Digital Signal Processing

http://kom.aau.dk/~zt/cources/DSP/

Exercises of Lecture 8 (MM8)

Exercise 8.1. We wish to use the Kaiser window method to design a descrete-time filter with generalized linear phase that meets specifications of the following form :

$$
\begin{aligned}
|H(e^{j\omega})| &\leq 0.01, && 0 \leq |\omega| \leq 0.25\pi \\
0.95 \leq |H(e^{j\omega})| &\leq 1.05, && 0.35\pi \leq |\omega| \leq 0.6\pi \\
|H(e^{j\omega})| &\leq 0.01, && 0.65\pi \leq |\omega| \leq \pi
\end{aligned}
$$

(a) Determine the minimum length (M+1) of the impulse response and the value of the Kaiser window parameter β for a filter that meets the preceding specifications.

(b) What is the delay of the filter?

(c) Determine the ideal impulse response $h_d[n]$ to which the Kaiser window should be applied.

Exercise 8.2. We wish to design and FIR lowpass filter satisfying the specifications

$$
\begin{aligned}
0.95 < H(e^{j\omega}) &< 1.05, && 0 \leq |\omega| \leq 0.25\pi \\
-0.1 < H(e^{j\omega}) &< 0.1, && 0.35\pi \leq |\omega| \leq \pi
\end{aligned}
$$

by applying a window w[n] to the impulse response $h_d[n]$for the ideal discrete-time lowpass filter with cutoff $\omega_c = 0.3\pi$. which of the windows listed in Table 7.1 can be used to meet this specification.

Exercise 8.3. A fourth order Type I linear-phase FIR filter, h[n], is to be designed using the window method.

The ideal (wanted) impulse response of the filter is defined as (M is the filter order):

$$
h_d[n] = \frac{\sin(n - \frac{M}{2})\frac{\pi}{4}}{(n - \frac{M}{2})\pi}
$$

(a) Find and sketch h[n] using a Hamming window

(b) Find the transfer function, H(z), of the filter

(c) Is the filter stable? (Justify your answer)