Department of Mechatronics Engineering
Rajshahi University of Engineering and Technology

Course No.: **MTE-2206.**

Course Title: **Sensor and Instrumentations Sessional.**

Experiment No: 03

Experiment Name: Verification of sampling theorem and analyze the effect of aliasing

Remarks

Date of Performance: 01.07.2021 Date of Submission: 08.07.21	Name: Thuhinul Islam Roll No.: 1808012 Session: 2018-19

Experiment no: **3**

Experiment Name: Verification of sampling theorem and analyze the effect of aliasing

Objectives:

1.To know about sampling theorem.
2.To know about the effect of aliasing effect.
3.To know how to convert continuous analog signal to discrete signal.

Theory:

Generally sampling theorem indicates the minimum-sampling rate at which a continuous-time signal needs to be uniformly sampled.As a result,Samples alone can be completely recovered by the original signal **.[1]** A continuous time signal can be represented in its samples and can be recovered back when sampling frequency f_s is greater than or equal to the twice the highest frequency component of message signal which means if f is the continuous time signal frequency ,

$f_s \geq 2f$ and if T is period than $T \leq 1/2f$ **[2]**

Aliasing is mainly a form of undersampling.When the sample rate is the same as the frequency of signal the waveform is built to look like a slower frequency waveform or a flat line.[3]

When sample frequency is equal to continuous signal frequency:

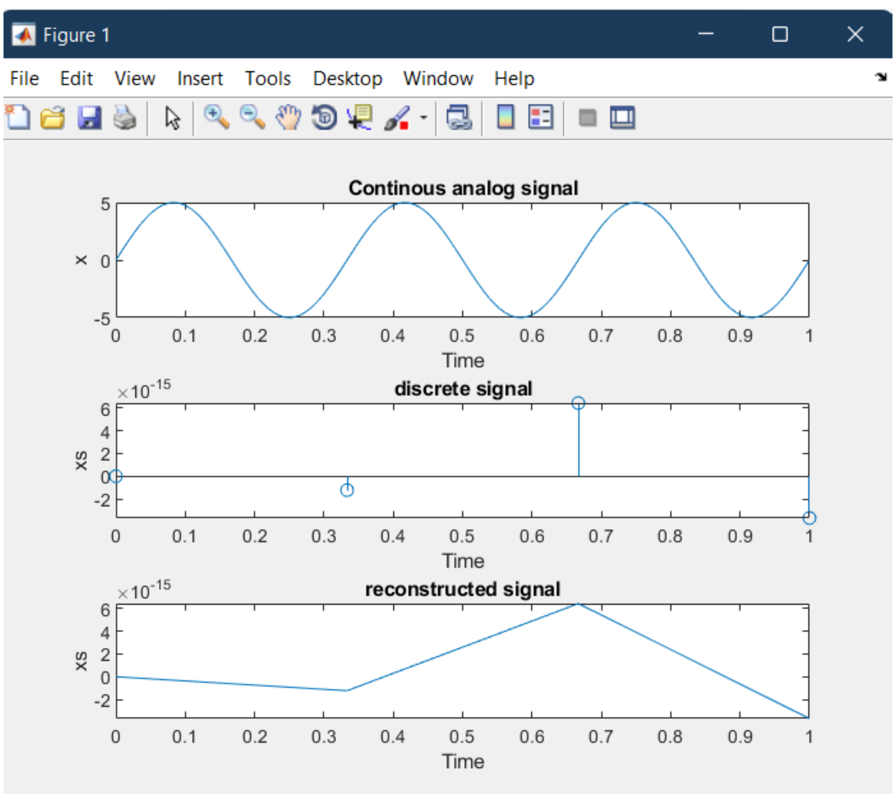
Code:

Signalsim.m

```
clc;
clear all;
%Continous analog signal
A= 5;
f=4;
theta=0;
t=0:0.002:2;
x=A*sin(2*pi*f*t+theta);
subplot(3,1,1)
plot(t,x)
xlabel("Time")
ylabel("x")
title("Continous analog signal")
%discrete signal
fs=f;
ts=1/fs;
tl=0:ts:fs*ts;
xs=A*sin(2*pi*f*tl+theta);
subplot(3,1,2)
stem(tl,xs)
xlabel("Time")
ylabel("xs")
title("discrete signal")
%reconstructed signal
subplot(3,1,3)
plot(tl,xs)
xlabel("Time")
ylabel("xs")
title("reconstructed signal")
```

COMMAND WINDOW

Output:

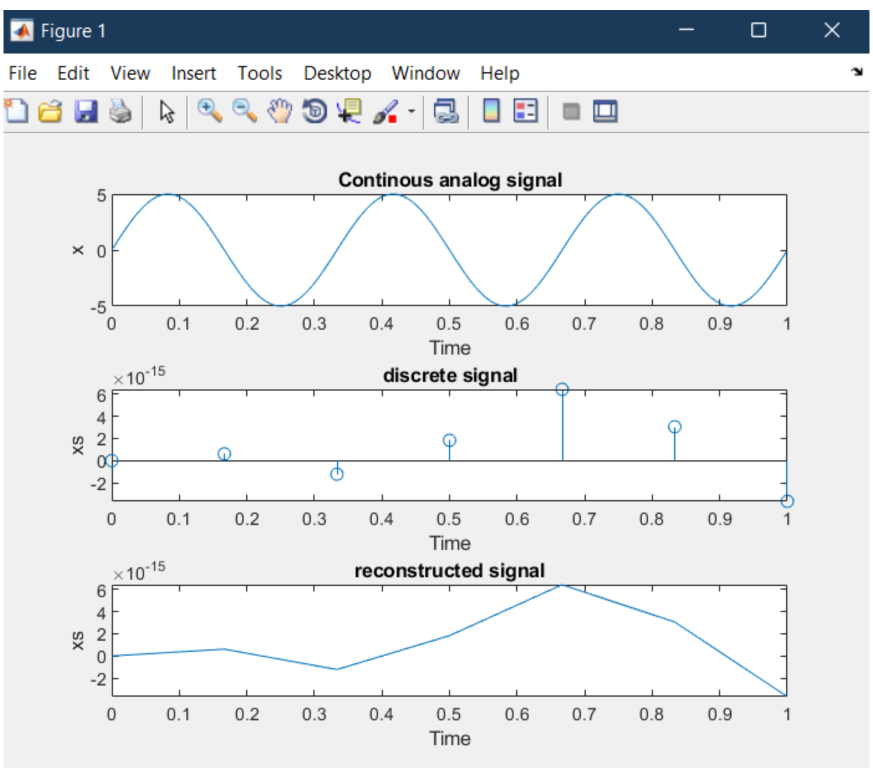


When sample frequency is twice of continuous signal frequency:

Code:

```
clc;
clear all;
%Continous analog signal
A= 5;
f=4;
theta=0;
t=0:0.002:2;
x=A*sin(2*pi*f*t+theta);
subplot(3,1,1)
plot(t,x)
xlabel("Time")
ylabel("x")
title("Continous analog signal")
%discrete signal
fs=2*f;
ts=1/fs;
tl=0:ts:fs*ts;
xs=A*sin(2*pi*f*tl+theta);
subplot(3,1,2)
stem(tl,xs)
xlabel("Time")
ylabel("xs")
title("discrete signal")
%reconstructed signal
subplot(3,1,3)
plot(tl,xs)
xlabel("Time")
ylabel("xs")
title("reconstructed signal")
```

Output:



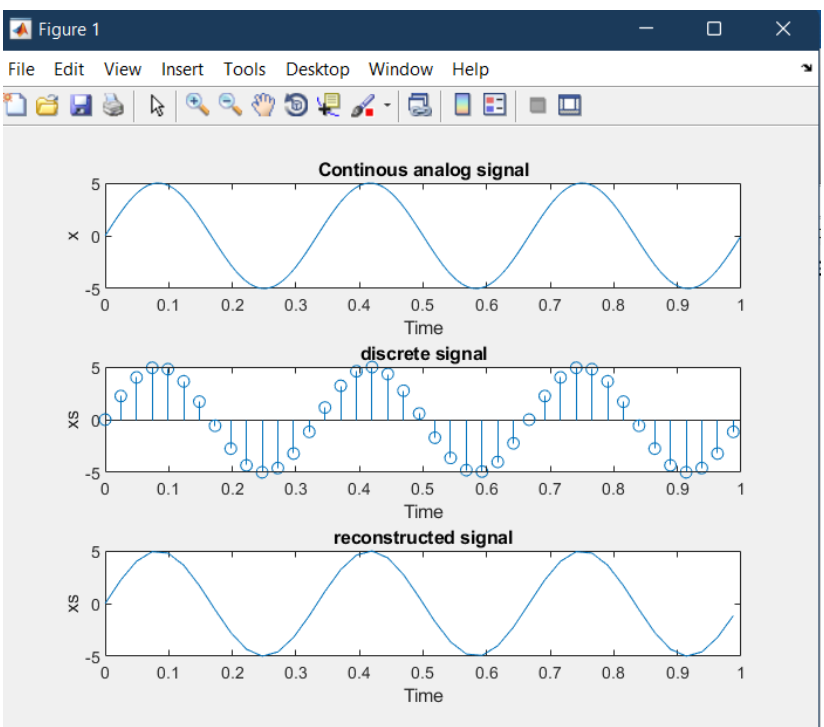
When sample frequency is more than twice of continuous signal frequency:

Code:

Signalsim.m

```
clc;
clear all;
%Continous analog signal
A= 7.85;
f=4;
theta=0.5;
t=0:0.0043:2;
x=A*sin(2*pi*f*t+theta);
subplot(3,1,1)
plot(t,x)
xlabel("Time")
ylabel("x")
title("Continous analog signal")
%discrete signal
fs=12.5*f;
ts=1/fs;
tl=0:ts:fs*ts;
xs=A*sin(2*pi*f*tl+theta);
subplot(3,1,2)
stem(tl,xs)
xlabel("Time")
ylabel("xs")
title("discrete signal")
%reconstructed signal
subplot(3,1,3)
plot(tl,xs)
xlabel("Time")
ylabel("xs")
title("reconstructed signal")
```

Output:



Discussion & conclusion:

The experiment was about verification of sampling theorem.From the outputs, we can be see that when sample frequency is same as continuous signal frequency , number of discrete value is less .When sample frequency is twice of continuous signal frequency, number of discrete values have increased . When sample frequency is more than twice of continuous signal frequency, discrete values have increased more than before and the reconstructed signal is almost same as the first signal. So it is proven that the experiment was done perfectly.

References:

1.Sampling Theorem,*Science Direct* Retrieved From https://www.sciencedirect.com/topics/engineering/sampling-theorem

2.Signals Sampling Theorem. *Tutorialspoint*. (n.d.),Retrieved From

https://www.tutorialspoint.com/signals_and_systems/signals_sampling_theorem.htm

3. What is aliasing,*Tektronix*,Retrieved From

https://www.tek.com/support/faqs/what-aliasing-and-how-do-i-detect-it-and-fix-it-my-oscilloscope