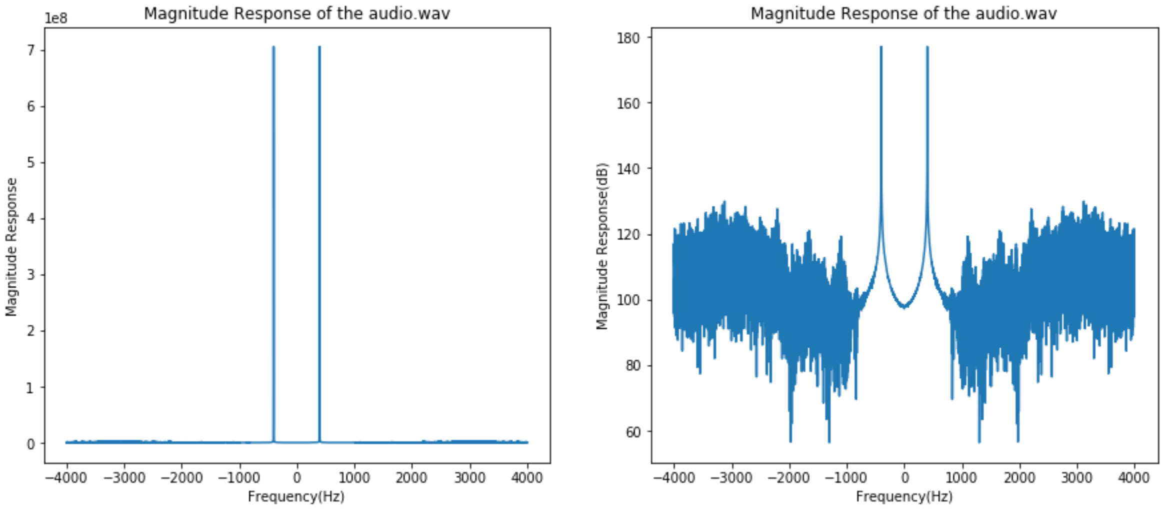
In [4]:

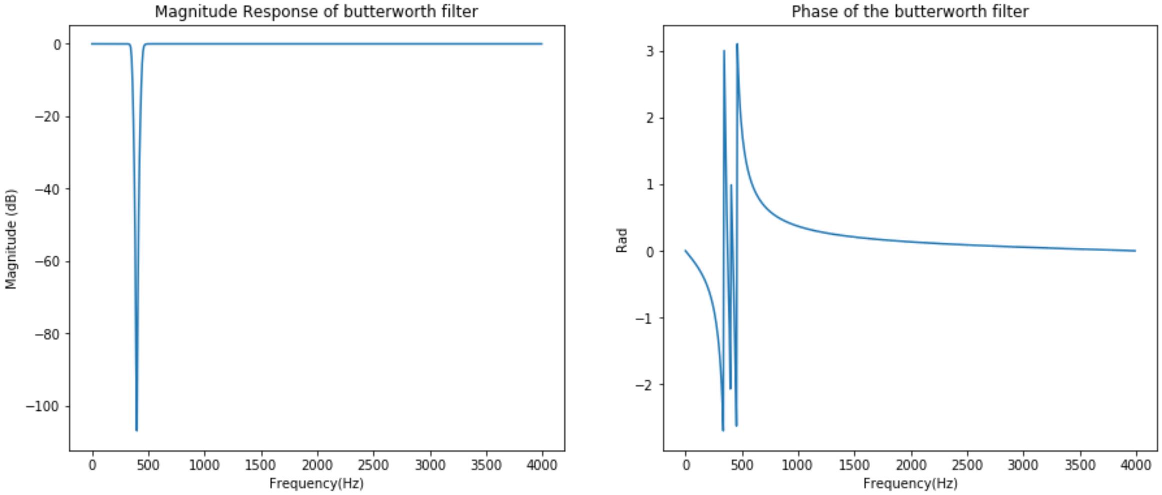
```
import os, math
import numpy as np
import matplotlib.pyplot as plt
import scipy
from scipy.io.wavfile import read
from IPython.display import Audio
print(os.getcwd())
sampling_rate, data = read('with_hum.wav')
Audio('with_hum.wav')

fft = np.fft.fft(data)
fft = np.fft.fftshift(fft)
x_label = np.linspace(-4000,4000,len(fft))

plt.figure(figsize=(15, 6))
plt.subplot(121)
plt.title('Magnitude Response of the audio.wav')
plt.xlabel('Frequency(Hz)')
plt.ylabel('Magnitude Response')
plt.plot(x_label, np.absolute(fft))

plt.subplot(122)
plt.title('Magnitude Response of the audio.wav')
plt.xlabel('Frequency(Hz)')
plt.ylabel('Magnitude Response(dB)')
plt.plot(x_label, 20*np.log10(np.absolute(fft)))
plt.show()
```

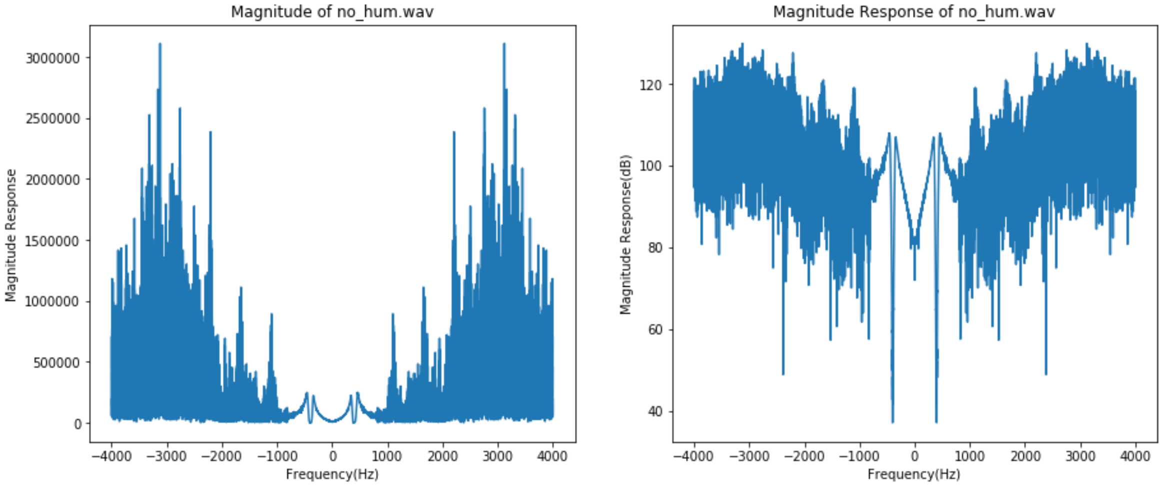
```
C:\Users\Annie\Desktop\Jupyter Notebooks
```



In [8]:

```
import os
import math
import numpy as np
import matplotlib.pyplot as plt
from scipy import signal
from scipy.io.wavfile import read, write
from IPython.display import Audio

sampling_rate, data = read('with_hum.wav')
Audio('with_hum.wav')
NyqR = sampling_rate/2
band = [350/NyqR, 450/NyqR]
nume, denom = signal.butter(5, band, btype = 'bandstop',analog = False)
w, h = signal.freqz(nume, denom)

plt.figure(figsize=(15, 6))
plt.subplot(121)
plt.title('Magnitude Response of butterworth filter')
plt.xlabel('Frequency(Hz)')
plt.ylabel('Magnitude (dB)')
plt.plot(w*NyqR/np.pi, 20*np.log10(h))
#plt.figure(figsize=(15, 6))
plt.subplot(122)
plt.title('Phase of the butterworth filter')
plt.xlabel('Frequency(Hz)')
plt.ylabel('Rad')
plt.plot(w*NyqR/np.pi, np.angle(h))
plt.show()

f_data = signal.lfilter(nume, denom, data).astype('int16')
write("no_hum.wav", data = f_data, rate = sampling_rate)
Audio("no_hum.wav")

fft = np.fft.fftshift(np.fft.fft(f_data))
x_label = np.linspace(-4000,4000,len(fft))

plt.figure(figsize=(15, 6))
plt.subplot(121)
plt.title('Magnitude of no_hum.wav')
plt.xlabel('Frequency(Hz)')
plt.ylabel('Magnitude Response')
plt.plot(x_label, np.absolute(fft))
#plt.figure(figsize=(15, 6))
plt.subplot(122)
plt.title('Magnitude Response of no_hum.wav')
plt.xlabel('Frequency(Hz)')
plt.ylabel('Magnitude Response(dB)')
plt.plot(x_label, 20*np.log10(np.absolute(fft)))
plt.show()
```


Magnitude Response of butterworth filter
Magnitude (dB)
0
−20
−40
−60
−80
−100
0
500
1000
1500
2000
2500
3000
3500
4000
Frequency(Hz)
Phase of the butterworth filter
Rad
3
2
1
0
−1
−2
0
500
1000
1500
2000
2500
3000
3500
4000
Frequency(Hz)


Magnitude of no_hum.wav
Magnitude Response
3000000
2500000
2000000
1500000
1000000
500000
0
−4000
−3000
−2000
−1000
0
1000
2000
3000
4000
Frequency(Hz)
Magnitude Response of no_hum.wav
Magnitude Response(dB)
120
100
80
60
40
−4000
−3000
−2000
−1000
0
1000
2000
3000
4000
Frequency(Hz)

In [6]:

```
"""
Question:
Briefly describe your filter design. Why does your filter have the number of
Could you achieve the same effect with less taps? What are the practical effe

I designed a band-stop butterworth filter with the function signal.butter()
which filters out the frequency at 400Hz (centered at 400Hz) with attenuatior
of about 110dB in order to decrease the effect of the hum.

The numtap (I understand it as order) is set to 5, which allows the attenuati
smaller numbers.
I have tried 1, 3, and 5, and the result was that the higher the order is, th
Setting numtaps to a smaller number might end up with bad listening effect.
"""
```

Out[6]:

```
'\nQuestion:\nBriefly describe your filter design. Why does your filter hav
e the number of taps that it has? \nCould you achieve the same effect with
less taps? What are the practical effects of using less taps?\n\nI designed
a band-stop butterworth filter with the function signal.butter()\nwhich fil
ters out the frequency at 400Hz (centered at 400Hz) with attenuation\nof ab
out 110dB in order to decrease the effect of the hum.\n\nThe numtap (I unde
rstand it as order) is set to 5, which allows the attenuation reach a lower
dB than\nsmaller numbers.\nI have tried 1, 3, and 5, and the result was tha
t the higher the order is, the lower dB we get in the stop band.\nSetting n
umtaps to a smaller number might end up with bad listening effect.\n'
```

In [ ]: