ELEN 458 Lab 3

Active Filter Synthesis & Approximation: Designing a Crossover Filter

I Objective

The objective of the lab is to familiarize the student with a filter generating software and the differences between the approximation techniques.

II Component List

- Components (Resistors and Capacitors) necessary for lab will vary depending on your design.
- LM 248 Quad Opamp (x2).

III Introduction

The design of higher order active filters is usually performed using software tools. These tools accomplish the transfer function approximation based on response specifications specified by the user (usually box constraints). Next, the software will synthesize the filter in a particular topology (such as cascade) and implementation (such as active-RC). All component values are automatically generated, and in many cases, a simulator-input file is generated. These software tools simplify the task of generating large, complex filters.

In this lab, we will use FIESTA2 to help us generate an audio crossover filter. FIESTA2 performs approximation and synthesis of active-RC filters. The program is available on *eesun3*. To get started in FIESTA2, please follow the additional handout given.

A block diagram of an audio system using a two-way crossover is shown in figure 1. A crossover splits a signal into multiple frequency bands. These bands can then be individually processed, allowing for improved overall performance. In the case of the audio output system shown below. The original audio signal is filtered two ways. A low pass filter selects the bass sounds, which are then amplified, and passed to a speaker specially designed to handle low frequency signals, woofer. A high pass filter selects the treble sounds, which are amplified and sent to the tweeter, which is specially designed to handle high frequency signals. By using two specialized speakers instead of one, we obtain much better sound quality, because there is less distortion and more frequencies are preserved (especially in the lower frequency range). In this lab, we will design and build the filters that realize the crossover filters.

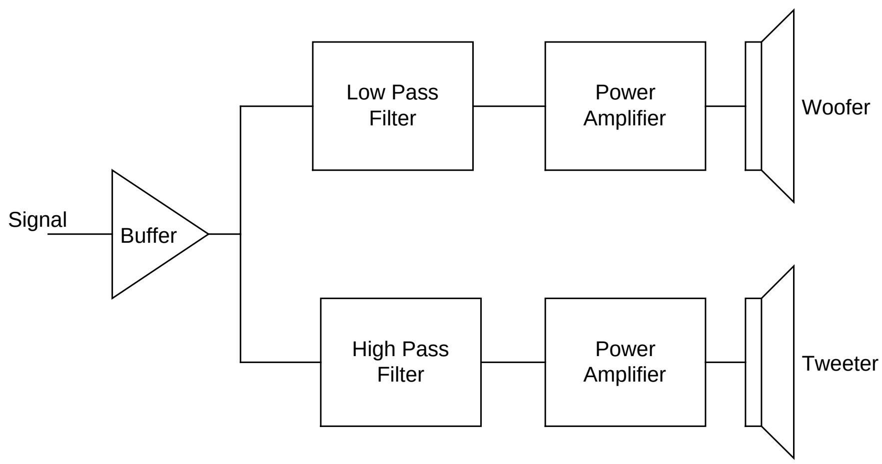

Figure 1

IV Prelab

Using the FIESTA2 software, design a low pass and high pass filter to implement the crossover. The box constraints are as follows:

- Low Pass Filter
  - Pass Frequency : 500Hz
  - Stop Frequency : 2kHz
  - Maximum Attenuation in the Passband : 3dB
  - Minimum Attenuation in the Stopband : 36dB

- High Pass Filter
  - Pass Frequency : 5kHz
  - Stop Frequency : 2kHz
  - Maximum Attenuation in Passband : 3dB
  - Minimum Attenuation in Stopband : 23dB

Perform the design using the Inverse Chebyshev and Elliptical approximation methods. Draw neat schematics for each filter synthesized, use the nearest standard component value for each component included on the schematic. For each filter, obtain a HSPICE input file and be sure to use the LM741 macro model in the simulations. Simulate the filters using HSPICE and provide plots of magnitude and phase response (you will have at least a total of 16 graphs). For each filter, plot all the magnitude response and phase responses together. Also, be sure to turn in all FIESTA2 files (approximation data). When running FIESTA2, carefully observe all the different responses generated by the GRAPHICS output option for each approximation method (this will be important for the lab report).

V Lab Procedure

Build and test the crossover based on the Ellipitical approximation (be sure that the TA verifies your circuit for proper operation). Provide a plot of the magnitude and phase response in the lab report. Also, in the report compare and contrast the approximation methods listed above. What are the advantages and disadvantages of each method? Be sure to base your analysis on the following factors (besides others) : order, ripple in the passband/stopband, phase response, group delay response, time domain response.