Lab 10

IIR Filter Design

Band-Pass Filter (5 points)

A discrete bandpass filter must fulfill the following specifications: the passband frequencies are $f_{p1} = 12MHz$, $f_{p2} = 25MHz$, the stopband frequencies $f_{s1} = 3MHz$ and $f_{s1} = 30MHz$ and the attenuations are $A_p = 1dB$ and $A_s = 60dB$. The sampling frequency of the system is $f_m = 80MHz$. Using the Butterworth, Chebyshev-I and Chebyshev-II approximations, do the following:

1. Design the filter $H(z)$, calculating the filter's order n, ϵ^2 and the cut-off frequency of the corresponding analog filter.
2. Plot the frequency response in Magnitude, phase and group delay of the discrete filters and make sure they fulfill the specifications.
3. Plot the impulse response of the three filters in the same figure.
4. Generate a discrete random signal (normal distribution) with zero mean and variance $\sigma = 1$. The samples will be sampled at $f_m = 80MHz$. Filter that signal with the three filters designed in the previous step.
5. Plot the three results in the same figure in a time axis.

Low-Pass Filters (5 Points)

In file `din.mat` is given the baseband signal of a GMSK modulator. The sampling frequency is $32MHz$ and the symbol period is $0.5\mu s$. Design a low-pass filter with the following specifications:

- Passband frequency, $f_p = 1.8MHz$.
- Passband Attenuation, $A_p = 1dB$.
- Stopband frequency, $f_s = 6MHz$.

- Stopband Attenuation, $A_s = 60db$.

1. Design 3 digital filters, Butterworth, Chebyshev-I and Chebyshev-II.
2. Plot the frequency responses of the three filters (Magnitude Response and Group Delay)
3. Filter the signal `din` with the three obtained filters and plot them in the same figure.
4. Explain the delay differences between the filters with the frequency responses of the filters.