Independent University, Bangladesh

Department of Electrical and Electronic Engineering

BAETE Accredited

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Course Title	: Digital Signal Processing LAB
Course Code	: EEE 321L / ETE 324L (New); ECR 305L (Old)
Instructor	: Dr. Kh Shahriya Zaman
Experiment No.	: **07**
Experiment Name	: **Study on signal sampling, reconstruction and aliasing.**

Objectives:

- To understand the sampling and reconstruction of signal

MATLAB functions:

- "fplot(y, [x_{min}, x_{max}])": plots the curve defined by the function "y = @x $f(x)$" over the default interval [x_{min}, x_{max}] for x.

- interp1(x, y, xq) returns interpolated values of a 1-D function at specific query points using linear interpolation. Vector x contains the sample points, and y contains the corresponding values, $y(x)$. Vector xq contains the coordinates of the query points.

  Example code:

```
%% Continuous signal
tmin = -0.005;
tmax = 0.005;
y = @(x) exp(-1000*abs(x));
figure(1)
fplot(y, [tmin tmax])
legend("original signal")

%% Sampling
Fs = 1000;
Ts = 1/Fs;
td = tmin:Ts:tmax;
n = tmin/Ts:1:tmax/Ts;
yd = y(n*Ts);
figure(1)
hold on
stem(n*Ts,yd)
figure(2)
stem(n,yd)

%% Reconstruction
M=2; %upsampling factor
tr = tmin:Ts/M:tmax;
yr = interp1(td,yd,tr,"cubic");
figure(1)
plot(tr,yr)
% Options:   'linear', 'nearest', 'next', 'previous',
%            'pchip', 'cubic', 'v5cubic', 'makima',
%            or 'spline'
```

Lab Work:

1. Let $x_a(t) = e^{-1000|t|}$. Sample $x_a(t)$ at $F_s = 4000$ sample/sec to obtain $x(n)$. Reconstruct the original signal and plot it.

```
%Hemal Sharma
%ID: 2221855
%Continuos Signal
tmin = -0.005;
tmax = 0.005;
x = @(t)exp(-1000*abs(t));
figure(1)
fplot(x, [tmin tmax])
legend("original signal")
%Sampling
Fs = 4000;
Ts = 1/Fs;
td = tmin:Ts:tmax;
n = tmin/Ts:1:tmax/Ts;
xd = x(n*Ts);
figure(1)
hold on
stem(n*Ts,xd)
figure(2)
stem(n,xd)

%Reconstruction
M = 2;
tr = tmin:Ts/M:tmax;
xr = interp1(td,xd,tr, "cubic");
figure(1)
plot(tr,xr)
```

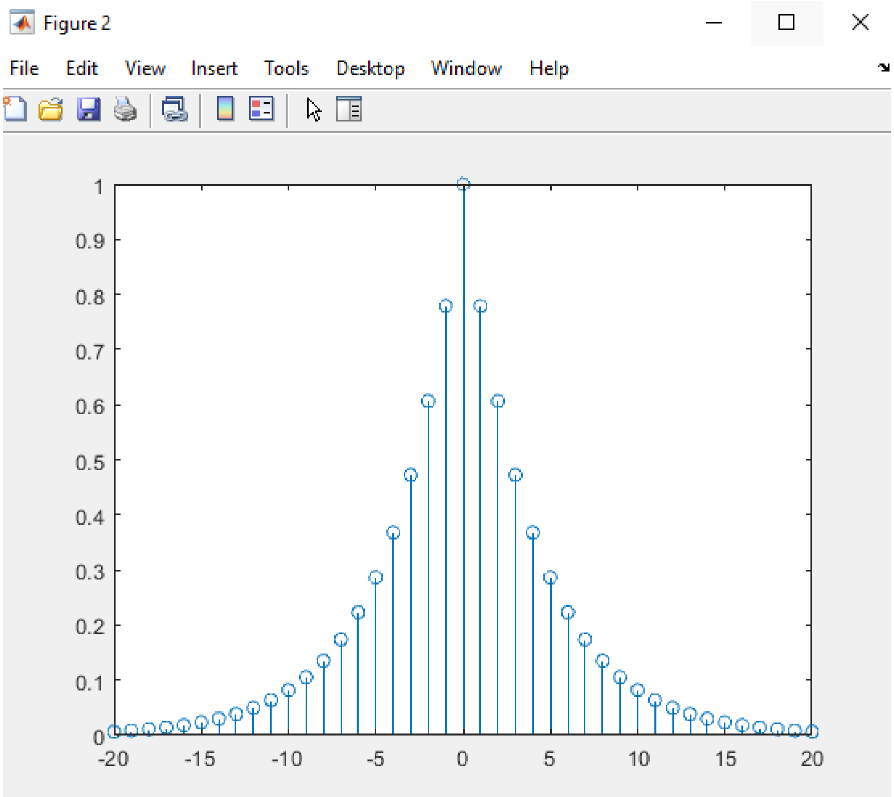

Figure 1 Down sampled Signal

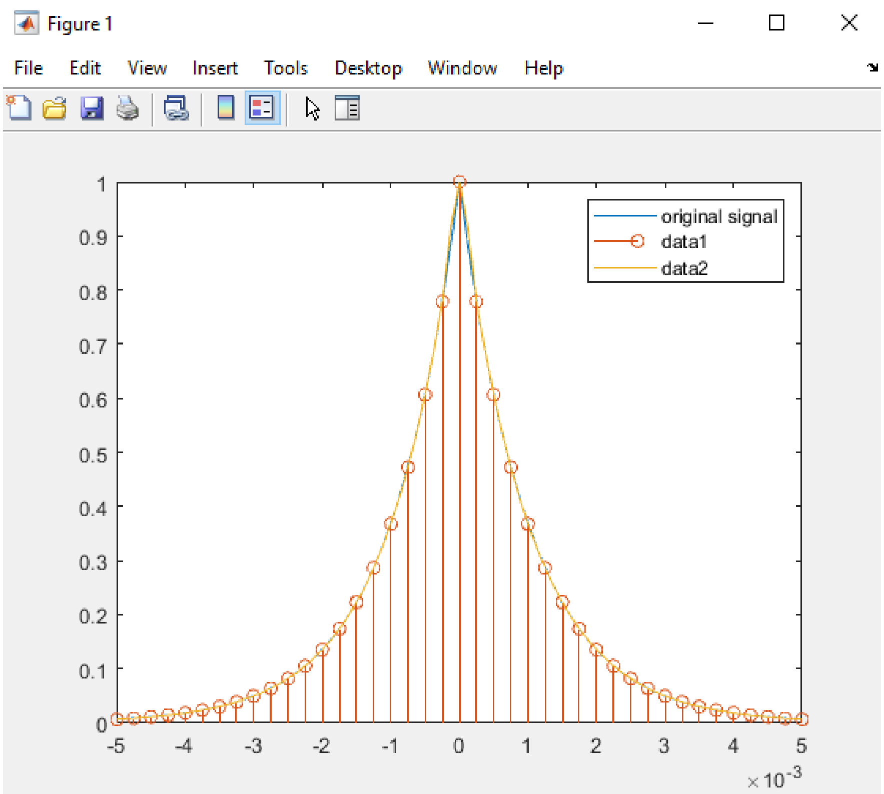

Figure 2 Original and Reconstructed Signal

2. Let $x_a(t) = \cos(10\pi t)$. Sample $x_a(t)$ at $Ts = 0.010$ sec intervals to obtain $x(n)$. Reconstruct the original signal and plot it.

```
%Hemal Sharma
%ID: 2221855
%Continuos Signal
tmin = -0.2;
tmax = 0.2;
x = @(t)cos(10*pi*(t));
figure(1)
fplot(x, [tmin tmax])
legend("original signal")
%Sampling
Fs = 100;
Ts = 1/Fs;
td = tmin:Ts:tmax;
n = tmin/Ts:1:tmax/Ts;
xd = x(n*Ts);
figure(1)
hold on
stem(n*Ts,xd)
figure(2)
stem(n,xd)

%Reconstruction
M = 2;
tr = tmin:Ts/M:tmax;
xr = interp1(td,xd,tr, "linear");
figure(1)
plot(tr,xr)
```

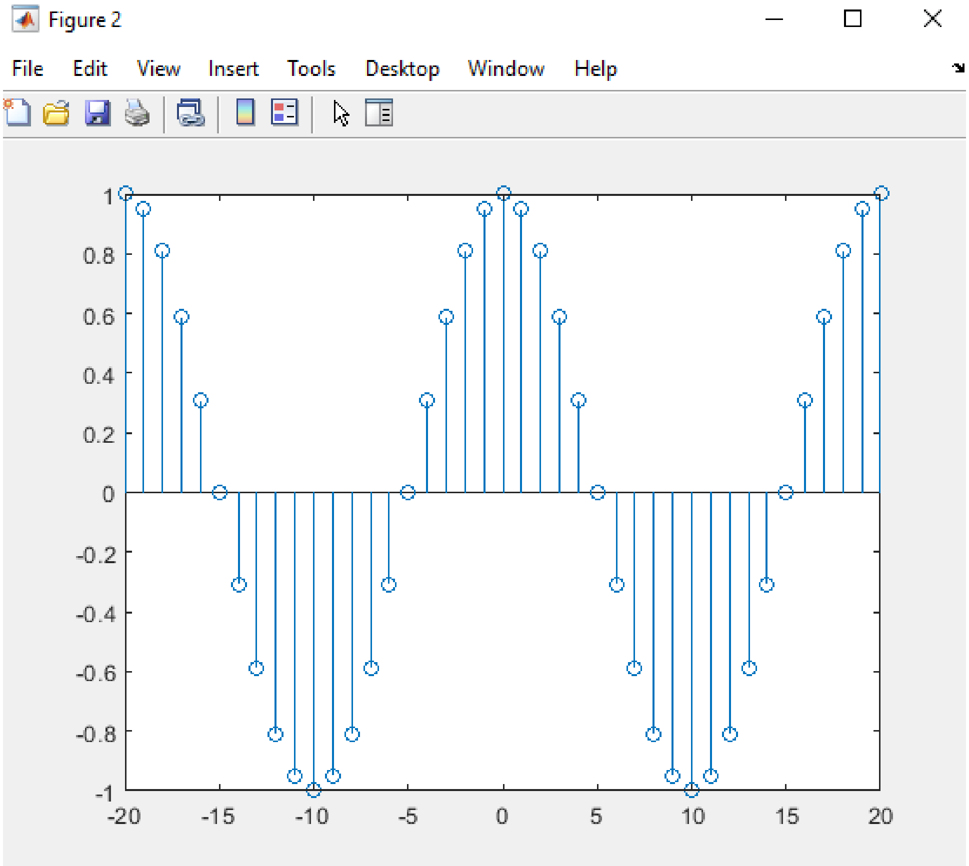

Figure 3 Down sampled Signal

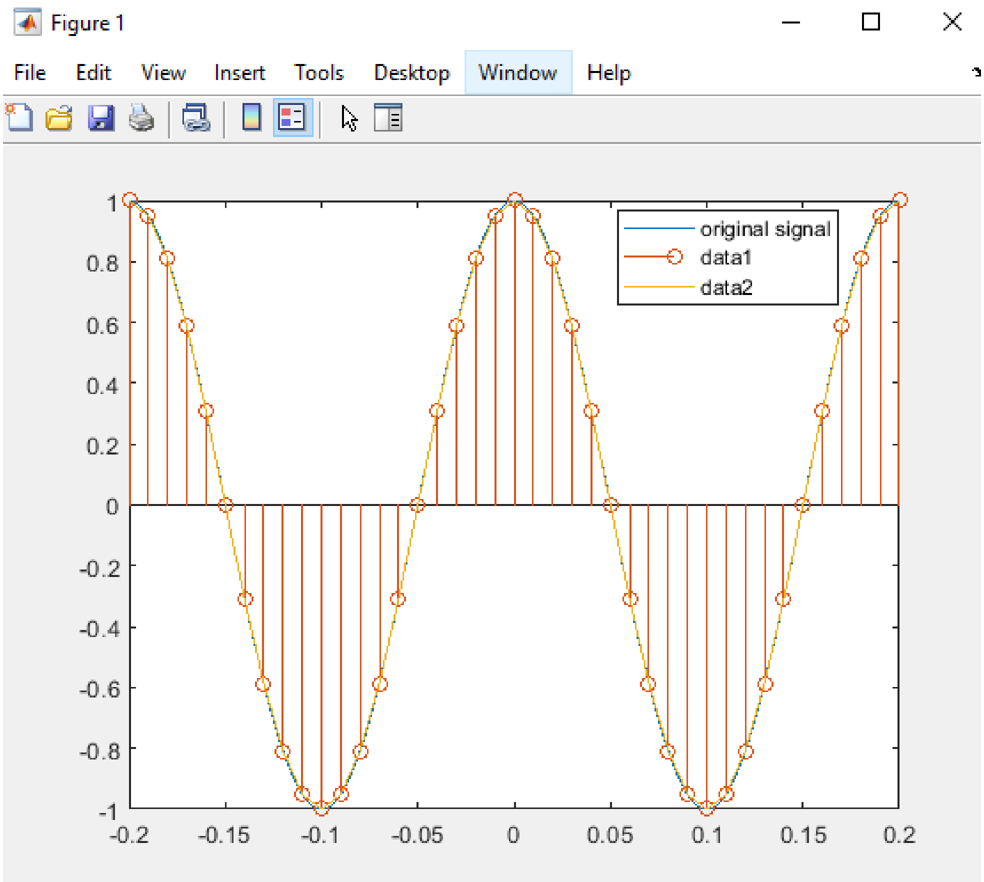

Figure 4 Original and reconstructed Signal

Lab Assignment: 7

3. Let $x_a(t) = e^{(-500t + 50)}$. Sample $x_a(t)$ at $F_s = 4000$ sample/sec to obtain x(n). Reconstruct the original signal and plot it.

```
%Hemal Sharma
%ID: 2221855
%Continuos Signal
tmin = -0.005;
tmax = 0.005;
x = @(t)exp(-500*(t)+50);
figure(1)
fplot(x, [tmin tmax])
legend("original signal")
%Sampling
Fs = 4000;
Ts = 1/Fs;
td = tmin:Ts:tmax;
n = tmin/Ts:1:tmax/Ts;
xd = x(n*Ts);
figure(1)
hold on
stem(n*Ts,xd)
figure(2)
stem(n,xd)

%Reconstruction
M = 2;
tr = tmin:Ts/M:tmax;
xr = interp1(td,xd,tr, "linear");
figure(1)
plot(tr,xr)
```

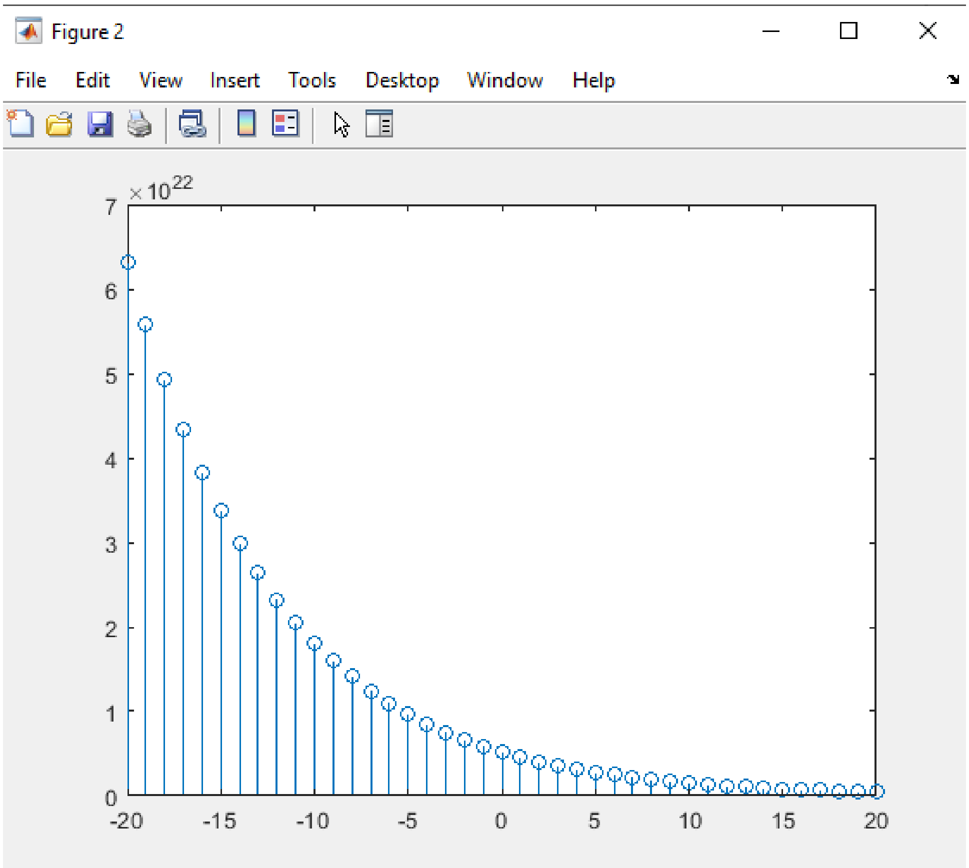

Figure 5 Down Sampled Signal

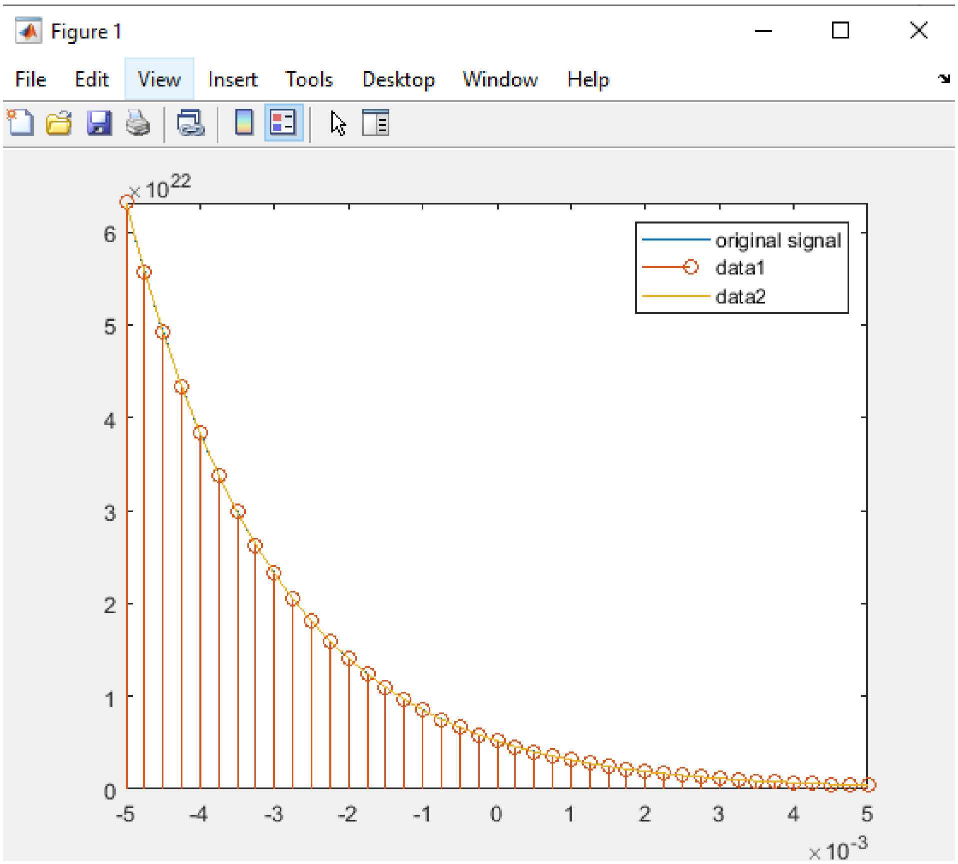

Figure 6 Original and Reconstructed Signal

4. Let $x_a(t) = \cos(20\pi t+\pi/4)$. Sample $x_a(t)$ at Ts = 0.010 sec intervals to obtain x(n). Reconstruct the original signal and plot it.

```
%Hemal Sharma
%ID: 2221855
%Continuous Signal
tmin = -0.2;
tmax = 0.2;
x = @(t)cos((20*pi*(t))+(pi/4));
figure(1)
fplot(x, [tmin tmax])
legend("original signal")
%Sampling
Fs = 100;
Ts = 1/Fs;
td = tmin:Ts:tmax;
n = tmin/Ts:1:tmax/Ts;
xd = x(n*Ts);
figure(1)
hold on
stem(n*Ts,xd)
figure(2)
stem(n,xd)

%Reconstruction
M = 2;
tr = tmin:Ts/M:tmax;
xr = interp1(td,xd,tr, "cubic");
figure(1)
plot(tr,xr)
```

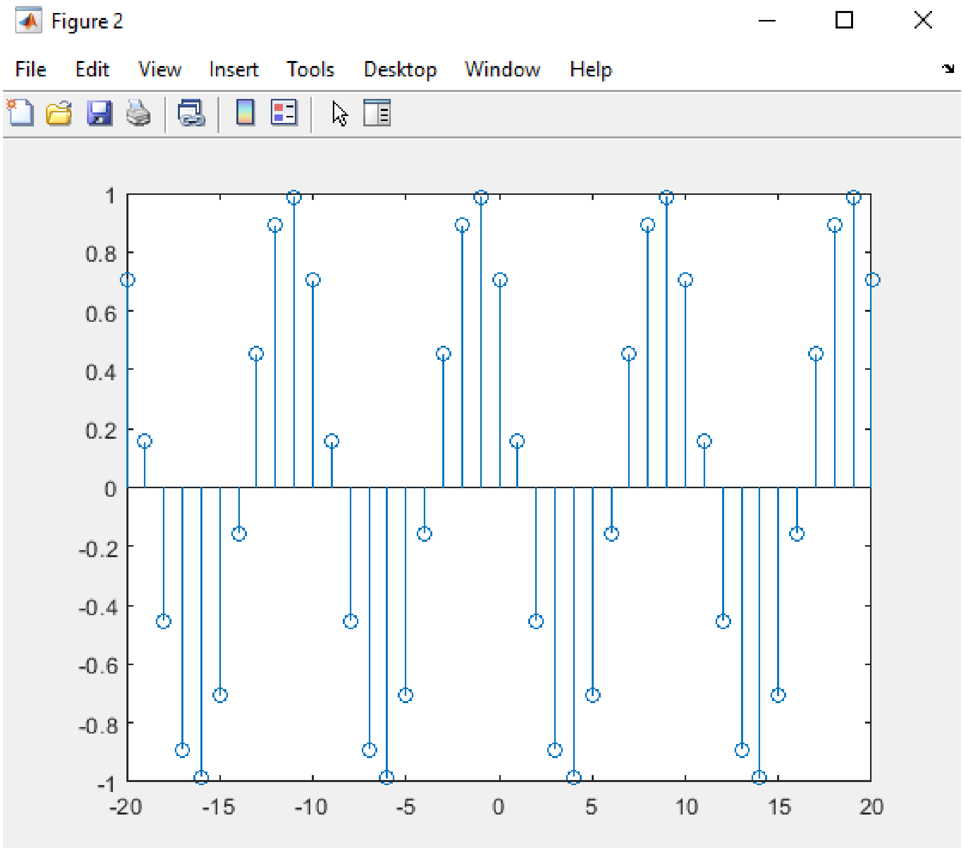

Figure 7 Down sampled Signal

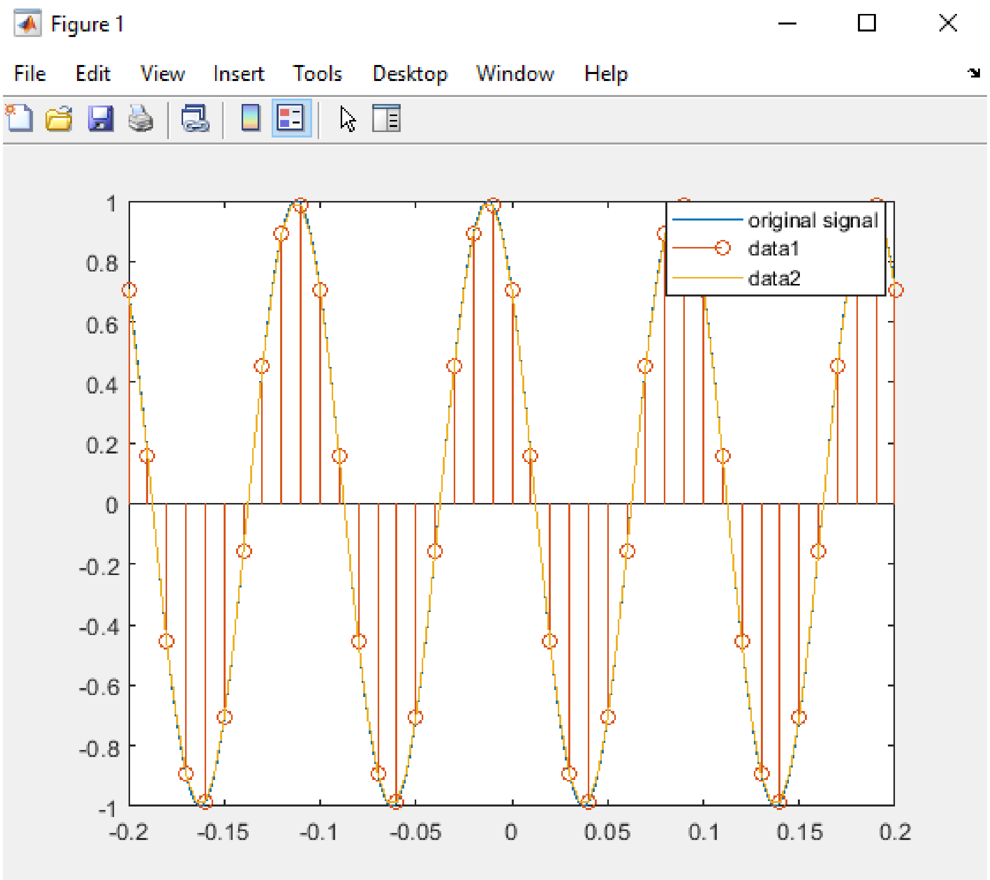

Figure 8 Original and Reconstructed Signal