Lab 5: Study of Properties of Systems (Linearity, Causality, Memory, Stability and Time invariance)

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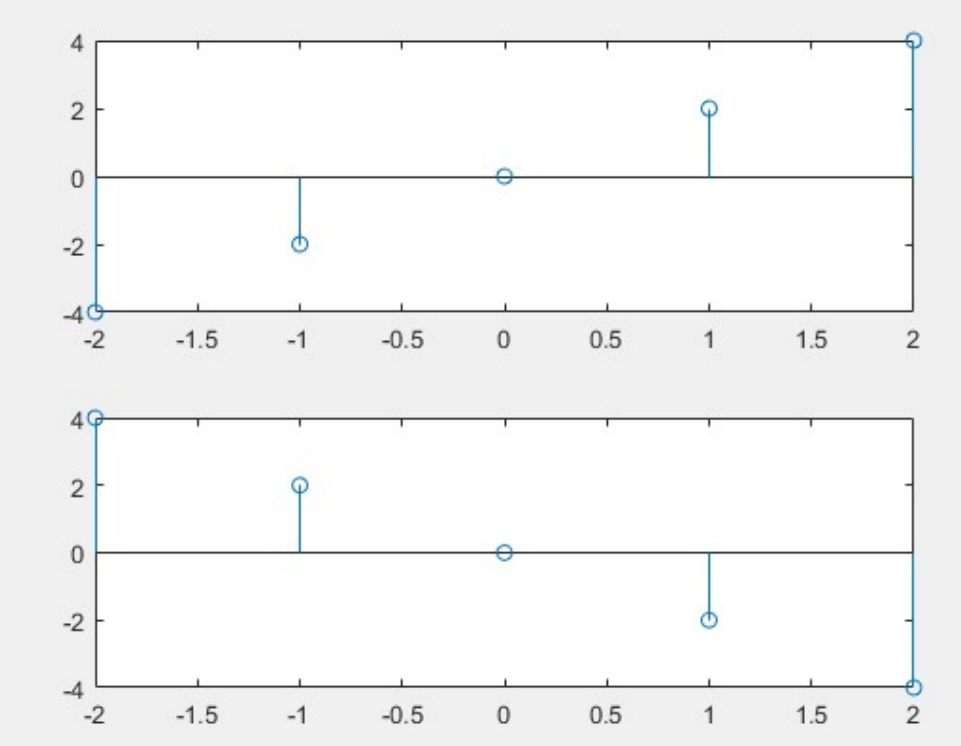
Task 01: Find out if the discrete-time system described by the I/O relationship $y[n] = x[-n]$ is:

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

Command:

```
n = -
2:2; x
=
2.*n;
subplo
t(2,1,1
)
stem(n
,x)
subplo
t(2,1,2
)
stem(-
n,x)
```



(a&b)

Dynamic (i.e., with memory) and **non-Causal** because y[n] depends on future value of n.

c) Linear or non-linear

(Input signals $x_1[n] = 2n, -2 \le n \le 4, x_2[n] = n/3, -2 \le n \le 4, a_1 = 2 and a_2 = 3$ **)**

Command:

n = -2:4; x1 = 2.*n; x2 =

n./3; a1 = 2; a2 = 3; x =

a1.*x1 + a2.*x2; y = -x;

subplot(2,1,1),

stem(n,y,'LineWidth',2)

xlabel('n') ylabel('y1[n]')

y1 = -x1; y2 = -x2; y =

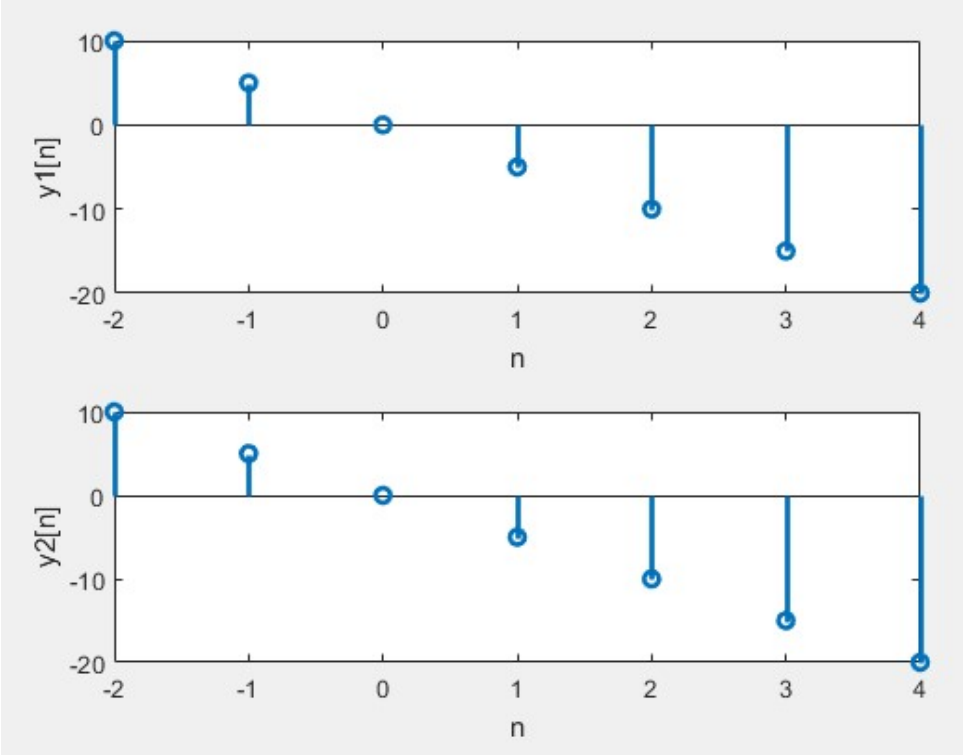
a1.*y1 + a2.*y2;

subplot(2,1,2),

stem(n,y,'LineWidth',2)

xlabel('n')

ylabel('y2[n]')



Linear, because of the same graph.

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

n = -2:4; x = 2.*n; n0 = 3;

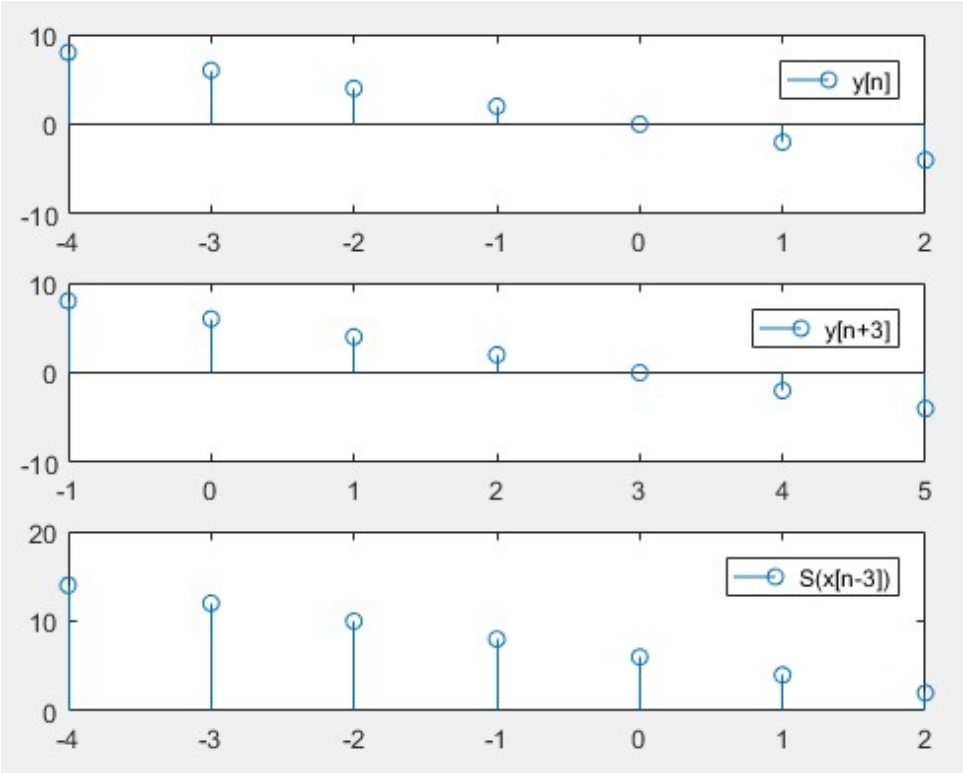
subplot(3,1,1), stem(-n,x),

legend('y[n]') subplot(3,1,2),

stem(-(n-3),x), legend('y[n+3]')

x = 2.*(n+3); subplot(3,1,3),

stem(-n,x), legend('S(x[n-3])')



Time variant, due to the unidentical graphs.

Task 02: Find out if the discrete-time system described by the I/O relationship

$y[n] = x[1-2n]$ **is:**

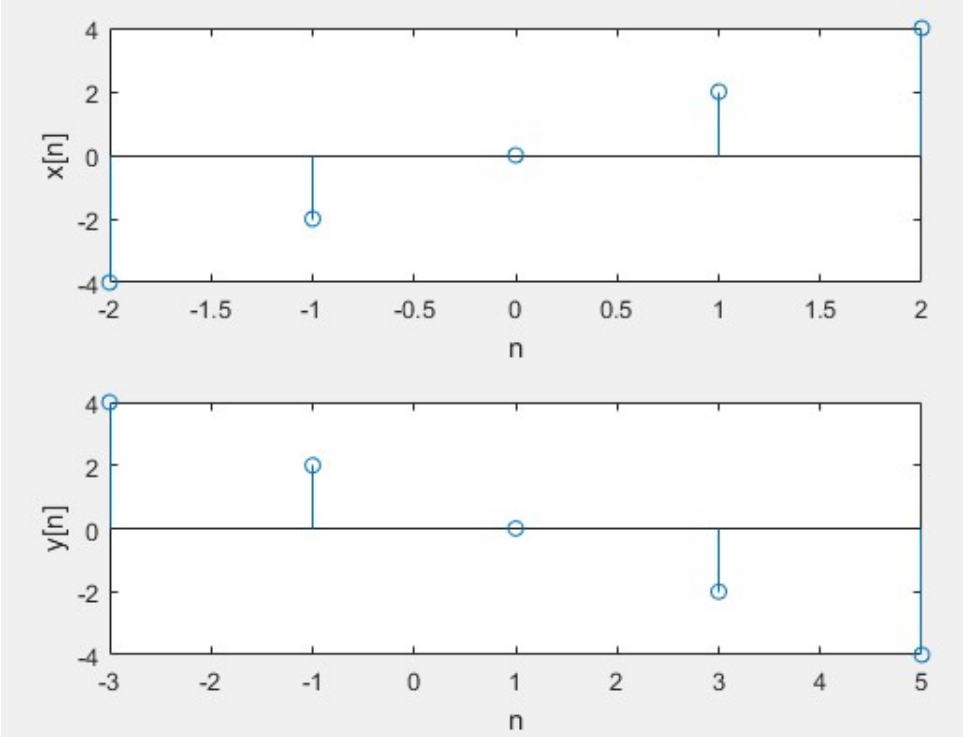
a) **Static or Dynamic (input signal** $x[n] = 2n, -2 \le n \le 2$ **)**

$x[n] = 2n, -2 \le n \le 2$

b) **Causal or non-causal (input signal) Command:**

```
n = -
2:2; x =
2.*n;
subplot
(2,1,1)
stem(n,
x)
ylabel(
'x[n]')
xlabel(
'n') y =
x;
subplo
t(2,1,2
)
stem(1
-
2.*n,y
)
ylabel('y[n]')
```

xlabel('n')



(a) & (b) **Non-Causal** and **Dynamic (**i.e. With Memory) as it depends on Future as well as past values.

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

Command:

n = -2:4; x1 = 2.*n; x2

= n./3; a1 = 2; a2 = 3; x

= a1.*x1 + a2.*x2;

subplot(2,1,1) stem(1-

2.*n,x)

xlabel('n') ylabel('S1')

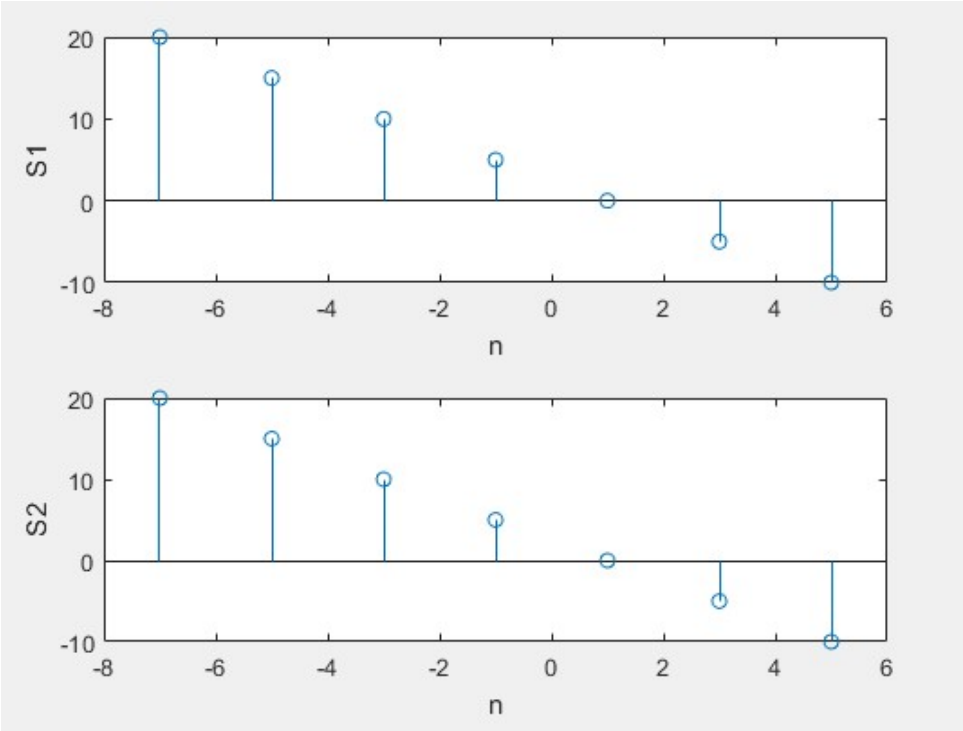
subplot(2,1,2) y1 =

a1.*x1; y2 = a2.*x2; y =

y1 + y2; stem(1-2.*n,y)

xlabel('n')

ylabel('S2')



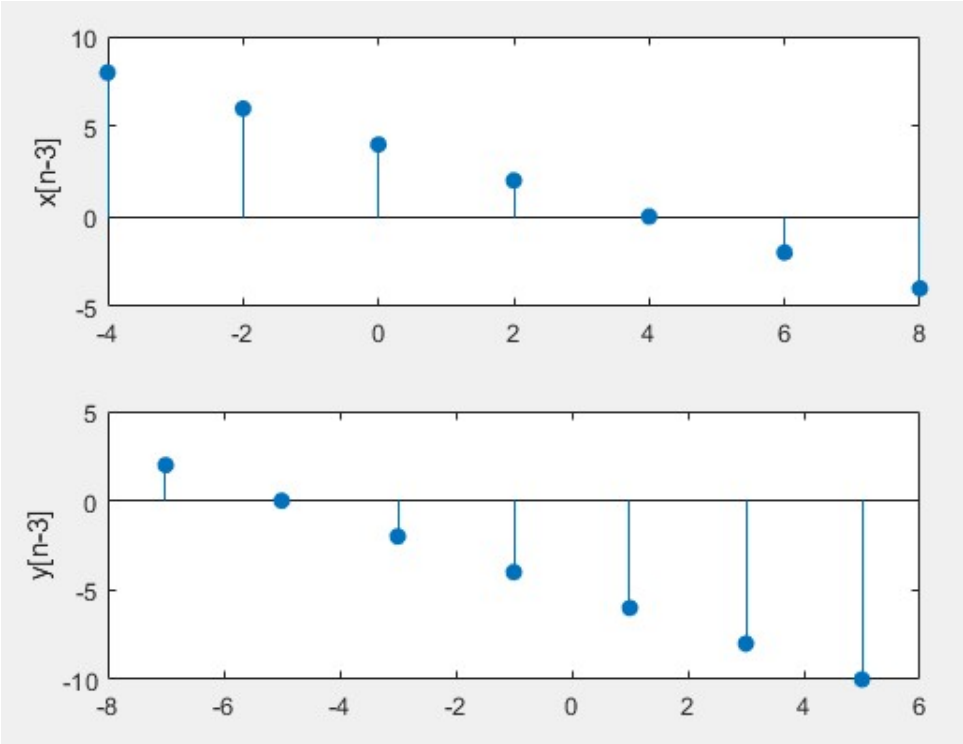
Signal is **linear** due to both identical graphs.

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

Command:

n = -2:4; x =
2.*n; n0 = 3;
subplot(2,1,1)
stem(n0+1-

```
2.*n,x,'fill')
ylabel('x[n-
3]') y = 2.*(n-
n0);
subplot(2,1,2)
stem(1-
2.*n,y,'fill')
ylabel('y[n-
3]')
```



As the graphs are not alike, so **Time variant**.

Critical Analysis/Conclusion:

In this lab, I learnt about signal responses employing basic features of systems in the concerned lab. These properties determine the signal's characteristics, which may be plotted easily in MATLAB and evaluated using analysis tools.