ÉCOLE POLYTECHNIQUE FÉDÉRALE DE LAUSANNE
School of Computer and Communication Sciences

Handout 11 Signal Processing for Communications
Midterm April 20, 2010

PROBLEM 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.

(d) Plot the Fourier transform of $h[n] = h_d[n]w[n]$.

Hint.

`http://en.wikipedia.org/wiki/Window_function`

PROBLEM 2. We decide to design a Type I M-tap FIR filter. We require the filter to be lowpass, with a transition band from $\omega_p = 0.4\pi$ to $\omega_s = 0.6\pi$; we further state that the tolerances for the realized filters magnitude must not exceed 10 percent in the passband and 1 percent in the stopband.

(a) Estimate the minimum length M of the impulse response using Kaisar's formula.

(b) Use Matlab and run the Parks-McClellan algorithm to find the filter. Check that the filter satisfies the design specification, and if not, increase the number of taps.

PROBLEM 3. Design a FIR bandpass filter using Kaisar's window which passes frequencies between 0.4π and 0.6π , allowing transition bands from $0.3\pi, 0.4\pi$ and $0.6\pi, 0.8\pi$ (i.e., the stopbands are $0, 0.3\pi$ and $0.8\pi, \pi$). The desired stop-band attenuation is 80 dB, and the passband ripple is required to be no greater than 0.1 dB.

Hint. Use kaiserord and fir1 commands.