Lab Report

IA 3203 – DIGITAL SIGNAL PROCESSING

Department of Instrumentation and Automation Technology
University of Colombo

DSP 303 – Linear Time Invariant Systems

Registration No: 2021t01108

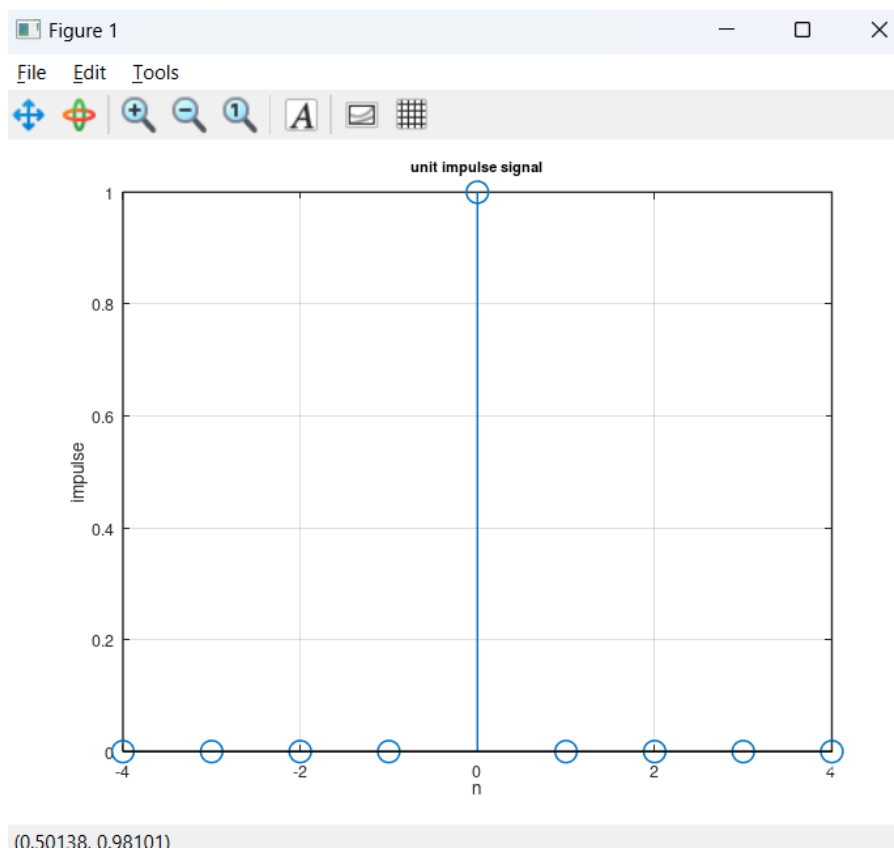**Students Name: G.G.B.S Gunawardana**

Date (dd/mm/yy): 19/07/2024

Exercise:

Question 01.a:

Answer:

Octave code:

```
1   clear alll;
2   close all;
3   clc;
4
5   n = -4:4;
6
7   %---------a-----------
8
9   impulse = (n==0);
10  stem(n, impulse);
11  xlabel('n');
12  ylabel('impulse');
13  title('unit impulse signal');
14  grid on;
15
```
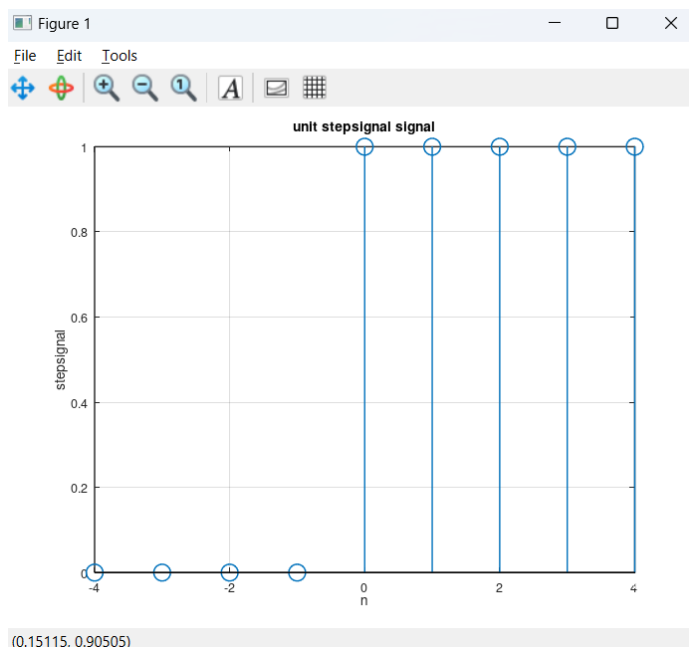
Figures:

Question 01.b:

Answer:

Octave code:

```
%--------b-----------
n = -4:4;

stepsignal = (n >= 0);
stem(n, stepsignal);
xlabel('n');
ylabel('stepsignal');
title('unit stepsignal signal');
grid on;
```
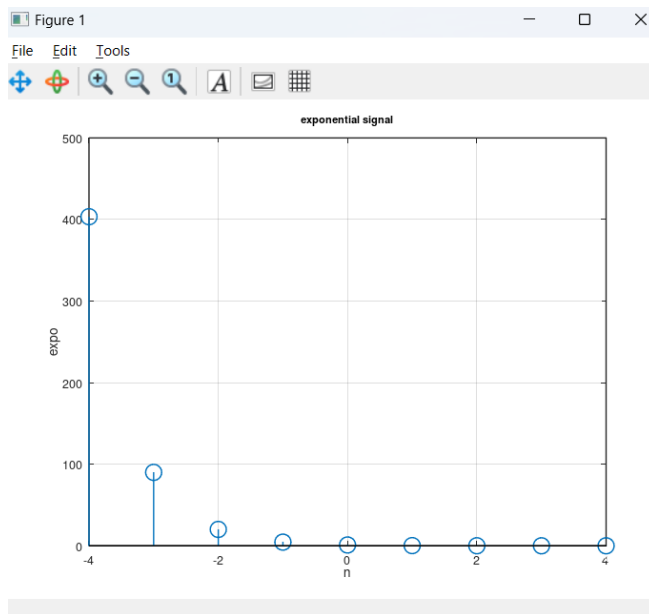
Figures:

Question 01.c:

Answer:

Octave code:

```
%--------c-----------
n = -4:4;

expo = exp(-(3/2)*n);

stem(n, expo);
xlabel('n');
ylabel('expo');
title('exponential signal');
grid on;
```

Figures:

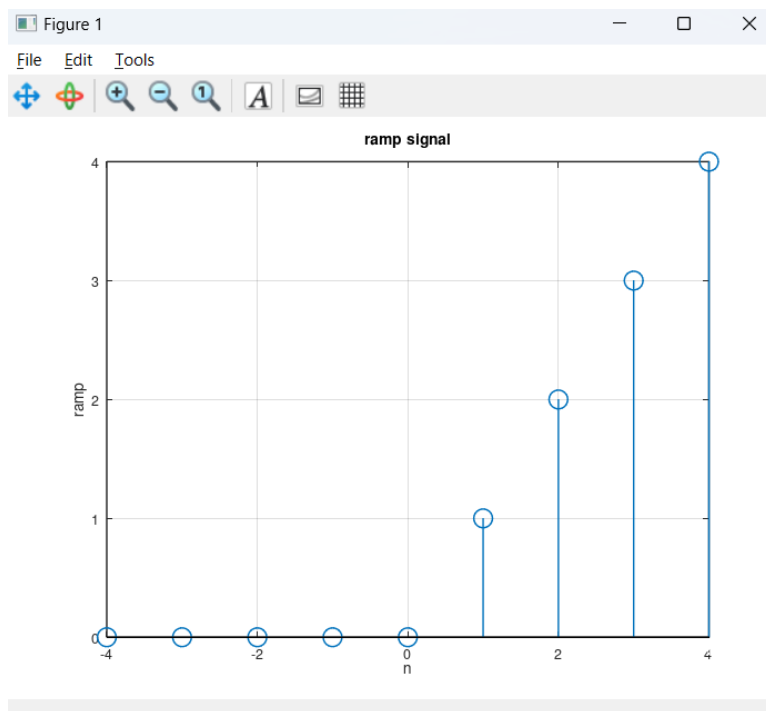Question 01.d:

Answer:

Octave code:

```
%---------d------------
n = -4:4;

ramp = n.*(n>=0);

stem(n, ramp);
xlabel('n');
ylabel('ramp');
title('ramp signal');
grid on;
```
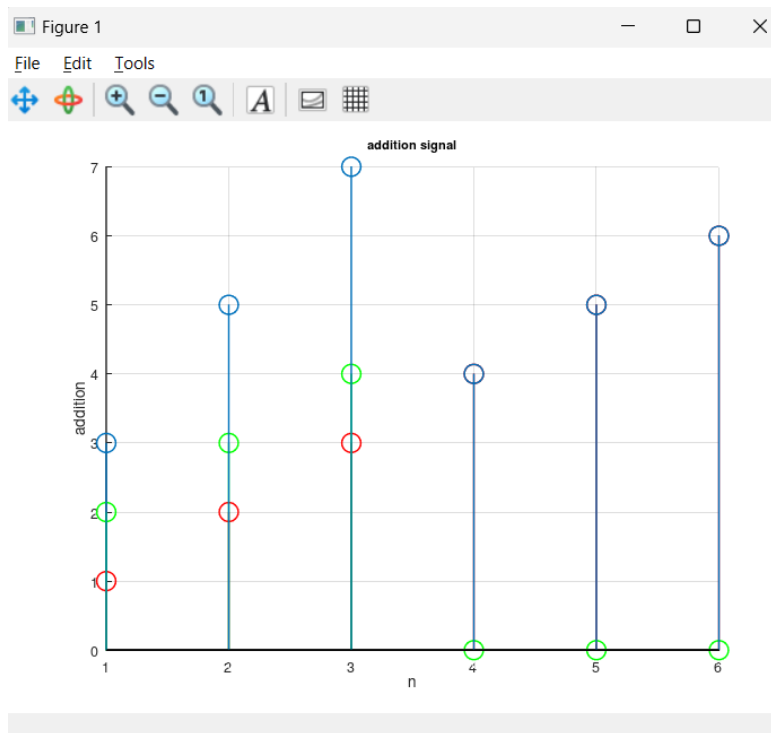
Figures:

Question 01.e:

Answer:

Octave code:

```
%----------e------------

x1=[1,2,3,4,5,6];

x2=[2,3,4,0,0,0];

addition = (x1 + x2);

figure;
hold on;

stem(x1,'r');
xlabel('n');
ylabel('x1');
title('input x1 signal');
grid on;

stem(x2,'g');
xlabel('n');
ylabel('x2');
title('input x2 signal');
grid on;

stem(addition);
xlabel('n');
ylabel('addition');
title('addition signal');
grid on;
hold off;
```
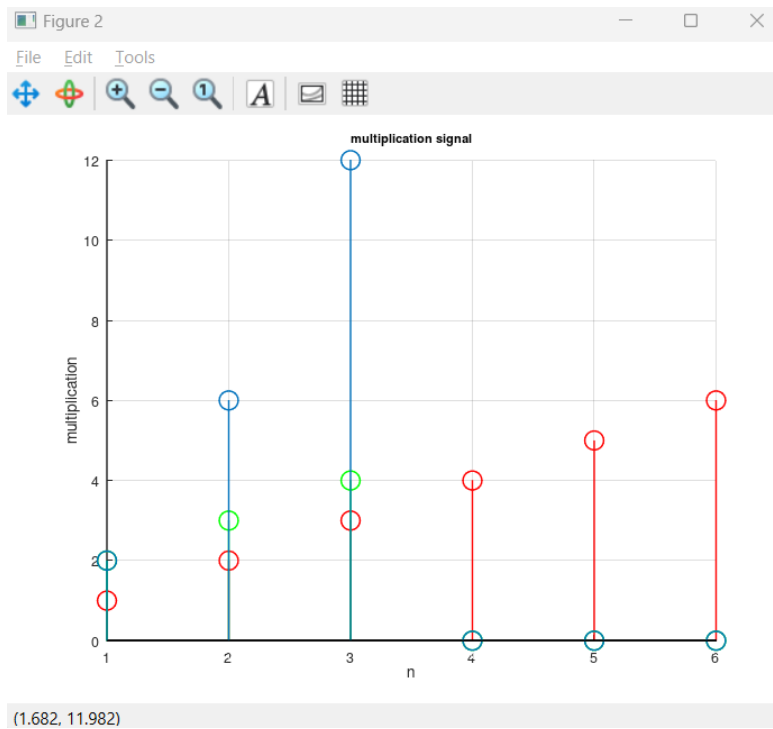
Figures:

Question 01.f:

Answer:

Octave code:

```
%----------f------------
x1=[1,2,3,4,5,6];

x2=[2,3,4,0,0,0];

mul = (x1 .* x2);

figure;
hold on;

stem(x1,'r');
xlabel('n');
ylabel('x1');
title('input x1 signal');
grid on;

stem(x2,'g');
xlabel('n');
ylabel('x2');
title('input x2 signal');
grid on;

stem(mul);
xlabel('n');
ylabel('multiplication');
title('multiplication signal');
grid on;
hold off;
```
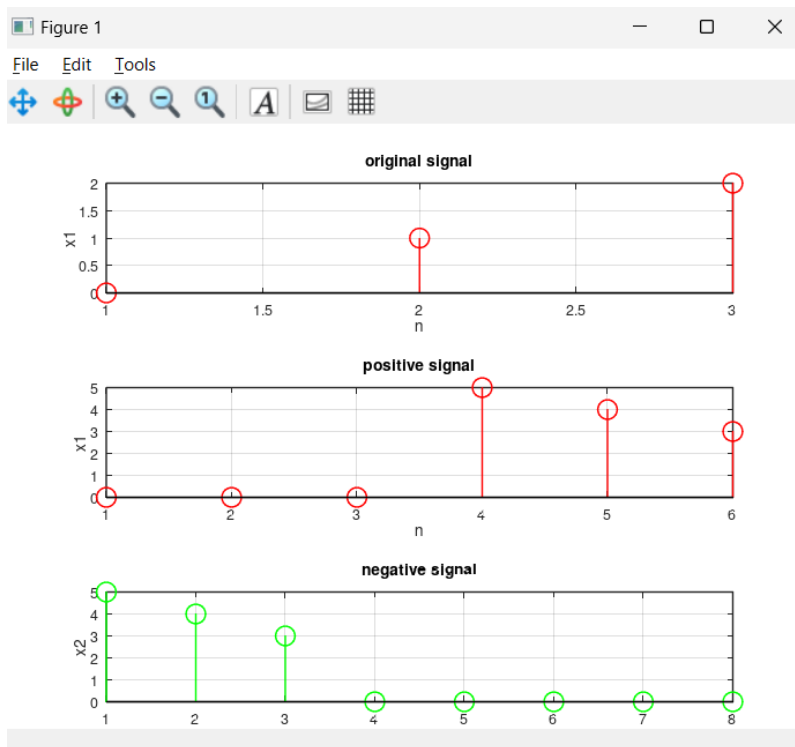
Figures:

multiplication signal

Question 01.g:

Answer:

Octave code:

```
%-----------g-------------
x = [5,4,3];

n1 = 3;
n2 = 5;

n_original = 0:length(x)-1;
n_positive = [zeros(1,n1),x];
n_negative = x;
n_negative = [n_negative, zeros(1,n2)];


subplot(3,1,1);
stem(n_original,'r');
xlabel('n');
ylabel('x1');
title('original signal');
grid on;

subplot(3,1,2);
stem(n_positive,'r');
xlabel('n');
ylabel('x1');
title('positive signal');
grid on;

subplot(3,1,3);
stem(n_negative,'g');
xlabel('n');
ylabel('x2');
title('negative signal');
grid on;
```
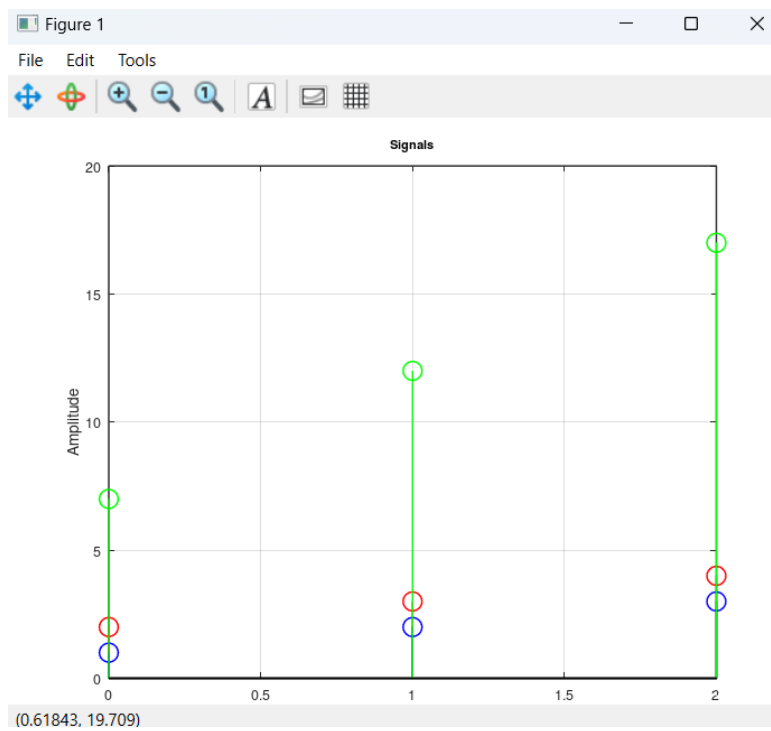
Figures:

Figure 1   — □ ×

original signal

positive signal

negative signal

Question 02.a:

Answer:

Octave code:

```
Q2a.m ×
1    clear all;
2    close all;
3    clc all;
4
5
6    x1 = [2, 3, 4];
7    x2 = [1, 2, 3];
8    a = 2;
9    b = 3;
10
11   x = (a .* x1) + (b .* x2);
12   n = 0:length(x)-1;
13
14   stem(n, x1,'r'); hold on;
15   stem(n, x2,'b');
16   stem(n, x,'g');
17   title('Signals');
18   xlabel('n');
19   ylabel('Amplitude');
20   grid on;
21
22
```
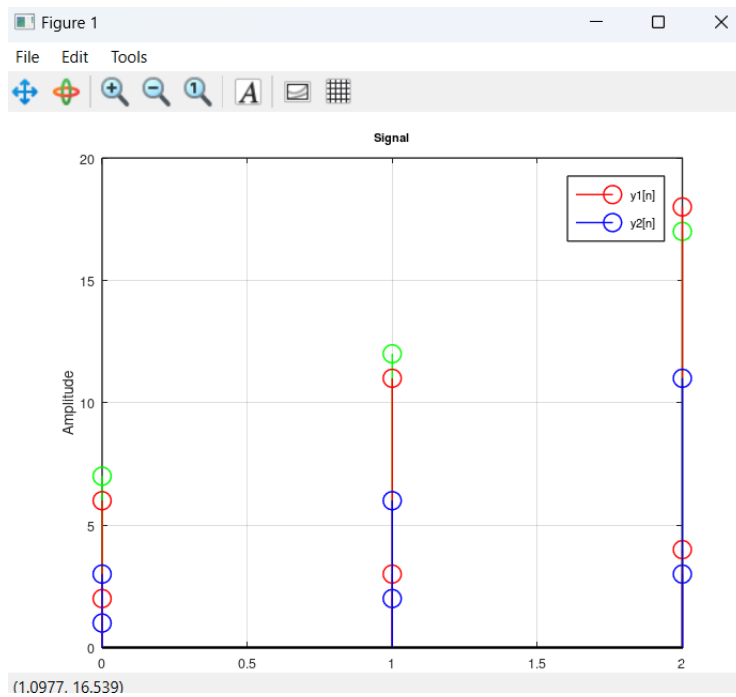
Figures:

Question 02.b:

Answer:

Octave code:

```
%-------------b-----------------

x1 = [2, 3, 4];
x2 = [1, 2, 3];
s = 2;
y1 = x1.^2 + s;
y2 = x2.^2 + s;

stem(n, y1, 'r');
hold on;
stem(n, y2,'b');
legend('y1[n]', 'y2[n]');
title('Signal');
xlabel('n');
ylabel('Amplitude');
```
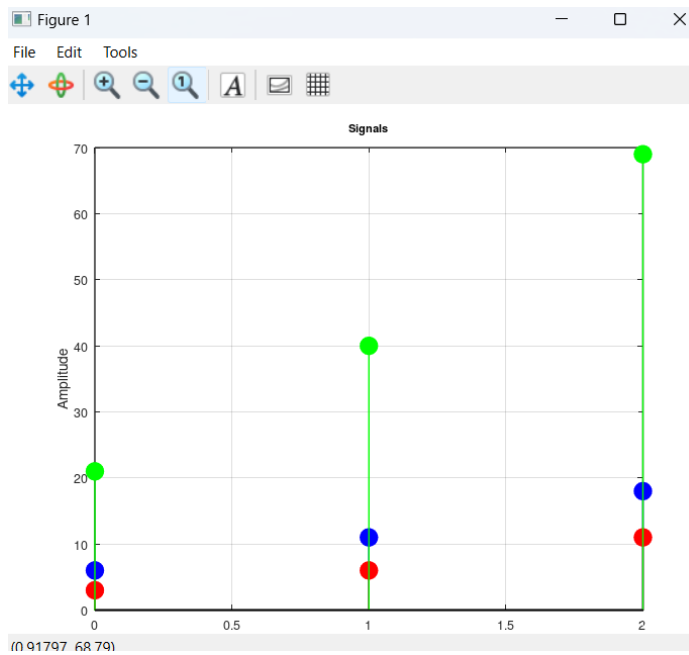
Figures:

Question 02.c:

Answer:

Octave code:

```
%------------c--------------------

x1 = [2, 3, 4];
x2 = [1, 2, 3];
a = 2;
b = 3;

x = (a .* x1) + (b .* x2);
n = 0:length(x)-1;

s = 2;
y1 = x1.^2 + s;
y2 = x2.^2 + s;


y =(a*y1)+ (b*y2);

stem(n, y1, 'filled', 'b');
hold on;
stem(n, y2, 'filled', 'r');
stem(n, y, 'filled', 'g');
title('Signals');
xlabel('n');
ylabel('Amplitude');
grid on;
```
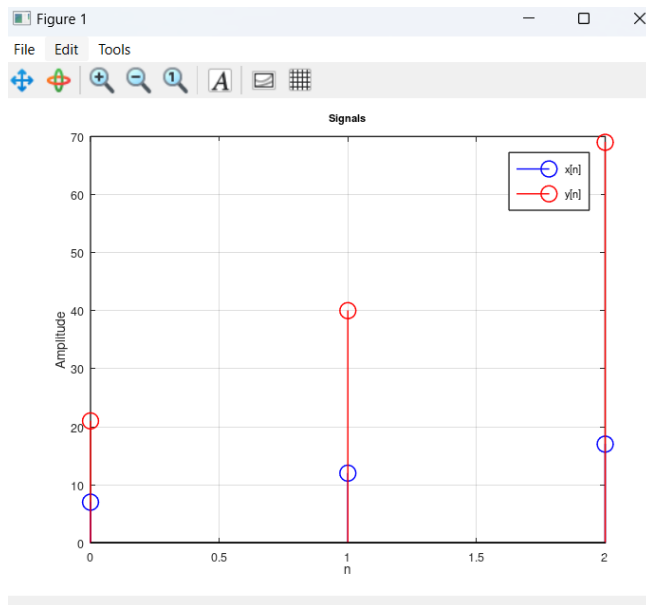
Figures:

Question 02.d:

Answer:

Octave code:

```
%--------------d------------------

x1 = [2, 3, 4];
x2 = [1, 2, 3];
a = 2;
b = 3;

x = (a .* x1) + (b .* x2);
n = 0:length(x)-1;

s = 2;
y1 = x1.^2 + s;
y2 = x2.^2 + s;
y = (a*y1) + (b*y2);

stem(n, x, 'b');
hold on;
stem(n, y, 'r');
legend('x[n]', 'y[n]');
title('Signals');
xlabel('n');
ylabel('Amplitude');
grid on;
```
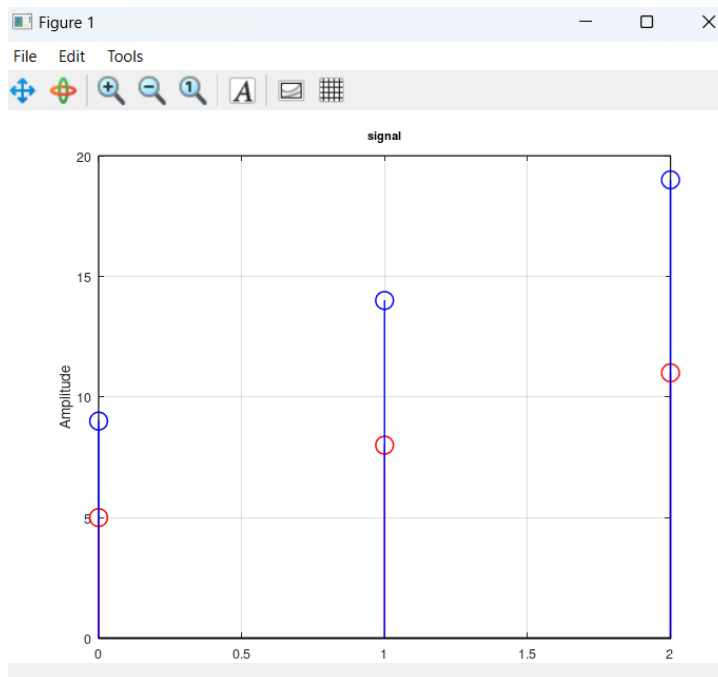
Figures:

Question 02.e:

Answer:

Octave code:

```octave
%--------------e--------------

x1 = [1, 2, 3];
x2 = [2, 3, 4];
a = 1;
b = 2;

x = (a.*x1) + (b.*x2);
y1 = a.*x1;
y2 = b.*x2;
y = a.*y1 + b.*y2;
n = 0:2;
figure;

stem(n, x, 'r', 'DisplayName','x[n]');
hold on;
stem(n, y, 'b', 'DisplayName', 'y[n]');
xlabel('n');
ylabel('Amplitude');
title('signal');
grid on;
hold off;
```

Figures:

Question 02.f:

Answer: A system is considered **linear** if it satisfies two main properties:

- Superposition
- Homogeneity

Both of these properties fail to satisfy the linearity of the equation. therefore, system given by the transformation the equation is **non-linear**.
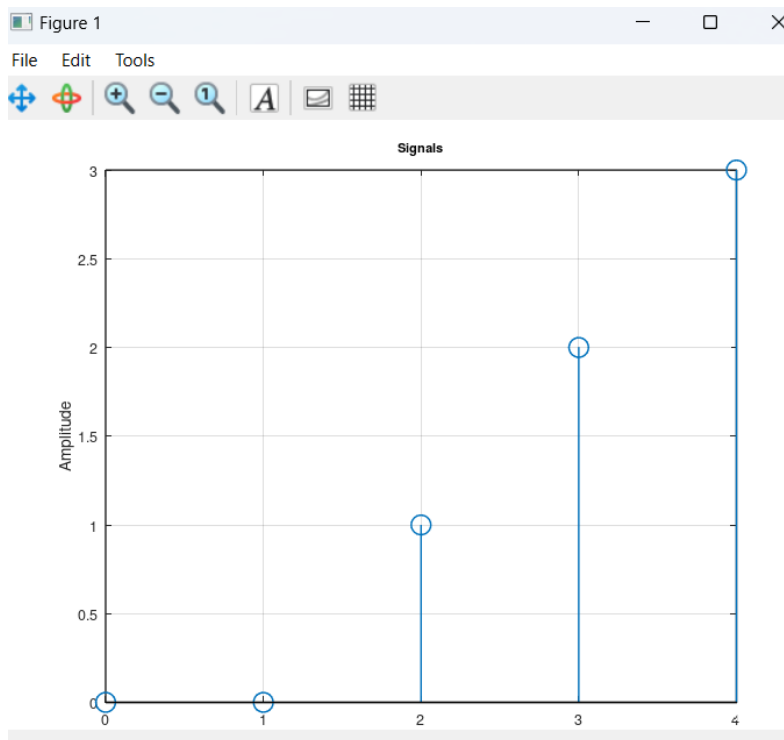
Question 03.a:

Answer:

Octave code:

```
Q3a.m ✕
1    clear all;
2    close all;
3    clc;
4
5    x1 = [1, 2, 3];
6    n0 = 2;
7    n = 0:length(x1) + (n0 - 1);
8    x2 = zeros(1, length(n));
9    x2(n >= n0) = x1(n(n >= n0)-n0 + 1);
10   stem(n, x2);
11   title('Signals');
12   xlabel('n');
13   ylabel('Amplitude');
14   grid on;
```
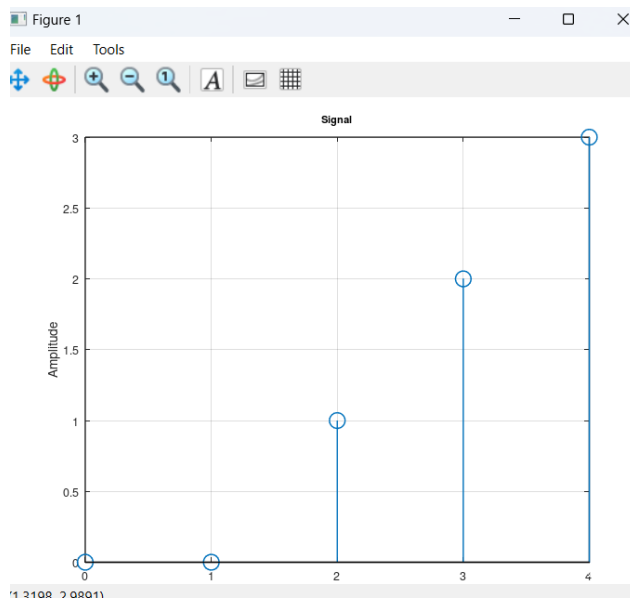
Figures:

Question 03.b:

Answer:

Octave code:

```
clear all;
close all;
clc;

x1 = [1, 2, 3];
n0 = 2;
n = 0:length(x1) + (n0 - 1);
x2 = zeros(1, length(n));
x2(n >= n0) = x1(n(n >= n0) - n0 + 1);
y = x2;

stem(n, y);
title('Signal');
xlabel('n');
ylabel('Amplitude');
grid on;
```

Figures:

Question 03.c:

Answer:

Octave code:

```
%-----------------------C-----------------

x1 = [1, 2, 3];
n0 = 2;
n = 0:length(x1) + (n0 - 1);
x2 = zeros(1, length(n));
x2(n >= n0) = x1(n(n >= n0) - n0 + 1);
y = x2;
stem(n, y);
title('Signal');
xlabel('n');
ylabel('Amplitude');
grid on;
```
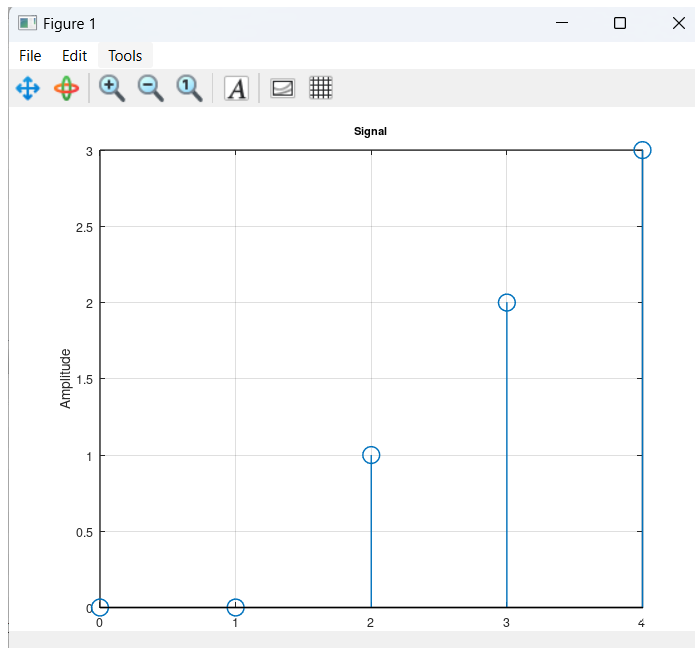
Figures:

Question 03.d:

Answer:

Octave code:

```
%----------------d--------------------

x1 = [1, 2, 3];
n0 = 2;
n = 0:length(x1) + (n0 - 1);
x2 = zeros(1, length(n));
x2(n >= n0) = x1(n(n >= n0) - n0 + 1);
y = x2;

stem(n, y);
title('Signal');
xlabel('n');
ylabel('Amplitude');
grid on;
```
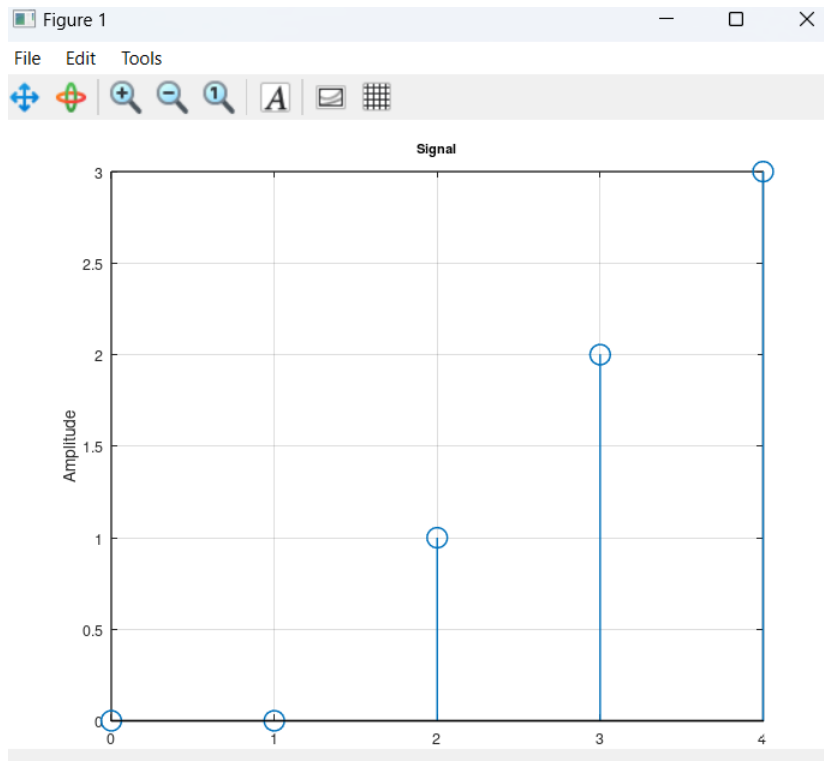
Figures:

Question 03.e:

Answer:

The system is **non-linear**. The transformation equation violates linearity because squaring the input introduces non-linear behavior, failing the superposition and homogeneity principles required for linear systems.