LAB NOTE

Subject: Electronic Design Principles

Topic: Basic Op Amp

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1. Objectives

- Building an A) inverting amplifier B) Non-inverting amplifier C) Voltage follower.
- Design a circuit using one of the quad Op-amps in your first semester ESD kit.

Requirement:

1. Decide the power to be applied to the IC based on your datasheet. State your reason. (hint: +/- 3 up to +/- 10).
2. Prepare circuits in advance and prepare the tables with predicted/calculated outcomes to compare with the actual values (minimum 10 entries).
3. The amplification should be approximately 2 for both amplifiers.
4. Use a potentiometer (variable resister) to vary the input voltage.

2. Theory and Calculation

2.1 Theory

- A noninverting amplifier is a configuration in which the signal is on the noninverting input and a portion of the output is returned to the inverting input.
- An inverting amplifier is a configuration in which the noninverting input is grounded and the signal is applied through a resistor to the inverting input.
- A special case of the inverting amplifier is when Rf =0 and Ri = ∞. This forms a voltage follower or unity gain buffer with a gain of 1

2.2 Design and Calculation

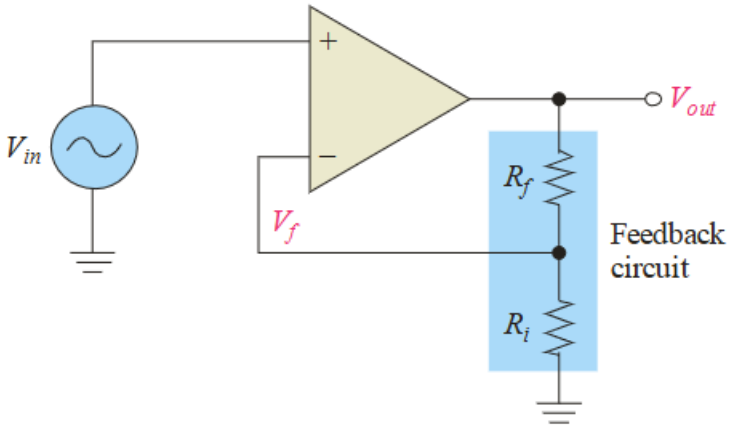


Figure 2-1: Non-inverting amplifier's design

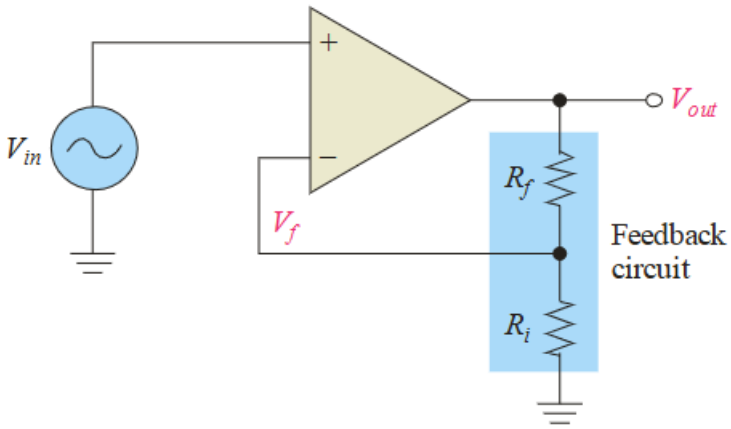


Figure 2-2: Inverting amplifier's design

2. Theory and Calculation

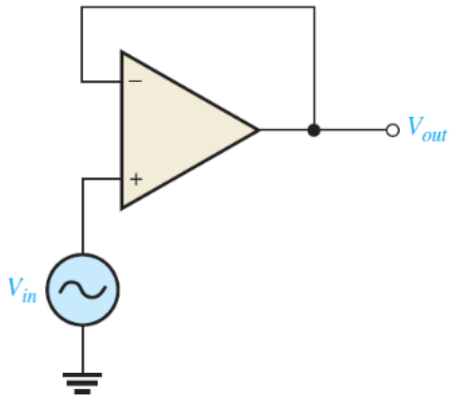


Figure 2-3: Voltage follower's design

For this design the following equipment are use:

- 3 Resistors $10k\Omega$ and 1 Resistor $22k\Omega$
- IC LM348N
- Function Generator
- Power Supply

Non-inverting amplifier formula to calculate gain:

$$A = 1 + \frac{R_f}{R_i}$$

Inverting amplifier formula to calculate gain:

$$A = -\frac{R_f}{R_i}$$

Voltage follower formula's gain will be a constant 1:

$$A = 1$$

Formula to calculate V_{out}:

$$V_{out} = A \times V_{in}$$

Because the requirement is to build a circuit with gain approximately 2, so:

- **Non-inverting amplifier:**

$$A = 1 + \frac{R_f}{R_i}$$

Assuming $R_i = 10k\Omega$, so:

$$2 = 1 + \frac{R_f}{10k\Omega}$$

$$R_f = 10k\Omega$$

So for non-inverting amplifier, 2 resistor $10k\Omega$ will be used.

- **Inverting amplifier:**

$$A = -\frac{R_f}{R_i}$$

Assuming $R_i = 10k\Omega$, so:

$$-2 = -\frac{R_f}{10k\Omega}$$

$$R_f = 20k\Omega$$

Because the kit does not have a resistor with value $20k\Omega$, so instead will use $22k\Omega$ resistor.

So for inverting amplifier resistor $10k\Omega$ and resistor $22k\Omega$ will be used.

- **Power supply:**

recommended operating conditions

	MIN	MAX	UNIT
Supply voltage, V_{CC+}	4	18	V
Supply voltage, V_{CC-}	–4	–18	V

Figure 2-4: LM348N's datasheet

From the datasheet, it said that it recommended that the power supply of V_{cc+} should be in range from 4V to 18V, and for V_{cc-} should be from -4 to -18.

3. Design and Result

For this assignment, 10 cases will be tested, 4 will be with DC power and 6 will be from AC power.

3.1 Multisim's design for all 3 circuits.

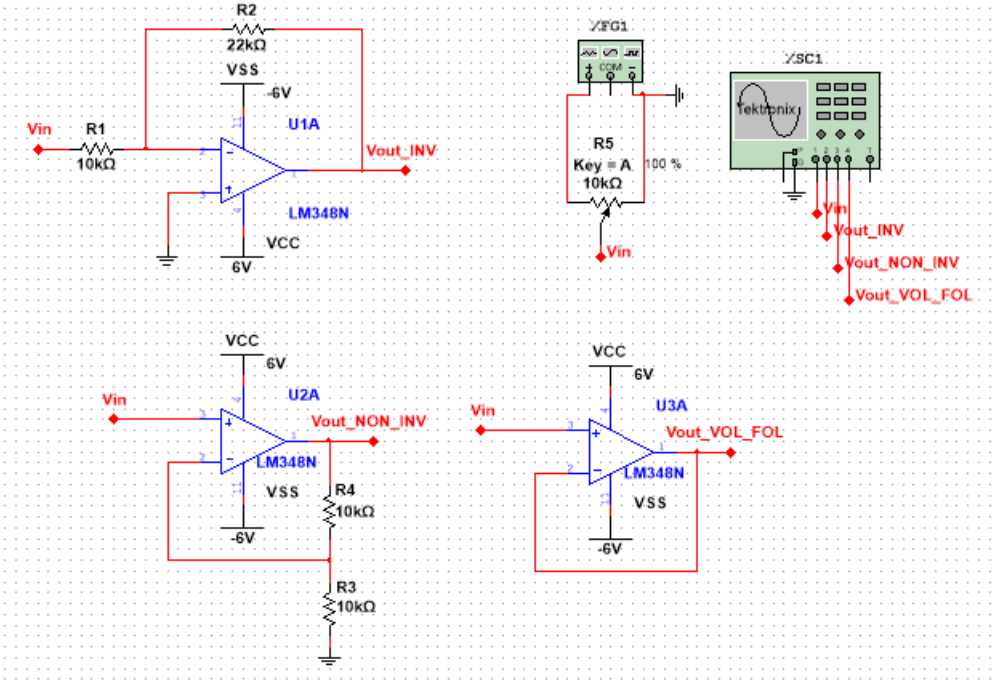


Figure 3-1: Multisim's design

3.2 Breadboard's design

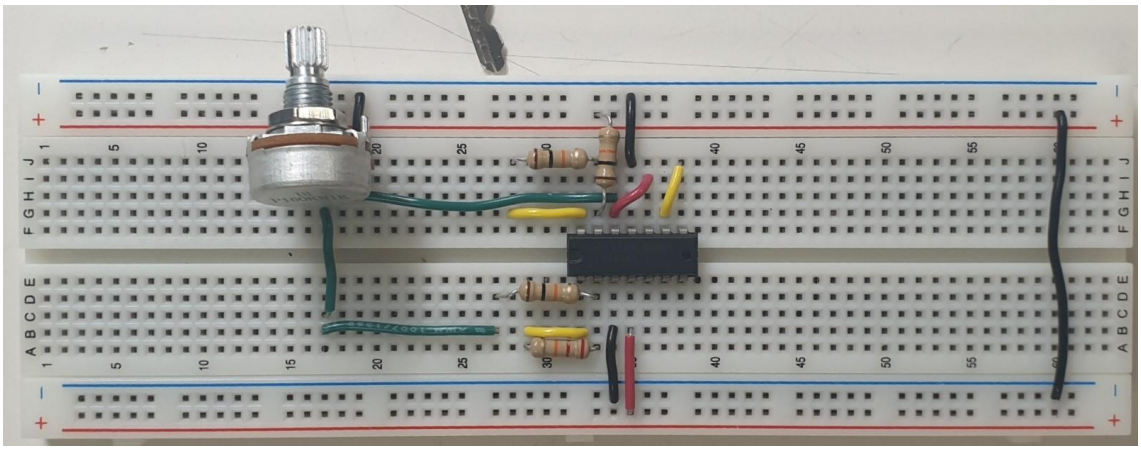


Figure 3-2: Breadboard's design

3.3 Result

3.3.1 DC power

- Inverting

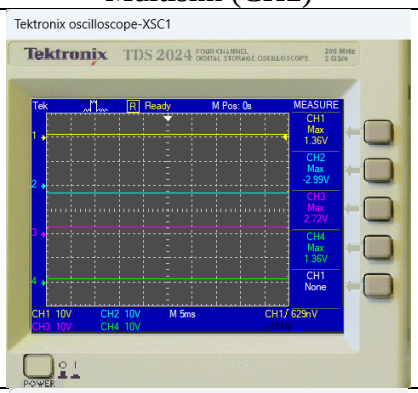
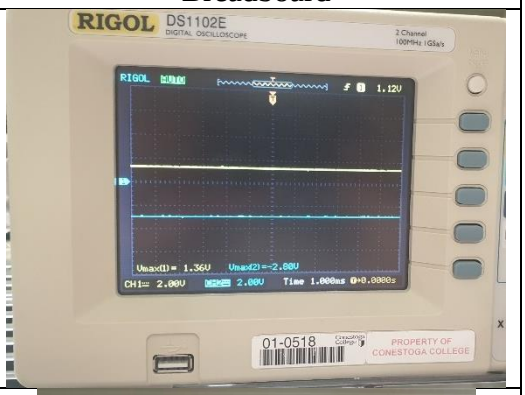
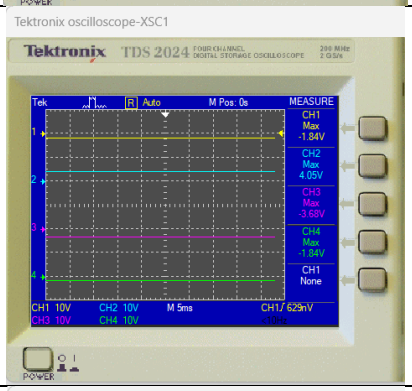
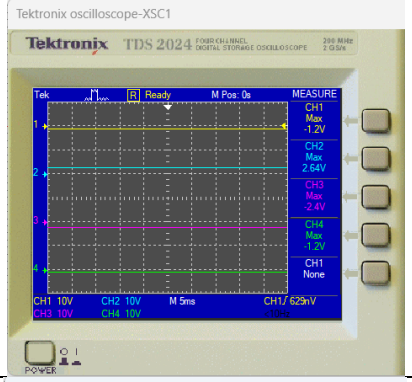
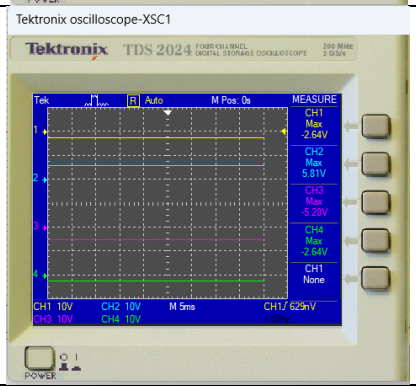
Input	Output		
	Theory	Multisim (CH2)	Breadboard
1.36	-2.72		
-1.84	3.68		
-1.2	2.4		
-2.6	5.2		

Table 3-1: DC power for Inverting Amplifier

3. Result

- Non -Inverting

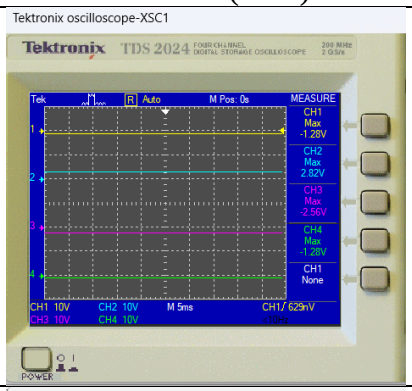
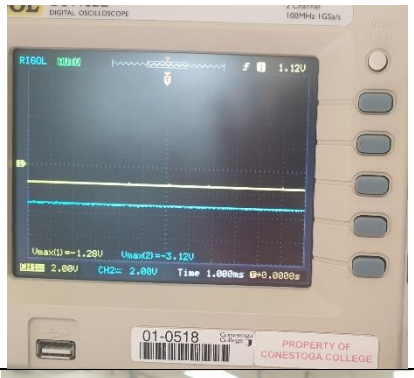
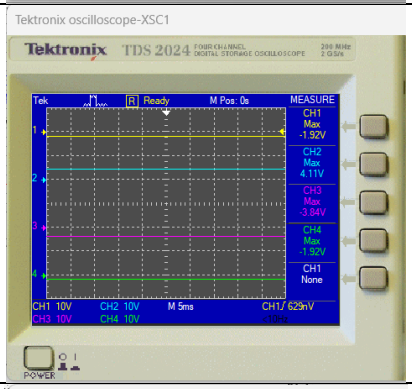
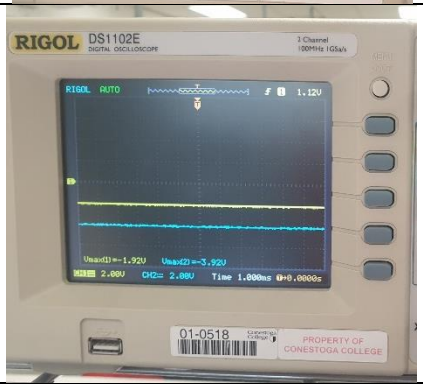
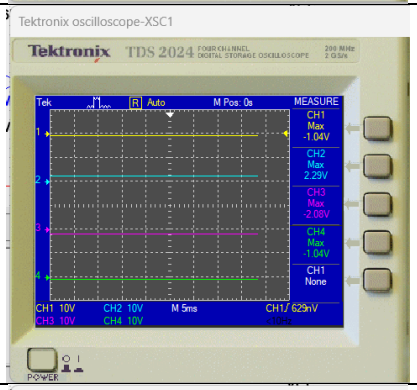
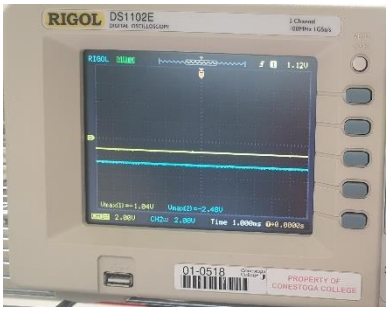
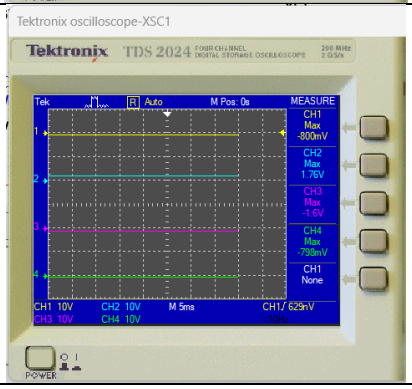
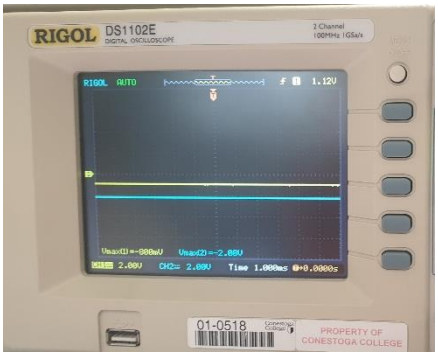
Input	Output		
	Theory	Multisim (CH3)	Breadboard
-1.28	-2.56		
-1.92	-3.84		
-1.04	-2.08		
-0.8V	-1.6		

Table 3-2: DC power for Non-Inverting Amplifier

3. Result

- Voltage follower:

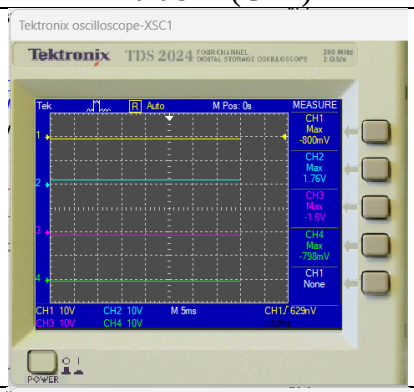
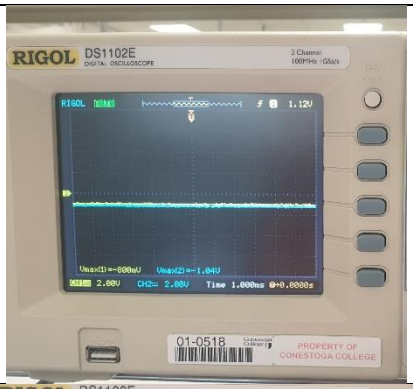
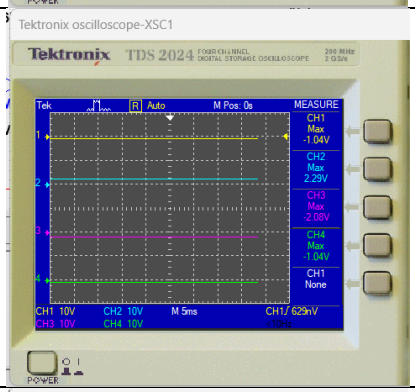
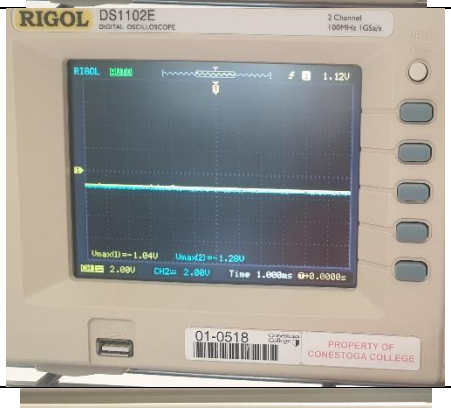
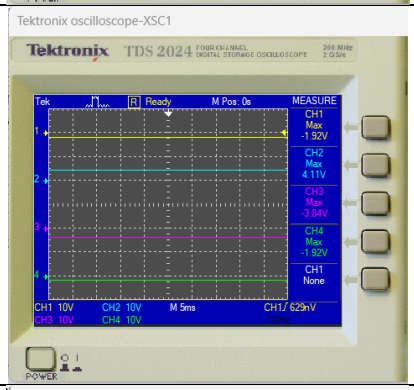
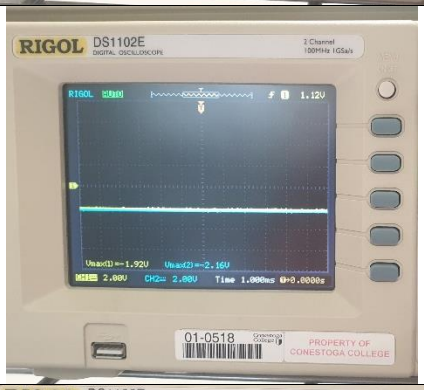
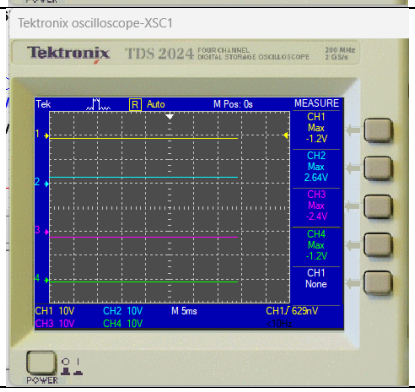
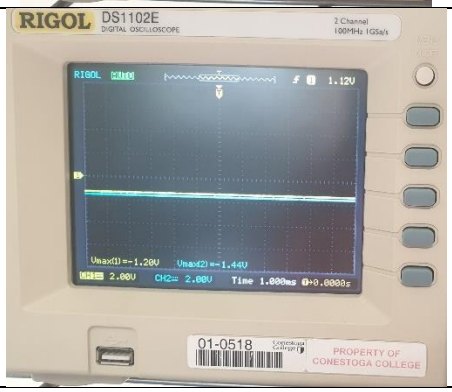
Input	Output		
	Theory	Multisim (CH4)	Breadboard
-0.8	-0.8		
-1.04	-1.04		
-1.92	-1.92		
-1.2	-1.2		

Table 3-3: DC power for Voltage Follower

3.3.2 AC power

- Inverting

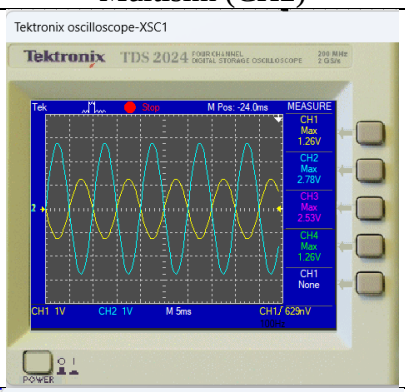
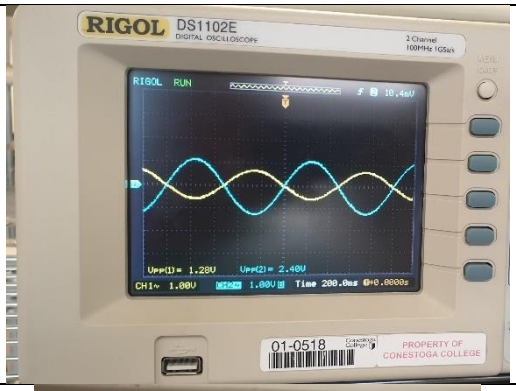
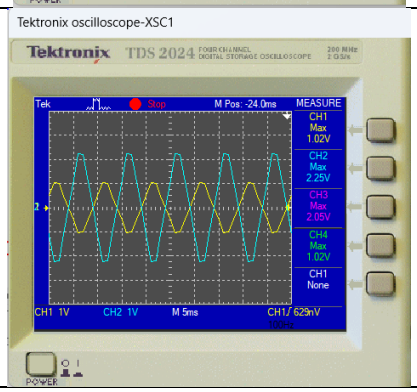
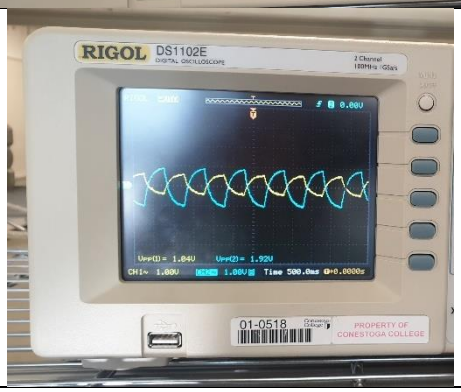
Input (Vpp)	Output		
	Theory	Multisim (CH2)	Breadboard
1.28	2.56		
1.04	2.08		

Table 3-4: AC power for Inverting Amplifier

- Non-inverting

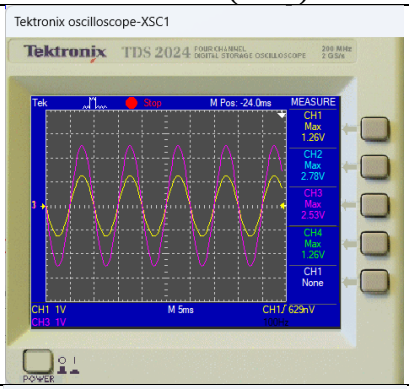
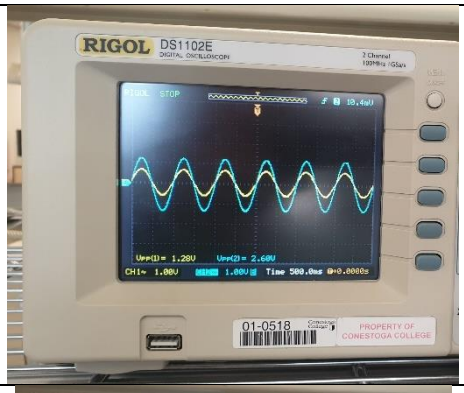
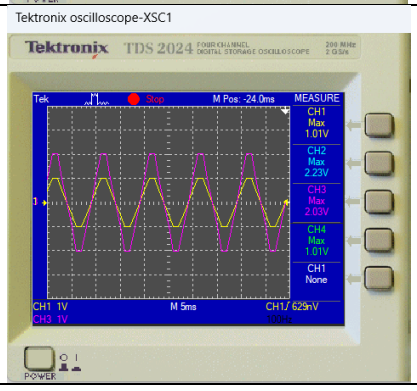
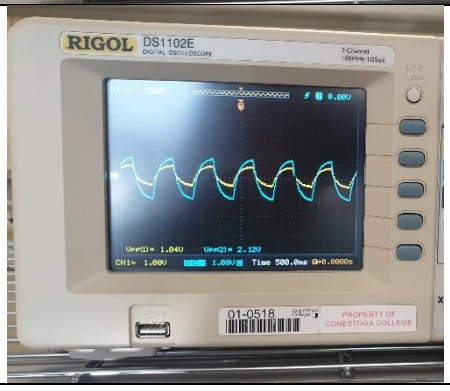
Input (Vpp)	Output		
	Theory	Multisim (CH3)	Breadboard
1.28	2.56		
1.04	2.08		

Table 3-5: AC power for Inverting Amplifier

3. Result

- Voltage Follower

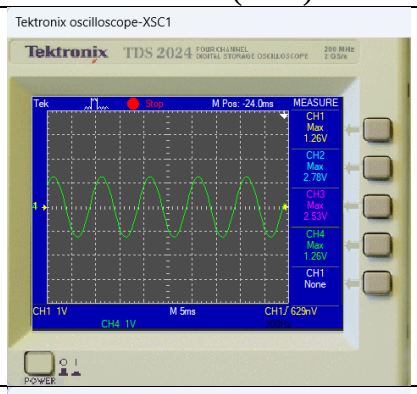
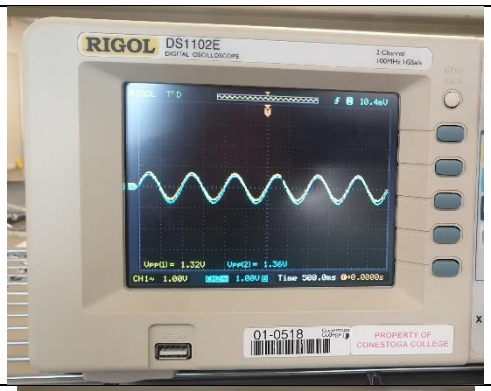
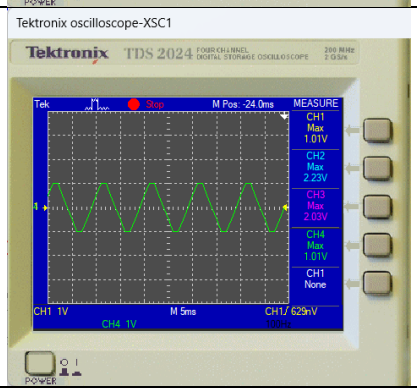
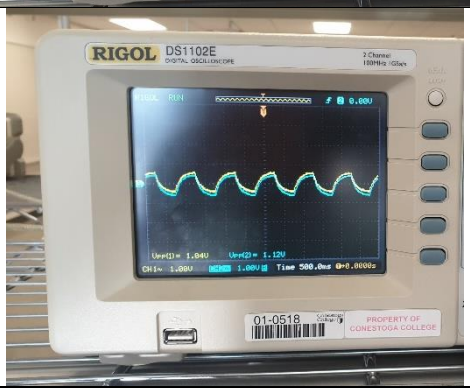
Input (Vpp)	Output		
	Theory	Multisim (CH4)	Breadboard
1.28	1.28		
1.04	1.04		

Table 3-6: AC power for Voltage Follower

4. CONCLUSION

From the result of all cases:

- All cases have Theory's result, Multisim's result and Breadboard's result nearly the same.

REFERENCES