PreLab 3 – Audio Amplifier Design and Prototyping

GOAL

The overall goal of Lab3 is to build a battery powered audio amplifier.

OBJECTIVES

Lab3a: (1) Design an audio amplifier using an op amp and Class AB stage.
(2) Build a prototype on a breadboard.
(3) Test your prototype to validate your design.

Lab3b : (1) Build a soldered version.
(2) Demonstrate a working amplifier.

GENERAL GUIDELINES

1) Students are allowed (even encouraged) to work together. **However, you must turn in your own work!**
2) Prelabs count for 10% of the total lab grade.
3) Prelabs are due at the beginning of the lab session. Prof. Hedrick will immediately grade the prelabs using the following binary rubric: reasonable effort = 10 pts, poor effort = 0 pts.

INTRODUCTION

The overall goal of Lab3 (two weeks) is to build a battery-powered audio amplifier. You get to keep the soldered version of your amplifier (includes audio cable and speaker)! The overall specifications are the following:

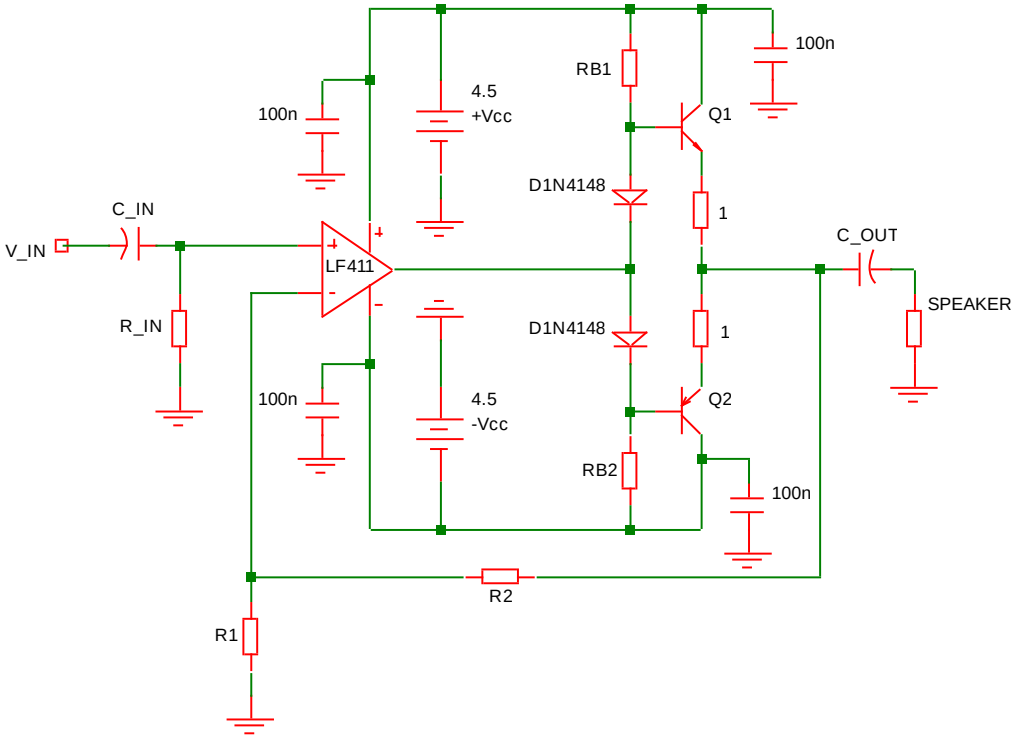
1) +/- V_{CC} = +/- 4.5V
2) Overall voltage gain $\geq$ 10 from 400 Hz to 4 kHz
3) Input impedance $R_{IN} \geq 50$ kΩ
4) Drive a 16 Ω speaker with up to 125 mW.

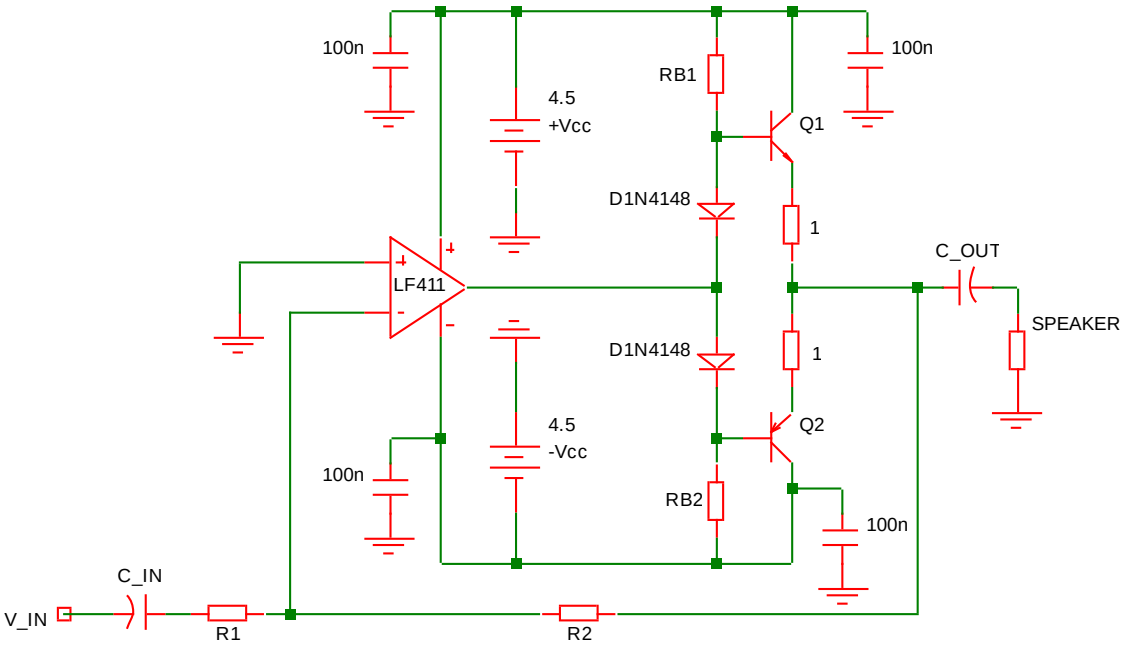
Some other circuit features are the following:

1) The signal source is capacitively coupled to the amplifier.
2) The input coupling capacitor should produce a roll-off frequency $\leq$ 4 Hz.
3) Use an op amp + Class AB push-pull output stage.
4) Use a LF411 JFET-input op amp (this has a low input offset voltage).
5) Use 1N4148 biasing diodes
6) The Class AB push-pull stage has 1 Ω emitter resistors.
7) The speaker is capacitively coupled to the output stage.
8) The output coupling capacitor should produce a roll-off frequency $\leq$ 40 Hz.

AMPLIFIER DESIGN

Many amplifier designs are possible, but two reasonable choices are (1) a non-inverting op amp + Class AB stage (2) an inverting op amp + Class AB stage. Example circuit diagrams for each are provided below:





Your design calculations should include the following:

- Choice of Q1 (2N3904, 2N4401, or TIP31A). The TIP31A is a power transistor (datasheet on course website).
- The pnp version of the above transistors are (2N3906, 2N4403, or TIP32A).
- Adequate power rating of Q1 (assume Q2 is the same).
- Choice of RB1 and RB2 (choose standard value).
- Confirmation that the LF411 will provide the desired max output with +/- V_{CC} = +/- 4.5V.
- Choice of (R_{IN}, R1, R2) for non-inverting amplifier
- Choice of (R1, R2) for inverting amplifier.
- Choice of C_{IN} (choose standard value). Note that $f_C = 1/(2\pi R_{IN}C_{IN})$.
- Choice of C_{OUT} (choose standard value). Note that $f_C = 1/(2\pi R_{LOAD}C_{OUT})$.
- Multisim simulation of the entire circuit.
    - Provide the schematic.
    - Perform transient simulations at 400 Hz, 1 kHz, and 4 kHz.
    - Provide waveforms of V_{IN} and V_{OUT} for all three cases.
    - Compute the voltage gain V_{OUT}/V_{IN} for all three cases.
    - Measure the input impedance Z_{IN} for all three cases. Remember that $Z_{IN} = V_{IN}/I_{IN}$.
    - Make sure your simulation results satisfy the design requirements!

- **Show your calculations and simulations to Prof. Hedrock.**

- **Do not worry if your calculations and/or simulations are not complete by the start of the lab session. Prof. Hedrick will grade the prelab based on effort. Having said this, you will receive a zero if you present little to no work.**

(End of PreLab3)