

# Lab 5

## IIR Filter Design

October 12, 2015

### 1 Introduction

There are specifications regarding passband, and stopband edges, passband ripple and stopband attenuation when designing filters. There are also several common filter types such as Butterworth, Chebychev and Elliptic filters, each having its advantages and disadvantages. In this lab you will design a high order filter based on the given specification.

### 2 Prelab

#### 2.1 Part 1

1. On Figure 1 label
  - passband edge
  - stopband edge
  - passband ripple, and
  - stopband attenuation.
2. Design a Butterworth IIR filter with the following specifications:
  - $f_{pass} = 4kHz$ ,
  - $A_{pass} = 0.1dB$ ,
  - $f_{stop} = 4.5kHz$ ,
  - $A_{stop} = 50dB$ ,
  - $f_s = 48kHz$ .

Use the `butter` function from matlab, first to obtain the numerator and denominator polynomials, and again to obtain the poles and zeros of the filter.

3. What is the order of the filter?
4. Plot the pole-zero diagrams for both cases.

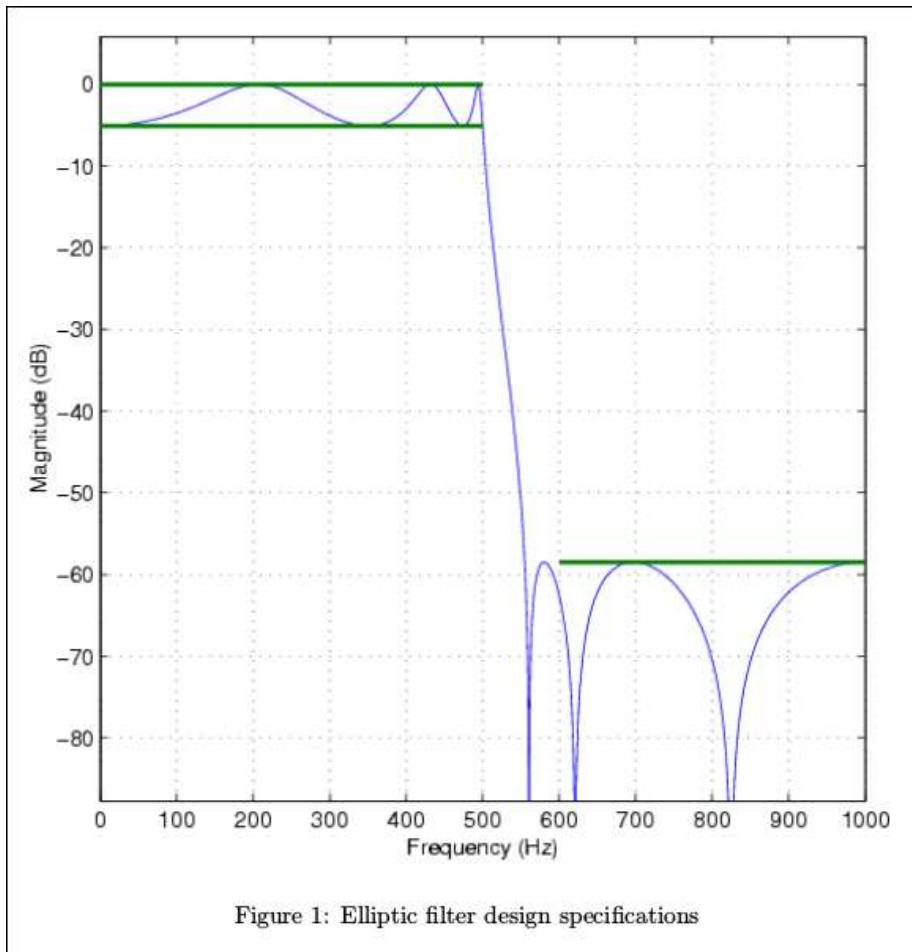


Figure 1: Elliptic filter design specifications

## 2.2 Part 2

1. Design an elliptic filter with the above specifications listed in Part 1.
2. There are several ways to group the poles and zeros of the filters. Implement the filter twice: once by pairing the poles closest to the unit circle and go inward, and the other by pairing the poles furthest from the unit circle and go outward. Each time pair the poles with the zeros closest to it.
3. Compare the performance of the two implementations.

### 3 Lab

Measure the frequency response of the elliptic filter (magnitude and phase), and compare it with the MATLAB results. Plot the magnitude and phase responses of  $H(w)$  vs  $w$ . (Connect a function generator to the board input and an oscilloscope to the output. Output the original signal on the left channel without change, and the filtered signal on the right channel).