Experiment No.: 13

Experiment Name: Generation of Continuous-Time and Discrete-Time Signals using MATLAB

Description of the Problem:

The objective of this experiment is to generate and visualize **continuous-time** and **discrete-time** standard signals such as sine, cosine, exponential, ramp, and unit step signals using MATLAB.

These signals are fundamental in **Digital Signal Processing (DSP)** and are often used for testing, analyzing, and simulating systems in both time domains.

Basic Theory:

1️⃣ Continuous-Time Signals

Continuous-time signals are defined for **every value of time (t)**.
Examples include:

- **Sine wave:** $x(t) = \sin(2\pi f t)$
- **Cosine wave:** $x(t) = \cos(2\pi f t)$
- **Exponential:** $x(t) = e^{-at}$
- **Ramp:** $x(t) = t$
- **Unit step:**

$$u(t) = \begin{cases} 1, & t \geq 0 \\ 0, & t < 0 \end{cases}$$

2️⃣ Discrete-Time Signals

Discrete-time signals are defined only at **specific time instants (n)**, generally obtained by sampling a continuous signal.
Examples include:

- **Sine wave:** $x[n] = \sin(\omega n)$
- **Cosine wave:** $x[n] = \cos(\omega n)$
- **Exponential:** $x[n] = a^n$
- **Ramp:** $x[n] = n$
- **Unit step:**

$$u[n] = \begin{cases} 1, & n \geq 0 \\ 0, & n < 0 \end{cases}$$

This experiment demonstrates the visual difference between continuous and discrete signals using MATLAB plotting functions.

Source Code Sample:

```
clc;
clear all;
close all;

%% ================================
%  Continuous-Time Signals
%  ================================

% Define continuous time variable
t = -5:0.01:5;   % time from -5 to 5 seconds with step size 0.01 (high
resolution)

% Define continuous signals
x1 = sin(2*pi*1*t);      % Sine wave of 1 Hz
x2 = cos(2*pi*1*t);      % Cosine wave of 1 Hz
x3 = exp(-0.5*t);        % Exponential decay
x4 = t;                  % Ramp signal
x5 = (t >= 0);           % Unit step signal

% Plot continuous signals
figure('Name','Continuous-Time Signals');
subplot(3,2,1);
plot(t,x1,'LineWidth',1.5);
title('Continuous Sine Wave'); xlabel('Time (s)'); ylabel('Amplitude'); grid
on;

subplot(3,2,2);
plot(t,x2,'LineWidth',1.5);
title('Continuous Cosine Wave'); xlabel('Time (s)'); ylabel('Amplitude');
grid on;

subplot(3,2,3);
plot(t,x3,'LineWidth',1.5);
title('Exponential Signal'); xlabel('Time (s)'); ylabel('Amplitude'); grid
on;

subplot(3,2,4);
plot(t,x4,'LineWidth',1.5);
title('Ramp Signal'); xlabel('Time (s)'); ylabel('Amplitude'); grid on;

subplot(3,2,5);
plot(t,x5,'LineWidth',1.5);
title('Unit Step Signal'); xlabel('Time (s)'); ylabel('Amplitude'); grid on;
```

```
%% ================================
%  Discrete-Time Signals
%  ================================

% Define discrete time variable
n = -5:5;    % Discrete sample indices

% Define discrete signals
x1d = sin(0.2*pi*n);     % Discrete sine wave
x2d = cos(0.2*pi*n);     % Discrete cosine wave
x3d = (0.8).^n;          % Discrete exponential (decaying for n>0)
x4d = n;                 % Discrete ramp
x5d = (n >= 0);          % Discrete unit step

% Plot discrete signals
figure('Name','Discrete-Time Signals');
subplot(3,2,1);
stem(n,x1d,'filled');
title('Discrete Sine Wave'); xlabel('n'); ylabel('Amplitude'); grid on;

subplot(3,2,2);
stem(n,x2d,'filled');
title('Discrete Cosine Wave'); xlabel('n'); ylabel('Amplitude'); grid on;

subplot(3,2,3);
stem(n,x3d,'filled');
title('Discrete Exponential Signal'); xlabel('n'); ylabel('Amplitude'); grid
on;

subplot(3,2,4);
stem(n,x4d,'filled');
title('Discrete Ramp Signal'); xlabel('n'); ylabel('Amplitude'); grid on;

subplot(3,2,5);
stem(n,x5d,'filled');
title('Discrete Unit Step Signal'); xlabel('n'); ylabel('Amplitude'); grid
on;
```

Sample Input:

No user input is required.
All signals are **predefined** within the code — it runs automatically.

Sample Output:

After running the code:

1. Two MATLAB figures appear —
    - **Figure 1:** Continuous-Time Signals (Sine, Cosine, Exponential, Ramp, Unit Step)

- **Figure 2:** Discrete-Time Signals (Sine, Cosine, Exponential, Ramp, Unit Step)

2. Each subplot clearly shows the shape and nature of each signal.

Screenshot:

Figure 13.1: Continuous-Time Signal Plots in MATLAB

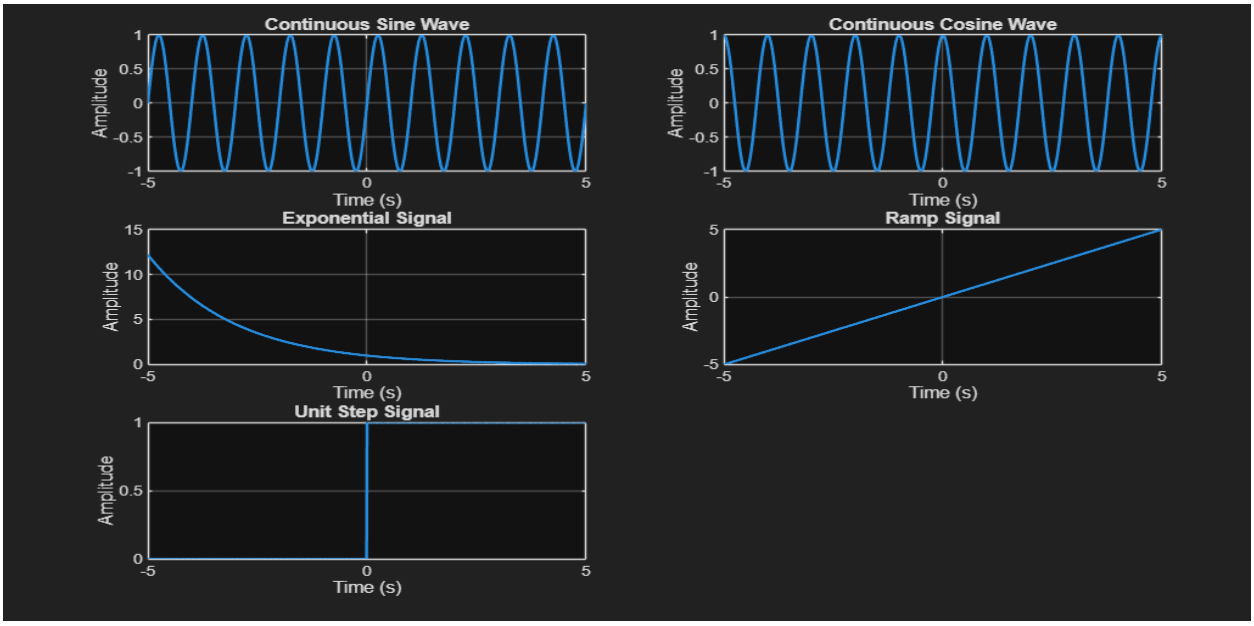

Figure 13.2: Discrete-Time Signal Plots in MATLAB