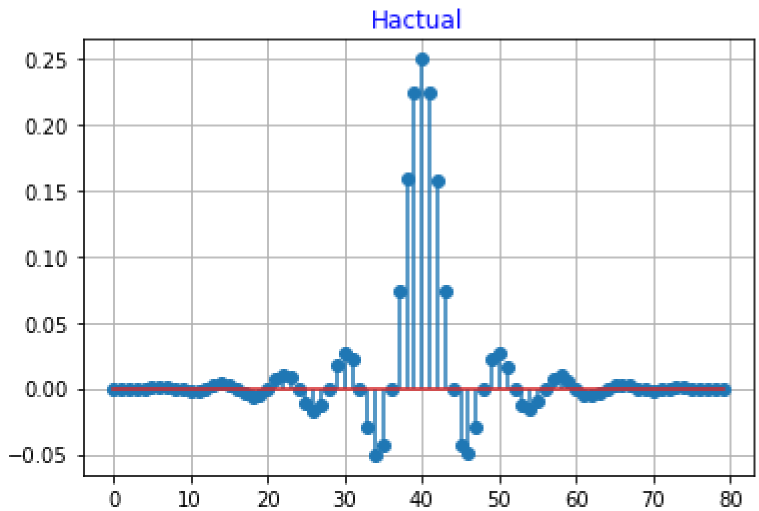
In [ ]:

```python
# experiment 4 - Design a Low pass filter Type 1 fIR filter using Window design method
# wp = 0.2 Pi
# Ws = 0.3pi
# deltaP = deltaS = 0.01
import numpy as np
import matplotlib.pyplot as plt
import math

pi = np.pi

wp = 0.2*pi
Ws = 0.3*pi
deltaP = deltaS = 0.01
alphaS = 20*math.log(deltaS,10) #log(value,base)
alphaS = 40


# In hanning filter stop band attenuation is 44 and out attenuation is 40 so we will ch
# equation of hanning filter is (1 - cos((2*pi*n)/(N-1)))/2
# and transition width is Ws - Wp = 8*pi/N
# 0.3*pi - 0.2*pi = 8*pi/N then ==> N = 80
# now equation is  Hd[n] =  (1 - cos((2*pi*n)/(80-1))/2

Wn = []

for i in range(0,80):
    x =  (1 - np.cos((2*pi*i)/(79)))/2
    Wn.append(x)

# print(Wn)

# now HD for Low pass filter
# hd[n]  = { sin(Wc*(n-Tow))/(pi*(n-tow))  n != tow
#                       Wc/pi                n  = tow      }


# Wc  = ( Wp + Ws )/2 = (0.2 + 0.3 )pi/2 ==> 0.25*pi
Hd = []
tow = 40
Wc =  0.25*pi
for n in range(0,80):
    if(n == tow):
        Hd.append(0.25)
    else:
        x = np.sin(Wc*(n-tow))/(pi*(n-tow))
        Hd.append(x)


# print(Hd)


Hactual = []

N = 80

for i in range(0,N):
    x = Hd[i]*Wn[i]
    Hactual.append(x)
```

```
# print(Hactual)
n = np.arange(0,80)
plt.stem(n,Hactual)
plt.grid()
plt.title('Hactual',color='b')
```

Out[ ]:

```
Text(0.5, 1.0, 'Hactual')
```




In [ ]:

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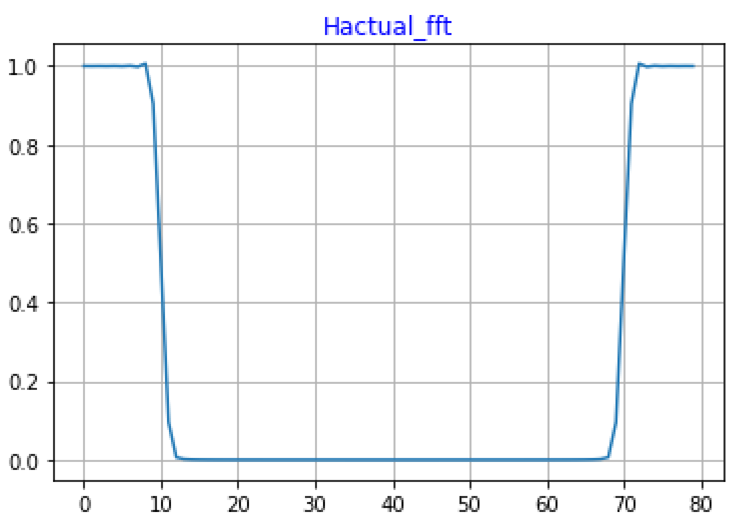
Hactual_fft = np.fft.fft(Hactual)
plt.plot(abs(Hactual_fft))
plt.grid()
plt.title('Hactual_fft',color='b')
```

Out[ ]:

```
Text(0.5, 1.0, 'Hactual_fft')
```




In [ ]:

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max_for_deltaP = np.max(abs(Hactual_fft[0:10]))
max_for_deltaS = np.max(abs(Hactual_fft[10:20]))

actual_delta_p = max_for_deltaP - 1
actual_delta_s = max_for_deltaS

print(actual_delta_p)
print(actual_delta_s)
```

```
0.005910284173742841
0.4999427598435654
```