Exercises about digital filter design

Exercise 1

Design a lowpass filter with passband edge frequency 1.5 kHz, stopband edge frequency 3 kHz, passband ripple 1 dB, minimum stopband attenuation 40 dB, sampling frequency 48 kHz.

Design Butterworth, Chebyshev type I and type II, and Elliptic filters. View the frequency response and annotate the filter orders.

Exercise 2

Design an highpass filter with passband edge frequency 3 kHz, stopband edge frequency 1.5 kHz, passband ripple 1 dB, minimum stopband attenuation 40 dB, sampling frequency 48 kHz.

Design Butterworth, Chebyshev type I and type II, and Elliptic filters. View the frequency response and annotate the filter orders.

Exercise 3

Open the audio file 'File48M.wav'. Filter the signal with the lowpass and highpass elliptic filters previously designed and save the output signals. Listen to the output signals.

Exercise 4

Consider the filter with a single pole for $p = 0.8$ described by

$$y(n) = 0.8y(n-1) + x(n).$$

Diagram the frequency response. Use it to filter 'File48M.wav' and listen to the result. Diagram the output signal for `n=1:200`. Consider the filter with a single pole in p^{-1} described by

$$y(n) = \frac{1}{0.8}y(n-1) + x(n).$$

Diagram the frequency response. Use it to filter 'File48M.wav'. Diagram the output signal for `n=1:200` and compare it with the previous output signal.

Exercises about FIR filter design

Exercise 1

Design a bandpass filter using the window method with the following specifications:

- Maximum deviation in the passband 4%.
- Minimum attenuation in stopbands 50 dB.
- Passband from 1600 Hz till 2400 Hz.
- Stopbands from 0 Hz till 1200 Hz, and from 2800 Hz till 4000 Hz.
- Sampling frequency 8000 Hz.

Use function `fir1` and Kaiser window.

Exercise 2

Design a bandpass filter using the least-square method (`firls`) and the Parks McClellan algorithm (`remez`) with the following specifications:

- Passband from 1600 Hz till 2400 Hz.
- Stopbands from 0 Hz till 1200 Hz, and from 2800 Hz till 4000 Hz.
- Sampling frequency 8000 Hz.
- Same filter order of Exercise 1.

On the same figure, plot the magnitude response in dB of the filter of Exercise 1 and of the two filters of this exercise.

Exercise 3

Using the window method and function `fir2`, design an FIR equalizer of order 50 for the magnitude response specified by the following plot:

```
f = [0, 0.2, 0.8, 1];
A = [1.5, 1.5, 0.5, 1];
plot(f,A);
```