**Design Contest**

**Important Notice**

This project is to be done in teams of two. You should not discuss this project with anyone except your lab partner. Plagiarism will result in a grade of 0 for all teams involved.

**Design Problem:**

Some relatives recently had their son-in-law - a construction worker - run audio cables in their house to allow them to listen to music from one source in multiple rooms. Unfortunately, the music in one room is accompanied by an annoying low frequency buzz. Since you are a student in Electrical Engineering, you have been asked to help solve the problem. Some investigation reveals that the audio lines were run right next to the wiring for a power outlet, and the buzzing is caused by 60Hz noise. Moving the audio cables is not an option due to the layout of the house, so you decide to design a filter to reduce the effects of the noise and improve sound quality.

**Current System:**

```
 Audio Source  ---------------->  Noisy Line  ----------------->  Speakers
```

**Proposed Solution:**

```
 Audio Source  ---------------->  Noisy Line  ----------------->  Filter  ---------------->  Speakers
```

If your filter sufficiently attenuates the 60Hz noise without affecting the rest of the audio signal too much, this will solve the problem and earn the gratitude of your relatives.

You have two weeks to complete the project. Attend your normal lab sections to work on the project. When your filter is complete, have the lab instructors test the performance. Your final report is due at the beginning of your regular lab period during dead-week (November 29 – December 2).
Project Requirements

You should design your circuit before coming to lab, and verify it in PSpice and Matlab. Circuit design (including a complete circuit diagram) and verification must be presented to the TA before beginning the testing of the circuit in the laboratory. Be prepared to explain your design process and the circuit to the TA.

The circuit will be tested by hooking it up between a noisy signal and speakers and listening to the output, but also by measuring the attenuation at various frequencies. Your filter will be judged by how well it attenuates a 60Hz signal (more is better) and how much it attenuates nearby signals at 30, 50, 55, 65, 70, and 120 Hz (less is better). Also, be sure that it passes higher frequency signals, since audio signals may range up to ~20kHz.

The quality of your filter will be judged with the following performance measure:

\[ F = 20 \log[H(j2\pi60)] + \sum_{i=1}^{6} 20 \log[H(j2\pi f_i)] \]

where the frequencies \( f_i \) correspond to 30, 50, 55, 65, 70, and 120 Hz. The smaller the value of \( F \), the better the circuit. You should shoot for values less than -20.

There will be a prize for the team with the smallest value for \( F \).

Project Report

The project report should contain a complete description of your design process, including Matlab and Pspice results that verify the filter operation. You need to explain how the filter works, and how you designed it. Experimental results should also be described. Include graphs of the experimental frequency response, and provide the value of \( F \) that your filter achieved. Explain any discrepancies between experimental results and the pre-lab. Provide suggestions for improving your filter.

Reference material:


Application notes available on the Internet from semiconductor manufacturers such as TI.