	Marwari University **Faculty of Technology** **Department of Information and Communication Technology**	
Subject: Digital Signal and Image Processing(01CT0513)	**Aim:** Simulate Discrete Time Sequences.	
Experiment No: 01	**Date: 05-08-2025**	**Enrollment No: 92301733054**

Aim: Simulate Discrete Time Sequences.

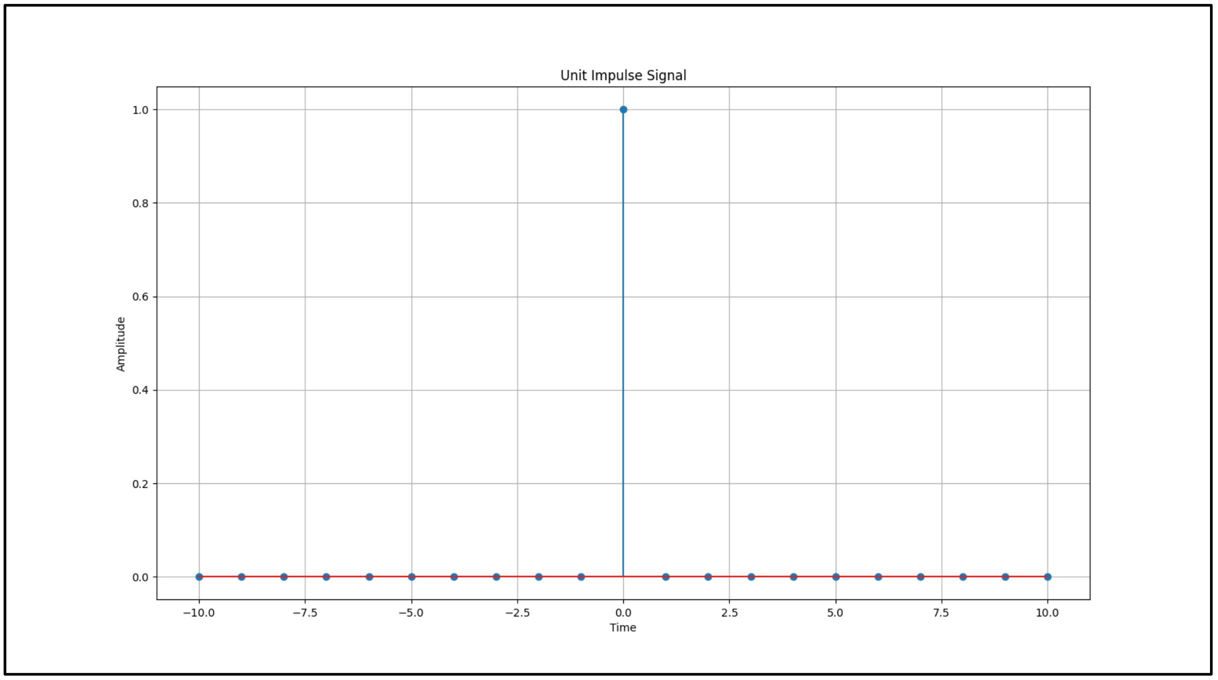
- **Write A Python Program to Generate the Given Signals and Plot them using Numpy and Matplotlib.**

1) Write a Python Programm To Plot Unit Impulse Signal.

Programm:-

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

def unit_impulse(length, position):
    signal = np.zeros(length)
    signal[position] = 1
    return signal

# Parameters
start = -10  # Start value of the x-axis range
stop = 10  # Stop value of the x-axis range
step = 1  # Step size

# Generate x-axis values
x = np.arange(start, stop+step, step)

# Generate unit impulse signal
impulse_signal = unit_impulse(len(x), abs(start)//step)

# Plot the signal
plt.stem(x, impulse_signal)
plt.xlabel('Time')
plt.ylabel('Amplitude')
plt.title('Unit Impulse Signal')
plt.grid(True)
plt.show()
```

Output:-



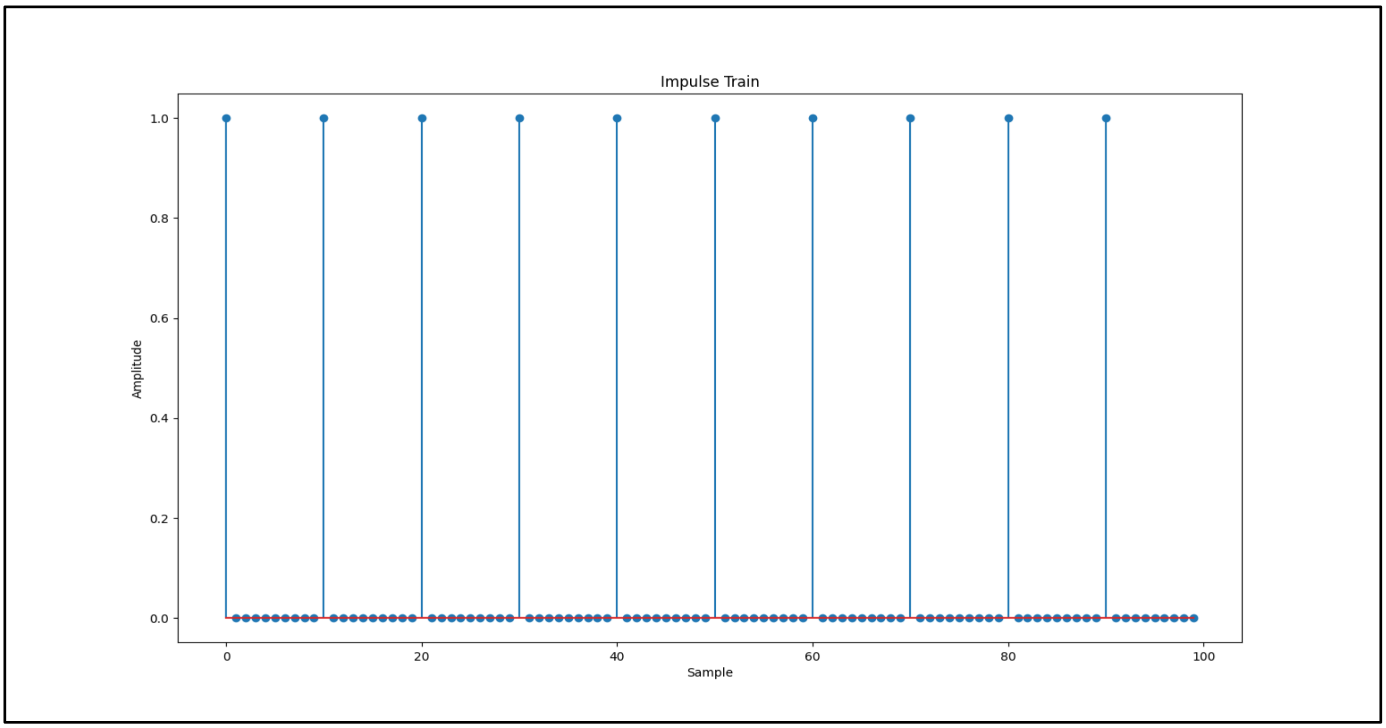
2) Write a Python Programm To Plot Unit Impulse Train.

Programm:-

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

def simulate_impulse_train(signal_length, period):
    impulse_train = np.zeros(signal_length)
    for n in range(signal_length):
        if n % period == 0:
            impulse_train[n] = 1
    return impulse_train

# Define the parameters for the impulse train
signal_length = 100  # Length of the impulse train
period = 10  # Period of the impulse train
```

```
# Simulate the impulse train
impulse_train = simulate_impulse_train(signal_length, period)

# Plot and display the impulse train
plt.stem(impulse_train)
plt.title('Impulse Train')
plt.xlabel('Sample')
plt.ylabel('Amplitude')
plt.show()
```

Output:-



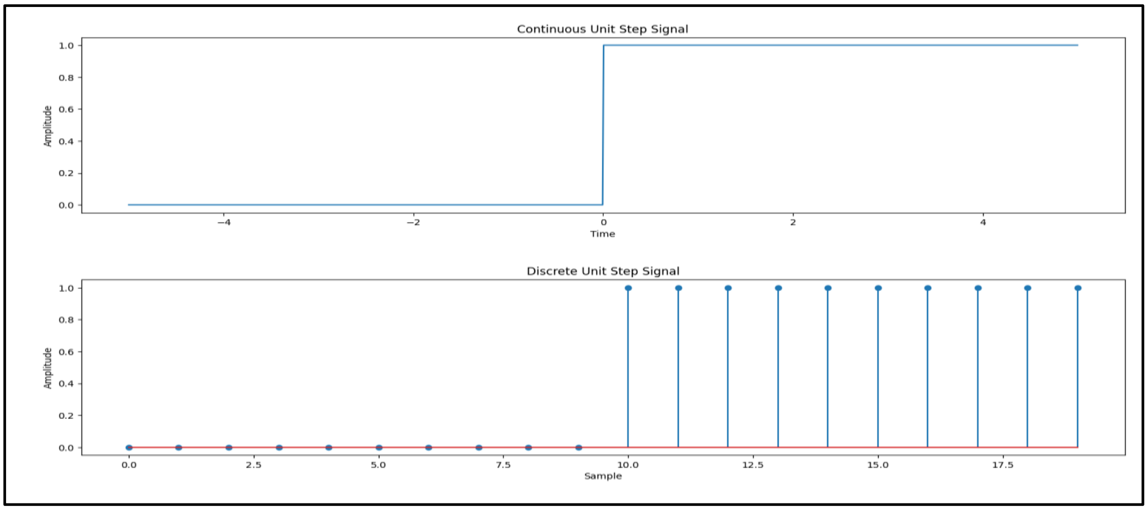
3) Write a Python Program to Simulate Continuous and Discrete Unit Step Signals.

Programm:-

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

def simulate_continuous_unit_step(time):
    unit_step = np.zeros_like(time)
    unit_step[time >= 0] = 1
    return unit_step
```

```
def simulate_discrete_unit_step(num_samples):
    unit_step = np.zeros(num_samples)
    unit_step[num_samples // 2:] = 1
    return unit_step

# Define the time range for the continuous unit step signal
time = np.linspace(-5, 5, 1000)  # Time range from -5 to 5

# Simulate the continuous unit step signal
continuous_unit_step = simulate_continuous_unit_step(time)

# Define the number of samples for the discrete unit step signal
num_samples = 20  # Number of samples

# Simulate the discrete unit step signal
discrete_unit_step = simulate_discrete_unit_step(num_samples)

# Plot and display the continuous and discrete unit step signals
plt.figure(figsize=(10, 6))
plt.subplot(2, 1, 1)
plt.plot(time, continuous_unit_step)
plt.title('Continuous Unit Step Signal')
plt.xlabel('Time')
plt.ylabel('Amplitude')

plt.subplot(2, 1, 2)
plt.stem(discrete_unit_step)
plt.title('Discrete Unit Step Signal')
plt.xlabel('Sample')
plt.ylabel('Amplitude')

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

Output:-



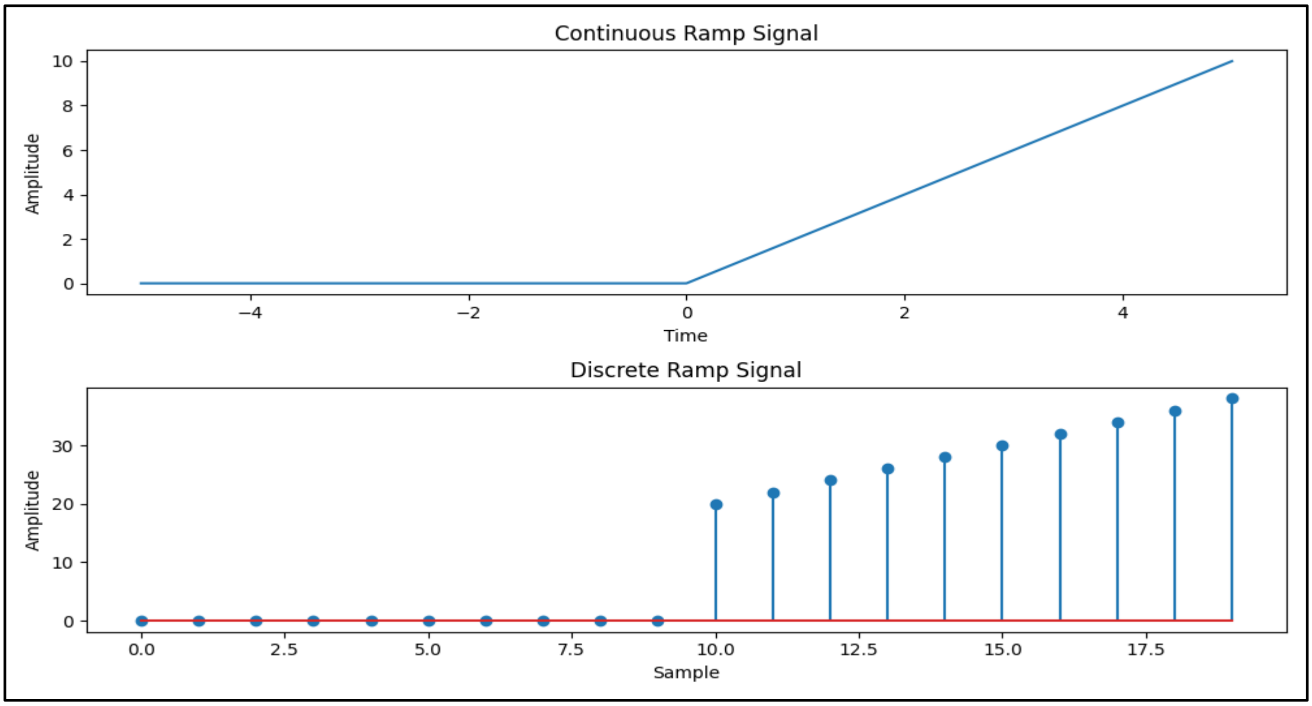
4) Write a Python Program to Simulate Continuous and Discrete Unit Ramp Signals.

Programm:-

```
import matplotlib.pyplot as plt
import numpy as np
def simulate_continuous_ramp(time, slope):
    ramp = np.zeros_like(time)
    ramp[time >= 0] = slope * time[time >= 0]
    return ramp
def simulate_discrete_ramp(num_samples, slope):
    ramp = np.zeros(num_samples)
    ramp[num_samples // 2:] = slope * np.arange(num_samples // 2, num_samples)
    return ramp
# Define the time range for the continuous ramp signal
time = np.linspace(-5, 5, 1000)  # Time range from -5 to 5

# Define the number of samples and slope for the discrete ramp signal
num_samples = 20  # Number of samples
slope = 2  # Slope of the ramp
# Simulate the continuous ramp signal
continuous_ramp = simulate_continuous_ramp(time, slope)
```

```
# Simulate the discrete ramp signal
discrete_ramp = simulate_discrete_ramp(num_samples, slope)

# Plot and display the continuous and discrete ramp signals
plt.figure(figsize=(10, 6))
plt.subplot(2, 1, 1)
plt.plot(time, continuous_ramp)
plt.title('Continuous Ramp Signal')
plt.xlabel('Time')
plt.ylabel('Amplitude')
plt.subplot(2, 1, 2)
plt.stem(discrete_ramp)
plt.title('Discrete Ramp Signal')
plt.xlabel('Sample')
plt.ylabel('Amplitude')

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

Output:-



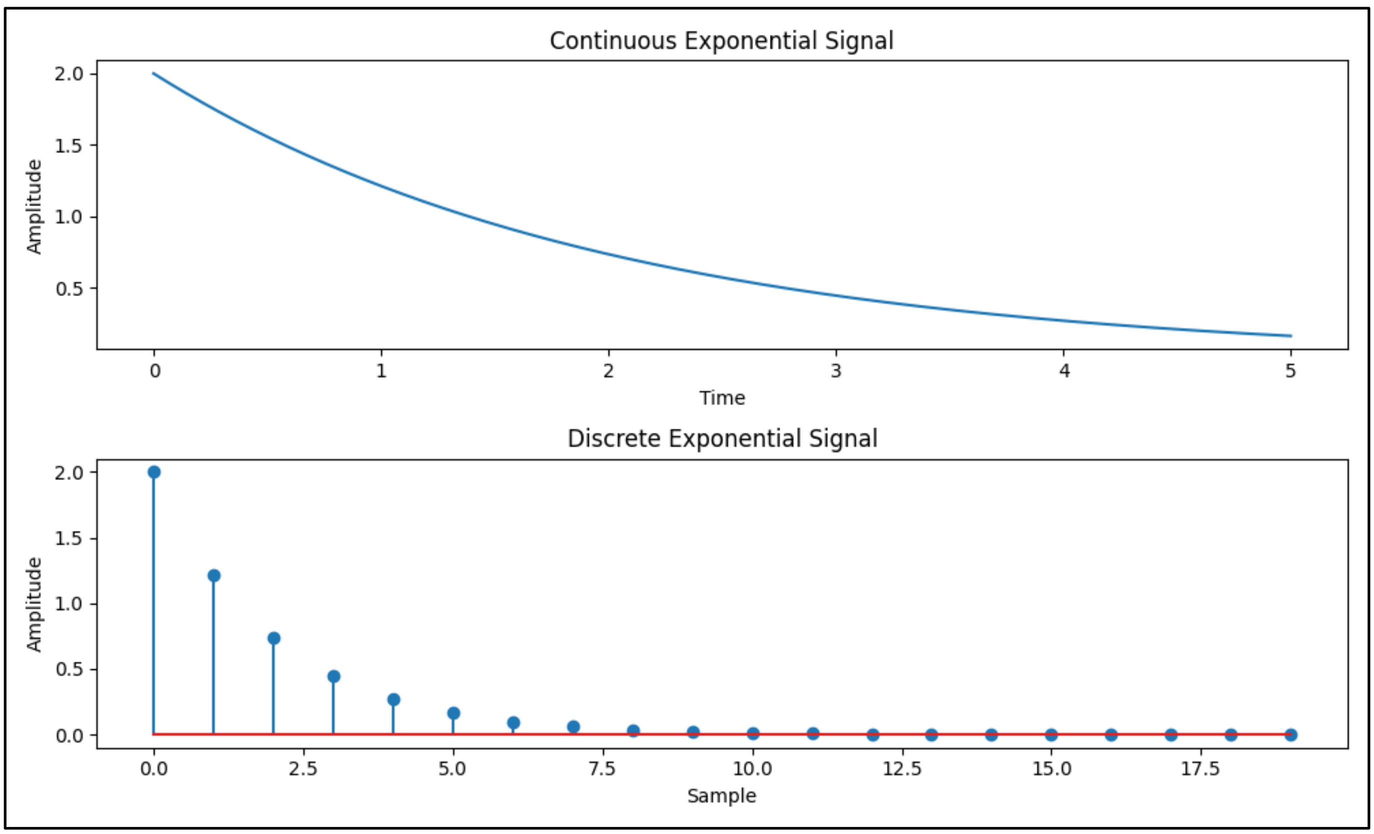
5) Write a Python Program to Simulate Continuous and Discrete Exponential Signals.

Programm:-

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

def simulate_continuous_exponential(time, amplitude, coefficient):
    exponential_signal = amplitude * np.exp(coefficient * time)
    return exponential_signal

def simulate_discrete_exponential(num_samples, amplitude, coefficient):
    exponential_signal = amplitude * \
        np.exp(coefficient * np.arange(num_samples))
    return exponential_signal

# Define the time range for the continuous exponential signal
time = np.linspace(0, 5, 1000)  # Time range from 0 to 5

# Define the number of samples, initial amplitude, and coefficient for the
# discrete exponential signal
num_samples = 20  # Number of samples
amplitude = 2  # Initial amplitude
coefficient = -0.5  # Exponential coefficient

# Simulate the continuous exponential signal
continuous_exponential = simulate_continuous_exponential(
    time, amplitude, coefficient)

# Simulate the discrete exponential signal
discrete_exponential = simulate_discrete_exponential(
    num_samples, amplitude, coefficient)

# Plot and display the continuous and discrete exponential signals
plt.figure(figsize=(10, 6))
plt.subplot(2, 1, 1)
plt.plot(time, continuous_exponential)
```

```
plt.title('Continuous Exponential Signal')

plt.xlabel('Time')
plt.ylabel('Amplitude')

plt.subplot(2, 1, 2)
plt.stem(discrete_exponential)
plt.title('Discrete Exponential Signal')
plt.xlabel('Sample')
plt.ylabel('Amplitude')

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

Output:-



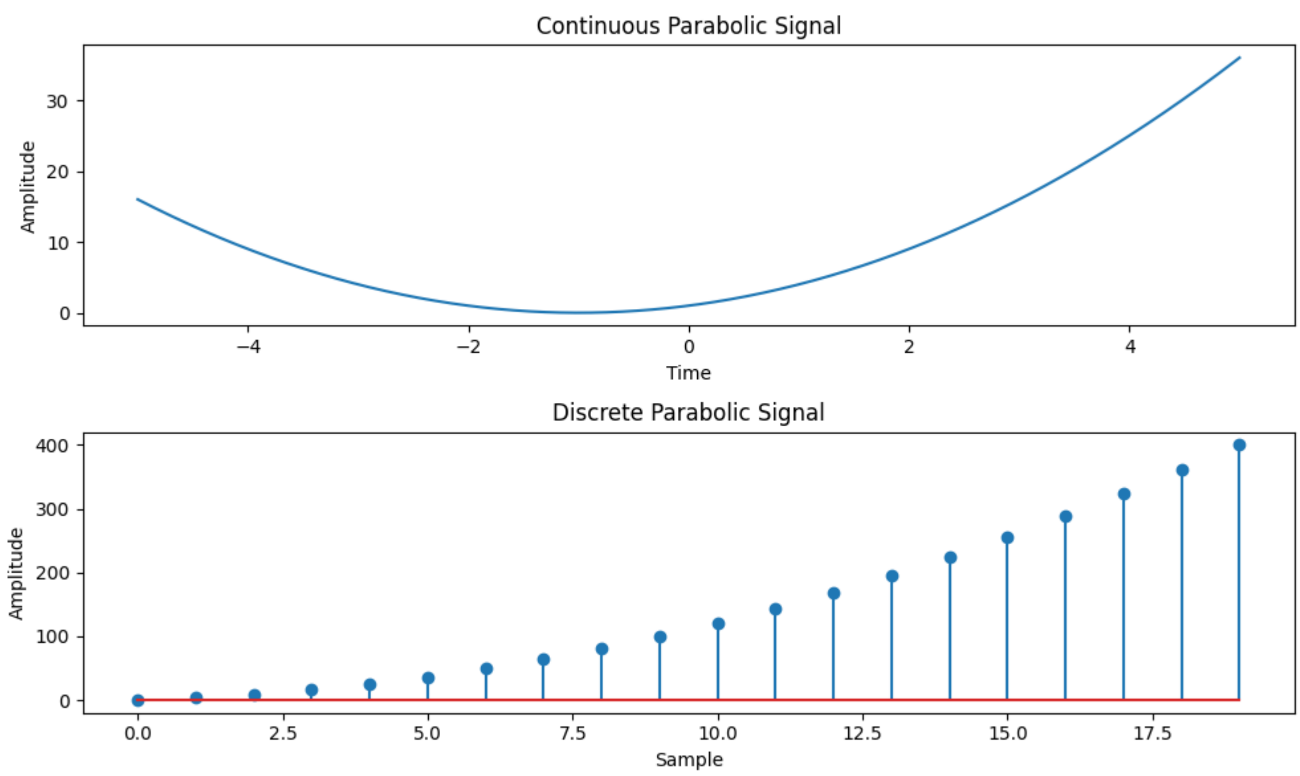
6) Write a Python Program to Simulate Continuous and Discrete Parabolic Signals.

Programm:-

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

def simulate_continuous_parabolic(time, coefficients):
    parabolic_signal = np.polyval(coefficients, time)
    return parabolic_signal

def simulate_discrete_parabolic(num_samples, coefficients):
    parabolic_signal = np.polyval(coefficients, np.arange(num_samples))
    return parabolic_signal

# Define the time range for the continuous parabolic signal
time = np.linspace(-5, 5, 1000)  # Time range from -5 to 5

# Define the number of samples and coefficients for the discrete parabolic
# signal
num_samples = 20  # Number of samples
coefficients = [1, 2, 1]  # Coefficients of the parabolic signal

# Simulate the continuous parabolic signal
continuous_parabolic = simulate_continuous_parabolic(time, coefficients)

# Simulate the discrete parabolic signal
discrete_parabolic = simulate_discrete_parabolic(num_samples, coefficients)

# Plot and display the continuous and discrete parabolic signals
plt.figure(figsize=(10, 6))
plt.subplot(2, 1, 1)
plt.plot(time, continuous_parabolic)
plt.title('Continuous Parabolic Signal')
plt.xlabel('Time')
plt.ylabel('Amplitude')
plt.subplot(2, 1, 2)
plt.stem(discrete_parabolic)
```

```
plt.title('Discrete Parabolic Signal')
plt.xlabel('Sample')
plt.ylabel('Amplitude')

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

<u>Output:-</u>



7) Write a Python Program to Simulate Continuous and Discrete Sine Wave Signals.

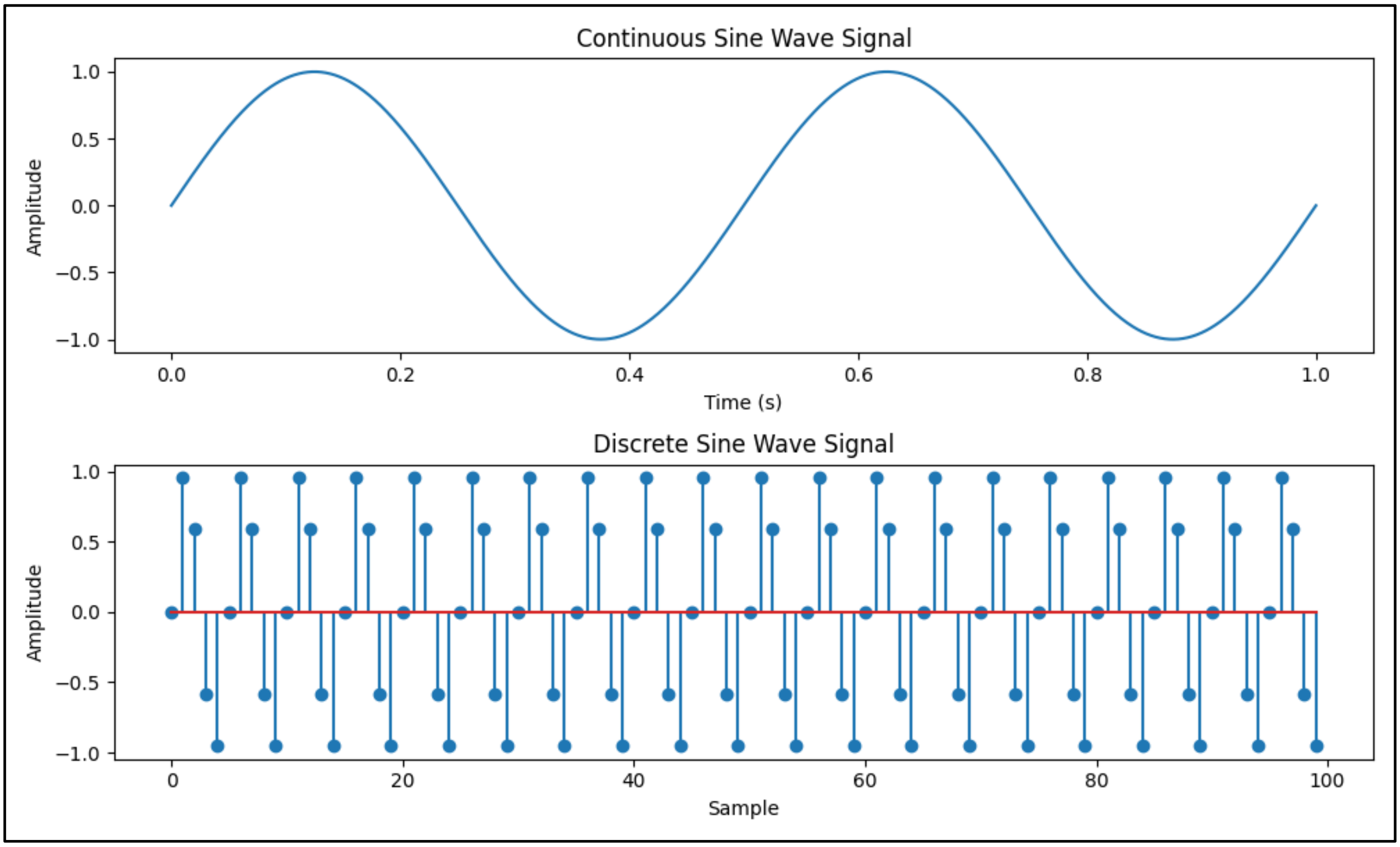
<u>Programm:-</u>

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

def simulate_continuous_sine_wave(time, amplitude, frequency, phase):
    sine_wave = amplitude * np.sin(2 * np.pi * frequency * time + phase)
    return sine_wave
```

```python
def simulate_discrete_sine_wave(num_samples, sampling_frequency, amplitude,
                                frequency, phase):
    time = np.arange(num_samples) / sampling_frequency
    sine_wave = amplitude * np.sin(2 * np.pi * frequency * time + phase)
    return sine_wave

# Define the time range for the continuous sine wave signal
time = np.linspace(0, 1, 1000)  # Time range from 0 to 1 second

# Define the number of samples, sampling frequency, and parameters for the
# discrete sine wave signal
num_samples = 100  # Number of samples
sampling_frequency = 10  # Sampling frequency in Hz
amplitude = 1  # Amplitude of the sine wave
frequency = 2  # Frequency of the sine wave in Hz
phase = 0  # Phase angle of the sine wave in radians

# Simulate the continuous sine wave signal
continuous_sine_wave = simulate_continuous_sine_wave(
    time, amplitude, frequency, phase)

# Simulate the discrete sine wave signal
discrete_sine_wave = simulate_discrete_sine_wave(
    num_samples, sampling_frequency, amplitude, frequency, phase)

# Plot and display the continuous and discrete sine wave signals
plt.figure(figsize=(10, 6))
plt.subplot(2, 1, 1)
plt.plot(time, continuous_sine_wave)
plt.title('Continuous Sine Wave Signal')
plt.xlabel('Time (s)')
plt.ylabel('Amplitude')

plt.subplot(2, 1, 2)
plt.stem(discrete_sine_wave)
plt.title('Discrete Sine Wave Signal')
plt.xlabel('Sample')
```

```
plt.ylabel('Amplitude')

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

Output:-



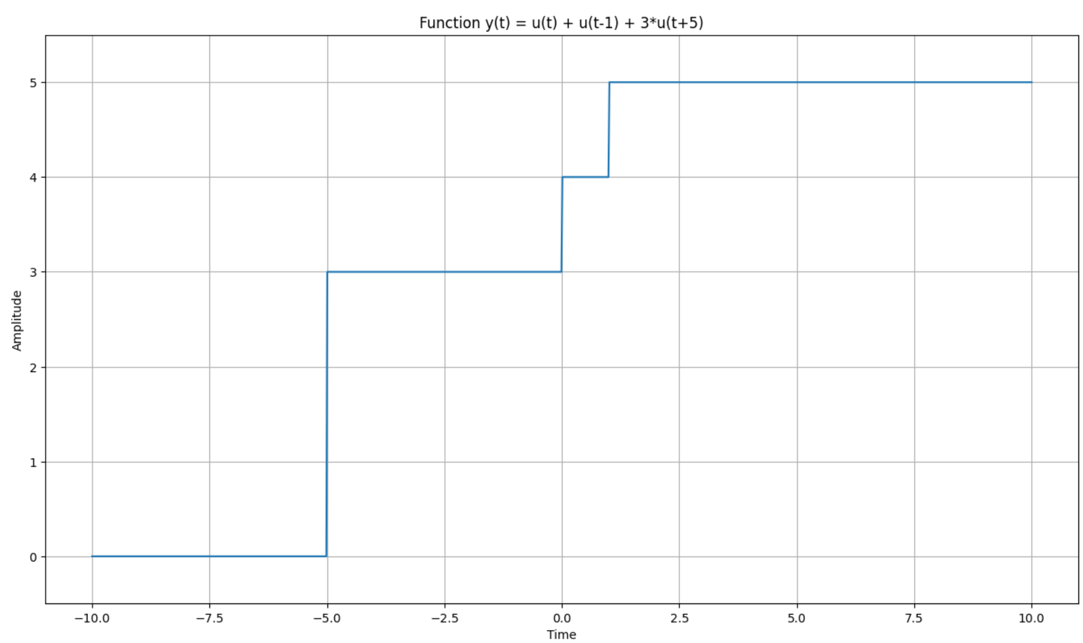
8) Write a Python Program to Simulate y(t) = u(t) + u(t-1) + 3u(t+5).

Programm:-

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

def simulate_function(time):
    y = np.zeros_like(time)
    y[time >= 0] = 1
    y[time >= 1] += 1
```

```
    y[time >= -5] += 3
    return y

# Define the time range
time = np.linspace(-10, 10, 1000)

# Simulate the function
function_values = simulate_function(time)

# Plot and display the function
plt.plot(time, function_values)
plt.title('Function y(t) = u(t) + u(t-1) + 3*u(t+5)')
plt.xlabel('Time')
plt.ylabel('Amplitude')
plt.ylim([-0.5, 5.5])
plt.grid(True)
plt.show()
```

Output:-

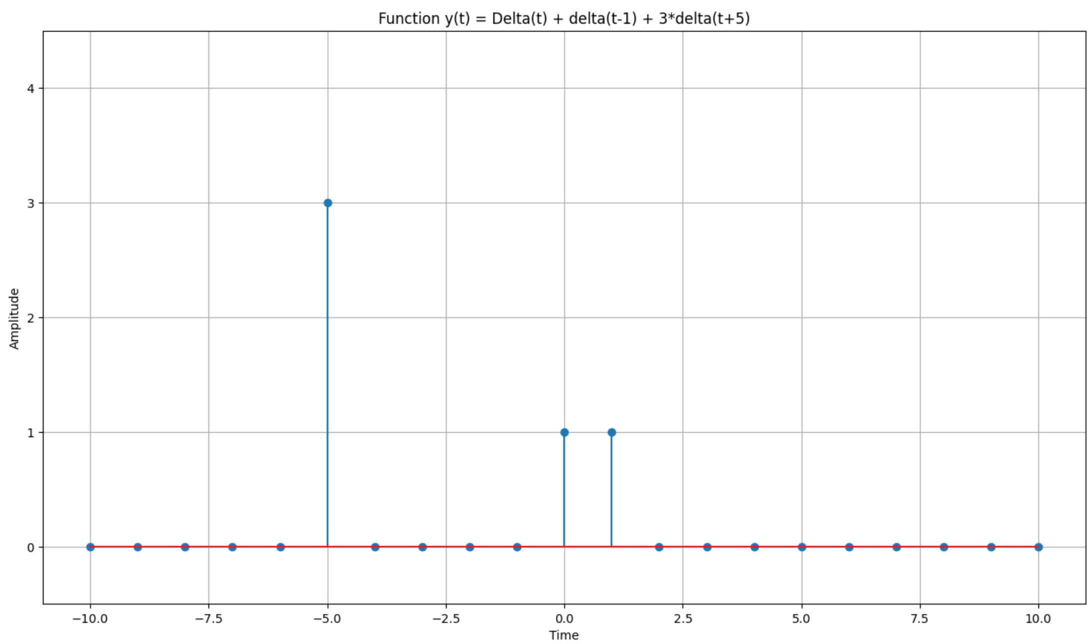


9) Write a Python Program to Simulate y(t) = Delta(t) + Delta(t-1) + 3*Delta(t+5).

Programm:-

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

def simulate_function(time):
    y = np.zeros_like(time)
    y[time == 0] = 1
    y[time == 1] += 1
    y[time == -5] += 3
    return y

# Define the time range
time = np.arange(-10, 11)

# Simulate the function
function_values = simulate_function(time)

# Plot and display the function
plt.stem(time, function_values)

plt.title('Function y(t) = Delta(t) + delta(t-1) + 3*delta(t+5)')
plt.xlabel('Time')
plt.ylabel('Amplitude')

plt.ylim([-0.5, 4.5])
plt.grid(True)
plt.show()
```

Output:-



❖ **Exercise.**

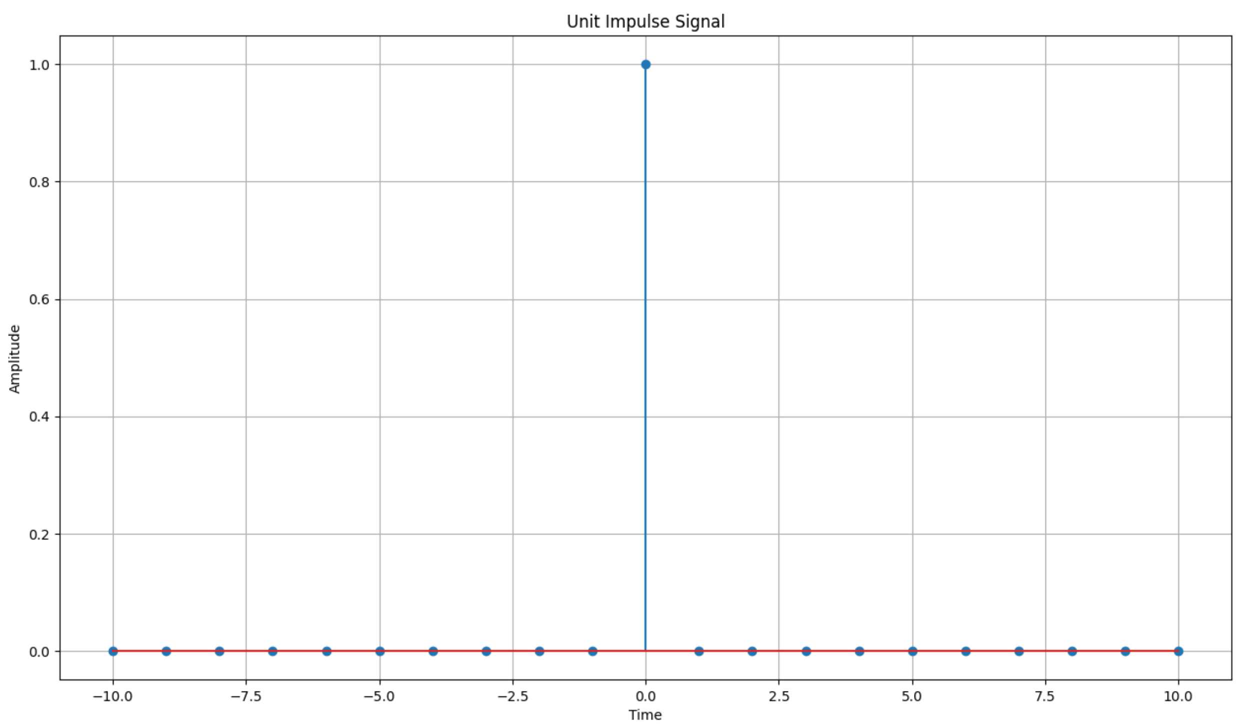
1) Write a Python Program to Simulate y(t) = Delta(t).

Programm:-

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

def unit_impulse(length, position):
    signal = np.zeros(length)
    signal[position] = 1
    return signal
```

```python
# Parameters
start = -10  # Start value of the x-axis range
stop = 10  # Stop value of the x-axis range
step = 1  # Step size

# Generate x-axis values
x = np.arange(start, stop+step, step)

# Generate unit impulse signal
impulse_signal = unit_impulse(len(x), abs(start)//step)

# Plot the signal
plt.stem(x, impulse_signal)
plt.xlabel('Time')
plt.ylabel('Amplitude')
plt.title('Unit Impulse Signal')
plt.grid(True)
plt.show()
```

Output:-



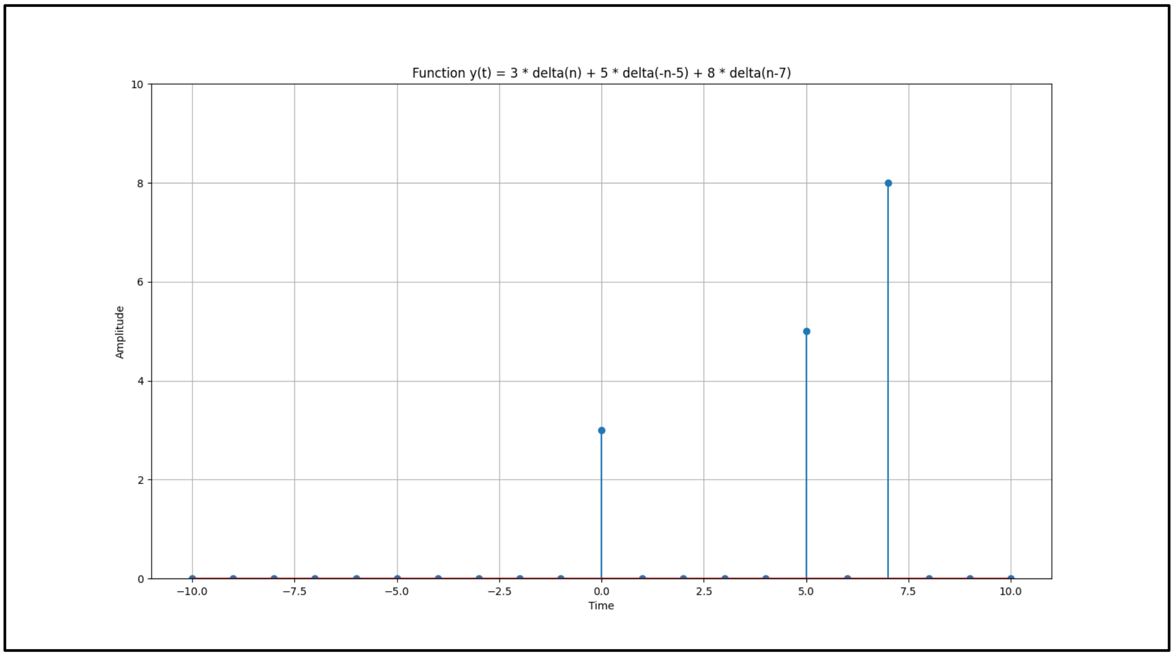
2) Write a Python Program to Simulate y(t) = 3 * Delta(n) + 5 * Delta(-n-5) + 8 * Delta(n-7)

Programm:-

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

def simulate_function(time):
    y = np.zeros_like(time)
    y[time == 0] = 3
    y[time == 5] += 5
    y[time == 7] += 8
    return y

# Define the time range
time = np.arange(-10, 11)
```

```
# Simulate the function
function_values = simulate_function(time)

# Plot and display the function
plt.stem(time, function_values)
plt.title('Function y(t) = 3 * delta(n) + 5 * delta(-n-5) + 8 * delta(n-7)')
plt.xlabel('Time')
plt.ylabel('Amplitude')
plt.ylim([0, 10])
plt.grid(True)
plt.show()
```

Output:-



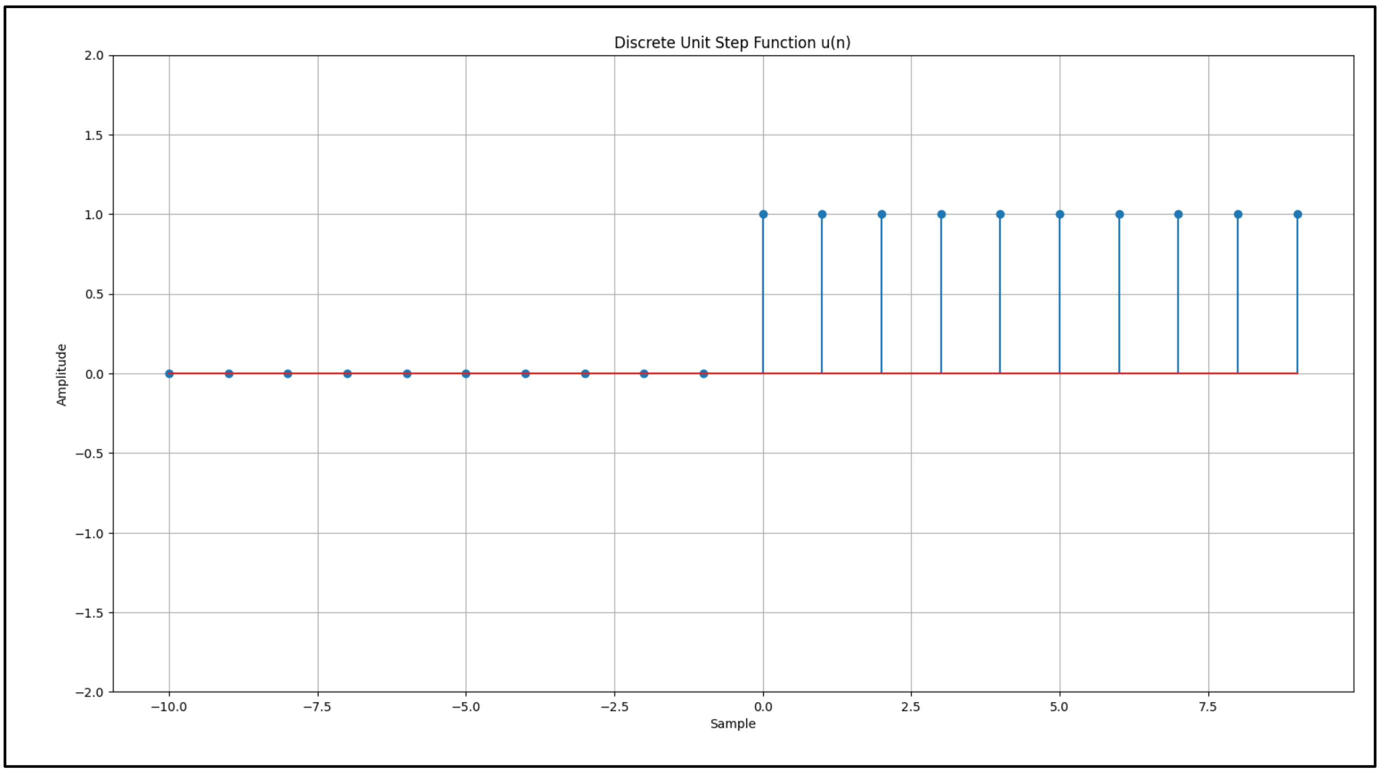
3) Write a Python Program to Simulate y(n) = u(n)

Programm:-

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

def simulate_discrete_unit_step(num_samples):
    unit_step = np.zeros(num_samples)
    unit_step[num_samples // 2:] = 1
    return unit_step

# Define the number of samples for the discrete unit step signal
num_samples = 20  # Number of samples

# Simulate the discrete unit step signal
discrete_unit_step = simulate_discrete_unit_step(num_samples)

# Plot and display the discrete unit step signal
plt.figure(figsize=(10, 6))
plt.stem(range(-num_samples//2, num_samples//2), discrete_unit_step)
plt.title('Discrete Unit Step Function u(n)')
```

```
plt.xlabel('Sample')
plt.ylabel('Amplitude')
plt.ylim([-2, 2])
plt.grid(True)
plt.tight_layout()
plt.show()
```

Output:-



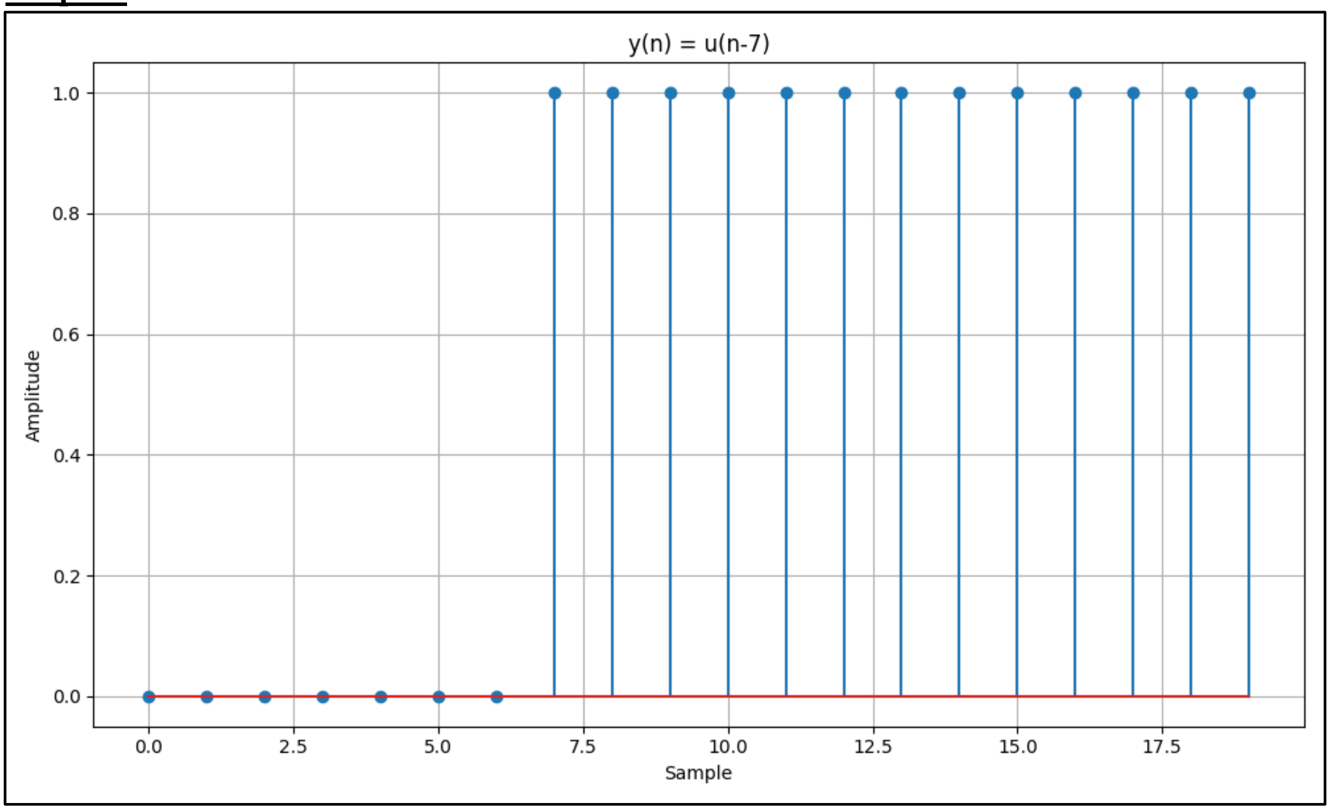
4) Write a Python Program to Simulate y(n) = u(n-7)

Programm:-

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

def simulate_discrete_unit_step(num_samples, delay):
    unit_step = np.zeros(num_samples)
    unit_step[delay:] = 1
    return unit_step
```

```python
# Define the number of samples for the discrete unit step signal
num_samples = 20  # Number of samples
delay = 7  # Delay by 7 samples

# Simulate the discrete unit step signal
discrete_unit_step = simulate_discrete_unit_step(num_samples, delay)

# Plot and display the discrete unit step signal
plt.figure(figsize=(10, 6))
plt.stem(range(num_samples), discrete_unit_step)
plt.title('y(n) = u(n-7)')
plt.xlabel('Sample')
plt.ylabel('Amplitude')
plt.grid(True)
plt.tight_layout()
plt.show()
```

Output:-

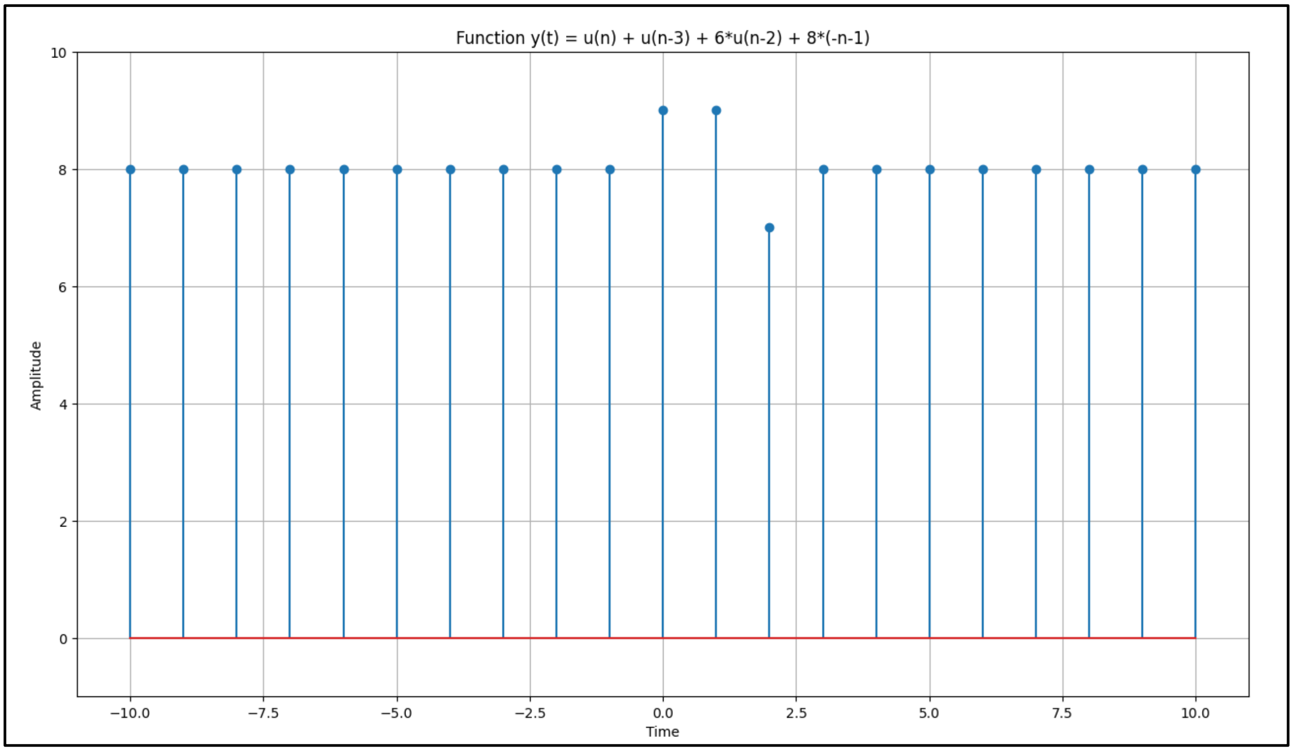


5) Write a Python Program to Simulate y(n) = u(n) + u(n-3) + 6 * u(n-2) + 8 * (-n-1)

Programm:-

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

def simulate_function(time):
    y = np.zeros_like(time)

    y[time >= 0] = 1  # u(t)
    y[time >= 3] += 1  # u(t-3)
    y[time >= 2] += 6  # 6*u(n-2)
    y[time <= 1] += 8  # 8*u(-n-1)

    return y

# Define the time range
time = np.arange(-10, 11)

# Simulate the function
function_values = simulate_function(time)

# Plot and display the function
plt.stem(time, function_values)
plt.title('Function y(t) = u(n) + u(n-3) + 6*u(n-2) + 8*(-n-1)')
plt.xlabel('Time')
plt.ylabel('Amplitude')
plt.ylim([-1, 10])
plt.grid(True)
plt.show()
```

Output:-



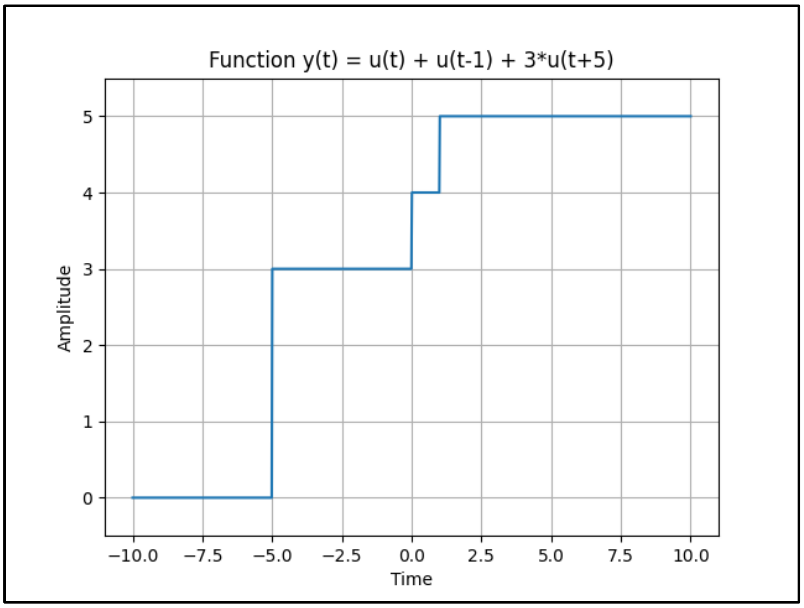
6) Write a Python Program to Simulate y(t) = u(t) + u(t-1) + 3 * u(t+5)

Programm:-

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

def simulate_function(time):
    y = np.zeros_like(time)
    y[time >= 0] = 1
    y[time >= 1] += 1
    y[time >= -5] += 3
    return y

# Define the time range
time = np.linspace(-10, 10, 1000)

# Simulate the function
function_values = simulate_function(time)
```

```
# Plot and display the function
plt.plot(time, function_values)
plt.title('Function y(t) = u(t) + u(t-1) + 3*u(t+5)')
plt.xlabel('Time')
plt.ylabel('Amplitude')
plt.ylim([-0.5, 5.5])
plt.grid(True)
plt.show()
```

Output:-



Conclusion:-

We started this experiment to learn how to simulate and visualize discrete and continuous-time signals using Python, NumPy, and Matplotlib. Through this, we understood basic signal types like impulse, step, ramp, and sine waves, which are essential for grasping core concepts in digital signal processing.