Homework 11

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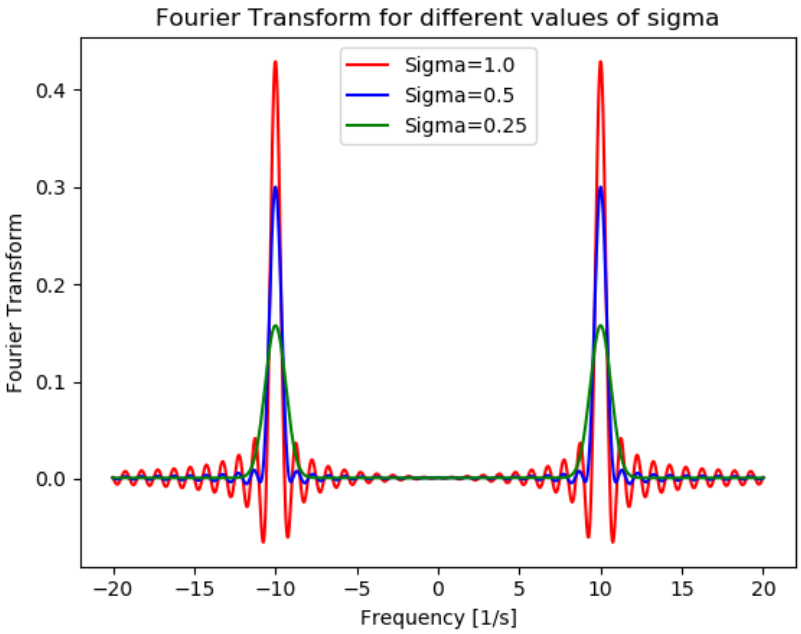
Problem 1

```
#Ryan Branagan
#Collaborators: N/A
#Branagan_hw11_p1.py
#4/10/19

import numpy as np
import pylab as p
#%%
#Define things
def FT(a,tax,fax):
    Aof = np.zeros_like(fax,dtype=complex)
    for i,f in enumerate(fax):
        #Setup Integrand/Product
        P = a*np.exp(-2*np.pi*1.j*f*tax)
        #Trap Rule
        dt = tax[1]-tax[0]
        Trap = (dt/2)*(P[0]+P[-1])+np.sum(P*dt)
        #Put it in an array
        Aof[i] = Trap
    return Aof

def func(t,f0,sigma):
    return np.cos(2*np.pi*f0*t)*np.exp(-1*(t**2)/(2*(sigma**2)))
#%%
#Parameters
t0 = 0
tf = 1
N = 10**3
f0 = 10
sigma = np.array([1,0.5,0.25])
```



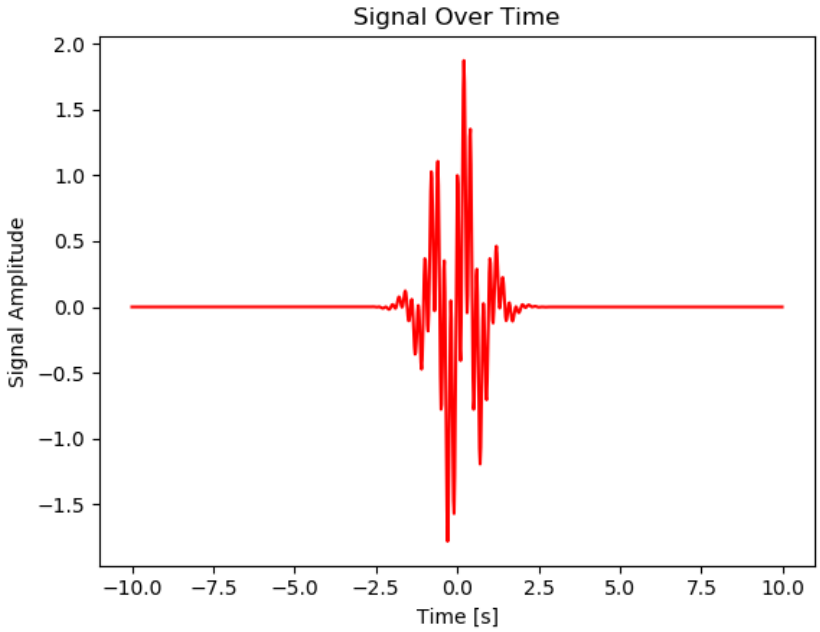

```
fax0 = -20
ff = 20

ts = np.linspace(t0,tf,N)
fax = np.linspace(fax0,ff,N)

Ans = np.array([np.zeros(N) for i in range(len(sigma))],dtype=complex)
for i,s in enumerate(sigma):
    aot = func(ts,f0,s)
    z = FT(aot,ts,fax)
    Ans[i] = z

fig,ax = p.subplots(1,1)
ax.plot(fax,Ans[0],'r-',label="Sigma="+str(sigma[0]))
ax.plot(fax,Ans[1],'b-',label="Sigma="+str(sigma[1]))
ax.plot(fax,Ans[2],'g-',label="Sigma="+str(sigma[2]))
ax.set_title("Fourier Transform for different values of sigma")
ax.set_xlabel("Frequency [1/s]")
ax.set_ylabel("Fourier Transform")
ax.legend()
```

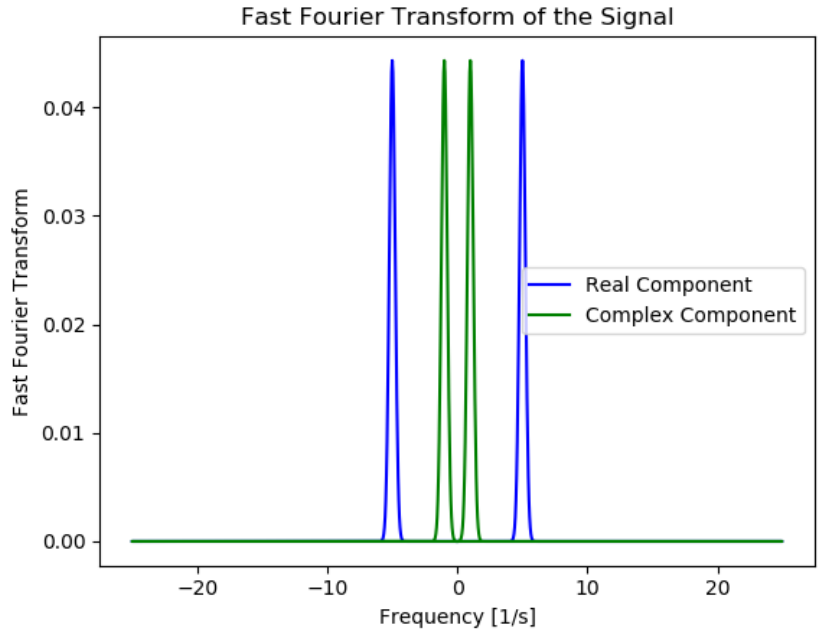
I probably shouldn't have put all the graphs on the same plot but it is easier and it is still able to be read. The graph contains the real and complex components.

Problem 2

```
#Ryan Branagan
#Collaborators: N/A
#Branagan_hw11_p2.py
#4/10/19

import numpy as np
import pylab as p
#%%
#Import Data
Dat = np.loadtxt("C:\\Users\\ryan-\\Documents\\251\\Homework 11\\Lesson16_Data.txt")
tax = Dat[:,0]
aot = Dat[:,1]

#Plot Original Signal
fig1, og = p.subplots(1,1)
og.plot(tax,aot,'r-')
og.set_title("Signal Over Time")
og.set_xlabel("Time [s]")
og.set_ylabel("Signal Amplitude")

#Fast Transform
Aof = np.fft.fft(aot)/len(tax)
freq = np.fft.fftfreq(len(tax),(tax[1]-tax[0]))

#Plot Transform
fig2, ax = p.subplots(1,1)
ax.plot(freq,np.abs(np.real(Aof)),'b-',label="Real Component")
ax.plot(freq,np.abs(np.imag(Aof)),'g-',label="Complex Component")
ax.set_title("Fast Fourier Transform of the Signal")
ax.set_xlabel("Frequency [1/s]")
ax.set_ylabel("Fast Fourier Transform")
ax.legend()
```

When comparing with other classmates we noticed that the 5Hz signal is contained in the real component while the 1Hz signal is contained in the complex part.


Signal Over Time
Signal Amplitude
2.0
1.5
1.0
0.5
0.0
−0.5
−1.0
−1.5
−10.0
−7.5
−5.0
−2.5
0.0
2.5
5.0
7.5
10.0
Time [s]


Fast Fourier Transform of the Signal
Fast Fourier Transform
0.04
0.03
0.02
0.01
0.00
−20
−10
0
10
20
Frequency [1/s]
Real Component
Complex Component