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Assignment 3
Digital Filter Design

Question 1

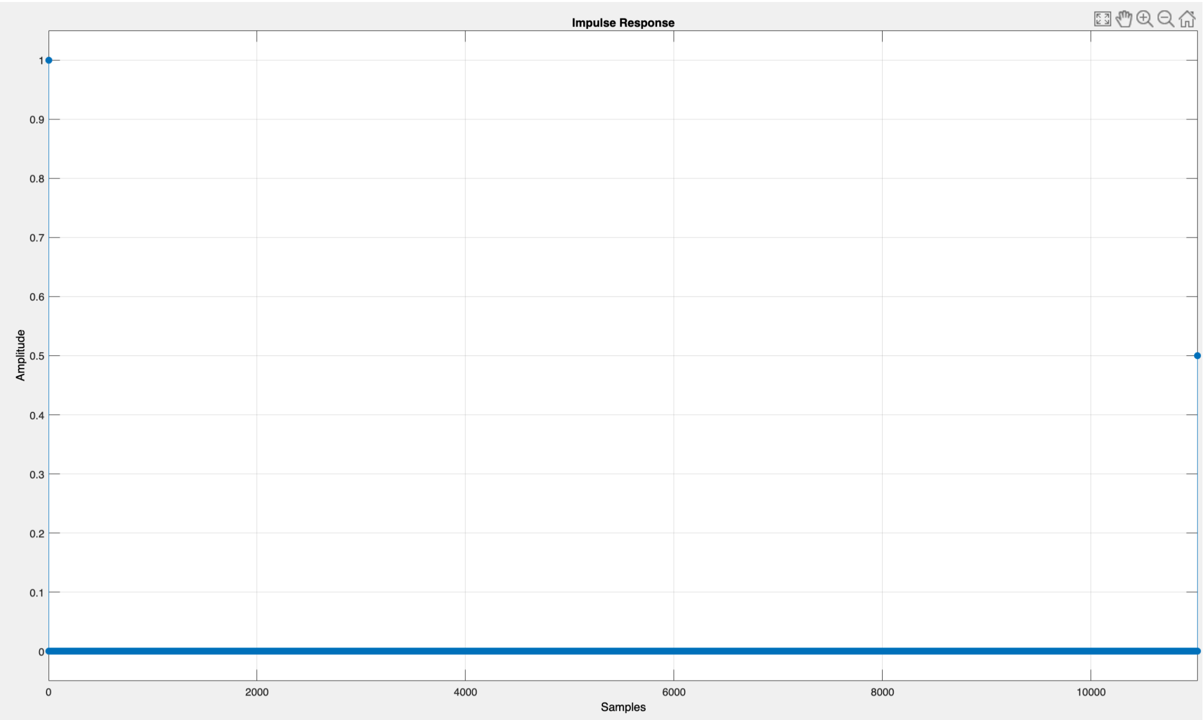
Q. Which cut-off frequency ensures you hear virtual pitch?

The cut-off frequencies are as follows:

Fstop : 439.0710

Fpass : 585.4280

Question 2



Impulse Response for output

Question 3

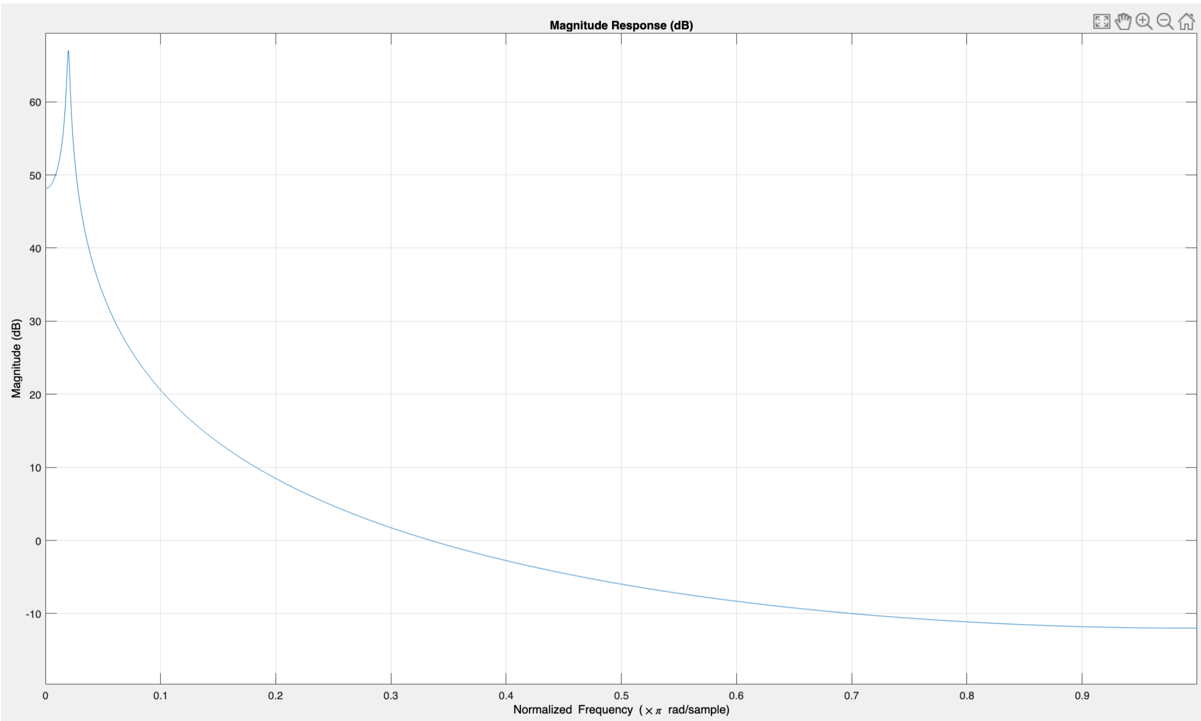
Q. At which point is the reverb noticeable?

At 100 delay, reverb it is noticeable.

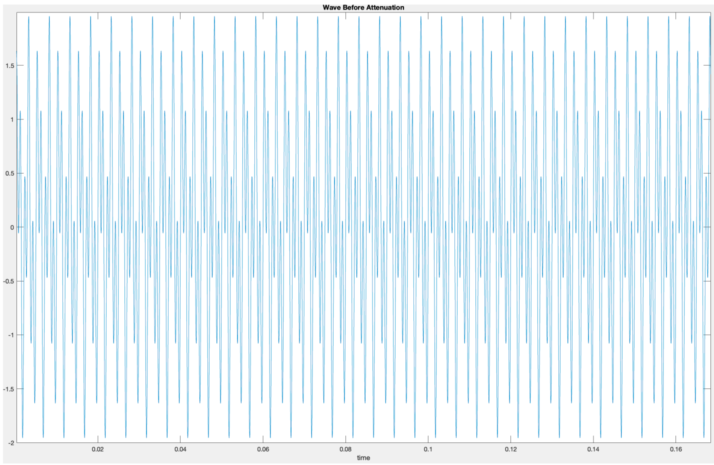
Q. At that time point of noticeable reverb, change gain from 0.1 to 1 in steps of 0.1 and comment on the results.

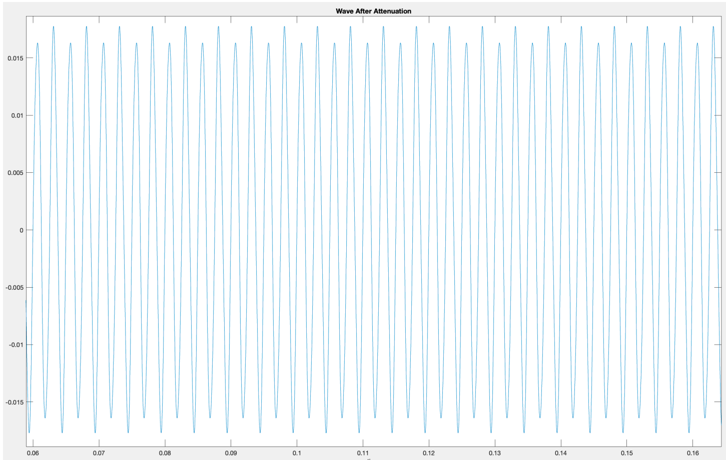
It was observed that lower gain value results in reduced reverb, while a higher gain value (e.g. 1) results in louder reverb. The reverb is not noticeable until the gain value is greater than 0.2.

Question 4



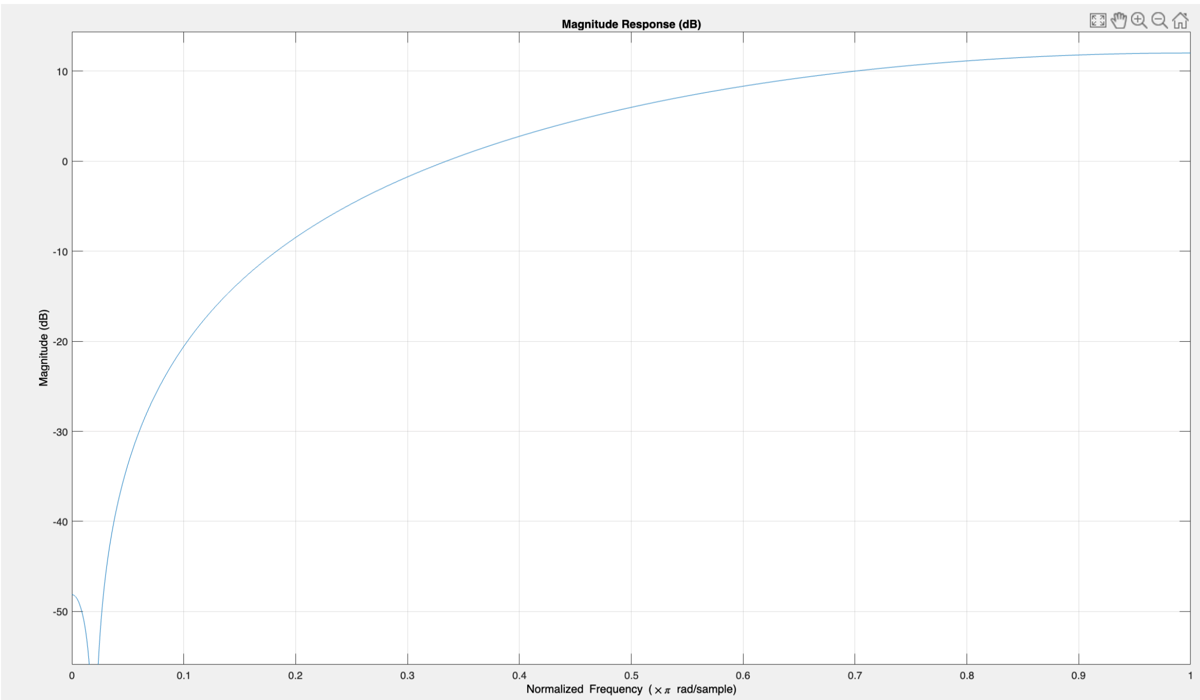
Magnitude Response





Input: Complex Sine Wave (400 Hz+ 1000 Hz)

Smooth; no significant distortion or amplification of the input signal



Bounded within the passband and stop-band

Question 5

Q. Effect of the notch filter on the complex wave.

The notch filter that we designed has a bandwidth of 50 Hz that attenuates 1000 Hz from the 2-second long signal composed of two sine waves with frequencies 1000 Hz and 400 Hz. It results in a filtered signal that only contains the 400 Hz sine wave. This is expected as the notch filter is designed to remove a narrow frequency band centred around 1000 Hz, which includes the 1000 Hz sine wave. As a result, the amplitude of the 1000 Hz sine wave is greatly reduced in the filtered signal, while the 400 Hz sine wave remains relatively unaffected. Therefore, the filtered signal sounds like a single sine wave with a frequency of 400 Hz, and the presence of the 1000 Hz sine wave is significantly reduced or eliminated.

Q. Comment on the stability of the filter.

As seen in the graph given below, our filter response seems to exhibit well-behaved characteristics such as smooth transitions, the absence of ringing or overshoots, and no significant distortion or amplification of the input signal. Also, the frequency response of our filter has a well-defined passband and stopband, and the magnitude response is also bounded within the passband and stopband as seen in the diagram Magnitude Response v/s Normalised Frequency graph. All these are the characteristics of a stable filter. Therefore, we can say with a high degree of certainty that our designed filter is stable.