GITHUB

Aim: Practical based on Signal Processing using Scipy

IDE:

What is SciPy?

SciPy is a free and open-source Python library used for scientific computing and technical computing. It is a collection of mathematical algorithms and convenience functions built on the NumPy extension of Python. It adds significant power to the interactive Python session by providing the user with high-level commands and classes for manipulating and visualizing data. As mentioned earlier, SciPy builds on NumPy and therefore if you import SciPy, there is no need to import NumPy.

Generates a sine wave and a square wave with a frequency of 5 Hz and a sampling frequency of 500 Hz.

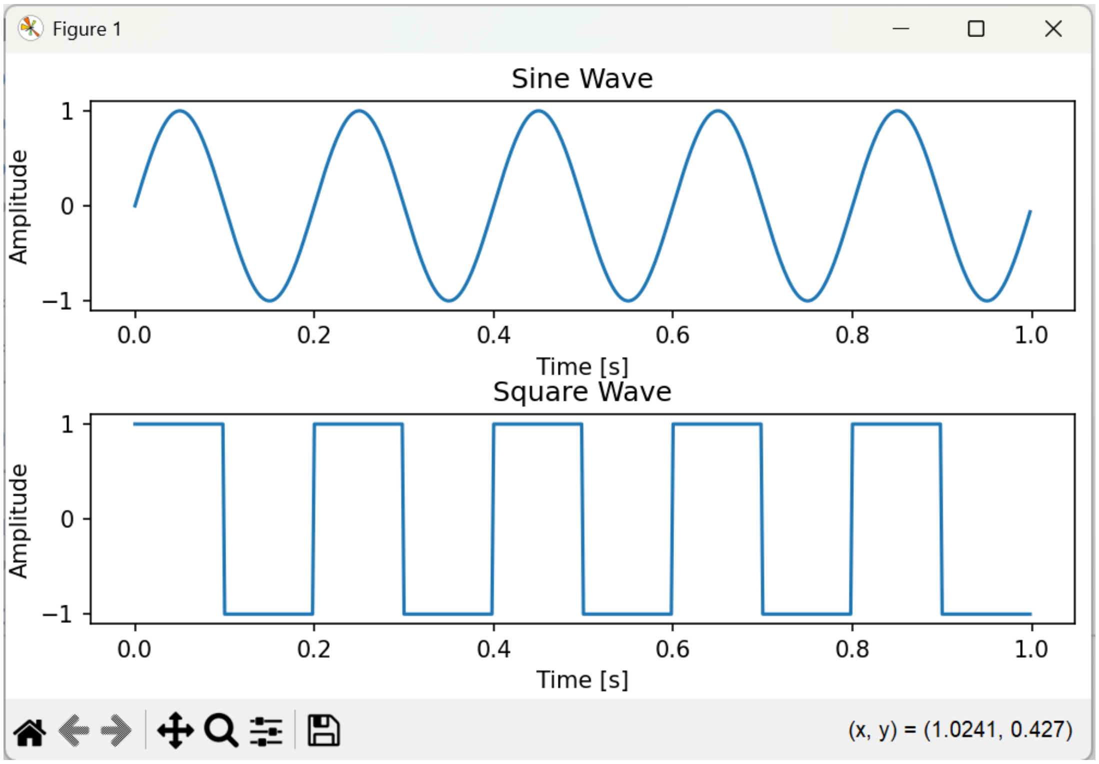
```
import numpy as np
import matplotlib.pyplot as plt
from scipy import signal
# Parameters
fs = 500  # Sampling frequency
f = 5  # Frequency of the signal
t = np.linspace(0, 1, fs, endpoint=False)  # Time array
# Create a sine wave signal
sine_wave = np.sin(2 * np.pi * f * t)
# Create a square wave signal using scipy
square_wave = signal.square(2 * np.pi * f * t)
# Plot the signals
plt.figure(figsize=(10, 5))
plt.subplot(2, 1, 1)
plt.plot(t, sine_wave)
plt.title('Sine Wave')
plt.xlabel('Time [s]')
plt.ylabel('Amplitude')
plt.subplot(2, 1, 2)
plt.plot(t, square_wave)
plt.title('Square Wave')
plt.xlabel('Time [s]')
plt.ylabel('Amplitude')
```

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

Triangular and Ramp signal

```
import numpy as np
import matplotlib.pyplot as plt
from scipy import signal
# Parameters
fs = 500  # Sampling frequency
f = 5  # Frequency of the signal
t = np.linspace(0, 1, fs, endpoint=False)  # Time array
# Create a triangular wave signal using scipy
triangular_wave = signal.sawtooth(2 * np.pi * f * t, 0.5)
# Create a ramp (sawtooth) signal using scipy
ramp_signal = signal.sawtooth(2 * np.pi * f * t)
# Plot the signals
plt.figure(figsize=(10, 5))
plt.subplot(2, 1, 1)
plt.plot(t, triangular_wave)
plt.title('Triangular Wave')
plt.xlabel('Time [s]')
plt.ylabel('Amplitude')
plt.subplot(2, 1, 2)
plt.plot(t, ramp_signal)
plt.title('Ramp Signal')
plt.xlabel('Time [s]')
plt.ylabel('Amplitude')
plt.tight_layout()
plt.show()
```

```python
import numpy as np
import matplotlib.pyplot as plt
from scipy import signal
# Parameters
fs = 500  # Sampling frequency
f = 5  # Frequency of the signal
t = np.linspace(0, 1, fs, endpoint=False)  # Time array
# Create a sine wave signal
sine_wave = np.sin(2 * np.pi * f * t)
# Create a square wave signal using scipy
square_wave = signal.square(2 * np.pi * f * t)
# Plot the signals
plt.figure(figsize=(10, 5))
plt.subplot(2, 1, 1)
plt.plot(t, sine_wave)
plt.title('Sine Wave')
plt.xlabel('Time [s]')
plt.ylabel('Amplitude')
plt.subplot(2, 1, 2)
plt.plot(t, square_wave)
plt.title('Square Wave')
plt.xlabel('Time [s]')
plt.ylabel('Amplitude')
plt.tight_layout()
plt.show()
```



#Elementary signals

```
import numpy as np
import matplotlib.pyplot as plt
from scipy import signal
# Parameters
fs = 500  # Sampling frequency
t = np.linspace(-1, 1, fs, endpoint=False)  # Time array
# 1. Unit Step Signal
unit_step = np.heaviside(t, 1)
# 2. Unit Impulse Signal (Dirac Delta)
unit_impulse = np.zeros_like(t)
unit_impulse[fs//2] = 1  # Impulse at t=0
# 3. Ramp Signal
ramp_signal = signal.sawtooth(2 * np.pi * t, 1)
# 4. Sine Wave
f_sine = 5  # Frequency of the sine wave
```

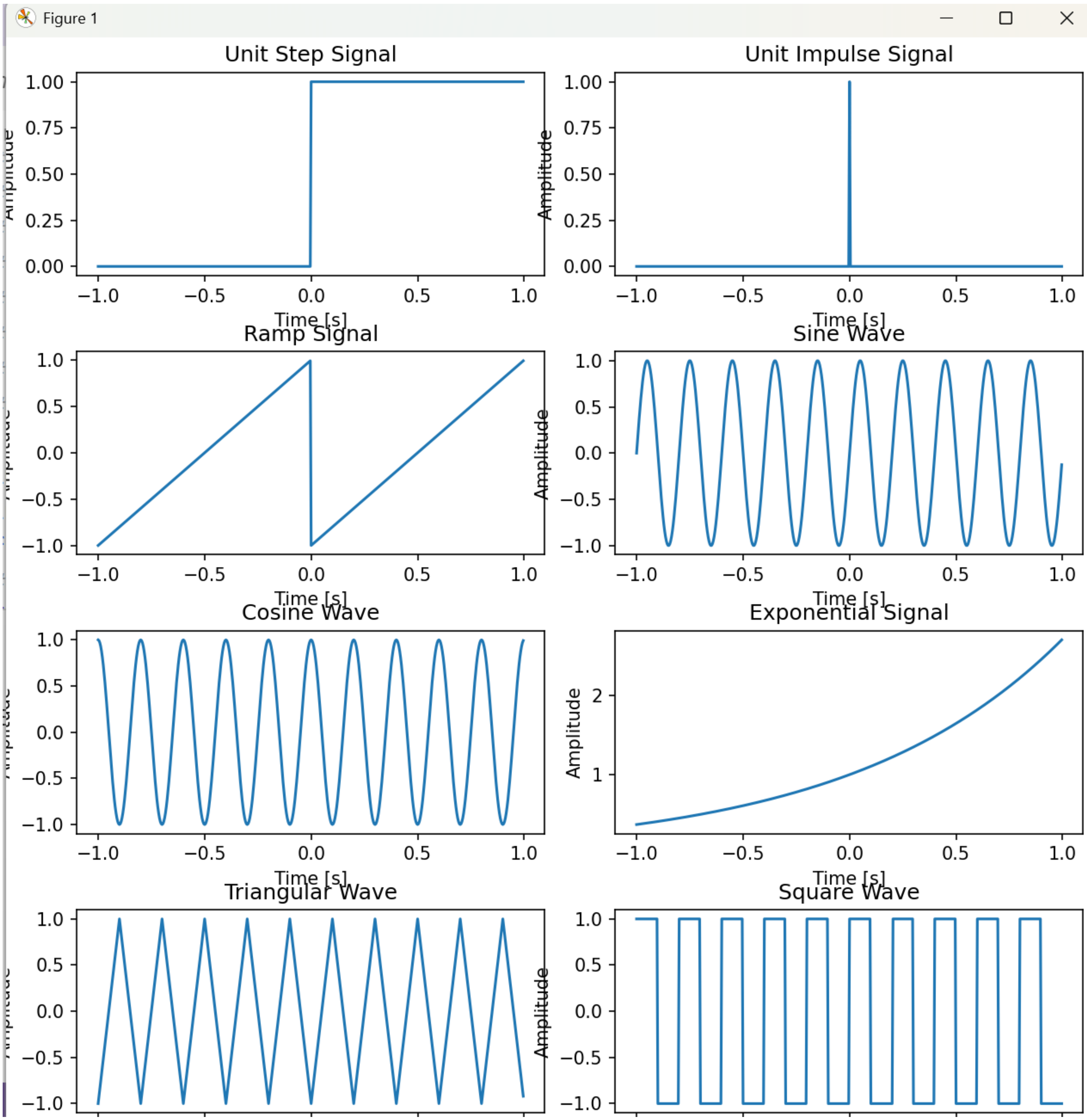
```
sine_wave = np.sin(2 * np.pi * f_sine * t)
# 5. Cosine Wave
f_cosine = 5  # Frequency of the cosine wave
cosine_wave = np.cos(2 * np.pi * f_cosine * t)
# 6. Exponential Signal
exponential_signal = np.exp(t)
# 7. Triangular Wave
triangular_wave = signal.sawtooth(2 * np.pi * 5 * t, 0.5)
# 8. Square Wave
square_wave = signal.square(2 * np.pi * 5 * t)
# Plot the signals
plt.figure(figsize=(12, 12))
plt.subplot(4, 2, 1)
plt.plot(t, unit_step)
plt.title('Unit Step Signal')
plt.xlabel('Time [s]')
plt.ylabel('Amplitude')
plt.subplot(4, 2, 2)
plt.plot(t, unit_impulse)
plt.title('Unit Impulse Signal')
plt.xlabel('Time [s]')
plt.ylabel('Amplitude')
plt.subplot(4, 2, 3)
plt.plot(t, ramp_signal)
plt.title('Ramp Signal')
plt.xlabel('Time [s]')
plt.ylabel('Amplitude')
plt.subplot(4, 2, 4)
plt.plot(t, sine_wave)
plt.title('Sine Wave')
plt.xlabel('Time [s]')
plt.ylabel('Amplitude')
plt.subplot(4, 2, 5)
plt.plot(t, cosine_wave)
```

```
plt.title('Cosine Wave')
plt.xlabel('Time [s]')
plt.ylabel('Amplitude')
plt.subplot(4, 2, 6)
plt.plot(t, exponential_signal)
plt.title('Exponential Signal')
plt.xlabel('Time [s]')
plt.ylabel('Amplitude')
plt.subplot(4, 2, 7)
plt.plot(t, triangular_wave)
plt.title('Triangular Wave')
plt.xlabel('Time [s]')
plt.ylabel('Amplitude')
plt.subplot(4, 2, 8)
plt.plot(t, square_wave)
plt.title('Square Wave')
plt.xlabel('Time [s]')
plt.ylabel('Amplitude')
plt.tight_layout()
plt.show()
```

```
plt.title('Unit Step Signal')
plt.xlabel('Time [s]')
plt.ylabel('Amplitude')
plt.subplot(4, 2, 2)
plt.plot(t, unit_impulse)
plt.title('Unit Impulse Signal')
plt.xlabel('Time [s]')
plt.ylabel('Amplitude')
plt.subplot(4, 2, 3)
plt.plot(t, ramp_signal)
plt.title('Ramp Signal')
plt.xlabel('Time [s]')
plt.ylabel('Amplitude')
plt.subplot(4, 2, 4)
plt.plot(t, sine_wave)
plt.title('Sine Wave')
plt.xlabel('Time [s]')
plt.ylabel('Amplitude')
plt.subplot(4, 2, 5)
plt.plot(t, cosine_wave)
plt.title('Cosine Wave')
plt.xlabel('Time [s]')
plt.ylabel('Amplitude')
plt.subplot(4, 2, 6)
plt.plot(t, exponential_signal)
plt.title('Exponential Signal')
```

	Marwadi University **Faculty of Engineering & Technology** **Department of Information and Communication Technology**
Subject: Programming With Python (01CT1309)	**Aim:** Practical based on Signal Processing using Scipy

Experiment No: 12	**Date:**	**Enrollment No: 92400133055**



Signal Classification

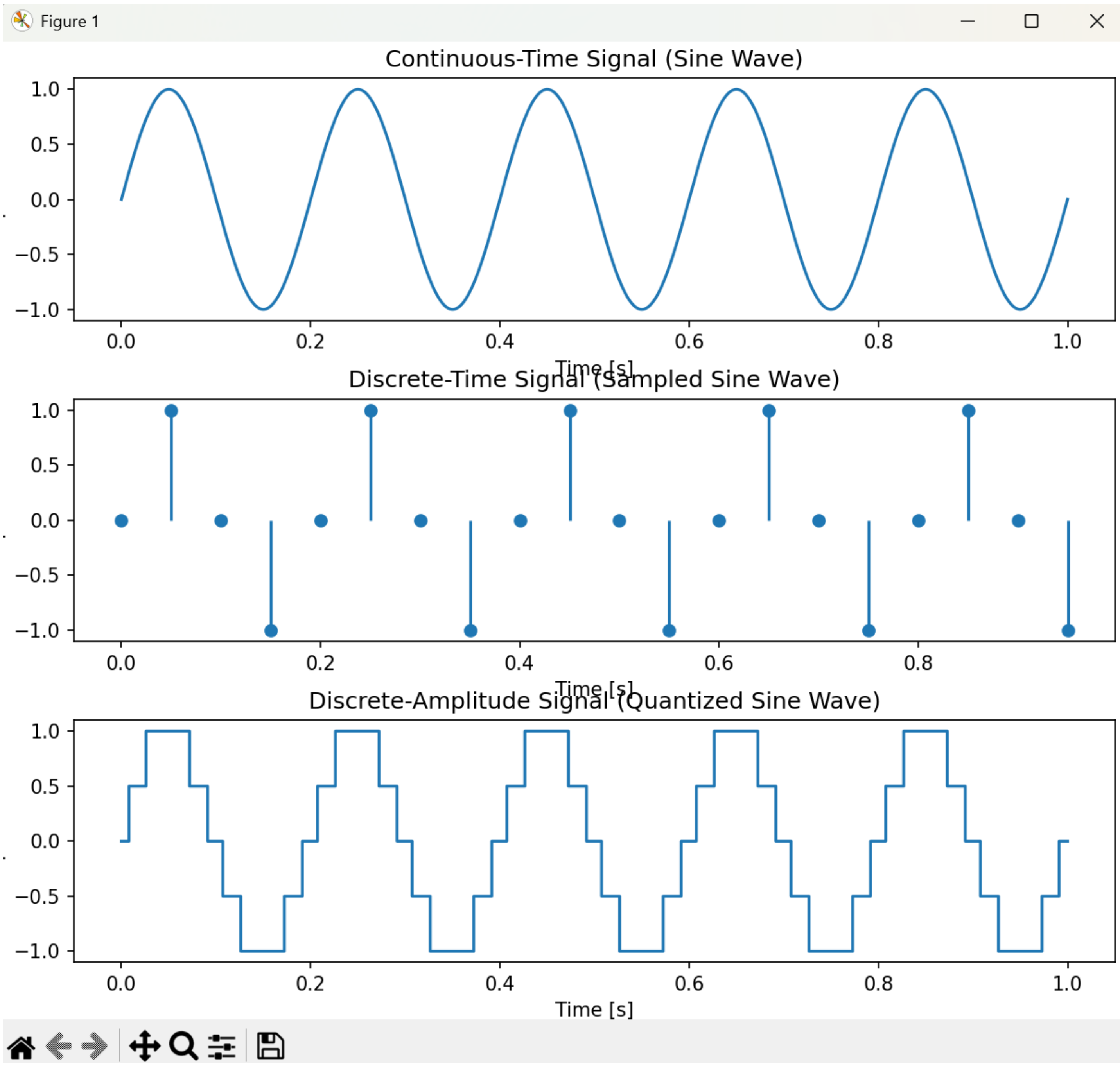
```
import numpy as np
import matplotlib.pyplot as plt

# Parameters
fs = 20  # Sampling frequency for discrete-time signal
t_continuous = np.linspace(0, 1, 1000)  # Time array for continuous signals
t_discrete = np.arange(0, 1, 1/fs)  # Discrete time array

# Generate a continuous-time sine wave
f = 5  # Frequency of the signal
continuous_signal = np.sin(2 * np.pi * f * t_continuous)

# Generate a discrete-time sine wave (sampled)
discrete_time_signal = np.sin(2 * np.pi * f * t_discrete)

# Discretize the amplitude (quantization) for the continuous-time signal
num_levels = 4  # Number of quantization levels
discrete_amplitude_signal = np.round(continuous_signal * (num_levels / 2)) / (num_levels / 2)

# Discretize both time and amplitude
discrete_time_amplitude_signal = np.round(discrete_time_signal * (num_levels / 2)) / (num_levels / 2)

# Plot the signals
plt.figure(figsize=(12, 10))

# Continuous-Time Signal
plt.subplot(4, 1, 1)
plt.plot(t_continuous, continuous_signal)
plt.title('Continuous-Time Signal (Sine Wave)')
plt.xlabel('Time [s]')
plt.ylabel('Amplitude')

# Discrete-Time Signal
plt.subplot(4, 1, 2)
```

plt.stem(t_discrete, discrete_time_signal, use_line_collection=True)
plt.title('Discrete-Time Signal (Sampled Sine Wave)')
plt.xlabel('Time [s]')
plt.ylabel('Amplitude')

# Discrete-Amplitude Signal
plt.subplot(4, 1, 3)
plt.plot(t_continuous, discrete_amplitude_signal, drawstyle='steps-pre')
plt.title('Discrete-Amplitude Signal (Quantized Sine Wave)')
plt.xlabel('Time [s]')
plt.ylabel('Amplitude')

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

# Parameters
fs = 20  # Sampling frequency for discrete-time signal
t_continuous = np.linspace(0, 1, 1000)  # Time array for continuous signals
t_discrete = np.arange(0, 1, 1/fs)  # Discrete time array

# Generate a continuous-time sine wave
f = 5  # Frequency of the signal
continuous_signal = np.sin(2 * np.pi * f * t_continuous)

# Generate a discrete-time sine wave (sampled)
discrete_time_signal = np.sin(2 * np.pi * f * t_discrete)

# Discretize the amplitude (quantization) for the continuous-time signal
num_levels = 4  # Number of quantization levels
discrete_amplitude_signal = np.round(continuous_signal * (num_levels / 2)) / (num_levels / 2)

# Discretize both time and amplitude
discrete_time_amplitude_signal = np.round(discrete_time_signal * (num_levels / 2)) / (num_levels

# Plot the signals
plt.figure(figsize=(12, 10))

```

Marwadi University Marwadi Chandarana Group NAAC A+	**Marwadi University** **Faculty of Engineering & Technology** **Department of Information and Communication Technology**	
Subject: Programming With Python (01CT1309)	**Aim:** Practical based on Signal Processing using Scipy	
Experiment No: 12	**Date:**	**Enrollment No: 92400133055**



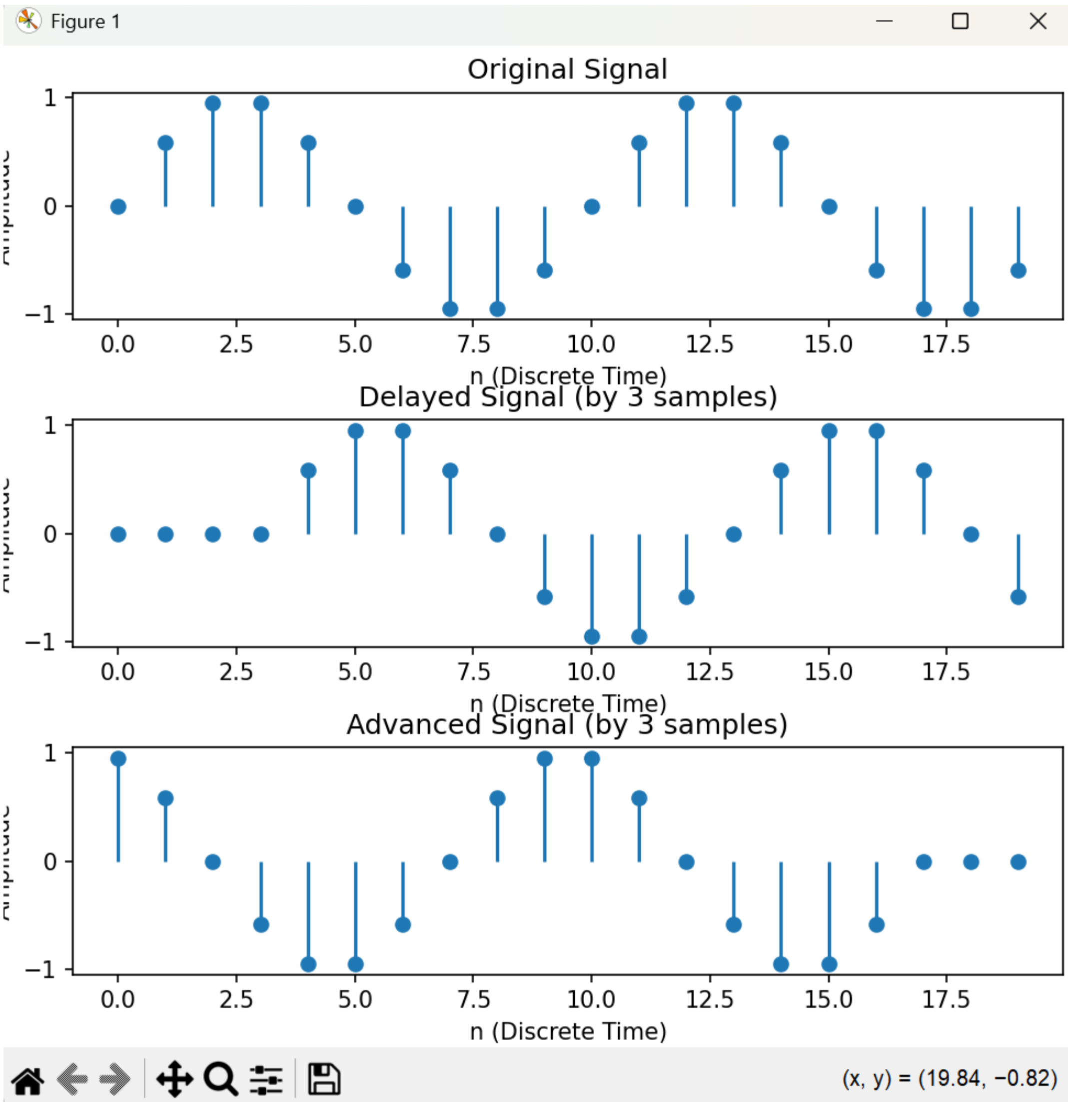
 # Discrete signal operation

import numpy as np

import matplotlib.pyplot as plt

```
# Parameters
n = np.arange(0, 20)  # Discrete time array (0 to 19)
signal = np.sin(0.2 * np.pi * n)  # Example discrete-time signal (sine wave)
# Delay the signal by 3 samples
delay = 3
delayed_signal = np.zeros_like(signal)
delayed_signal[delay:] = signal[:-delay]
# Advance the signal by 3 samples
advance = 3
advanced_signal = np.zeros_like(signal)
advanced_signal[:-advance] = signal[advance:]
# Plot the original and shifted signals
plt.figure(figsize=(12, 8))
# Original Signal
plt.subplot(3, 1, 1)
plt.stem(n, signal, use_line_collection=True)
plt.title('Original Signal')
plt.xlabel('n (Discrete Time)')
plt.ylabel('Amplitude')
# Delayed Signal
plt.subplot(3, 1, 2)
plt.stem(n, delayed_signal, use_line_collection=True)
plt.title(f'Delayed Signal (by {delay} samples)')
plt.xlabel('n (Discrete Time)')
plt.ylabel('Amplitude')
# Advanced Signal
plt.subplot(3, 1, 3)
plt.stem(n, advanced_signal, use_line_collection=True)
plt.title(f'Advanced Signal (by {advance} samples)')
plt.xlabel('n (Discrete Time)')
plt.ylabel('Amplitude')
plt.tight_layout()
plt.show()
```

```python
advance = 3
advanced_signal = np.zeros_like(signal)
advanced_signal[:-advance] = signal[advance:]

# Plot the original and shifted signals
plt.figure(figsize=(12, 8))

# Original Signal
plt.subplot(3, 1, 1)
plt.stem(n, signal, basefmt=" ")
plt.title('Original Signal')
plt.xlabel('n (Discrete Time)')
plt.ylabel('Amplitude')

# Delayed Signal
plt.subplot(3, 1, 2)
plt.stem(n, delayed_signal, basefmt=" ")
plt.title(f'Delayed Signal (by {delay} samples)')
plt.xlabel('n (Discrete Time)')
plt.ylabel('Amplitude')

# Advanced Signal
plt.subplot(3, 1, 3)
plt.stem(n, advanced_signal, basefmt=" ")
plt.title(f'Advanced Signal (by {advance} samples)')
plt.xlabel('n (Discrete Time)')
```



Post Lab Exercise:

a. Generate two sine wave signals with frequencies of 5 Hz and 10 Hz, both sampled at 1000 Hz for 1 second. Add the two signals together and plot the result.
b. Generate a 5 Hz sine wave and a 10 Hz cosine wave, both sampled at 500 Hz for 2 seconds. Multiply the two signals element-wise and plot the resulting signal.
c. Generate a 5 Hz sine wave signal and shift it in time by 0.1 seconds. Plot the original and shifted signals on the same graph for comparison.
d. Generate a 10 Hz sine wave and scale its amplitude by a factor of 3. Plot the original and scaled signals together.

e. Generate a 5 Hz sine wave and reverse it in time. Plot the original and reversed signals on the same graph.