
MATLAB Project

ECE512F**Objective:**

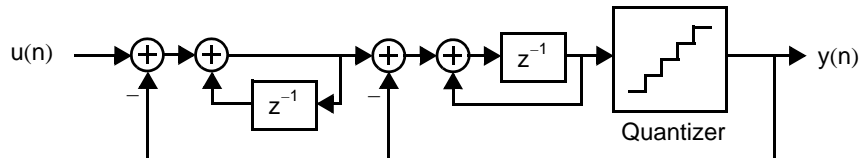
To introduce the basics of filter design using MATLAB as a CAD tool.

Useful Matlab commands:

plot, semilogx, loglog, subplot, bode, hold, xlabel, ylabel, title, grid, gtext, log10, ones, zeros, abs, angle, conv, poly, buttap, cheblap, ellipap, besslap, butter, cheby1, ellip, besself, buttord, cheblord, ellipord, grpdelay

- E1) Using MATLAB, plot the magnitude and phase responses for the following continuous-time lowpass filters.
 - a) A 4th order Butterworth filter with 3dB frequency at 1 rad/s from 0 to 10 rad/s
 - b) The same as a) but with the 3dB freq at 10 kHz and plot from 0 to 100kHz
 - c) Compare the filter coefficients for the 2 filters when in polynomial form.
- E2) Plot the magnitude responses for the following continuous-time lowpass filters.
 - a) A 4th order Cheby1 filter with a 1dB passband ripple up to 1 rad/s from 0 to 10 rad/s.
 - b) The same as c) but a Cheby2 filter
 - c) Compare the two magnitude responses for “ripple” locations
- E3) Plot the magnitude response for the following continuous-time lowpass filters on the same plot.
 - a) A 4th order Elliptic filter with 1dB passband ripple up to 1 rad/s and 30dB stopband attenuation from 0 to 10 rad/s.
 - b) A 4th order Bessel filter from 0 to 10 rad/s.
- E4) Write a MATLAB m-file that will plot the magnitude response for a second-order lowpass filter given ω_0 , Q , and dc gain. Plot the gain in dB from 0 to $10\omega_0$. Check your code with various pole-frequencies, Q and dc gains.
- E5) Write similar m-files as E4) for highpass, bandpass and notch second-order filters (you will need to modify the inputs).
- E6) Find the poles and zeros for a 4'th order Elliptic filter with 1 dB passband ripple up to 1 rad/s and 30dB stopband attenuation (this is the same as in E1)). Separate this filter into 2 biquad filters and plot the magnitude responses for each. Combine the two plots together to check that they result in the Elliptic filter once more.

- E7) Using the bilinear transform, find an $H(z)$ to realize a Chebyshev discrete-time filter with a peak gain of one, a passband frequency from 0 to 1kHz, and a stopband frequency of 1.5kHz when the sampling rate is 10kHz. The passband ripple and stopband attenuation should be 0.5dB and 20dB, respectively.
- E8) Use simulink to verify your design in E7) by applying white noise and plotting the power spectral density.
- E9) Put the second order modulator shown below into simulink.. Use a one bit quantizer



- that has +1 and -1 as its output and let all the sampling times be 1 second. Apply a sinusoidal input that is at $2\pi/128$ rad/sample and then filter the output with a 3rd order butterworth filter that has a passband edge at $2\pi/64$. Look at the time domain and frequency domain representations of the 1-bit and lowpass filtered signals.
- E10) Change the quantizer in E9) so that it uses 16 levels of quantization and re-investigate the signals.