# Q1

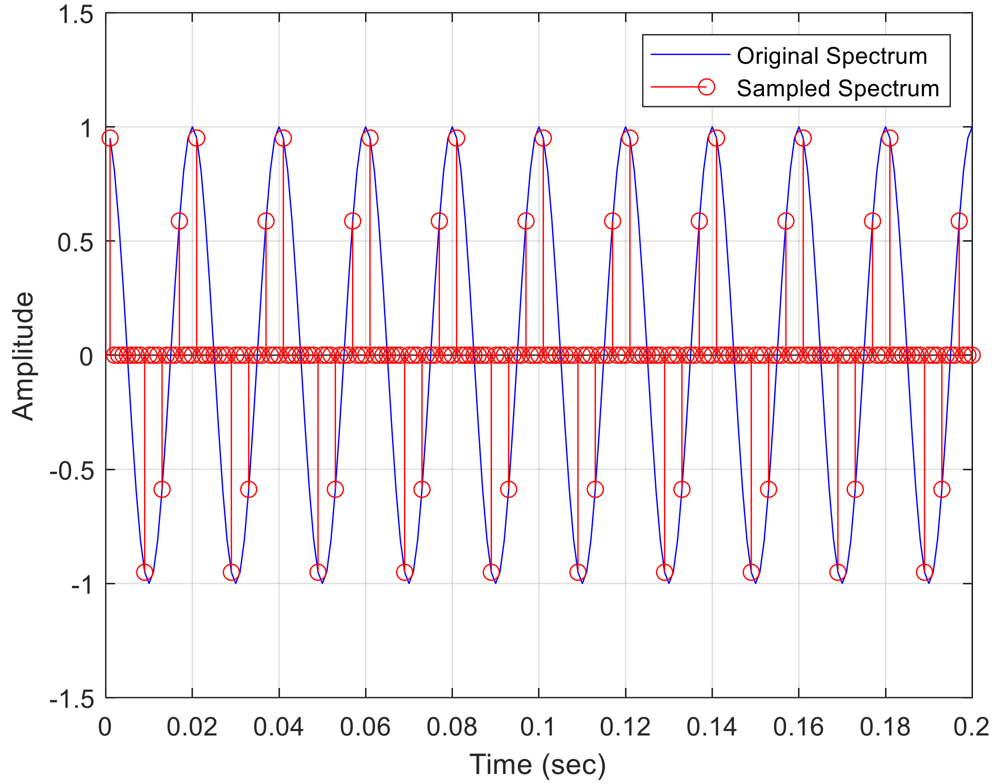


*Figure 1 – Original (fm = 50 Hz) And Downsampled (fdown = 250 Hz) Signal In Time Domain*

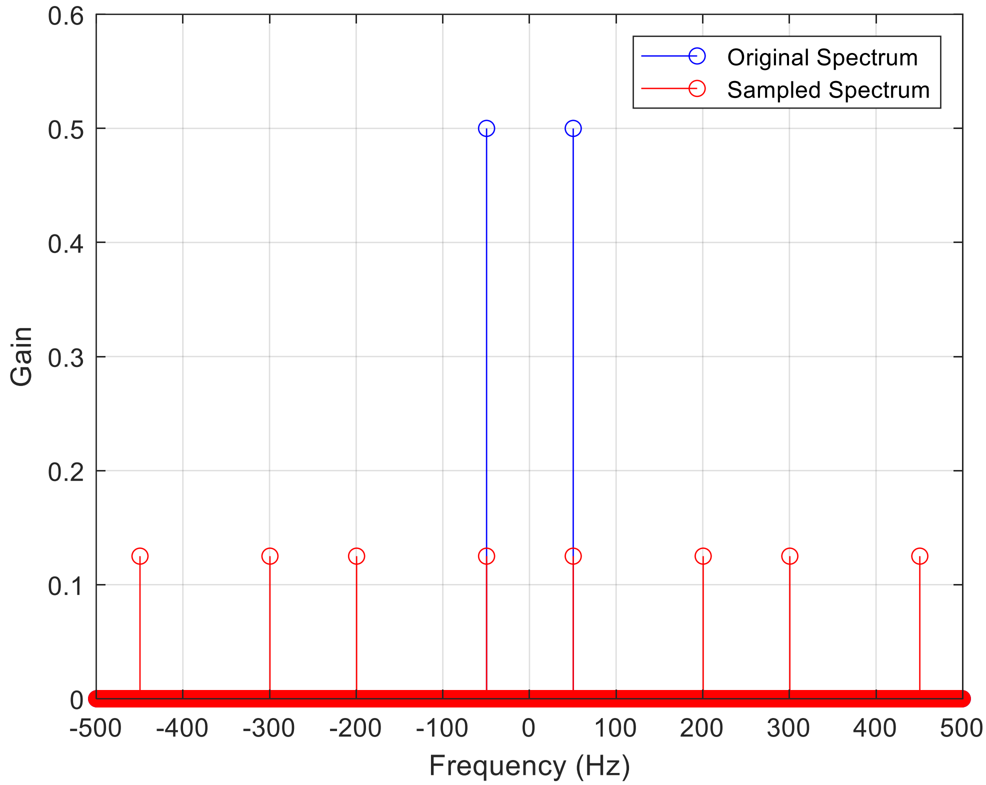


*Figure 2 – Original (fm = 50 Hz) And Downsampled (fdown = 250 Hz) Signal In Frequency Domain*

The reduction in gain depends on the ratio between the original and the new sampling rates. For example, if the original sampling rate was 1000 Hz and it was downsampled to 250 Hz, the gain would be reduced by a factor of 4:

$$Gain = \frac{\frac{1}{250}}{\frac{1}{1000}} = \frac{1000}{250} = 4$$

As a result, the frequency range and bandwidth of the signal would also be reduced to one-fourth of the original.

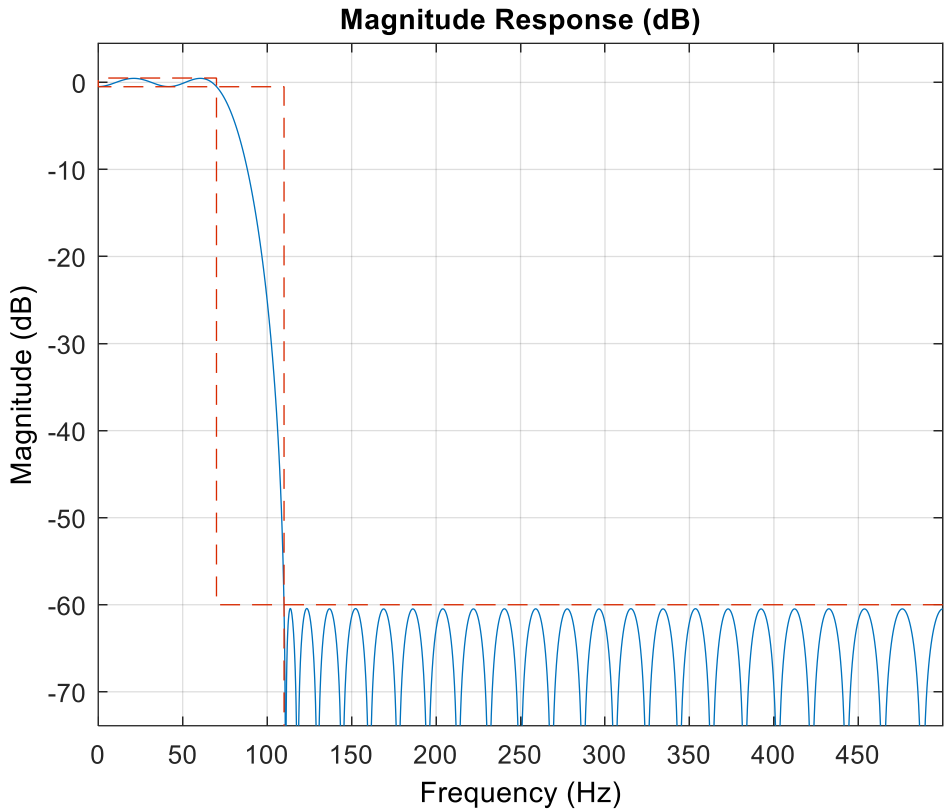


*Figure 3 – Low Pass Filter (cutoff = 70 Hz and stop = 110 Hz)*

We can shape our signal by tuning the f_cutoff and f_stop values of the low-pass filter we've implemented. By setting these parameters based on the signal's fundamental frequency, we can effectively reconstruct the original signal. The selected cutoff and stopband frequencies define the filter's transition band and the point at which attenuation begins. These settings help design the filter in a way that retains the essential low-frequency components of the signal, ensuring its main characteristics are preserved.

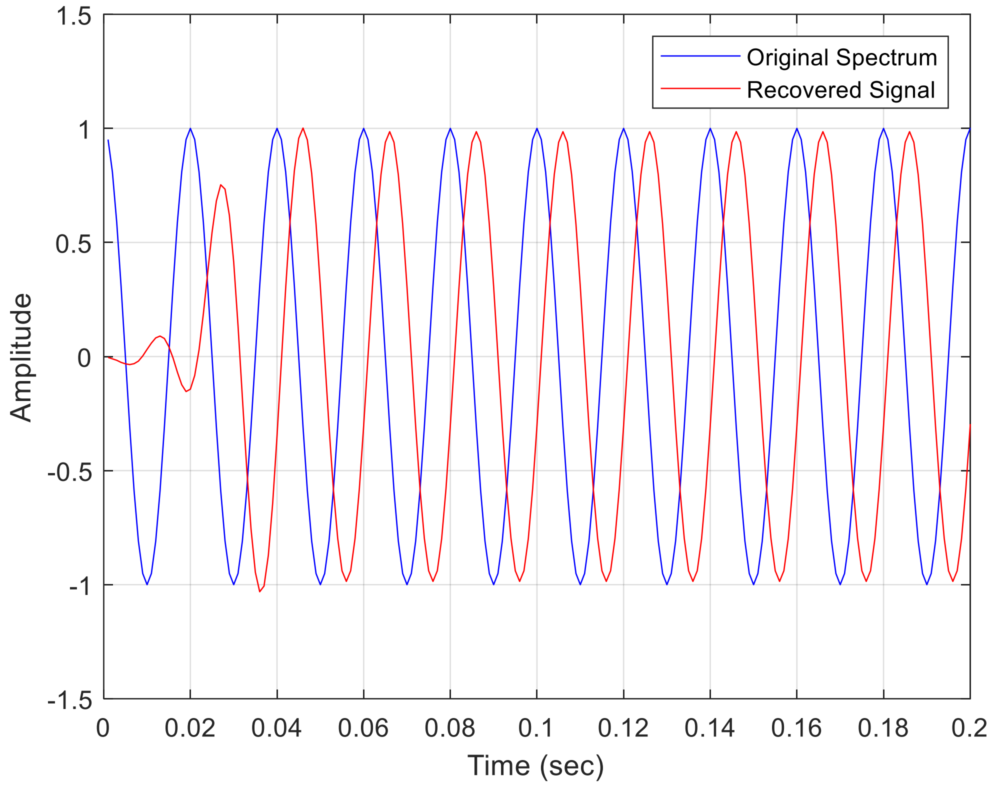


*Figure 4 - Original (fm = 50 Hz) And Recovered Signals In Time Domain*

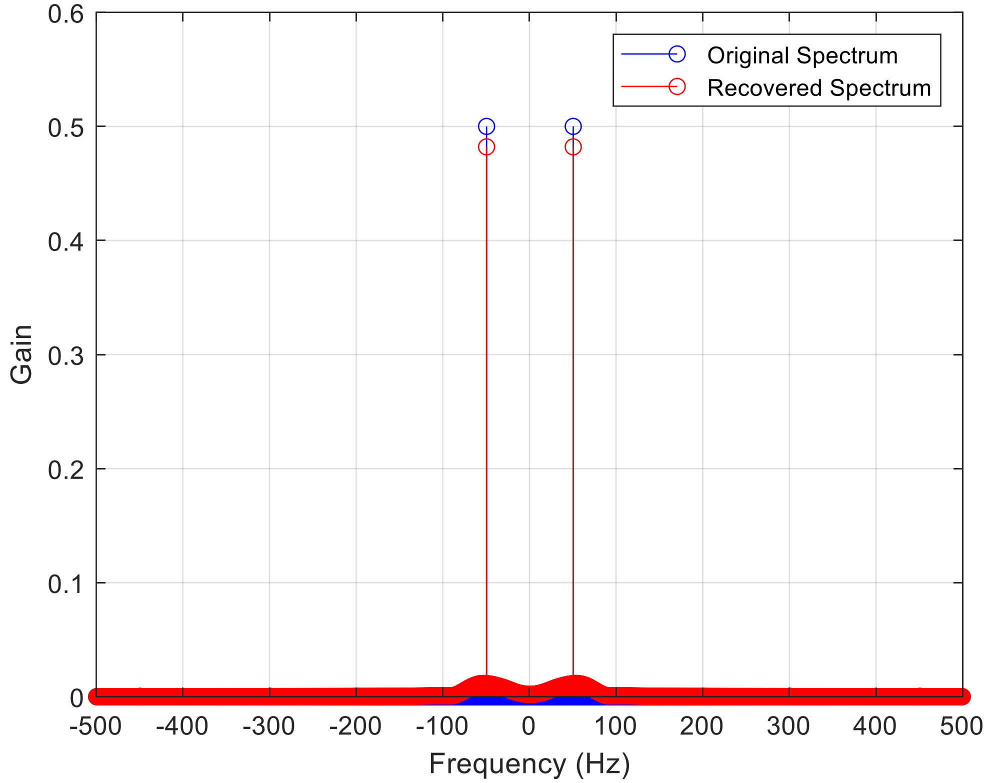


*Figure 5 - Original (fm = 50 Hz) And Recovered Signals In Frequency Domain*

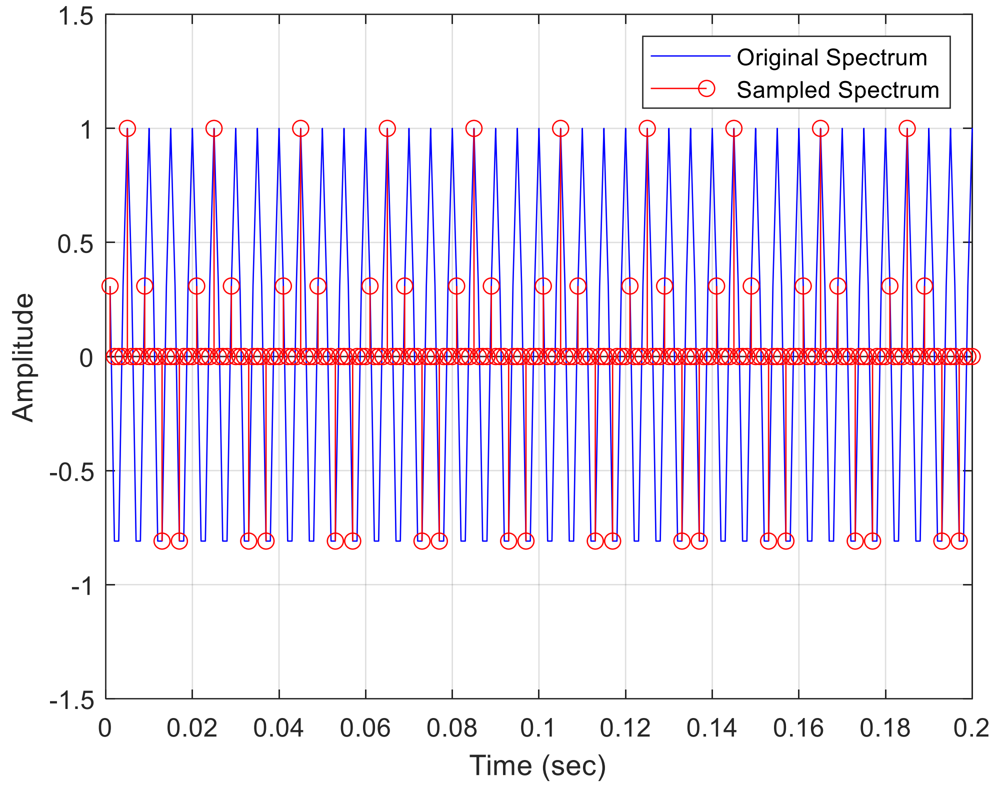


*Figure 6 - Original (fm = 200 Hz) And Downsampled (fdown = 250 Hz) Signal In Time Domain*

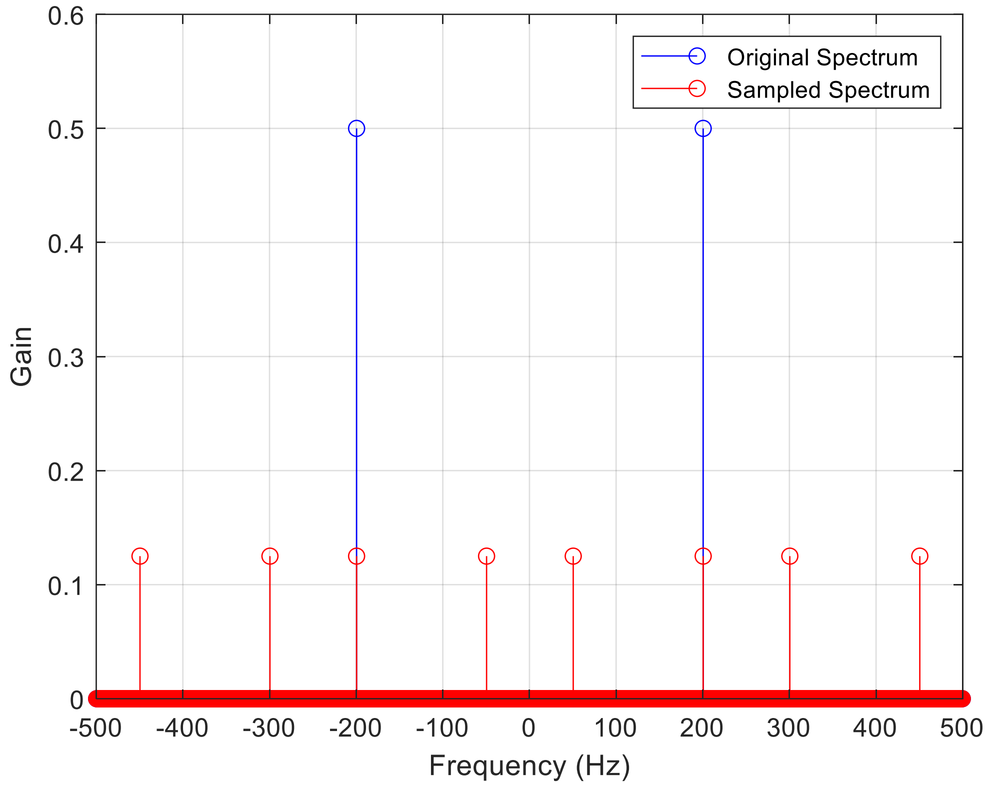


*Figure 7 - Original (fm = 200 Hz) And Downsampled (fdown = 250 Hz) Signal In Frequency Domain*

We canceled our Nyquist rate condition so, we lose the signal itself.

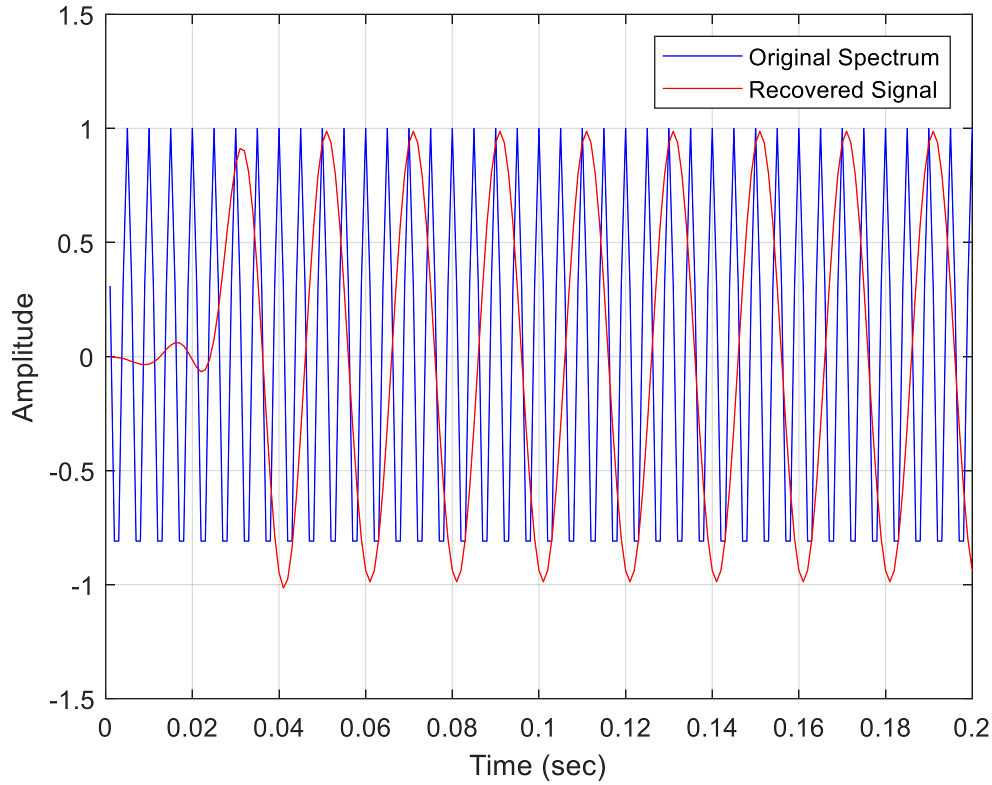


*Figure 8 - Original (fm = 200 Hz) And Recovered Signals In Time Domain*

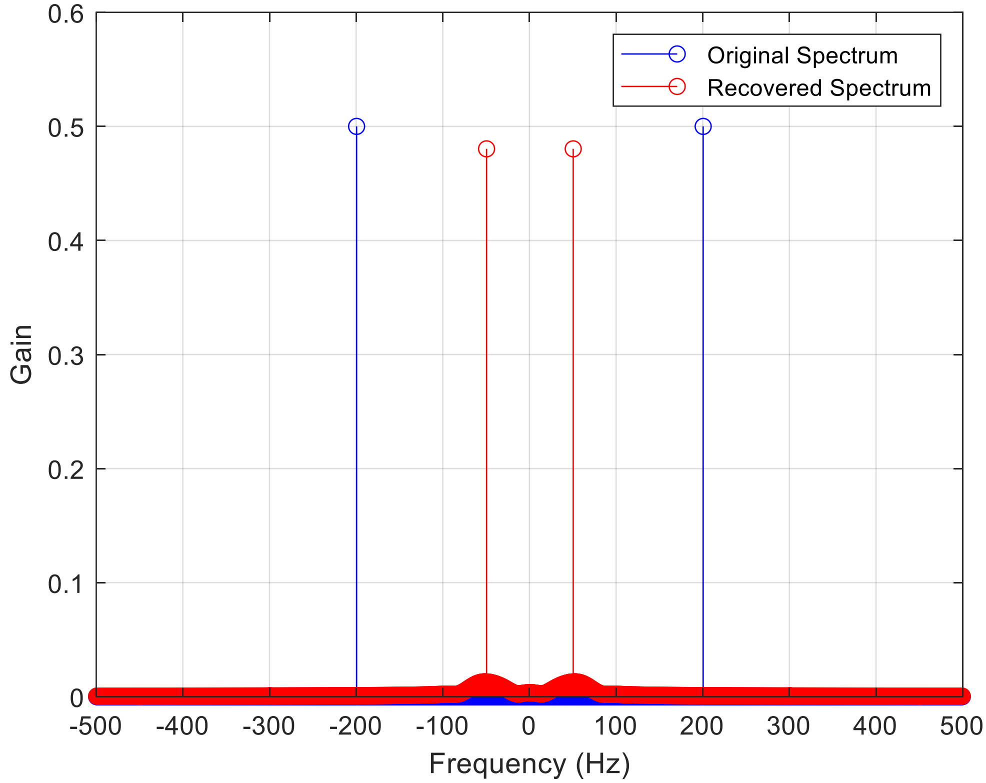


*Figure 9 - Original (fm = 200 Hz) And Recovered Signals In Frequency Domain*

## Q2

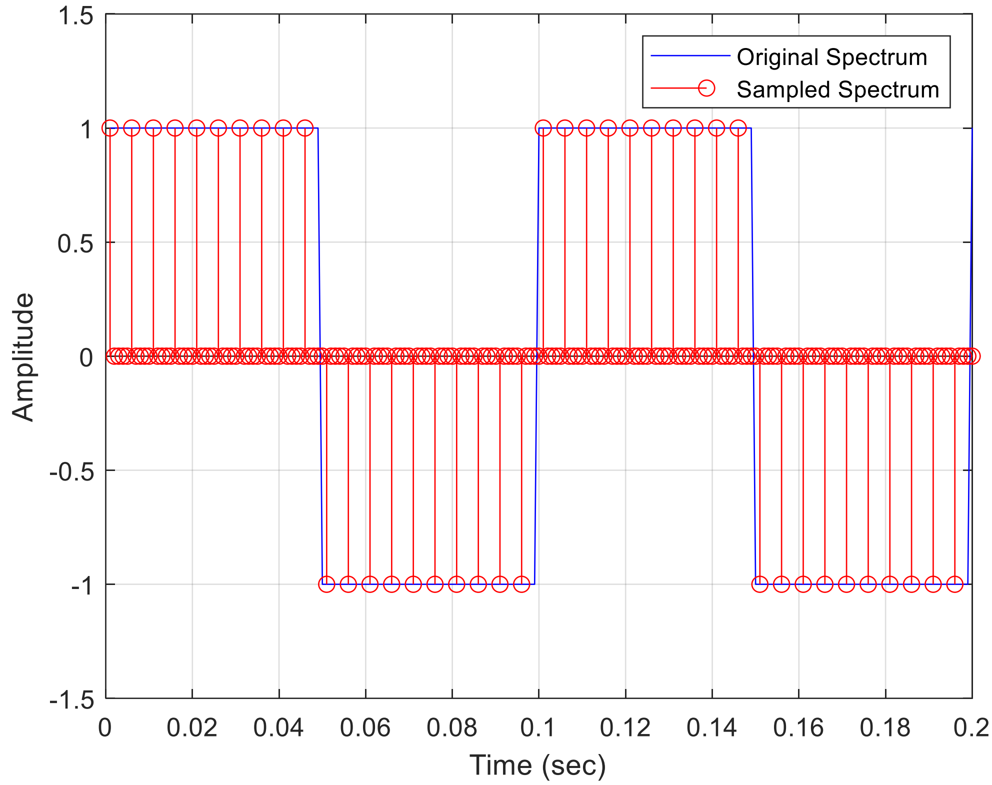


*Figure 10 - Original And Recovered Signals In Time Domain*

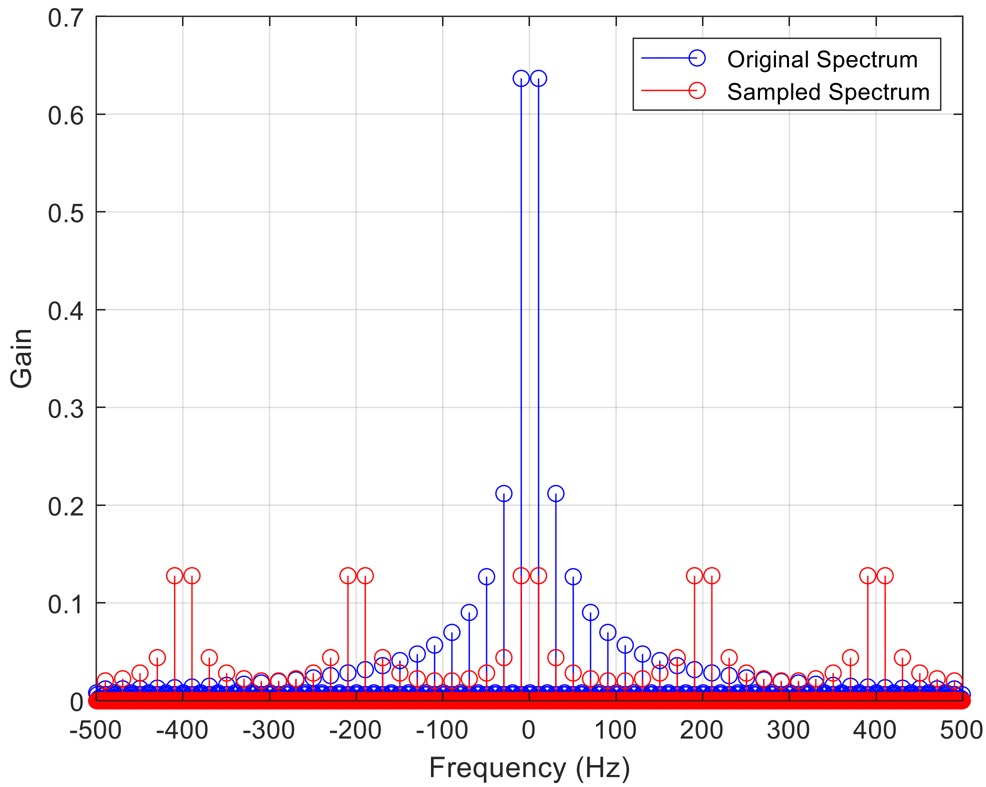


*Figure 7 - Original And Recovered Signals In Frequency Domain*

The reduction in gain depends on the ratio between the original and the new sampling rates. For example, if the original sampling rate was 1000 Hz and it was downsampled to 200 Hz, the gain would be reduced by a factor of 5:

$$Gain = \frac{\frac{1}{200}}{\frac{1}{1000}} = \frac{1000}{200} = 5$$

As a result, the frequency range and bandwidth of the signal would also be reduced to one-fourth of the original.

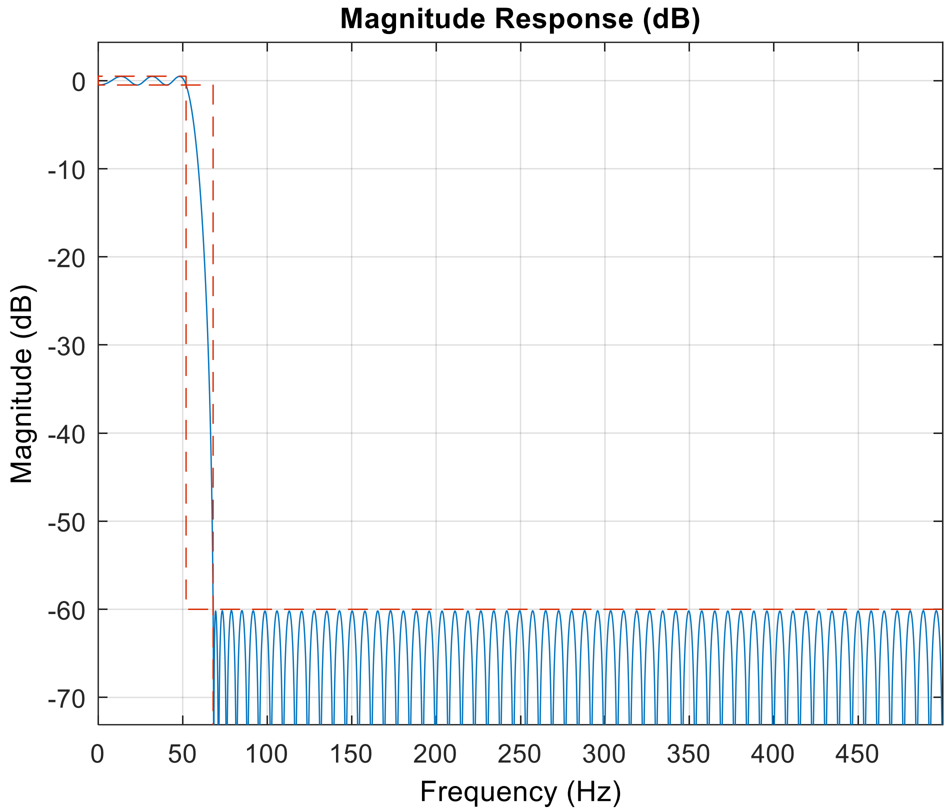


*Figure 8 - Low Pass Filter (cutoff = 52 Hz and stop = 68 Hz)*

We can shape our signal by tuning the f_cutoff and f_stop values of the low-pass filter we've implemented. By setting these parameters based on the signal's fundamental frequency, we can effectively reconstruct the original signal. The selected cutoff and stopband frequencies define the filter's transition band and the point at which attenuation begins. These settings help design the filter in a way that retains the essential low-frequency components of the signal, ensuring its main characteristics are preserved.

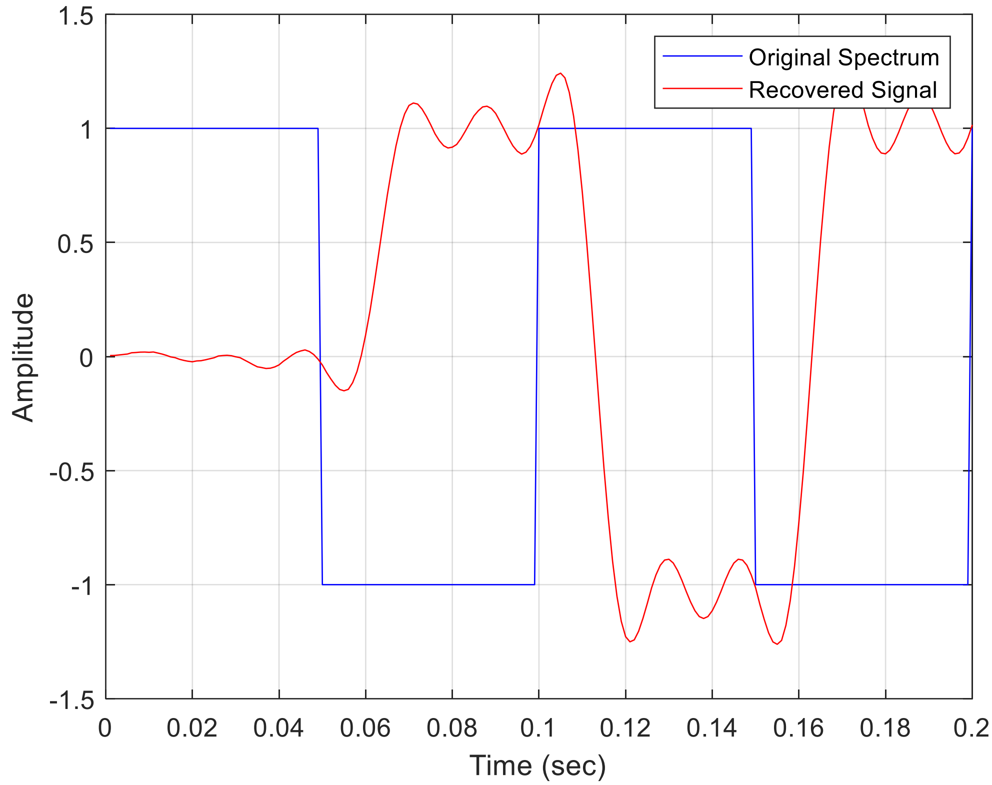


*Figure 9 - Original And Recovered Signals In Time Domain*

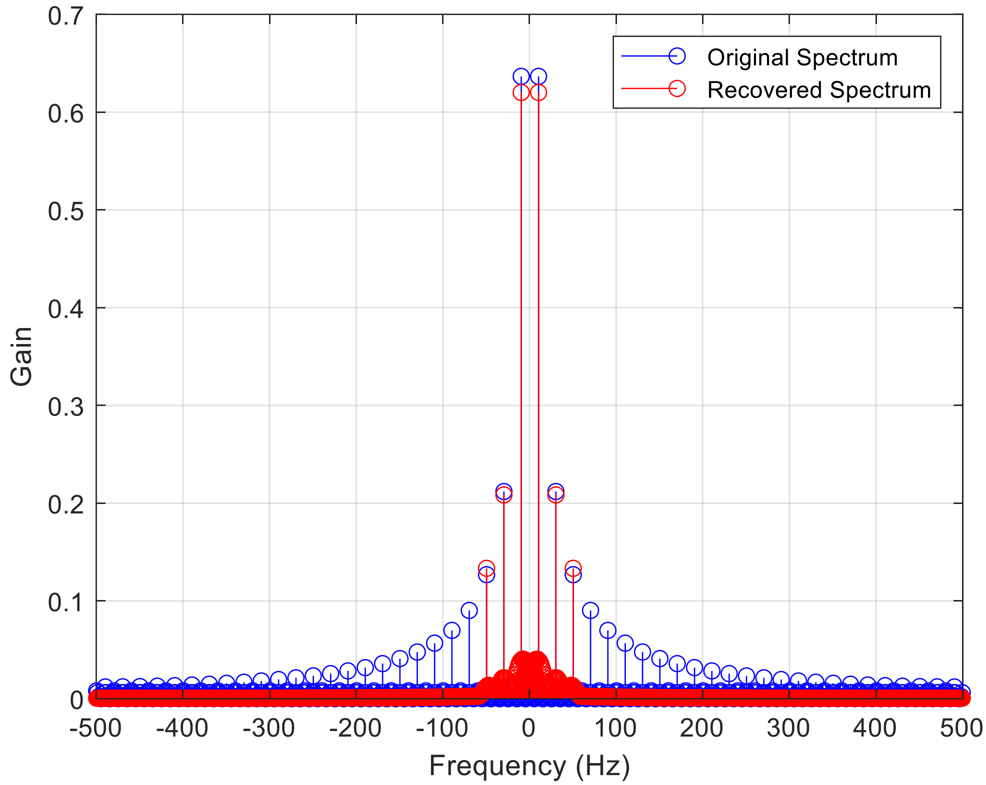


*Figure 10 - Original And Recovered Signals In Frequency Domain*