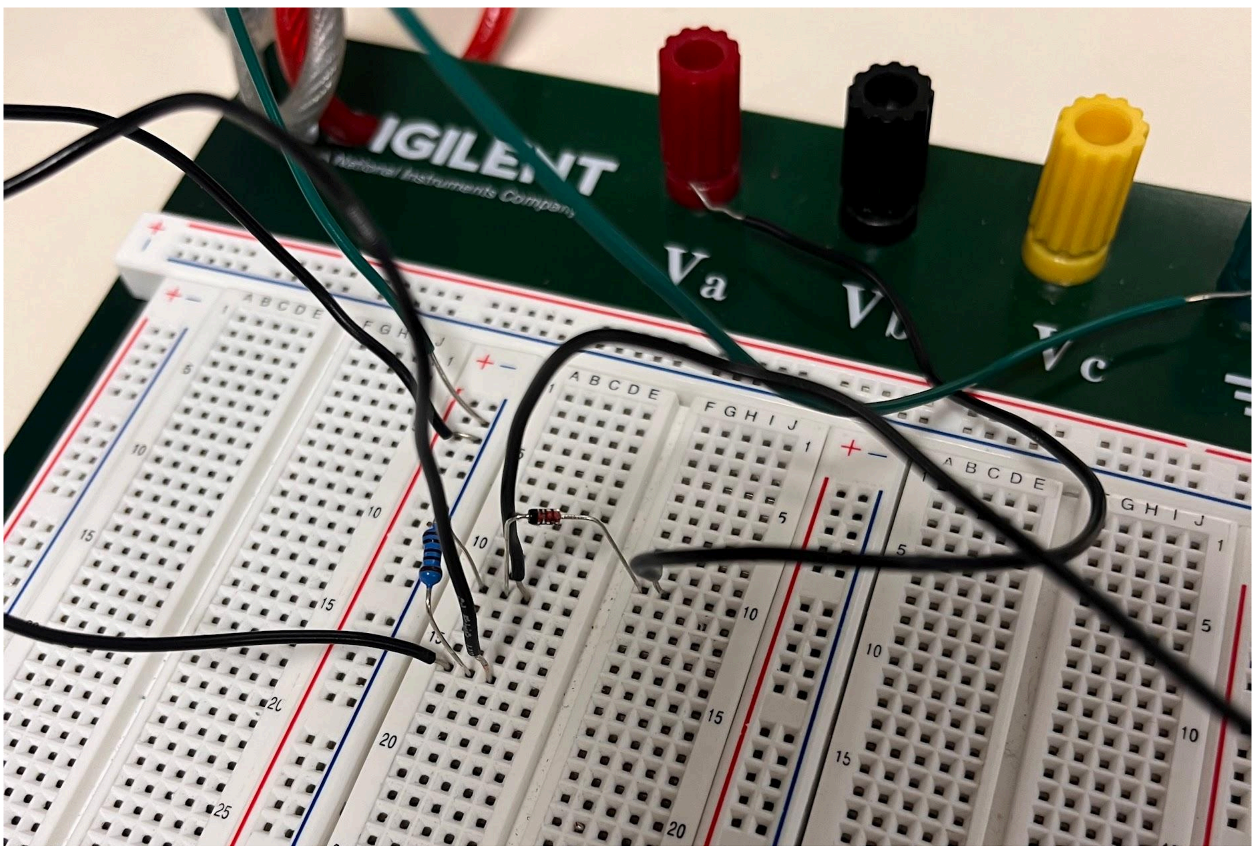
Lab Exercise:

Experiment 1: Rectifier & Peak Detector Circuit

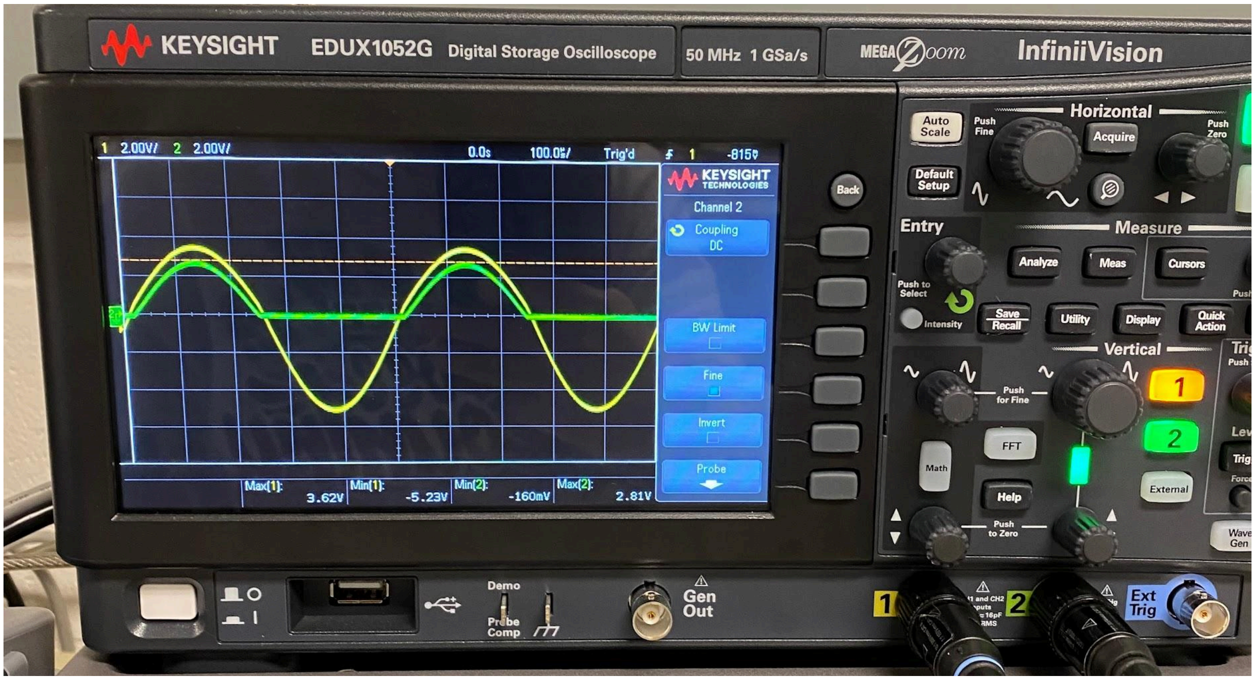
Consider the circuit below with a 1N4148 general purpose diode and $R = 100\ \text{k}\Omega$.



1. Assemble the circuit without the capacitor. Take a picture of the setup and include it in your report.

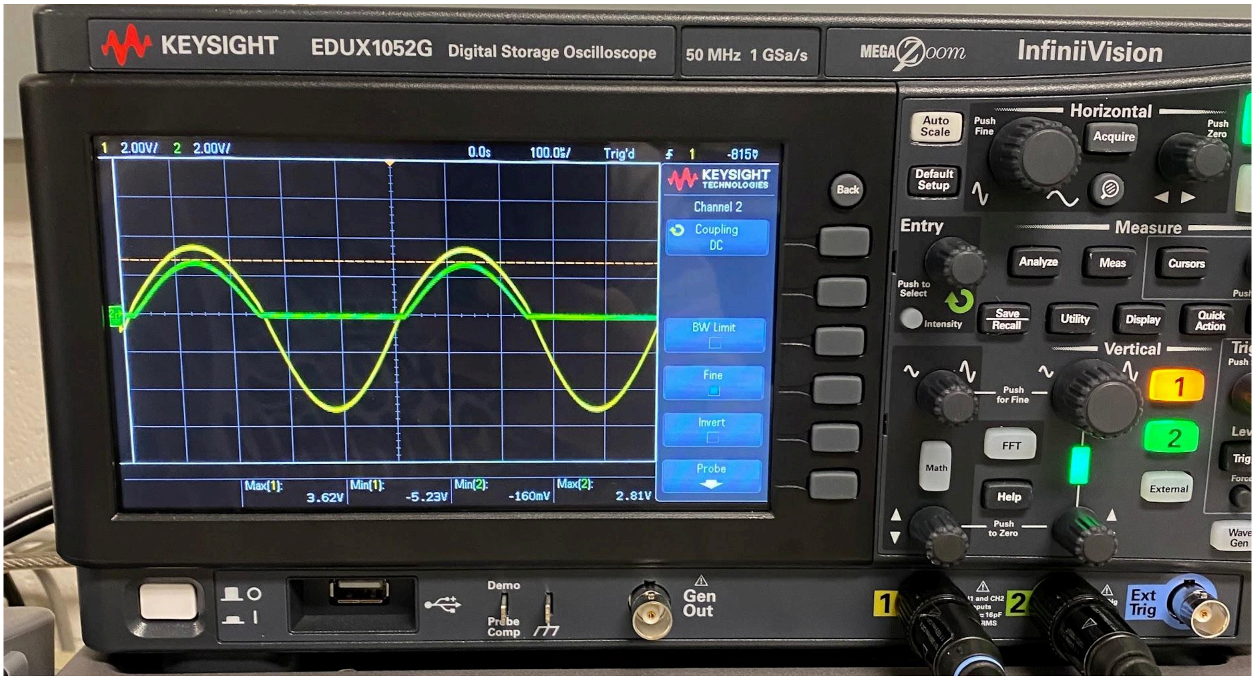


2. Set the function generator to produce a sinusoidal wave with an amplitude of 5 V, zero DC offset, and frequency of 2 kHz. Attach the function generator to vi . Attach scope channel 1 to vi and scope Channel 2 to vo, and have both traces be ”triggered” by channel 1.



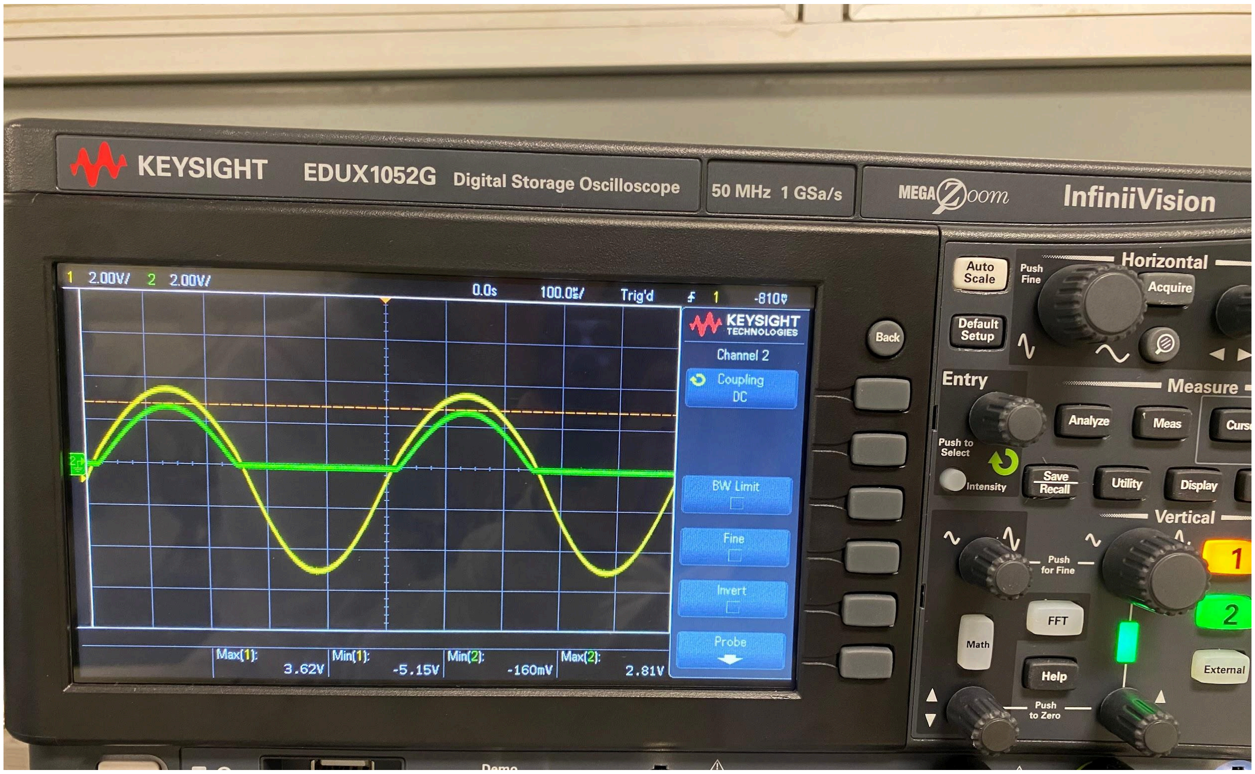
For the set up of the waveform generator, we used a sin wave, and used a frequency of 2kHz and a 10VPP (since amplitude is 5V).

3. Adjust the volt per division knob such that the signal is as large as possible (i.e., fills the display). Ensure that both channels have the same volt per division setting.



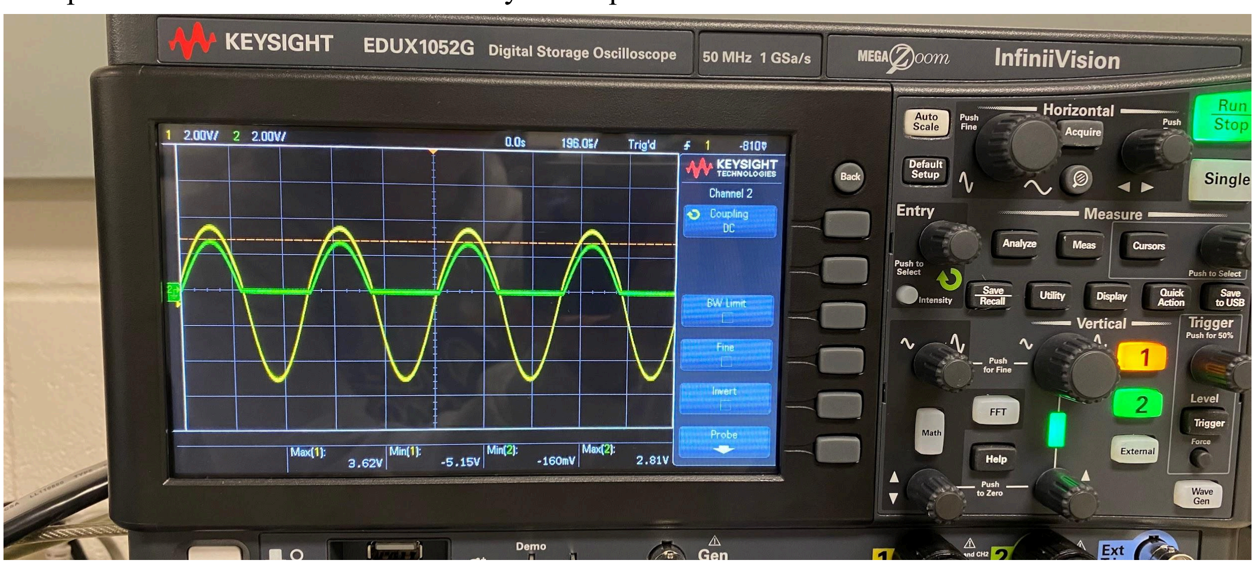
We made sure that the volt per division knob was equal to each other, by setting them both to 2V/.

4. Move the two traces such that the zero voltage values for both channels are in the middle of the display.



We used the tuners on the side, like the vertical knob and the one below it to adjust the traces to our desired outcome.

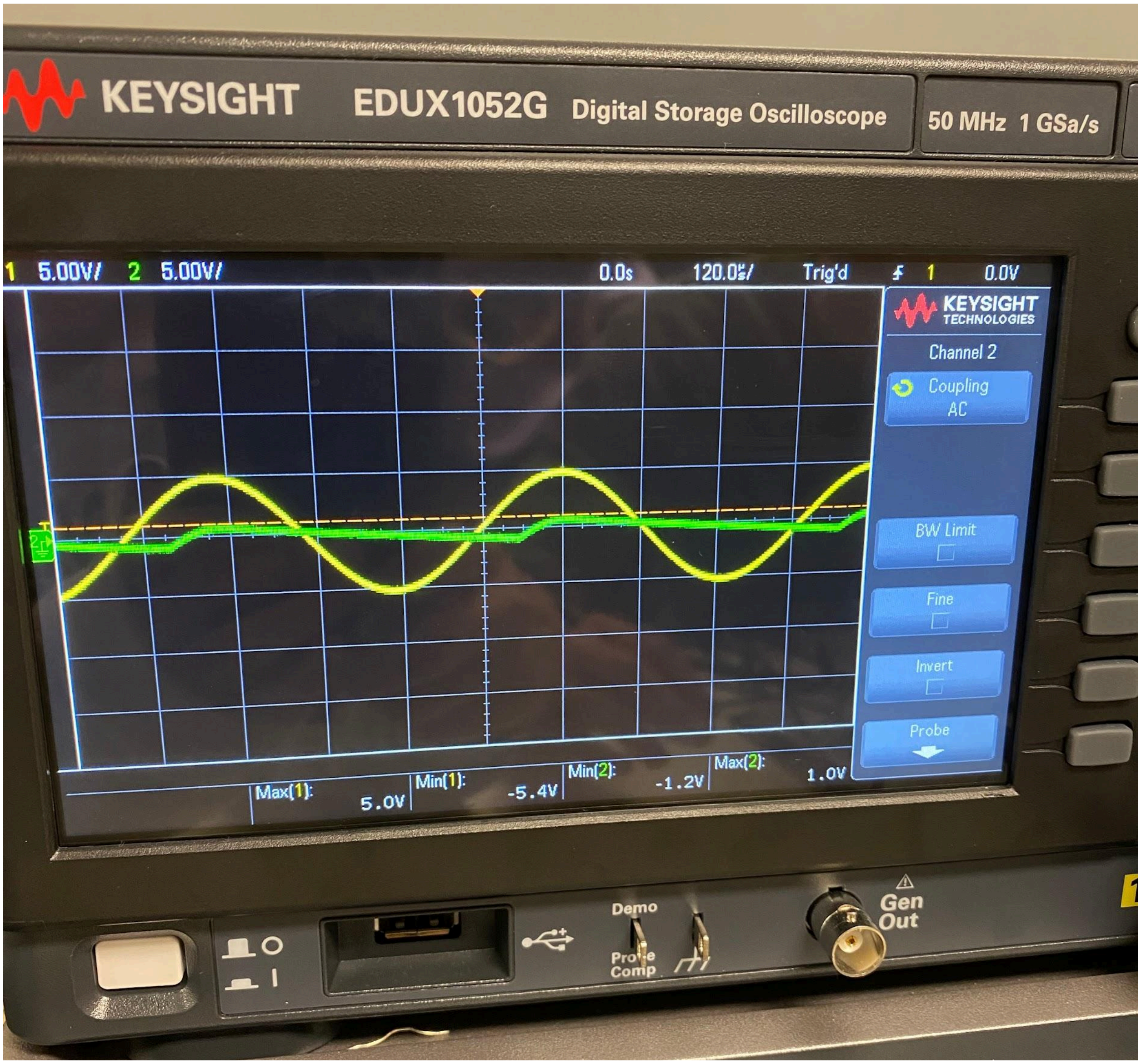
5. Expand the time selection so that only 2 to 4 periods of the waveform are shown.



To achieve this we used the “Push Fine” tuner and adjusted it so we could see 2 to 4 periods of the waveform.

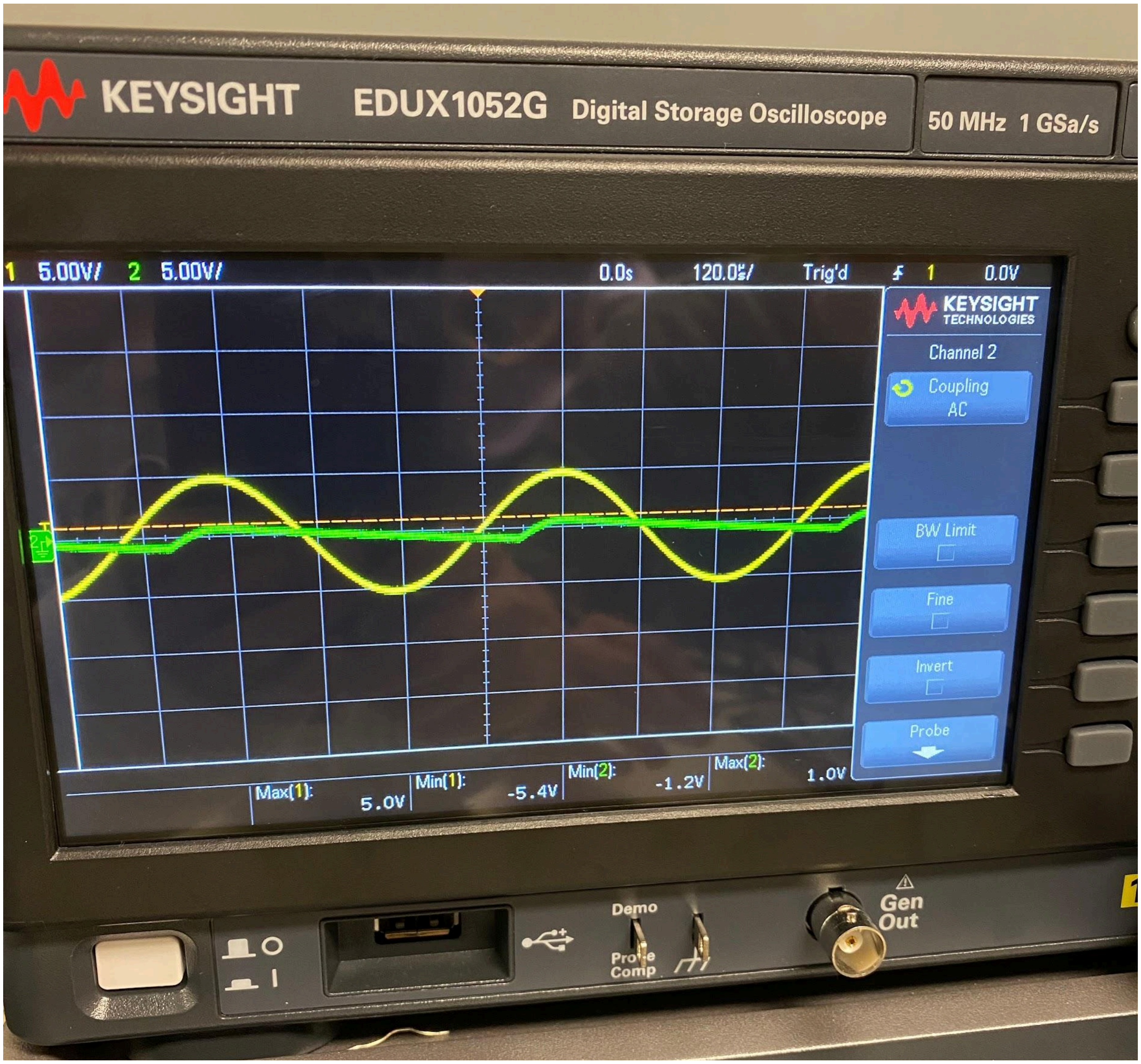
6. Disconnect the function generator without changing the function generator and scope settings. Attach a 10 nF capacitor (see circuit diagram above). Attach the function generator to the circuit and print out vo and vi .

10nF:



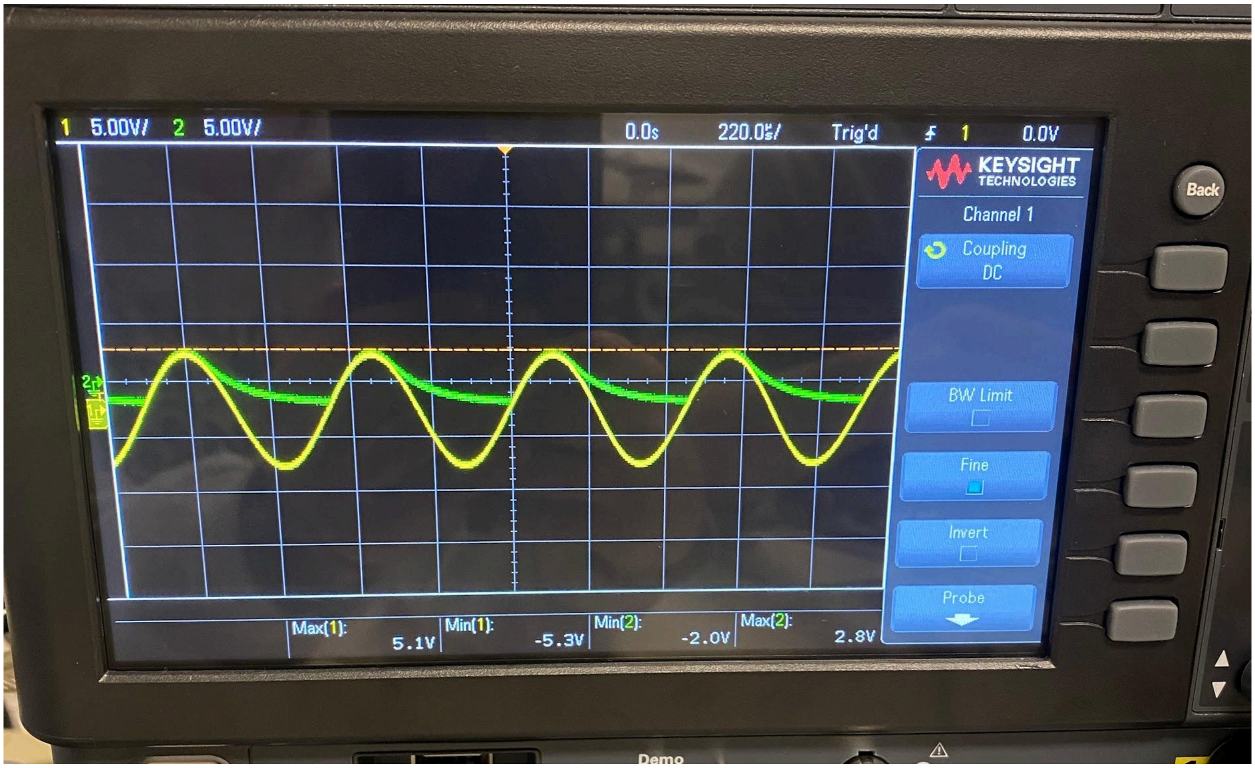
This is what the Digital Storage Oscilloscope printed out for the readings of vo and vi, with vo as the green line, and vi as the yellow one (with smooth curves).

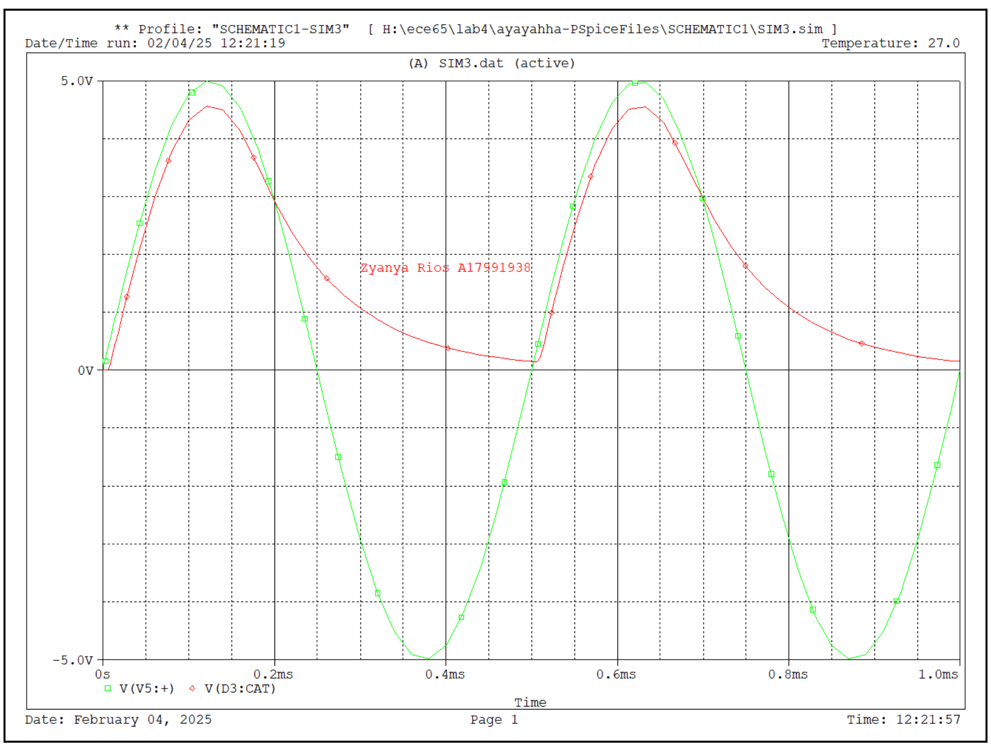
7. Take a picture of the oscilloscope display and include it in your report.



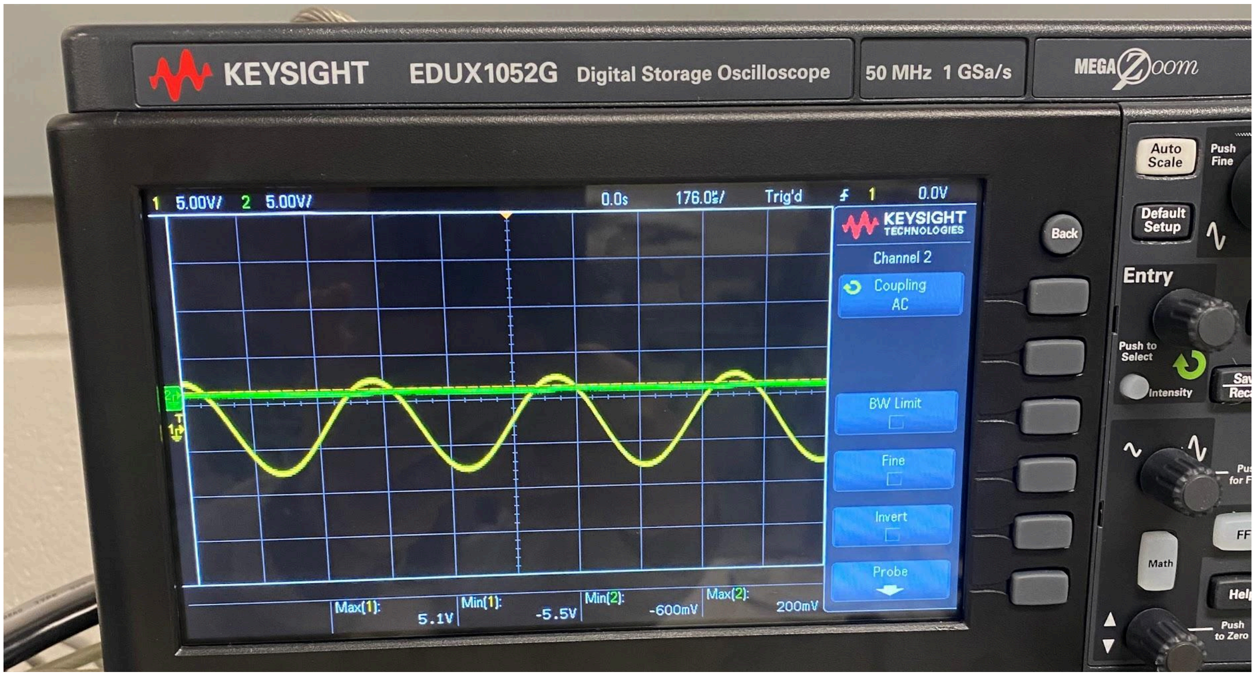
8. Repeat the previous two parts with the capacitor values you selected in the circuit analysis section.

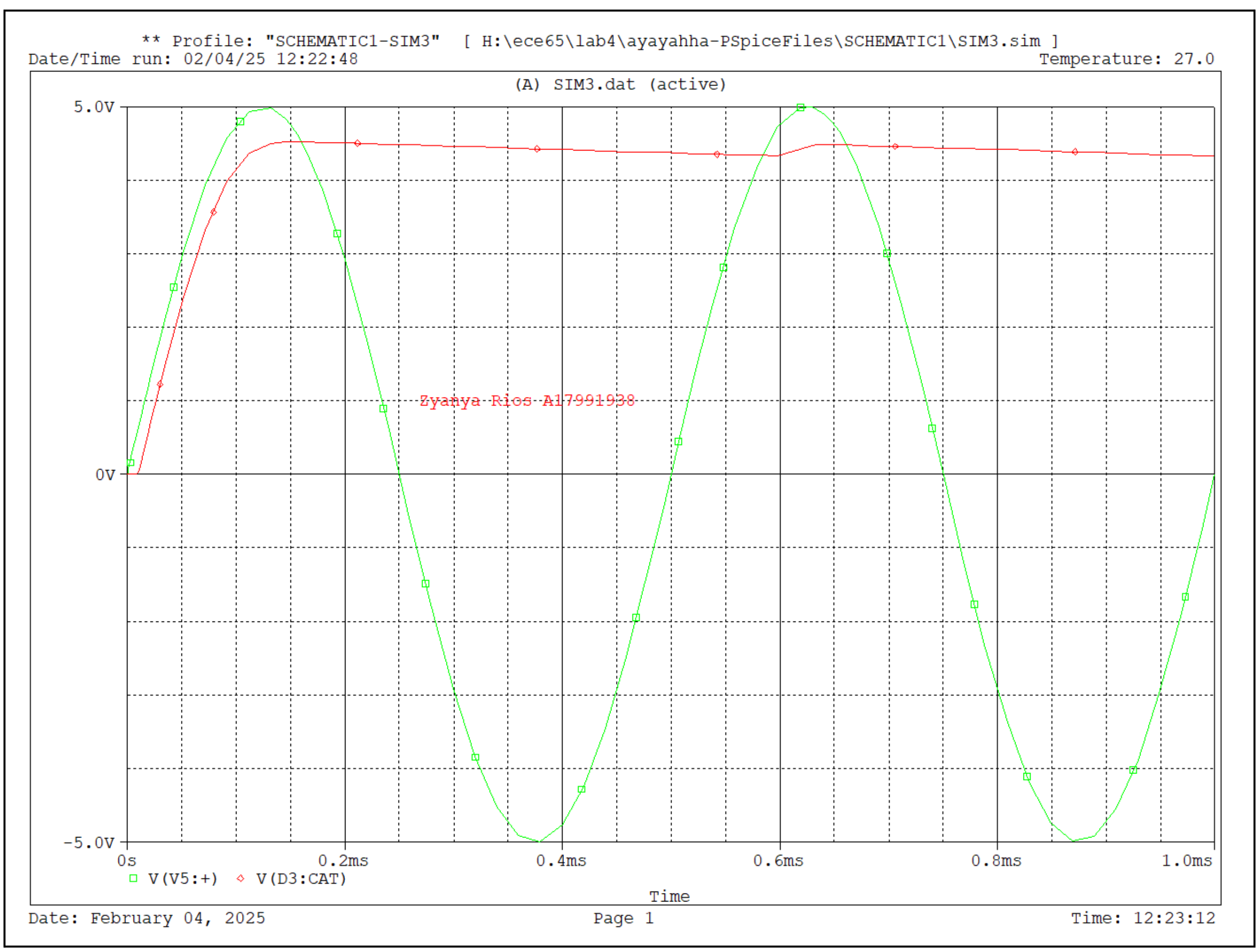
1nF:





100nF:


KEYSIGHT EDUX1052G Digital Storage Oscilloscope
50 MHz 1 GSa/s
MEGA Zoom
1 5.00V/ 2 5.00V/
0.0s 176.0?/ Trig'd 1 0.0V
Channel 2
Coupling AC
BW Limit
Fine
Invert
Probe
Back
Auto Scale
Default Setup
Entry
Push to Select
Intensity
Math
Max(1): 5.1V
Min(1): -5.5V
Min(2): -600mV
Max(2): 200mV


** Profile: "SCHEMATIC1-SIM3" [H:\ece65\lab4\ayayahha-PSpiceFiles\SCHEMATIC1\SIM3.sim]
Date/Time run: 02/04/25 12:22:48
Temperature: 27.0
(A) SIM3.dat (active)
5.0V
0V
-5.0V
0s
0.2ms
0.4ms
0.6ms
0.8ms
1.0ms
V(V5:+)
V(D3:CAT)
Time
Zyanya Rios A17991938
Date: February 04, 2025
Page 1
Time: 12:23:12

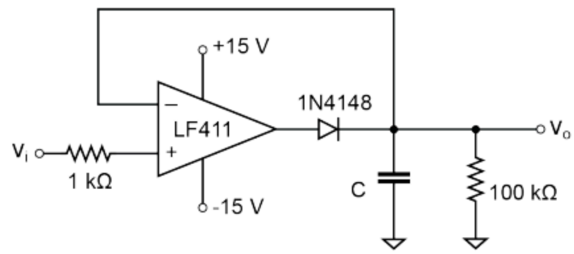
9. Compare the output voltage traces for three peak detector circuits. What are your conclusions?

The smallest capacitance of 1nF, had a vo with waves that indicate that it takes longer for the capacitor to discharge. The 10nF capacitor took longer for it to be discharged compared to the first one. The largest capacitance 100nF we used took the longest to discharge.

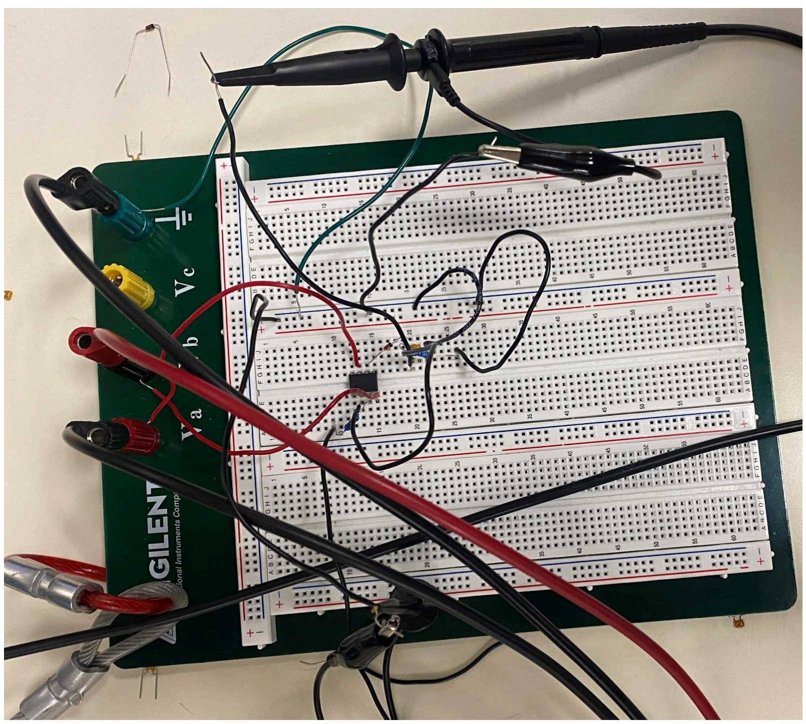
We concluded that as capacitance increases, the longer it takes for the capacitor to discharge because a greater capacitance value will increase the time constant, which means that the capacitor will charge more slowly at greater capacitance values. Therefore, a greater capacitor will have better peak detection results by smoothing out fluctuations and holding the peak voltage for longer periods of time.

Experiment 2: Op-amp Peak Detector

Consider the circuit below with a 1N4148 general purpose diode, and $C = 10\ nF$.

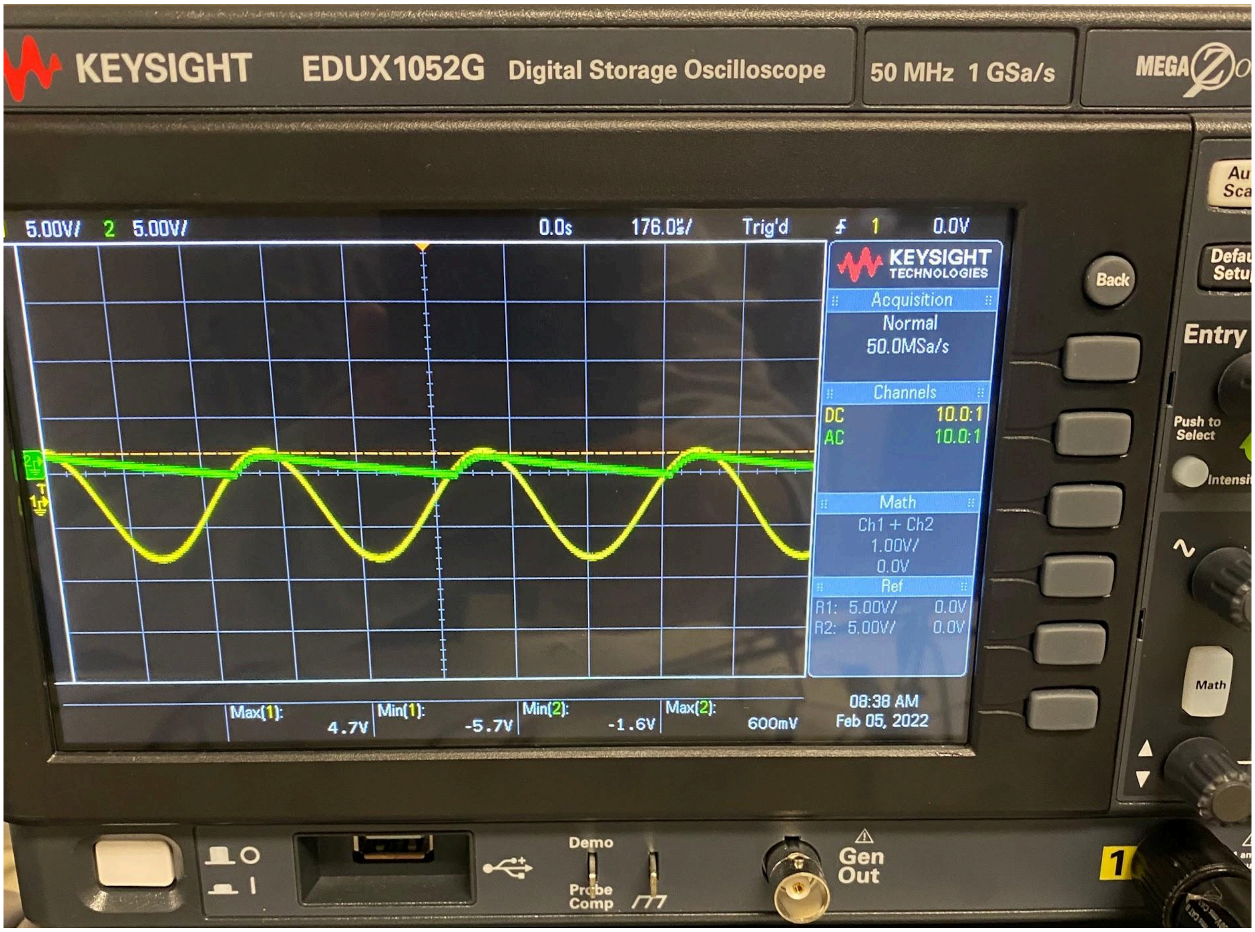


1. Assemble the circuit. Set the function generator to produce a sinusoidal wave with an amplitude of 5 V, zero DC offset, and frequency of 2 kHz. Attach the function generator to vi . Attach the scope channel 1 to vi and the scope Channel 2 to vo.



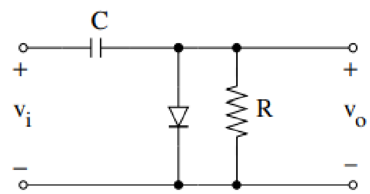
To create this circuit, we used an op-amp, a diode, a capacitor (10nF), and two resistors. We setted up the sinusoidal wave on the Waveform Generator to have a 10Vpp and a frequency of 2kHz.

2. Take a picture of the oscilloscope display and include it in your report

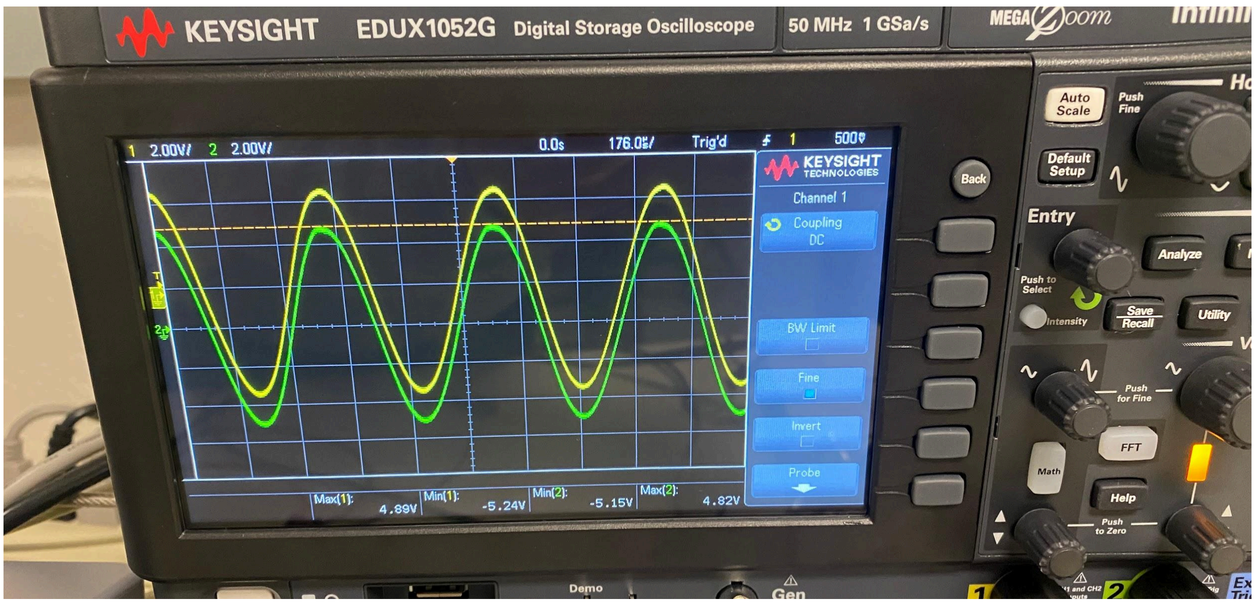


Experiment 3: Clamp Circuit

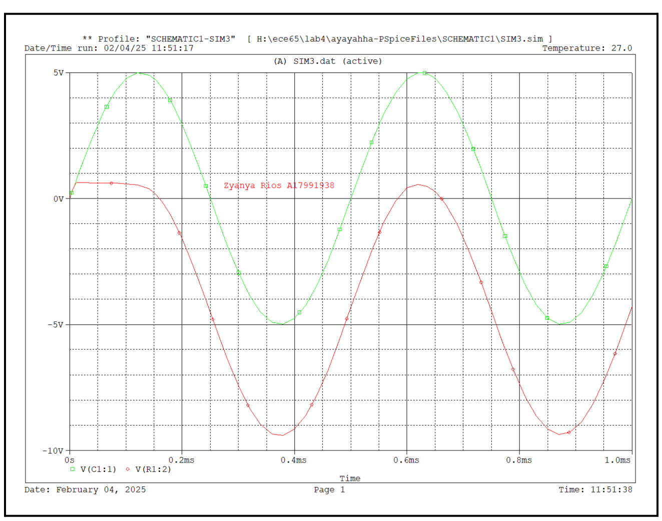
Consider the circuit below with a 1N4148 general purpose diode, $R = 100\ \text{k}\Omega$, and $C = 100$ nF.



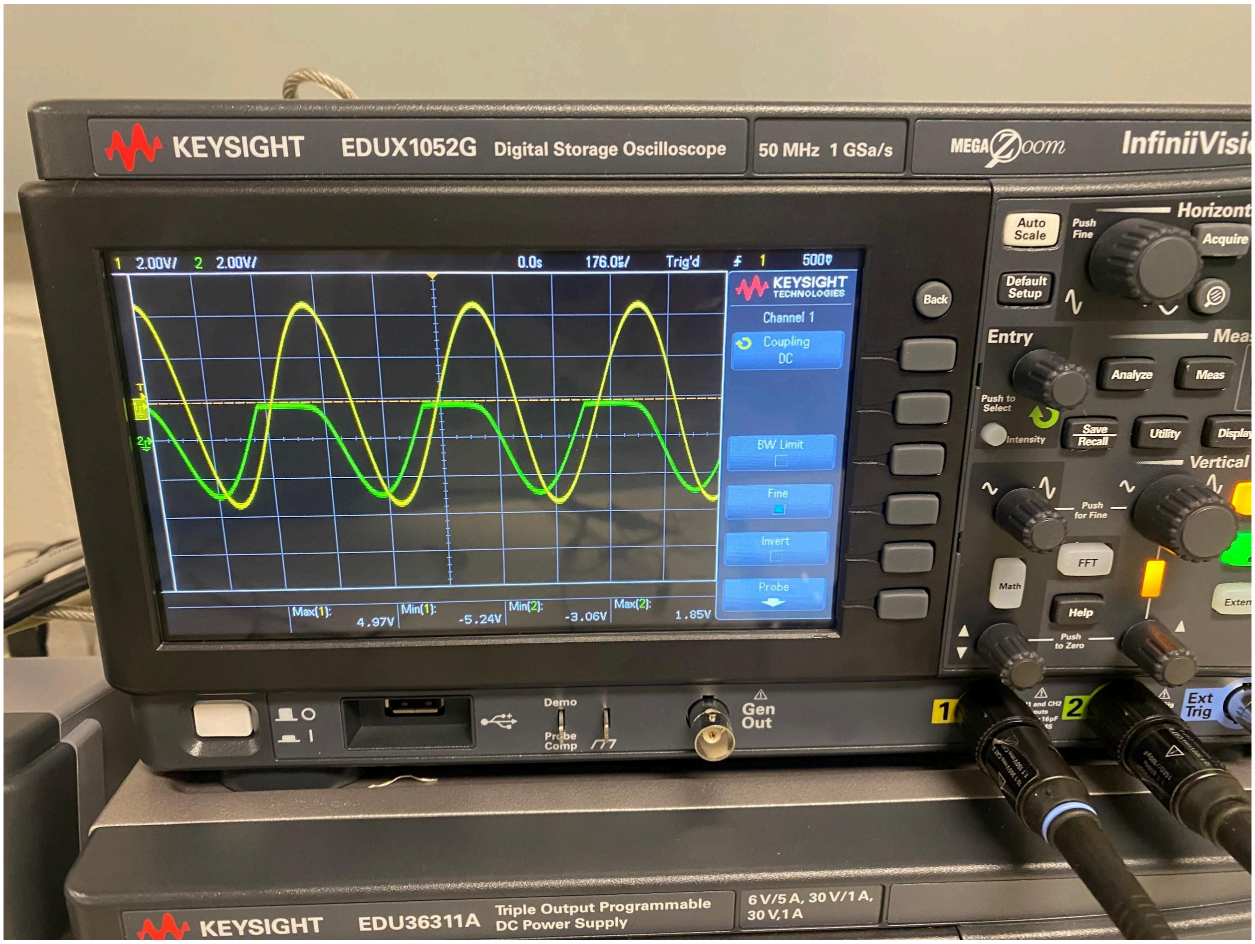
1. Assemble the circuit. Set the function generator to produce a sinusoidal wave with an amplitude of 5 V, zero DC offset, and frequency of 2 kHz. Attach the function generator to vi . Attach the scope channel 1 to vi , and the scope Channel 2 to vo. Take a picture of the oscilloscope display and include it in your report.



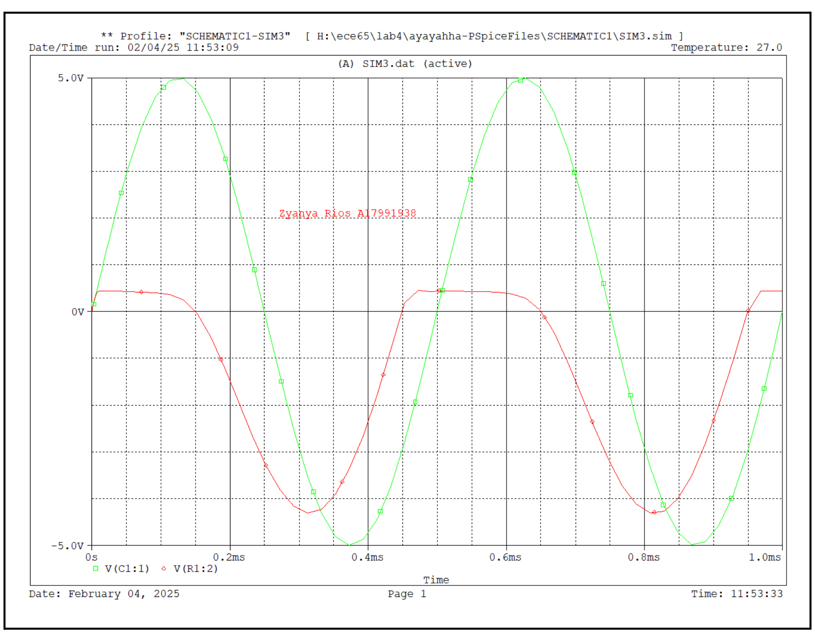
These results meet our expectations from prelab:



2. Disconnect the function generator without changing the function generator and scope settings. Replace the 100 nF capacitor with a 1 nF one. Take a picture of the oscilloscope display and include it in your report.



These results meet our expectations from prelab:



3. Compare the two cases. What are your conclusions?

By comparing the graphs we can see that the peaks with the 100nF capacitor follow the peaks pretty well. Whereas the 1nF capacitor doesn't follow it as well and looks shifted to the left. This is likely due to the difference in time constants where the 1nF discharges too quickly leading to faster responses rather than prolonged and stable ones.

Conclusion

In this lab, we analyzed the functionality of general purpose diodes (1N4148), and conducted three experiments.

The first experiment involved creating a rectifier and a peak detector circuit. We tested various capacitor values and found out that with smaller capacitor values, such as 1nF and 10nF, a circuit will function as a rectified circuit because the capacitor discharges too fast to maintain the peak. Whereas with a greater capacitor value like 100nF, the circuit will be able to create a better peak detection circuit that smooths out any fluctuations and holds peak voltage for longer periods of time.

Furthermore this idea is expanded in the second experiment as we combined the diode with an op-amp to once again create a peak detector circuit. After implementing the circuit, this circuit performs the same as the 10nF circuit created in experiment one by using the op-amp to cancel out the diode's voltage drop, and the capacitor to hold the peak.

Lastly, in experiment 3 we created a clamp circuit. Using our previous circuit elements with the same diode we implemented the clamp circuit. In this experiment we tested two different capacitance values (1nF and 100nF). When we used the 100nF, the clamp circuit performed the expected outcome as simulated in our pre-lab and the output seems to follow the peaks. Whereas for the 1nf the output seems to not follow the peaks because its time constant (τ=RC) is too small so it discharges too fast.