Communication Engineering Notes on Sampling Techniques

Sampling is the process of converting analog signal into a discrete signal or making an analog or continuous signal to occur at a particular interval of time, this phenomena is known as sampling.

SAMPLING THEOREM:-

Sampling theorem states that a band limited signal having no frequency components higher than fm hertz can be sampled if its sampling freq is equal to or greater than Nyquist rate.

Sampling Techniques

Their are basically three types of Sampling techniques, namely:

1. Natural Sampling

2. Flat top Sampling

3. Ideal Sampling

1. Natural Sampling:

Natural Sampling is a practical method of sampling in which pulse have finite width equal to τ. Sampling is done in accordance with the carrier signal which is digital in nature.

With the help of functional diagram of a Natural sampler, a sampled signal g(t) is obtained by multiplication of sampling function c(t) and the input signal x(t).

Spectrum of Natural Sampled Signal is given by:

$$G(f) = A\tau / Ts \,.[\, \Sigma \sin c(n\, fs.\tau)\, X(f-n\, fs)]$$

2. Flat Top Sampling:

Flat top sampling is like natural sampling i.e; practical in nature. In comparison to natural sampling flat top sampling can be easily obtained. In this sampling techniques, the top of the samples remains constant and is equal to the instantaneous value of the message signal x(t) at the start of sampling process. Sample and hold circuit are used in this type of sampling.

Figure(a), shows functional diagram of a sample hold circuit which is used to generate fat top samples.

Figure(b), shows the general waveform of the flat top samples. It can be observed that only starting edge of the pulse represent the instantaneous value of the message signal x(t).

Spectrum of Flat top Sampled Signal is given by:

$$G(f) = fs \,.[\, \Sigma\, X(f-n\, fs).\, H(f)]$$

3. Ideal Sampling;

Ideal Sampling is also known as Instantaneous sampling or Impulse Sampling.Train of impulse is used as a carrier signal for ideal sampling. In this sampling technique the sampling function is a train of impulses and the principle used is known as multiplication principle.

Here,

Figure (a), represent message signal or input signal or signal to be sampled.

Figure (b), represent the sampling function.

Figure (c), represent the resultant signal.

Spectrum of IdealSampled Signal is given by:

$$G(f) = fs .[\Sigma X(f-n fs)]$$

NYQUIST RATE:

Nyquist rate is the rate at which sampling of a signal is done so that overlapping of frequency does not take place. When the sampling rate become exactly equal to 2fm samples per second, then the specific rate is known as Nyquist rate. It is also know aas the minimum sampling rate and given by: fs =2fm

Effect of Under sampling: ALIASING

It is the effect in which overlapping of a frequency components takes place at the frequency higher than Nyquist rate. Signal loss may occur due to aliasing effect. We can say that aliasing is the phenomena in which a high frequency component in the frequency spectrum of a signal takes identity of a lower frequency component in the same spectrum of the sampled signal.

Because of overlapping due to process of aliasing, sometimes it is not possible to overcome the sampled signal x(t) from the sampled signal g(t) by applying the process of low pass filtering since the spectral components in the overlap regions . hence this causes the signal to destroy.

The Effect of Aliasing can be reduced:

1) Pre alias filter must be used to limit band of frequency of the required signal fm Hz.

2) Sampling frequency fs must be selected such that fs > 2fm.