25/04/2023

Lab 2

Report

Matlab signal processing

Mazen Fattouh Sakr – 20011150
Yehia Mohamed Elsaid Taha - 20012227

Section 6

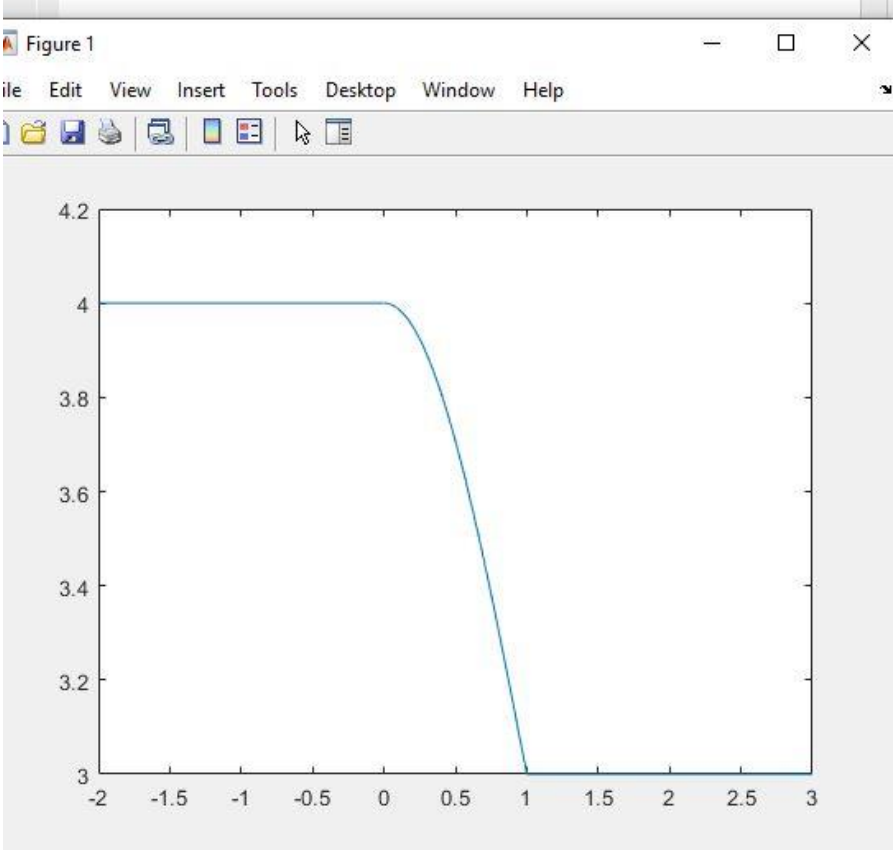
Question 1 :

The given signal consists of a DC segment from -2 to 0 seconds, a quarter cycle of a sinusoidal wave from 0 to 1 seconds, and another DC segment from 1 to 3 seconds. The sample rate is 100 Hz.

Code & Results:

Q2.m Q1.m

```
1 -    clc;
2 -    clear;
3 -    samplingfrequency = 100;
4 -    time1 = linspace(-2,0,5*samplingfrequency);
5 -    time2 = linspace(0,1,5*samplingfrequency);
6 -    time3 = linspace(1,3,5*samplingfrequency);
7 -    time = [time1 time2 time3];
8
9 -    signal1 = 4*time1./time1;
10 -   signal2 = sin(2*pi*0.25*time2+pi/2)+3;
11 -   signal3 = 3*time3./time3;
12 -   signal = [signal1 signal2 signal3];
13
14 -   plot(time,signal)
```



Question 2:

Plot the following functions on the same figure using subplot.

i) y= x sin x

ii) y= x^2 - 2(1/x)

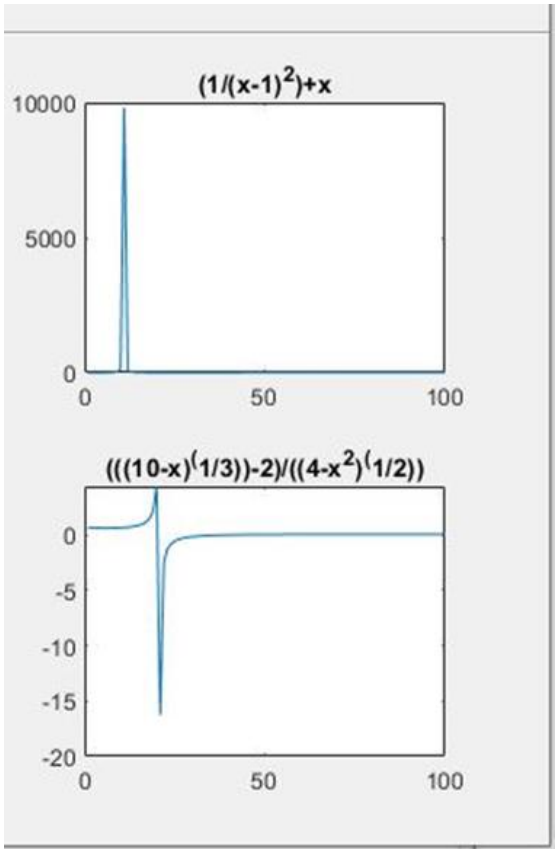
iii) y= (4/x^2) - (1/2x) + 2

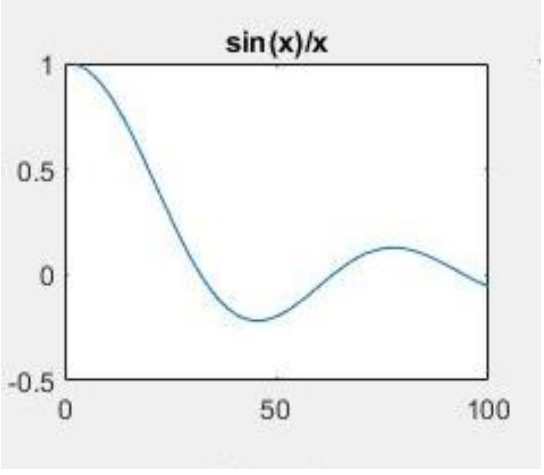
iv) y= ((4/x^4) - (10/x^2) + 2), where 0<=x<=10

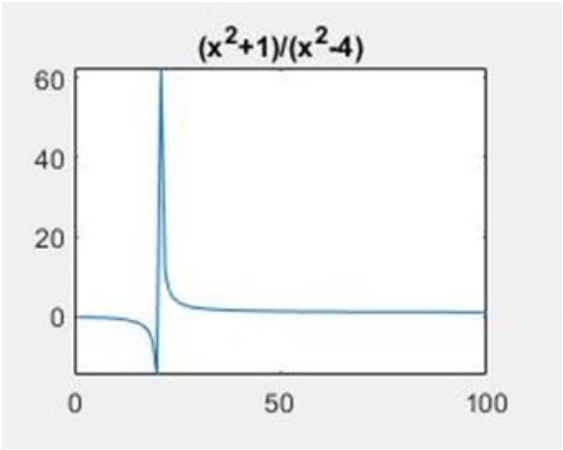
Code & Results:

Q3.m | Q2.m

```
clc;
clear;
x = linspace(0,10);

y1 = sin(x)./x;
y2 = (1./(x-1).^2)+x;
y3 = (x.^2+1)./(x.^2-4);
y4 = (((10-x).^1/3)-2)./((4-x.^2).^1/2);

subploty(y1,y2,y3,y4)

function [] = subploty(y1,y2,y3,y4)
    subplot(2,2,1);
    plot(y1)
    title('sin(x)/x');
    subplot(2,2,2);
    plot(y2)
    title('(1/(x-1)^2)+x');
    subplot(2,2,3);
    plot(y3)
    title('(x^2+1)/(x^2-4)');
    subplot(2,2,4);
    plot(y4)
    title('(((10-x)^(1/3))-2)/((4-x^2)^(1/2))');
end
```





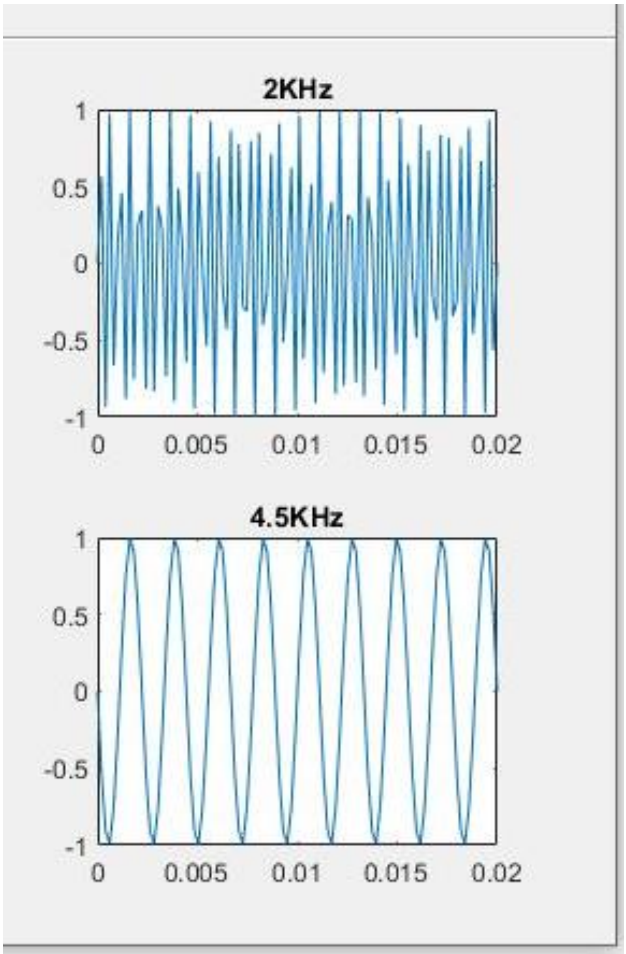


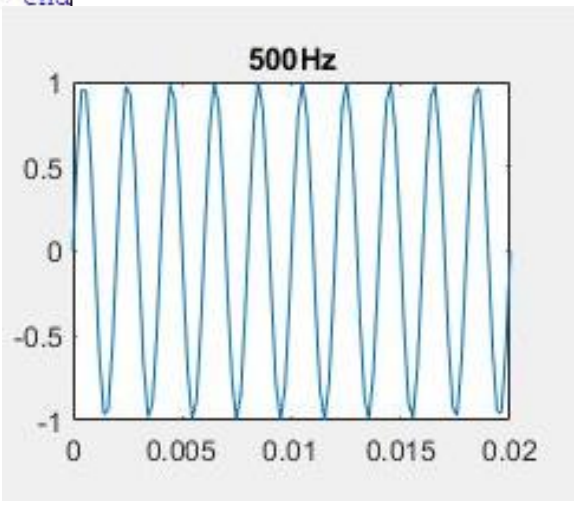
Question 3:

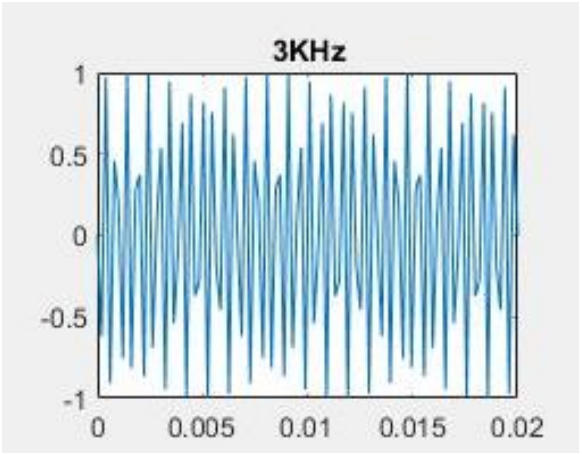
i. The graphs all represent sinusoidal signals of different frequencies. In the 500Hz plot since the sampling frequency is higher enough than the signal frequency it appears accurately without distortion. But in 2k,3k,4.5kHz signals since the sampling frequency isn't enough to represent these signals they are distorted.

Code & Results:

```
clc;
clear;
samplingFrequency = 5000;
samplingTime = 1/samplingFrequency;
time = linspace(0,samplingTime*100);

x1 = xFunction(500,time);
x2 = xFunction(2000,time);
x3 = xFunction(3000,time);
x4 = xFunction(4500,time);
subplotx(x1,x2,x3,x4,time)


function [x] = xFunction(frequency,time)
    x = sin(2*pi*frequency*time);
end

function [] = subplotx(x1,x2,x3,x4,time)
    subplot(2,2,1);
    plot(time,x1)
    title('500Hz');
    subplot(2,2,2);
    plot(time,x2)
    title('2KHz');
    subplot(2,2,3);
    plot(time,x3)
    title('3KHz');
    subplot(2,2,4);
    plot(time,x4)
    title('4.5KHz');
end
```







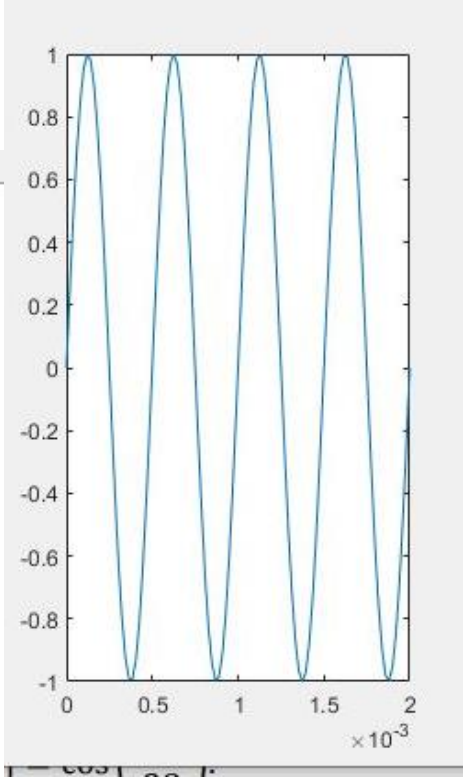
Question 3:

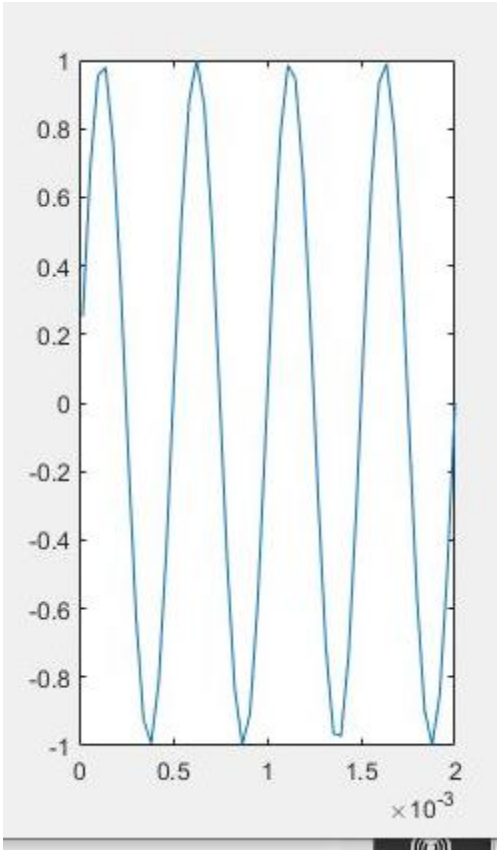
ii. The frequency of X[n] is 2KHz , No Y[n] isn't periodic, as it doesn't repeat over it's time range.

Code & Results:

Untitled5 | Q3_1.m | Q3_2.m | Q3.m

```
clc;
clear;
samplingFrequency = 50000;
samplingTime = 1/samplingFrequency;
time = linspace(0,samplingTime*100);

x = xFunction(2000,time);
subplot(1,2,1);
plot(time,x)

[y,ytime] = yfunction(x,time);
subplot(1,2,2);
plot(ytime,y)



function [y,ytime] = yfunction(x,time)
    y = x(2:2:end);
    ytime = time(2:2:end);
end

function [x] = xFunction(frequency, time)
    x = sin(2*pi*frequency*time);
end
```





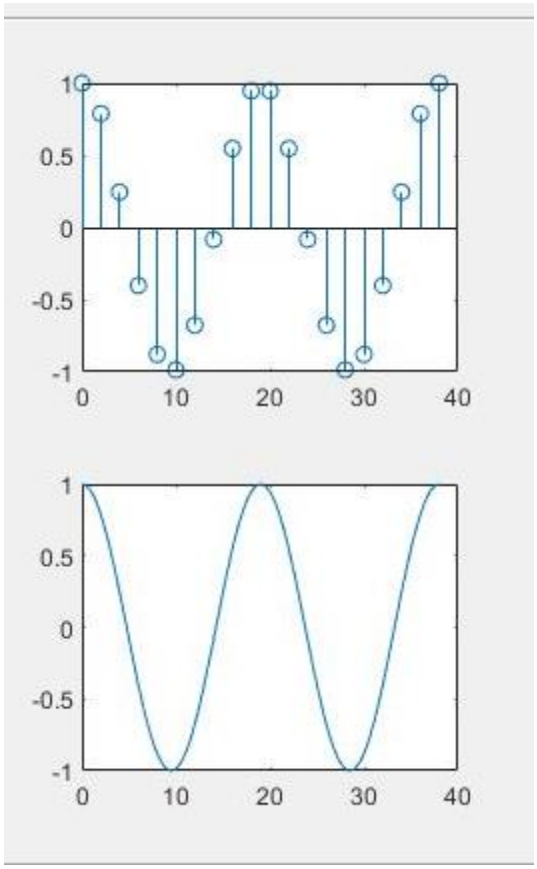
Question 4:

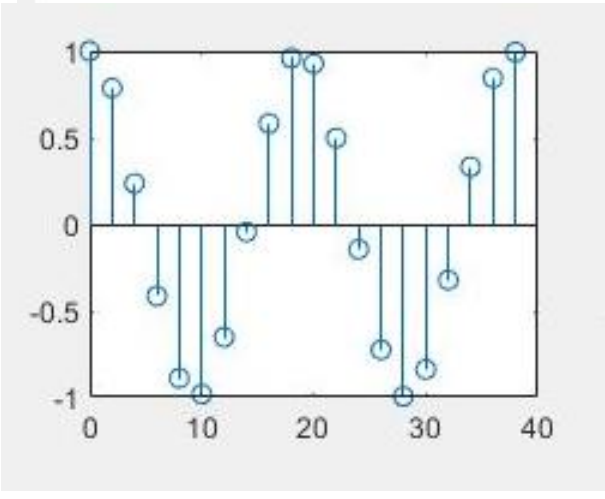
Yes, the sequences are periodic with a period of 4 seconds (2 sinusoidal cycles of the corresponding sinusoidal signal)

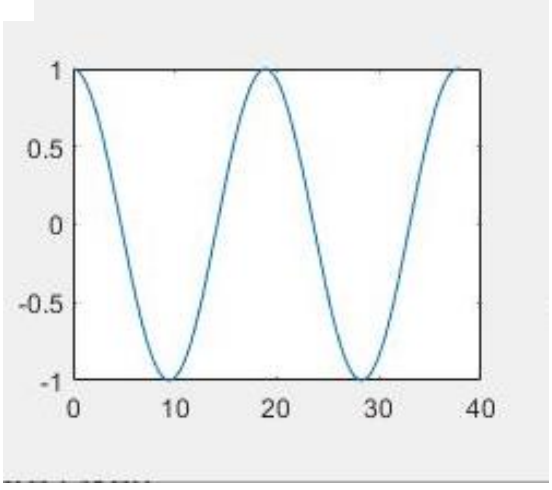
Code & Results:

Q4.m

```
clc;
clear;
%samplingtime = 2
%noOfSamples = 38/2=19
n = 0:19;
discreteTime = 0:2:38;
continousTime = linspace(0,38);

xdiscrete = cos(2*n/3);
ydiscrete = cos(8*pi*n/38);
xcontinous = cos(continousTime/3);
ycontinous = cos(4*pi*continousTime/38);

substem(discreteTime,xdiscrete,1)
substem(discreteTime,ydiscrete,2)
subPlot(continousTime,xcontinous,3)
subPlot(continousTime,ycontinous,4)

function [] = subPlot(time,func,position)
    subplot(2,2,position);
    plot(time,func)
end

function [] = substem(time,func,position)
    subplot(2,2,position);
    stem(time,func)
end
```







Question 5:

Let x[n] = [-1, -2, 4, 6, -5, 8, 10] where ^ is the zeroth index. Generate and plot samples using stem function for the following sequences.

Code & Results:

```
%we set the x array


%stem(n,x);
% Define input sequence x[n]
x = [-1, -2, 4, 6, -5, 8, 10];
l = -4:1:2;
% i. Generate and plot sequence x1[n]
x1 = zeros(1, length(x)); % Initialize x1 with zeros of same length as x

for n = 1:length(x)
    [a,b]= x1valid(n);
    if a && b
        x1(n) = 3*x(n+2) + x(n-4) + 2*x(n);
    elseif a && ~b
        x1(n) = 3*x(n+2) + 2*x(n);
    elseif ~a && b
        x1(n) = x(n-4) + 2*x(n);
    elseif ~a && ~b
        x1(n) = 2*x(n);
    end
end

subplot(2,2,1)
stem(l,x1); title('Sequence x1[n]'); xlabel('n'); ylabel('Amplitude');

% ii. Generate and plot sequence x2[n]
x2 = zeros(1, length(x)); % Initialize x2 with zeros of same length as x

for n = 1:length(x)
    ns = n-5;
    [a,b,c] = x2valid(n);
    if a && b && c
        x2(n) = x(n + 4)*x(n -1) + x(2 - n)*x(n);
    elseif (~a || ~c) && b
        x2(n) = x(8-n)*x(n);
    elseif a && ~b && c
        x2(n) = x(n + 4)*x(n -1);
    end

end

subplot(2,2,2)
stem(l,x2); title('Sequence x2[n]'); xlabel('n'); ylabel('Amplitude');

% iii. Generate and plot sequence x3[n]
```

```
% iii. Generate and plot sequence x3[n]
x3 = zeros(1, length(x)); % Initialize x3 with zeros of same length as x

for n = 1:length(x)
    result = 0;
    for s = 5:-1:1
        if(n-s >= 1)
            result = result + x(n-s);
        end
    end
    x3(n) = n* result;
end

subplot(2,1,2)
stem(x3); title('Sequence x3[n]'); xlabel('n'); ylabel('Amplitude');

function [x,y] = x1valid(ns)
    if ns+2 < 1 || ns+2 > 7
        x = 0;
    else
        x = 1;
    end
    if ns-4 < 1
        y = 0;
    else
        y = 1;
    end
end

function [x,y,z] = x2valid(ns)
    if ns+4 >7
        x=0;
    else
        x=1;
    end
    if 2-(ns-5) > 2
        y = 0;
    else
        y = 1;
    end
    if ns-1 < 1
        z=0;
    else
        z=1;
    end
end
```

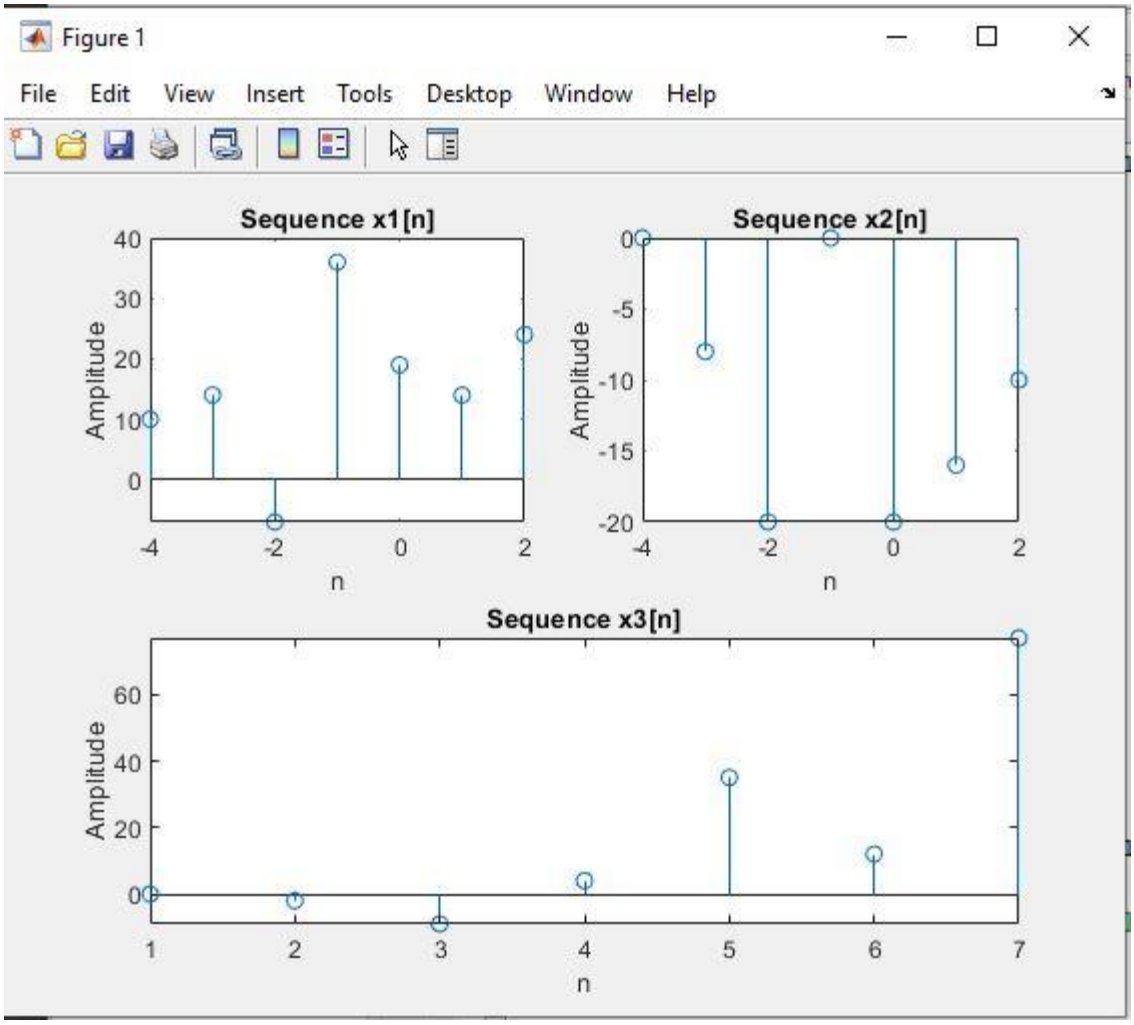


Figure 1
File Edit View Insert Tools Desktop Window Help
Sequence x1[n]
Amplitude
n
Sequence x2[n]
Amplitude
n
Sequence x3[n]
Amplitude
n

Question 6:

Generate and plot the samples (use stem function) of the following sequences using MATLAB:

Code & Results:

```
clc;
clear;
n1 = 0:25;
n2 = 0:20;

x1 = x1function();
subplot(2,2,1)
stem(n1,x1)

x2 = x2function();
subplot(2,2,2)
stem(n1,x2)

x3 = x3function();
subplot(2,2,3)
stem(n2,x3)

x4 = x4function();
subplot(2,2,4)
stem(n2,x4)

function [x] = x1function()
    x = zeros(1,26);
    for nShifted = 1:26
        n = nShifted-1;
        for m = 0:10
            x(nShifted) = x(nShifted)+(m+1)*(delta(n,n-2*m)-delta(n,n-2*m-1));
        end
    end
end

function [x] = x2function()
    x = zeros(1,26);
    for nShifted = 1:26
        n = nShifted-1;
        x(nShifted) = n*n*(unitstep(5,n)-unitstep(-6,n))+10*delta(n,n)
        +20*(0.5)^n*(unitstep(-4,n)-unitstep(-10,n));
    end
end

function [x] = x3function()
    x = zeros(1,21);
    for nShifted = 1:21
        n = nShifted-1;
        x(nShifted) = (0.9)^n*cos(0.2*pi*n+pi/3);
    end
```

```
            x(nShifted) = x(nShifted)+(m+1)*(delta(n,n-2*m)-delta(n,n-2*m-1));
        end
    end
end

function [x] = x2function()
    x = zeros(1,26);
    for nShifted = 1:26
        n = nShifted-1;
        x(nShifted) = n*n*(unitstep(5,n)-unitstep(-6,n))+10*delta(n,n)
        +20*(0.5)^n*(unitstep(-4,n)-unitstep(-10,n));
    end
end

function [x] = x3function()
    x = zeros(1,21);
    for nShifted = 1:21
        n = nShifted-1;
        x(nShifted) = (0.9)^n*cos(0.2*pi*n+pi/3);
    end
end

function [x] = x4function()
    x = zeros(1,21);
    for counter = 1:4:17
        x(counter)=1;
        x(counter+1)=2;
        x(counter+2)=3;
        x(counter+3)=2;
    end
end

function [ret] = unitstep(shift,in)
    if in >= -shift
        ret = 1;
    else
        ret = 0;
    end
end
function [ret] = delta(n,in)
    if n==in
        ret=1;
    else
        ret=0;
    end
end
```

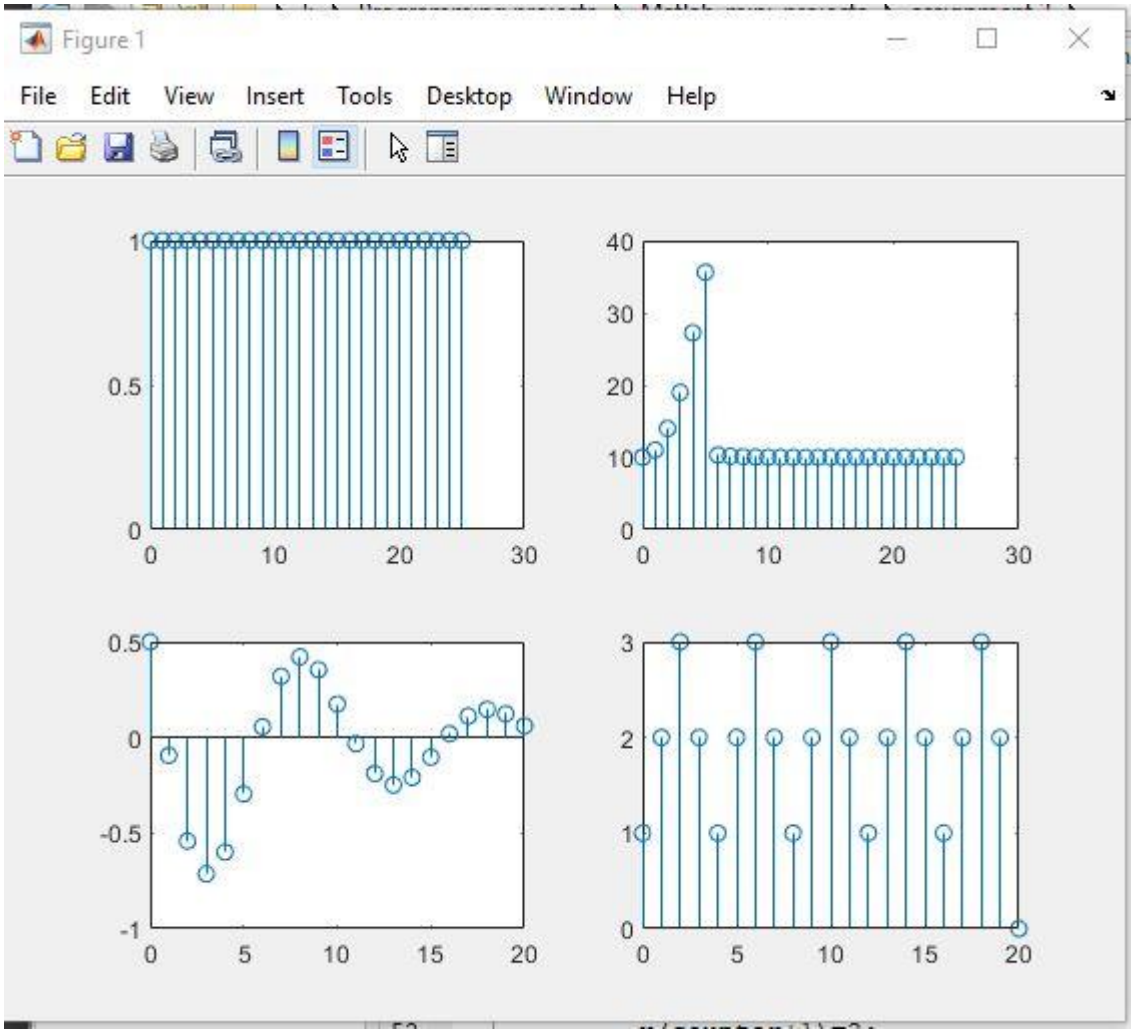


Figure 1
File Edit View Insert Tools Desktop Window Help
1
0.5
0
0 10 20 30
40
30
20
10
0
0 10 20 30
0.5
0
-0.5
-1
0 5 10 15 20
3
2
1
0
0 5 10 15 20

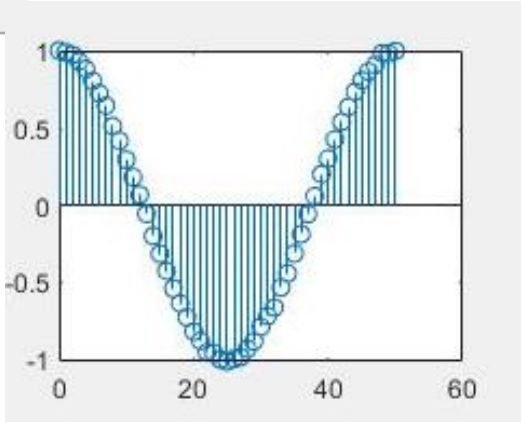
Question 7:

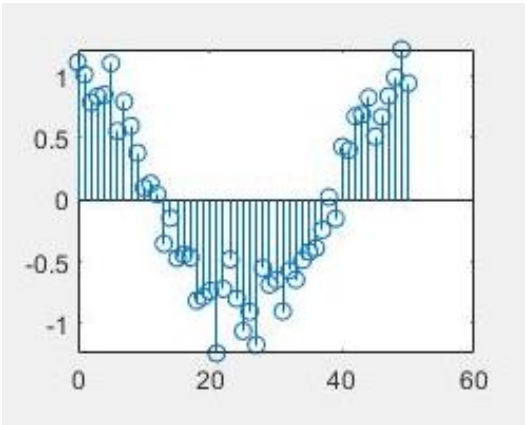
Comment: sigma represents the strength of interference noise on a communication channel so at low sigma (0.01) the signal goes through the channel undistorted, but as the sigma(noise) increases the signal becomes more distorted as in the case of sigma = 0.2, in the case of sigma = 2 the signal is completely distorted and the channel would be very hard to use for effective communication.

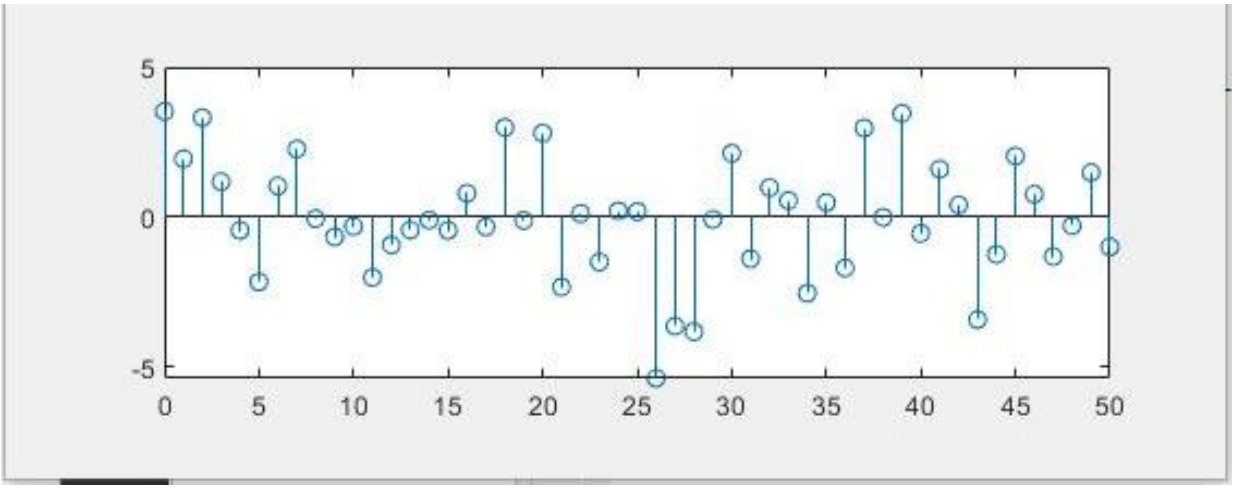
Code & Results:

Q7.m | Q6.m

```
clear;
clc;
time = 0:50;

x1 = xfunction(0.01);
x2 = xfunction(0.2);
x3 = xfunction(2);

subplot(2,2,1)
stem(time,x1)
subplot(2,2,2)
stem(time,x2)
subplot(2,1,2)
stem(time,x3)

function [x] = xfunction(sigma)
    x = zeros(1,51);
    w = randn(1,51);
    for n = 0:50
        x(n+1) = cos(0.04*pi*n)+sigma*w(n+1);
    end
end
```







Question 8:

Code & Results:

Q8.m

```
clc;
clear;
time = -10:10;

x = exp((-0.1+0.3*1i)*time);

subplot(2, 2, 1);
stem(time, abs(x));

subplot(2, 2, 2);
stem(time, angle(x));

subplot(2, 2, 3);
stem(time, real(x));

subplot(2, 2, 4);
stem(time, imag(x));
```