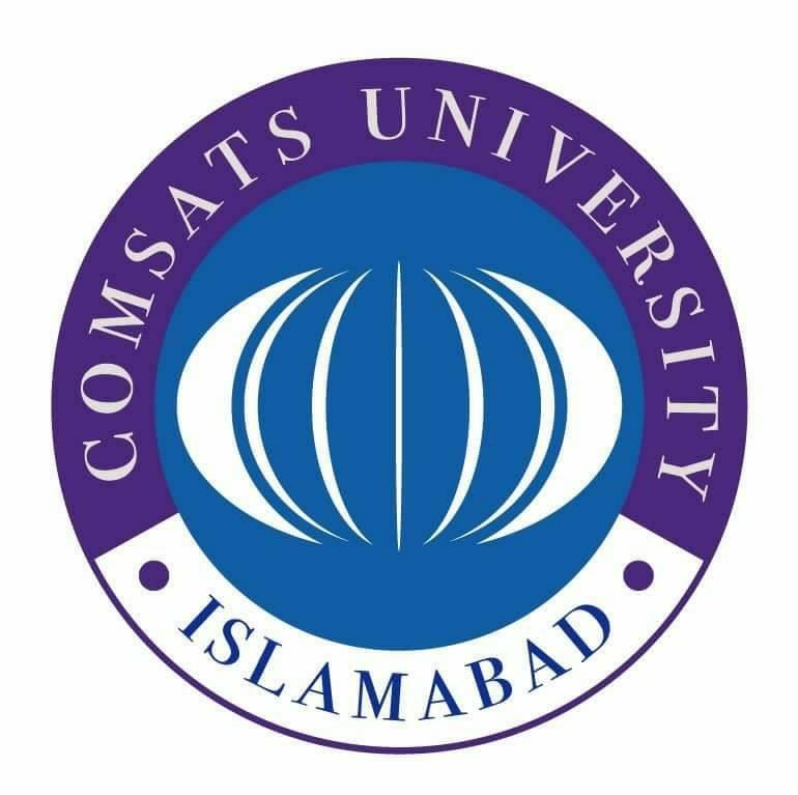


Name:	Muhammad Attiq
Registration Number:	FA23 – BCE – 060
Lab No:	5
Instructor:	Dr. Bilal Qasim
Class:	BCE – 4A

Lab 5

Study of Properties of Systems (Linearity, Causality, Memory, Stability and Time invariance)

Task 01: Find out if the discrete-time system described by the I/O relationship $y[n] = x[-n]$ is:

a) Static or Dynamic (input signal $x[n] = 2n, -2 \le n \le 2$)

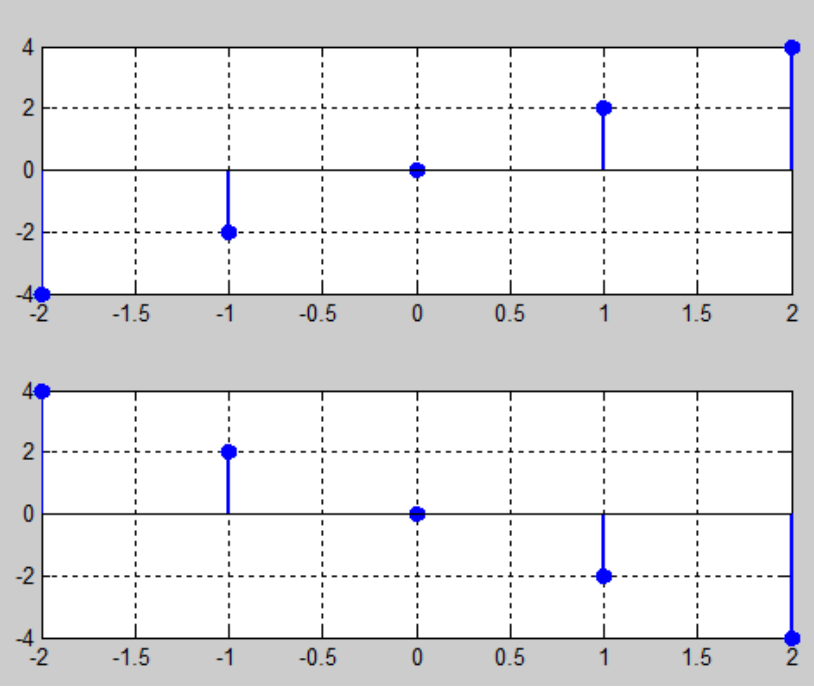
b) Causal or non-causal (input signal $x[n] = 2n, -2 \le n \le 2$)

c) Linear or non-linear (input signals $x_1[n] = 2n, -2 \le n \le 4, x_2[n] = n/3, -2 \le n \le 4, a_1 = 2 \text{ and } a_2 = 3$)

d) Shift invariant or shift variant (input signal $x[n] = 2n, -2 \le n \le 4$ and shift $n_0 = 3$)

(a)

```
n = -2:2;
x = 2.*n;
subplot(2, 1, 1);
stem(n,x, 'filled', 'linewidth', 1.5);
grid on;
subplot(2, 1, 2);
stem(-n,x, 'filled', 'linewidth', 1.5);
grid on;
```



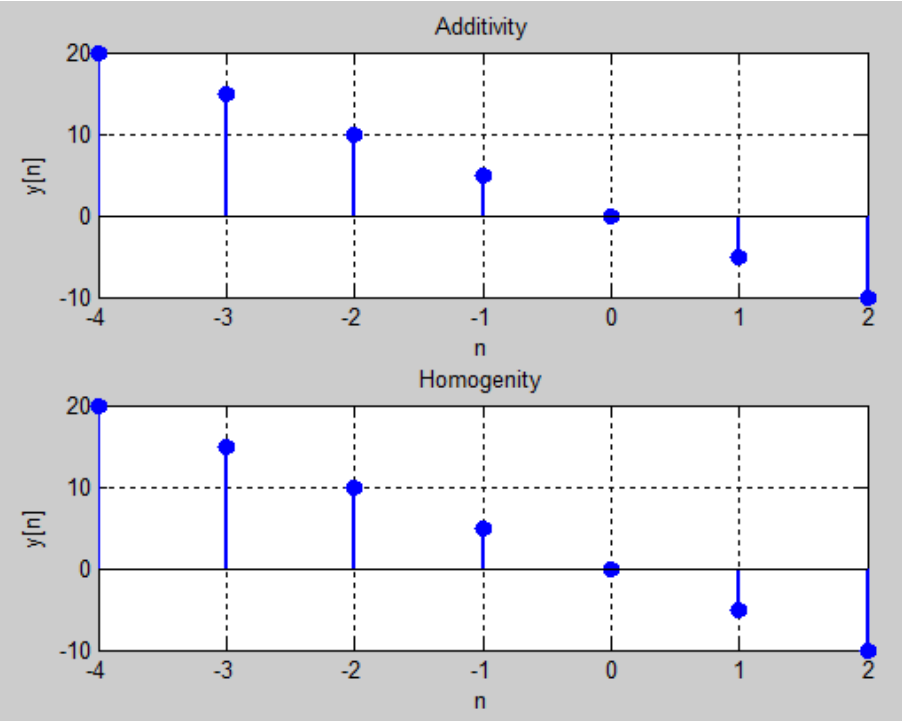
The above signal is a **Dynamic Signal** because there is shift in impulses**.**

(b)

The signal is **Non – Causal** because the output y[n] depends on the future values of n.

(c)

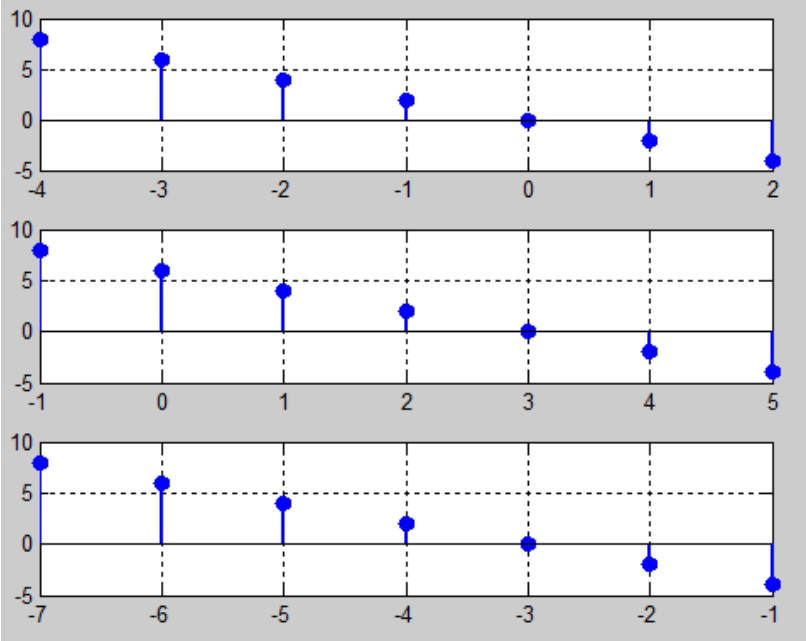
```
n = -2:4;
a1 = 2;
a2 = 3;
x1 = 2.*n;
x2 = n./3;
z = a1*x1 + a2*x2;
y = z;
subplot(2,1,1);
stem(-n, y, 'filled', 'linewidth', 1.5);
grid on;
title(Additivity);
xlabel('n');
ylabel('y[n]');
subplot(2,1,2);
y1 = x1;
y2 = x2;
z1 = a1.*y1;
z2 = a2.*y2;
y = z1 + z2;
stem(-n, y, 'filled', 'linewidth', 1.5);
grid on;
title(' Homogeneity ');
xlabel('n');
ylabel('y[n]');
```



The signal is **Linear** because it obeys both additivity and homogeneity.

(d)

```
n = -2:4;
x = 2.*n;
n0 = 3;
subplot(3, 1, 1);
stem(-n, x, 'filled', 'linewidth', 1.5);
grid on;
n1 = -(n-n0);
subplot(3, 1, 2);
stem(n1, x, 'filled', 'linewidth', 1.5);
grid on;
n2 = -(n+n0);
subplot(3, 1, 3);
stem(n2, x, 'filled', 'linewidth', 1.5);
grid on;
```



The system is **Time – Invariant**, because the graph not changes with time.

Task 02: Find out if the discrete-time system described by the I/O relationship $y[n] = x[1-2n]$ is:

a) Static or Dynamic (input signal $x[n] = 2n, -2 \le n \le 2$)

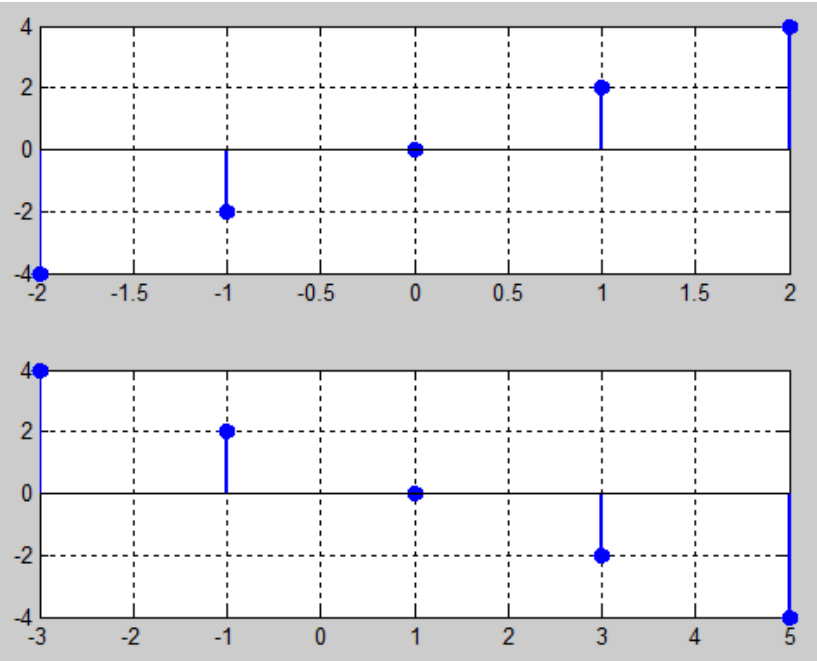
b) Causal or non-causal (input signal $x[n] = 2n, -2 \le n \le 2$)

c) Linear or non-linear (input signals $x_1[n] = 2n, -2 \le n \le 4$, $x_2[n] = n/3, -2 \le n \le 4$, $a_1 = 2$ *and* $a_2 = 3$)

d) Shift invariant or shift variant (input signal $x[n] = 2n, -2 \le n \le 4$ and shift $n_0 = 3$)

(a)

```
n = -2:2;
x = 2.*n;
subplot(2, 1, 1);
stem(n,x, 'filled', 'linewidth', 1.5);
grid on;
subplot(2, 1, 2);
stem(1-2.*n,x, 'filled', 'linewidth', 1.5);
grid on;
```



The above signal is a **Dynamic Signal** because there is shift in impulses**.**

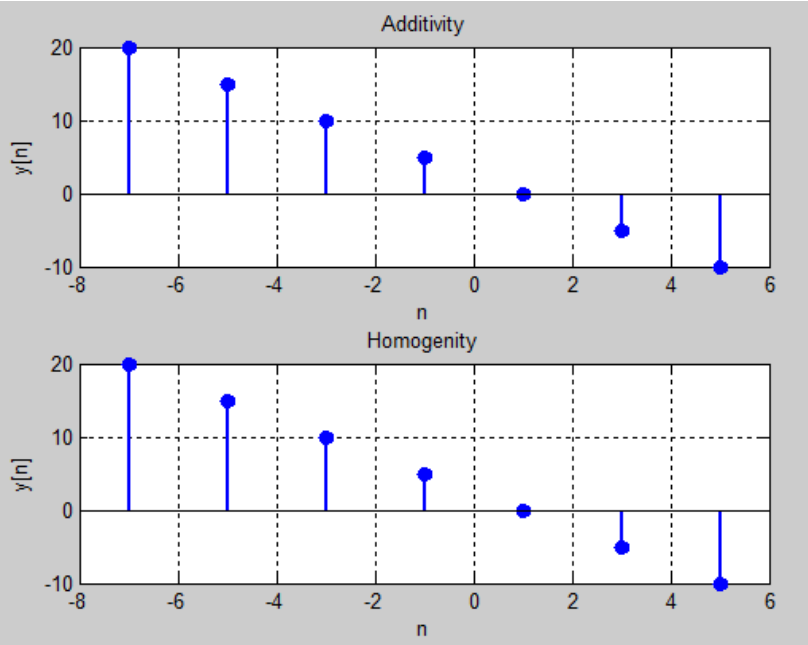
(b)

The signal is **Non – Causal** because the output y[n] depends on the future values of n.

(c)

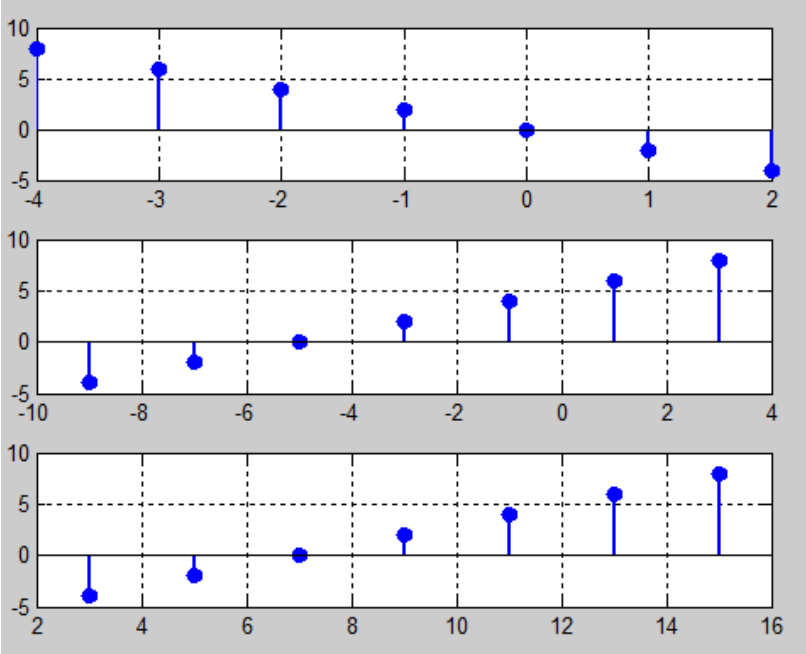
```
n = -2:4;
a1 = 2;
a2 = 3;
x1 = 2.*n;
x2 = n./3;
z = a1*x1 + a2*x2;
y = z;
subplot(2,1,1);
stem(1-2.*n, y, 'filled', 'linewidth', 1.5);
grid on;
title('Additivity');
```

```
xlabel('n');
ylabel('y[n]');
subplot(2,1,2);
y1 = x1;
y2 = x2;
z1 = a1.*y1;
z2 = a2.*y2;
y = z1 + z2;
stem(1-2.*n, y, 'filled', 'linewidth', 1.5);
grid on;
title('Homogenity');
xlabel('n');
ylabel('y[n]');
```



(d)

```
n = -2:4;
x = 2.*n;
n0 = 3;
subplot(3, 1, 1);
stem(-n, x, 'filled', 'linewidth', 1.5);
grid on;
n1 = -(n-n0);
subplot(3, 1, 2);
stem(1-2.*n1, x, 'filled', 'linewidth', 1.5);
grid on;
n2 = -(n+n0);
subplot(3, 1, 3);
stem(1-2.*n2, x, 'filled', 'linewidth', 1.5);
grid on;
```



(d)

The system is **Time – Invariant**, because the graph not changes with time.

Post-lab Task

Critical Analysis / Conclusion

In this lab, we analyzed system properties using MATLAB. The system was found to be dynamic, non-causal, linear, and time-variant based on its response to different inputs. These findings helped in understanding how systems behave and how they can be classified based on their characteristics.

Lab Assessment		
Lab Task Evaluation	/6	/10
Lab Report	/4	
Instructor Signature and Comments		