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# Design Project: Progress Report 1

## Objectives/Application:

**Describe the purpose of your system (audio amplifier system) and the specifications and goals.**

The purpose of this system is to be able to input an audio signal into a three-stage amplifier that we will design, simulate, build, and test. The goal is for the output of the system to be able to be produced into a speaker that can accurately relay the audio results.

To design the amplifier from scratch, we assumed several values. We decided that our DC component ($V_{CC}$) would be 12 V. We also determined that our voltage drop across $R_E$ = 400 mV. Values that are also assumed are $V_T$ = 25 mV, $I_E$ = 1 mA, $\beta$ = 100, $V_A = \infty$, $\beta /(1+\beta) = 1$, and $V_{BE}$ = 0.7 V. The gain $A_{V1}$ = -15.6 from the first stage, $A_{V2}$ = -16.8 after the second stage, and $A_{V3}$ = 1 (all decoupled from the load). Stage 3 is a buffer stage intended to drive the output load without more amplification of the input.

**Describe what would be the application for your designed system? Where/how would it be used?**

The application for our designed system would be to be able to amplify any weak audio signal that may come from a phone or laptop, and increase it enough to power an 8 Ohm speaker. Since the design is a multi-stage amplifier with impedance bridging, it should be suitable for real-world applications without the possibility of damaging other electronics. This is possible through the coupling capacitors, which limit the DC voltage that comes from $V_{CC}$ from being amplified so that the gain is not high, and therefore there is not enough voltage to damage an electronic, like a speaker.

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**Circuit Schematic/Description:**

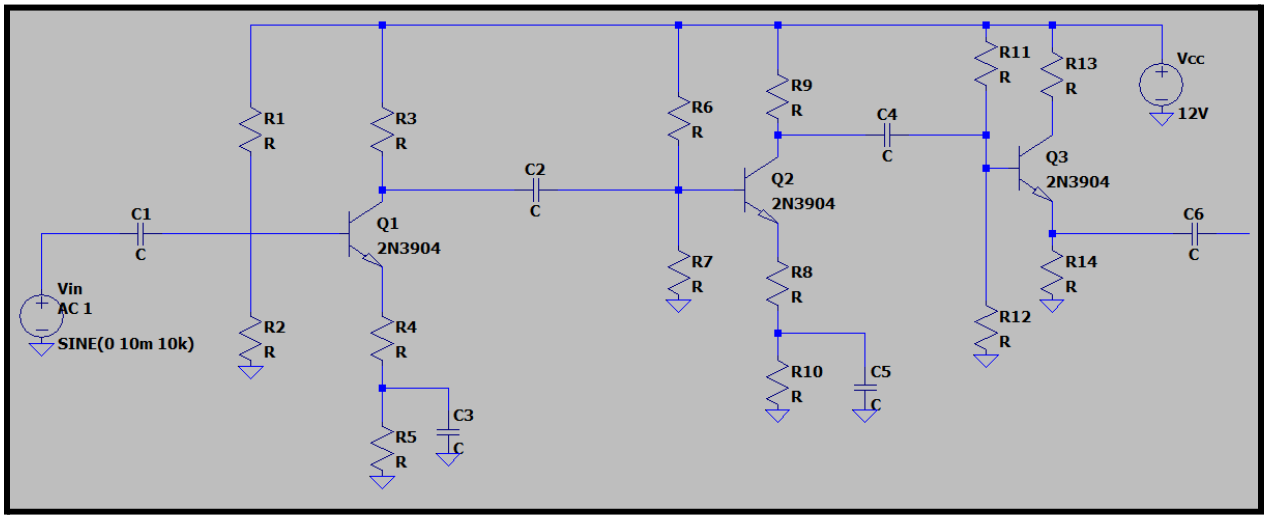


Figure 1: Three-Stage Amplifier Schematic

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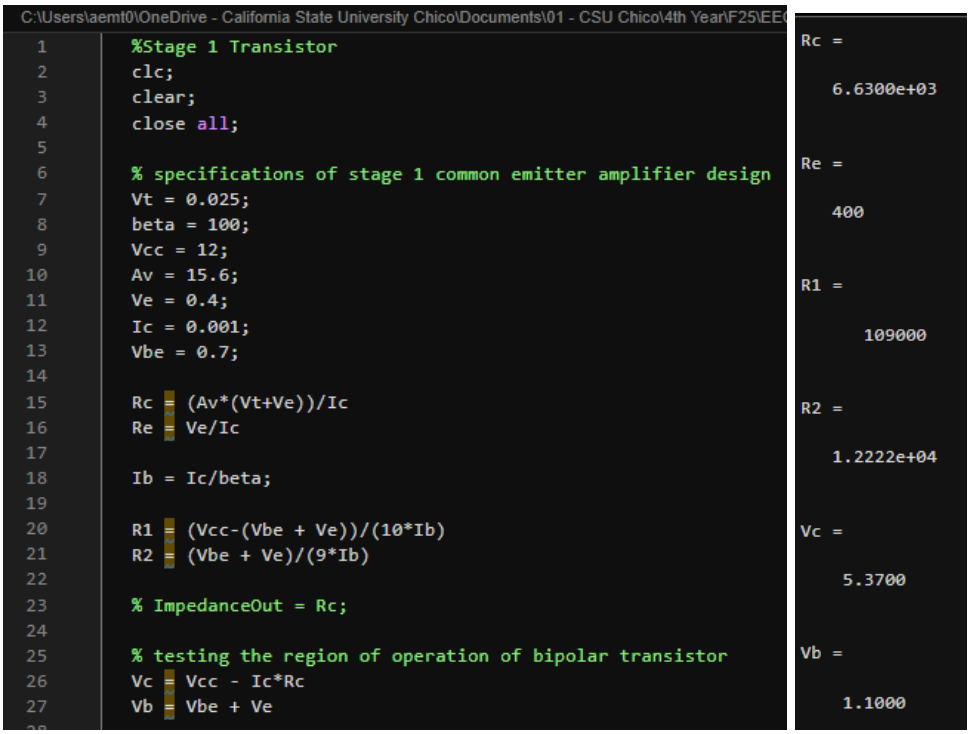


Figure 2: MATLAB Calculations for Stage 1 Amplifier

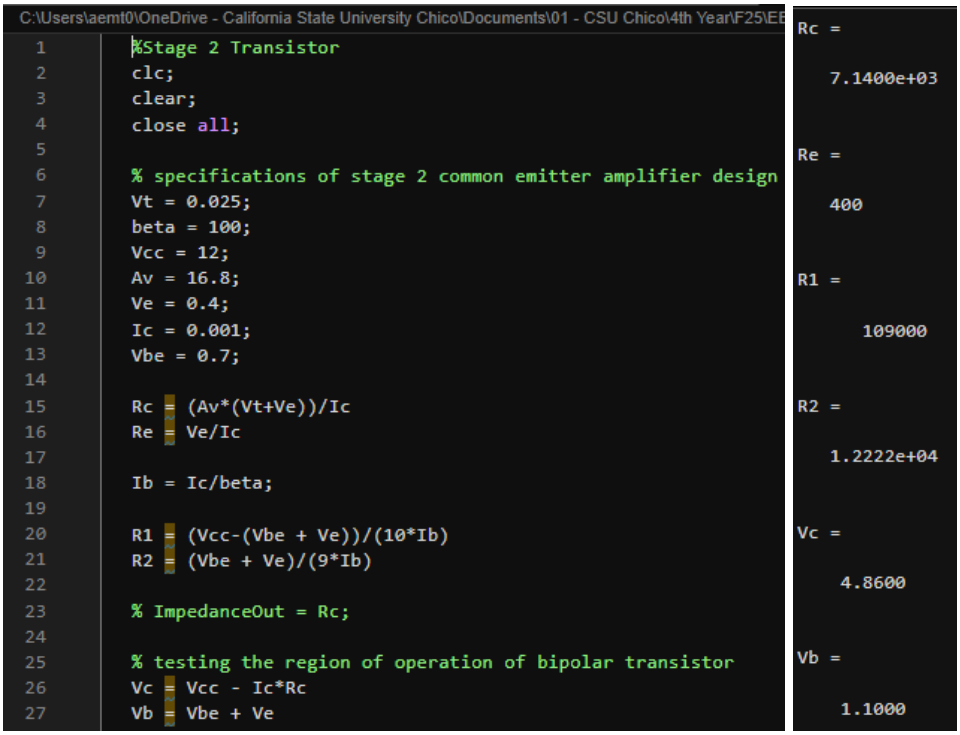


Figure 3: MATLAB Calculations for Stage 2 Amplifier

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After the MATLAB scripts were created for both Stage 1 and Stage 2, the resistor values were used to create circuit schematics in LTspice for both stages. It was worth noting that nearly all resistor values stayed the same. The only different resistor value was $R_C$, which changed from 6,630 Ohms to 7,140 Ohms from Stage 1 to Stage 2. This was due to the new $A_V$ value needed for Stage 2, which was -16.8 instead of -15.6.

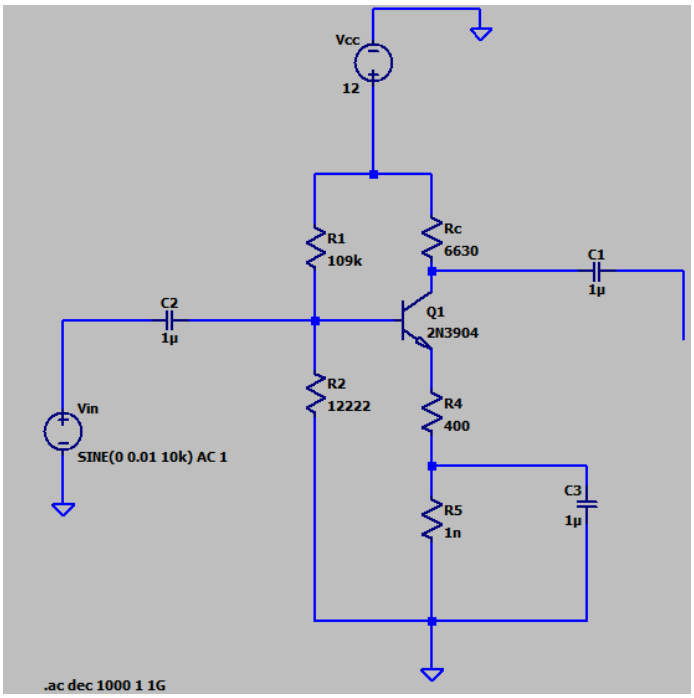


Figure 4: LTspice Schematic for Stage 1 (Decoupled)

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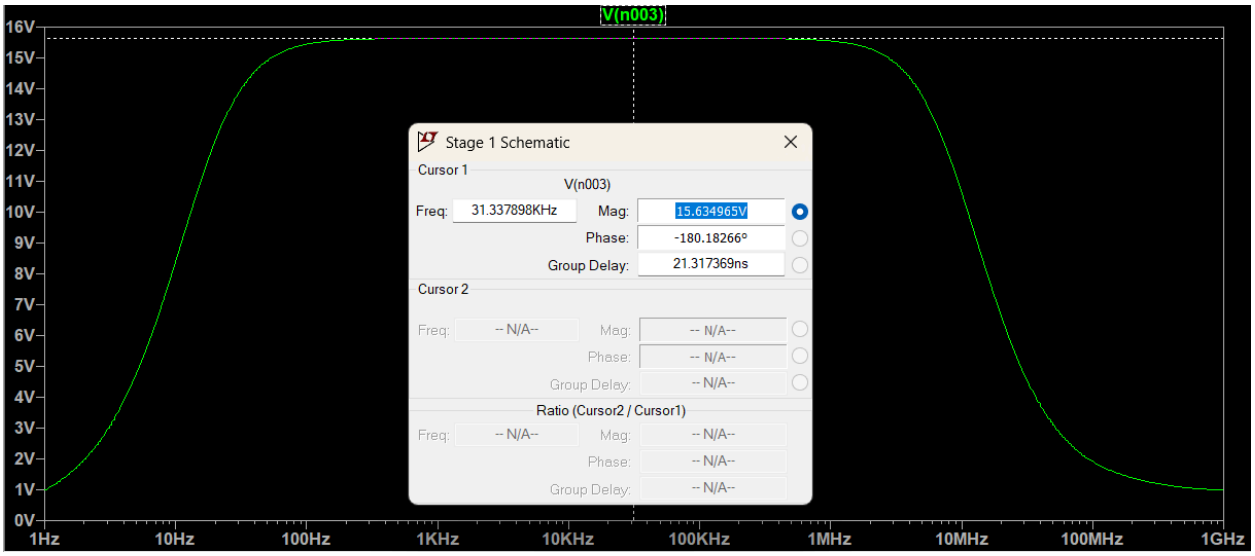


Figure 5: Bode Plot Showing Gain for Stage 1 Amplifier

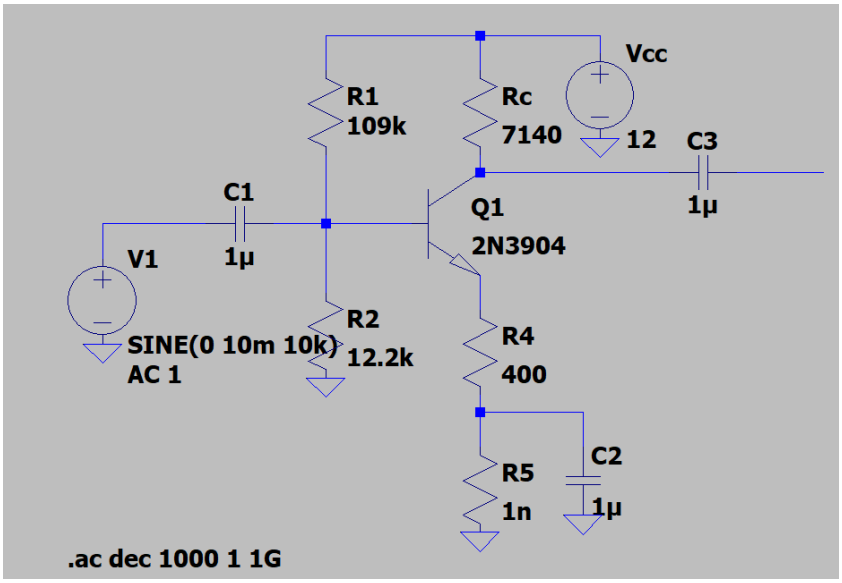


Figure 6: LTspice Schematic for Stage 2 (Decoupled)

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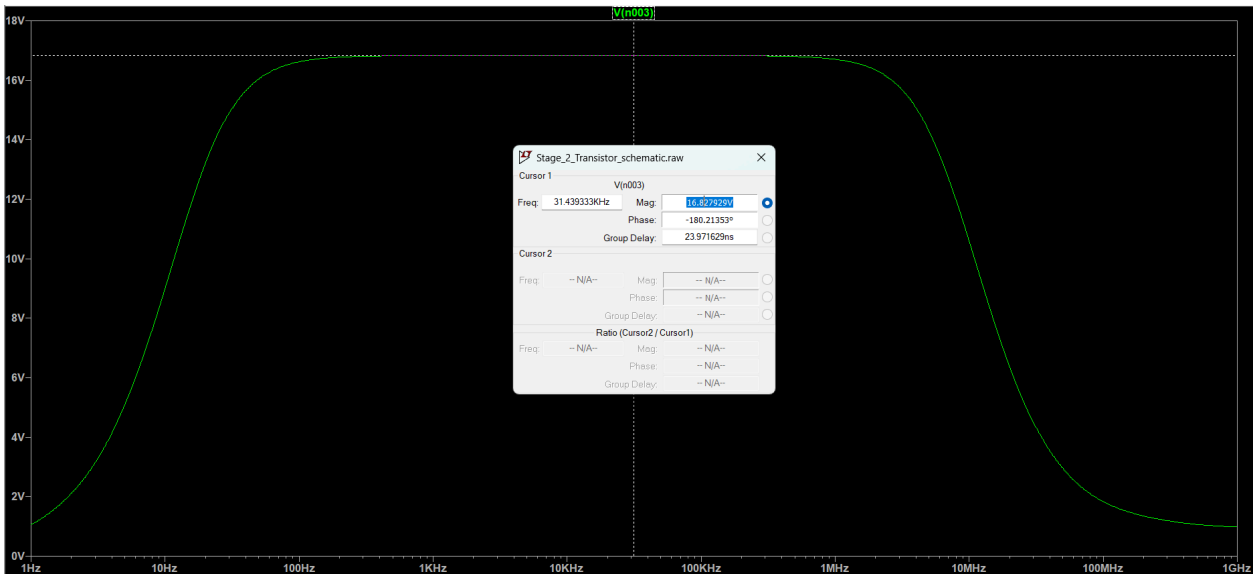


Figure 7: Bode Plot Showing Gain for Stage 2 Amplifier

After our first progress report, we have designed our schematic for our audio amplifier, done theoretical analysis to find equations to put into MatLab, written LtSPICE netlists and schematics, and more. In doing so, there were many specifications that we had to assume, and we were even given certain values in the design prompt.

After completing the MatLab equations, we ran the .m file to get our resistor values, which we then plugged into LtSPICE to find our gain and other values. After confirming our theoretical values and simulation values, we knew that our design was right as of the decoupled stage 1 and 2. This gave us confidence in our current amplifier design and allowed us to move on further through our first go at this schematic.

In this progress report, we have shown our understanding of a BJT audio amplifier. In doing so, we have given resistor values and netlists with gain for stage 1 and 2, and are working on stage 3 currently. Soon, we will have all three decoupled theoretical work done and will move on to impedance bridging.

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Team Contribution:

Adrian completed the first two bolded questions, along with doing the spice simulation for Stage 1 and the comment under figure 3.

Carson completed the schematic of the whole audio amplifier, along with the spice simulation of Stage 2. He was also in charge of the text below all of the figures.