

ECE 321 - Homework #1

Op Amp Amplifiers, Push-Pull Amplifiers. Due Monday, April 6th

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

LM833 Op Amps (max current = 50mA)

TIP112 and TIP117 transistors

- $\beta = 1000$
- $|V_{be}| = 1.4V$ (Darlington pair)

Voltage Amplifier:

Design a circuit which mixes and amplifies two cell phones cell phone to -10V to +10V (analog), capable of driving an 8 Ohm speaker at 12.5 Watts.

Problem 1) Design an amplifier which mixes and amplifiers audio signal from two cell phones:

Input (V_a and V_b): Two cell phones

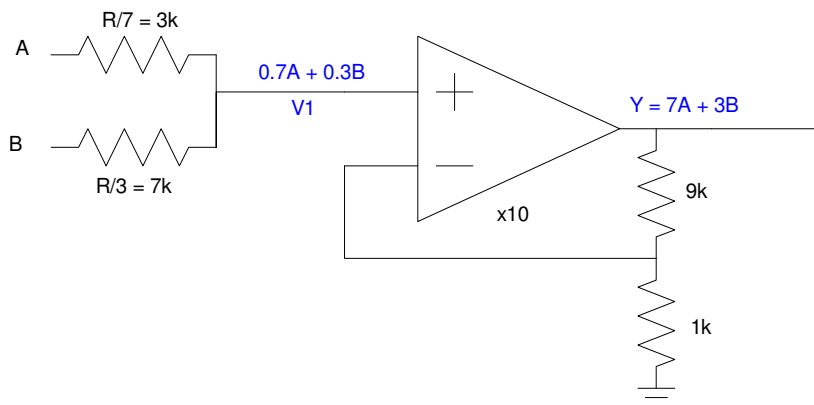
- 1Vpp AC signal
- 20 - 20kHz
- Capable of driving 1mA @ 1Vpp *meaning keep the input resistors larger than 1k*

Output: 1k resistor (worst case: 10mA @ 10V) *meaning an op-amp can drive the load directly*

Relationship

$$V_1 = 7V_a + 3V_b$$

Let $R = 21k$ (arbitrary)



Problem 2) Design push-pull amplifier to connect the output of problem #1 to an 8-Ohm speaker:

Input: V1

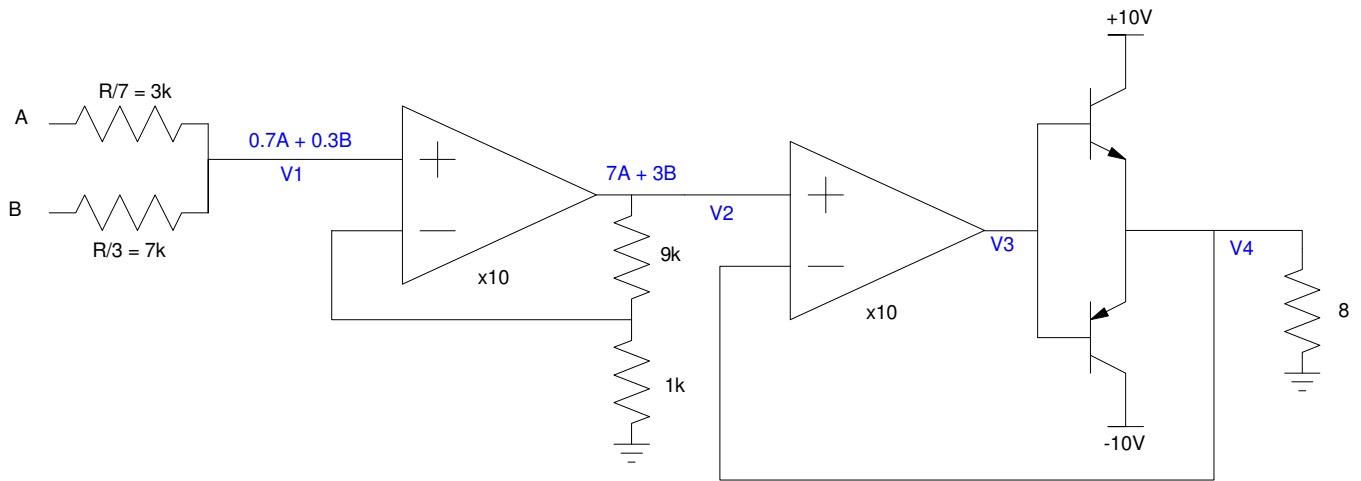
- 10Vpp AC signal
- 20 - 20kHz
- Capable of driving 10mA @ 1Vpp

Output: V2

- 8 Ohm speaker

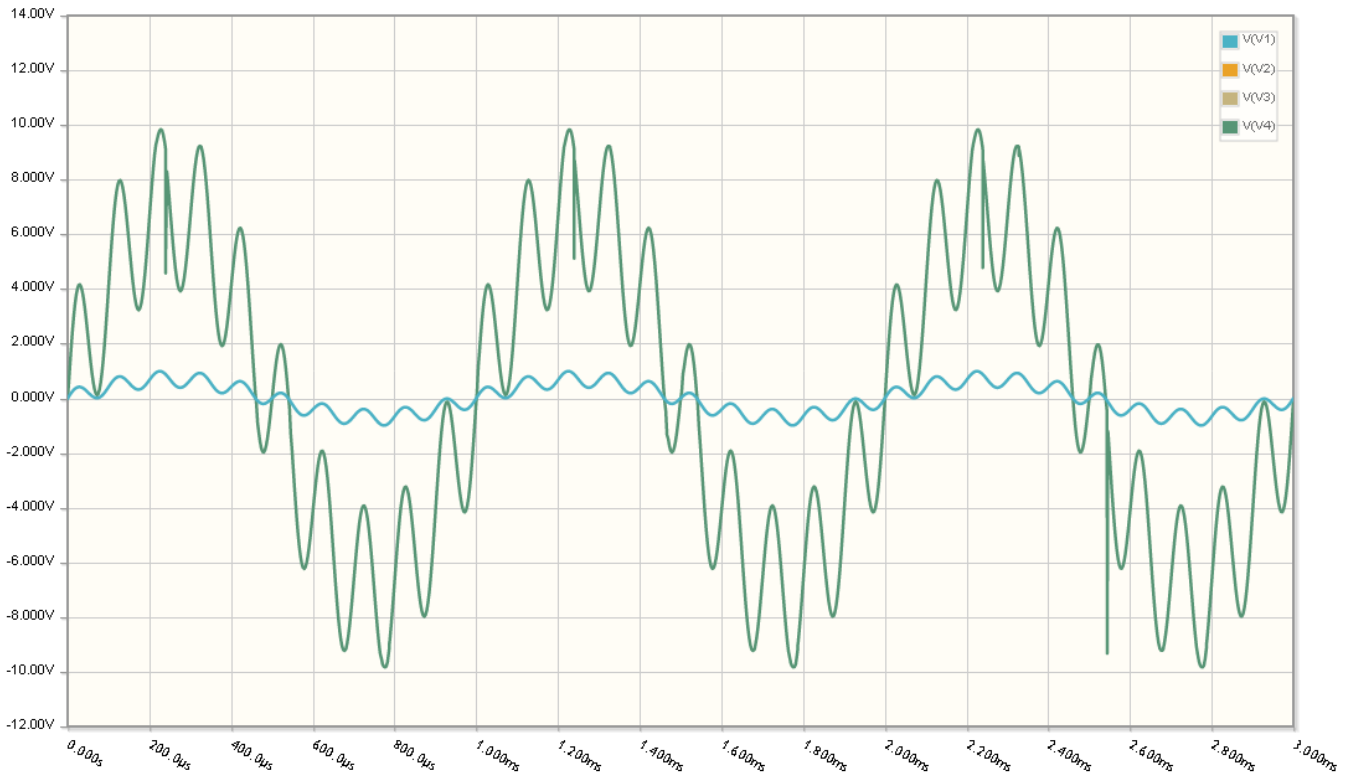
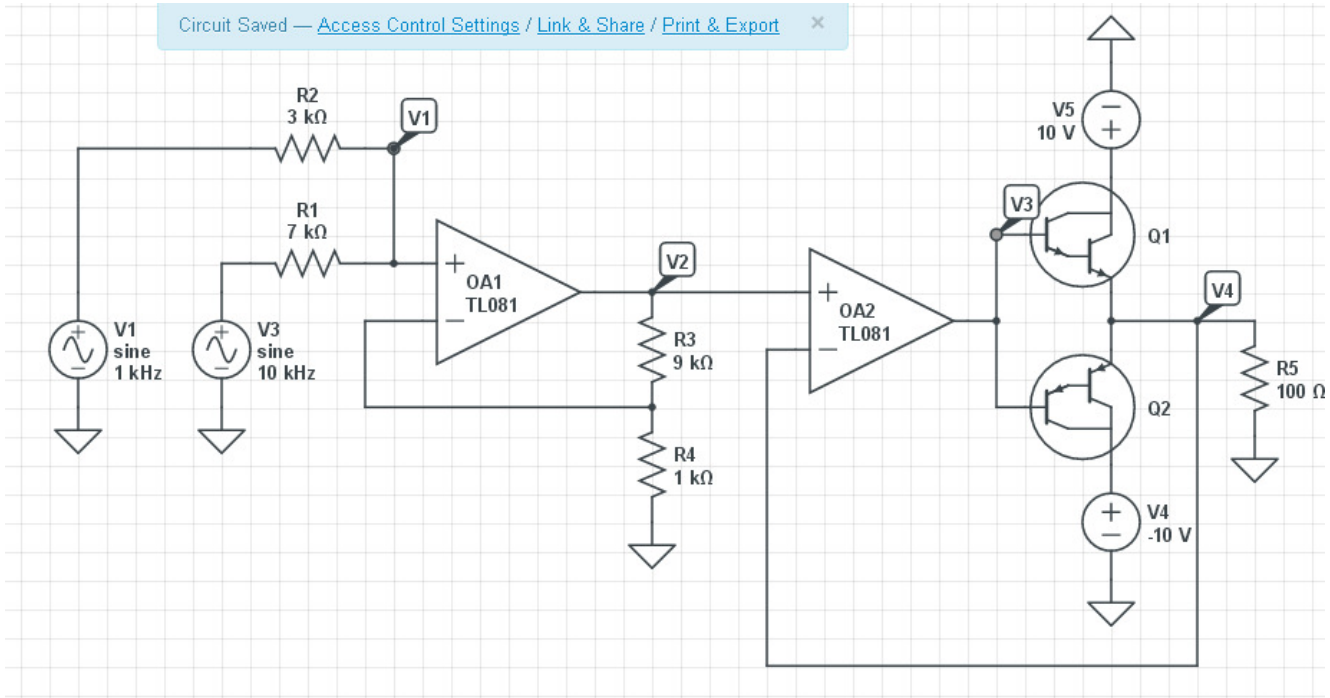
Relationship:

$$V_2 = V_1 \quad \text{i.e. no crossover distortion}$$



Problem #3: Simulate problem #1 and #2 in CircuitLab and verify that

- $V_2 = 7V_a$ (set $V_b = 0$)
- $V_2 = 3V_b$ (set $V_a = 0$)
- $V_2 = 7V_a + 3V_b$ (both V_a and V_b are on)



Current Amplifier:

Problem #4) Design a push-pull amplifier to take the output of problem #1 and drive an LED where the current is proportional to the voltage at V1

Input: V1

- 10Vpp AC signal
- 20 - 20kHz
- Capable of driving 10mA @ 1Vpp

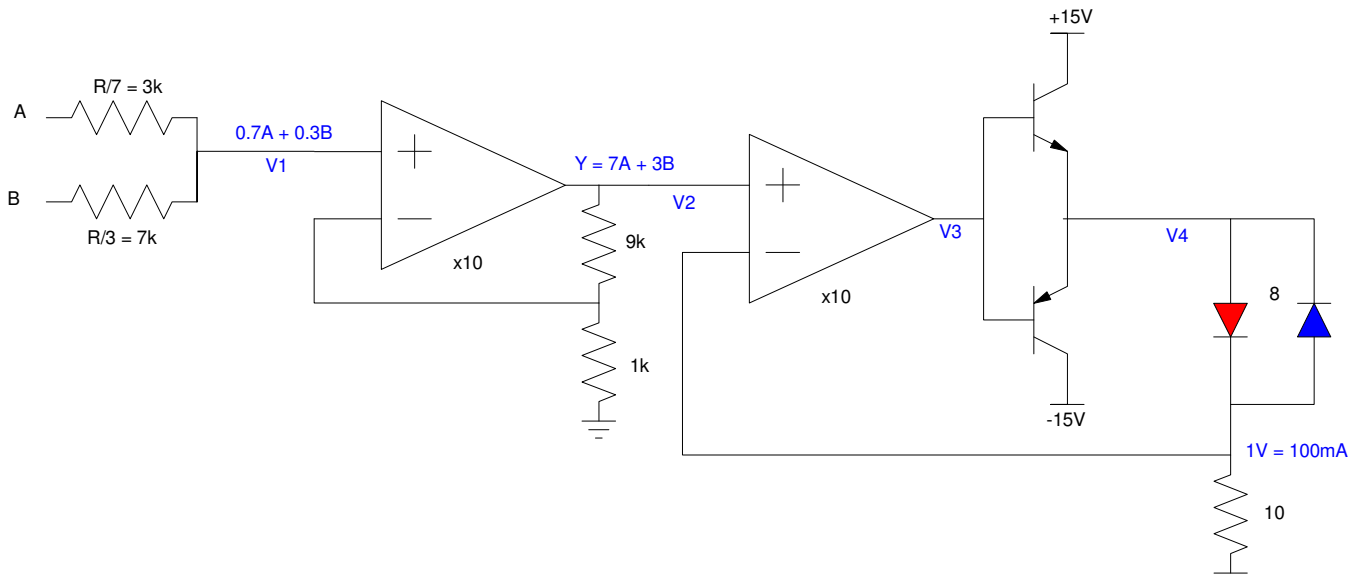
Output:

- Red LED (V1 > 0)
- Blue LED (V1 < 0)

Relationship:

- The current through the LED is

$$I_d = 100V_1 \text{ mA}$$



Problem #5: Simulate problem #1 and #4 in CircuitLab and verify that

- $I_d = 700V_a$ (mA) (set $V_b = 0$)
- $I_d = 300V_b$ (mA) (set $V_a = 0$)
- $V_2 = 700V_a + 300V_b$ (mA) (both V_a and V_b are on)

