Lab 4: Sensing Part 1

EECS 16B Spring 2024

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.
We're building this!
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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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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

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

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

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

\[ 2 = 1 + (wRC)^2 \]

\[ 1 = wRC \]

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

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

Everything that is less than \( f_c \) gets through. Note that our cutoff isn't clean and perfect because the attenuation is gradual.
REMINDER: BREADBOARD LAYOUT
Important Forms/Links

- Help request form: https://eecs16b.org/lab-help
- Checkoff request form: https://eecs16b.org/lab-checkoff
- Slides: http://links.eecs16b.org/lab4-slides
- Anon Feedback: https://eecs16b.org/lab-anon-feedback
- Checkoff Error: https://eecs16b.org/lab-checkoff-error