ECE 321 - Homework #1

Op Amp Amplifiers, Push-Pull Amplifiers. Due Monday, November 8th

Please make the subject "ECE 321 HW#1" if submitting homework electronically to Jacob_Glower@yahoo.com (or on blackboard)
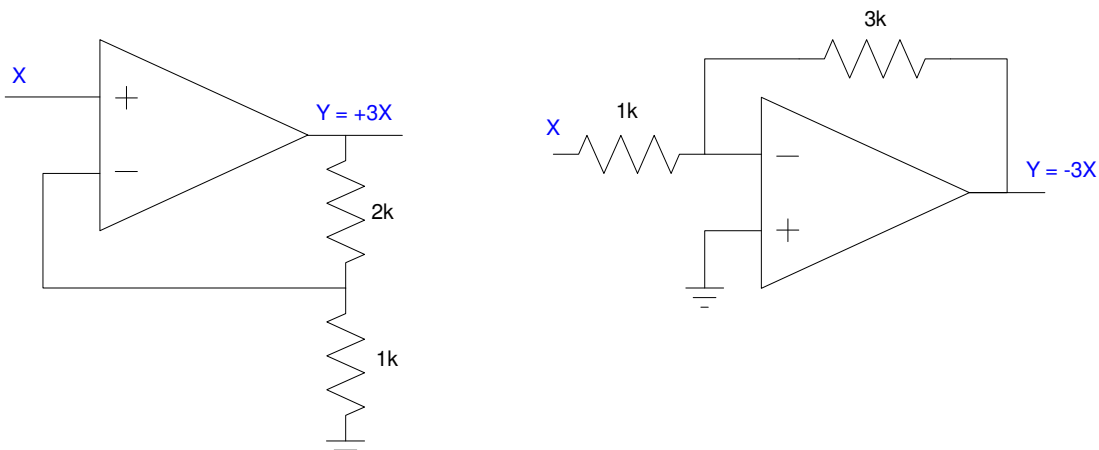
For all problems, assume you are using

- MCP602 Op Amps (max current = 50mA)
- 2SC6144 transistors (β = 200, 10A max, |Vbe| = 0.7V

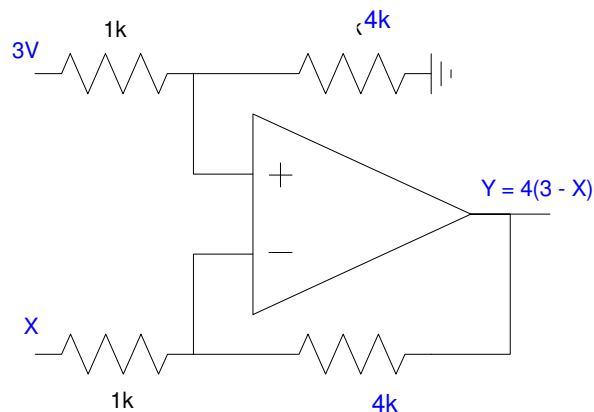## Amplfier:

Design a circuit to implement

1a) Y = +3X

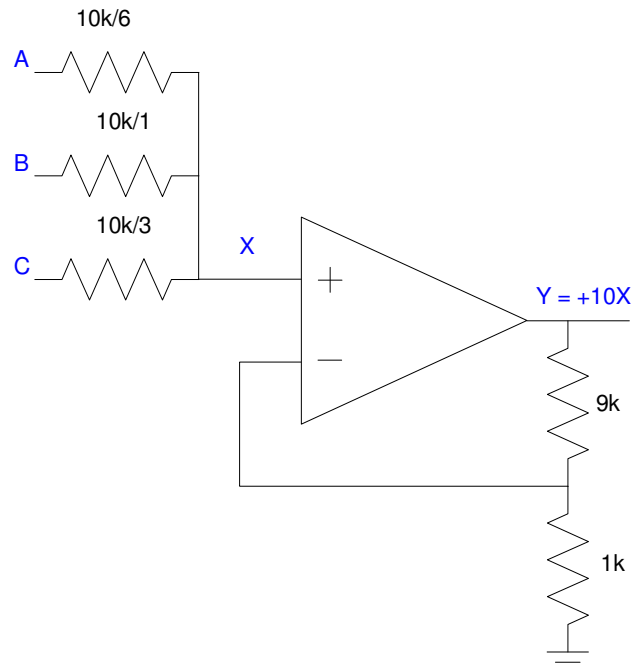1b) Y = -3X

1c) Y = 12 - 4X

Rewrite as

$$Y = 4(3 - X)$$

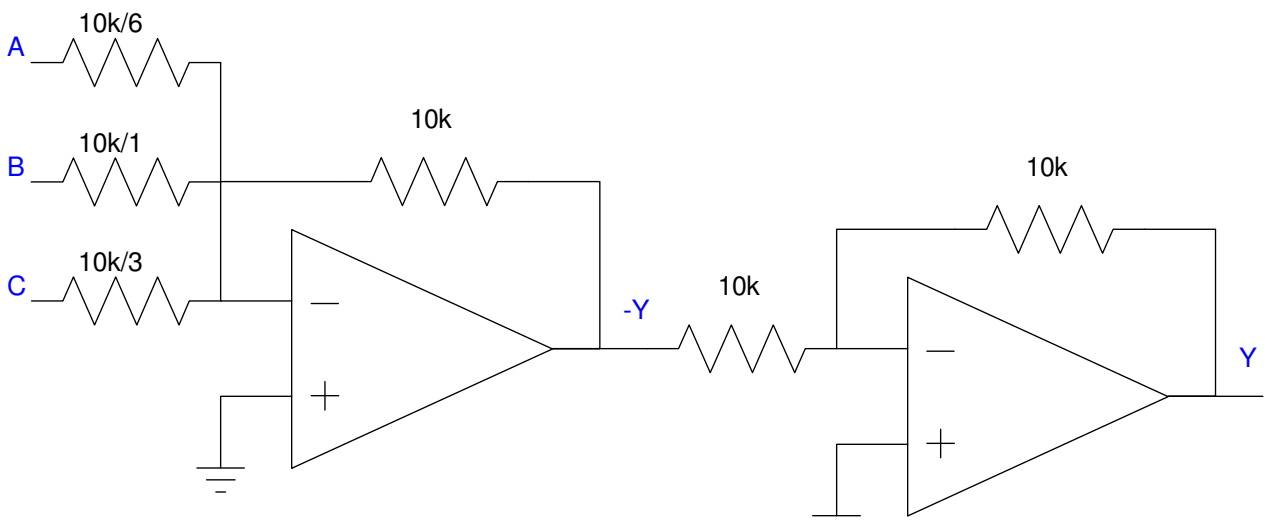# Mixer

2) Design a circuit to mix three signals together:

- $Y = 6A + 1B + 3C$

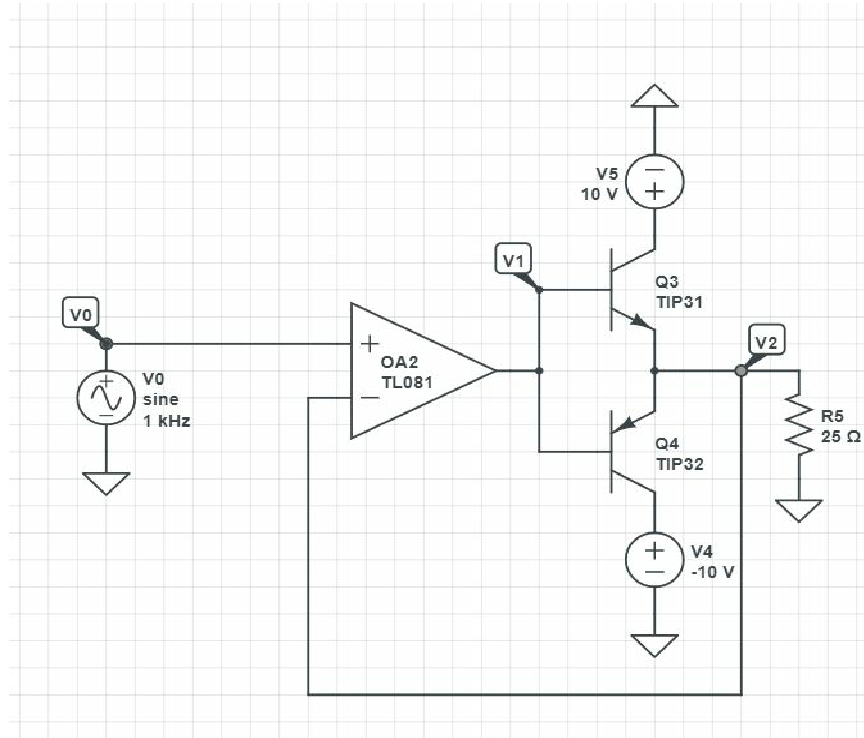Option 1: Rewrite as

$$Y = 10\left(\frac{6A+B+3C}{10}\right)$$

10k/6

A

10k/1

B

10k/3

X

+

Y = +10X

−

9k

1k

Option 2: Use inverting summing amplifiers

10k/6

A

10k

10k/1

B

10k

10k/3

C

−

+

-Y

10k

−

+

Y

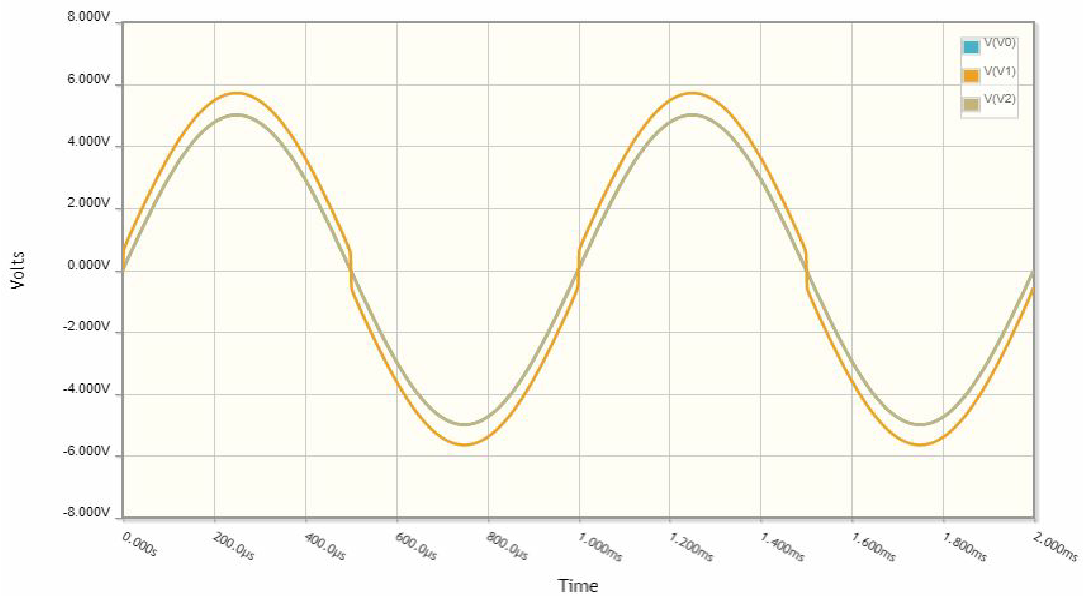## Push-Pull Amplifier

3) Design a circuit so that Y = X

- X = -5V to +5V, 10mA max
- Y = -5V to +5V, 200mA (25 ohm speaker (net))
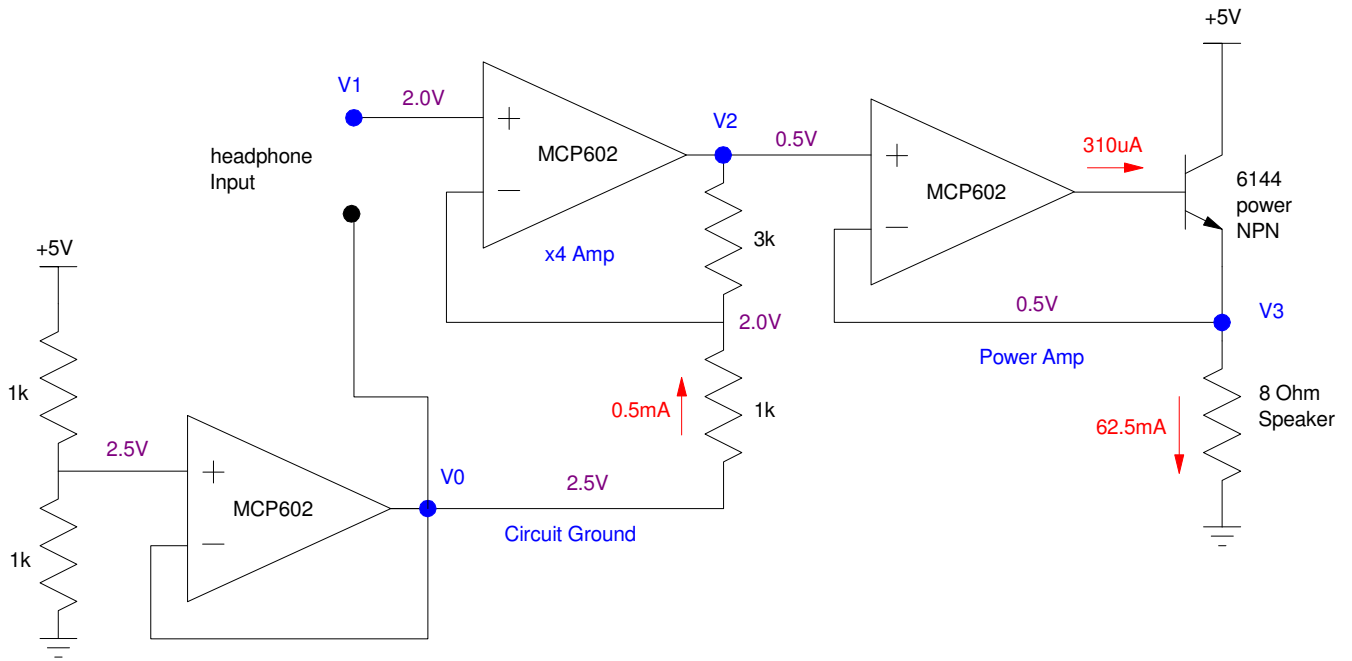

4) Simulate in CircuitLab

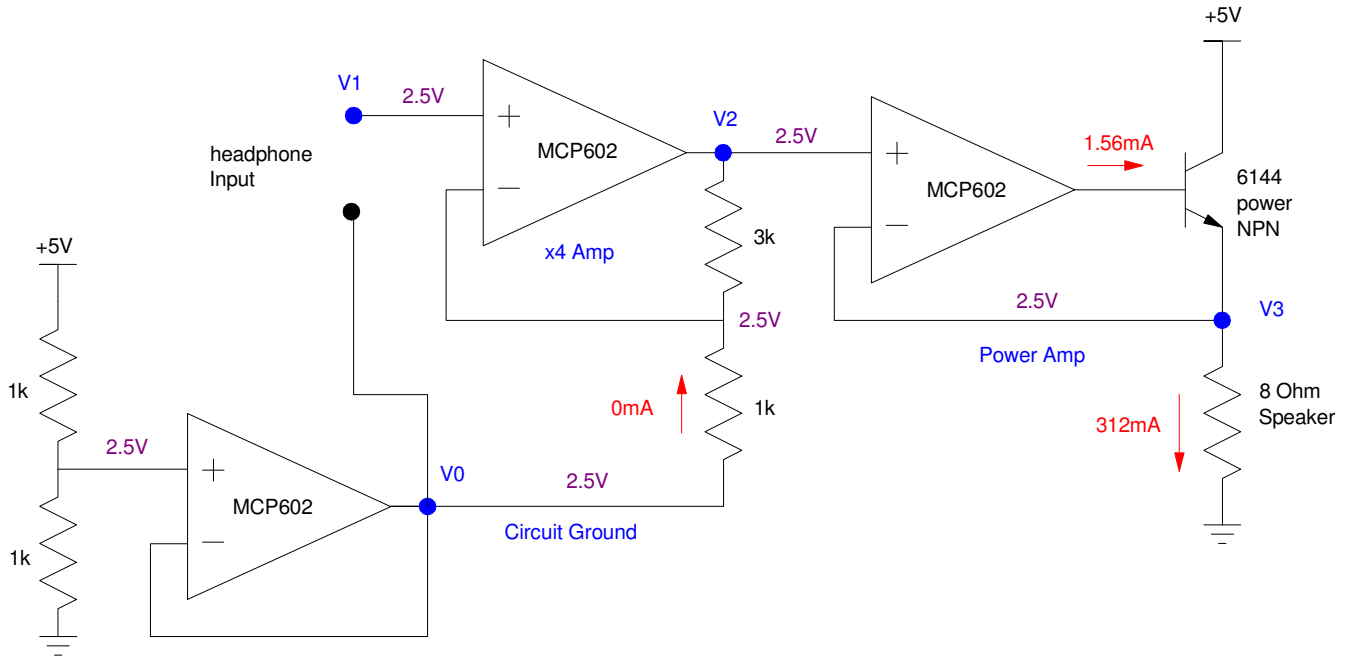## Lab (Hardware)

The following circuit

- Creates a 2.5V power supply from a single +5V supply (V0). This 2.5V supply then acts like circuit ground
- Amplifies the output of a cell phone (or computer or 555 timer) (V2), and
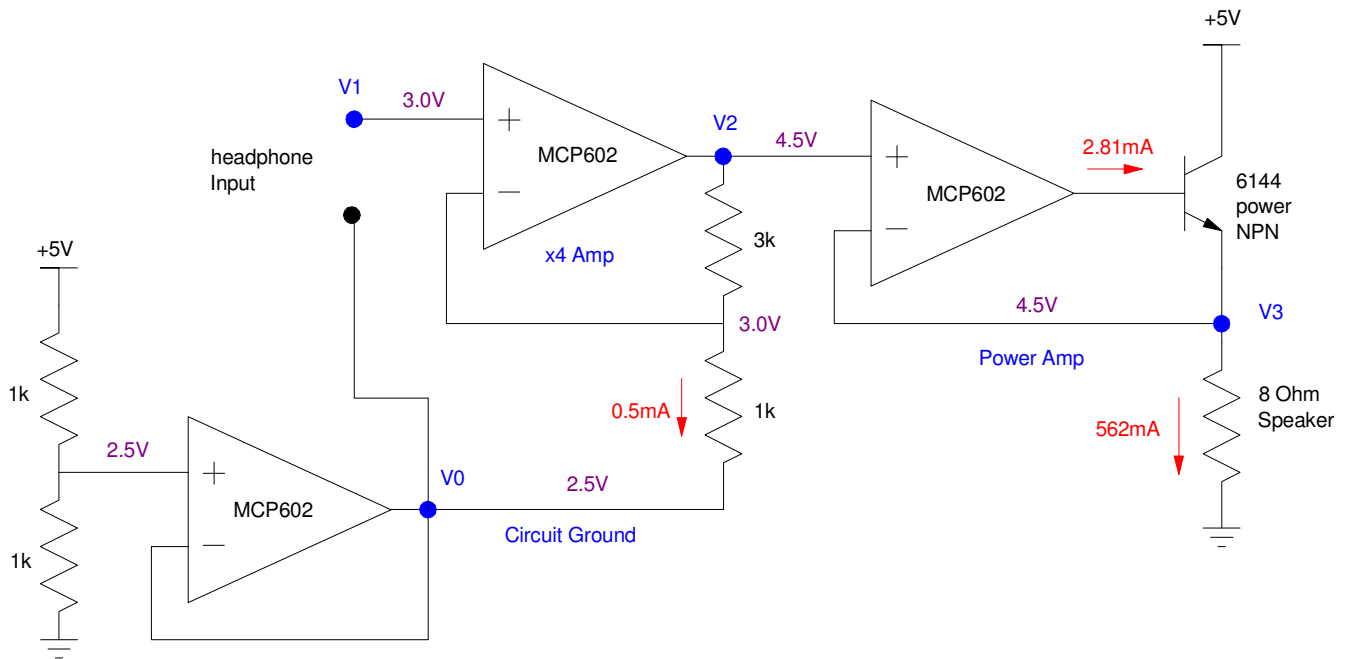- Drives an 8 Ohm speaker (V3)

5) Calculate the voltages and currens when

V1 = 2.0V

V1 = 2.5V

+5V

V1   2.5V
          +
             MCP602
headphone
Input
          −
          x4 Amp

V2   2.5V
                        +
                           MCP602
                        −
                        Power Amp

1.56mA

6144
power
NPN

+5V

1k

2.5V
          +
             MCP602
          −

V0

3k

2.5V

0mA   1k

2.5V
Circuit Ground

2.5V   V3

8 Ohm
Speaker

312mA

1k

V1 = 3.0V

+5V

V1   3.0V
          +
             MCP602
headphone
Input
          −
          x4 Amp

V2   4.5V
                        +
                           MCP602
                        −
                        Power Amp

2.81mA

6144
power
NPN

+5V

1k

2.5V
          +
             MCP602
          −

V0

3k

3.0V

0.5mA   1k

2.5V
Circuit Ground

4.5V   V3

8 Ohm
Speaker

562mA

1k

6) Simulate this curcuit in CircuitLab with

- V1 = 1Vpp, 1kHz sine wave
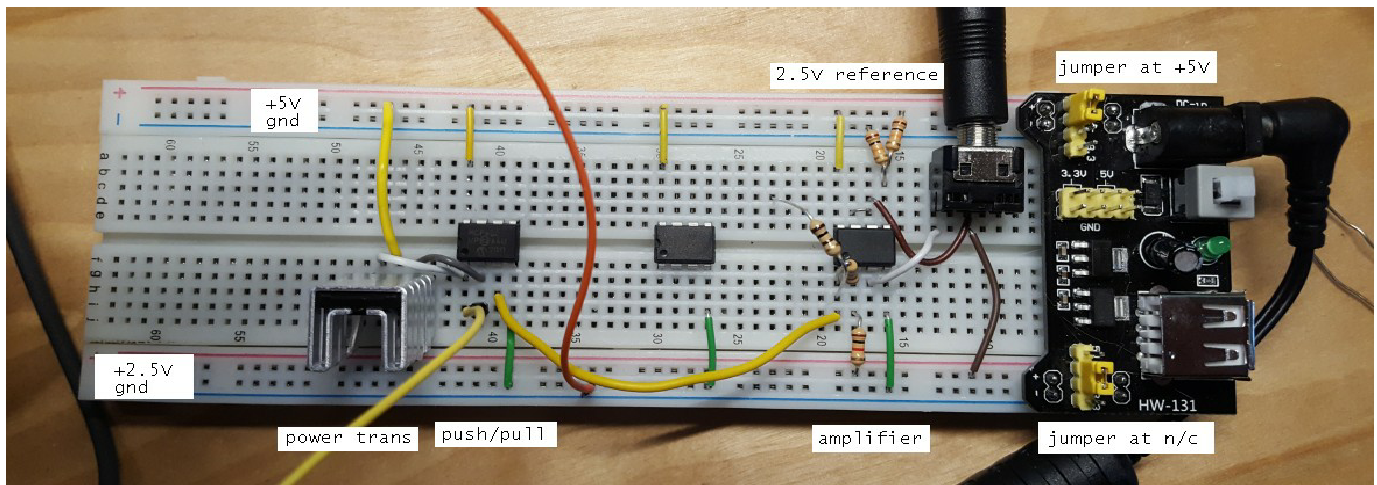
Note:

- V1 = 4*V0, centered at 2.5V (circuit ground)
- V2 = V1
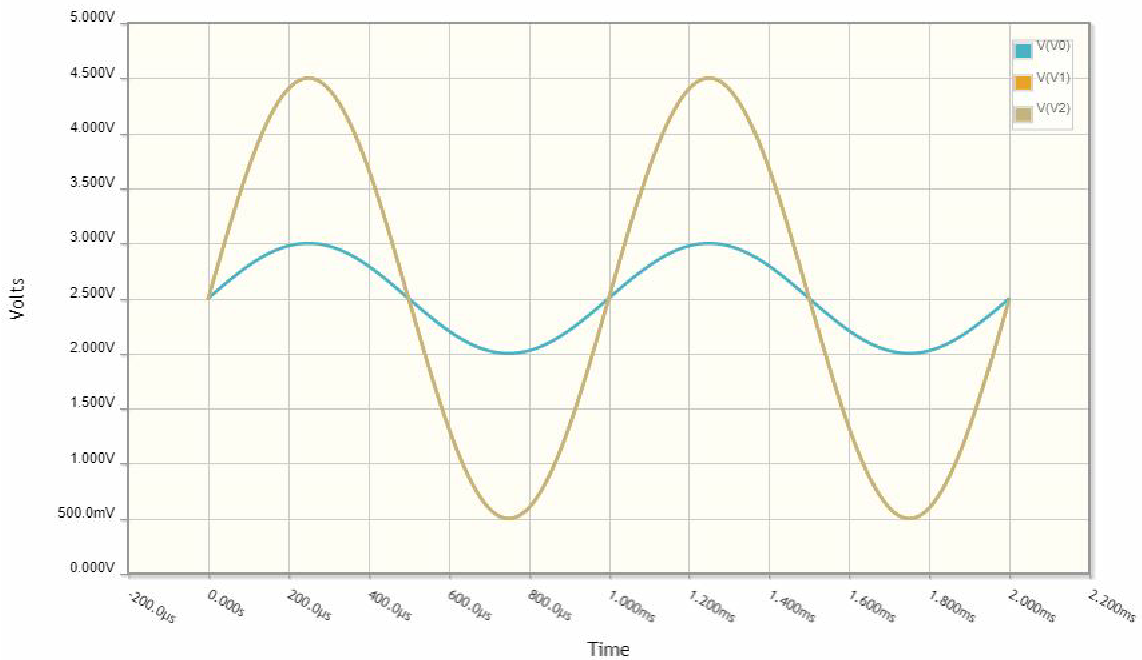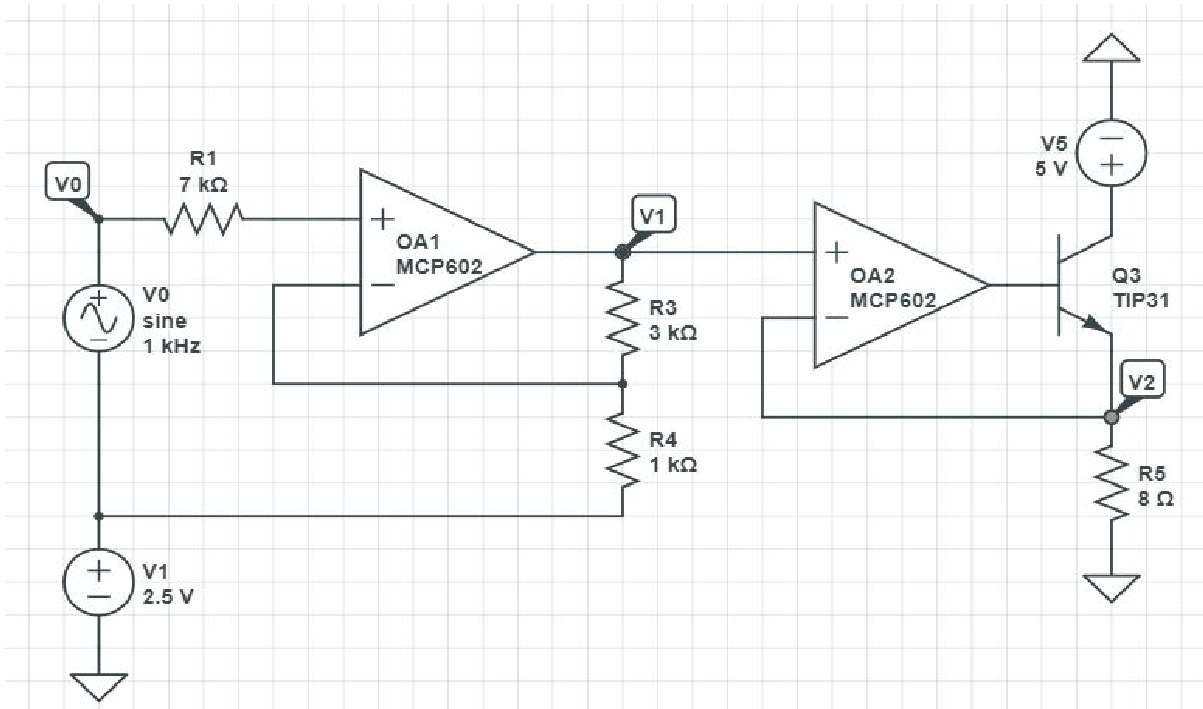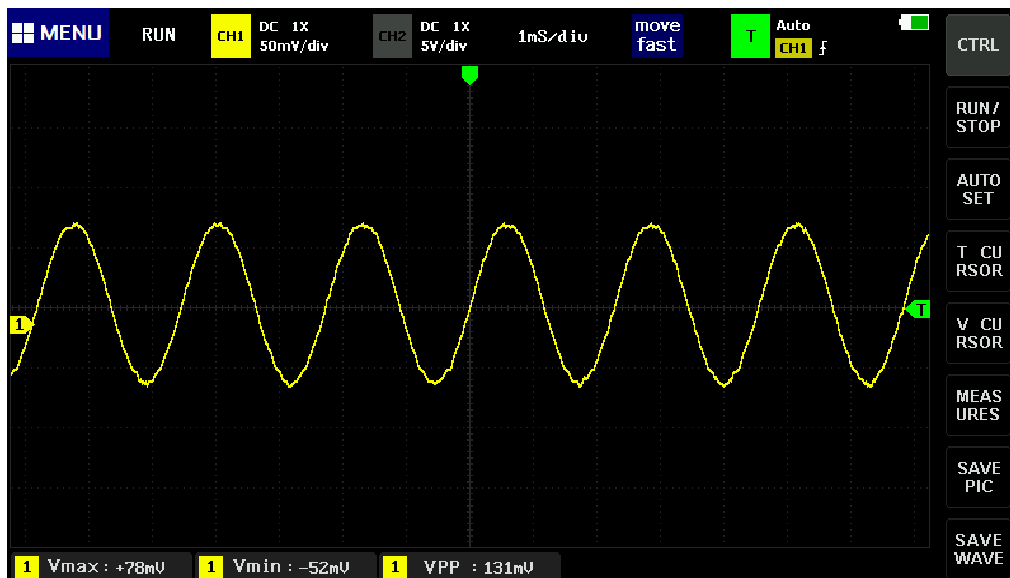
7) Build this circuit in hardware. With a sine wave input, (1kHz) verufy that that
   - V2 = 4*V1   (relative to circuit ground)
   - V3 = V2   (relative to circuit ground)

Using OnLineToneGenerator.com, a 440Hz sine wave was applied to the input
   - V1 = 44mVrms
   - V2 = 131Vrms sine wave
   - V3 = 131Vrms sine wave

8) Demo
- Replace V1 with an audio signal and verify the song plays on the speaker

Playing "Hot and Cold" by Elmo and Ms. Perry