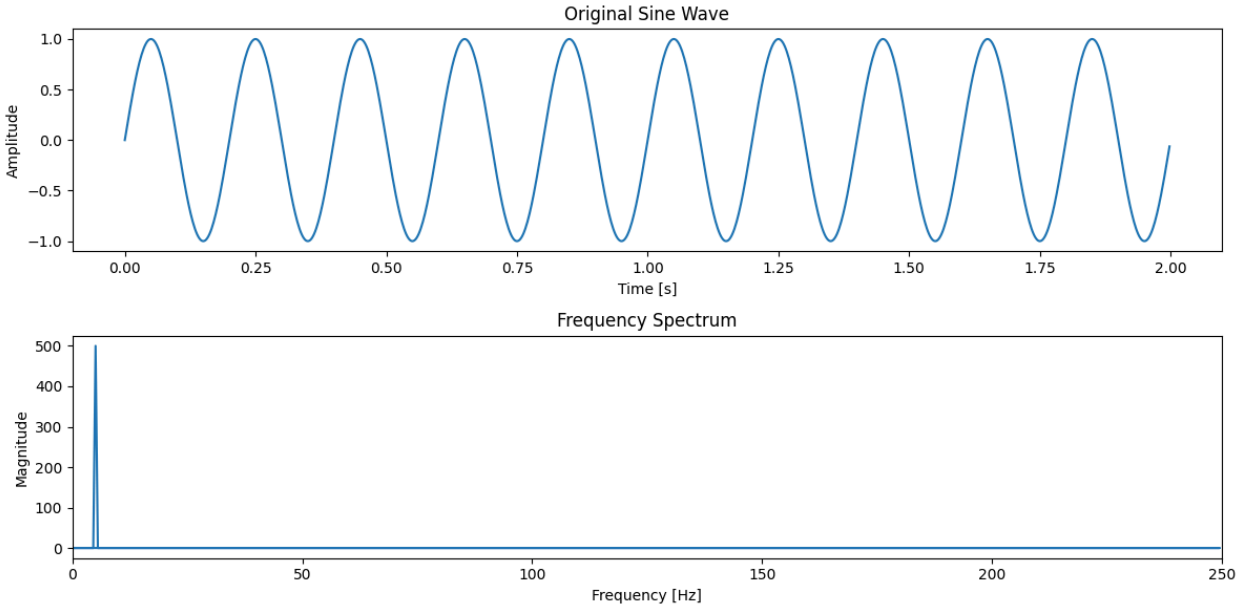
ASSIGNMENT 2

Question 1: Perform a Fast Fourier Transform (FFT) on a sine wave signal and visualize both the original signal and its frequency spectrum.

```
import numpy as np
import matplotlib.pyplot as plt

# Parameters
frequency = 5  # Frequency of the sine wave in Hz
sampling_rate = 500  # Sampling rate in Hz
duration = 2  # Duration in seconds

# Time array
t = np.linspace(0, duration, int(sampling_rate * duration),
endpoint=False)

# Generate sine wave
sine_wave = np.sin(2 * np.pi * frequency * t)

# Perform FFT
fft_result = np.fft.fft(sine_wave)
fft_magnitude = np.abs(fft_result)
fft_frequency = np.fft.fftfreq(len(fft_result), 1 / sampling_rate)

# Plot the original sine wave
plt.figure(figsize=(12, 6))

plt.subplot(2, 1, 1)
plt.plot(t, sine_wave)
plt.title('Original Sine Wave')
plt.xlabel('Time [s]')
plt.ylabel('Amplitude')

# Plot the FFT result (frequency spectrum)
plt.subplot(2, 1, 2)
plt.plot(fft_frequency, fft_magnitude)
plt.title('Frequency Spectrum')
plt.xlabel('Frequency [Hz]')
plt.ylabel('Magnitude')
```

```
plt.xlim(0, sampling_rate / 2)  # Limit x-axis to positive frequencies

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

OUTPUT:



Question 2: Use the scipy library to numerically integrate the function f(x)=xpower 2 over the range[0,5].

```
import scipy.integrate as integrate

# Define the function to integrate
def f(x):
    return x**2

# Perform the integration
result, error = integrate.quad(f, 0, 5)

print(f"The integral of f(x) = x^2 from 0 to 5 is: {result}")
```

OUTPUT:

```
The integral of f(x) = x^2 from 0 to 5 is: 41.66666666666666
Estimated error: 4.625929269271485e-13
```

Question: Solve a simple optimization problem where you need to minimize the function $f(x) = (x-3)^2 + 2$ using `scipy.optimize`.

```
import numpy as np
from scipy.optimize import minimize

def f(x):
    return (x - 3)**2 + 2

x0 = 0  # Initial guess
result = minimize(f, x0)

print("The minimum value of the function is:", result.fun)
print("The value of x at the minimum is:", result.x)
```

OUTPUT:

```
The minimum value of the function is: 2.000000000000001
The value of x at the minimum is: [3.00000003]
```

Question: Solve a system of linear equations using `numpy`. Given the system:

$$2x + 3y = 5$$

$$4x + y = 6$$

Solve for x and y.

```
import numpy as np

# Coefficient matrix
A = np.array([[2, 3], [4, 1]])
```

```
# Constant matrix
B = np.array([5, 6])

# Solve the system of equations
X = np.linalg.solve(A, B)

print(f"The solution is x = {X[0]}, y = {X[1]}")
```

OUTPUT:

```
The solution is x = 1.3, y = 0.8
```