EEE 391
Basics of Signals and Systems
2018-2019 Spring

Computer Assignment 2

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21502040

Implementation of Linearity Test:

Matlab Code:
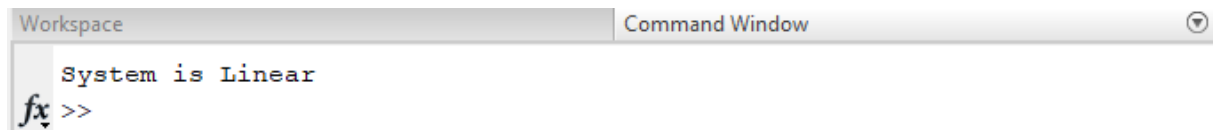
```matlab
%-----------linearity------------
x1 = [-3 -4 2 0 1 4 3 6 3 7];
x2 = [2 5 -1 7 -3 6 12 -9 8 -4];
% x1 = [9 23 15 -10 18 14 5 -1 6 11];
% x2 = [2 5 -1 7 -3 6 12 -9 8 -4];
amin=-5;
amax=5;
bmin=-5;
bmax=5;
N=10;
n=1:N;
a_val=[];%determine the a,b for wtich system is not Linear
b_val=[];
flag=1;%systen is linear
for a = amin:amax;
    for b= bmin:bmax;
        y1=System2(x1,n);
        y2=System2(x2,n);
        w= a*y1+b*y2;
        xx = a*x1+b*x2;
        yy = System2(xx,n);
        if(isequal(w,yy)==0)
            flag=0;
            a_val=[a_val a];
            b_val=[b_val b];
        end
    end
end

if(length(a_val)==0) %#ok<ISMT>
    disp('System is Linear')
else
    for i =1:length(a_val)
        S= ['System is not Linear for a = ',num2str(a_val(i)),
' and b = ',num2str(b_val(i))];
        disp(S);
    end

end
```
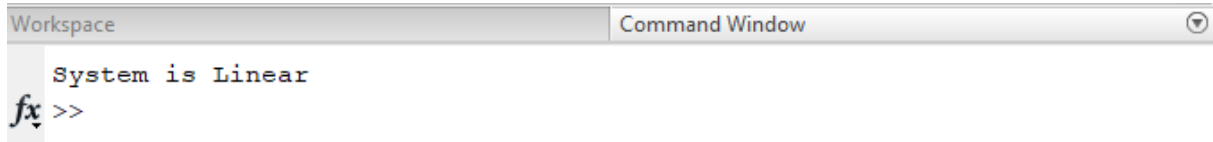
My code prints out the a and b values for which system is not linear. If the system is linear, the message 'System is Linear' is printed out on the Command Window.

a) Output on the command window:

For x1 [-3 -4 2 0 1 4 3 6 3 7]; and x2 = [2 5 -1 7 -3 6 12 -9 8 -4];

Workspace	Command Window	
System is Linear		
fx >>		

For x1 = [9 23 15 -10 18 14 5 -1 6 11]; and x2 = [2 5 -1 7 -3 6 12 -9 8 -4];

Workspace	Command Window	
System is Linear		
fx >>		

b) Output on the command window:

For x1 [-3 -4 2 0 1 4 3 6 3 7]; and x2 = [2 5 -1 7 -3 6 12 -9 8 -4];

Workspace	Command Window	
System is Linear		
fx >>		

For x1 = [9 23 15 -10 18 14 5 -1 6 11]; and x2 = [2 5 -1 7 -3 6 12 -9 8 -4];

System is Linear
fx >>

c) Output on the command window:

For x1 [-3 -4 2 0 1 4 3 6 3 7];
and x2 = [2 5 -1 7 -3 6 12 -9 8 -4];

System is not Linear for a = 2 and b = -3
System is not Linear for a = 2 and b = -2
System is not Linear for a = 2 and b = 0
System is not Linear for a = 2 and b = 1
System is not Linear for a = 2 and b = 2
System is not Linear for a = 2 and b = 3
System is not Linear for a = 2 and b = 4
System is not Linear for a = 2 and b = 5
System is not Linear for a = 3 and b = -5
System is not Linear for a = 3 and b = -4
System is not Linear for a = 3 and b = -3
System is not Linear for a = 3 and b = -1
System is not Linear for a = 3 and b = 0
System is not Linear for a = 3 and b = 1
System is not Linear for a = 3 and b = 2
System is not Linear for a = 3 and b = 3
System is not Linear for a = 3 and b = 4
System is not Linear for a = 3 and b = 5
System is not Linear for a = 4 and b = -5
System is not Linear for a = 4 and b = -4
System is not Linear for a = 4 and b = -2
System is not Linear for a = 4 and b = -1
System is not Linear for a = 4 and b = 0
System is not Linear for a = 4 and b = 1
System is not Linear for a = 4 and b = 2
System is not Linear for a = 4 and b = 3
System is not Linear for a = 4 and b = 4
System is not Linear for a = 4 and b = 5
System is not Linear for a = 5 and b = -5
System is not Linear for a = 5 and b = -3
System is not Linear for a = 5 and b = -2
System is not Linear for a = 5 and b = -1
System is not Linear for a = 5 and b = 0
System is not Linear for a = 5 and b = 1
System is not Linear for a = 5 and b = 2
System is not Linear for a = 5 and b = 3
System is not Linear for a = 5 and b = 4
System is not Linear for a = 5 and b = 5

For x1 = [9 23 15 -10 18 14 5 -1 6 11];

and x2 = [2 5 -1 7 -3 6 12 -9 8 -4];

System is non Linear

System is not Linear for a = -1 and b = 3
System is not Linear for a = -1 and b = 4
System is not Linear for a = -1 and b = 5
System is not Linear for a = 0 and b = -5
System is not Linear for a = 0 and b = -4
System is not Linear for a = 0 and b = -3
System is not Linear for a = 0 and b = -2
System is not Linear for a = 0 and b = -1
System is not Linear for a = 0 and b = 0
System is not Linear for a = 0 and b = 2
System is not Linear for a = 0 and b = 3
System is not Linear for a = 0 and b = 4
System is not Linear for a = 0 and b = 5
System is not Linear for a = 1 and b = -5
System is not Linear for a = 1 and b = -4
System is not Linear for a = 1 and b = -3
System is not Linear for a = 1 and b = -2
System is not Linear for a = 1 and b = -1
System is not Linear for a = 1 and b = 1
System is not Linear for a = 1 and b = 2
System is not Linear for a = 1 and b = 3
System is not Linear for a = 1 and b = 4
System is not Linear for a = 1 and b = 5
System is not Linear for a = 2 and b = -5
System is not Linear for a = 2 and b = -4
System is not Linear for a = 2 and b = -3
System is not Linear for a = 2 and b = -2
System is not Linear for a = 2 and b = 0
System is not Linear for a = 2 and b = 1
System is not Linear for a = 2 and b = 2
System is not Linear for a = 2 and b = 3
System is not Linear for a = 2 and b = 4
System is not Linear for a = 2 and b = 5
System is not Linear for a = 3 and b = -5
System is not Linear for a = 3 and b = -4
System is not Linear for a = 3 and b = -3
System is not Linear for a = 3 and b = -1
System is not Linear for a = 3 and b = 0
System is not Linear for a = 3 and b = 1

d) Output on the command window:

For x1 [-3 -4 2 0 1 4 3 6 3 7];
and x2 = [2 5 -1 7 -3 6 12 -9 8 -4];

```
System is not Linear for a = 2 and b = -3
System is not Linear for a = 2 and b = -2
System is not Linear for a = 2 and b = -1
System is not Linear for a = 2 and b = 1
System is not Linear for a = 2 and b = 2
System is not Linear for a = 2 and b = 3
System is not Linear for a = 2 and b = 4
System is not Linear for a = 2 and b = 5
System is not Linear for a = 3 and b = -5
System is not Linear for a = 3 and b = -4
System is not Linear for a = 3 and b = -3
System is not Linear for a = 3 and b = -2
System is not Linear for a = 3 and b = -1
System is not Linear for a = 3 and b = 1
System is not Linear for a = 3 and b = 2
System is not Linear for a = 3 and b = 3
System is not Linear for a = 3 and b = 4
System is not Linear for a = 3 and b = 5
System is not Linear for a = 4 and b = -5
System is not Linear for a = 4 and b = -4
System is not Linear for a = 4 and b = -3
System is not Linear for a = 4 and b = -2
System is not Linear for a = 4 and b = -1
System is not Linear for a = 4 and b = 1
System is not Linear for a = 4 and b = 2
System is not Linear for a = 4 and b = 3
System is not Linear for a = 4 and b = 4
System is not Linear for a = 4 and b = 5
System is not Linear for a = 5 and b = -5
System is not Linear for a = 5 and b = -4
System is not Linear for a = 5 and b = -3
System is not Linear for a = 5 and b = -2
System is not Linear for a = 5 and b = -1
System is not Linear for a = 5 and b = 1
System is not Linear for a = 5 and b = 2
System is not Linear for a = 5 and b = 3
System is not Linear for a = 5 and b = 4
System is not Linear for a = 5 and b = 5
```

For x1 = [9 23 15 -10 18 14 5 -1 6 11];
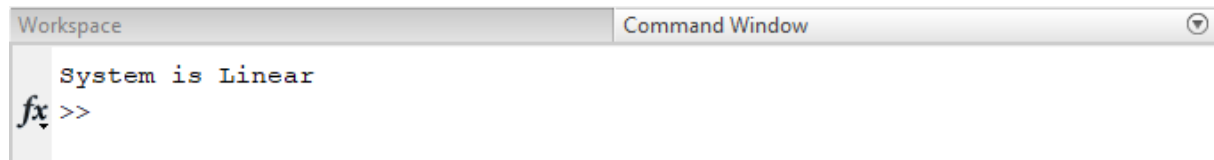
and x2 = [2 5 -1 7 -3 6 12 -9 8 -4];

System is non Linear

```
System is not Linear for a = -2 and b = -1
System is not Linear for a = -2 and b = 0
System is not Linear for a = -2 and b = 1
System is not Linear for a = -2 and b = 2
System is not Linear for a = -2 and b = 3
System is not Linear for a = -2 and b = 4
System is not Linear for a = -2 and b = 5
System is not Linear for a = -1 and b = -5
System is not Linear for a = -1 and b = -4
System is not Linear for a = -1 and b = -3
System is not Linear for a = -1 and b = -2
System is not Linear for a = -1 and b = -1
System is not Linear for a = -1 and b = 0
System is not Linear for a = -1 and b = 1
System is not Linear for a = -1 and b = 2
System is not Linear for a = -1 and b = 3
System is not Linear for a = -1 and b = 4
System is not Linear for a = -1 and b = 5
System is not Linear for a = 0 and b = -5
System is not Linear for a = 0 and b = -4
System is not Linear for a = 0 and b = -3
System is not Linear for a = 0 and b = -2
System is not Linear for a = 0 and b = -1
System is not Linear for a = 1 and b = -5
System is not Linear for a = 1 and b = -4
System is not Linear for a = 1 and b = -3
System is not Linear for a = 1 and b = -2
System is not Linear for a = 1 and b = -1
System is not Linear for a = 1 and b = 1
System is not Linear for a = 1 and b = 2
System is not Linear for a = 1 and b = 3
System is not Linear for a = 1 and b = 4
System is not Linear for a = 1 and b = 5
System is not Linear for a = 2 and b = -5
System is not Linear for a = 2 and b = -4
System is not Linear for a = 2 and b = -3
System is not Linear for a = 2 and b = -2
System is not Linear for a = 2 and b = -1
System is not Linear for a = 2 and b = 1
```

e) Output on the command window:

For x1 [-3 -4 2 0 1 4 3 6 3 7];
and x2 = [2 5 -1 7 -3 6 12 -9 8 -4];

```
Workspace                              Command Window                          ⊙
    System is Linear
fx >>
```

For x1 = [9 23 15 -10 18 14 5 -1 6 11];

and x2 = [2 5 -1 7 -3 6 12 -9 8 -4];

```
Workspace                              Command Window                          ⊙
    System is Linear
fx >>
```
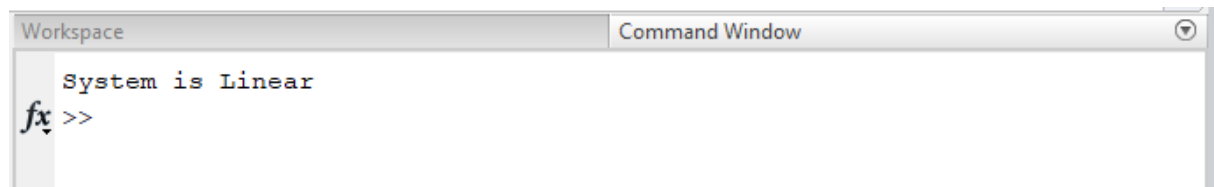
System is Linear

Implementation of Time Invariance Test:

Matlab Code:

```
x = [-3 -4 2 0 1 4 3 6 3 7];
% x = [5 -11 9 2 3 -6 0 -7 3 10];
N=10;
n=1:N;
n_val=[];
nmin=-50;
nmax=50;
for n0=nmin:nmax
    x0=delay(x,n0);
    w=System1(x0,n);
    y=System1(x,n);
    y0=delay(y,n0);
    if(isequal(w,y0)==0)
        n_val=[n_val n0];
    end
end
if(length(n_val)==0)  %#ok<ISMT>
    disp('System is Time Invariant')
```

```
else
    for i =1:length(n_val)
        S= ['System is not Time Invariant for n =
',num2str(n_val(i))];
        disp(S);
    end

end
```

My code prints out the n0 values for which system is not time invariant. If the system is time invariant, the message 'System is Time Invariant' is printed out on the Command Window.

a) Output on the command window:

For x = [-3 -4 2 0 1 4 3 6 3 7];

For x = [5 -11 9 2 3 -6 0 -7 3 10];

System is not Time invariant

b) Output on the command window:

For x = [-3 -4 2 0 1 4 3 6 3 7];

```
Workspace                                        Command Window
    System is not Time Invariant for n = -8
    System is not Time Invariant for n = -7
    System is not Time Invariant for n = -6
    System is not Time Invariant for n = -5
    System is not Time Invariant for n = -4
    System is not Time Invariant for n = -3
    System is not Time Invariant for n = -2
    System is not Time Invariant for n = -1
    System is not Time Invariant for n = 1
    System is not Time Invariant for n = 2
    System is not Time Invariant for n = 3
    System is not Time Invariant for n = 4
    System is not Time Invariant for n = 5
    System is not Time Invariant for n = 6
    System is not Time Invariant for n = 7
    System is not Time Invariant for n = 8
    System is not Time Invariant for n = 9
fx >>
```
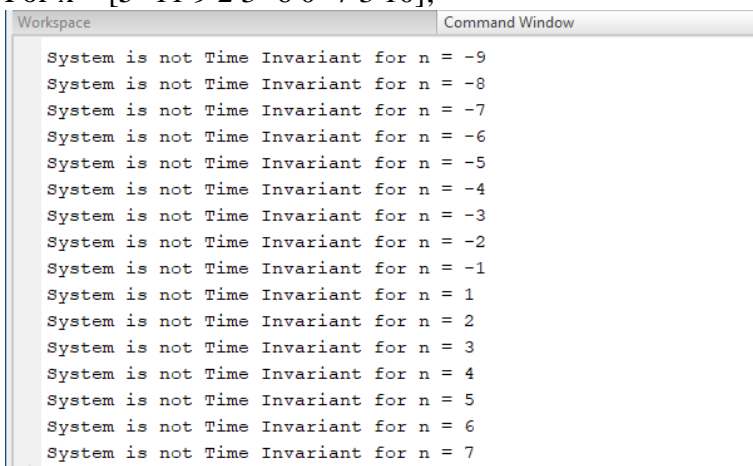
For x = [5 -11 9 2 3 -6 0 -7 3 10];

```
Workspace                                        Command Wir
    System is not Time Invariant for n = -8
    System is not Time Invariant for n = -7
    System is not Time Invariant for n = -6
    System is not Time Invariant for n = -5
    System is not Time Invariant for n = -4
    System is not Time Invariant for n = -3
    System is not Time Invariant for n = -2
    System is not Time Invariant for n = -1
    System is not Time Invariant for n = 1
    System is not Time Invariant for n = 2
    System is not Time Invariant for n = 3
    System is not Time Invariant for n = 4
    System is not Time Invariant for n = 5
    System is not Time Invariant for n = 6
    System is not Time Invariant for n = 7
    System is not Time Invariant for n = 8
    System is not Time Invariant for n = 9
fx >>
```
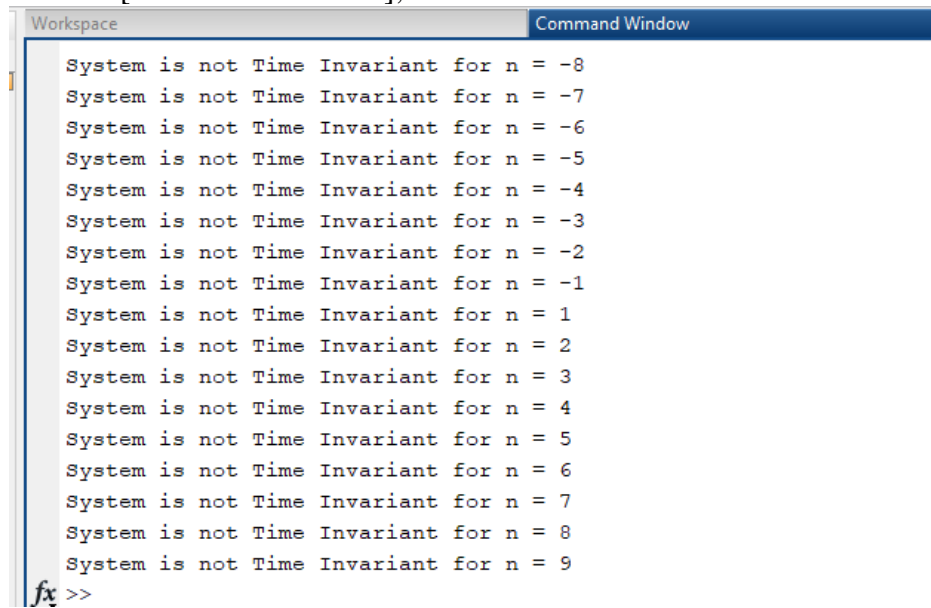
System is not time invariant
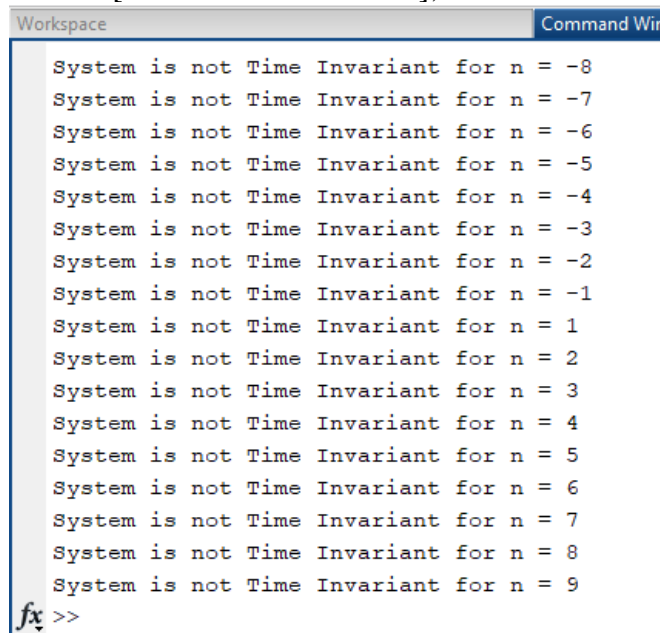
c) Output on the command window:

For x = [-3 -4 2 0 1 4 3 6 3 7];

```
System is not Time Invariant for n = -45
System is not Time Invariant for n = -44
System is not Time Invariant for n = -43
System is not Time Invariant for n = -42
System is not Time Invariant for n = -41
System is not Time Invariant for n = -40
System is not Time Invariant for n = -39
System is not Time Invariant for n = -38
System is not Time Invariant for n = -37
System is not Time Invariant for n = -36
System is not Time Invariant for n = -35
System is not Time Invariant for n = -34
System is not Time Invariant for n = -33
System is not Time Invariant for n = -32
System is not Time Invariant for n = -31
System is not Time Invariant for n = -30
System is not Time Invariant for n = -29
System is not Time Invariant for n = -28
System is not Time Invariant for n = -27
System is not Time Invariant for n = -26
System is not Time Invariant for n = -25
System is not Time Invariant for n = -24
System is not Time Invariant for n = -23
System is not Time Invariant for n = -22
System is not Time Invariant for n = -21
System is not Time Invariant for n = -20
System is not Time Invariant for n = -19
System is not Time Invariant for n = -18
System is not Time Invariant for n = -17
System is not Time Invariant for n = -16
System is not Time Invariant for n = -15
System is not Time Invariant for n = -14
System is not Time Invariant for n = -13
System is not Time Invariant for n = -12
System is not Time Invariant for n = -11
System is not Time Invariant for n = -10
System is not Time Invariant for n = -9
System is not Time Invariant for n = -8
System is not Time Invariant for n = -7
```

For x = [5 -11 9 2 3 -6 0 -7 3 10];

```
System is not Time Invariant for n = -43
System is not Time Invariant for n = -42
System is not Time Invariant for n = -41
System is not Time Invariant for n = -40
System is not Time Invariant for n = -39
System is not Time Invariant for n = -38
System is not Time Invariant for n = -37
System is not Time Invariant for n = -36
System is not Time Invariant for n = -35
System is not Time Invariant for n = -34
System is not Time Invariant for n = -33
System is not Time Invariant for n = -32
System is not Time Invariant for n = -31
System is not Time Invariant for n = -30
System is not Time Invariant for n = -29
System is not Time Invariant for n = -28
System is not Time Invariant for n = -27
System is not Time Invariant for n = -26
System is not Time Invariant for n = -25
System is not Time Invariant for n = -24
System is not Time Invariant for n = -23
System is not Time Invariant for n = -22
System is not Time Invariant for n = -21
System is not Time Invariant for n = -20
System is not Time Invariant for n = -19
System is not Time Invariant for n = -18
System is not Time Invariant for n = -17
System is not Time Invariant for n = -16
System is not Time Invariant for n = -15
System is not Time Invariant for n = -14
System is not Time Invariant for n = -13
System is not Time Invariant for n = -12
System is not Time Invariant for n = -11
System is not Time Invariant for n = -10
System is not Time Invariant for n = -9
System is not Time Invariant for n = -8
System is not Time Invariant for n = -7
System is not Time Invariant for n = -6
System is not Time Invariant for n = -5
```

System is not time invariant

d) Output on the command window:

For x = [-3 -4 2 0 1 4 3 6 3 7];

```
Workspace                              Command Window
  System is Time Invariant
fx >>
```

For x = [5 -11 9 2 3 -6 0 -7 3 10];

```
Workspace                              Command Window
  System is Time Invariant
fx >>
```

System is time invariant

e) Output on the command window:

For x = [-3 -4 2 0 1 4 3 6 3 7];

```
Workspace                              Command Window
  System is not Time Invariant for n = 1
  System is not Time Invariant for n = 2
  System is not Time Invariant for n = 3
  System is not Time Invariant for n = 4
  System is not Time Invariant for n = 5
  System is not Time Invariant for n = 6
  System is not Time Invariant for n = 7
  System is not Time Invariant for n = 8
  System is not Time Invariant for n = 9
fx >>
```

For x = [5 -11 9 2 3 -6 0 -7 3 10];

```
Workspace                              Command Window
  System is not Time Invariant for n = 1
  System is not Time Invariant for n = 2
  System is not Time Invariant for n = 3
  System is not Time Invariant for n = 4
  System is not Time Invariant for n = 5
  System is not Time Invariant for n = 6
  System is not Time Invariant for n = 7
  System is not Time Invariant for n = 8
  System is not Time Invariant for n = 9
fx >>
```

System is not time invariant

Implementation of Time Invariance Test:

Matlab Code:

```matlab
%------------causality------------
n_val=[];
x=[2 0 -3 10 6 8 1 -5 -2 9];
n=1:N;
for i = 1:length(x)-1;
    z = x;
    z(i:end) = 0;
    w = System1(z,n);
    y = System1(x,n);
    w = w(1:i-1);
    y = y(1:i-1);
    if(isequal(w,y)==0)
        n_val=[n_val i];
    end
end

if(length(n_val)==0)  %#ok<ISMT>
    disp('System is Causal')
else
    for i =1:length(n_val)
        S= ['System is not Causal for n =
',num2str(n_val(i))];
        disp(S);
    end

end
```
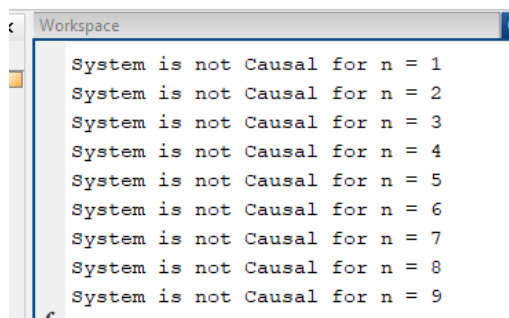
My code prints out the n values for which system is Causal. If the system is causal, the message 'System is Causal is printed out on the Command Window.

Since we are not given any specific input, i created my own input as x=[2 0 -3 10 6 8 1 -5 -2 9];

a) Output on the command window:

```
System is not Causal for n = 1
System is not Causal for n = 2
System is not Causal for n = 3
System is not Causal for n = 4
System is not Causal for n = 5
System is not Causal for n = 6
System is not Causal for n = 7
System is not Causal for n = 8
System is not Causal for n = 9
```
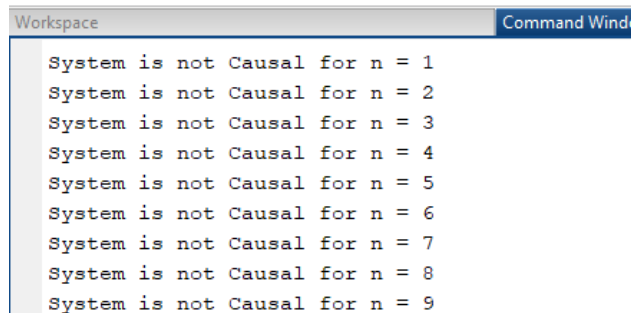
b) Output on the command window:

Workspace

```
System is not Causal for n = 1
System is not Causal for n = 2
System is not Causal for n = 3
System is not Causal for n = 4
System is not Causal for n = 5
System is not Causal for n = 6
System is not Causal for n = 7
System is not Causal for n = 8
System is not Causal for n = 9
```
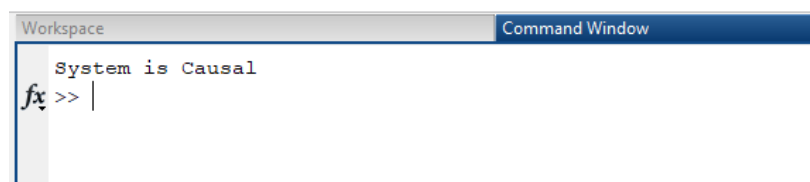
c) Output on the command window:

Workspace   Command Windo

```
System is not Causal for n = 1
System is not Causal for n = 2
System is not Causal for n = 3
System is not Causal for n = 4
System is not Causal for n = 5
System is not Causal for n = 6
System is not Causal for n = 7
System is not Causal for n = 8
System is not Causal for n = 9
```
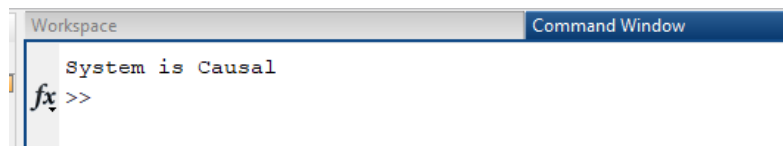
d) Output on the command window:

Workspace   Command Window

```
System is Causal
fx >> |
```

e) Output on the command window:

Full code:

```matlab
% %-----------linearity-------------
x1 = [-3 -4 2 0 1 4 3 6 3 7];
x2 = [2 5 -1 7 -3 6 12 -9 8 -4];
x1 = [9 23 15 -10 18 14 5 -1 6 11];
x2 = [2 5 -1 7 -3 6 12 -9 8 -4];
amin=-5;
amax=5;
bmin=-5;
bmax=5;
N=10;
n=1:N;
a_val=[];%determine the a,b for wtich system is not Linear
b_val=[];
flag=1;%systen is linear
for a = amin:amax;
    for b= bmin:bmax;
        y1=System5(x1,n);
        y2=System5(x2,n);
        w= a*y1+b*y2;
        xx = a*x1+b*x2;
        yy = System5(xx,n);
        if(isequal(w,yy)==0)
            flag=0;
            a_val=[a_val a];
            b_val=[b_val b];
        end
    end
end

if(length(a_val)==0)  %#ok<ISMT>
    disp('System is Linear')
else
    for i =1:length(a_val)
        S= ['System is not Linear for a = ',num2str(a_val(i)),
' and b = ',num2str(b_val(i))];
        disp(S);
    end

end
```

```matlab
%-----------time invariance-------
x = [-3 -4 2 0 1 4 3 6 3 7];
% x = [5 -11 9 2 3 -6 0 -7 3 10];
N=10;
n=1:N;
n_val=[];
nmin=-50;
nmax=50;
for n0=nmin:nmax
    x0=delay(x,n0);
    w=System5(x0,n);
    y=System5(x,n);
    y0=delay(y,n0);
    if(isequal(w,y0)==0)
        n_val=[n_val n0];
    end
end
if(length(n_val)==0) %#ok<ISMT>
    disp('System is Time Invariant')
else
    for i =1:length(n_val)
        S= ['System is not Time Invariant for n = ',num2str(n_val(i))];
        disp(S);
    end

end

%------------causality------------
n_val=[];
x=[2 0 -3 10 6 8 1 -5 -2 9];
N=10;
n=1:N;
for i = 1:length(x)-1;
    z = x;
    z(i:end) = 0;
    w = System4(z,n);
    y = System4(x,n);
    w = w(1:i-1);
    y = y(1:i-1);
    if(isequal(w,y)==0)
        n_val=[n_val i];
    end
end

if(length(n_val)==0) %#ok<ISMT>
    disp('System is Causal')
else
    for i =1:length(n_val)
        S= ['System is not Causal for n = ',num2str(n_val(i))];
```

```matlab
        disp(S);
    end

end

function y= System1(x,n)
% for i = 1:length(x)
%     y(i) = n*x(i);
% end
L = length(x);
for i = 1:L-2
    y(i) = n(i)*x(i+2);
end
y(L) = 0;
y(L-1) = 0;

function y= System2(x,n)
L = length(x);
c=1;
for i = 1:length(x)
    if(rem(i,2)==1)
        y(c)=x(i);
        c=c+1;
    end
end

function y= System3(x,n)
% for i = 1:length(x)
%     y(i) = n*x(i);
% end
L = length(x);
for i = 1:L-4
    y(i) = 3*x(i+4)+5;
end
y(L) = 5;
y(L-1) = 5;
y(L-2) = 5;
y(L-3) = 5;

function y= System4(x,n)
L = length(x);
for i = 1:length(x)
    if(x(i) < 0)
        y(i)=-x(i);
    else
        y(i)=x(i);
    end
end

function y= System5(x,n)
L = length(x);
```

```
for i = 1:L
    y(i) = sum(x(1:i));
end

function [ y ] = delay(x,n0)
L=length(x);
if ( n0<0)
    y = [zeros(1,(-n0)) x(1:end+n0)];
else
    y = [ x(n0+1:end) zeros(1,(n0))];
end
y = y(1:L);
```