ECE 438 Lab4a Report
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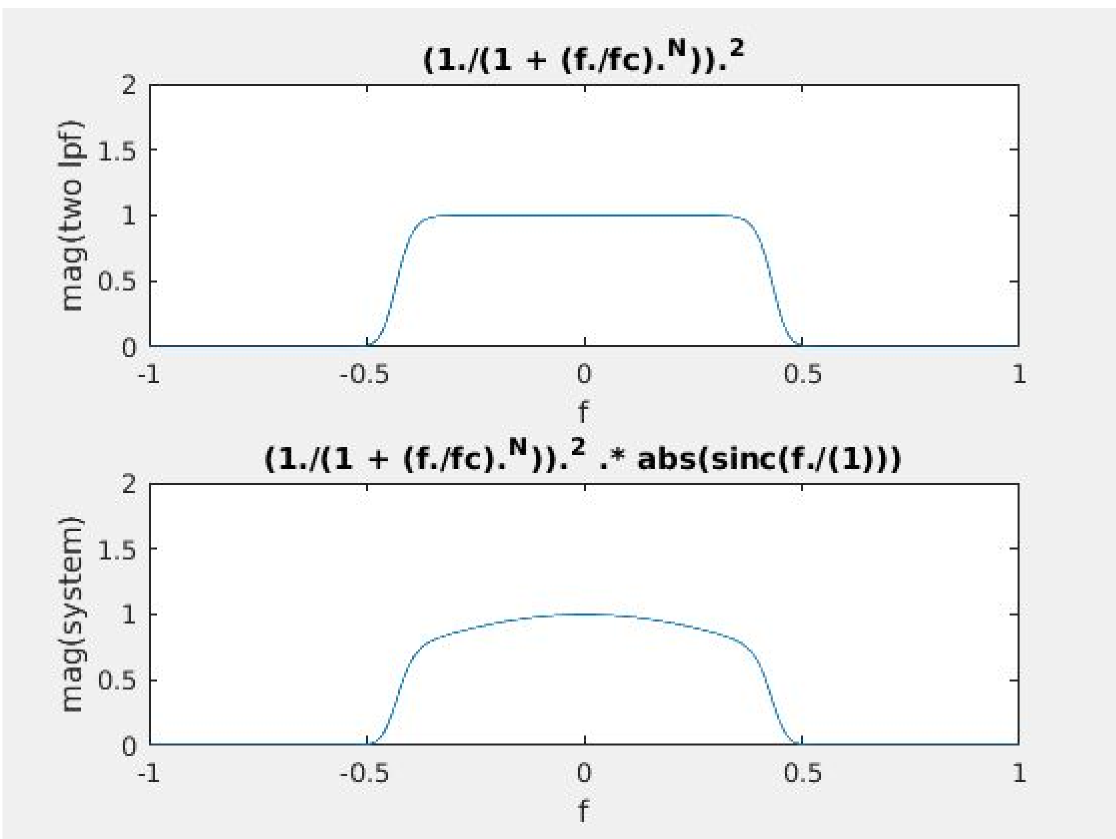
1.2 Sampling and Reconstruction Using Sample-and-Hold

INLAB REPORT: Do the following using Ts= 1 sec, fc= 0.45 Hz, andN= 20. Use Matlab to produce the plots (magnitude only), for frequencies in the range:f = -1:0.001:1.

•Compute and plot the magnitude response of the system in Figure 2 without the sample-and-hold device.

•Compute and plot the magnitude response of the complete system in Figure 2.

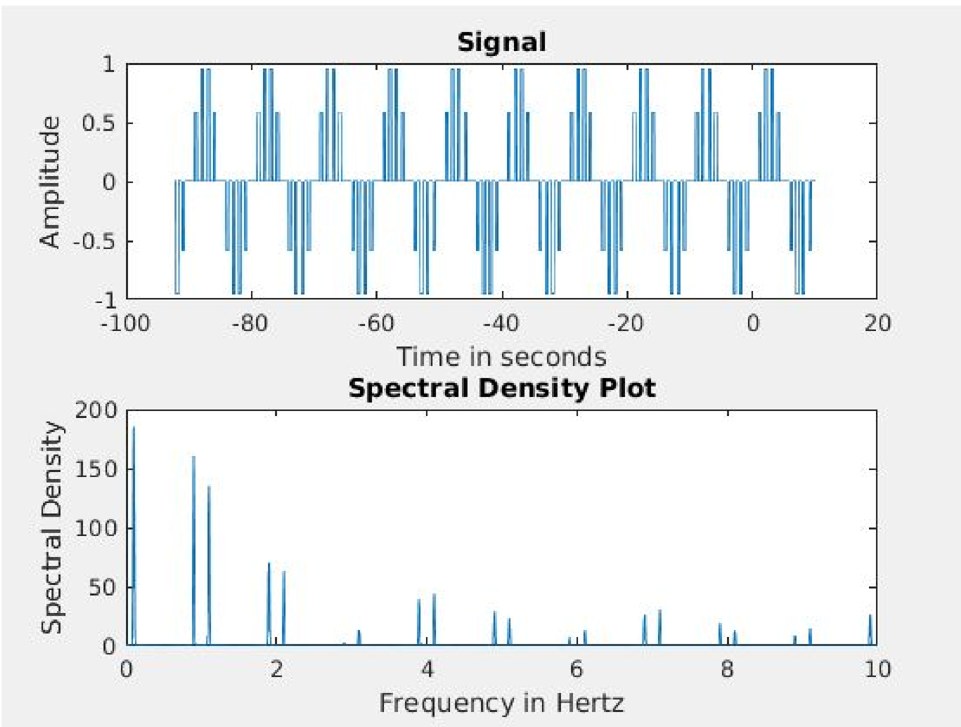
•Comment on the shape of the two magnitude responses. How might the magnitude response of the sample-and-hold affect the design considerations of a high quality audioCD player?

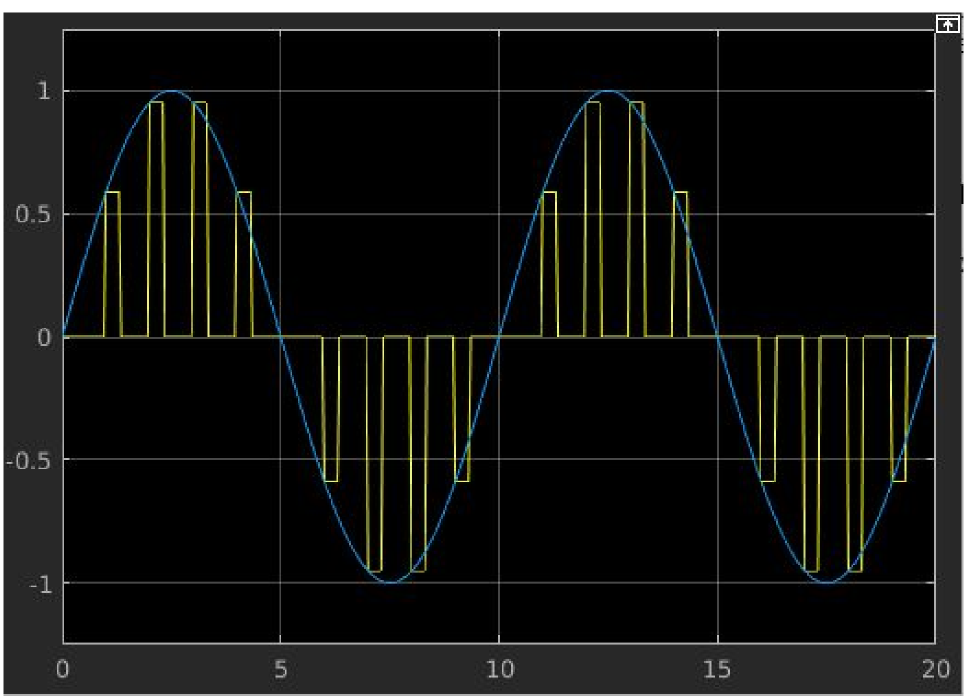


- The two low pass filters in series produced a magnitude plot that was flatter than when the sample-and-hold was added in between the filters. With the sample-and-hold added, the CD player might modulate musical signals (i.e. Bass & Treble) unevenly

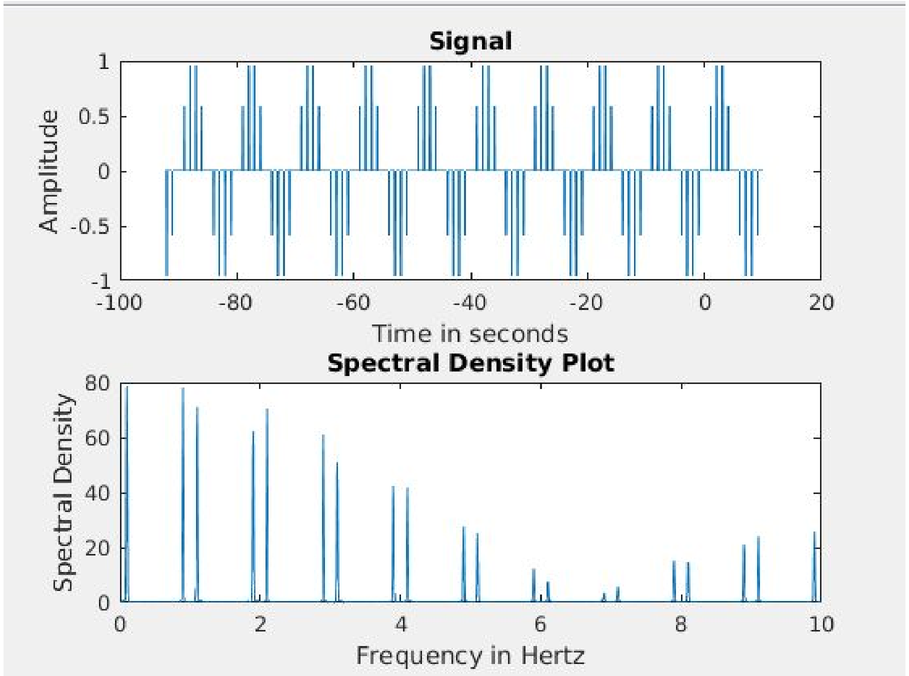
3 Sampling and Reconstruction with an Impulse Generator

INLAB REPORT: Submit the plot of the input/output signals and the plot of the output signal and its frequency spectrum. On the plot of the spectrum of the reconstructed signal, circle the aliases, i.e. the components that do NOT correspond to the input sine wave.

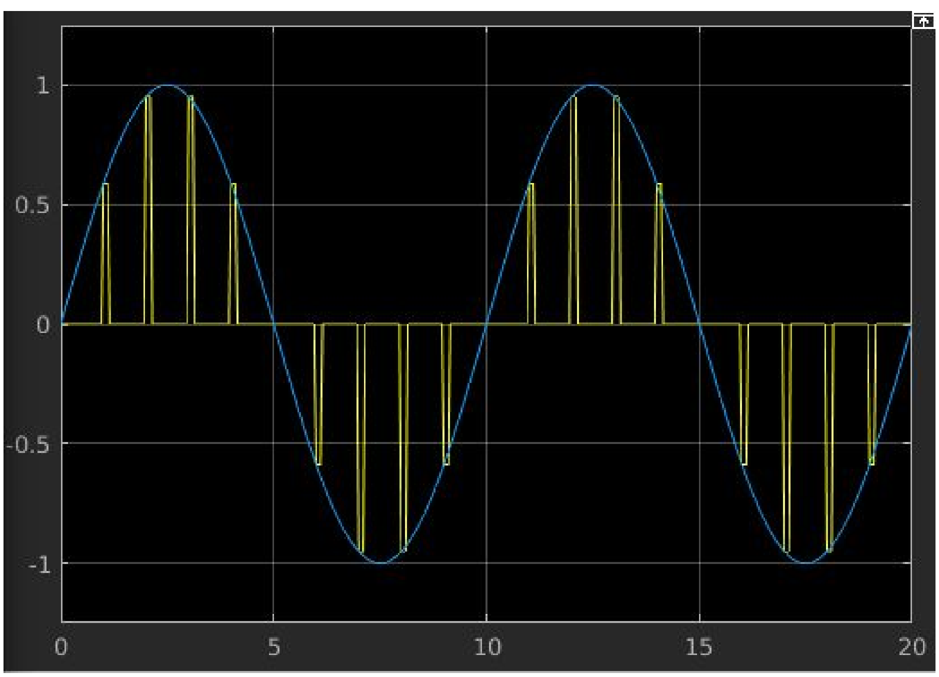




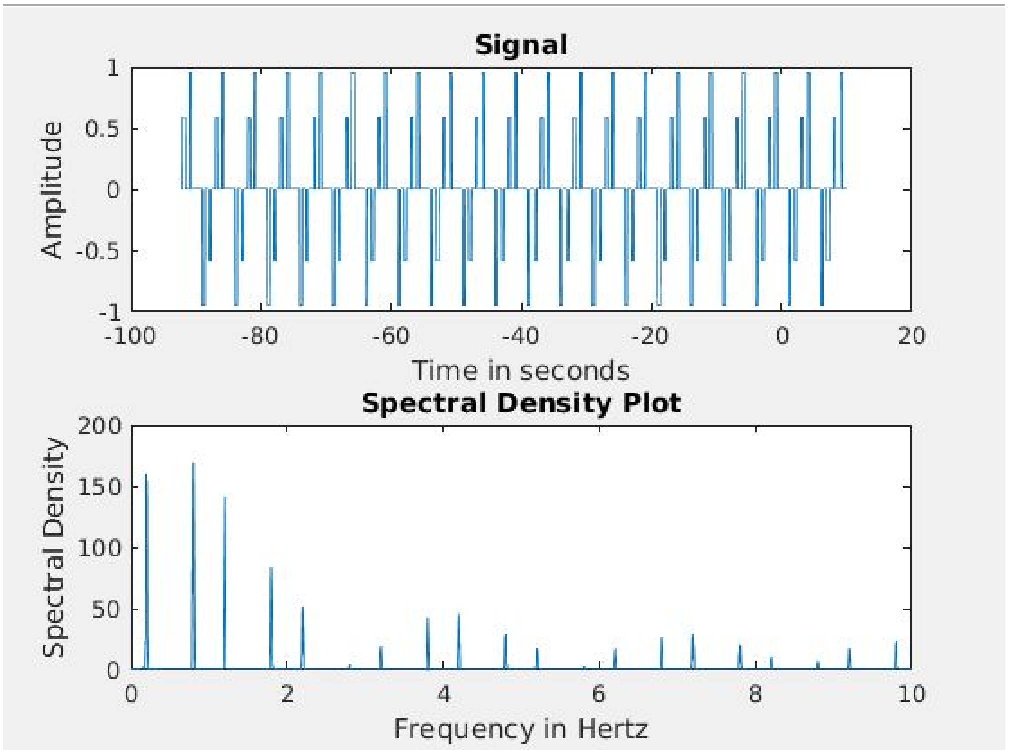
INLAB REPORT:Submit the plot of the output frequency spectrum for a pulse width of 0.1 sec. Indicate on your plot what has changed and explain why.



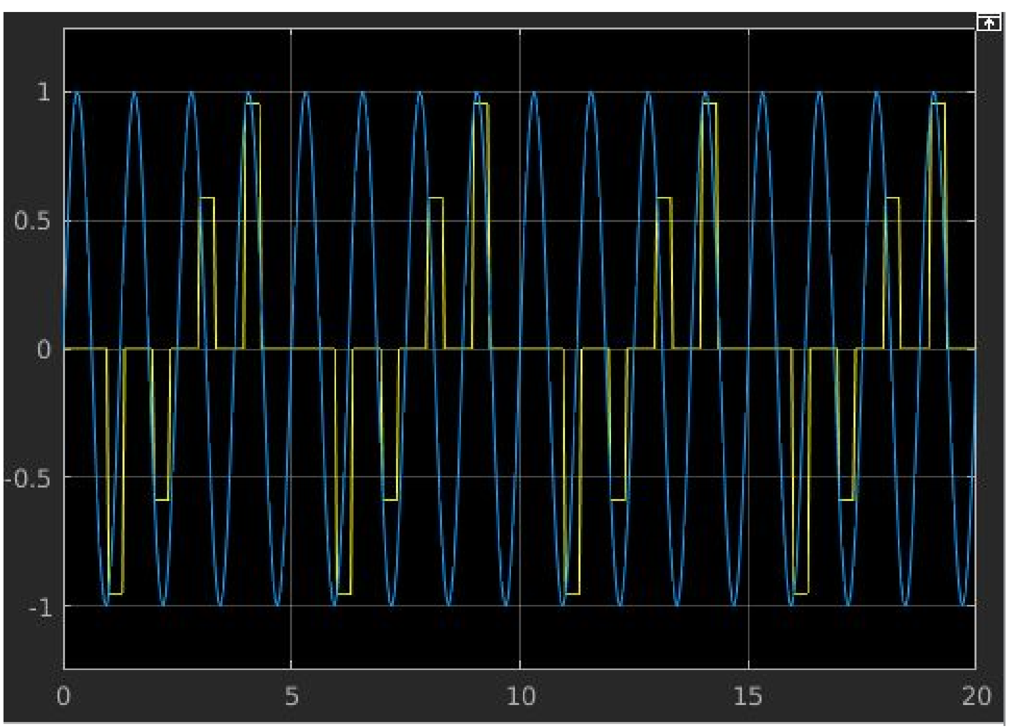
- By decreasing the pulse width from 0.3 sec to 0.1 sec, the plot of spectral densities is symptomatic of a sinc envelope that is now more expansive over frequency than before. This is because as the width of the rectangular pulse is shrunk in the time domain, the resulting frequency-domain sinc function is conversely more stretched out over frequency. The consequent spectral density plot reflects how the modified sinc signal decays slower over frequency than before, resulting in higher absolute spectral density samples at the corresponding frequencies overall and fewer cycles of the envelope displayed from 0 Hz to 10 Hz.



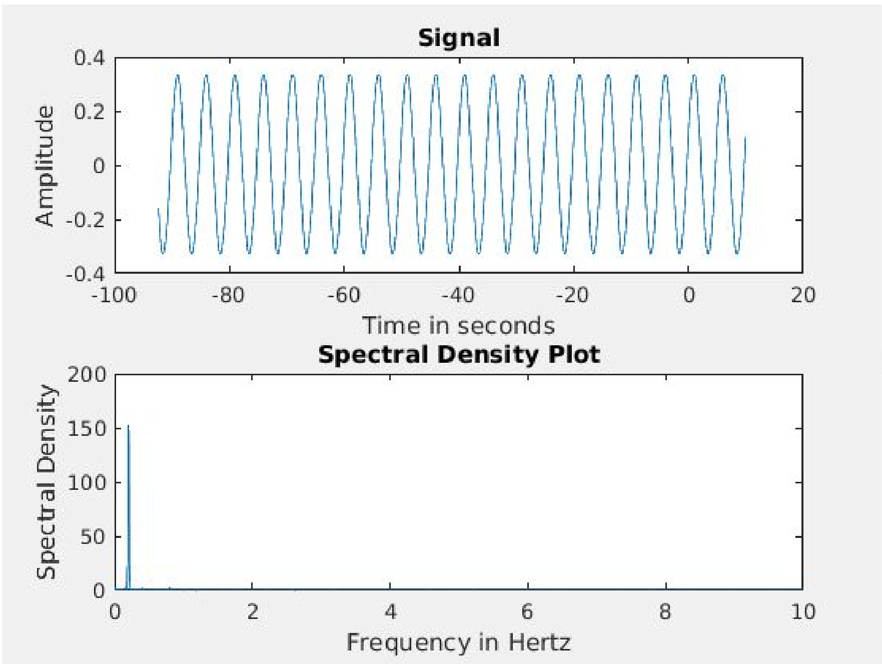
INLAB REPORT:Submit the plot of the input/output signals and the plot of the output signal and its fre-quency spectrum. On the frequency plot, label the frequency peak that corresponds to the lowest frequency (the fundamental component) of the output signal. Explain why the lowest frequency is no longer the same as the frequency of the input sinusoid.



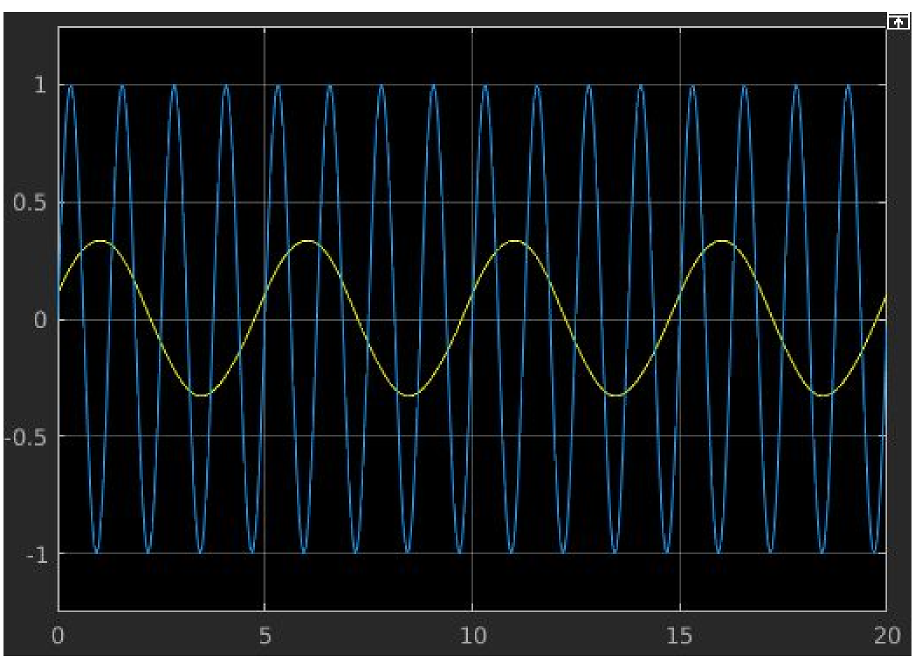
- The lowest frequency is not the same as the frequency of the input sine because the DTFT of the sine wave is two impulses at -0.8 & 0.8. When the impulses get repeated every 1/Ts, or 1 Hz in this case, impulses at 0.2 Hz and 1.8 Hz are obtained; 0.2 Hz is the lowest frequency seen in this spectral density plot



INLAB REPORT:Submit the plot of the input/output signals and the plot of the output signal and its frequency spectrum. Explain why the output signal has the observed frequency spectrum.

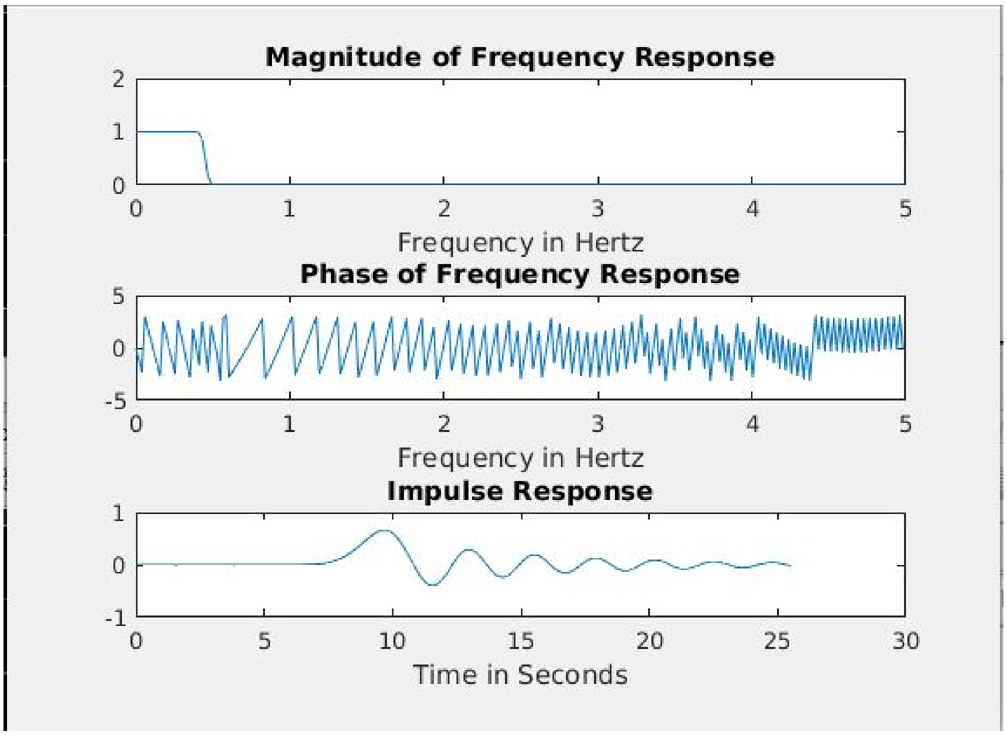


- The output signal only has a frequency spike at 0.1 because the rest of the frequency spikes got filtered by the low pass filter with cutoff frequency 0.5 Hz that was added to the output of the impulse generator.

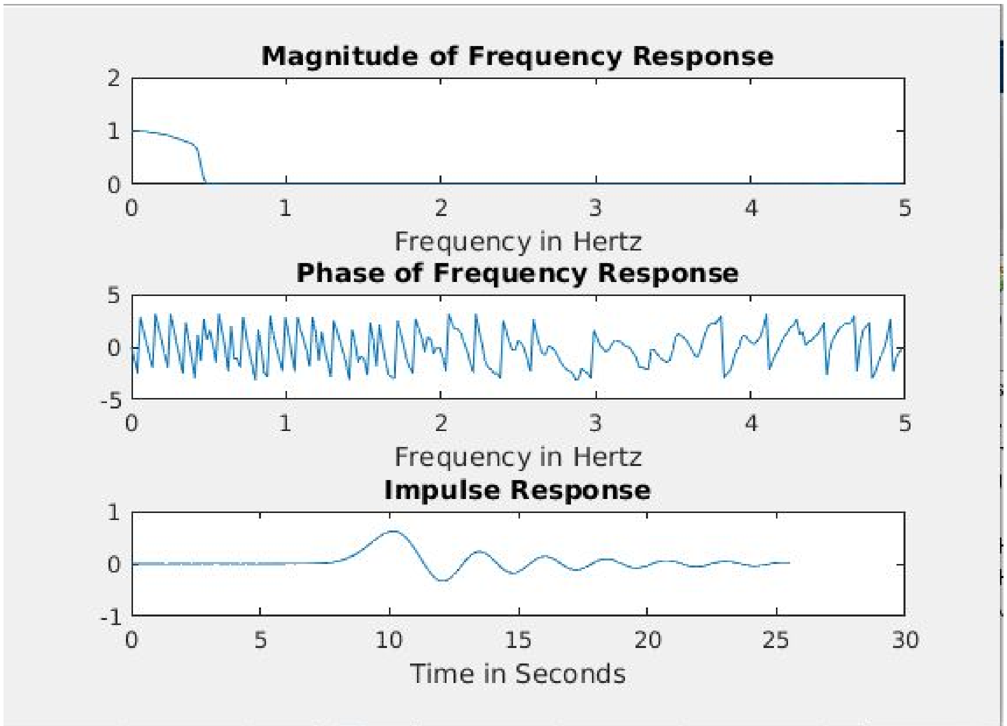


4 Sampling and Reconstruction with Sample and Hold

INLAB REPORT:Submit the figure containing plots of the magnitude response, the phase response, and the impulse response of this system. Use the tall mode to obtain a larger printout by typing orient('tall') directly before you print.



INLAB REPORT:Submit the figure containing plots of the magnitude response, the phase response, and the impulse response of this system. Explain the reason for the difference in the shape of this magnitude response versus the previous magnitude response. Give an analytical expression for the behavior of the magnitude plot for frequencies below 0.45 Hz.



- The difference between the shapes of the magnitude response is due to the addition of the sample-and-hold which produces a roll-off in frequencies near the Nyquist rate.
- For frequencies below fc = 0.45 Hz, the magnitude plot begins to look more like a sinc function from -0.45 Hz to 0.45 Hz. when f = 0, sinc(0) is like a delta function.

$$\left(\frac{1}{1+\left(\frac{f}{f_c}\right)^N}\right)^2 |\mathrm{sinc}(f/f_s)|$$