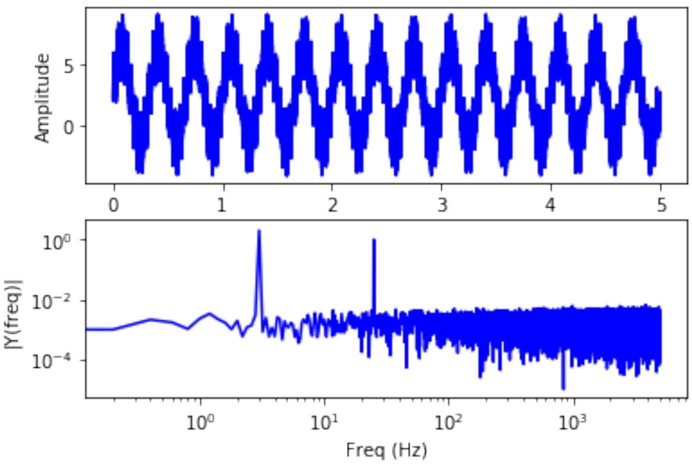
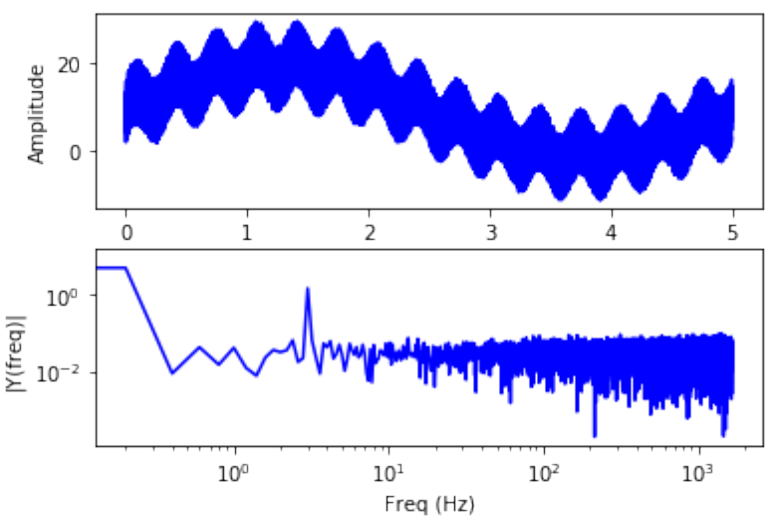
HW 2: Digital Signal Processing

4)

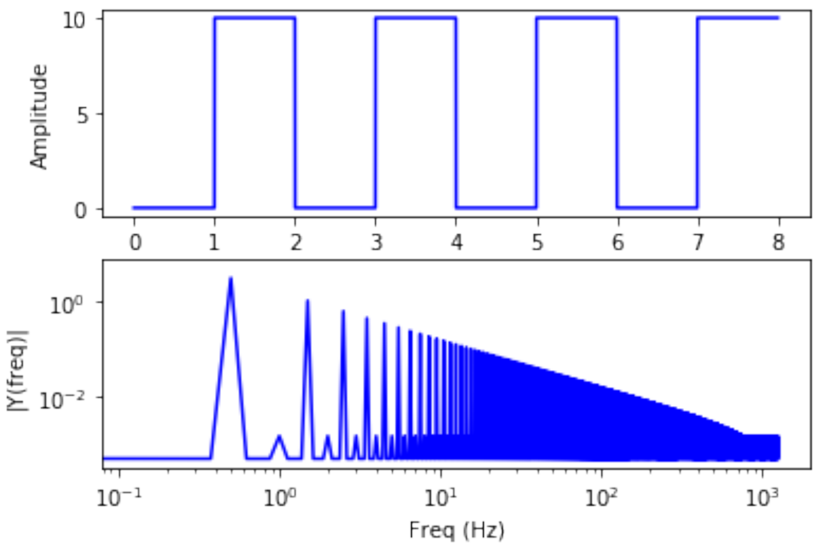
sigA:



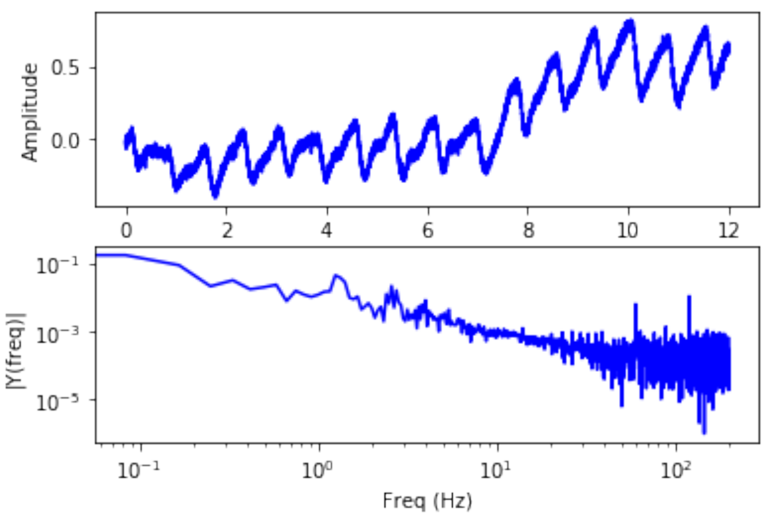
sigB:



sigC:



sigD:



Code (same for all cases other than “sigA” being replaced with “sigB,” “sigC,” “sigD”):

```
# FFT for sigA

t = [] # column 0
data1 = [] # column 1
data2 = [] # column 2

with open('sigA.csv') as f:
    # open the csv file
    reader = csv.reader(f)
    for row in reader:
        # read the rows 1 one by one
        t.append(float(row[0])) # leftmost column
```

```
    data1.append(float(row[1])) # second column

plt.plot(t, data1)

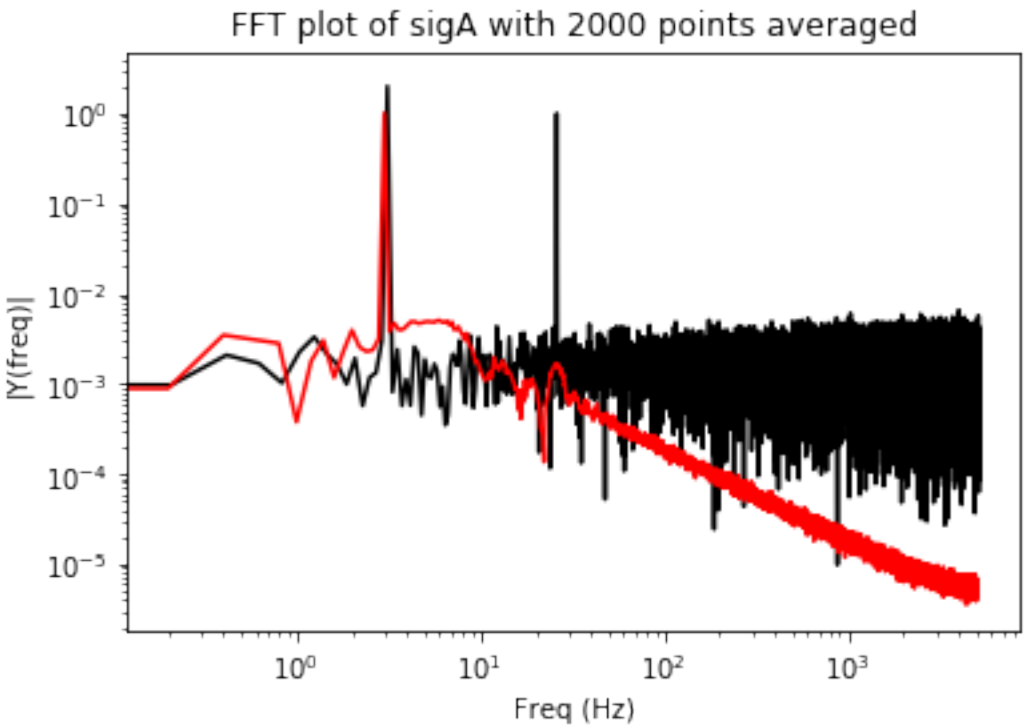
samplerate = len(data1)/t[-1]
print(samplerate)
print(len(data1))

# FFT for sigA

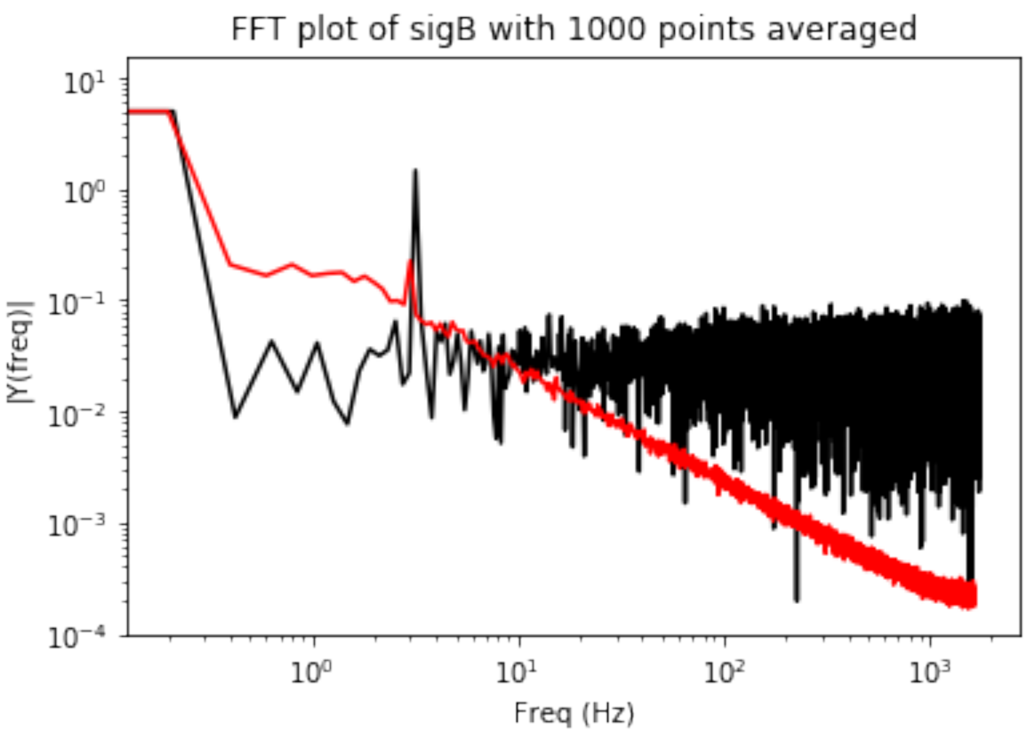
Fs = samplerate # sample rate
Ts = 1.0/Fs; # sampling interval
ts = np.arange(0,t[-1],Ts) # time vector
y = data1 # the data to make the fft from
n = len(y) # length of the signal
k = np.arange(n)
T = n/Fs
frq = k/T # two sides frequency range
frq = frq[range(int(n/2))] # one side frequency range
Y = np.fft.fft(y)/n # fft computing and normalization
Y = Y[range(int(n/2))]

fig, (ax1, ax2) = plt.subplots(2, 1)
ax1.plot(t,y,'b')
ax1.set_xlabel('Time')
ax1.set_ylabel('Amplitude')
ax2.loglog(frq,abs(Y),'b') # plotting the fft
ax2.set_xlabel('Freq (Hz)')
ax2.set_ylabel('|Y(freq)|')
plt.show()
```

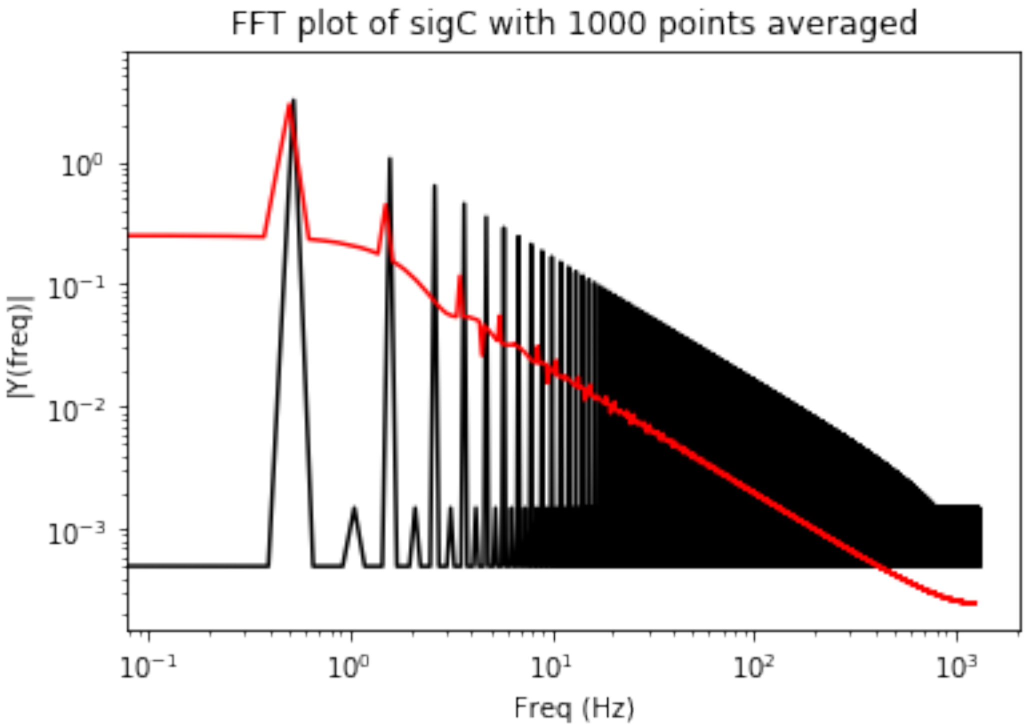
5)

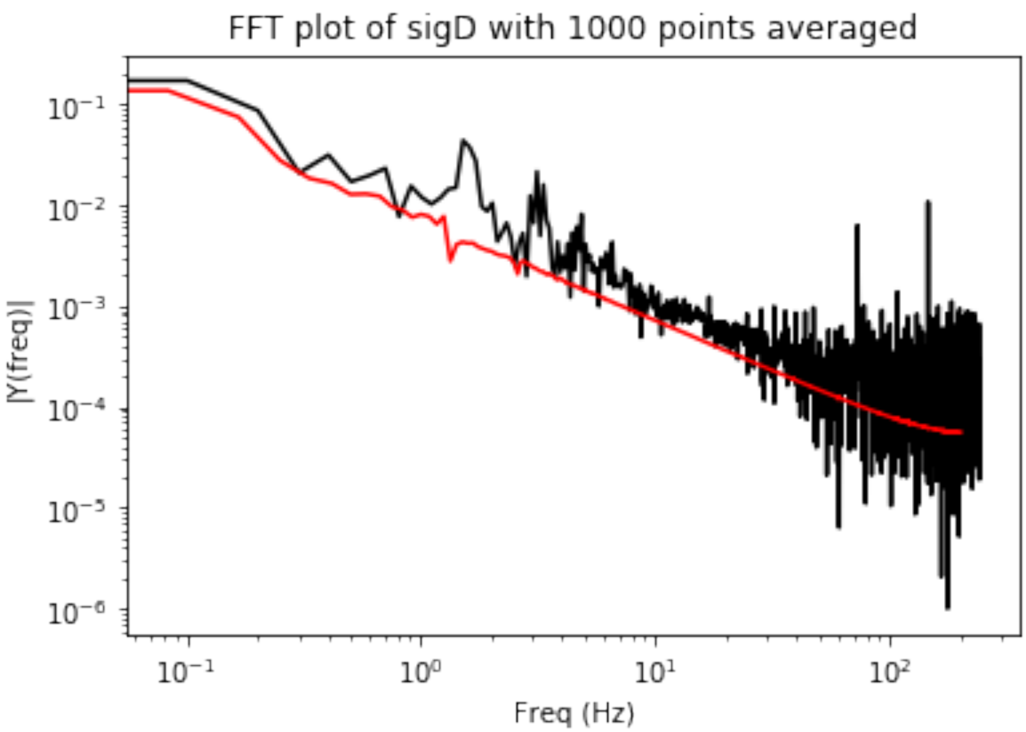


FFT plot of sigA with 2000 points averaged
|Y(freq)|
Freq (Hz)



FFT plot of sigB with 1000 points averaged
|Y(freq)|
Freq (Hz)





Code (same for all cases other than “sigA” being replaced with “sigB,” “sigC,” “sigD”):

```
# Low pass filter sigA
```

```
t = [] # column 0
data1 = [] # column 1

with open('sigA.csv') as f:
    # open the csv file
    reader = csv.reader(f)
    for row in reader:
        # read the rows 1 one by one
        t.append(float(row[0])) # leftmost column
        data1.append(float(row[1])) # second column

data = data1.copy()
x = 2000
newdata = []

for i in range(x):
    data.insert(i, 0)
for j in range(len(data)-x):
    sum = 0
    for i in range(x):
        sum = sum + data[j + x - i]
    avg = sum/x
    newdata.append(avg)

samplerate = len(data)/t[-1]
newsamplerate = len(newdata)/t[-1]


# FFT for sigA

Fs = samplerate # sample rate
Ts = 1.0/Fs; # sampling interval
ts = np.arange(0,t[-1],Ts) # time vector
y = data1 # the data to make the fft from
n = len(y) # length of the signal
k = np.arange(n)
T = n/Fs
frq = k/T # two sides frequency range
frq = frq[range(int(n/2))] # one side frequency range
Y = np.fft.fft(y)/n # fft computing and normalization
Y = Y[range(int(n/2))]
```

```
plt.loglog(frq,abs(Y),'black') # plotting the fft
plt.xlabel('Freq (Hz)')
plt.ylabel('|Y(freq)|')

# plt.plot(t, data1)
# plt.plot(t, newdata)

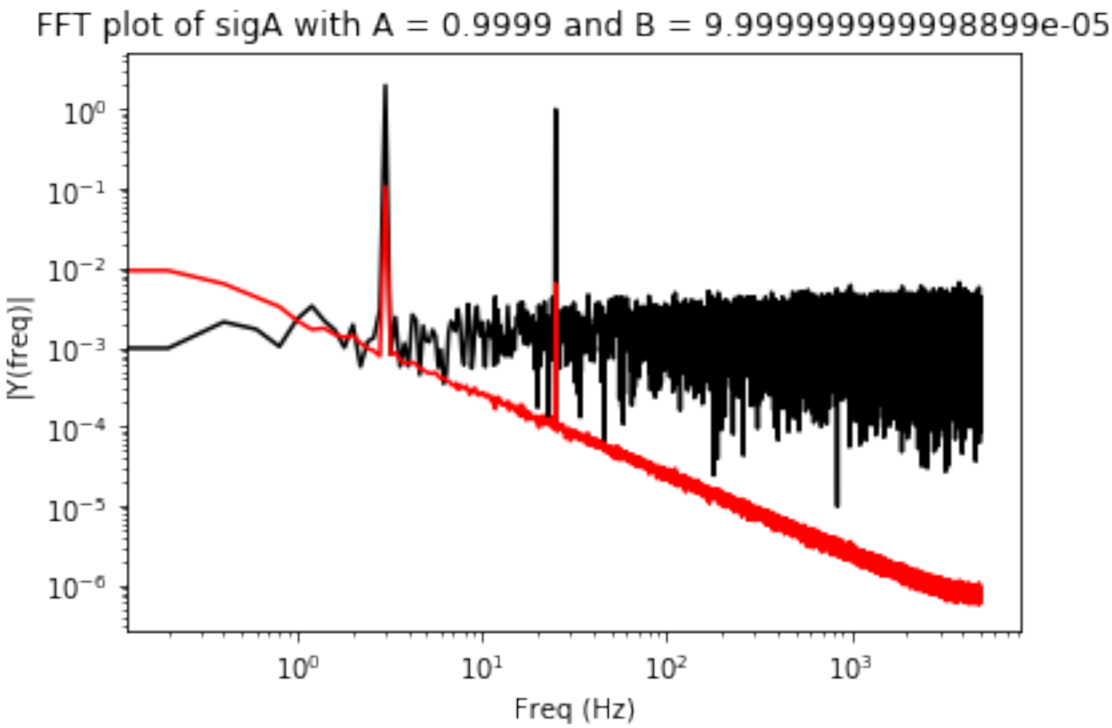

# plotting the new sample FFT
samplerate = len(newdata)/t[-1]

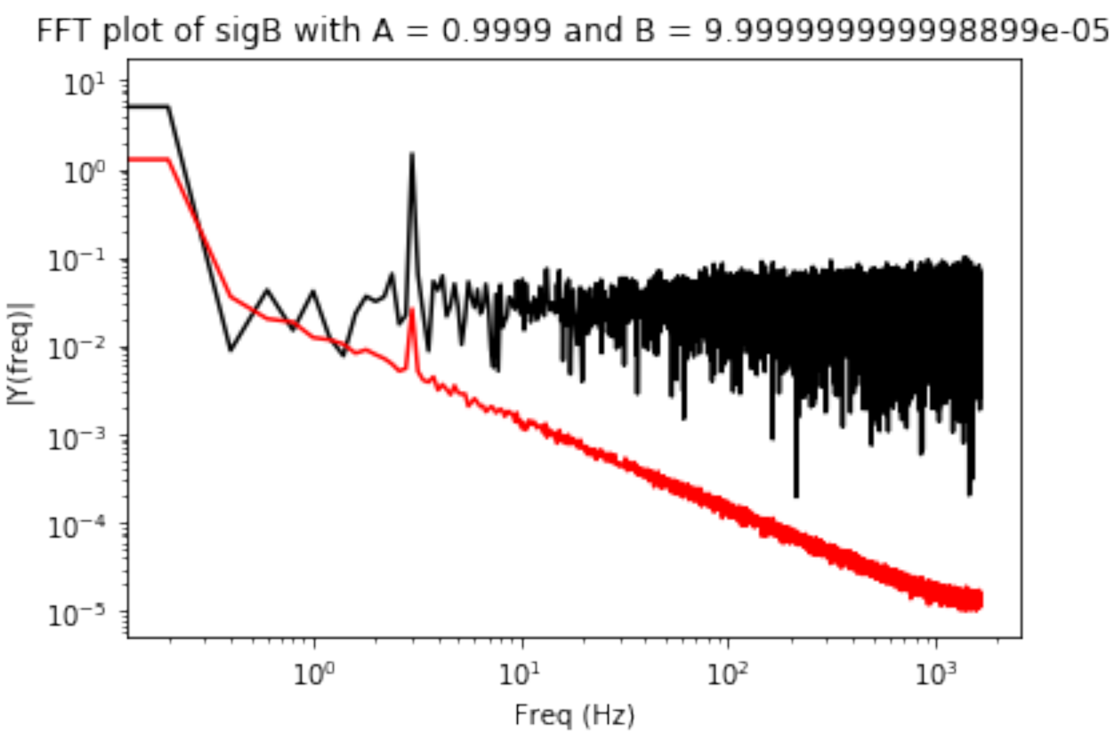
# FFT for sigA

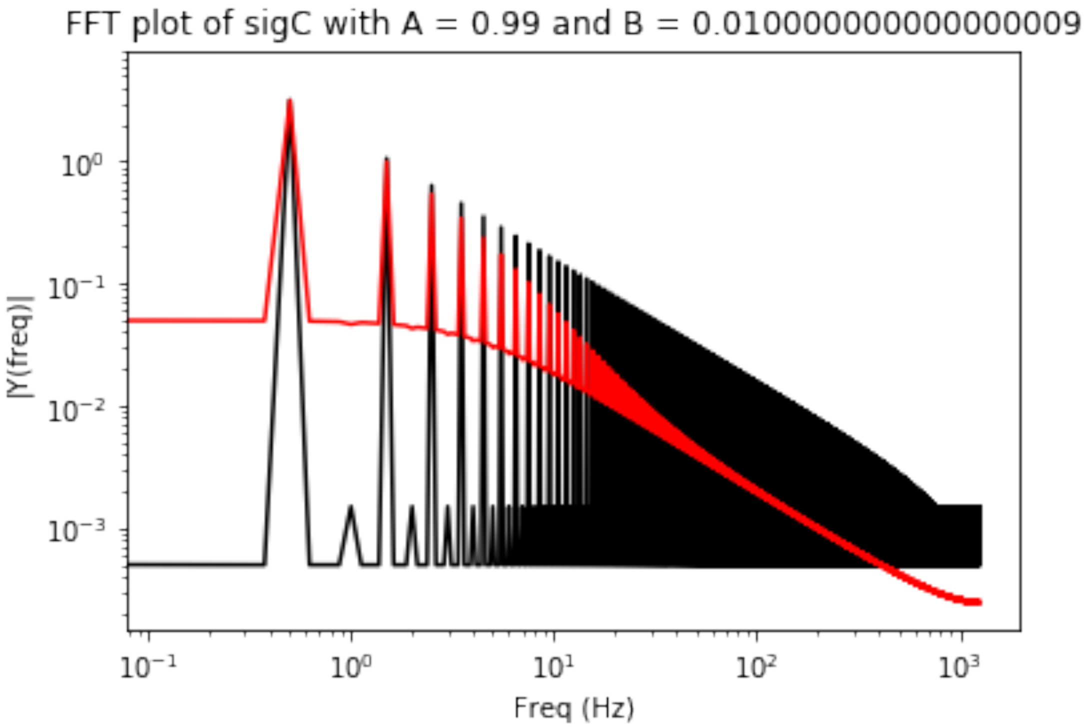
Fs = samplerate # sample rate
Ts = 1.0/Fs; # sampling interval
ts = np.arange(0,t[-1],Ts) # time vector
y = newdata # the data to make the fft from
n = len(y) # length of the signal
k = np.arange(n)
T = n/Fs
frq = k/T # two sides frequency range
frq = frq[range(int(n/2))] # one side frequency range
Y = np.fft.fft(y)/n # fft computing and normalization
Y = Y[range(int(n/2))]

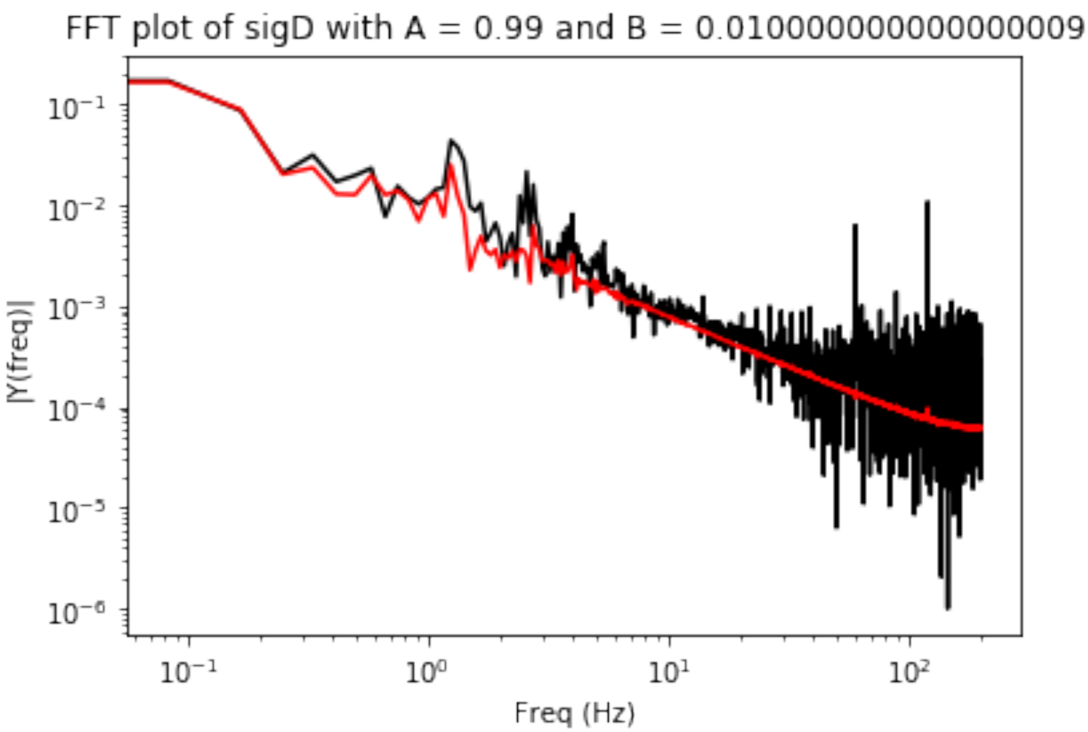

plt.loglog(frq,abs(Y),'red') # plotting the fft
plt.title('FFT plot of sigA with ' + str(x) + ' points averaged')
plt.show()
```

6)


FFT plot of sigA with A = 0.9999 and B = 9.999999999998899e-05
|Y(freq)|
Freq (Hz)


FFT plot of sigB with A = 0.9999 and B = 9.999999999998899e-05
|Y(freq)|
Freq (Hz)





Code (same for all cases other than “sigA” being replaced with “sigB,” “sigC,” “sigD”):

```
# Low pass filtering with an IIR for sigA

t = [] # column 0
```

```
data1 = [] # column 1

with open('sigA.csv') as f:
    # open the csv file
    reader = csv.reader(f)
    for row in reader:
        # read the rows 1 one by one
        t.append(float(row[0])) # leftmost column
        data1.append(float(row[1])) # second column

data = data1.copy()
A = 0.9999
B = 1-A
newdata = []
newdata.append(data[0])

for i in range(1, len(data)):
    newdata.append(A*newdata[i-1] + B*data[i])

samplerate = len(data)/t[-1]
newsamplerate = len(newdata)/t[-1]


# FFT for sigA

Fs = samplerate # sample rate
Ts = 1.0/Fs; # sampling interval
ts = np.arange(0,t[-1],Ts) # time vector
y = data1 # the data to make the fft from
n = len(y) # length of the signal
k = np.arange(n)
T = n/Fs
frq = k/T # two sides frequency range
frq = frq[range(int(n/2))] # one side frequency range
Y = np.fft.fft(y)/n # fft computing and normalization
Y = Y[range(int(n/2))]


plt.loglog(frq,abs(Y),'black') # plotting the fft
plt.xlabel('Freq (Hz)')
plt.ylabel('|Y(freq)|')


# plotting the new sample FFT
```

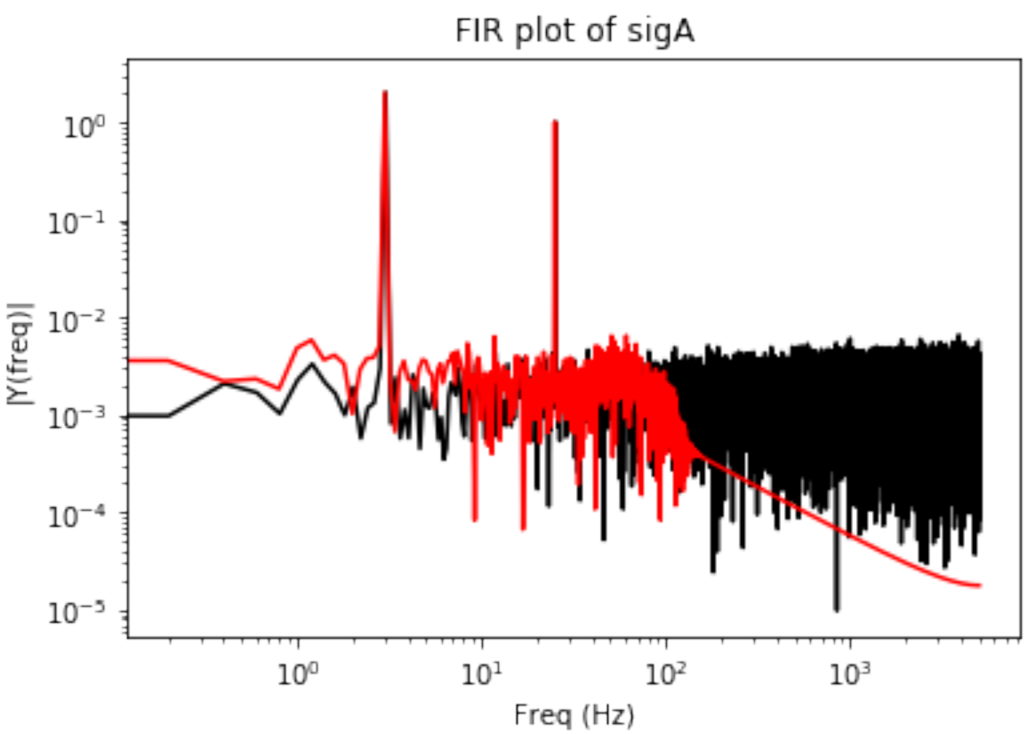
```
samplerate = len(newdata)/t[-1]

# FFT for sigA

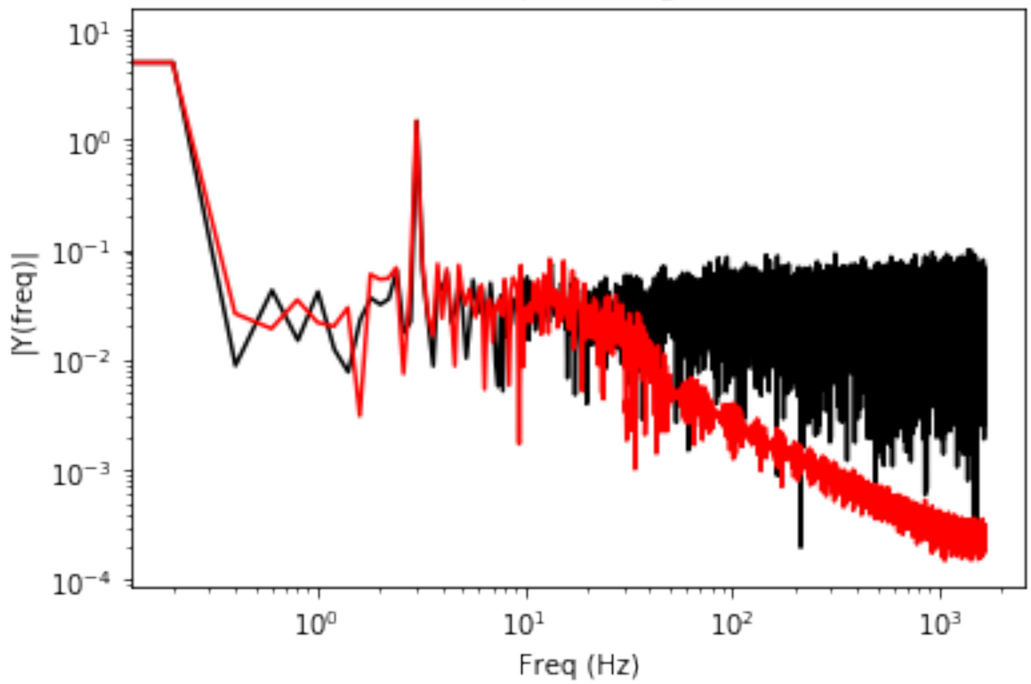
Fs = samplerate # sample rate
Ts = 1.0/Fs; # sampling interval
ts = np.arange(0,t[-1],Ts) # time vector
y = newdata # the data to make the fft from
n = len(y) # length of the signal
k = np.arange(n)
T = n/Fs
frq = k/T # two sides frequency range
frq = frq[range(int(n/2))] # one side frequency range
Y = np.fft.fft(y)/n # fft computing and normalization
Y = Y[range(int(n/2))]


plt.loglog(frq,abs(Y),'red') # plotting the fft
plt.title('FFT plot of sigA with A = ' + str(A) + ' and B = '+ str(B)+ '')
plt.show()
```

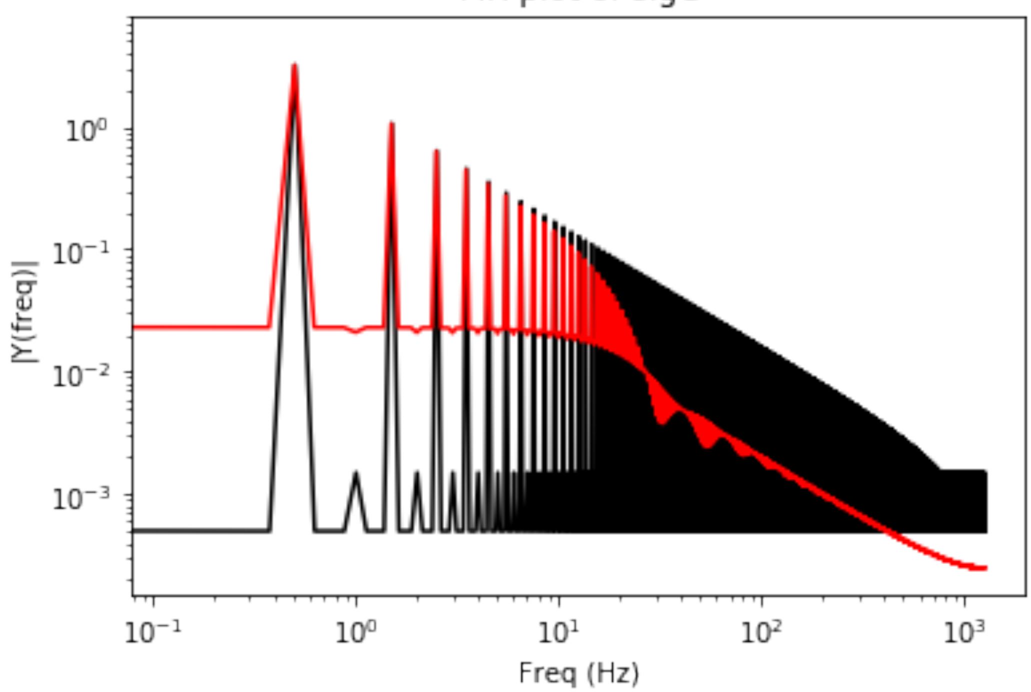
7)

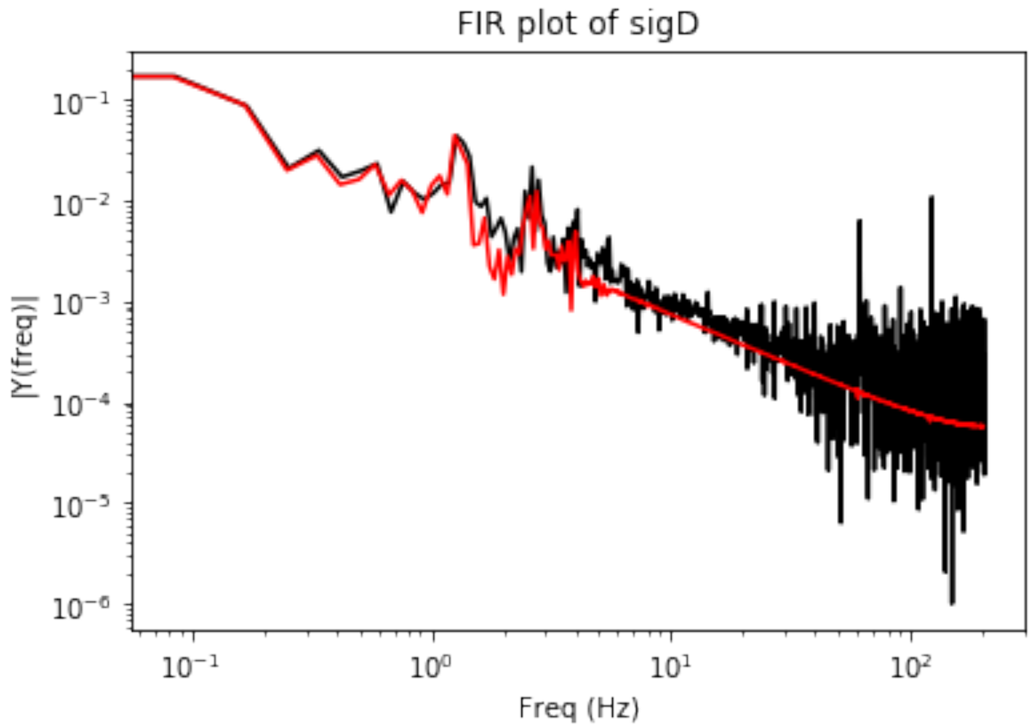


FIR plot of sigB



FIR plot of sigC





Code (same for all cases other than “sigA” being replaced with “sigB,” “sigC,” “sigD”):

NOTE: FOR CLARITY, WEIGHTS HAVE BEEN REMOVED AND REPLACED WITH “**……”** ACTUAL WEIGHTS ARE LISTED BELOW FOR EACH DATA SAMPLE

```
# Low pass filter sigA

t = [] # column 0
data1 = [] # column 1

with open('sigA.csv') as f:
   # open the csv file
   reader = csv.reader(f)
   for row in reader:
      # read the rows 1 one by one
      t.append(float(row[0])) # leftmost column
      data1.append(float(row[1])) # second column

weights = ……
data = data1.copy()
x = len(weights)
newdata = []
```

```
for i in range(x):
   data.insert(i, 0)
for j in range(len(data)-x):
   sum = 0
   for i in range(x):
      sum = sum + weights[i]*data[j + x - i]
   newdata.append(sum)

samplerate = len(data)/t[-1]
newsamplerate = len(newdata)/t[-1]

# plt.plot(t,data1)
# plt.plot(t,newdata)

# FFT for sigD

Fs = samplerate # sample rate
Ts = 1.0/Fs; # sampling interval
ts = np.arange(0,t[-1],Ts) # time vector
y = data1 # the data to make the fft from
n = len(y) # length of the signal
k = np.arange(n)
T = n/Fs
frq = k/T # two sides frequency range
frq = frq[range(int(n/2))] # one side frequency range
Y = np.fft.fft(y)/n # fft computing and normalization
Y = Y[range(int(n/2))]


plt.loglog(frq,abs(Y),'black') # plotting the fft
plt.xlabel('Freq (Hz)')
plt.ylabel('|Y(freq)|')


# plotting the new sample FFT
samplerate = len(newdata)/t[-1]

# FFT for sigD

Fs = samplerate # sample rate
Ts = 1.0/Fs; # sampling interval
ts = np.arange(0,t[-1],Ts) # time vector
y = newdata # the data to make the fft from
n = len(y) # length of the signal
```

```
k = np.arange(n)
T = n/Fs
frq = k/T # two sides frequency range
frq = frq[range(int(n/2))] # one side frequency range
Y = np.fft.fft(y)/n # fft computing and normalization
Y = Y[range(int(n/2))]


plt.loglog(frq,abs(Y),'red') # plotting the fft
plt.title('FIR plot of sigA')
plt.show()
```

Weights for sigA:

```
weights = [
    0.000000000000000000,
    0.000000022609304456,
    0.000000092137658127,
    0.000000210376981500,
    0.000000378074907886,
    0.000000594900325696,
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Weights for sigB:

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