Lab 4: Sensing Part 1

EECS 16B Fall 2023

Slides: http://links.eecs16b.org/lab4-slides
Administrivia

- What’s that

I AM ONCE AGAIN ASKING YOU TO CHECK THE LAB CHECKOFFS GRADESCOPE
Lab 4 Overview

- Build and test mic board circuitry
  - Build biasing circuit
  - Tune mic board
  - Measure the frequency response of the speaker-microphone system
  - Build Low Pass Filter
BREADBOARD LAYOUT
A Powerful Note

- Do NOT power the 5V rail from the 5V output from the power supply.
- Instead, use the 9V input rail to power the 9V → 5V regulator which will power everything related to 5V off the rails.
- Ensure your power rails are still 5V before starting.
Mic Board Circuitry

An annoyingly loud journey
What’s a Mic Board?

Mic board circuits pick up voice and sound signals and then convert them into electrical signals, which are amplified.
Mic Board Schematic

We're building this!
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2. **Buffer**
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2. Buffer
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3. Removing Mic Drift
   - The 1μF capacitor is a coupling capacitor, meaning it serves as a short to AC voltage but blocks DC voltage. Used to remove unpredictable mic offset so we can add our own via OS1
   - OS1 - centers signal at 2.5V. Connected through a 100kΩ resistor, since OS1’s voltage isn’t equal to our signal.
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3. **Removing Mic Drift**
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4. **Non-inverting amplifier**
   - Uses a potentiometer for variable gain
   - **OS2** - serves as a virtual ground so we don’t amplify the 2.5V offset
Review: Potentiometers

- Wiper divides resistive material, creating two resistors with variable length
- Resistance is proportional to length, so wiper changes the resistance ratio!
- Resistors form a voltage divider
Low Pass Filter Derivation

\[ V_{out} = V_{in} \cdot \frac{Z_c}{Z_R + Z_c} = V_{in} \cdot \frac{1}{R + j\omega C} = V_{in} \cdot \frac{1}{j\omega RC + 1} \]

\[ \frac{V_{out}}{V_{in}} = H(j\omega) \text{ and cutoff frequency is at half power, where } \frac{V_{out}}{V_{in}} = \frac{1}{\sqrt{2}} = 0.707. \]

\[ |H(j\omega)| = \frac{1}{\sqrt{2}} = \frac{\sqrt{1}}{\sqrt{(\omega RC)^2 + (1)^2}} = \frac{1}{\sqrt{1 + (\omega RC)^2}} \]

\[ 2 = 1 + (\omega RC)^2 \]
\[ 1 = \omega RC \]

\[ \omega = \frac{1}{RC} \text{ angular cutoff frequency} \]
\[ f_c = \frac{1}{2\pi RC} \text{ cutoff frequency} \]

Everything that is less than \( f_c \) gets through. Note that our cutoff isn't clean & perfect because the attenuation is gradual.
We use a unity gain buffer in between the LPF and LED to prevent loading.

If your LED is not lighting up, but based on the waveform generator your frequencies are attenuating properly, change the unity gain buffer into a non-inverting amplifier. You may use any reasonable gain of choice.
REMINDER: BREADBOARD LAYOUT
Important Forms/Links

- Help request form: [https://eecs16b.org/lab-help](https://eecs16b.org/lab-help)
- Checkoff request form: [https://eecs16b.org/lab-checkoff](https://eecs16b.org/lab-checkoff)
- Extension Requests: [https://eecs16b.org/extensions](https://eecs16b.org/extensions)
- Makeup Lab: [https://makeup.eecs16b.org](https://makeup.eecs16b.org)
- Slides: [http://links.eecs16b.org/lab4-slides-sp23](http://links.eecs16b.org/lab4-slides-sp23)
- Anon Feedback: [https://eecs16b.org/lab-anon-feedback](https://eecs16b.org/lab-anon-feedback)
- Checkoff Error: [https://eecs16b.org/lab-checkoff-error](https://eecs16b.org/lab-checkoff-error)