In [1]:
```
import numpy as np
from matplotlib import pyplot as plt
from scipy import signal
import scipy.io.wavfile as wav
import IPython.display as ipd
from IPython.display import HTML
import pywt

## . . Import the pywt library
## . . Uncomment if necessary
#!pip install PyWavelets
```

LAB 13 - Applications of Wavelet Transform

DUE: 26 April 2024 @ 11.59pm

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The purpose of this lab is to give you practice with applications of the wavelet transform.

Note: You must show your numerical work, and your computations must be reproducible either as a number of short python codes or (preferrably) in a single Jupyter Notebook! **Please include a PDF version of your assignment to help the TA with the grading process.**

Q1 - Computing the central ferquency for continuous wavelets

(1a) Import the pyWavelets package and create a wavelet function object for a continuous wavelet.

Hint: Check the variable *wavelet_func* in the *plotWavelets* function

In [2]:
```
w=pywt.ContinuousWavelet("morl")
```

(1b) List all availble Gaussian and Morlet wavelets

In [3]:
```
for family in pywt.families():
    if (family == "gaus"):
        print("%s family: " % family + ', '.join(pywt.wavelist(family)))
    elif (family == "morl"):
        print("%s family: " % family + ', '.join(pywt.wavelist(family)))
    else:
        continue
```

```
gaus family: gaus1, gaus2, gaus3, gaus4, gaus5, gaus6, gaus7, gaus8
morl family: morl
```

(1c) Build one wavelet from each of the two lists above and then compute the magnitude spectra each.

In [4]:
```
#build wavelet
wG = pywt.ContinuousWavelet('gaus7')
```

```
wM = pywt.ContinuousWavelet('morl')
time = np.arange(-4, 4, 0.01)

psiG, xG = wG.wavefun(length=800)
psiM, xM = wM.wavefun(length=800)

#compute magnitude spectra
gFFT= np.fft.fft(psiG)
mFFT= np.fft.fft(psiM)
magG= np.abs(gFFT)
magM= np.abs(mFFT)

print(len(xG))
print(len(xM))
```

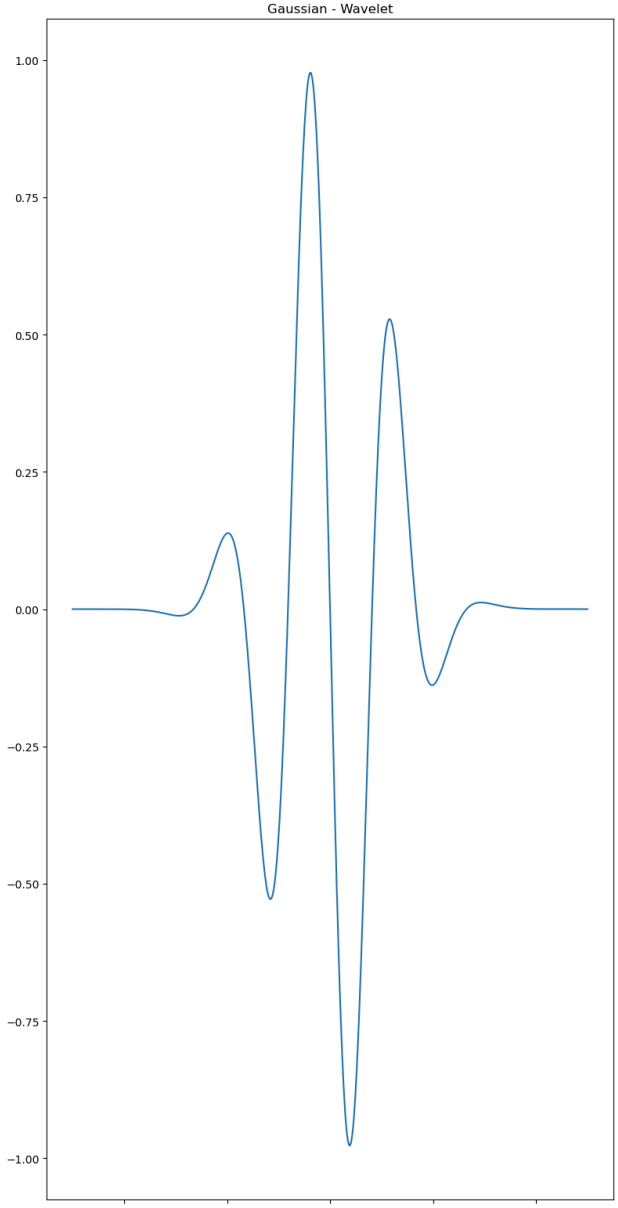
```
800
800
```

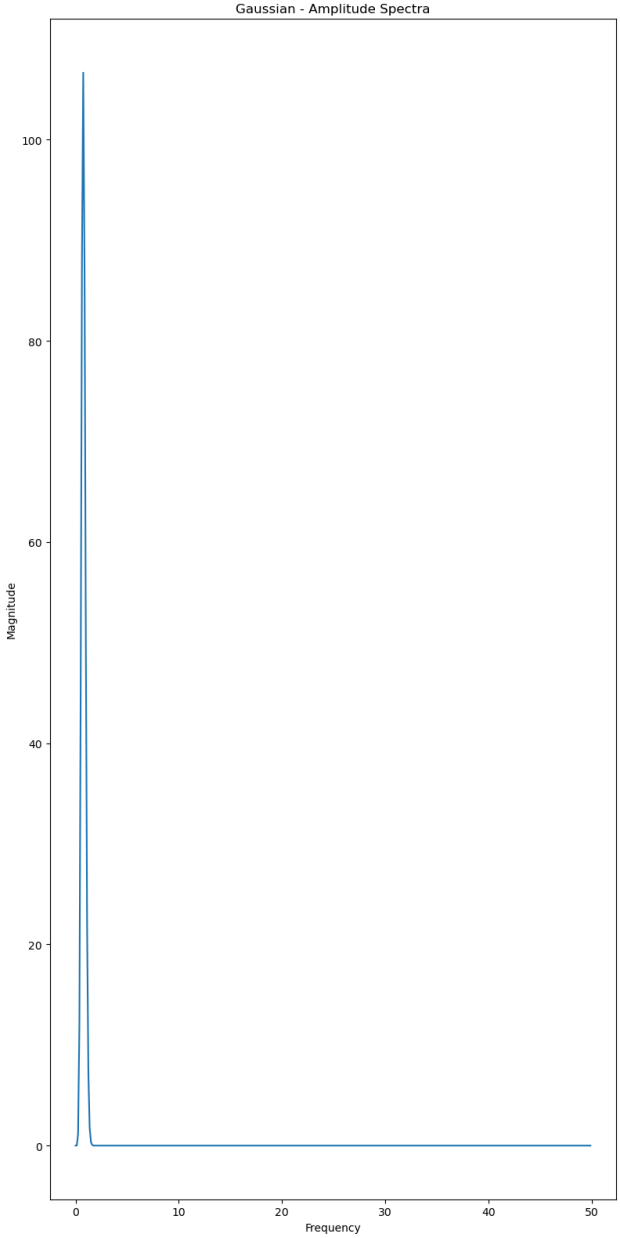
(1d) Compute the frequency values for the two spectra from (1c).

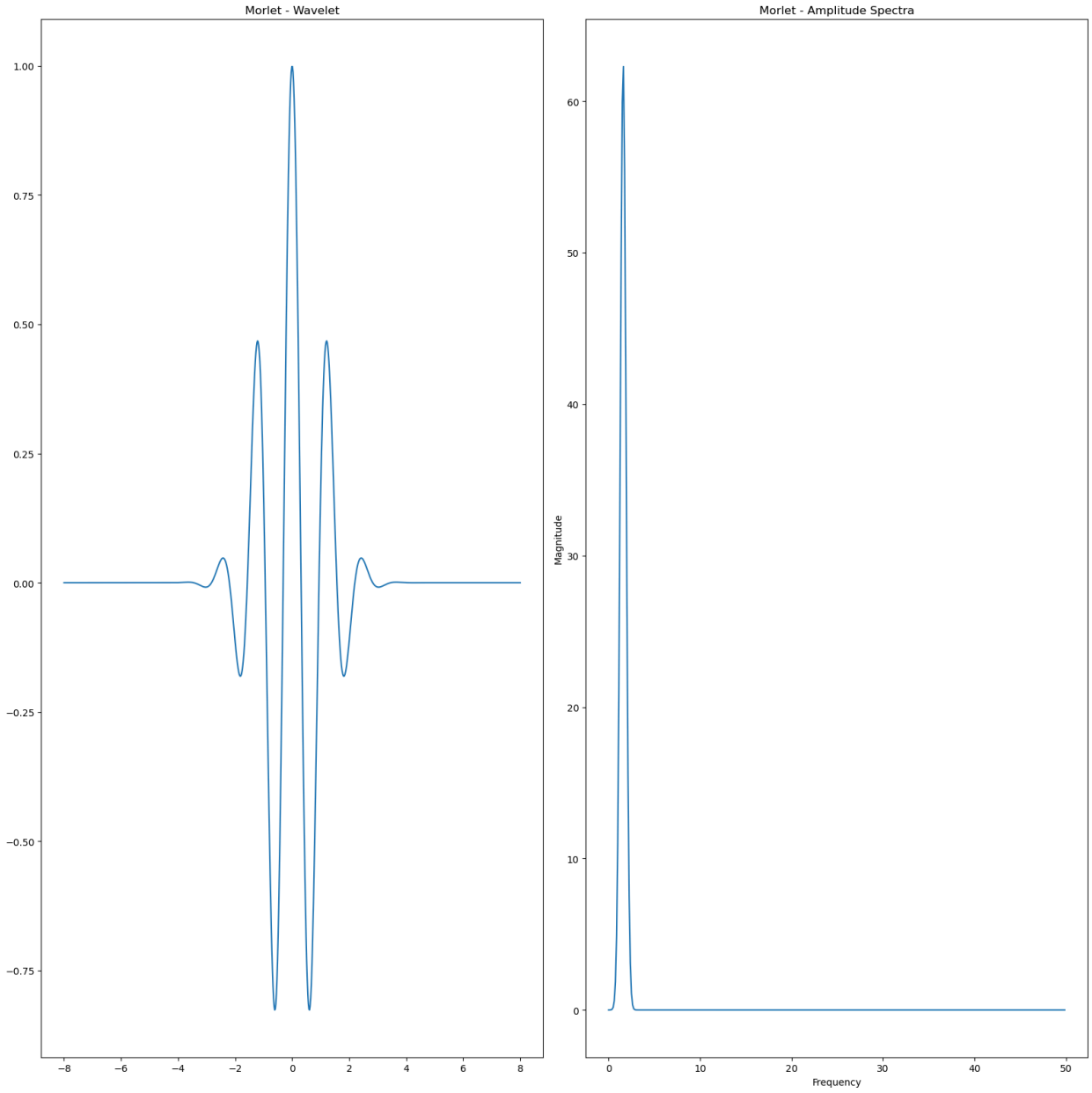
In [5]:
```
# I am going to assume we are doing 100 Hz sampling
dt= 0.01
freqs= np.fft.fftfreq(len(time), dt)
```

(1e) Plot the two wavelets along with first half of their amplitude spectra using the correct x-axis values for the wavelets and their spectra.

In [6]:
```
plt.figure(figsize=(16,16))

#gaussian
plt.subplot(1, 2, 1)
plt.plot(xG, psiG)
plt.title("Gaussian - Wavelet")

plt.subplot(1, 2, 2)
plt.plot(freqs[: len(freqs)//2], magG[:len(magG)//2])
plt.xlabel('Frequency')
plt.ylabel('Magnitude')
plt.title('Gaussian - Amplitude Spectra')

plt.tight_layout()
plt.show()

#morlet
plt.figure(figsize=(16,16))

plt.subplot(1, 2, 1)
plt.plot(xM, psiM)
plt.title("Morlet - Wavelet")

plt.subplot(1, 2, 2)
plt.plot(freqs[: len(freqs)//2], magM[:len(magM)//2])
plt.xlabel('Frequency')
plt.ylabel('Magnitude')
plt.title('Morlet - Amplitude Spectra')

plt.tight_layout()
plt.show()
```


Gaussian - Wavelet
1.00
0.75
0.50
0.25
0.00
−0.25
−0.50
−0.75
−1.00
−4
−2
0
2
4


Gaussian - Amplitude Spectra
Magnitude
100
80
60
40
20
0
0
10
20
30
40
50
Frequency



Q2 - Computing spectograms using the continuose wavelet transform

(2a) Using the central frequencies for the two wavelets in Question 1 above and *dt* for the above signal, find the range of scales that recoveres the full range of frequencies in the above magnitude spectrum for each wavelet.

In [7]:
```
dt=0.01
fs= 1/dt

#central frequencies
cG= pywt.central_frequency(wG)
cM= pywt.central_frequency(wM)

rG = pywt.frequency2scale(wG, cG)
rM = pywt.frequency2scale(wM, cM)
```

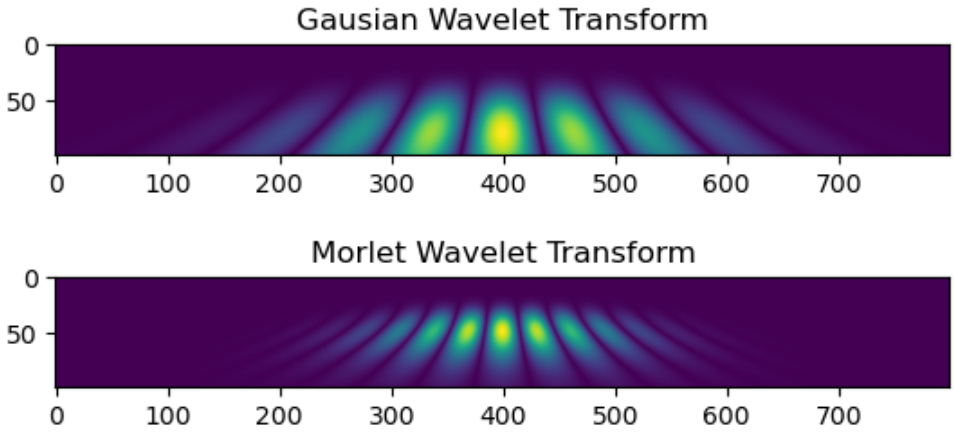
```
scaleG= np.arange(1,100)*rG
scaleM= np.arange(1,100)*rM
```

(2b) Compute the *continuous wavelet transform* using the two wavelets and their corresponding scales above.

In [8]:
```
coefG2, freqG2= pywt.cwt(psiG, scaleG, wG)
coefM2, freqM2= pywt.cwt(psiM, scaleM, wM)
```

(2c) Plot the two wavelet transforms using *plt.imshow()*. Make sure you change the y-axis values to match the frequencies values returned by *pywt.cwt* .

In [9]:
```
plt.imshow(abs(coefG2))
plt.title("Gausian Wavelet Transform")
plt.show()

plt.imshow(abs(coefM2))
plt.title("Morlet Wavelet Transform")
plt.show()
```



I spent alot of time on this assignment but could not figure out what to do, I have outputs for every question, so this is what I can submit. Even after reaching out to the TA some questions were left unanswered. For example, what we are considering our signal in the transform and throughout this assignment. I think the directions for this assignment were extremely vague and difficult to interpret.