EE324: Experiment No.3
Active Noise Cancellation

Batch No:3
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1 Overview of the experiment

1.1 Aim of the experiment

The aim of the experiment is to design and implement a compensator to achieve noise cancellation in headphones.

1.2 Method

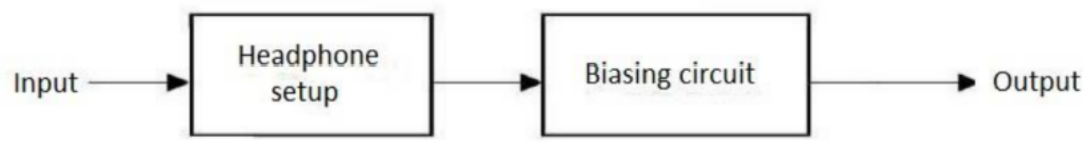
First obtain the transfer function of the given headphone and then with the help of MATLAB design a commpensator to acheive the desired specifications and then implement the designed compensator using an analog circuit and analyse the circuit to verify.

1.3 Objectives

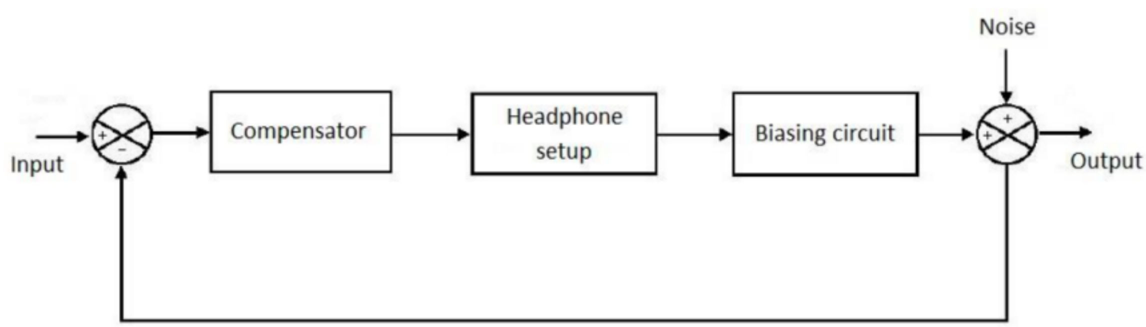
- To achieve an attenuation of 20 dB, when a noise of 100 Hz frequency is applied.
- To attain a gain margin of 5db and phase margin of 30°.

2 Block Diagram

2.1 Open Loop



2.2 Closed Loop



3 Approach

2In this experiment, we calculated the transfer function of the headphone provided to us. This is achieved by sending an input of sine wave using an AFG and then observed the output on a DSO. We took a range of 40-7400 Hz and plotted the gain and phase plots using that data. Then we used MATLAB to design a compensator to achieve the desired objectives. After getting an ideal compensator, we used the values provided to us in the lab and implemented the best possible compensator.

4 Challenges faced and their Solutions

- The headphone setup provided to us was either faulty or was extremely noise sensitive which made system characterisation very difficult. Even though we obtained the Bode plot, it was not possible to stabilise the system as we obtained an increasing phase plot. So, we found the characteristics again but got similiar results. In the end, the TA gave us the readings and asked us to design a compensator for that data.
- We initailly tried a first-order lag compensator and used it to achieve the desired results but failed to do so. As the slope was of 20db/decade which was too small so we went for the second-order lag compensator and succesfully designed it.
- The exact values of resistance and capacitance were not available to us in order to implement the designed compensator. So, we went for the best possible and implemented and used MATLAB to verify the validity. We had to put many resistance, capacitor values in parallel or series to achieve the desired output.

5 Experiment results

5.1 Open Loop Characteristics

5.1.1 Magnitude Plot

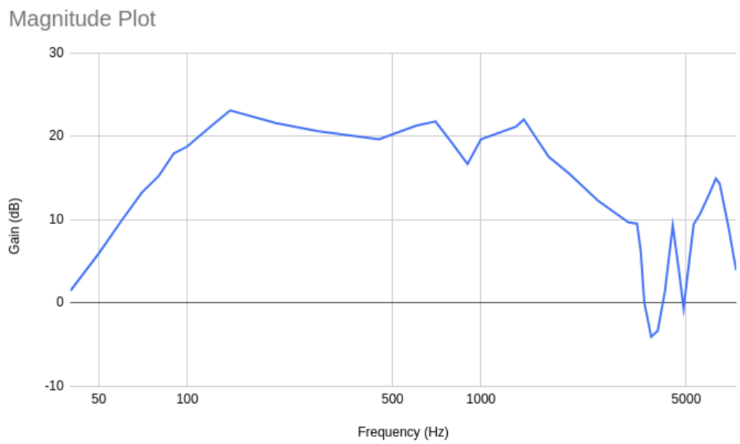


Figure 1: Open Loop Magnitude Response

Gain Margin = -2db

5.1.2 Phase Plot

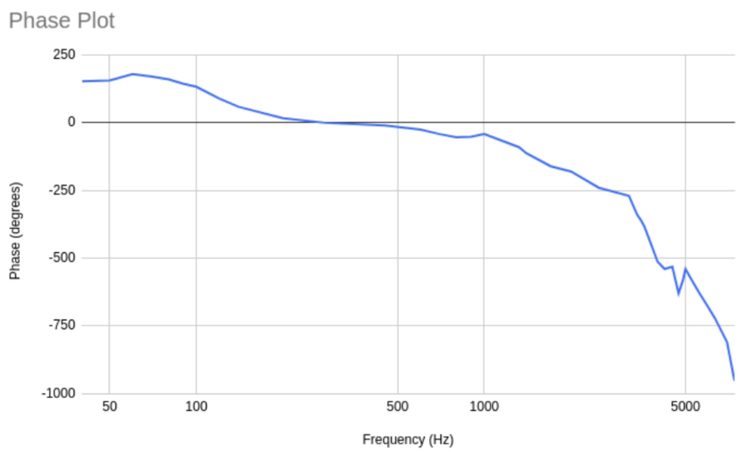
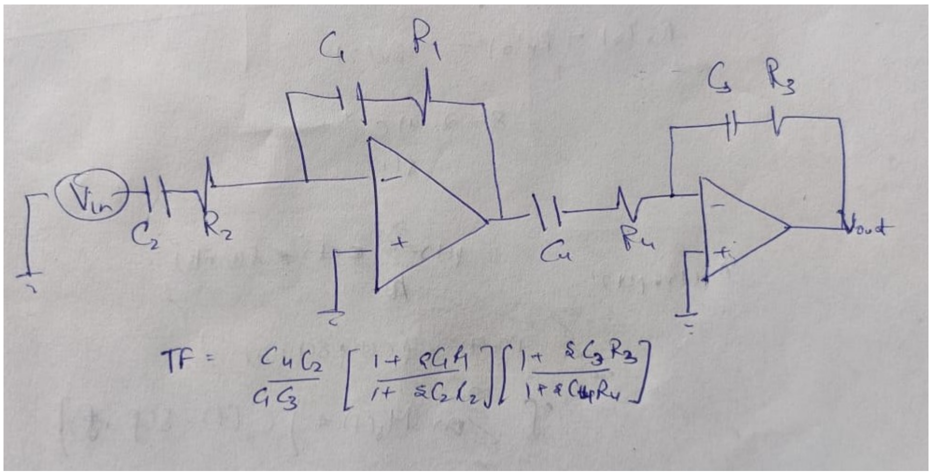


Figure 2: Open Loop Phase Response

Phase Margin = 7.57°

5.2 Compensator

The final Compensator after using the provided Resistance, Capacitor values.



Compenstar

Here,

$R_1 = 6 * 1.5KHz = 9KHz,$
$R_2 = 6 * 15KHz = 90KHz,$
$R_3 = 3 * 3.3KHz = 9.9KHz,$
$R_4 = 3 * 15KHz = 45KHz$

and,

$C_1 = C_2 = 100KpF,$
$C_3 = 100/2KpF + 5 * 4.7KpF = 68.8KpF,$
$C_4 = 220KpF.$

5.2.1 Magnitude Plot

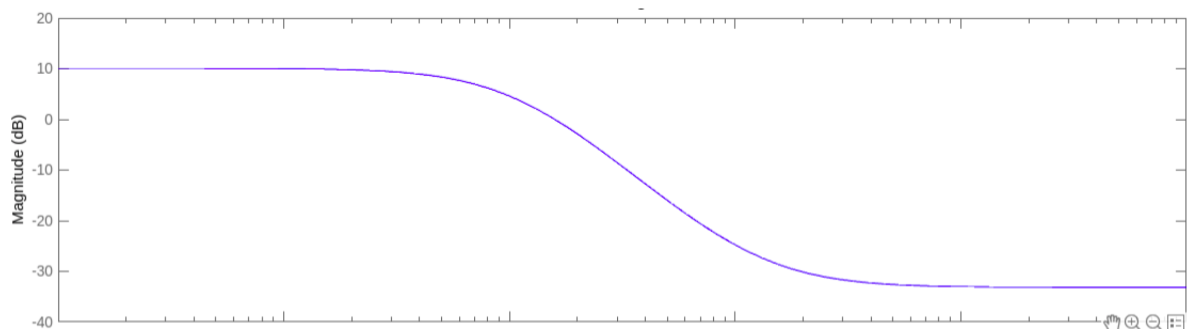


Figure 3: Compensator Magnitude Response

5.2.2 Phase Plot

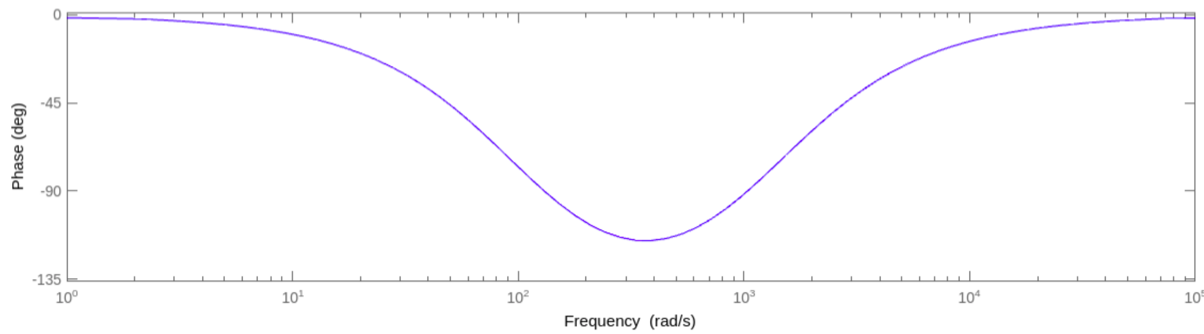


Figure 4: Compensator Phase Response

Transfer Function

```
0.021995 (s+1111) (s+1468)
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    (s+111.1) (s+101)
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5.3 Closed Loop Characteristics

5.3.1 Magnitude Plot

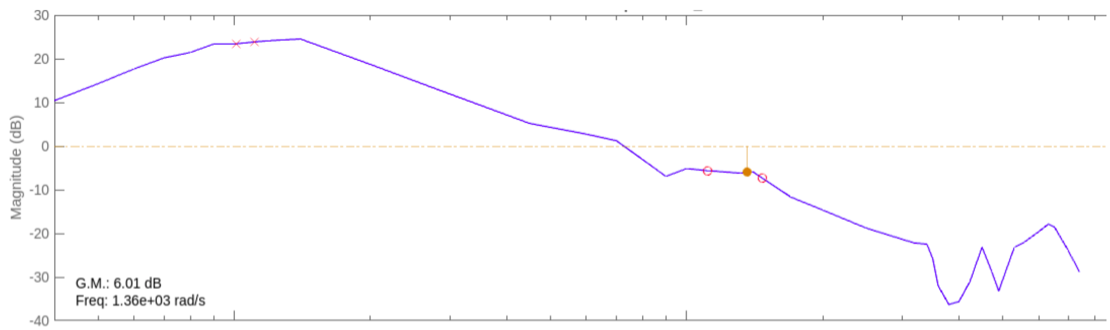

Figure 5: Close Loop Magnitude Response

5.3.2 Phase Plot

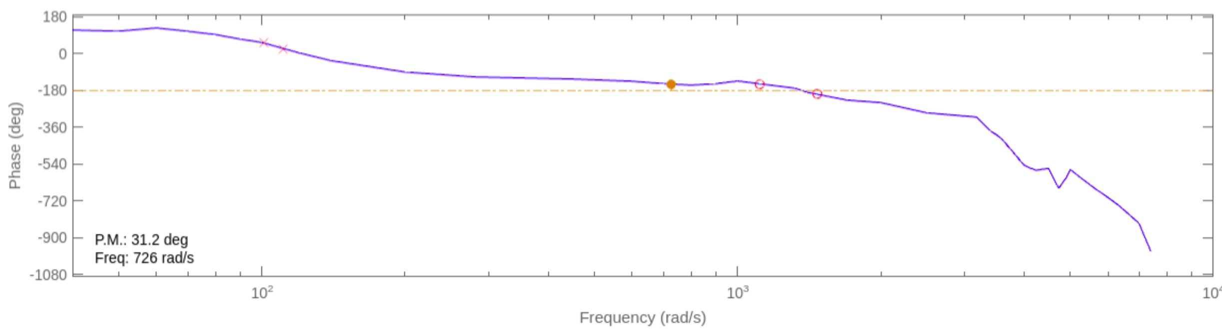

Figure 6: Close Loop Phase Response

5.4 Final Results

Gain at 100Hz	Gain Margin	Phase Margin
21db	6.01db	31.2°