K. J. Somaiya College of Engineering, Mumbai-77

Batch: B2 **Roll No.: 16010122221**

Experiment No. 2

Grade: AA / AB / BB / BC / CC / CD /DD

Signature of the Staff In-charge with date

Title: Represent discrete time signals and perform different operations on them.

Objective: To familiarize the beginner to MATLAB by introducing the basic features and commands of the program.

Expected Outcome of Experiment:

CO	Outcome
CO1	Identify various discrete time signals and systems and perform signal manipulation

Books/ Journals/ Websites referred:

1. http://www.mathworks.com/support/
2. www.math.mtu.edu/~msgocken/intro/intro.html
3. www.mccormick.northwestern.edu/docs/efirst/matlab.pdf
4. A.Nagoor Kani “Digital Signal Processing”, 2nd Edition, TMH Education.

Pre Lab/ Prior Concepts:

Using MATLAB we can easily generate all basic functions such as unit step, ramp, growing and decaying exponential, etc. The various signals plotted in this program are Step signal

Ramp signal, Exponential signal etc

1. Unit Step Signal

The step signal is defined as

U[n] = k ; if n>=0

= 0 ; otherwise

When k=1 it is called as unit step signal.

2. Ramp Signal

The ramp signal is

defined as r[n] = n

; if n>=0

= 0 ; otherwise

3. Exponential Signal

The exponential signal is defined as

X[n] =a^n

When 'a' is greater than 1 it is **increasing** exponential

When 'a' is less than 1 it is **decaying** exponential.

4. Impulse Signal

The impulse signal is defined

as d[n] = k ; if n=0

= 0 ; otherwise

When k=1 it is called as unit impulse

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The functions used in this program are:

a. Ones

This function is used to create an array of all

ones Syntax: Y=ones (m, n)

Description:

Y=ones (n) returns an n-by-n matrix of 1's.

An error message appears if n is not a scalar.

Y=ones (m, n) or Y=ones([m n]) returns an m-by-n matrix of ones.

b. Zeros

This function is used to create an array of all zeros

Syntax: Y=zeros(m,n)

Description:

Y=zeros(n) returns an n-by-n matrix of 0's.

An error message appears if n is not a scalar.

Y=zeros (m,n) or Y=ones([m n]) returns an m-by-n matrix of Zeros.

c. EXP

This function is used to plot exponential signals

Syntax: Y=exp(X)

Description:

The exp function is an elementary function that operates element-wise on arrays. Its domain includes complex numbers.

Y=exp(X) returns the exponential for each element of X.

For complex, it returns the complex exponential.

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Steps with Syntax for representation of above discrete time signals:

```
n=-10:1:10;
% Unit Step Signal
U = (n >= 0);
subplot(2,2,1);
stem(n, U, 'LineWidth', 2, 'MarkerSize', 6, 'Color',
'red','MarkerFaceColor','g');
title('Unit Step Signal U[n]');
xlabel('n');
ylabel('U[n]');
grid on;
axis([-10 10 -0.1 1.1]);


% Ramp Signal
r = (n >= 0) .* n;
subplot(2,2,2);
stem(n, r, 'LineWidth', 2, 'MarkerSize', 6, 'Color',
'cyan','MarkerFaceColor','b');

title('Ramp Signal ');
xlabel('n');
ylabel('r[n]');
grid on;
axis([-10 10 -1 10]);


% Exponential Signal
a = 4;
X = a.^n;
subplot(2,2,3);
plot(n, X, 'LineWidth', 2, 'Color', 'green','MarkerFaceColor','red');

title('Exponential Signal');
xlabel('n (a=4)');
ylabel('X[n]');
grid on;
axis([-10 10 -1 200]);

% Impulse Signal
d = (n == 1);
subplot(2,2,4);
stem(n, d, 'LineWidth', 2, 'MarkerSize', 6, 'Color',
'blue','MarkerFaceColor','w');
title('Impulse Signal ');
xlabel('n');
ylabel('d[n]');
grid on;
axis([-10 10 -0.1 1.1]);
```

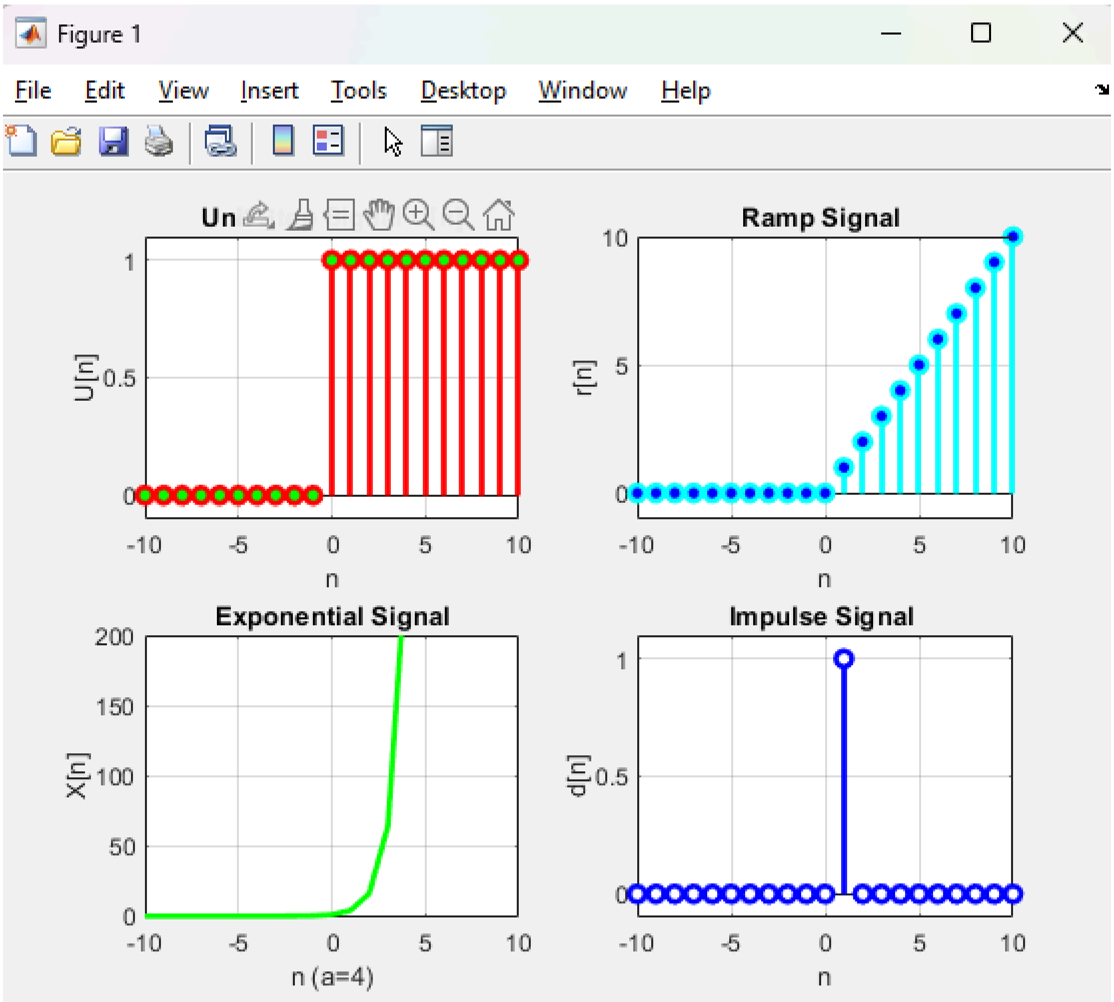
Figure 1
File
Edit
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Un
Ramp Signal
Exponential Signal
Impulse Signal
U[n]
r[n]
X[n]
d[n]
n
n (a=4)
-10
-5
0
5
10
0.5
1
50
100
150
200

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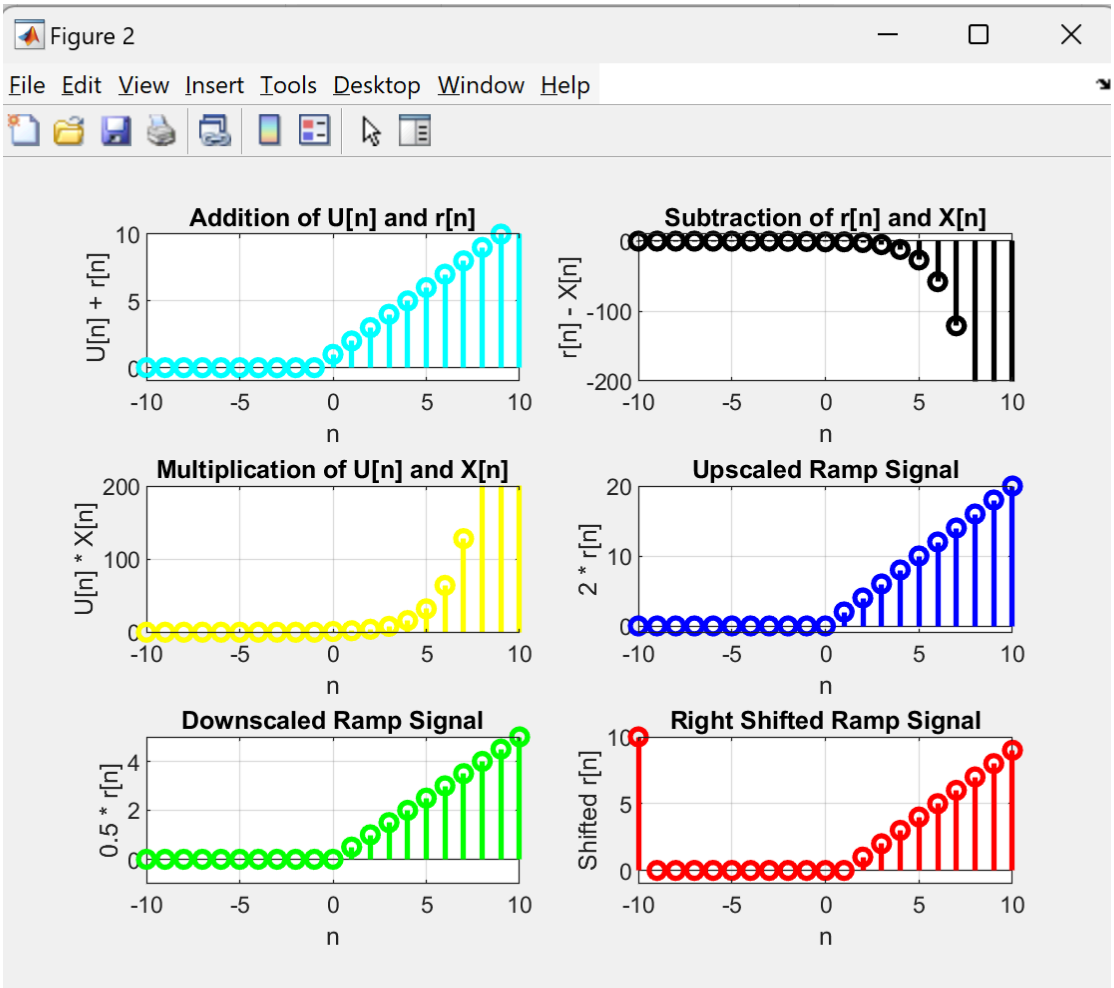
Operations on Signals:

1. Addition of signals.
2. Subtraction of signals.
3. Multiplication of two signals.
4. Scaling – Upscaling & Downscaling.
5. Shift operation – Advance/Right shift & Delay/Left shift.

Steps with Syntax for representation of above operations on discrete time signals:

```
% 1. Addition of signals (Unit Step + Ramp)
Addition = U + r;
% 2. Subtraction of signals (Ramp - Exponential)
Subtraction = r - X;
% 3. Multiplication of two signals (Unit Step * Exponential)
Multiplication = U .* X;
% 4. Scaling the Ramp signal (Upscaling by 2 and Downscaling by 0.5)
Upscaling = 2 * r;
Downscaling = 0.5 * r;
% 5. Shift Operation (Right shift Ramp by 1)
Shift_Right = circshift(r, 1);
% Plot the operations
figure;
subplot(3,2,1);
stem(n, Addition, 'LineWidth', 2, 'MarkerSize', 6, 'Color', 'c');
title('Addition of U[n] and r[n]');
xlabel('n');
ylabel('U[n] + r[n]');
grid on;
axis([-10 10 -1 10]);
subplot(3,2,2);
stem(n, Subtraction, 'LineWidth', 2, 'MarkerSize', 6, 'Color', 'k');
title('Subtraction of r[n] and X[n]');
xlabel('n');
ylabel('r[n] - X[n]');
grid on;
axis([-10 10 -200 10]);
subplot(3,2,3);
stem(n, Multiplication, 'LineWidth', 2, 'MarkerSize', 6, 'Color', 'y');
title('Multiplication of U[n] and X[n]');
xlabel('n');
ylabel('U[n] * X[n]');
grid on;
axis([-10 10 -1 200]);
subplot(3,2,4);
stem(n, Upscaling, 'LineWidth', 2, 'MarkerSize', 6, 'Color', 'b');
title('Upscaled Ramp Signal');
xlabel('n');
```

```
ylabel('2 * r[n]');
grid on;
axis([-10 10 -1 20]);
subplot(3,2,5);
stem(n, Downscaling, 'LineWidth', 2, 'MarkerSize', 6, 'Color', 'g');
title('Downscaled Ramp Signal');
xlabel('n');
ylabel('0.5 * r[n]');
grid on;
axis([-10 10 -1 5]);
subplot(3,2,6);
stem(n, Shift_Right, 'LineWidth', 2, 'MarkerSize', 6, 'Color', 'r');
title('Right Shifted Ramp Signal');
xlabel('n');
ylabel('Shifted r[n]');
grid on;
axis([-10 10 -1 10]);
```



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Conclusion:-

The experiment successfully introduced the basics of MATLAB, including its fundamental features and commands. By generating and manipulating various discrete-time signals like Unit Step, Ramp, Exponential, and Impulse, the objective of familiarizing beginners with MATLAB's capabilities was achieved.

Post Lab Questions

1. **Let $x(n) = 8(0.5)^n$ (u[n+1] - u[n-3]). Sketch the following signals**
   - I. **Y(n) = [x-3]**
   - II. **F(n) = x[n+1]**
   - III. **G(n) = x[-n+4]**

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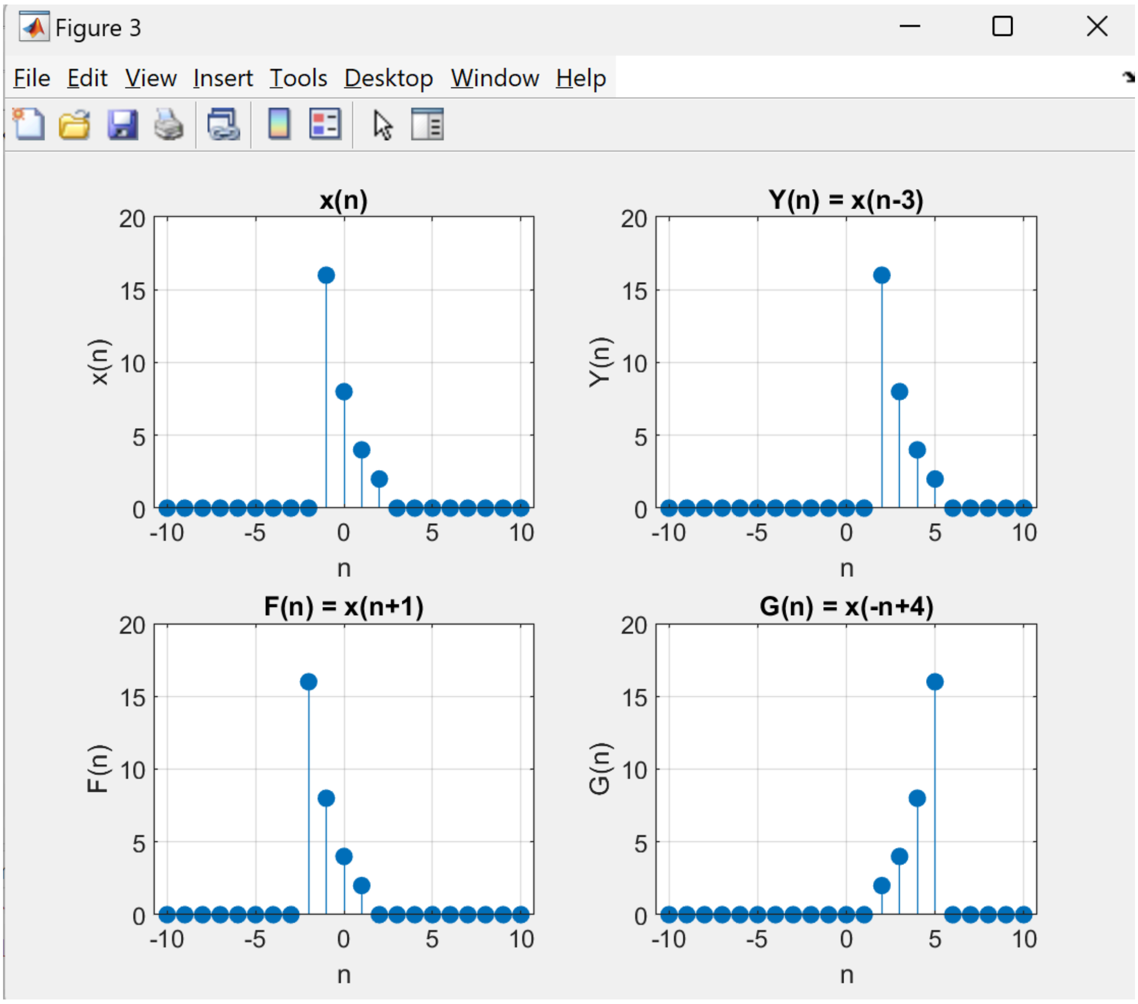
ANS -



2. **The process of conversion of continuous time signal into discrete time signal is known as .____________________________**

ANS- Sampling

3. **Which of the following is example of deterministic signal?**
    a. **Step**
    b. **Ramp**
    c. **Exponential**
    d. **All of the**

above ANS - d.All of the above

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4. **For energy signals the energy will be finite and the average power will be__**

ANS - Zero

5. **In a signal x(n), if 'n' is replaced by 'n/3' the it is called____________________.**

ANS - Expansion

6. **The system y(n)=sin[x(n)] is**
   a. **Stable**
   b. **BIBO stable**
   c. **Unstable**
   d. **None of the**

above ANS -a. Stable