Overall System - Operation, Measurements, and Lab Equipment

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Objectives

The objective of this lab was to familiarize ourselves with various lab equipment and measurement techniques needed for analyzing the performance of a stereo amplifier system. We focused on measuring the gain and frequency response of key components, including the buffer, preamp, mixer, and treble/bass circuits. Additionally, we ensured that the measurements obtained met the design specifications.

Procedure

Equipment and supplies

- Function Generator
- Oscilloscope
- Stereo Amplifier System
- Jumper Wires
- Audio Jack
- Microphone
- Powered Speakers
- DuPont Cables

Procedure

Measure Line Buffer Performance

1. **Setup**: The Preamp & Mixer PCB and Treble & Bass PCB were removed, leaving only the Buffer PCB installed.
2. **Connections**: A function generator was connected to the Buffer In pin, and an oscilloscope was used to measure both the input and output signals.
3. **Measurements**: A 2V peak-to-peak sinusoidal signal was injected, and the oscilloscope recorded the output.
4. **Results**: The gain was calculated using: A=Vout/Vin
5. **Observation**: The buffer circuit was tested to ensure it provided unity gain, maintaining signal integrity while preventing loading effects from the following stages.
6. **Frequency Response Table** (Left Channel Only):

Table 1 – Frequency Response (You only need to collect data for the Left Channel.)

V = **2**Vpp Function Generator	Frequency (Hz)	Vin (Vpp)	Vout (Vpp)	Gain (A)
Left Channel	20Hz	2.02v	5.84v	2.89A
Left Channel	20KHz	2.08v	5.12v	2.46A

$$Deviation_{right}(dB) = 20.log_{10}\left(A_{R(\max)}\ \right) - 20.log_{10}\left(A_{R(\min)}\right) = 20.log_{10}\left(\frac{A_{R(\max)}}{A_{R(\min)}}\right) = 1.40dB$$

Does the given circuit meet frequency response specifications as outlined in Appendix A?

Yes, the circuit meets the specified frequency response requirements. The measured gains at 20Hz (9.22 dB) and 20kHz (7.82 dB) are within the ±3 dB range of the nominal 9.5 dB.

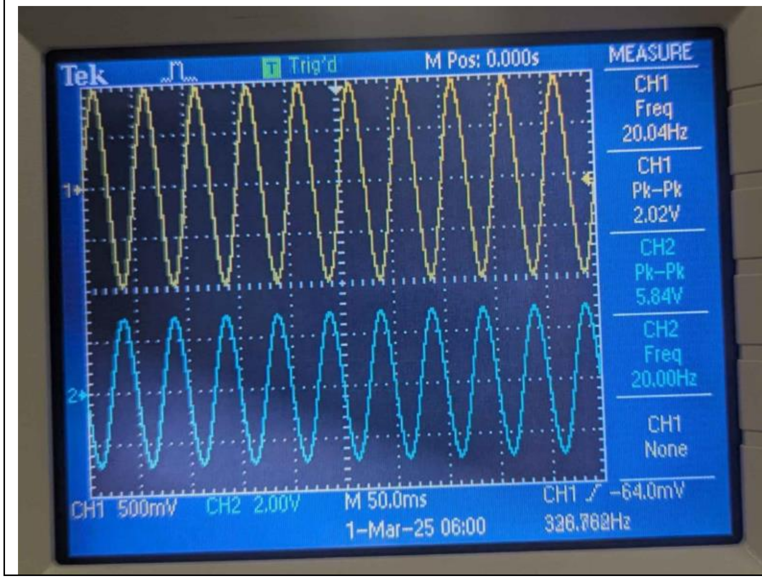
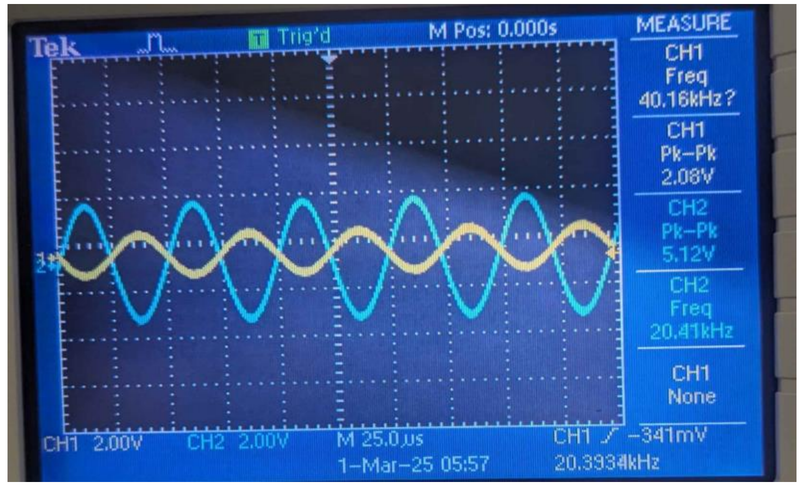
Buffer Left 20Hz	Butter Left 20KHz
	

Figure 1and 2 shows the oscilloscope measurements for the Left Channel at 20 Hz and 20 kHz

Measure Microphone Preamp Circuit Performance

1. **Setup**: The Preamp & Mixer PCB was inserted into the chassis.
2. **Connections**: The function generator was connected to the input of the preamp circuit (JB1), and an oscilloscope measured the output from JB5.
3. **Measurements**: The gain was calculated using the same formula as in the buffer section.
4. **Observation**: The preamp circuit successfully amplified the weak microphone signal to a stronger level suitable for further processing.

Measure Mixer Circuit Performance

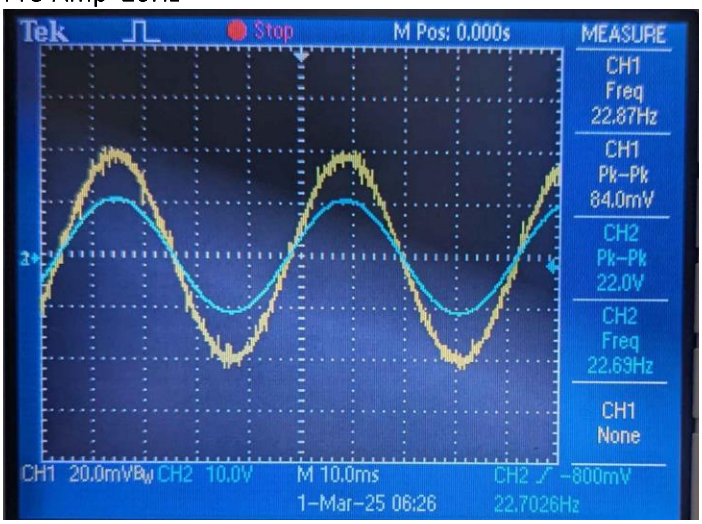
1. **Setup**: The Preamp & Mixer PCB was configured with the input connected to both the microphone and audio sources.
2. **Connections**: The oscilloscope was used to measure the left channel output.
3. **Measurements**: The sum of the input signals was verified.
4. **Observation**: The mixer successfully combined signals from multiple sources, ensuring a balanced output.

5. **Frequency Response Table**:

Table 2 Pre-Amp and Mixer Frequency Response

Amplifier	Frequency (Hz)	Vin (Vpp)	Vout (Vpp)	|AdB|
Pre-Amp	20Hz	84mV	22.0v	259
Pre-Amp	20KHz	86.40mV	21.2v	245.37
Mixer left Channel	20Hz	4.16mV	8.16v	1.961
Mixer left Channel	20KHz	4.32mV	8.24v	1.907

Pre-Amp 20Hz



Mixer left Channel 20Hz

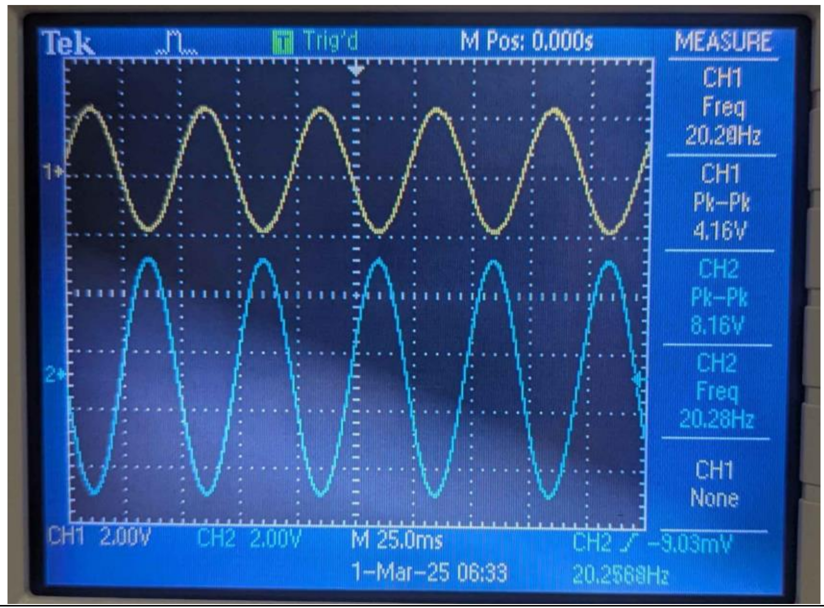


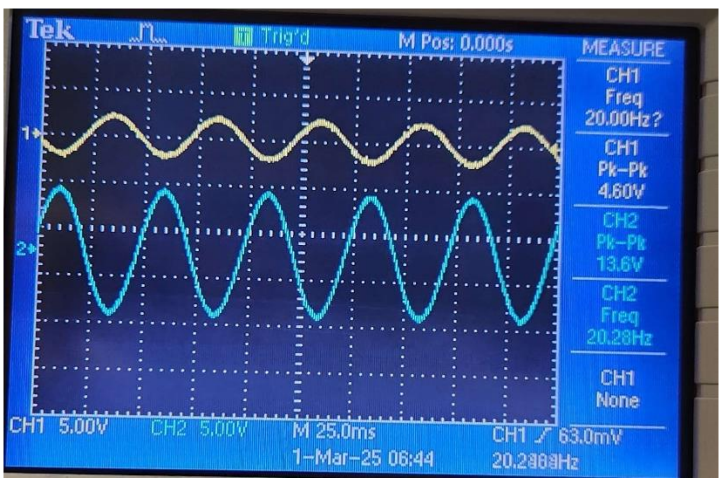
Figure 3and 4 shows the oscilloscope measurements for Pre-Amp and Mixer at 20 Hz and 20 KHz.

Measure Treble and Bass Circuit Performance

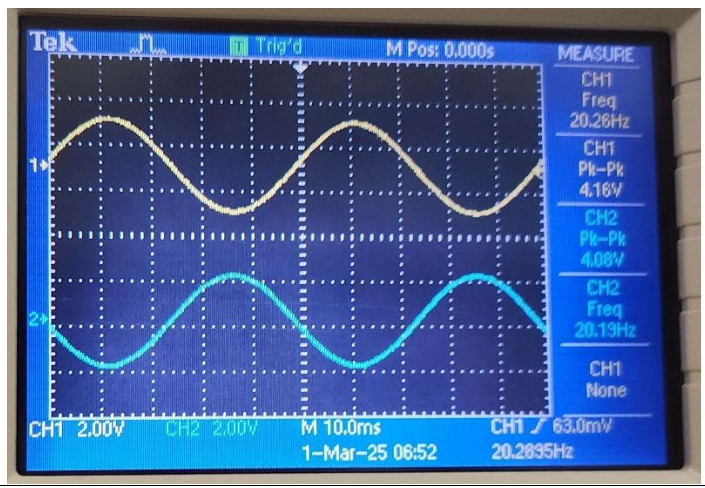
1. **Setup**: The Buffer, Mixer, and Treble & Bass PCBs were inserted into the chassis.
2. **Connections**: The function generator was used to inject a test signal, and the oscilloscope measured the left and right channel responses.
3. **Measurements**: The gain was recorded for both the treble and bass circuits at different settings ($\alpha = 0$ and $\alpha = 1$).
4. **Observation**: The treble and bass controls adjusted frequency response as expected, boosting or cutting high and low frequencies.
5. **Results**: *Table 3 Treble and Bass Frequency Response Measurements.*

	Channel	$f(Hz)$	Treble			Bass		
			V_{in}	V_{out}	$\lvert A_{dB}\rvert$	V_{in}	V_{out}	$\lvert A_{dB}\rvert$
$\alpha = 0$	Left	20Hz	4.16v	4.8	0.981	4.24v	1.44v	0.340
		20KHz	4.24v	1.20v	0.283	4.24v	4.32v	1.02
$\alpha = 1$	Left	20Hz	4.16v	4.08v	0.981	4.60v	13.6v	8.5
		20KHz	5v	16.8v	3.36	4.24v	13.6v	8.5

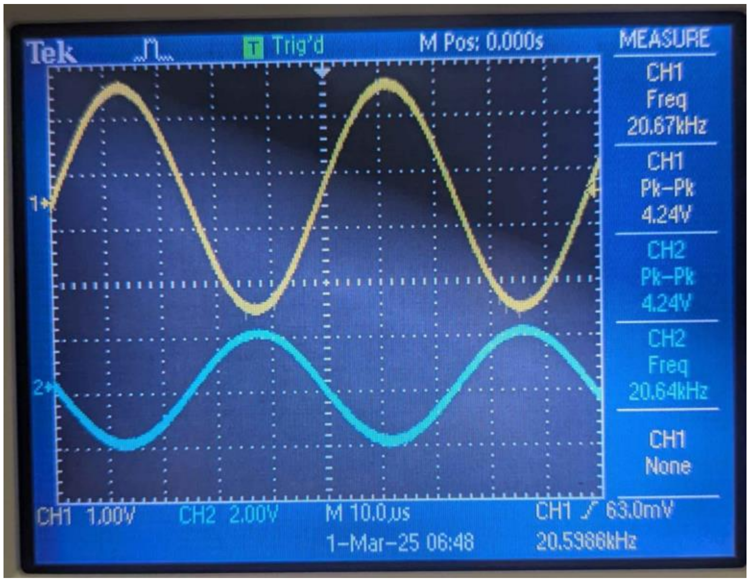
Base1 at 20Hz



Treble 1 at 20Hz



Base 1 at 20KHz



Treble 1 at 20KHz

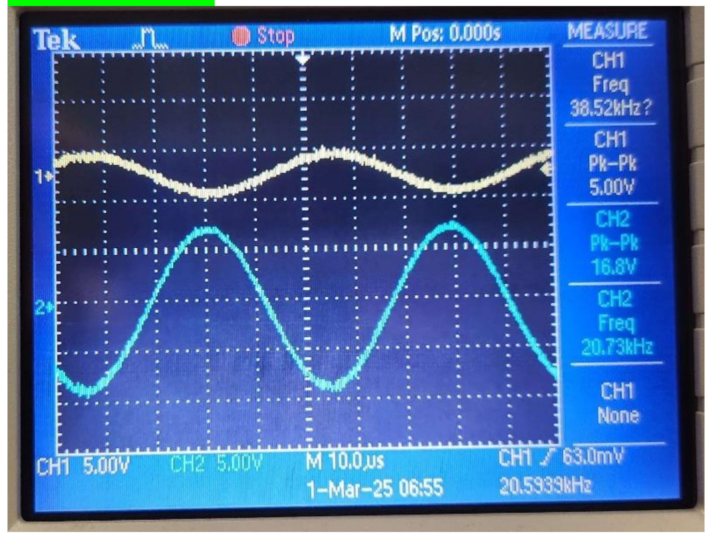


Figure 5,6, 7and 8 shows the oscilloscope measurements for Base and Treble when its 1 at 20 Hz and 20K Hz.

Laboratory Cleanliness Picture

Conclusion

This lab provided hands-on experience in measuring the performance of a stereo amplifier system. The function generator and oscilloscope were essential tools for verifying circuit behavior. Key takeaways include:

- The buffer amplifier maintained the expected gain across the tested frequency range, ensuring signal integrity.
- The preamp circuit amplified the microphone signal correctly, ensuring proper signal strength for mixing.
- The mixer circuit successfully combined multiple audio sources.
- The treble and bass circuits demonstrated expected frequency adjustments, effectively enhancing or reducing specific frequency bands.

Some challenges encountered included setting up oscilloscope probes correctly without introducing noise and ensuring the function generator provided a stable signal.

Future improvements could involve using higher-quality connectors to minimize signal interference and refining the measurement approach for the mixer circuit to obtain more realistic gain values.

Overall, the measured values were within the design specifications, confirming the amplifier system's proper operation with minor areas for refinement.