Digital Signals Processing Lab

Experiment 3: Sampling Theorem and Aliasing and its Effects

I Pre Lab

1 Define Sampling Rate.

Soln. The sampling rate refers to the number of samples of audio recorded every second.

2 Why is signal to be sampled?

Soln. If the signal contains high frequency components, we will need to sample at a higher rate to avoid losing information that is in the signal. In general, to preserve the full information in the signal, it is necessary to sample at twice the maximum frequency of the signal.

3 Define Sampling Theorem

Soln. 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.

4. What is aliasing? When is aliasing occurred?

Soln. Aliasing is the effect of new frequencies appearing in the sampled signal after reconstruction, that were not present in the original signal. It is caused by too low sample rate for sampling a particular signal or too high frequencies present in the signal for a particular sample rate.

5 How to avoid aliasing?

Soln. To avoid aliasing we can:

- ensure it is the [0, fs/2) range (low pass filtering) or
- Increase the sample rate.

This implies that we know what range our signal is in before we sample it.

II Post Lab Questions

1. If Signal $x(t) = 5\sin(800\pi t)$ is Samples what is the minimus Sampling rate requires to avoid aliasing? Determine the descrete time Signal after Samples

Sol.
Minimum Sampling rate to avoid aliasing.

$f_s = 2f_m$ (Nyquist rates)

Given, $\omega_m = 800\pi$

$$f_m = \frac{\omega_m}{2\pi}$$

$\therefore f_m = 400 Hz.$

Sampling freq, $f_s = 2 \times 400 = 800$ Samples / sec.

$$T_s = \frac{1}{800}$$

$\therefore$ Direct time Signal is $x(n) = 5\sin(800\pi \times \frac{n}{800})$

$$x(n) = 5\sin(n\pi)$$

2. Define Aliasing frequency with an example.

Sol. ~~Fs~~ Alias frequency is given by,

$F_{alias} = |(R_s \times R_{int}) - F_s|$ where, R_s is the Sampling rate.

R_{int} is the closest integer multiple of R_s and F_s is the Signal frequency.

3. Graphical rep. of discrete time Signal of $x(n)$ for the following cases a) $f_s = f_m$, b) $f_s = 2f_m$ c) $f_s < f_m$, d) $f_s > 2f_m$

Sol.