BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY

Department of Electrical and Electronic Engineering

Course No: EEE 208 (Software)

Course Title: Electronic Circuits II Laboratory

Project Name—

Active Noise Cancellation

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Group 7

Section C2

Level 2 , Term 2

Introduction

To listen something attentively, we all want a quiet place. But in this modern age, it is rare to find such kind of place.But if anyone eliminate the noise from environment while listening , then he or she can listen properly. In this project, our objective is reducing the noise. When we input any music or anything else , noise is easily mixed with it. Our project can lessen the noise from the audio file to a great extent. Here we have built a simple op-amp based circuit. Our main theme was basically superposition of two wave. By this , we just inverted noise with proper magnitude and shifting and almost reached to our desire output by superimposing it with main audio input file.

Working Principle

Sounds-cancelling headphones work primarily by mounting a microphone on the outside of the headphones, which gathers up ambient noise. Then these noise sounds are amplified according to the magnitude of the inverted noise got from main music input which are basically unwanted. After this, the amplified noise is shifted lightly. At main music input port, the music along with the noises are inverted. Further, when the two are summed up, the desired noise-free output (music, voice/speech) will come properly. Here , this project is mainly op-amp based. And the operations (amplification , delay ,invert , sum) are done by opamp UA741.

Block Diagram

Basically , we have designed our project through 3 phases : a pre-amplifier, a delay and an inverting summer.Here the noise we do not want is taken additionally by the external microphone . There is likely a tiny hole on the external casing of each ear—piece. These are the microphones that are the input at the far left of the diagram below.

Then comes Pre-amplifier. The noise wave is then amplified with an increment in amplitude. For this operation, we have used op-amp as the gain factor in it can be determined by the ratio of the two resistors we take.

The delay filter delays the signal according to the distance from ear to microphone. We know there is a velocity difference between light and sound signal. So the time difference after pre-amplifying and the output of bottom summer is not negligible.Basically , the bottom inverting summer is in the main input of headphone where along with the music/speech , unwanted noises from the environment are mixed to ear.This is happened with the speed of sound. But noise through the external microphone and the rest of circuit , this is electric signal. So to lessen the time gap, the delay works to line up the two signal.

Lastly, the summing amplifier combines the signals.The amplifier at bottom is just next to the main input of air or head phones. Here the music or speech we listen is amplified . Also the surrounding noise comes to our ear through the earbuds. This noise will also be inverted and amplified by this summer. The summer at top is the final stage . This stage combines the inverted noisy music with the processed noise signal, cancels the noise and then inverts the resultant wave.

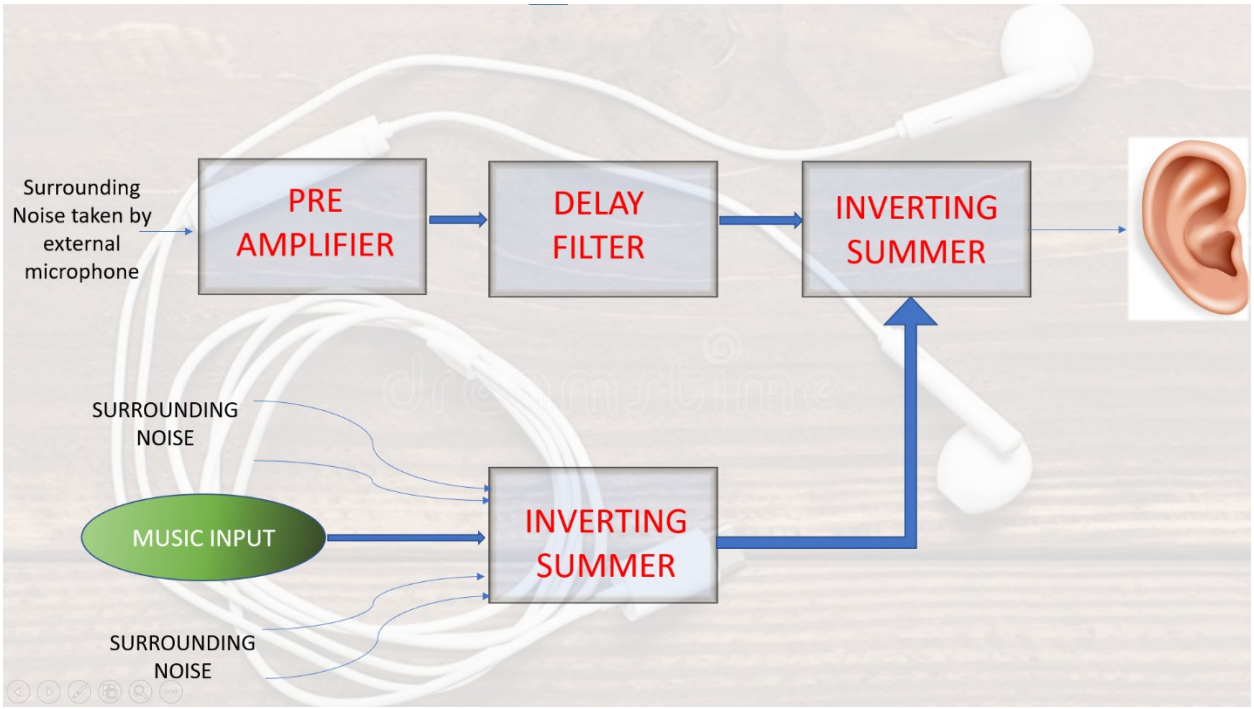
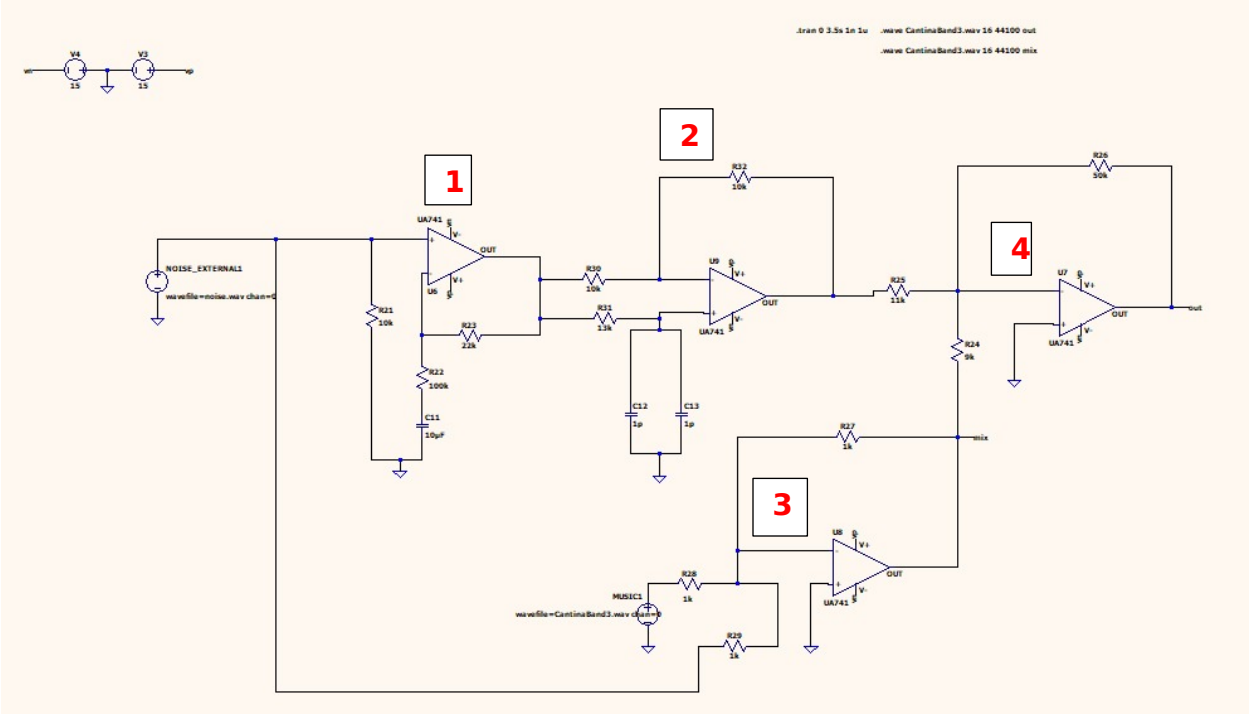


Fig : Block Diagram of the circuit

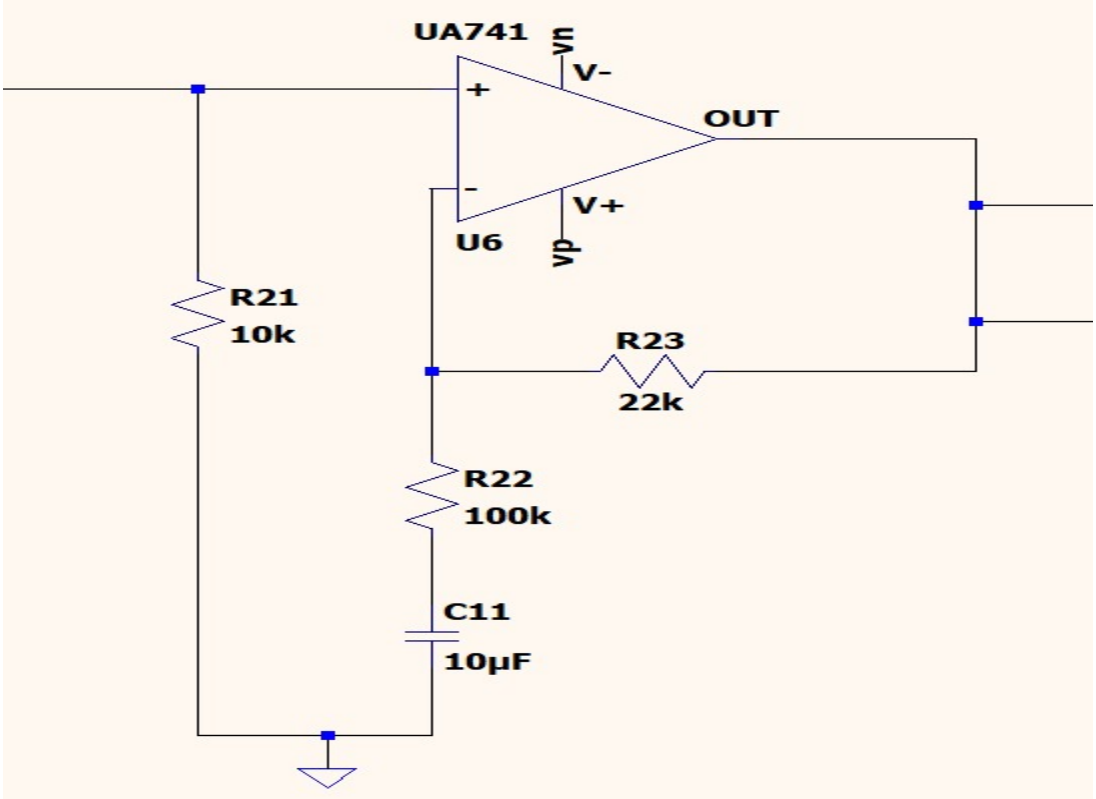
Circuit Diagram

We developed the main circuit diagram at LTSpice. The schematic is given below-



Sub-circuit Explanation

1.Pre-Amplifier –



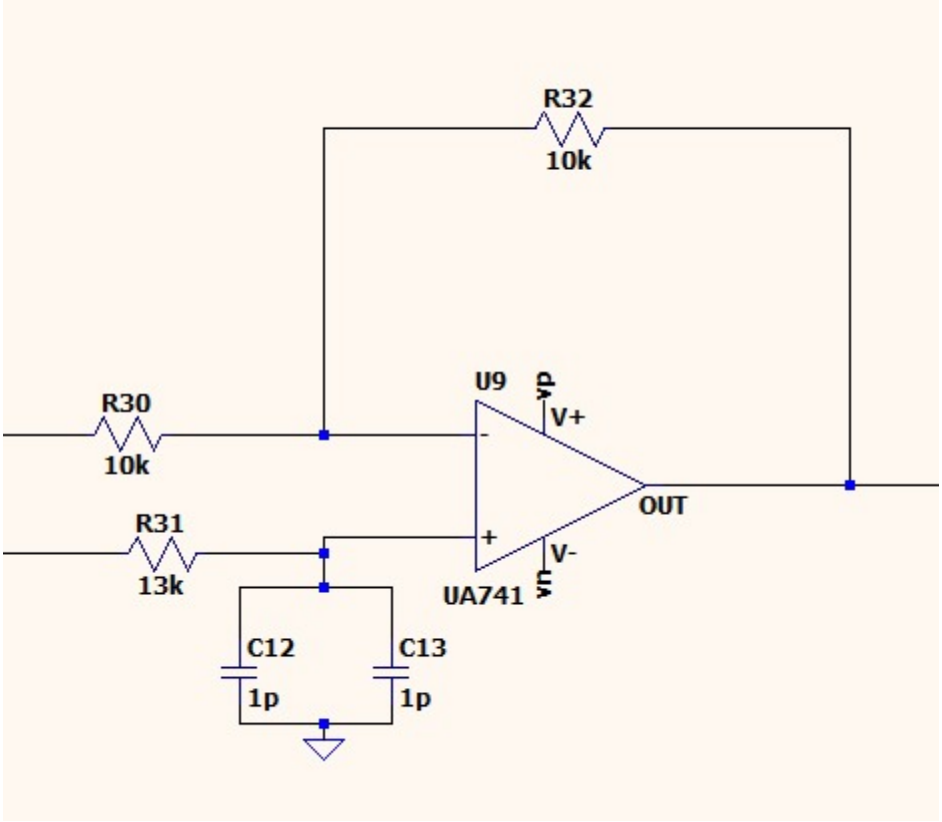
This stage amplifies the noise caught by external microphone to a higher level because the waves themselves are tiny and would result in minimum voltages.The gain here is defined by resistors ratio.

$$\text{Gain} = \frac{R23}{R22} = \frac{22k}{100k} = 0.22$$

Here we have set a very small gain for theoretical reason as the noise is set up manually.Practically , the gain can be high or low according to noise amplitude. There is a rheostat for gain changing.

The capacitor reduces the DC offset. DC components will cause issues that will compound as the signals travel through thr circuit and will result in a poorly working system. From here the noise will pass to the delay.

2.Delay Filter –



The delay filter provides the delay to the noise-cancelling signal that helps align all the signals and noise so that the summing process is much more effective. We have also known the speed difference of sound and electric signals. As a result, the noise from the actually will arrive an instant later than the noise from the circuit to the ear.

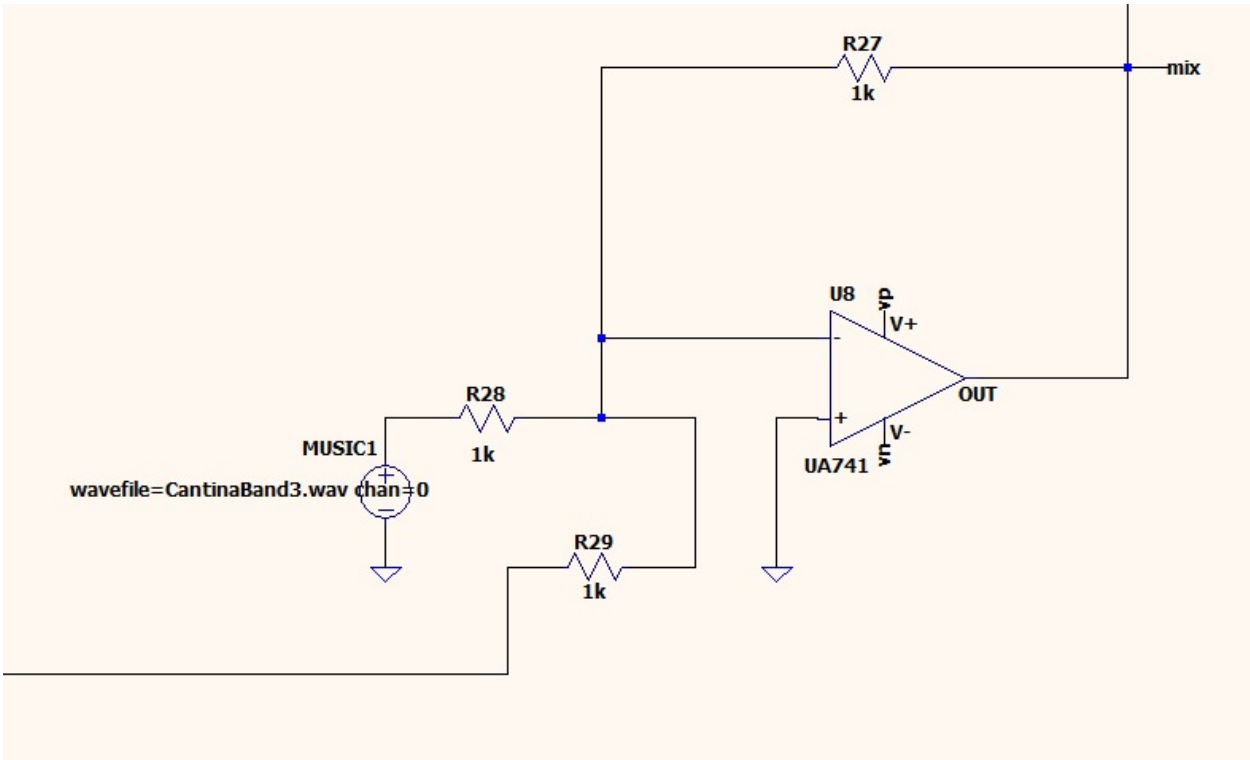
If the distance from external microphone to the ear is L , the speed of sound is Vsand the time delay is t ,then formula is , L=Vs * t

$$\text{Therefore , } t = \frac{L}{Vs}$$

The phase lag is then $\Delta w=(360°)*t*f$

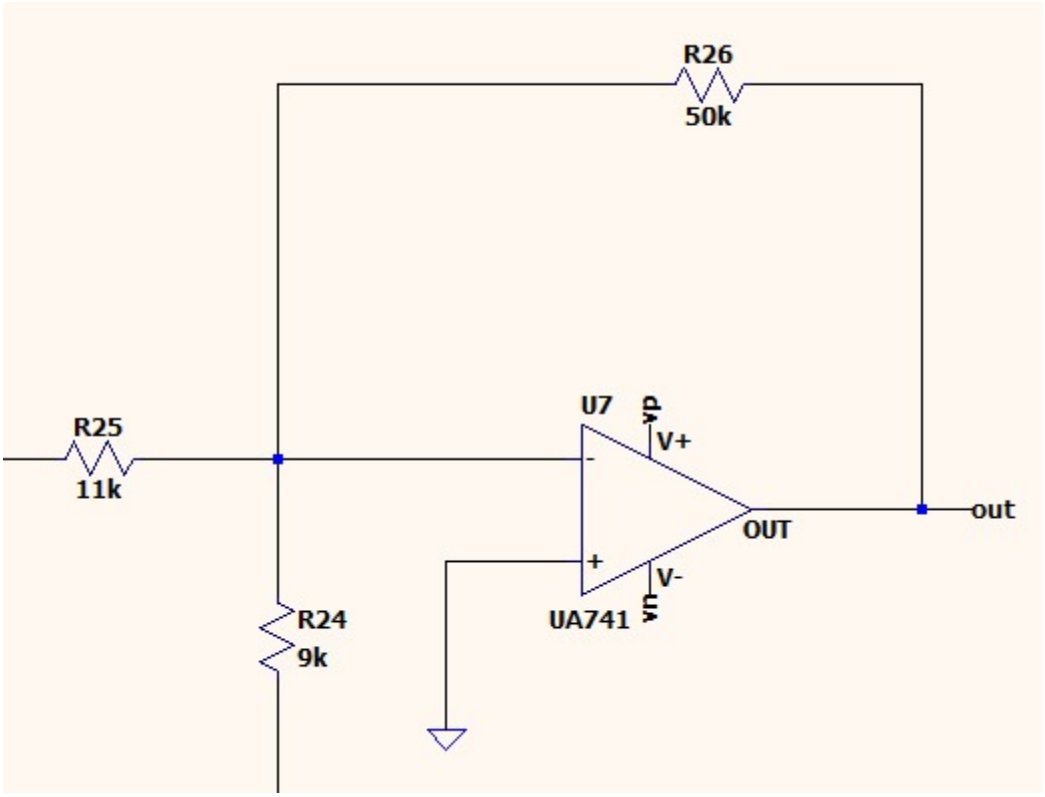
This frequency needs to be decided and is based on the range that the active noise cancellation is expected to perform. In circuit , frequency depends on R31 , C12 , C13.

3.Inverting Summer –



Inverting summer (3) mainly takes the music as input .Surrounding noise will also be added with music as well. Then it gets inverted with a particular gain .

Gain = $\frac{R27}{R28} = \frac{R27}{R29}$

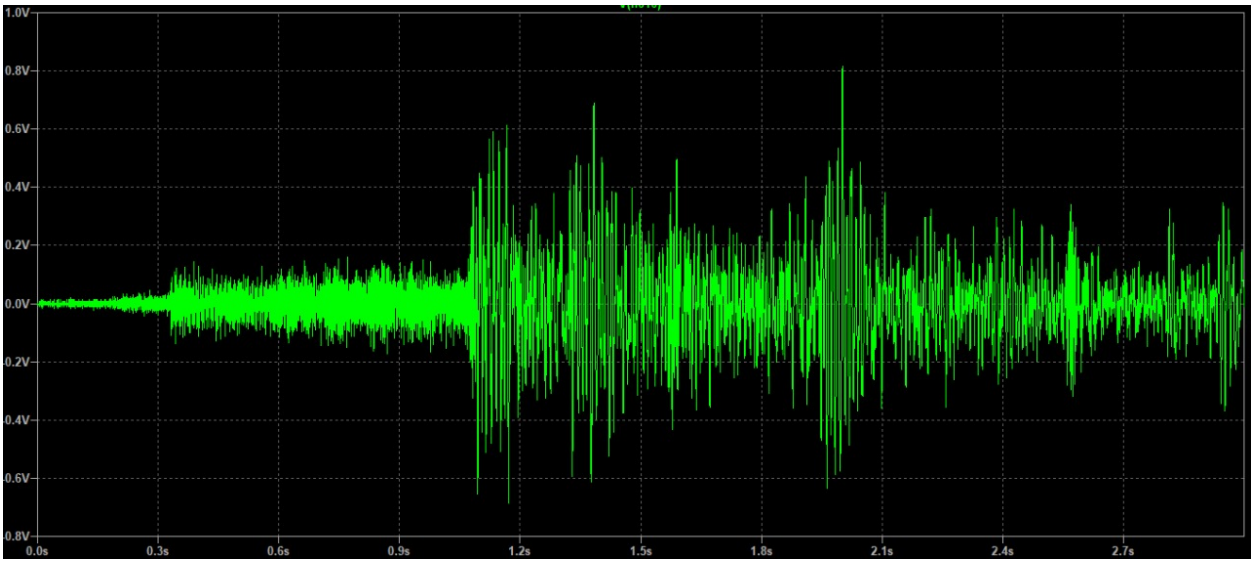


The final stage is inverting summer (4). It combines the amplified noise with output of amplifier(3). Then the noise and mixed one are summed up.Here the phase of noises are totally opposite. To eliminate totally, we have to equal the magnitude. Thus the gain is achieved. And as noise gets subtracted , we get the desired noise-free music.

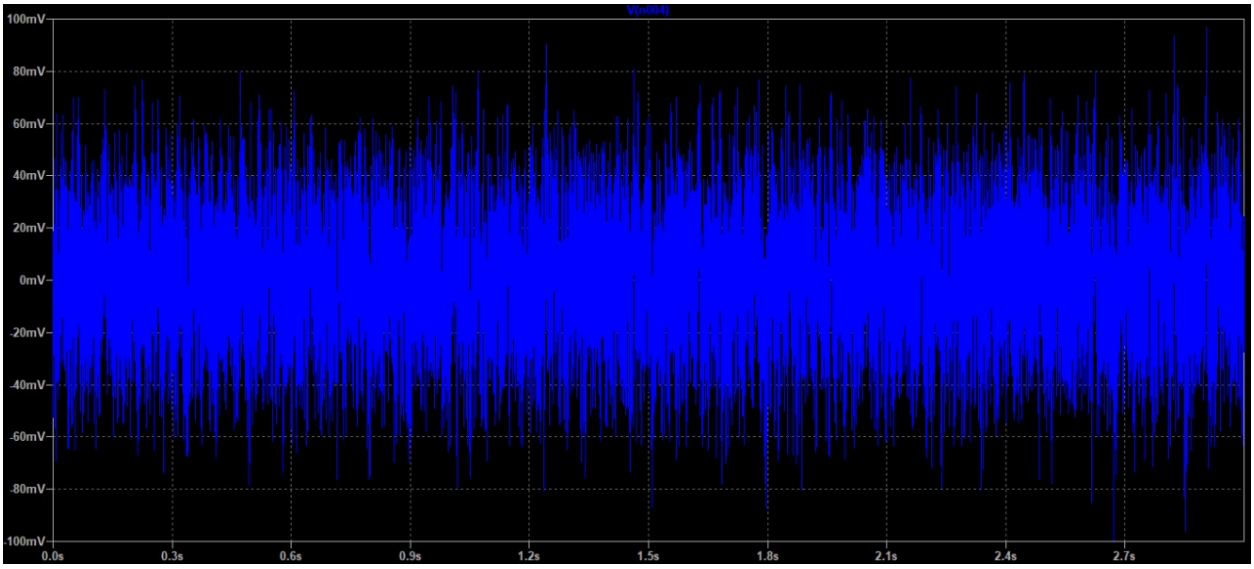
Sample Input Output Cases

Wave Plot—

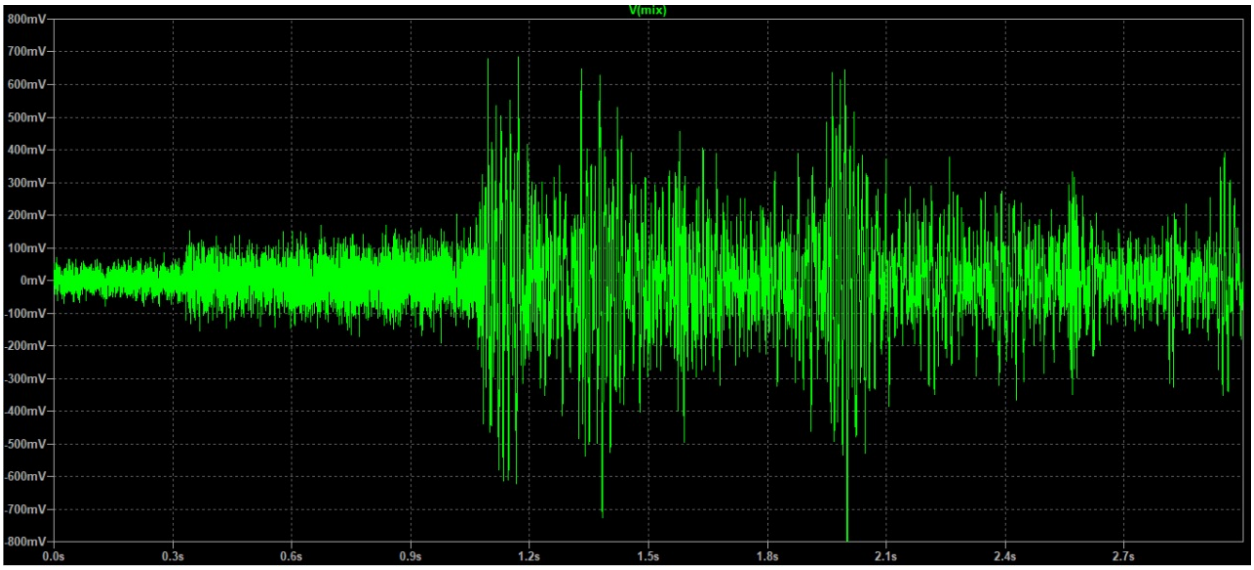
Main music –



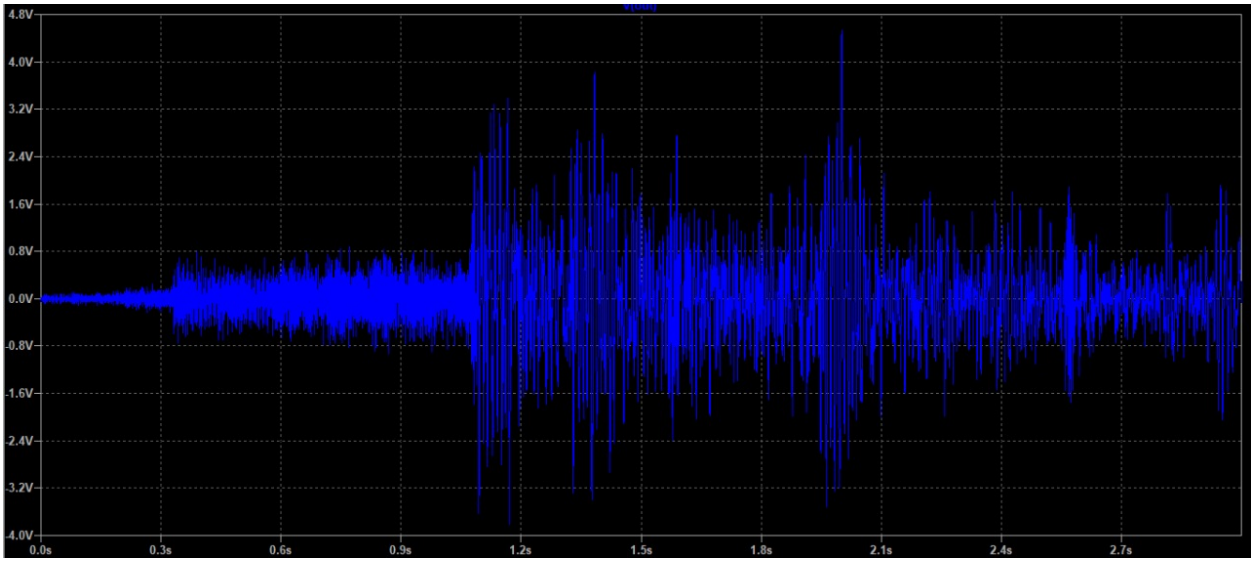
Noise—



Mixed (Music+Noise)—



Output—



Some test case of audio file is attached with the drive link below—

https://drive.google.com/drive/folders/1izbRnT9g-CM4l_Qj7F9NV5h1O_RO4i-i?usp=sharing

Limitations

In project, we gave noise manually and eliminated it. So there should be no error. But there are two limitations we have to talk about—

- The delay filter we used basically had no effects in circuit. As capacitance was very low , the shifting was also low. But in real headphone circuit, it is very important to maintain appropriate phase sequence between electric and sound signal.
- The pre-amplifier is used to maintain the proper magnitude. But here as the noise was in our hand, so this stage had no values in the circuit.But practically, it is most important.

Future Work

Discussion