Method 1

Noise filtering and then debluring the given transmitted signal y[n]

In [24]:

```
# importing required libraries for basic mathematics and manupulation

import pandas as pd
import matplotlib.pyplot as plt
import numpy as np
import math
```

In [25]:

```
#reads the csv and stores it in a dataframe

df = pd.read_csv('data.csv')
```

In [26]:

```
#displays first five rows
df.head()
```

Out[26]:

	x[n]	y[n]
0	35.4312	33.3735
1	35.1511	34.3744
2	34.8284	35.7514
3	34.4656	35.5869
4	34.0656	36.0826

In [27]:

```
# removing headers
df = df.rename(columns={col: "" for col in df})
df.head()
```

Out[27]:

0	35.4312	33.3735
1	35.1511	34.3744
2	34.8284	35.7514
3	34.4656	35.5869
4	34.0656	36.0826

In [28]:

```
# converting data into 1D lists
x = df.iloc[:,0]
y = df.iloc[:,1]
y.head()
```

Out[28]:

```
0    33.3735
1    34.3744
2    35.7514
3    35.5869
4    36.0826
Name: , dtype: float64
```

In [29]:

```
# converts to numpy array which supports complex number manipulation
x = np.array(x)
y = np.array(y)
```

Representation of initial signals

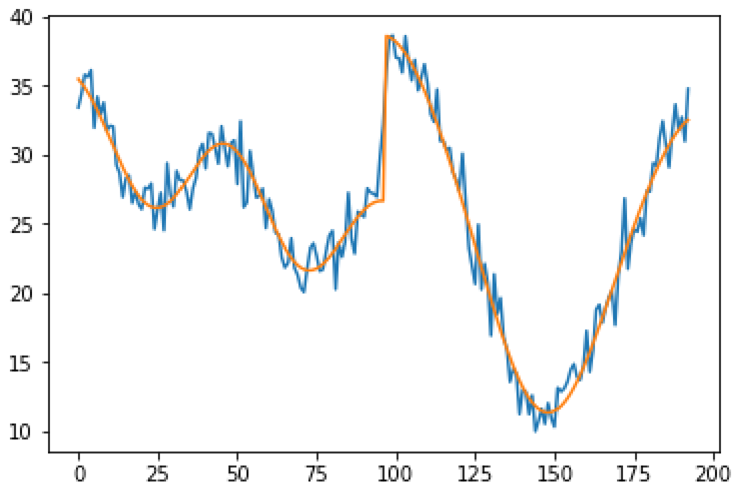
The orange plot represents original signal x[n] and blue plot represents transmitted signal y[n]

In [30]:

```
plt.plot(range(0,193),y)
plt.plot(range(0,193),x)
```

Out[30]:

```
[<matplotlib.lines.Line2D at 0x28b07adb8b0>]
```



Step 1 : Removng noise by using moving averages

In [31]:

```
window_size = 5       # indicates that we are taking average of 5 consecutive samples

i = 0
y_denoised = []

while i < len(y) - window_size + 1:                          # while loop used untill the array en
                                                             # one unit everytime the loop runs

    this_window = y[i : i + window_size]


    window_average = sum(this_window) / window_size
    y_denoised.append(window_average)
    i += 1

y_denoised.insert(-2,(y[-2]+y[-3]+y[-4])/3)                  # we fall short of 4 values when wind
y_denoised.insert(-1,(y[-1]+y[-2]+y[-3])/3)                  # manually by using the same method b
                                                             # minimum deviation at the edges


y_denoised.insert(0,(y[0]+y[1]+y[2])/3)
y_denoised.insert(1,(y[1]+y[2]+y[3])/3)
```

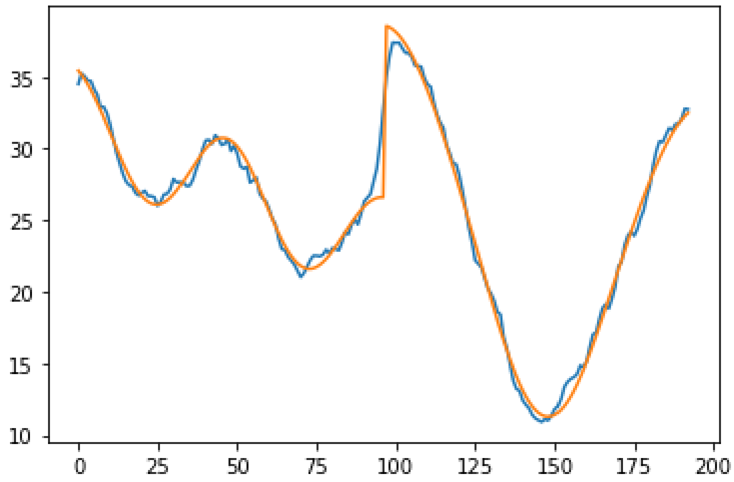
Plot of the denoised signal against original signal

In [32]:

```
plt.plot(range(0,193),y_denoised)
plt.plot(range(0,193),x)
```

Out[32]:

```
[<matplotlib.lines.Line2D at 0x28b08baef70>]
```



Deblur using DTFT

In [33]:

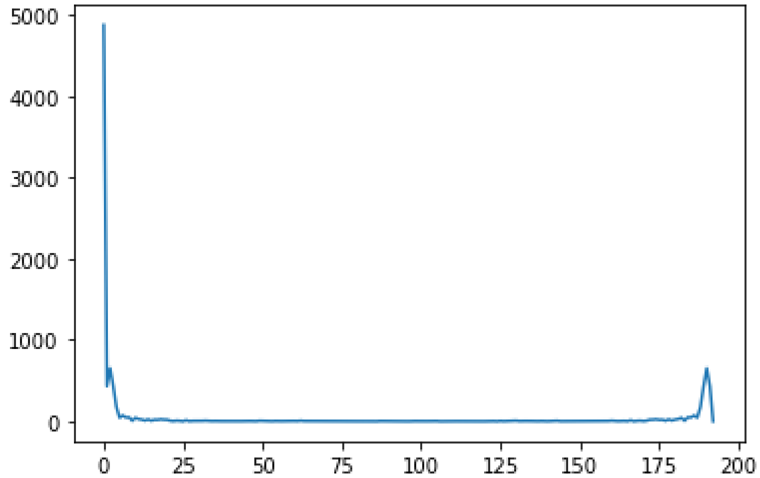
```
# dtft algorithm for the denoised version of y[n]

N = len(y_denoised)
w = np.linspace(0,2*math.pi,N)              # taking 193 samples of w between 0 and 2*pi

X = np.zeros(N,dtype = 'complex_')          # array to store dtft

for k in range(0,N-1):                      # outer loop to change the value of k
    X[k] = 0

    for n in range(0,N-1):                  # inner loop to change the value of n

        X[k] = X[k] + y_denoised[n]* math.e**(-1j *w[k] *n)            # formula for dtf
```

In [34]:

```
# plot for dtft
plt.plot(range(0,193),abs(X))
```

Out[34]:

```
[<matplotlib.lines.Line2D at 0x28b08c106d0>]
```



In [35]:

```
# dtft for h[n]

h = np.array([1/16, 1/4, 3/8, 1/4, 1/16])          # given

N = 193

w=[]
for i in range (193):                               # taking 193 samples of w between 0 and
    w.append(2*math.pi*i/193)

H = np.zeros(N,dtype = 'complex_')

for k in range(0,N-1):                              # same dtft algorithm as above
    H[k-2] = 0                                      # replace k by 2-k since the middle valu

    for n in range(0,5):

        H[k-2] = H[k-2] + h[n]* math.e**(-1j *w[k-2] *n)
```

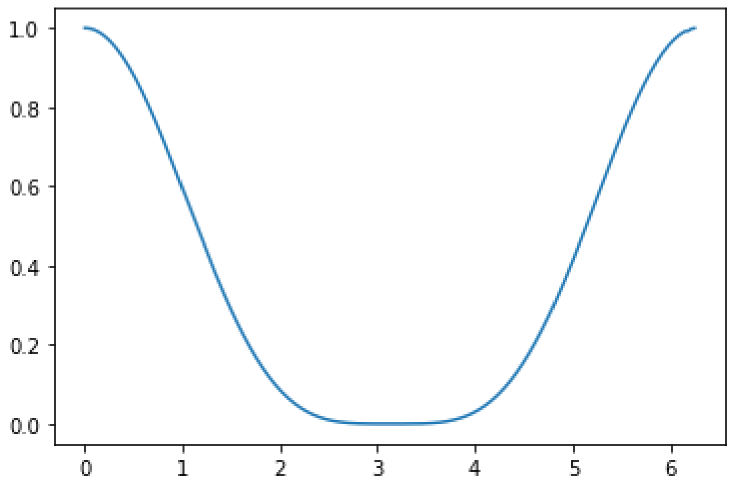
Plot for DTFT of h[n]

In [36]:

```
H[190] = (H[191] + H[189]) /2

plt.plot(range(0,193),abs(H))
```

Out[36]:

```
[<matplotlib.lines.Line2D at 0x28b08c74250>]
```



In [37]:

```
# In the above plot we see that H(e^jw) approches zero at certain values and thus X_final(e
# To avoid this senario we clip the graph at an appropriate value which is determined by tr
# value to all the values below the threshold

H_mod = list(abs(H))

for n, i in enumerate(H_mod):
    if i < 0.8:
        H_mod[n] = 0.8
```

In [38]:

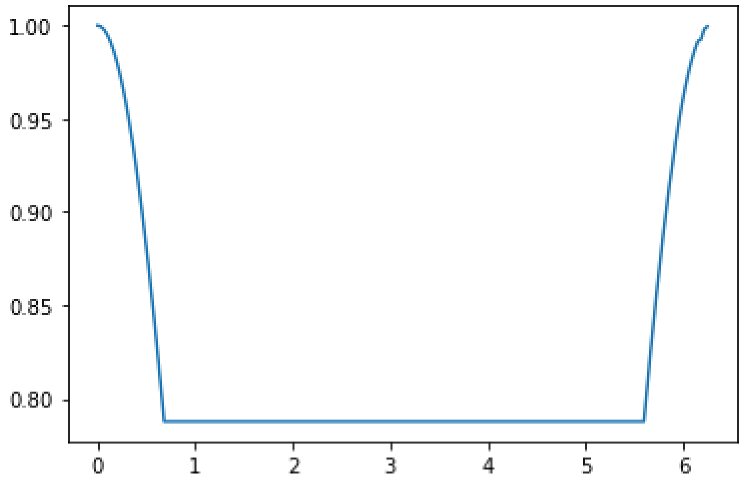
```
for i in range(22,172):          # assigns the given to all the numbers in this range

    H[i] = 0.15920910143656403-0.7716376423250288j
```

In [39]:

```
plt.plot(range(0,193),abs(H))
```

Out[39]:

```
[&lt;matplotlib.lines.Line2D at 0x28b08cc4b20&gt;]
```



In [40]:

```
X_final = X/H                    # dtft for the X_final
```

In [41]:

```
# using inverse fourier transform to convert X_final to X1:

N = len(X_final)
w = np.linspace(0,2*math.pi,N)          # taking 193 samples of w between 0 and 2*pi

X1 = np.zeros(N,dtype = 'complex_')

# Applying the summation formula for inverse dtft

for k in range(0,N-1):
    X1[k] = 0

    for n in range(0,N-1):

        X1[k] = ( X1[k] + X_final[n]* math.e**(1j * w[k] *n))

X1 = X1 / 193
```

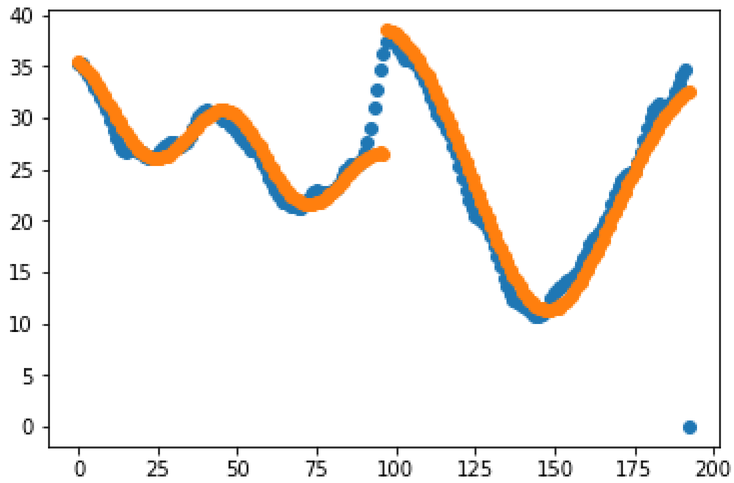
Final plot for X1[n] and comparision with original x[n]

In [42]:

```
plt.scatter(range(0,193),abs(X1))
plt.scatter(range(0,193),x)
#plt.plot(w,y)

plt.show

# Orange plot represents original signal x[n]
# Blue plot represents X1[n]
```

Out[42]:

```
<function matplotlib.pyplot.show(close=None, block=None)>
```



In [43]:

```
# for comparing these plots we can calculate the mean error between all the values
# As the value of error decreases, accuracy of determining x[n] increases.

abs_error = []

for i in range(0,191):                              # excluding last 2 values since they ar
    abs_error.append(abs(X1[i]+x[i]))

mean_error = sum(abs_error)/191

print(mean_error)
```

50.57979074862414

In [ ]:

```
```