Experiment No.: 11

Experiment Name: Sampling of an Analog Signal using MATLAB

Description of the Problem:

The objective of this experiment is to **sample a continuous-time analog signal** to convert it into a discrete-time signal.

Theory:

- In **Digital Signal Processing (DSP)**, analog signals must be **sampled** to be processed digitally.
- **Sampling** is done at discrete intervals $t = nT_s$, where $T_s = \frac{1}{f_s}$is the sampling period and $f_s$is the sampling frequency.
- According to the **Nyquist theorem**, $f_s$must be at least twice the maximum frequency of the analog signal to avoid **aliasing**:

$$f_s \geq 2f_{max}$$

- This experiment demonstrates **sampling** and compares the continuous and sampled signals visually.

Source Code Sample:

```
% Sampling an Analog Signal
clc;
clear;
close all;

% Step 1: Define continuous time signal
t = 0:0.001:1;                % continuous time (high resolution)
f = 5;                        % frequency of analog signal (Hz)
x = sin(2*pi*f*t);            % analog signal (sine wave)

% Step 2: Define sampling parameters
fs = 20;                      % sampling frequency (Hz)
ts = 1/fs;                    % sampling time interval
n = 0:ts:1;                   % discrete time instants

% Step 3: Sample the signal
x_sampled = sin(2*pi*f*n);    % sampled signal values

% Step 4: Plot the signals
```

```
subplot(2,1,1);
plot(t, x, 'b', 'LineWidth', 1.5);
title('Original Analog Signal');
xlabel('Time (s)');
ylabel('Amplitude');
grid on;

subplot(2,1,2);
stem(n, x_sampled, 'r', 'filled');
hold on;
plot(t, x, 'b--');
title(['Sampled Signal (fs = ' num2str(fs) ' Hz)']);
xlabel('Time (s)');
ylabel('Amplitude');
grid on;
```

Sample Input:

No manual input is required; all values are predefined in the code:

- Analog signal: $x(t) = \sin(2\pi f t)$
- Frequency: $f = 5$ Hz
- Sampling frequency: $f_s = 20$ Hz

Sample Output:

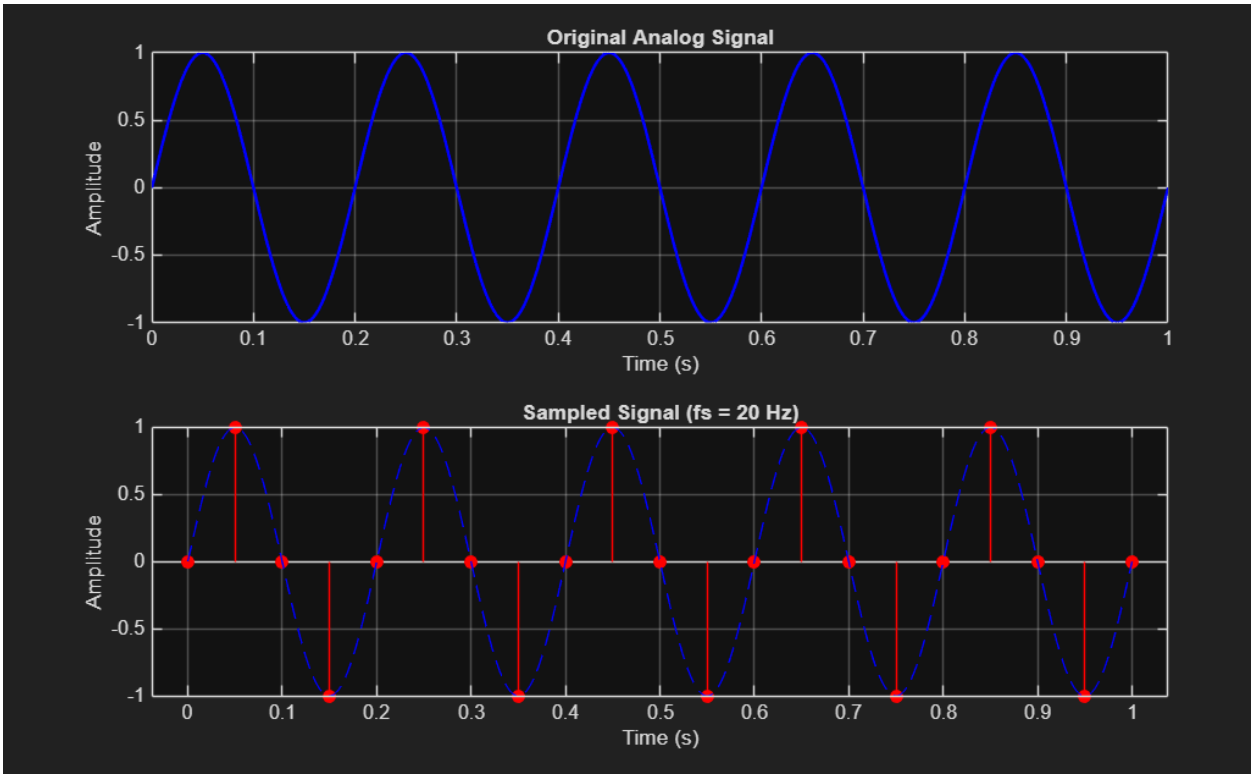
After running the code:

1. **Original Analog Signal** → first subplot (continuous blue line)
2. **Sampled Signal** → second subplot (red stem plot)
3. **Comparison** → sampled signal plotted over original signal (blue dashed line)

This visually shows how the continuous-time signal is discretized at specific sampling intervals.

Screenshot:

Figure 11.1: Original and Sampled Signals in MATLAB


Original Analog Signal
Amplitude
Time (s)
Sampled Signal (fs = 20 Hz)
Amplitude
Time (s)