(40 pts) Question 1

Set the sampling rate as Fs = 500 Hz.

1) Generate a signal which is the sum of two sinusoidals with frequencies 25 Hz and 75 Hz whose spectrums are shown in Fig.1. Comment on your results.

```
n = length(x1); % x1 is the input signal.
fre_x1 = fftshift(fft(x1,n)); % Computes the Fourier
Transform (y-axis)
stem(f,abs(fre_x1)/n) % Plot the spectrum of x1
```

2) Obtain a low pass filter as shown in Figure 2 which allows the 25 Hz component and suppress the 75 Hz component. You can set PassbandFrequency as 50 Hz and StopbandFrequency 60 Hz. Comment on your results.

```
f_cutoff = 50;
f_stop = 60;
lpFilt =
designfilt('lowpassfir','PassbandFrequency',f_cuto
ff,'StopbandFrequency',f_stop,'SampleRate',Fs);
fvtool(lpFilt) % Visualize Filter
rec_x1 = filter(lpFilt,x); % x is the filter input signal
```

3) Plot the original 50 Hz sinusoidal signal and filtered signal in both frequency (Figure 3) and time domain (Figure 4). Comment on your results.

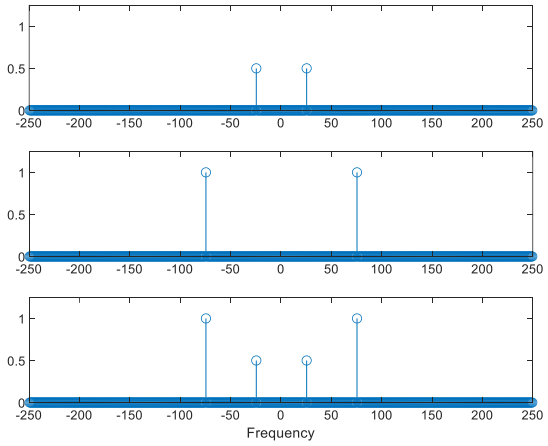

Figure 1 – (a) 1st sinusoidal, (b) 2nd sinusoidal, (c) sum of two sinusoidals

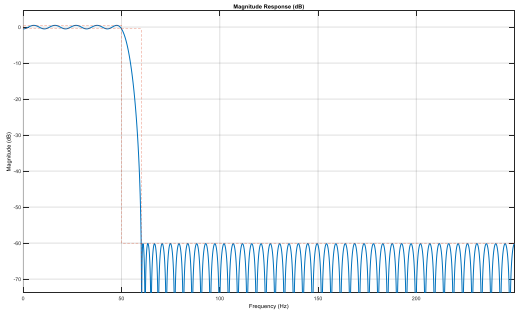

Figure 2 – Low pass filer

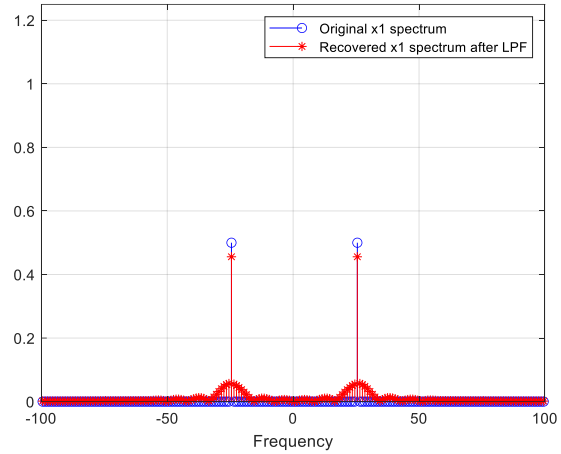

Figure 3 – Original 1st sinusoidal and filtered signal spectrum

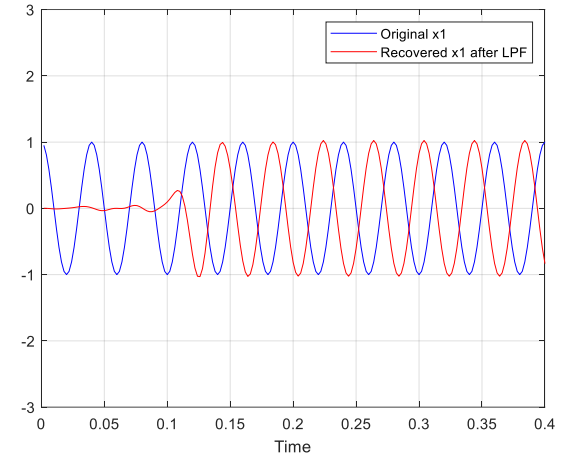

Figure 4 - Original 1st sinusoidal and filtered signal in time domain.

(60 pts) Question 2

Set the sampling rate as 500 Hz.

1) (40 pts) Generate a periodic square signal (as in Week 2) whose fundamental frequency is 10 Hz. Plot the signal in both time and frequency domains. Show that the Fourier Transform of the periodic square signal is the same as its Fourier Series coefficients (with 10 harmonics as shown in Figure 5).
2) (20 pts) Obtain a low pass filter which should keep the first 3 harmonics of the signal only as in Figure 6. Specify passband and stopband frequencies and observe the filtered signal in both time and frequency domain. Comment on your results.

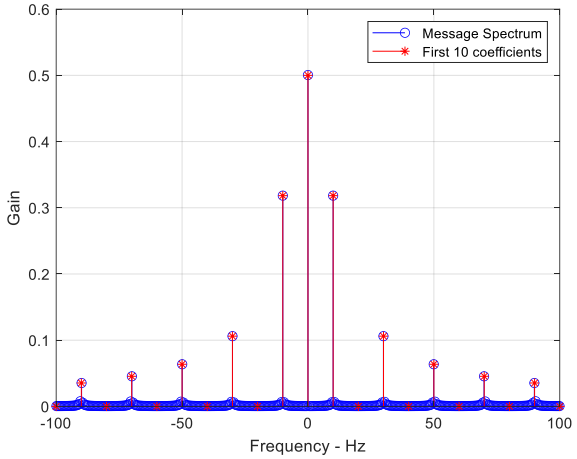

Figure 5 – Fourier Transform of the periodic square signal and its first k = 10 harmonics.

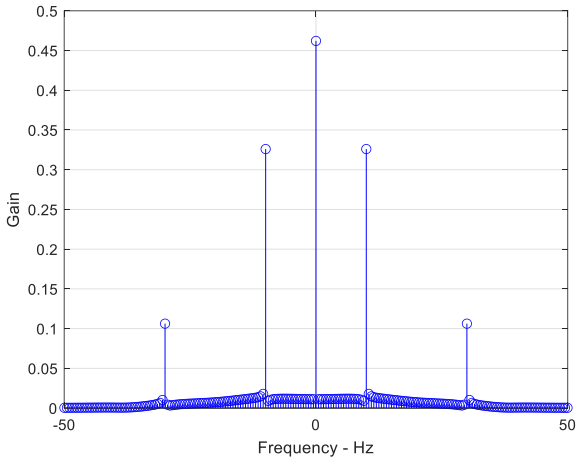

Figure 6 – Spectrum of the square periodic signal after LPF.