

## EE 3054 Lab 6: Recursive Digital Filters

Please carefully read the notes on *Recursive Digital Filters* before the lab.

1. Use the Matlab function `ellip` to obtain a  $3^{rd}$  order digital filter with pass-band ripple  $\delta_p = 0.01$ , stop-band ripple  $\delta_s = 0.01$ , and cut-off frequency  $0.4\pi$ . [That means, use `Wn = 0.4` in `ellip`.] You will need to convert  $\delta_p$ ,  $\delta_s$  to  $R_p$  and  $R_s$ . Make a plot of the magnitude of the frequency response, on a linear scale and in dB, and of the impulse response. Also make a plot of the pole-zero diagram (using `zplane`).
2. Repeat the previous problem, but instead use a filter of order 4.
3. Repeat the previous problem, but obtain instead a filter of order 6. Comment on your observations. How does the frequency response of the elliptic filter improve as the filter order is increased? How does the impulse response change?
4. Read the full `help` file for `ellip`. This command can be used to obtain high-pass filters, band-pass filters, and band-stop filters as well. Design a discrete-time high-pass filter and plot the frequency response, impulse response, and pole-zero diagram.
5. Design a discrete-time bandpass filter and plot the frequency response, impulse response, and pole-zero diagram.
6. Other types of IIR digital filters can be design with Matlab. The Butterworth and Chebyshev filters are commonly used filter types. These filters can be designed in Matlab using the commands `butter`, `cheby1`, `cheby2`. Use the `help` command to investigate these filters. Design a Butterworth low-pass IIR digital low-pass filter of order 4 using `butter`, and make the corresponding graphs.
7. Design a Chebyshev-I low-pass IIR digital low-pass filter of order 4 using `cheby1`, and make the corresponding graphs.
8. Design a Chebyshev-II low-pass IIR digital low-pass filter of order 4 using `cheby2`, and make the corresponding graphs.

To turn in: Graphs of the frequency responses, impulse responses, and pole-zero diagram and your comments: In what ways do the four types of IIR filters differ (`ellip`, `butter`, `cheby1`, `cheby2`)? How do they differ in the frequency response and pole-zero plots? What happens as you increase the order of these filters?