Digital Signal Processing

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

Exercises of Lecture 4 (MM4)

Exercise 4.1. Design a discrete-time filter that meets specifications

$$0.87 \le |H(e^{j\omega})| \le 1, \qquad 0 \le |\omega| \le 0.25\pi,$$

$$|H(e^{j\omega})| \le 0.21, \qquad 0.35\pi \le |\omega| \le \pi$$

by using the impulse invariance method to a continuous-time Butterworth filter having magnitude-squared function

$$|H_c(j\Omega)|^2 = \frac{1}{1+(\Omega/\Omega_c)^{2N}}$$

Determine the integer order N and the quantity Ω_c such that the continuous-time Butterworth filter exactly meets the specifications. (Assume that *Td*=1)

Exercise 4.2. We wish to use the Kaiser window method to design a discrete-time filter with generalized linear phase that meets specifications of the following form:

$$|H(e^{j\omega})| \le 0.01, \qquad 0 \le |\omega| \le 0.25\pi$$

$$0.95 \le |H(e^{j\omega})| \le 1.05, \qquad 0.35\pi \le |\omega| \le 0.6\pi$$

$$|H(e^{j\omega})| \le 0.01, \qquad 0.65\pi \le |\omega| \le \pi$$

(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 4.3. We wish to design an FIR lowpass filter satisfying the specifications

$$0.95 < H(e^{j\omega}) < 1.05, \qquad 0 \le |\omega| \le 0.25\pi$$

$$-0.1 < H(e^{j\omega}) < 0.1, \qquad 0.35\pi \le |\omega| \le \pi$$

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?