ECE-210-B HW7

Instructor: Jonathan Lam

Spring 2021

For each of the following scenarios, you will generate a filter, create magnitude-phase plots for the filter, and apply the filter. First, we will generate a test vector x on which to apply the filters. Let x be the sum of sinusoids of all integer frequencies from 1Hz to 5kHz. Set $t = [0, 2]$, using an sampling frequency of 100kHz. I.e.,

$$x = \sum_{f=1}^{50000} \sin(2\pi f t),\ \{0 \le t \le 2\}$$

For each filter, follow these steps (you may want to define this in a function so you don't have to repeat this code). Subplots recommended!

1. Use the given specifications to produce the lowest-order filter which meets the specs. Either:
   (a) Use `filterDesigner` to generate a MATLAB function that returns a filter, and then call the function to create the filter object; or
   (b) Use the functions for designing and estimating the order of specific types of filters (e.g., `cheby2ord`, `cheby2`) to generate it without `filterDesigner`. Make sure all the parameters are correctly specified! Refer to the lecture example.
2. Apply `freqz` on the filter object to produce a frequency-response plot. Similarly to in HW6, don't use this to plot the frequency response: manually plot the frequency response, making sure you follow all the same instructions as in HW6 #2d.
3. Apply the filter to the signal x, defined above.
4. Plot the Fourier transform of the filtered signal using `fft` and `plot`. Refer to the lecture examples for the proper way to use FFT and obtain the proper scaling (use one of the two scaling methods mentioned).

Type	Type	F_s	A_{pass}	A_{stop}	Frequency specs
Butterworth	HPF	100kHz	5dB	50dB	$F_{stop} = 10\text{kHz}, F_{pass} = 20\text{kHz}$
Chebyshev Type I	LPF		2dB	40dB	$F_{stop} = 35\text{kHz}, F_{pass} = 15\text{kHz}$
Chebyshev Type II	bandstop		5dB	50dB	$F_{stop} = 15\text{kHz}, 35\text{kHz}, F_{pass} = 5\text{kHz}, 45\text{kHz}$
Elliptic	bandpass		5dB	50dB	$F_{stop} = 15\text{kHz}, 35\text{kHz}, F_{pass} = 20\text{kHz}, 30\text{kHz}$