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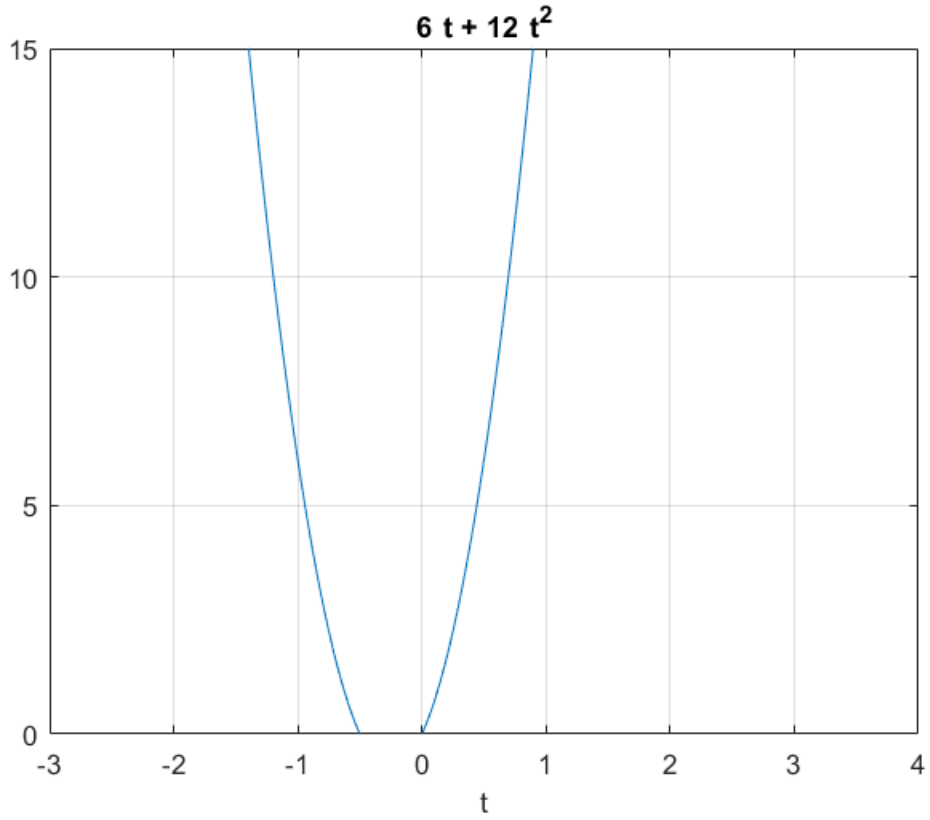
Lab 3 - C2 6/9/2017

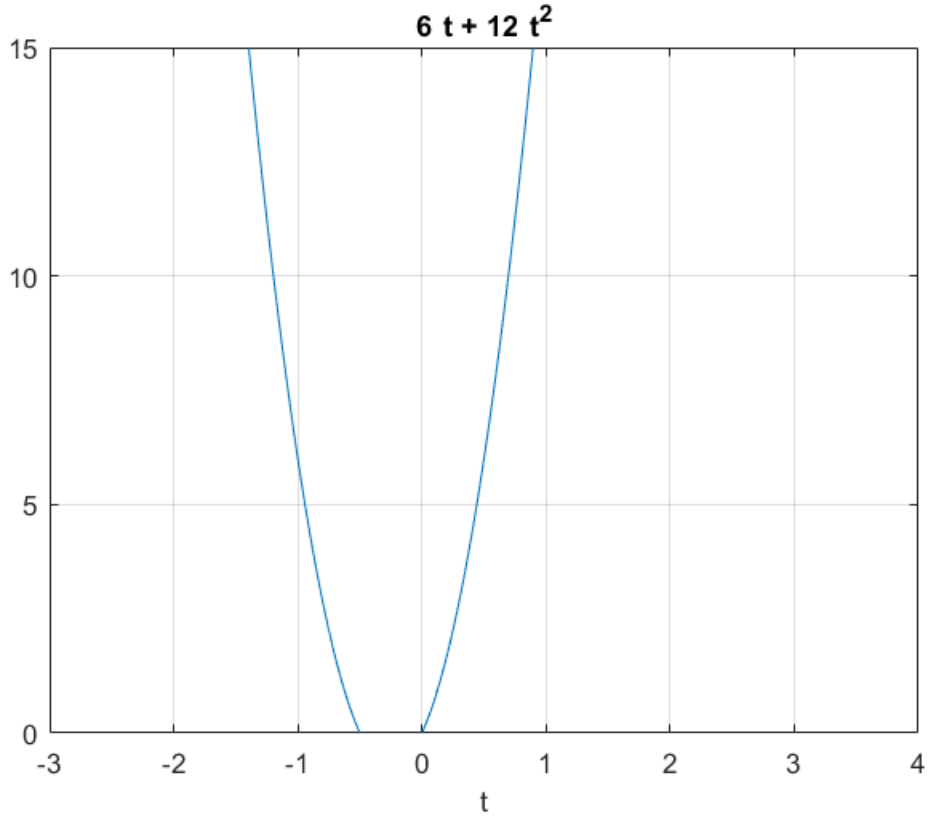
```
% memoryless/static = same time y(t) = x(t)
% memory/dynamic  = diff time y(t) = x(t/2)
```

Problem 1

1.1 linear/nonlinear

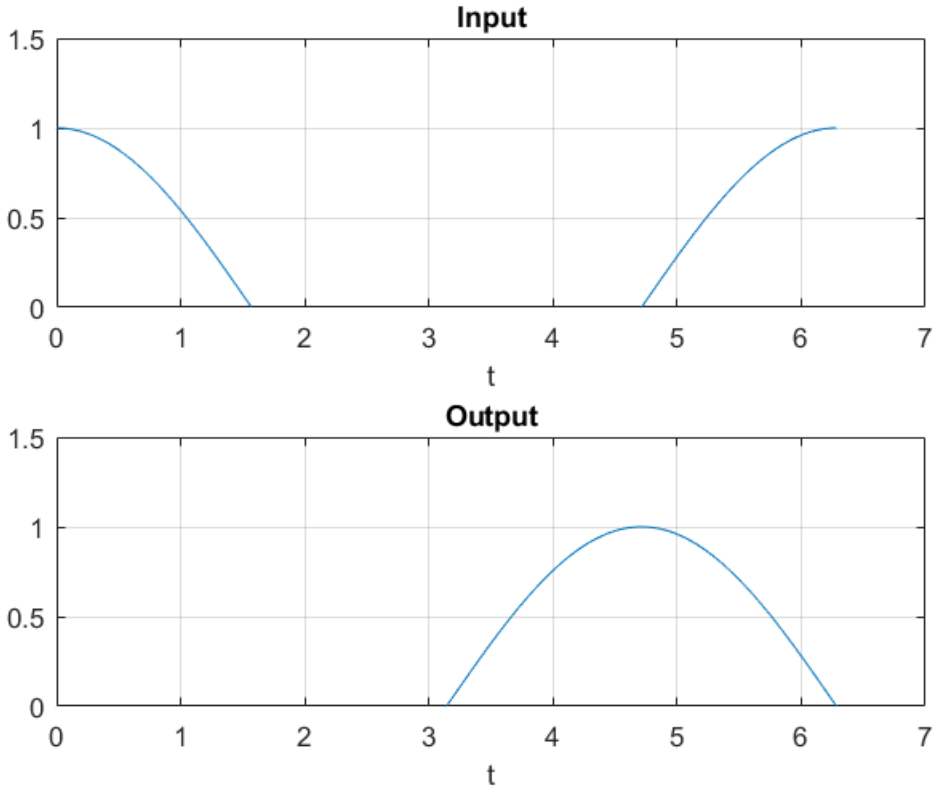
```
close all; clc; clear;
syms t
% input random x1, x2, a1, a2 vals
x1 = t.^2;
x2 = t.^3;
a1 = 3;
a2 = 4;

figure;
y = diff(a1*x1 + a2*x2);
ezplot(y)
ylim([0 15]); xlim([-3 4]); grid on

figure;
y = a1*diff(x1) + a2*diff(x2);
ezplot(y)
ylim([0 15]); xlim([-3 4]); grid on

% Since the plots and functions are equal then the system is linear.
```


6 t + 12 t^2
15
10
5
0
-3
-2
-1
0
1
2
3
4
t


6 t + 12 t^2
15
10
5
0
-3
-2
-1
0
1
2
3
4
t

1.2 Causal or non-causal

```
syms t
x = cos(t);
y = diff(x);

figure;
subplot(2,1,1)
ezplot(x);
title('Input')
ylim([0 1.5]); xlim([0 7]); xticks(-5:1:10); grid on

subplot(2,1,2)
ezplot(y);
title('Output')
ylim([0 1.5]); xlim([0 7]); xticks(-5:1:10); grid on

% Causal since the input signal occurs at a time before the
% Output signal. In addition the output signal overlaps with
% further parts of the input signal.
```



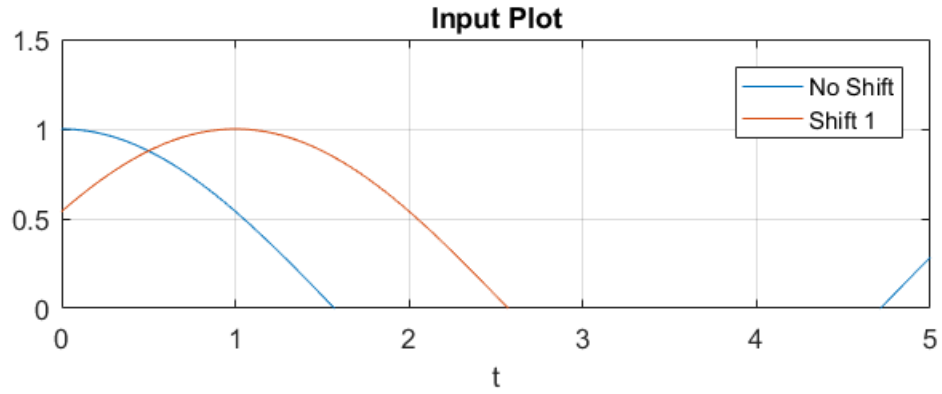
1.3 static or dynamic

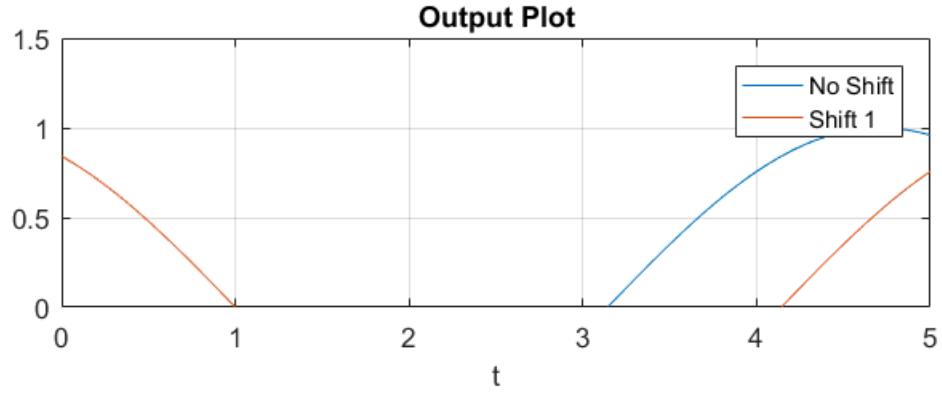
```
% The system is dynamic or with memory
% Based on 1.2 plots, the output value is shifted slightly ahead
```

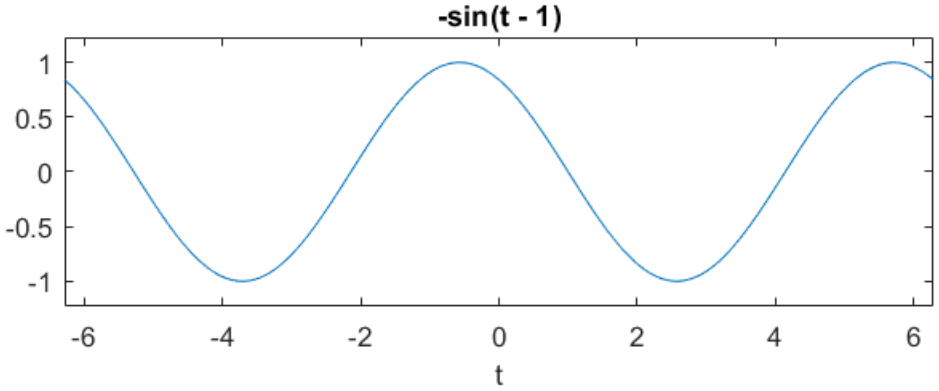
```
% causing it to not be aligned exactly with the input values
 (memoryless).
```

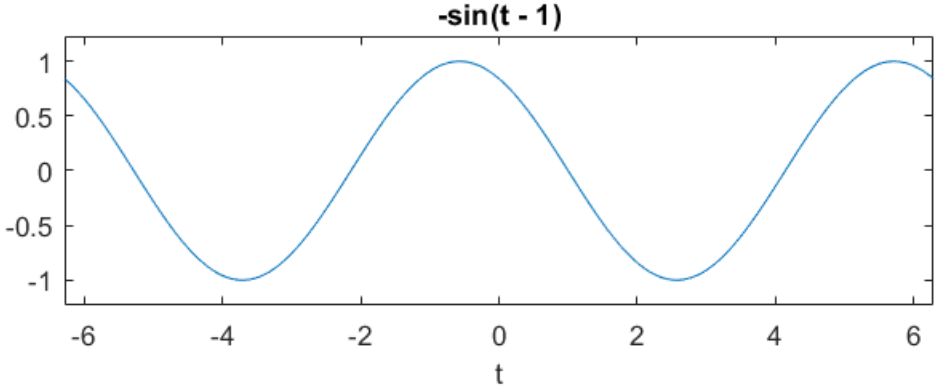
1.4 Time Variant or Invariant

```
syms t
x = cos(t);
y = diff(x);
x1 = subs(x,t,t-1);
y1 = subs(y,t,t-1);

figure;
subplot(2,1,1);
ezplot(x);
hold on;
ezplot(x1);
ylim([0 1.5]); xlim([0 5]); xticks(-5:1:10); grid on
title('Input Plot')
legend('No Shift','Shift 1');

subplot(2,1,2);
ezplot(y);
hold on;
ezplot(y1);
ylim([0 1.5]); xlim([0 5]); xticks(-5:1:10); grid on
title('Output Plot')
legend('No Shift','Shift 1');

z1 = diff(subs(x,t,t-1)); % S{x(t-1)}
z2 = subs(y,t,t-1); % y(t-1)
figure;
subplot(2,1,1);
ezplot(z1);
subplot(2,1,2);
ezplot(z2);

% The System is Time-Invariant since the time shift of
% the input signal correlates exactly with the shift
% of the output signal. Also S{x(t-1)} = y(t-1) as shown
% in the last two graphs.
```


Input Plot
No Shift
Shift 1
t

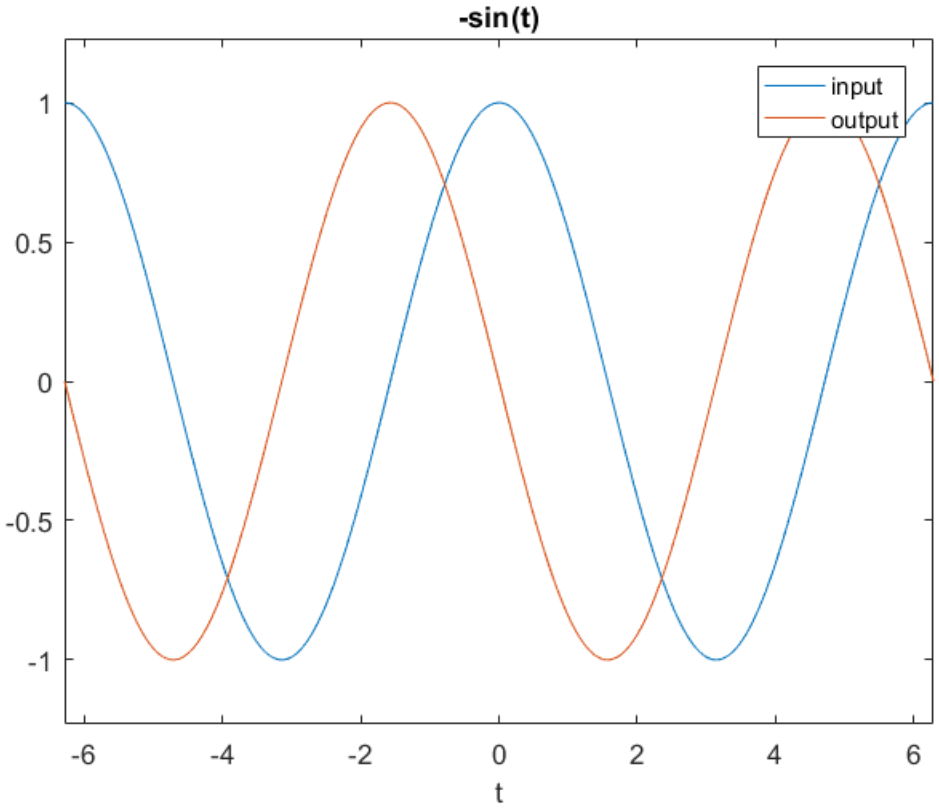

Output Plot
No Shift
Shift 1
t


-sin(t - 1)
t


-sin(t - 1)
t

1.5 Stable or unstable

```
syms t
x = cos(t);
y = diff(x);

figure;
ezplot(x);
hold on;
ezplot(y);
legend('input','output')

% Since the System is BIBO (bounded input & output)
% Then it is a stable system.
```

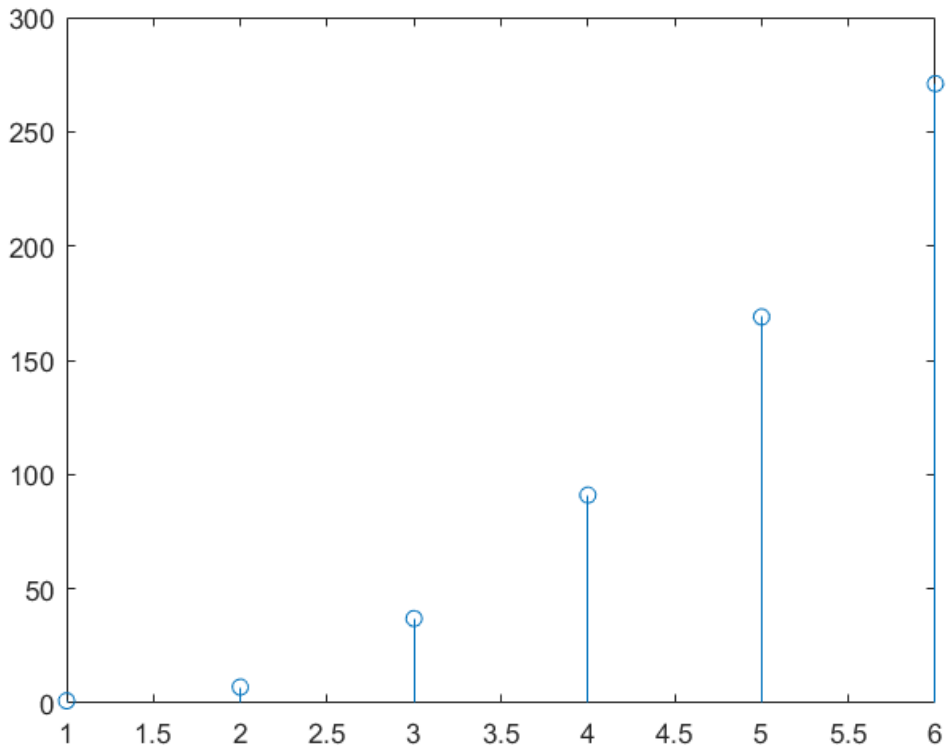


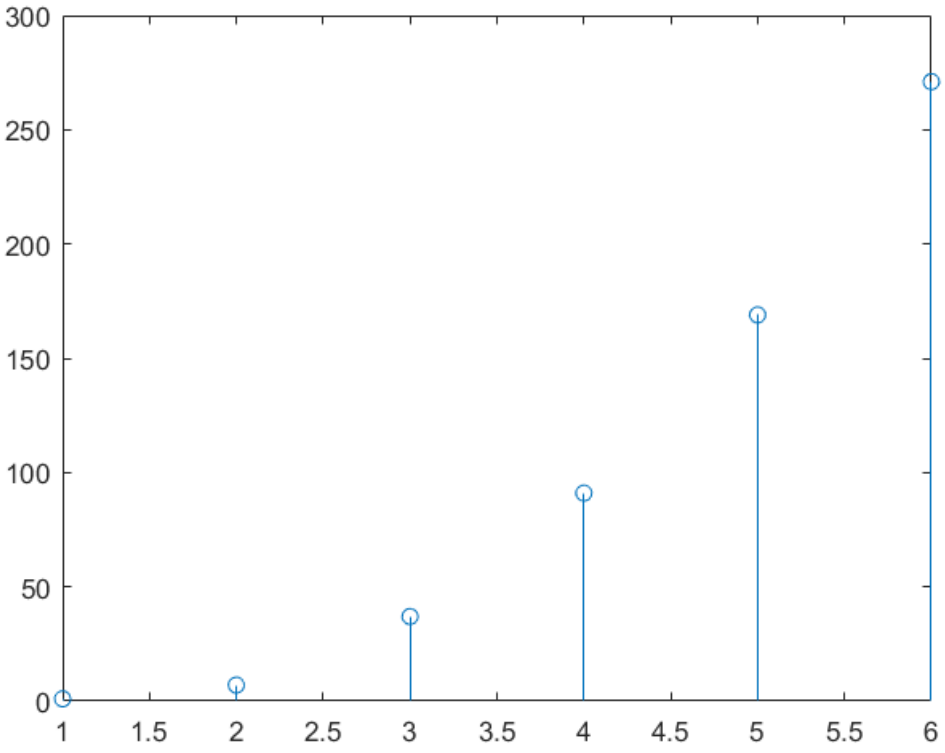
problem 2

2.1 Linear or non-linear

```
t = 0:5;
% input random x1, x2, a1, a2 vals
x1 = t.^2;
x2 = t.^3;
% x1n = subs(x1,t,t-1); % x1[n-1] is not working
```

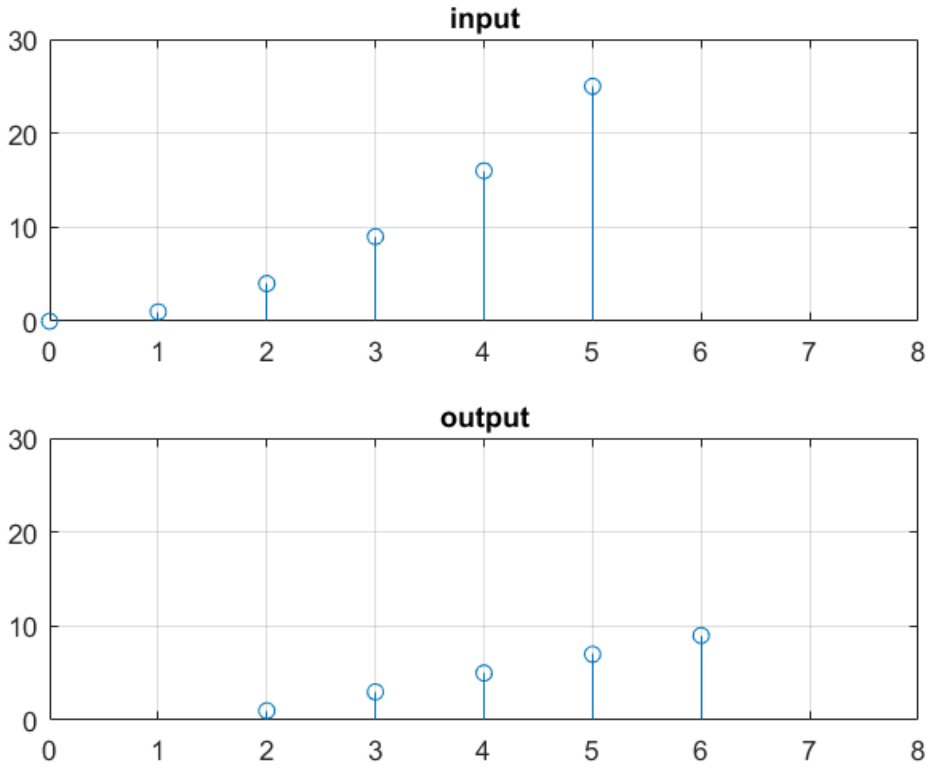
```
% x2n = subs(x2,t,t-1); % x2[n-1]
x1n = (t-1).^2;
x2n = (t-1).^3;
a1 = 3;
a2 = 4;

% using y[n] = x[n] - x[n-1]
figure;
% S{a1*x1(t)+a2*x2(t)}
y = (a1*x1 + a2*x2)-(a1*x1n + a2*x2n);
stem(y)

figure;
% a1*S{x1(t)} + a2*{x2(t)}
y = a1*(x1-x1n) + a2*(x2-x2n);
stem(y)

% The system is linear since S{a1*x1(t)+a2*x2(t)} = a1*S{x1(t)} +
 a2*{x2(t)}
% as shown when the plotted functions are the exact same.
```





2.2 Causal or non-causal

```
syms t
t = 0:5;
x = t.^2;
y = t.^2-(t-1).^2;

figure;
subplot(2,1,1);
stem(t,x);
ylim([0 30]); xlim([0 8]); xticks(-3:1:8);
grid on
title('input')

subplot(2,1,2);
stem(t+1,y);
ylim([0 30]); xlim([0 8]); xticks(-3:1:8);
grid on
title('output')

% The System is causual since the output occurs during and
% after the input signal
```



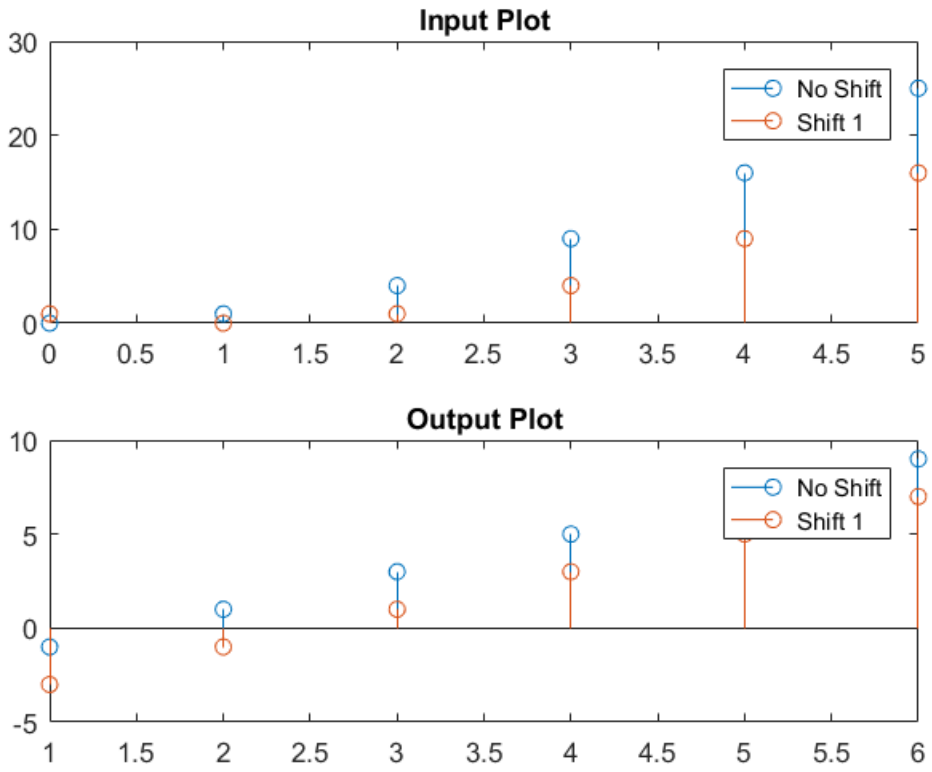
2.3 Static or dynamic

```
% The system is dyanmic or with memory
% Based on 2.2 plots, the output signal times are shifted slightly
 after
% the input signals thus requiring memory.
```

2.4 Shift Invariant or shift variant

```
t = 0:5;
x = t.^2;
y = t.^2-(t-1).^2;
x1 = (t-1).^2;
y1 = (t-1).^2-(t-2).^2;

figure;
subplot(2,1,1)
stem(t,x);
hold on;
stem(t,x1);
title('Input Plot')
legend('No Shift','Shift 1');

subplot(2,1,2)
stem(t+1,y);
```

```
hold on;
stem(t+1,y1);
title('Output Plot')
legend('No Shift','Shift 1');

% The System is Time-Invariant since the time shift of
% the input signal correlates exactly with the shift
% of the output signal.
```



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