College of Engineering, Design and Computing
UNIVERSITY OF COLORADO DENVER

**DEPARTMENT OF ELECTRICAL ENGINEERING**

**ELEC 3900: CIRCUIT DESIGN AND FABRICATION**

**SUMMER 2025**

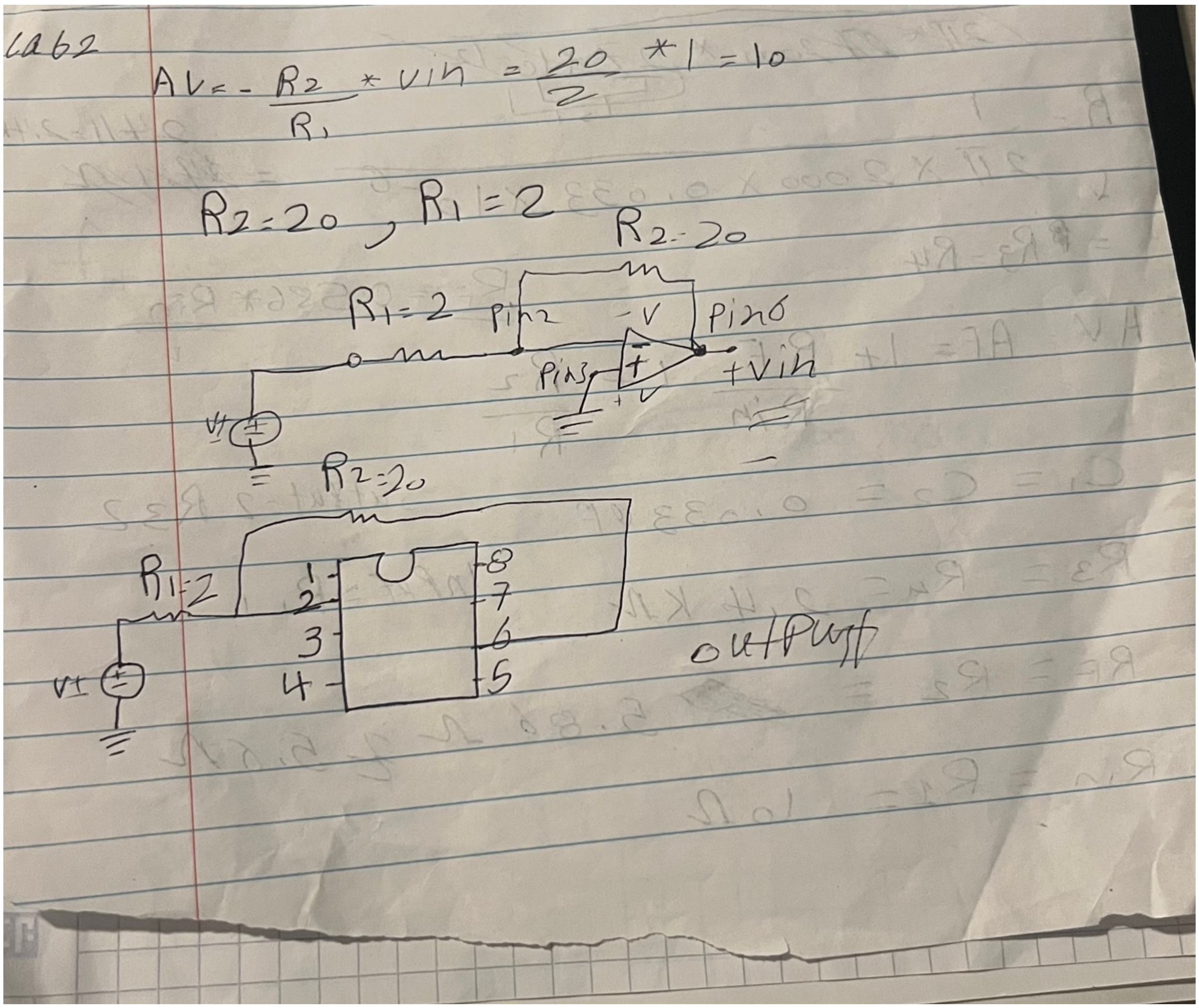
# LAB#2

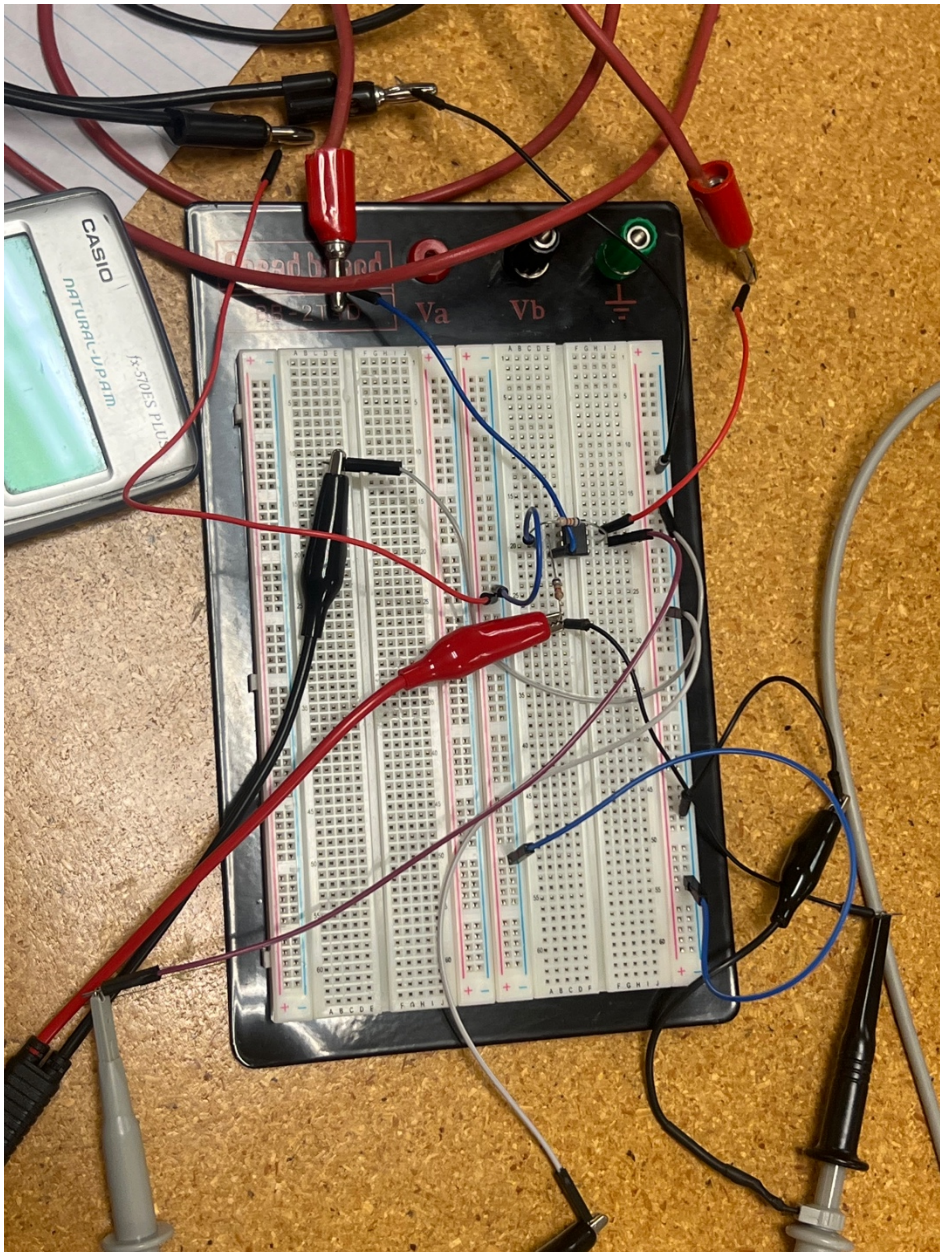
# OP-AMP APPLICATIONS

KHALED ALOTAIBI

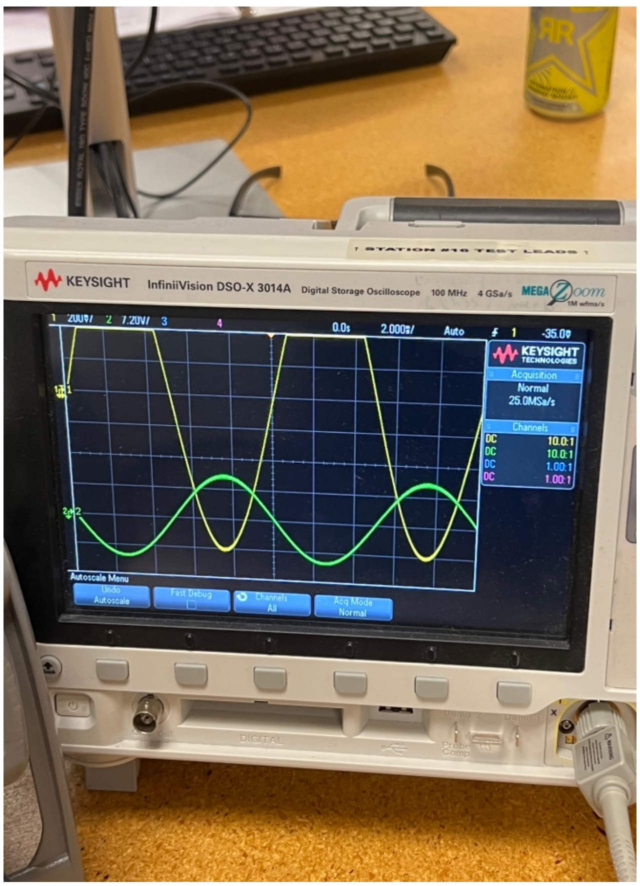
# EXPERIMENT#1: Inverting Amplifier

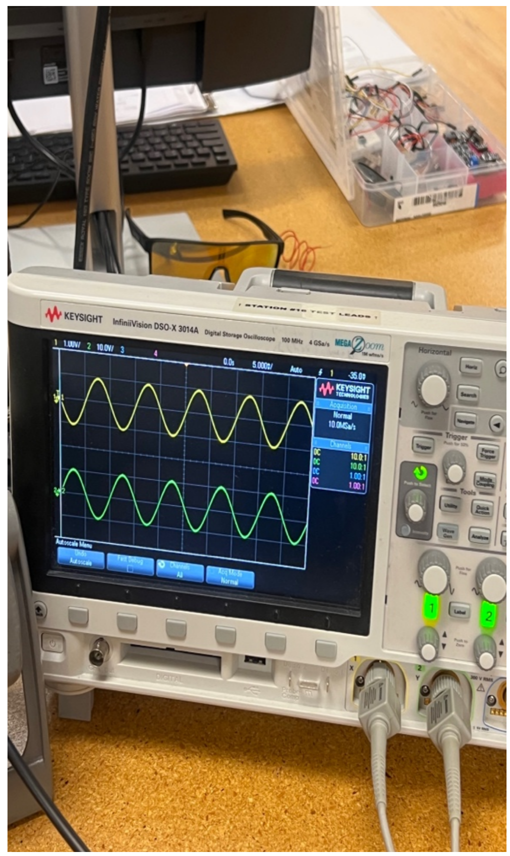
1-

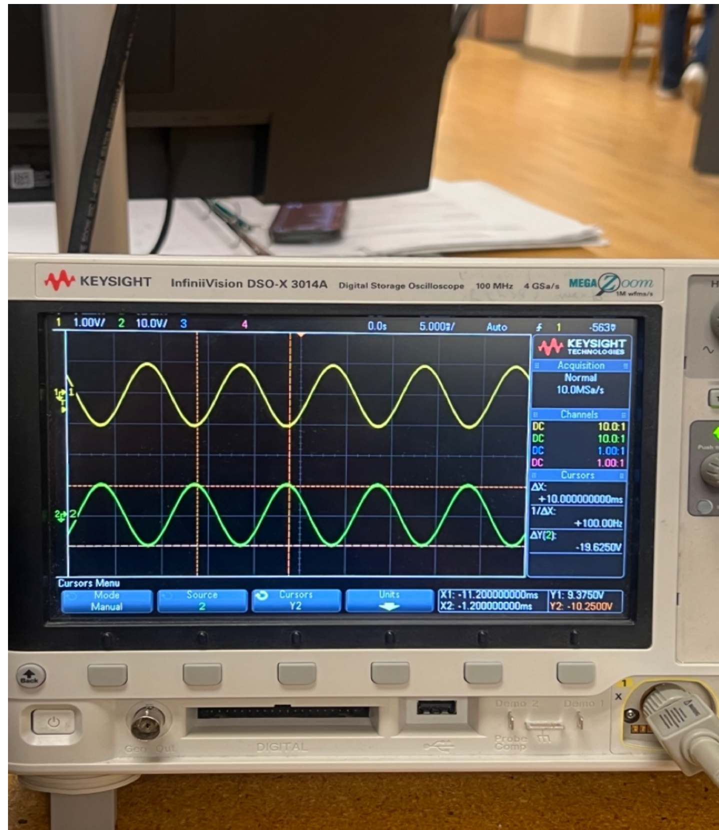


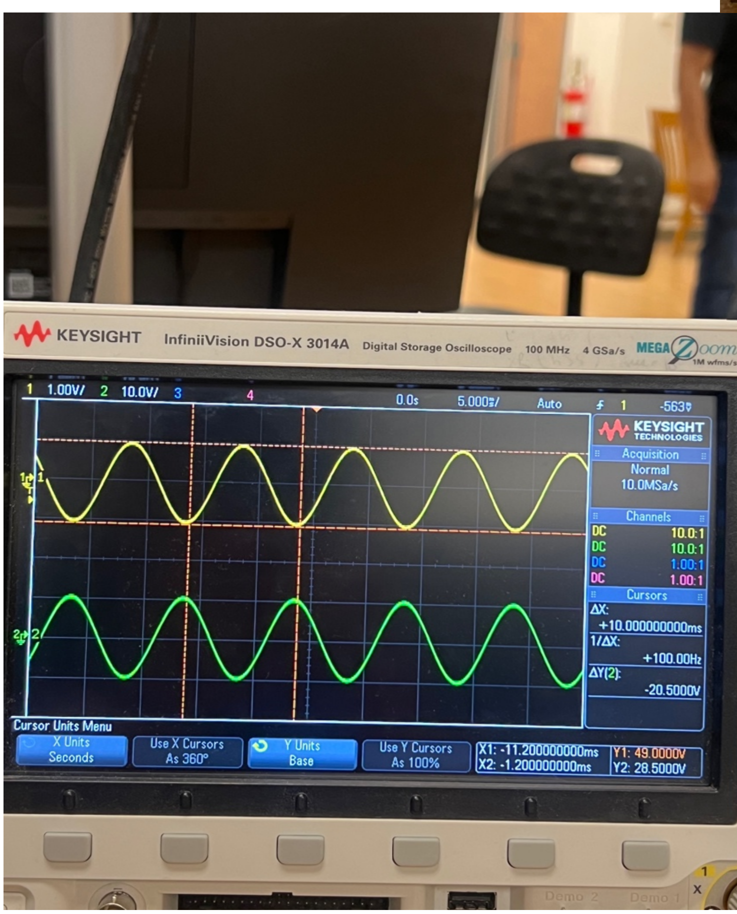

CASIO
NATURAL-V.P.A.M.
fx-570ES PLUS
Va
Vb

2-

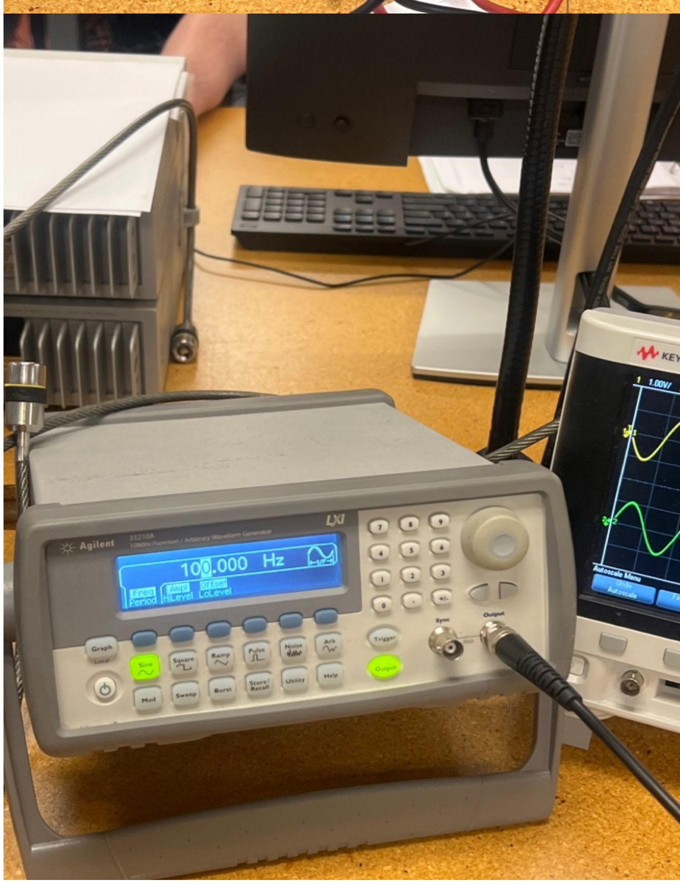

KEYSIGHT
InfiniiVision DSO-X 3014A
Digital Storage Oscilloscope
100 MHz
4 GSa/s
Acquisition
Normal
25.0MSa/s
Channels
Autoscale Menu
Fast Debug
Acq Mode
Normal


KEYSIGHT
InfiniiVision DSO-X 3014A

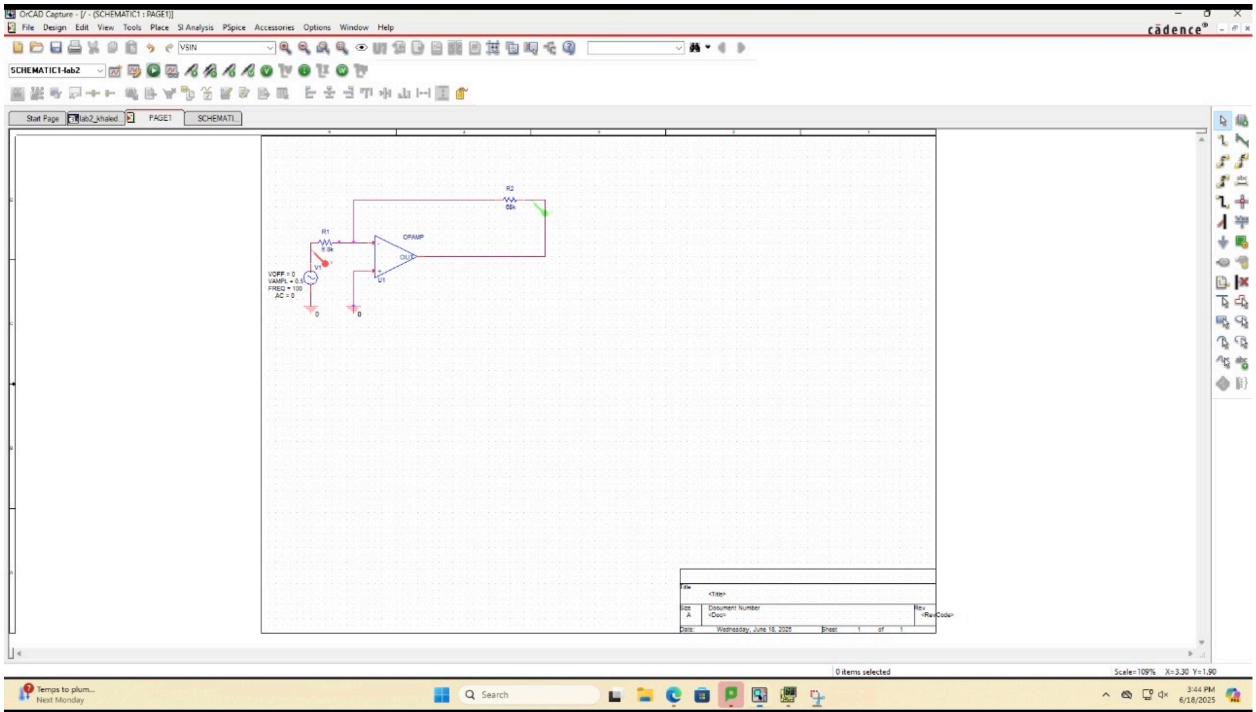

KEYSIGHT
InfiniiVision DSO-X 3014A
Digital Storage Oscilloscope
100 MHz
4 GSa/s
1.00V/
10.0V/
0.0s
5.000s/
Auto
Acquisition
Normal
10.0MSa/s
Channels
Cursors
ΔX:
+10.000000000ms
1/ΔX:
+100.00Hz
ΔY(2):
-19.6250V
Cursors Menu
Mode
Manual
Source
2
Cursors
Y2
Units
X1: -11.200000000ms
X2: -1.200000000ms
Y1: 9.3750V
Y2: -10.2500V

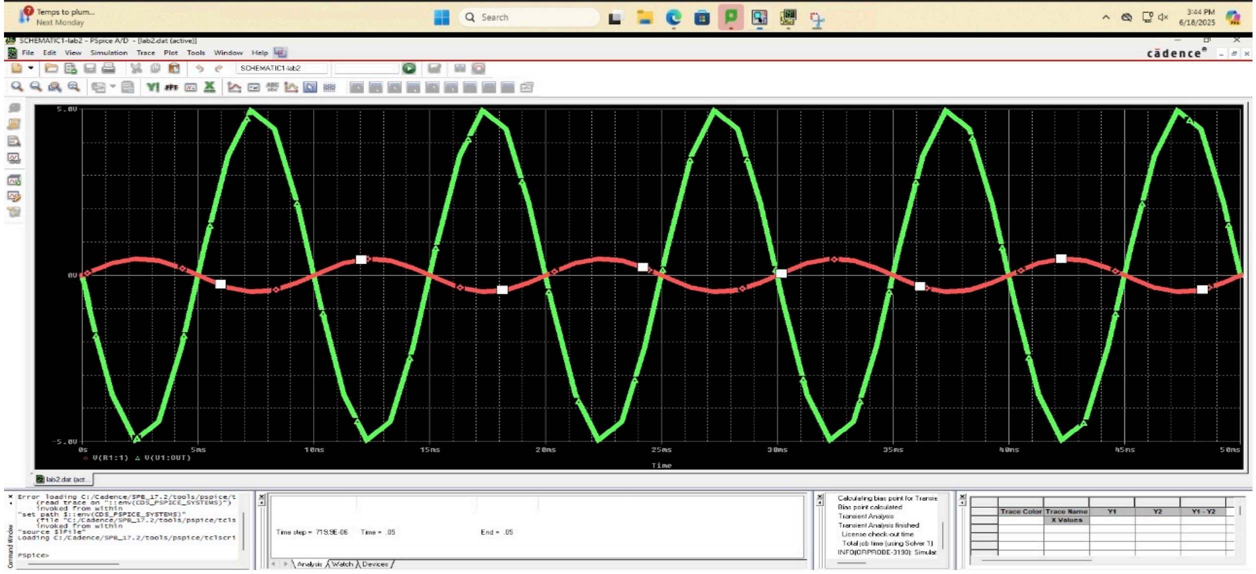

KEYSIGHT
InfiniiVision DSO-X 3014A
Digital Storage Oscilloscope
100 MHz
4 GSa/s
1.00V/
10.0V/
0.0s
5.000s/
Auto
Acquisition
Normal
10.0MSa/s
Channels
Cursors
ΔX:
+10.000000000ms
1/ΔX:
+100.00Hz
ΔY(2):
-20.5000V
Cursor Units Menu
X Units
Seconds
Use X Cursors
As 360°
Y Units
Base
Use Y Cursors
As 100%
X1: -11.200000000ms
X2: -1.200000000ms
Y1: 49.0000V
Y2: 28.5000V


VOLTAGE
CURRENT
REAR CONTROL
POWER
BK PRECISION®
1685B
SWITCHING MODE POWER SUPPLY
1-60VDC 5A
AUX. OUTPUT 5A MAX.
Please ask your instructor before use
Agilent
E3630A
VOLTS
AMPS
12.53
0.00
VOLTAGE ADJUST
METER
OUTPUT
UCD ELECTRICAL
-12.26
0.00


Agilent
100.000 Hz

3-



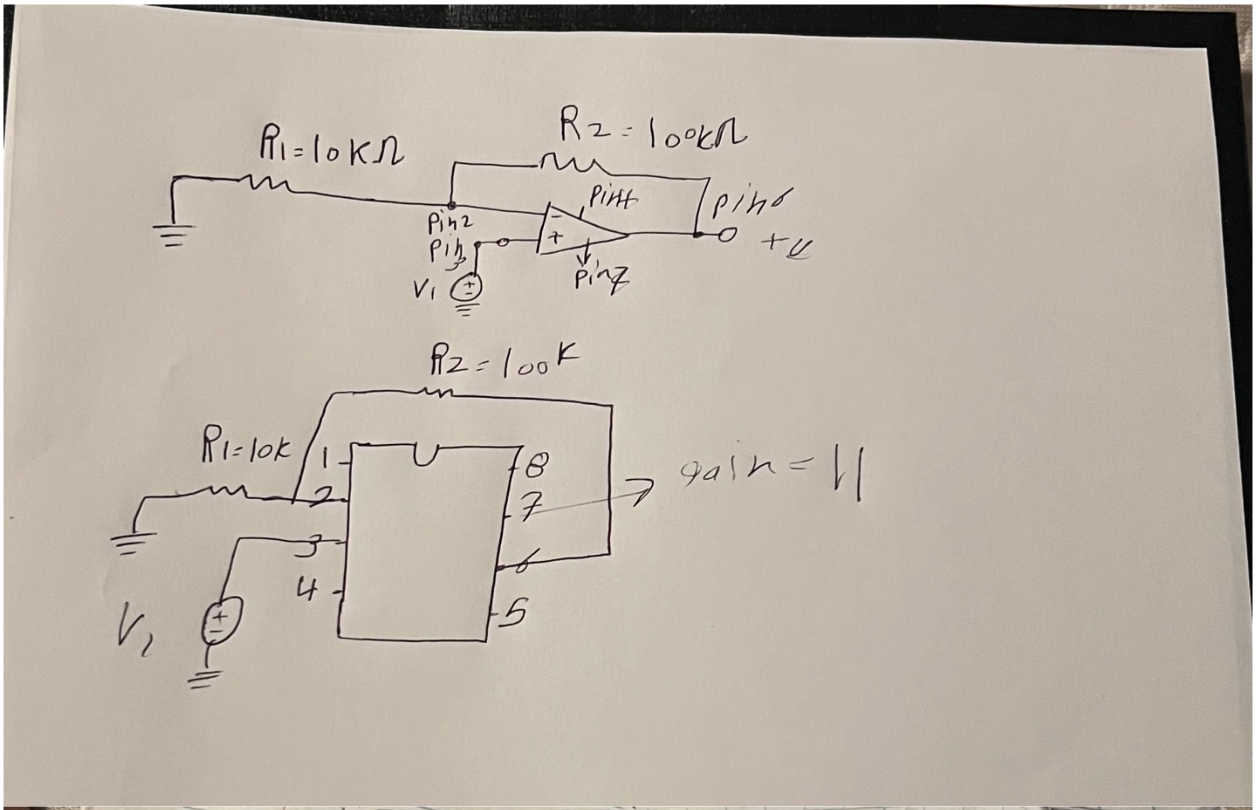


10/10

According to the manual calculation, the gain of inverting amplifier should be 10, and it can be seen in the oscilloscope and simulation that the output waveform is 10 times amplified. Then as the name suggests, output will be inverted as compared to input which means it will be 180 out of phase than the input which is also evident in the graphs.

# EXPERIMENT#2: Non-inverting amplifier

1-




Lab2 Experiment 2

$AV = \{1 + \frac{R_2}{R_1}\} Vin$

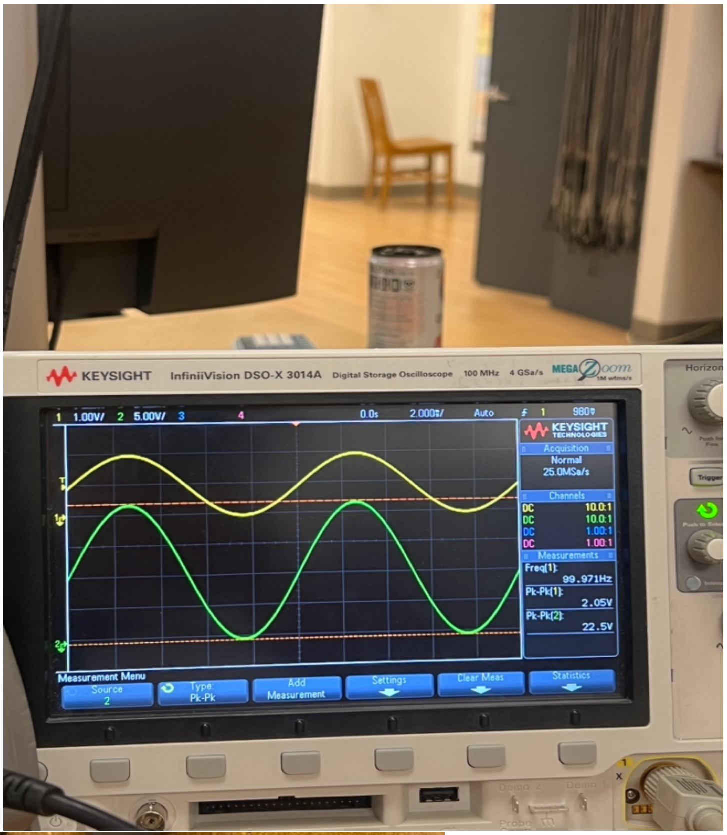
non-inverting op-amp, gain of 11, Vin = 1 VP.P

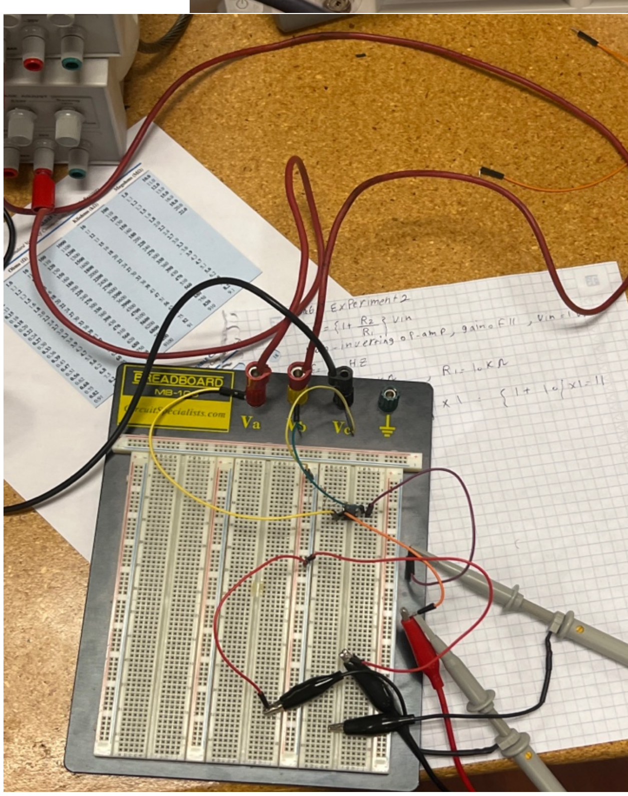
f = 100 HZ

$R_2 = 100 k\Omega$, $R_1 = 10 K\Omega$

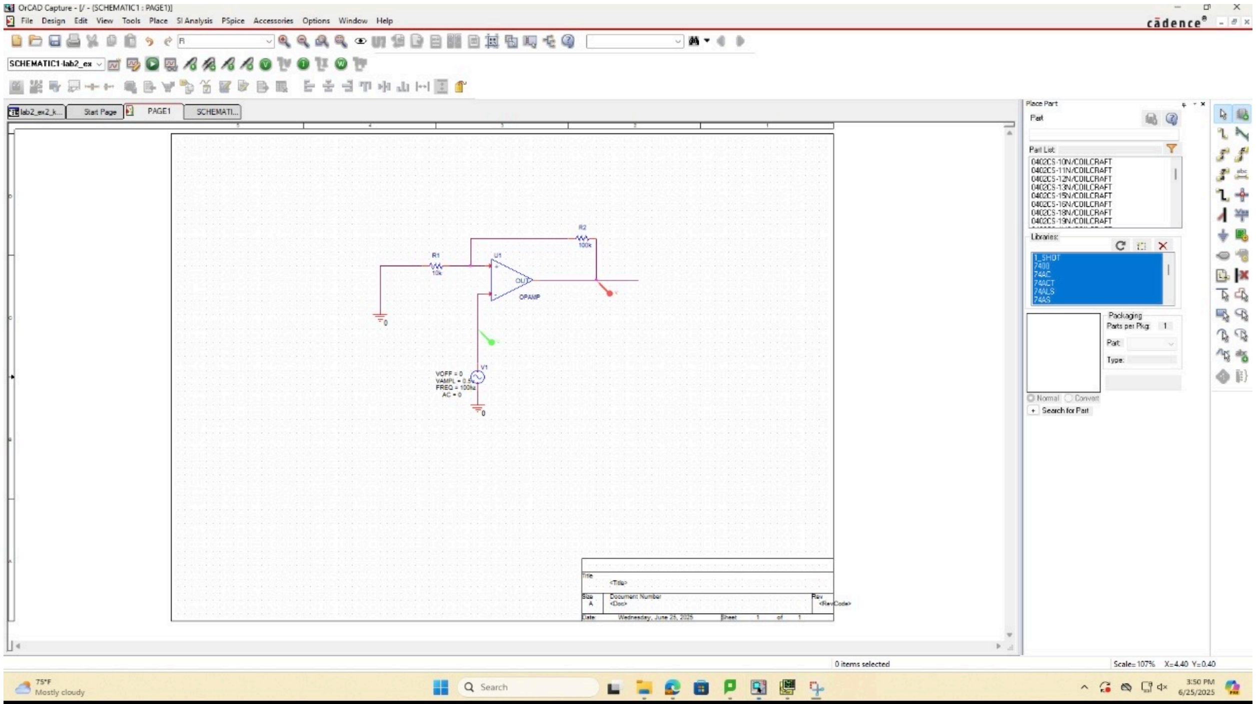
$11 = \{1 + \frac{100}{10}\} \times 1 = \{1 + 10\} \times 1 = 11$

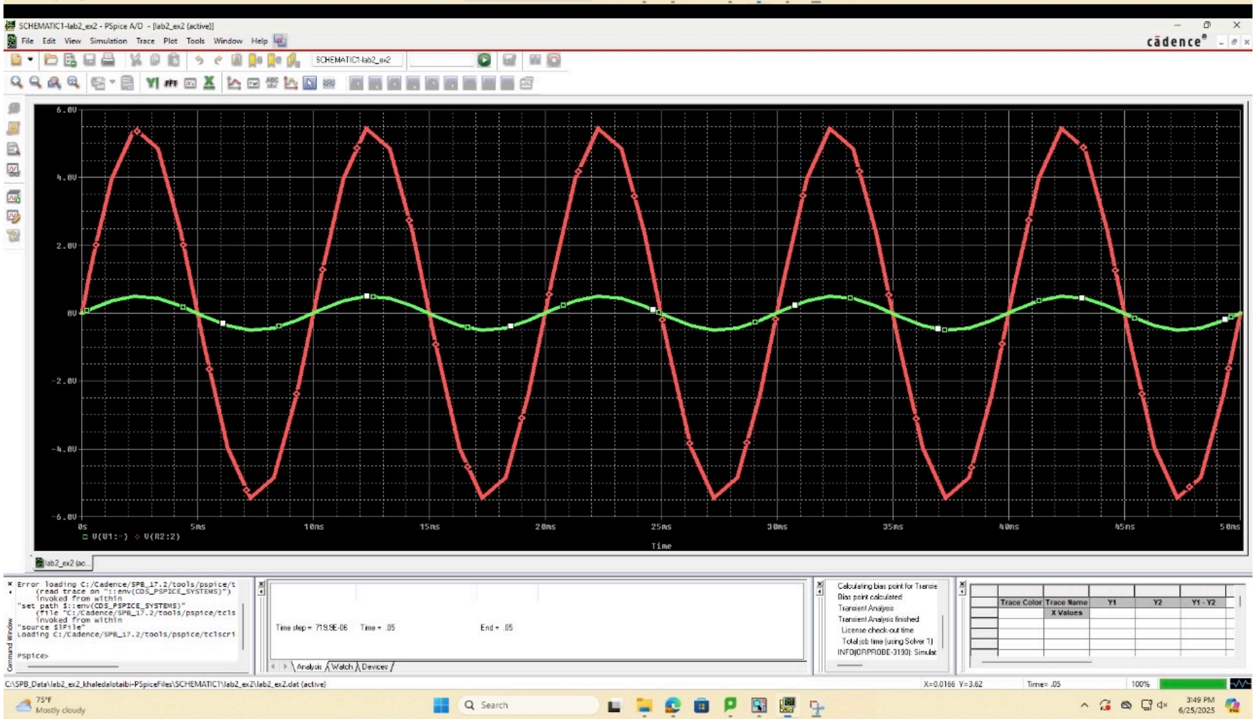
2-


KEYSIGHT
InfiniiVision DSO-X 3014A
Digital Storage Oscilloscope
100 MHz
4 GSa/s
1.00V/
5.00V/
0.0s
2.000ms/
Auto
KEYSIGHT TECHNOLOGIES
Acquisition
Normal
25.0MSa/s
Channels
DC 10.0:1
DC 10.0:1
DC 1.00:1
DC 1.00:1
Measurements
Freq(1):
99.971Hz
Pk-Pk(1):
2.05V
Pk-Pk(2):
22.5V
Measurement Menu
Source
2
Type:
Pk-Pk
Add
Measurement
Settings
Clear Meas
Statistics


BREADBOARD
Va
Vc
Experiment 2

3-



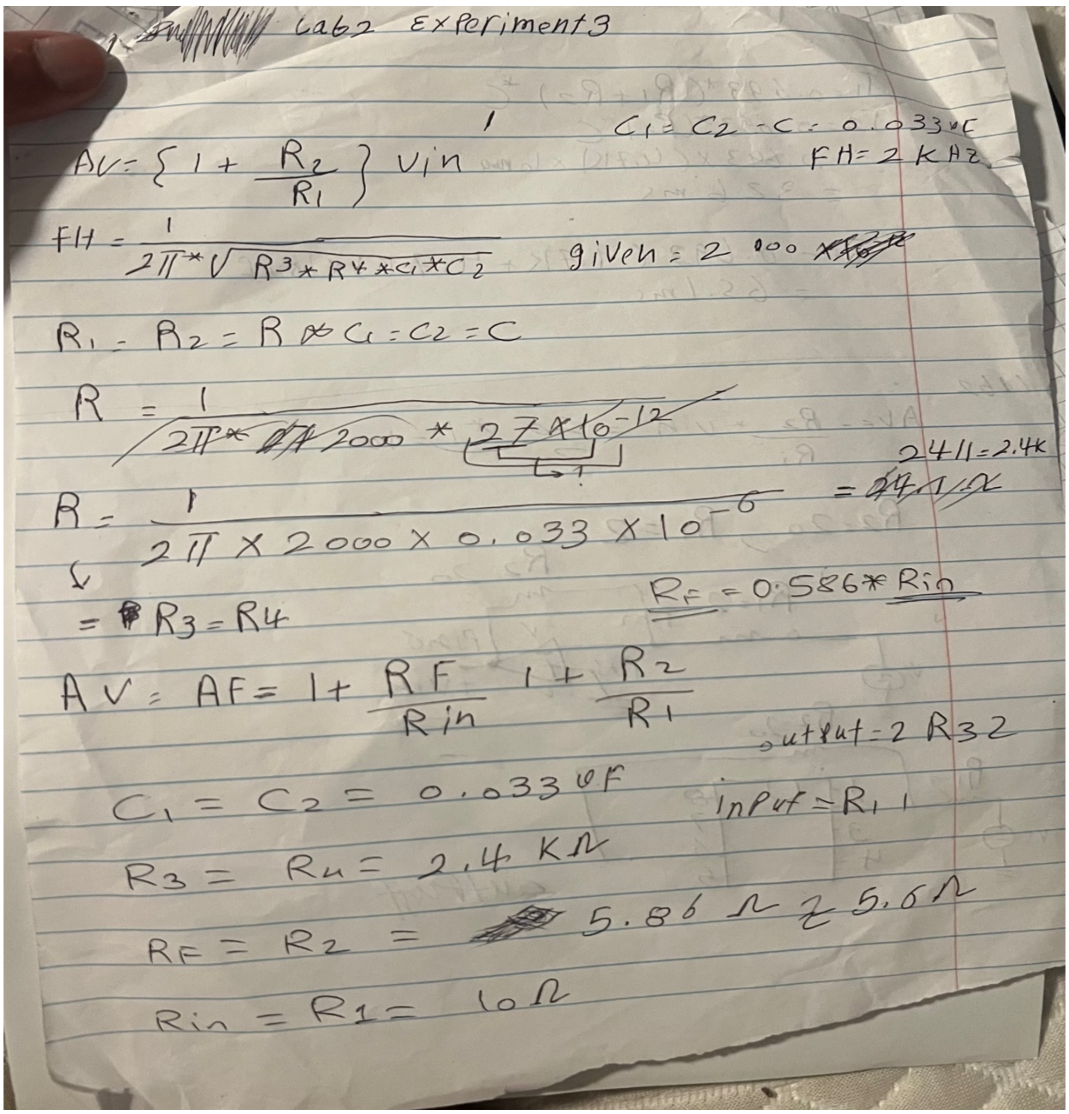



According to the manual calculation, the gain of non inverting amplifier should be 11, and it can be seen in the oscilloscope and simulation that the output waveform is 11 times amplified. Then as the name suggests, output will be non inverted as compared to input which means it will in phase with the input which is also evident in the graphs.

10/10

# EXPERIMENT#3: Low Pass Filter

1 and 2 &3



Lab2 Experiment3

$C_1 = C_2 = C = 0.033\,uF$

$FH = 2\,KHz$

$AV = \left\{ 1 + \frac{R_2}{R_1} \right\} Vin$

$FH = \frac{1}{2\pi * \sqrt{R_3 * R_4 * C_1 * C_2}}$ given = 2 000

$R_1 = R_2 = R$ & $C_1 = C_2 = C$

$R = \frac{1}{2\pi * 2000 * 27 \times 10^{-12}}$

$R = \frac{1}{2\pi \times 2000 \times 0.033 \times 10^{-6}}$ = 2411 = 2.4K

$= R_3 = R_4$

$R_F = 0.586 * Rin$

$AV = AF = 1 + \frac{RF}{Rin}$ $1 + \frac{R_2}{R_1}$

output = 2 R32

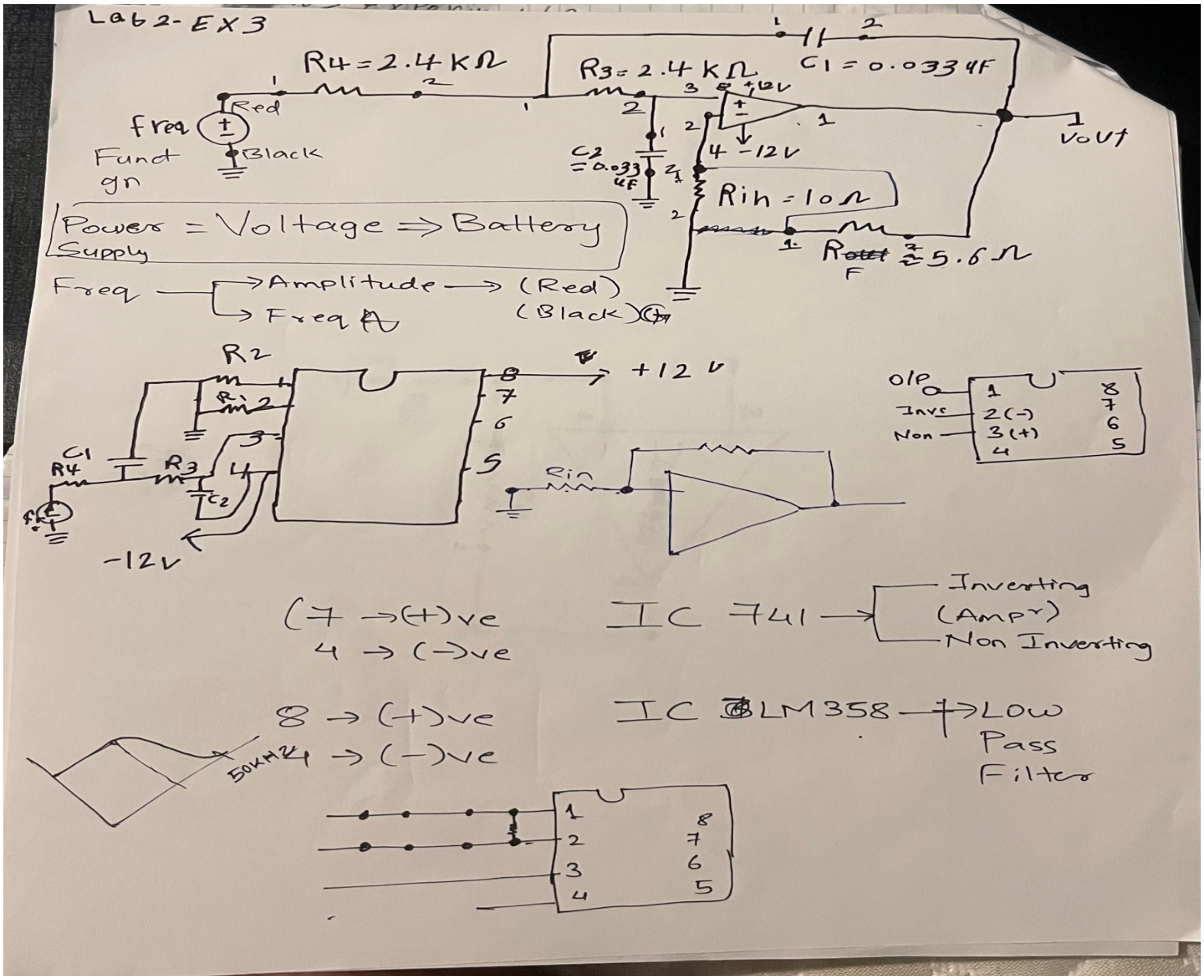
Input = R1 1

$C_1 = C_2 = 0.033\,uF$

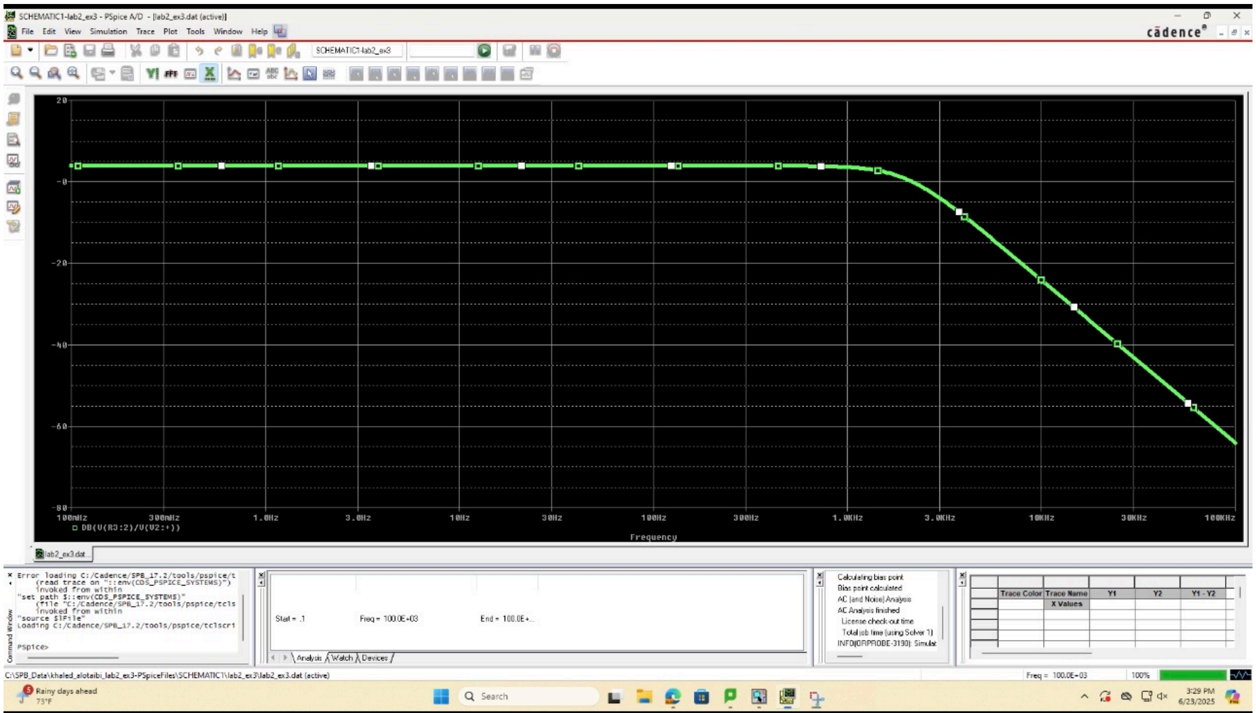
$R_3 = R_4 = 2.4\,K\Omega$

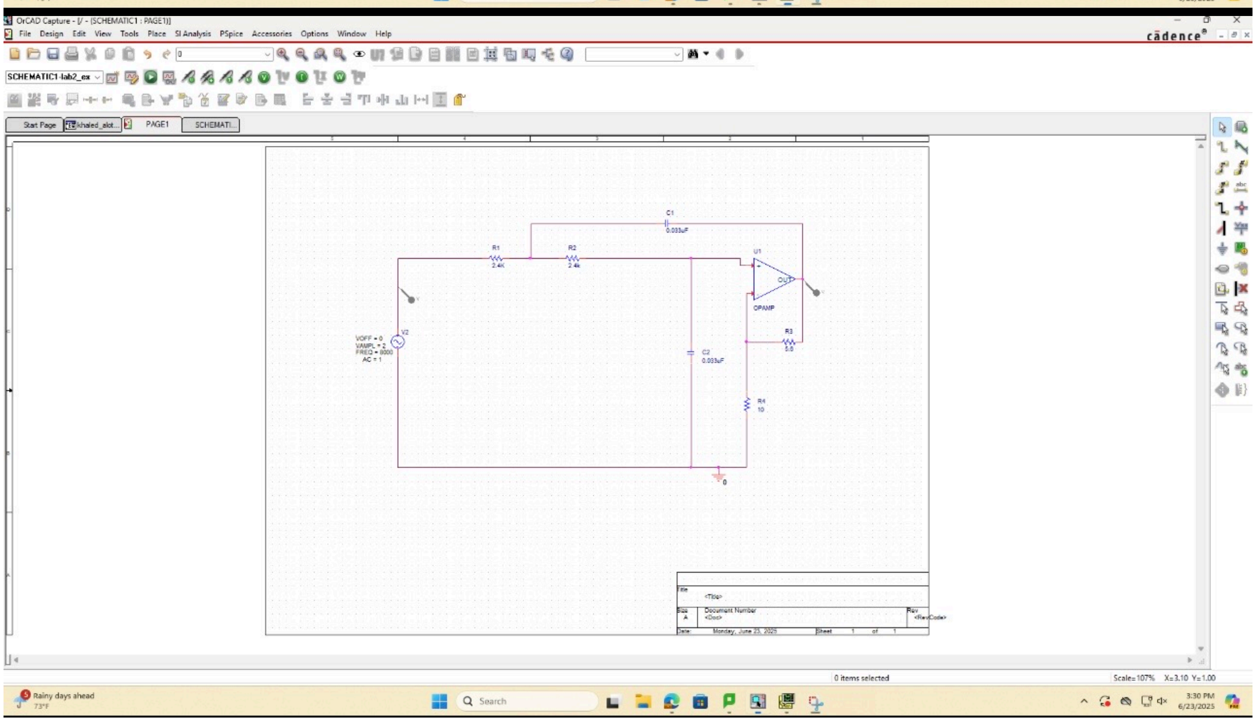
$R_F = R_2 = 5.86\,\Omega \approx 5.6\,\Omega$

$Rin = R_1 = 10\,\Omega$

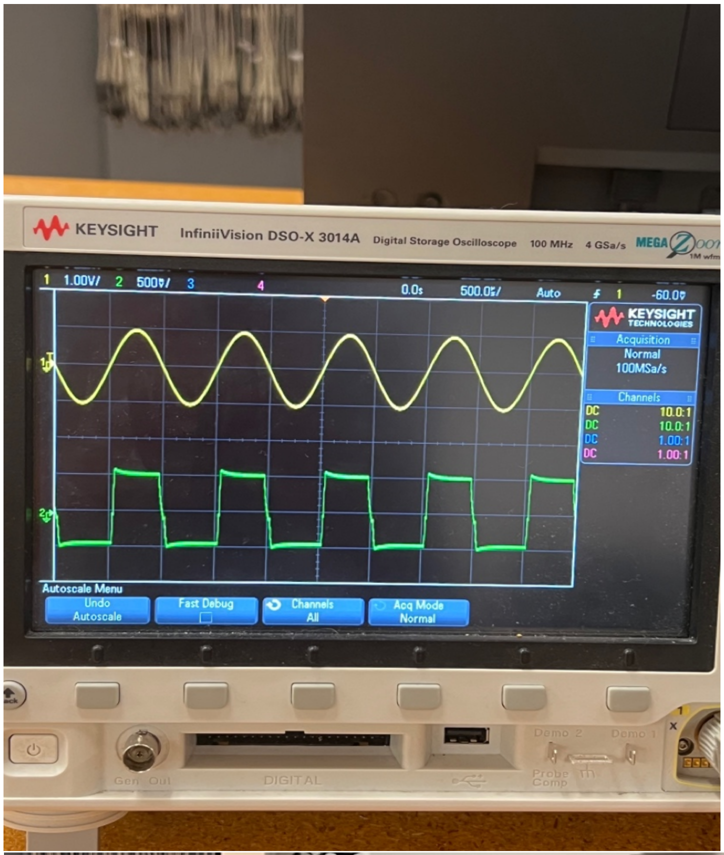

Lab2-EX3
R4=2.4KΩ
R3=2.4KΩ
C1=0.033uF
+12V
-12V
Freq
Fund gn
Red
Black
Vout
Rin=10Ω
RF=5.6Ω
Power Supply = Voltage ⇒ Battery
Freq → Amplitude → (Red)
→ Freq
(Black)
+12V
-12V
O/P
Inv
Non
Rin
(7 → (+)ve
4 → (-)ve
8 → (+)ve
4 → (-)ve
50KHz
IC 741 → Inverting (Ampr) / Non Inverting
IC LM358 → Low Pass Filter

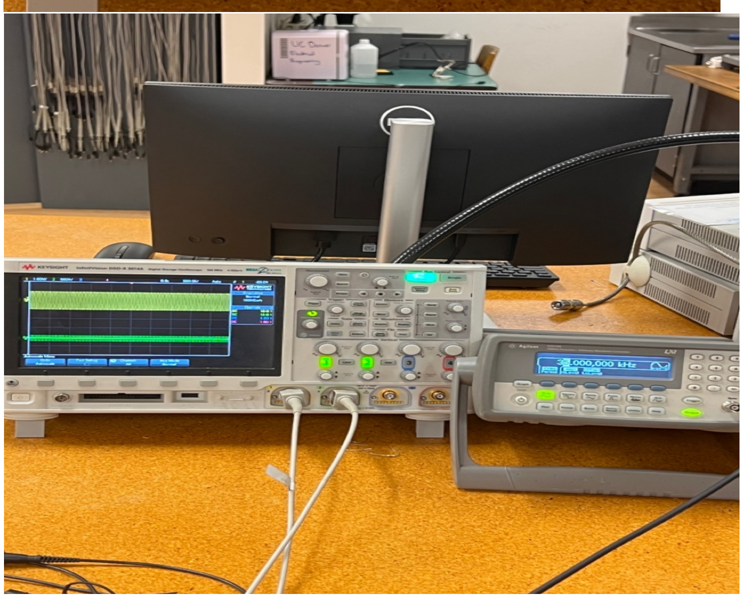
4-





5-





We calculated the values of resistors and capacitors based on the cutoff frequency of 2khz. For a low pass filter, whenever the signal of less than 2khz is passed, it will allow it. But when signal is out of the band, it will attenuate it.

10/10

# EXPERIMENT#4: High Pass Filter

1-

Lab #2 Experiment 4

$$R = \frac{1}{2\pi f c} = \frac{1}{2\pi}$$

$f_H = 5000\,Hz$

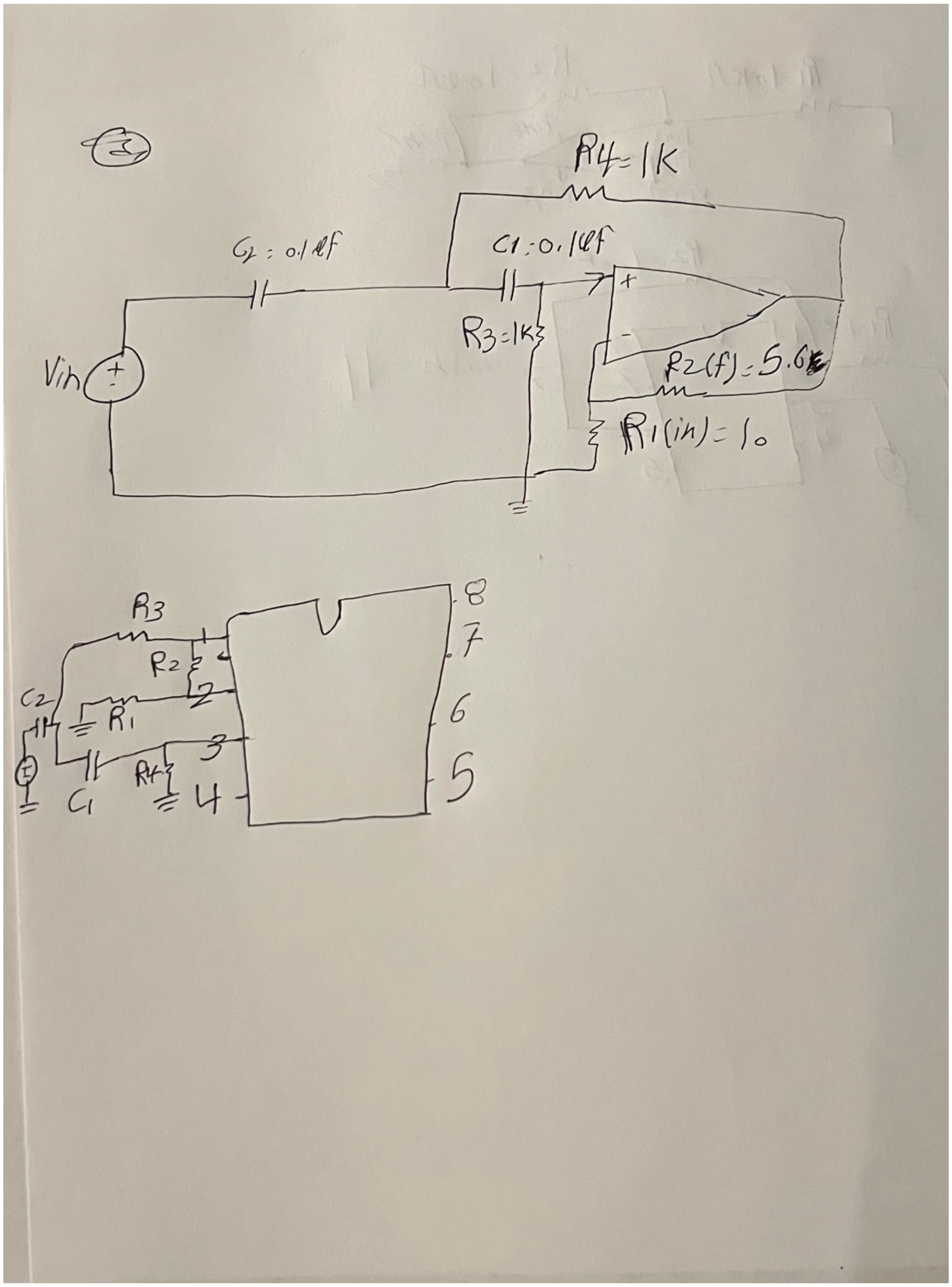
$$R = \frac{1}{2\pi \times 5000\,C} = \frac{1}{2\pi \times 5000 \times 0.033 \times 10^{-6}}$$

$= 964.5 = 1K$

$R_3 = 1K$ $R_4 = 1K$

$R_1 = 10$ $R_2 = 5.86 \approx 5.6$

2&3-


R4=1K
C2: 0.1 uf
C1: 0.1 uf
R3=1K
Vin
R2(f)=5.6K
R1(in)=10
R3
R2
C2
R1
R4
C1
8
7
6
5
4
3
2

4-