EE 15 Project Documentation

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A. Project specifications
- Filter type: Band-stop
- Range: 142 – 242 Hz

B. Program features
- User-defined input.
- Filters signal on 142 – 242 Hz range by Pole-Zero method.
- Plots Pole-Zero map, input signal waveform and frequency components, magnitude spectrum of filter, filtered signal waveform and frequency components.

C. Program flow

Line 25 to 35. User inputs number of input signals. User specifies frequencies of input signals. Lastly, the user will input sampling rate, **s_r**.

Line 37. Sampling rate, **S_R**, is setup as 2*pi/(sampling rate) for ease of use in the following code. Zeroes and poles will depend on the sampling rate.

Line 40 to 47. Zeroes are setup from 142 to 242 Hz with an interval of 10. Zeroes are stored in an array with variable named **Z**. Complex conjugate pairs are considered.

Line 51 to 67. Poles are setup on both sides of the cutoff frequency. The Ranges and intervals of the poles were chosen by trial and error. Poles are stored in an array with variable named **P**. Complex conjugate pairs are considered.

Line 70 to 71. Coefficients of the characteristics polynomial of **Z** and **P** are stored in **NUM** and **DEN**, respectively.

Line 73. With **NUM** and **DEN**, a discrete time transfer function, **HZ**, is created by 'filt' function.

Line 75. With **NUM** and **DEN**, **w** and **mag** are acquired through an already-defined function, freqzM. It will be used in plotting the magnitude spectrum.

Line 78 to 85. Pre-defined set of code for getting functions **xk** and **y**.

Line 89 to 93. Pole-Zero plot and Magnitude Spectrum (with labels) are created in a single window.

Line 101 to 105. Input signal waveform and input signal frequency components are created using variable **xk**. Filtered signal waveform and filtered signal frequency components are created using variable **y**.

D. Sample run

Number of test frequencies: 4
frequency 1: 90 Hz
frequency 2: 150 Hz
frequency 3: 230 Hz
frequency 4: 300 Hz
Sampling rate: 700 Hz

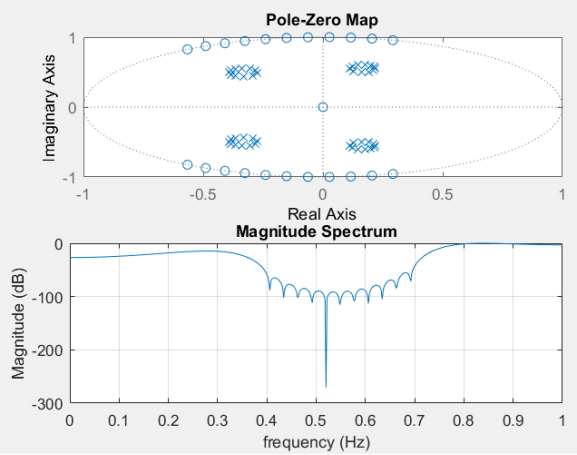

Fig. 1. Pole-Zero plot, Magnitude spectrum plot of designed filter.

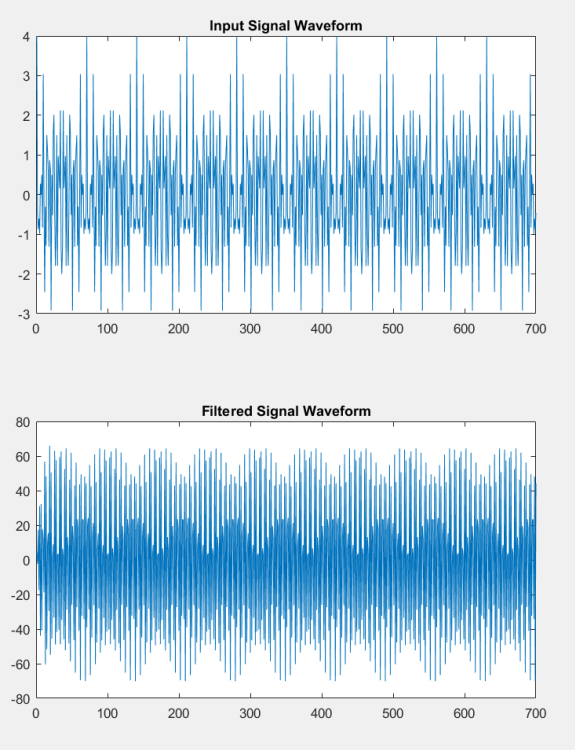

Fig. 2. Input and filtered signal waveforms.

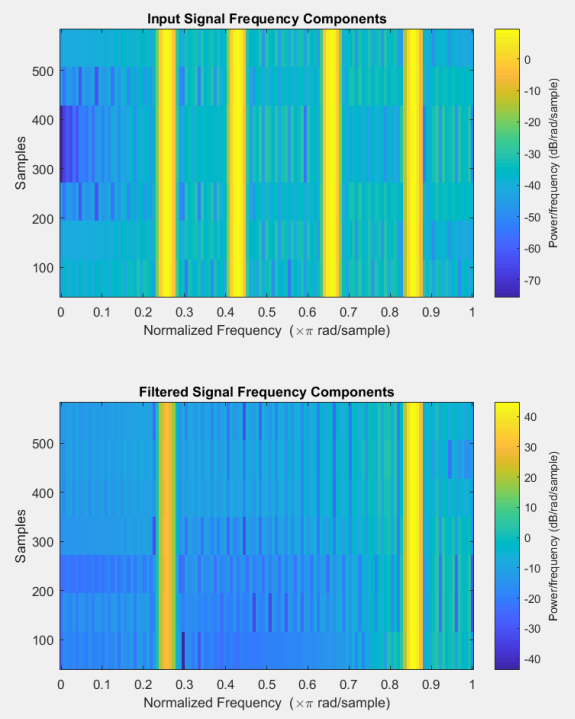

Fig. 3. Input and filtered frequency components.

E. Limitations

The design of the filter, specifically in the setup of poles and zeroes were chosen manually by means of trial and error. The design is not perfect, yet a good approximation for a band-stop filter at 142 Hz to 242 Hz. From the test runs, it was seen to be filtering properly at sampling rates approximately 1000 ± 40% Hz. It is also important that the program be used for frequencies relatively close to the range of the filter ($f<10^4$).