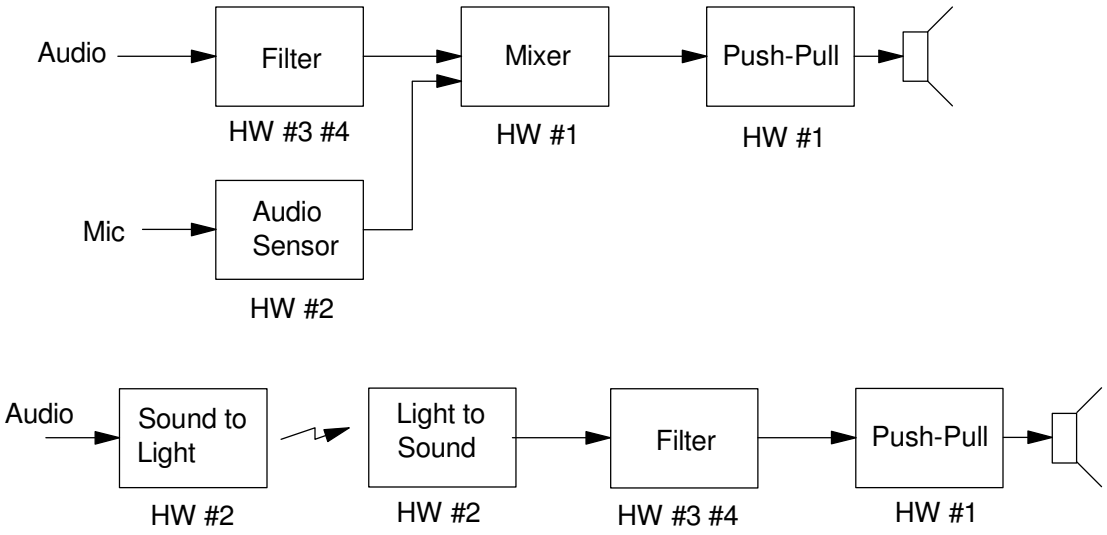
ECE 321 - Homework #1

Op Amp Amplifiers, Push-Pull Amplifiers. Due Monday, April 4th

Please make the subject "ECE 321 HW#1" if submitting homework electronically to Jacob_Glower@yahoo.com (or on blackboard)

1) Pick an amplifier to build for ECE 321 Analog Electronics. This amplifier needs to include
   - A speaker and a push-pull amplifier (homework #1)
   - An amplifier and/or mixer (homework #1),
   - A sensor (light, audio, temperature / 555 timer) and
   - A filter (homework #3 and #4),

Some suggestions are...



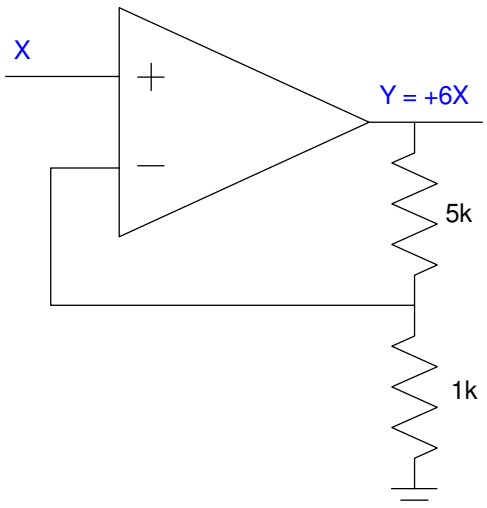
For all problems, assume you are using
- MCP602 Op Amps (max current = 50mA)
- 2SC6144 transistors (β = 200, 10A max, |Vbe| = 0.7V), or
- TIP112 / TIP117 NPN and PNP power transistors (for a push-pull amplifier).
  - β = 1000, 3A max, |Vbe| = 1.4V

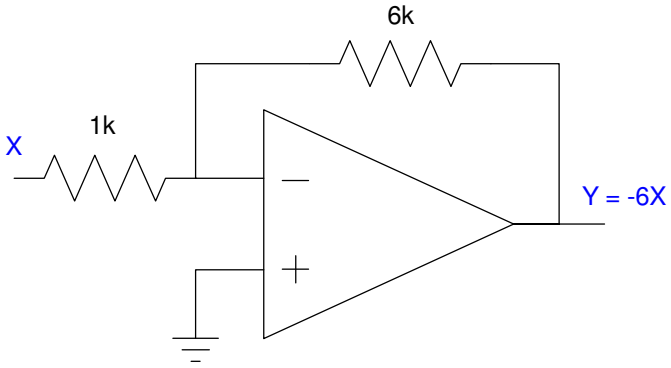
Amplfier:

Design a circuit to implement

2a) Y = +6X

2b) Y = -6X

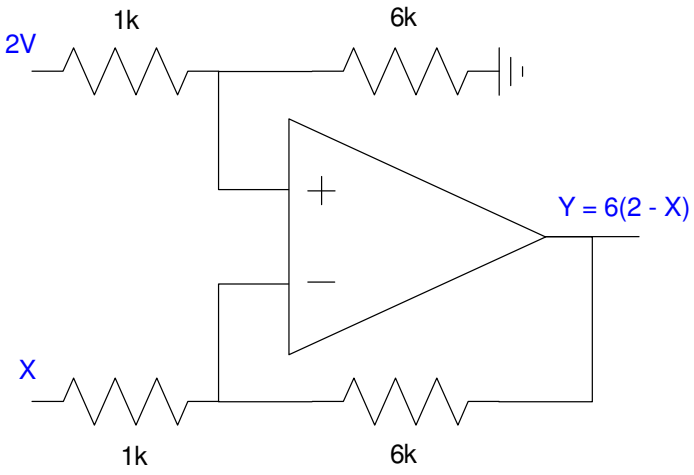




2c) Y = 12 - 6X

Rewrite as

$$Y = 6(2 - X)$$



Mixer

3) Design a circuit to mix three signals together:

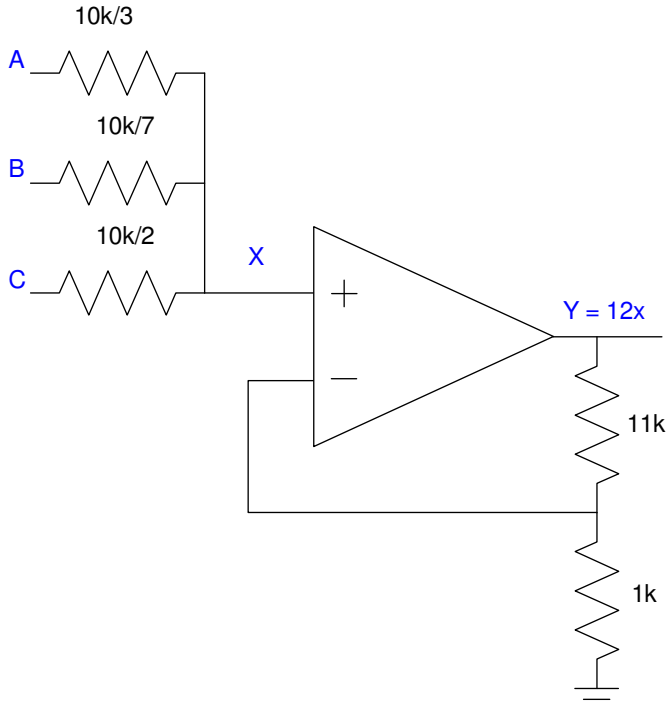
- Y = 3A + 7B + 2C

Rewrite as

$$Y = \left(\frac{3A+7B+2C}{12}\right) \cdot 12$$

$$X = \left(\frac{3A+7B+2C}{12}\right)$$

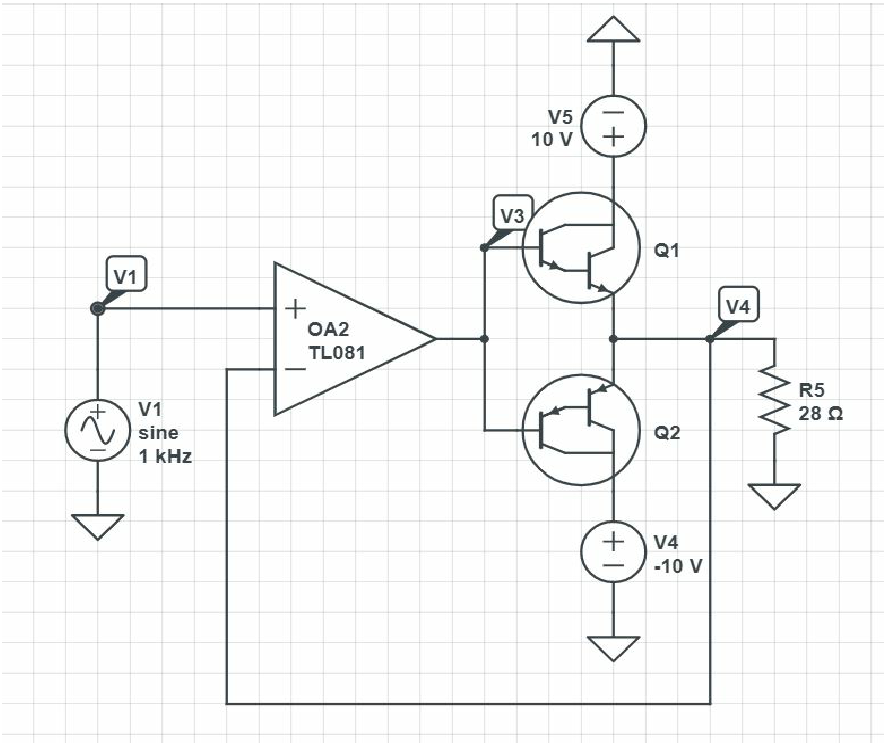
$$Y = 12X$$



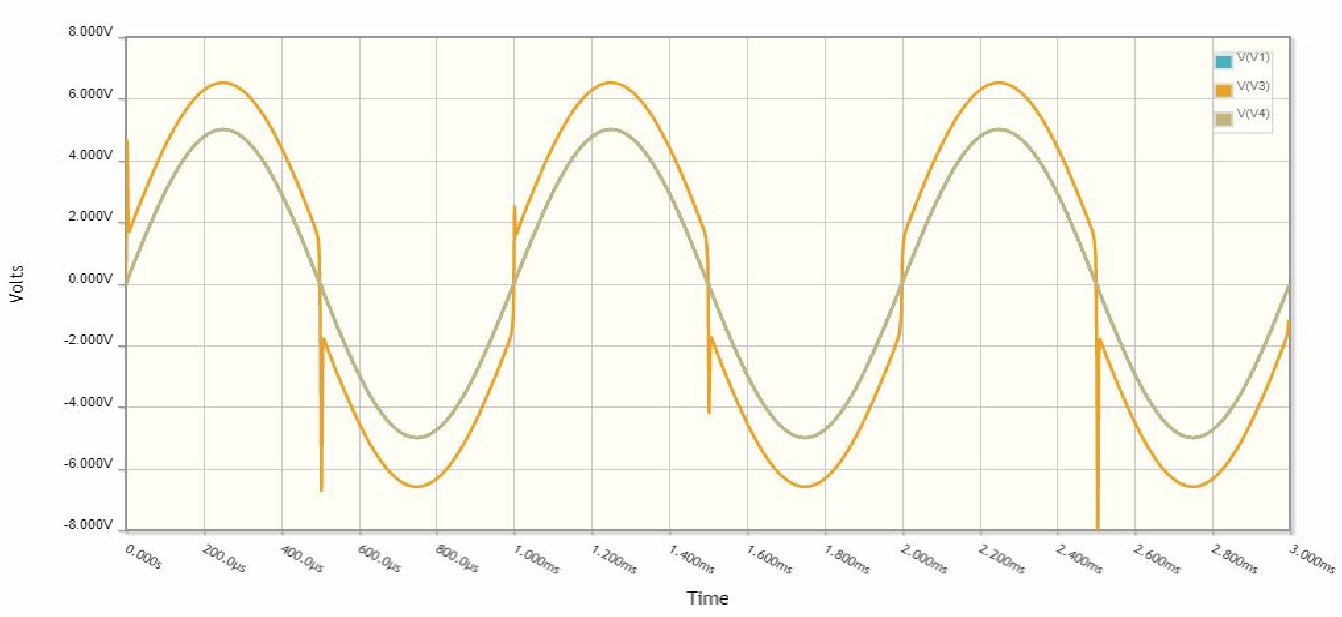
Push-Pull Amplifier

4) Design a circuit so that Y = X

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



5) Simulate in CircuitLab

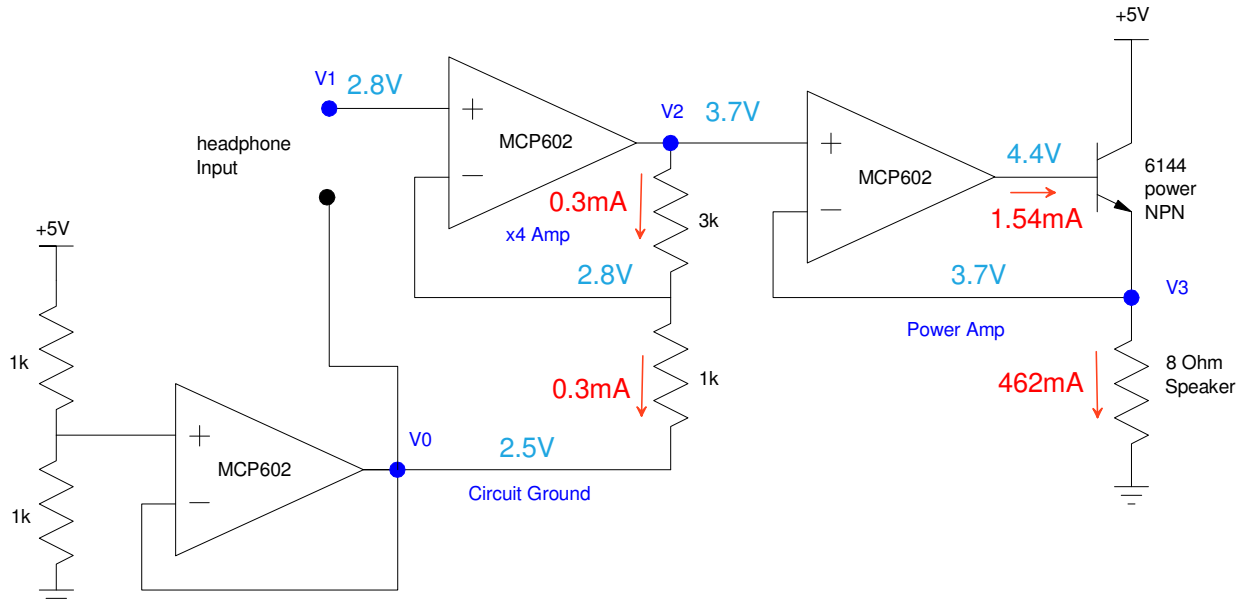


Lab (Hardware) -

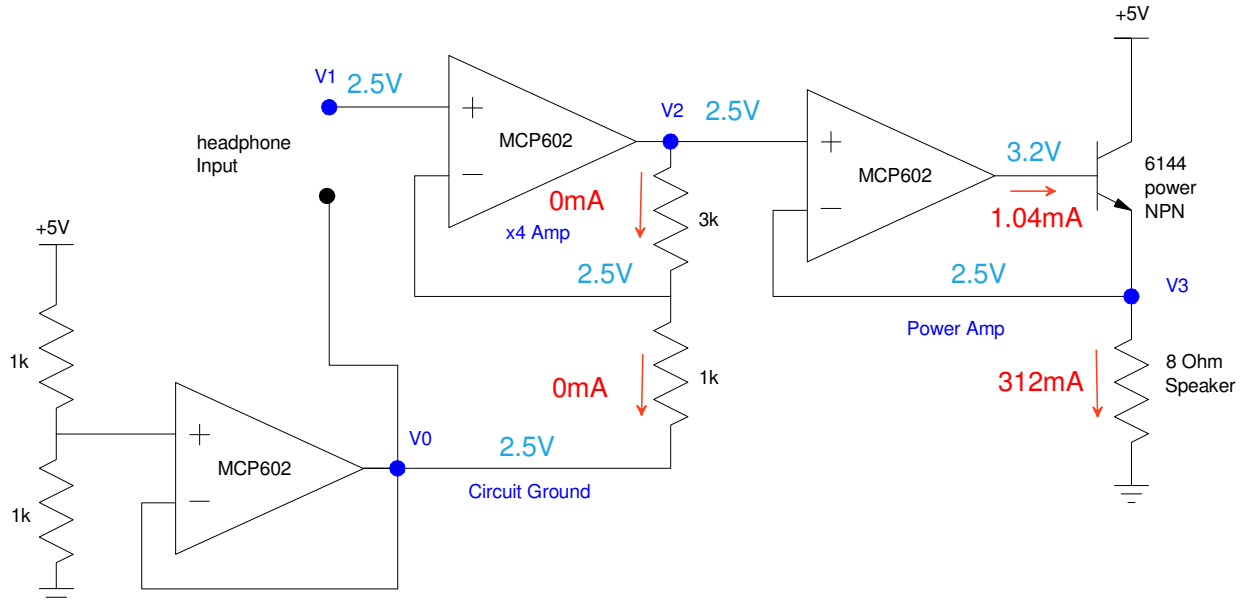
Option #1 (single +5V power supply)

6) Calculate the voltages and currents when

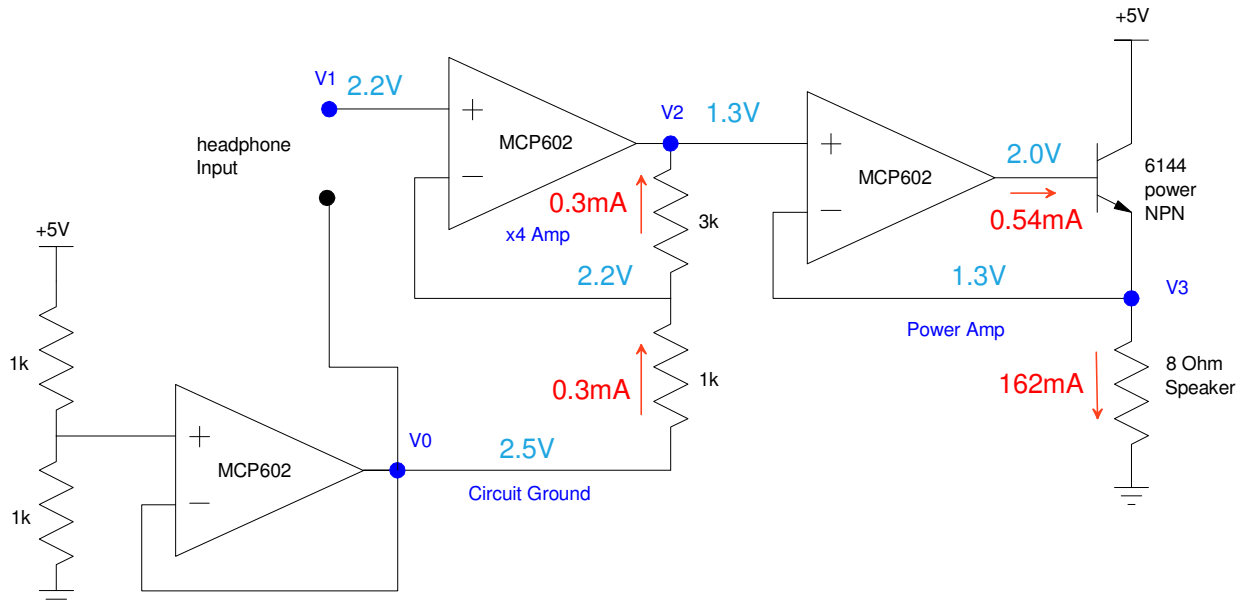
Vin = +0.3V relative to circuit ground (2.8V)



V1 = circuit ground (2.5V)

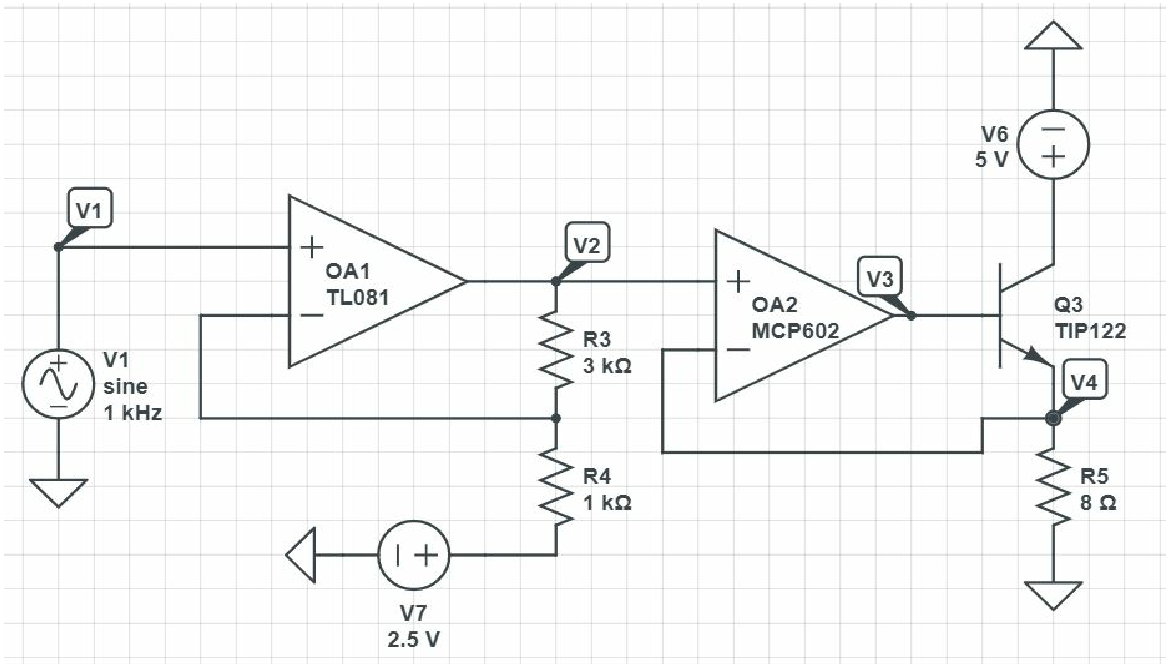


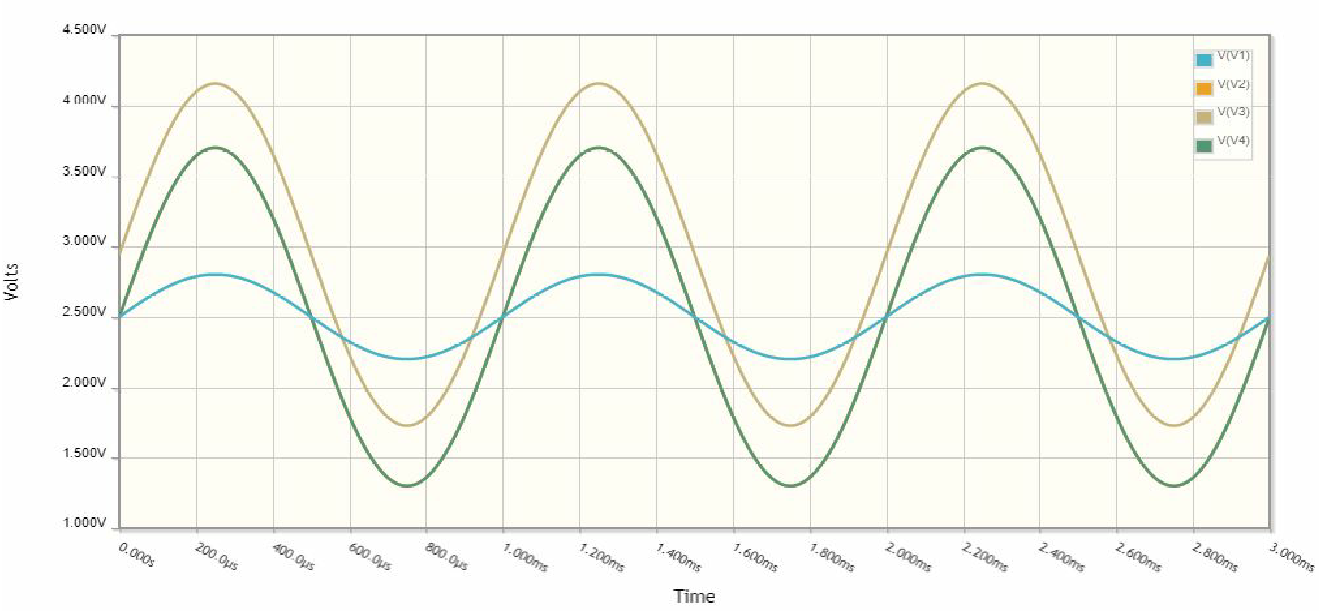
Vin = -0.3V relative to circuit ground (2.2V)



7) Simulate this curcuit in CircuitLab with

- V1 = 0.3Vp, 1kHz sine wave



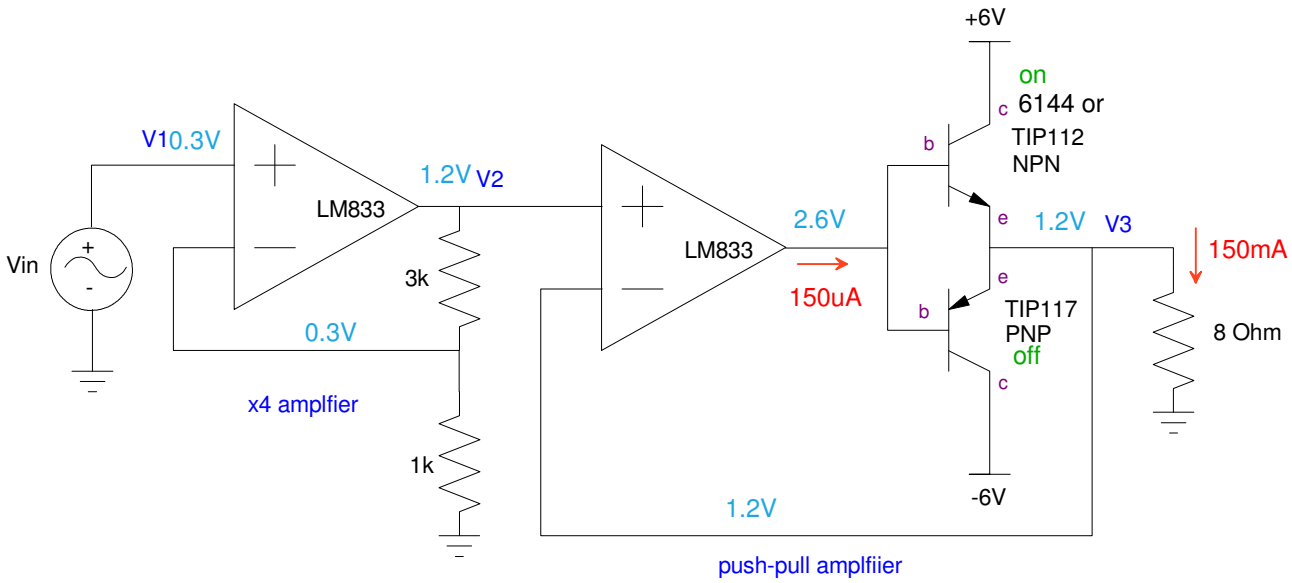


Option #2 (dual power supplies: +6V & -6V)

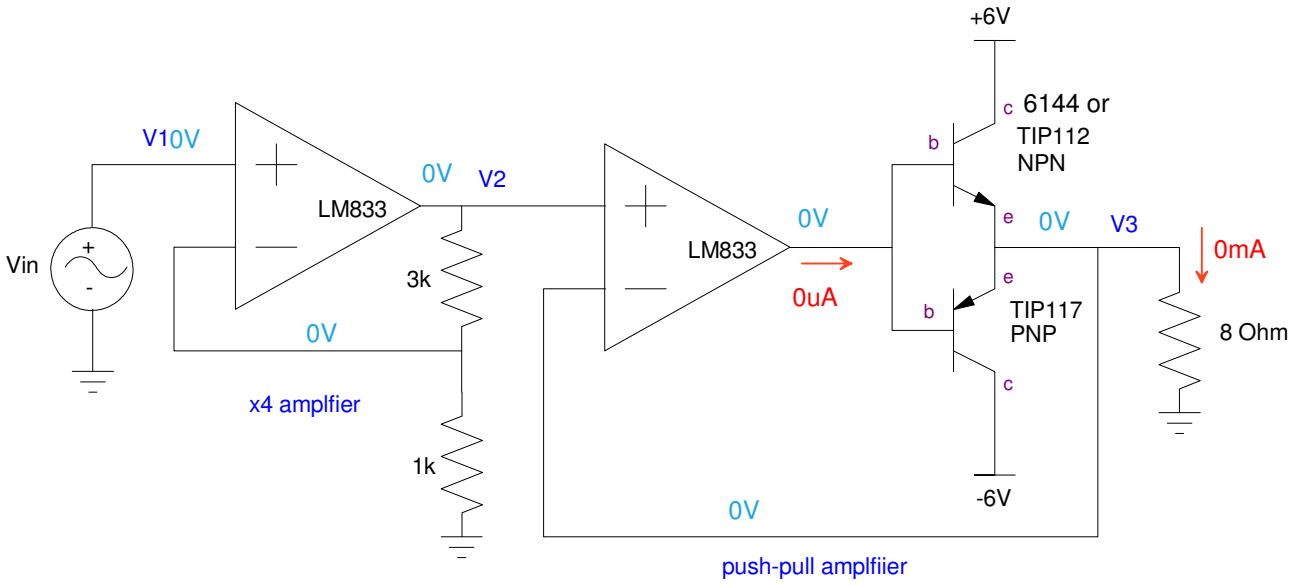
6) Calculate the voltages and currents when

Vin = circuit ground + 0.3V

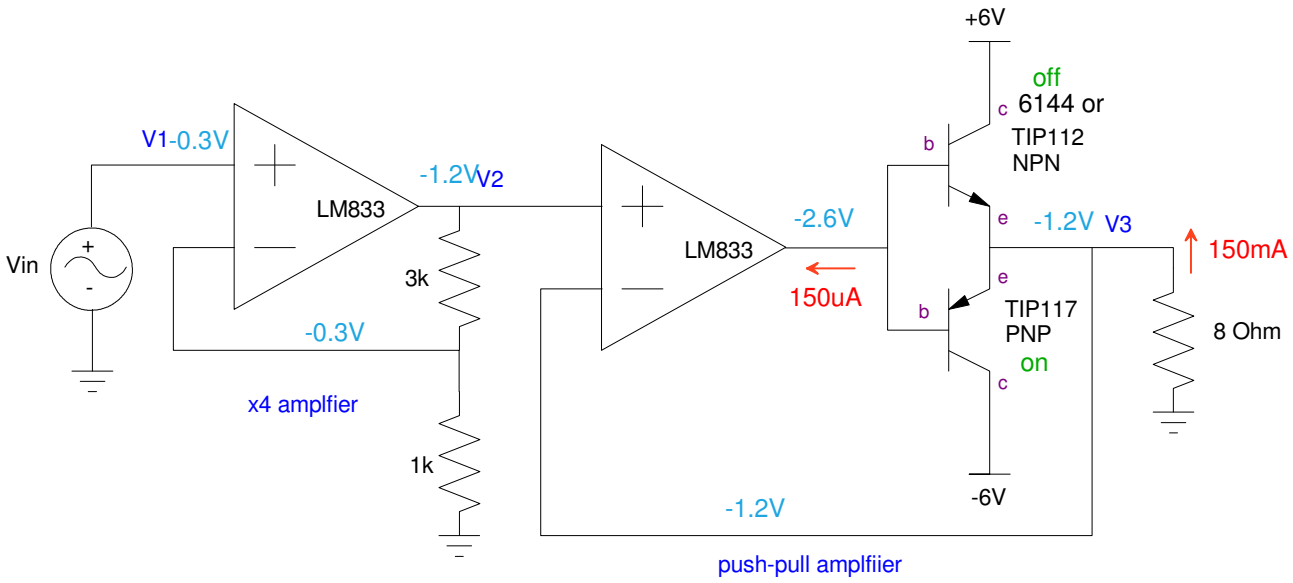
- Assume |Vbe| = 1.4V (Darlington pair)



V1 = circuit ground



V1 = circuit ground - 0.3V



Hardware: @ 600Hz

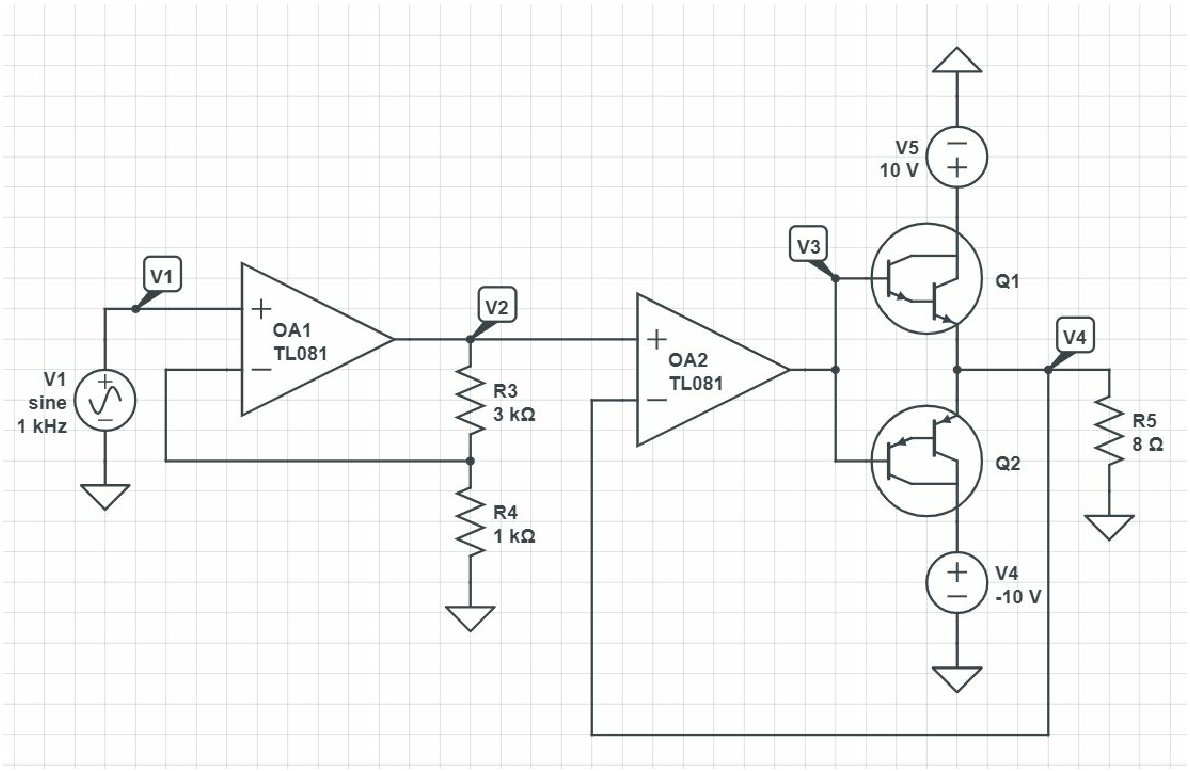
V1 = 168mVrms

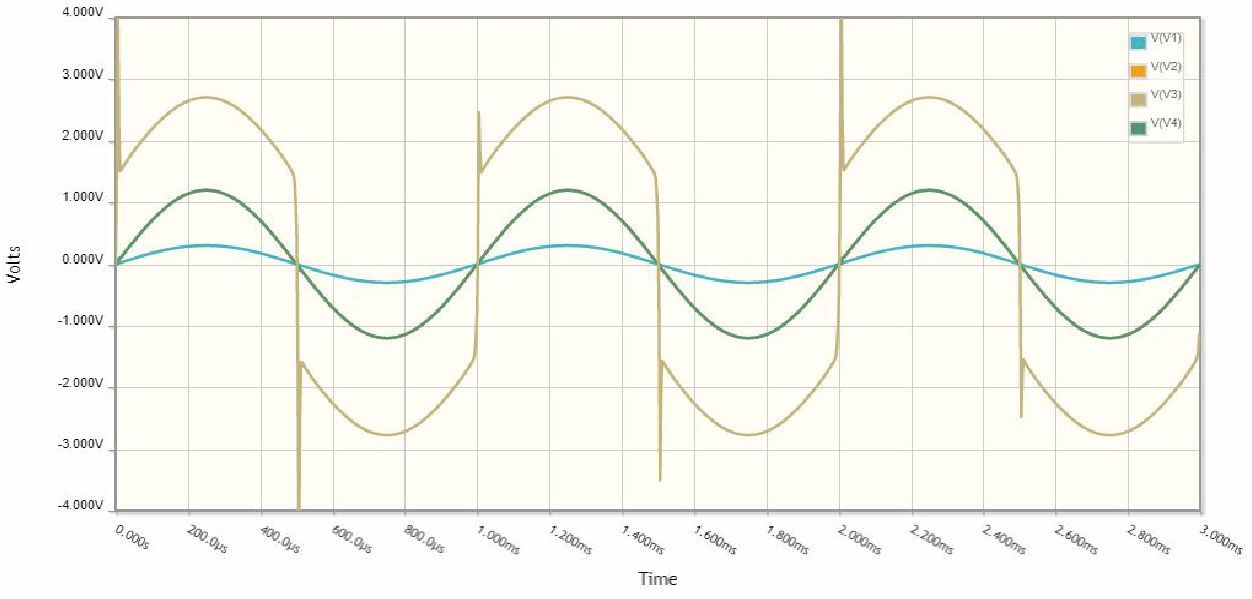
V2 = 686mVrms (x11 amp)

V3 = 680mVrms

7) Simulate this curcuit in CircuitLab with

- V1 = 0.3Vp, 1kHz sine wave





8) 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)

8) Demo

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