EXPERIMENT NO.3

AIM: To verify sampling theorem.

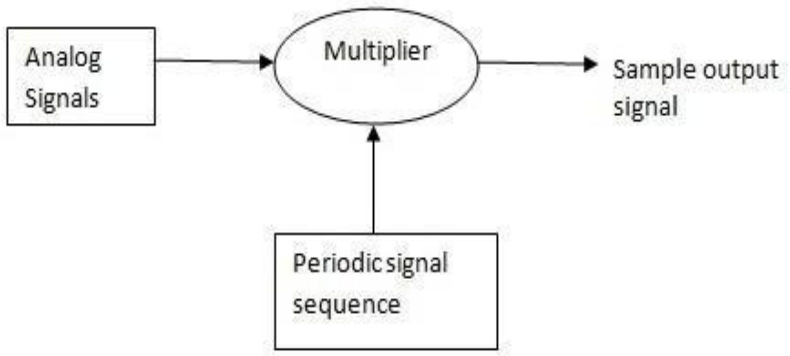
APPARATUS: MATLAB software

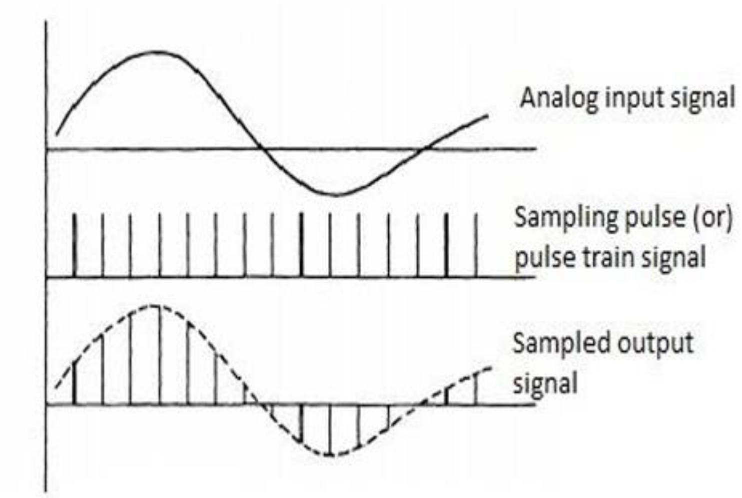
THEORY: Sampling is defined as, “The process of measuring the instantaneous values of continuous-time signal in a discrete form.” Sample is a piece of data taken from the whole data which is continuous in the time domain. When a source generates an analog signal and if that has to be digitized, having 1s and 0s i.e., High or Low, the signal has to be discretized in time. This discretization of analog signal is called as Sampling. Sampling frequency is the reciprocal of the sampling period. This sampling frequency, can be simply called as Sampling rate. The sampling rate denotes the number of samples taken per second, or for a finite set of values. For an analog signal to be reconstructed from the digitized signal, the sampling rate should be highly considered. The rate of sampling should be such that the data in the message signal should neither be lost nor it should get over-lapped. Hence, a rate was fixed for this, called as Nyquist rate. To discretize the signals, the gap between the samples should be fixed. That gap can be termed as a sampling period T_s.

Suppose that a signal is band-limited with no frequency components higher than fm Hertz. That means, fm is the highest frequency. For such a signal, for effective reproduction of the original signal, the sampling rate should be twice the highest frequency. This rate of sampling is called as Nyquist rate. The sampling theorem, which is also called as Nyquist theorem, delivers the theory of sufficient sample rate in terms of bandwidth for the class of functions that are bandlimited.

The sampling theorem states that, “a signal can be exactly reproduced if it is sampled at the rate f_s which is greater than twice the maximum frequency fm.” The sampling theorem specifies the minimum-sampling rate at which a continuous-time signal needs to be uniformly sampled so that the original signal can be completely recovered or reconstructed by these samples alone. This is usually referred to as Shannon's sampling theorem.

fs >=2 fm



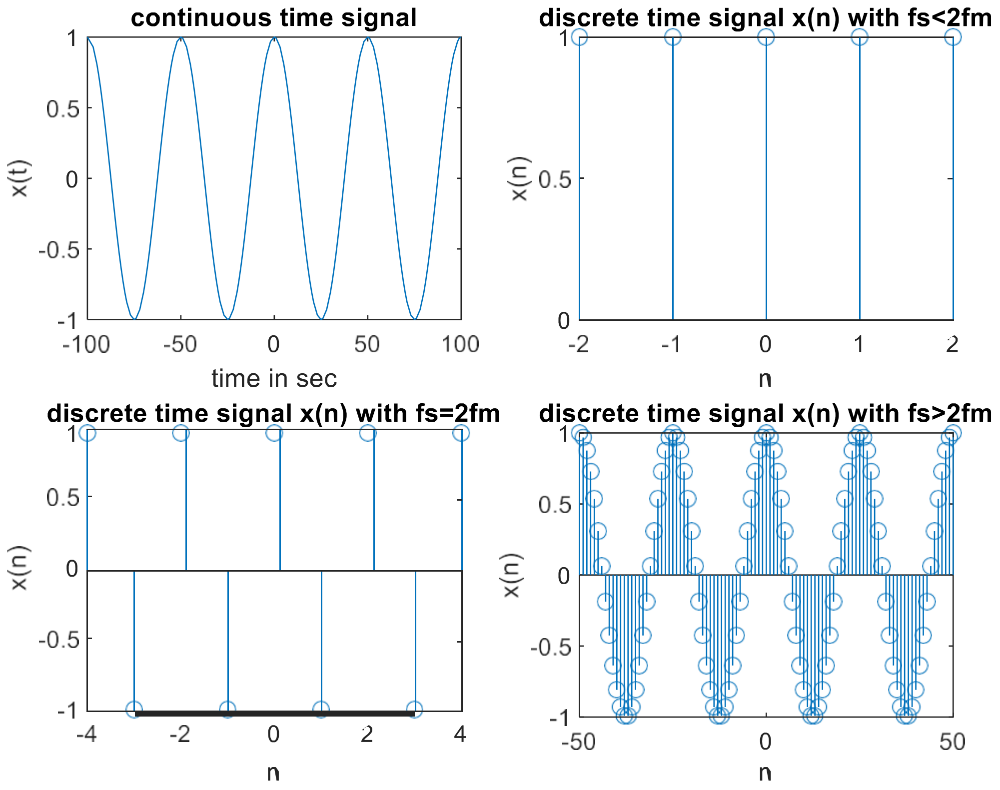


PROGRAM:

```
clear all;
close all;
t=-100:01:100;
fm=0.02;
x=cos(2*pi*t*fm);
subplot(2,2,1);
plot(t,x);
xlabel('time in sec');
ylabel('x(t)');
title('continuous time signal');
fs1=0.02;
n1=-2:2;
x1=cos(2*pi*fm*n1/fs1);
subplot(2,2,2);
stem(n1,x1);
title('discrete time signal x(n) with fs<2fm');
xlabel('n');
ylabel('x(n)');
fs2=0.04;
n2=-4:4;
x2=cos(2*pi*fm*n2/fs2);
subplot(2,2,3);
stem(n2,x2);
title('discrete time signal x(n) with fs=2fm');
xlabel('n');
ylabel('x(n)');
n3=-50:50;
fs3=0.5;
x3=cos(2*pi*fm*n3/fs3);
subplot(2,2,4);
```

```
stem(n3,x3);
xlabel('n');
ylabel('x(n)');
title('discrete time signal x(n) with fs>2fm');
disp(x);
disp(x1);
disp(x2);
disp(x3);
```

OUTPUT:



POST LAB QUESTION:

Q1. State the following terms.

Aliasing, Types of sampling, Advantages, Disadvantages and Applications of sampling, Quantization.