SNS COLLEGE OF TECHNOLOGY

An Autonomous Institution

Coimbatore-35

Accredited by NBA – AICTE and Accredited by NAAC – UGC with 'A+' Grade

Approved by AICTE, New Delhi & Affiliated to Anna University, Chennai

DEPARTMENT OF ELECTRONICS & COMMUNICATION ENGINEERING

19ECB301-ANALOG AND DIGITAL COMMUNICATION

III YEAR/ V SEMESTER

UNIT 3 – DIGITAL COMMUNICATION

TOPIC – Sampling

UNIT III –Digital Communication

UNIT III DIGITAL COMMUNICATION 9+6

THEORY

Block diagram of Digital communication, Low pass Sampling, Quantization- Types.

Baseband Transmission: Properties of Line codes- Power Spectral Density of Line codes –ISI- Nyquist criterion for distortion less transmission – Correlative coding – Eye pattern – Equalization- Linear equalization, Decision -feedback equalization, Adaptive linear equalizer.

Sampling Theorem :-

"A band limited signal having no spectral components above 'f_m' Hz can be determined uniquely by values sampled at uniform intervals of $T_s \leq \frac{1}{2f_m}$ sec (T_s is Sampling time."

* The Nyquist rate of sampling gives the minimum sampling frequency needed to reconstruct the analog signal from sampled waveform.

$$\boxed{f_s \geq 2f_m}$$

* Nyquist interval is Reciprocal of nyquist rate. That is $1/f_s$.

* Time interval Between two adjecent Samples is also said to be Nyquist interval.

1.2 Sampling :-

Formatting an analog signal proceeds in three steps.

1. Discretisation in time, which is known by the name of sampling.
2. Discretisation in amplitude, which is known as quantization.
3. Encoding - encoding the quantised values.

SAMPLING

Definition:-

Analog signal is converted into discrete time signal.

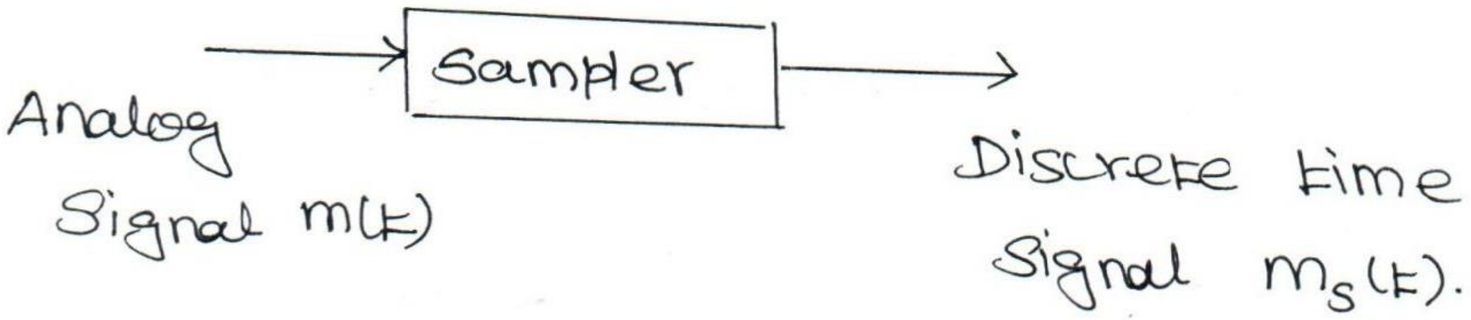
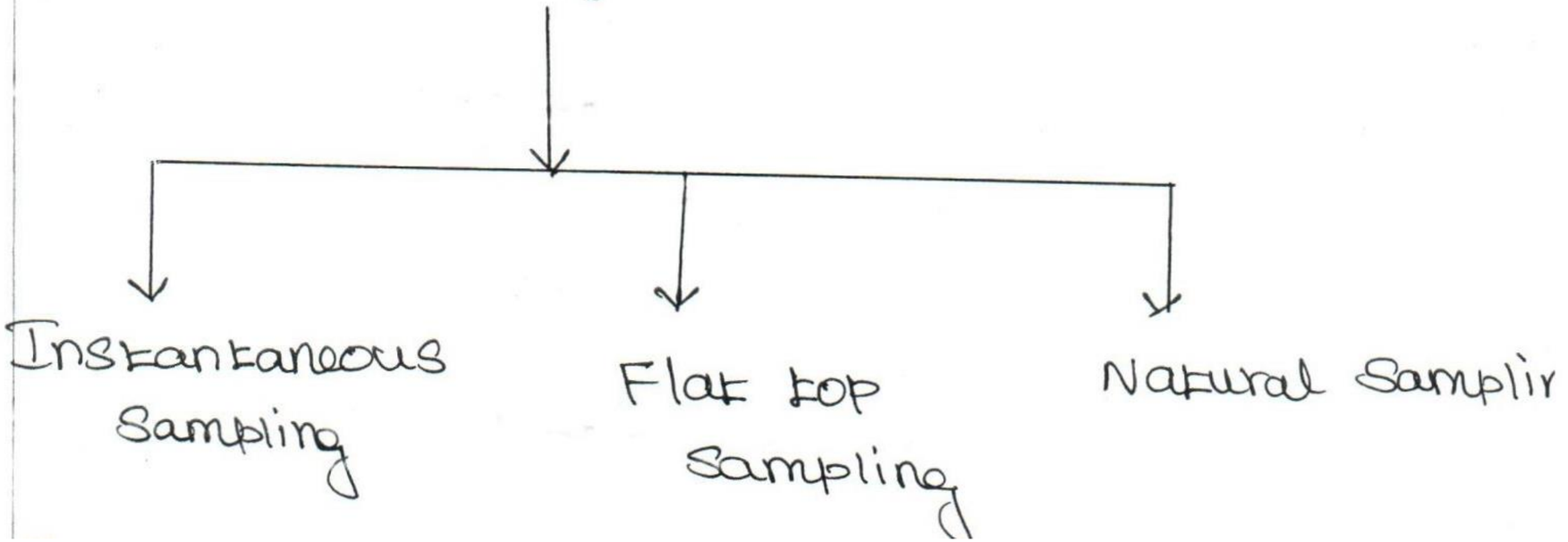


fig: 1 SAMPLER DIAGRAM.

1.2.2 Types of sampling :-



ALIASING

Aliasing:-

If the sampling frequency "f_s" is less than Nyquist rate ($2f_m$), then a type of distortion referred as aliasing occurs

i-e $\boxed{f_s < 2f_m}$

The interference of high frequency components with low frequency components in the spectrum of sampled version is called Aliasing.

↑ M(f)

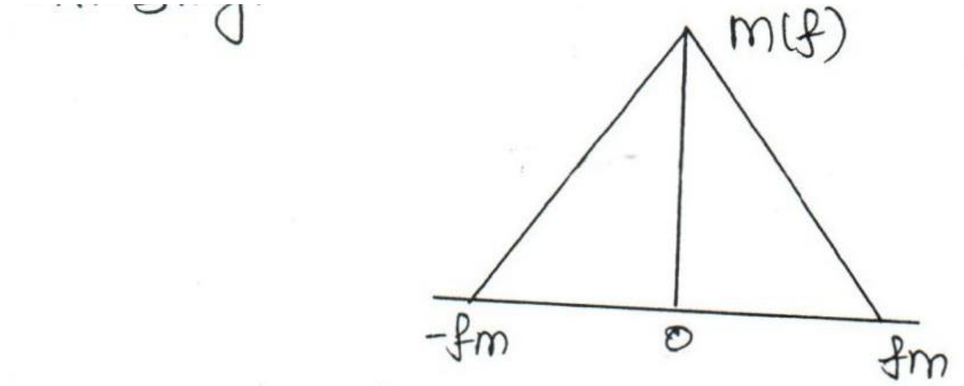


Fig 2.1(a) Spectrum of a Signal.

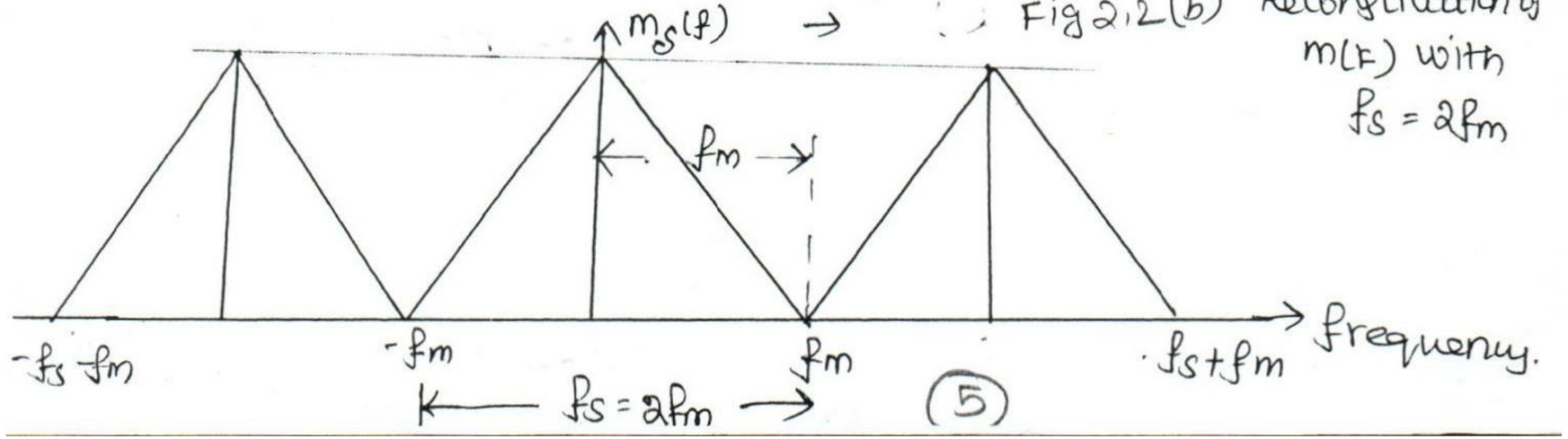


Fig 2.1.2(b) Reconstruction of m(t) with $f_s = 2f_m$

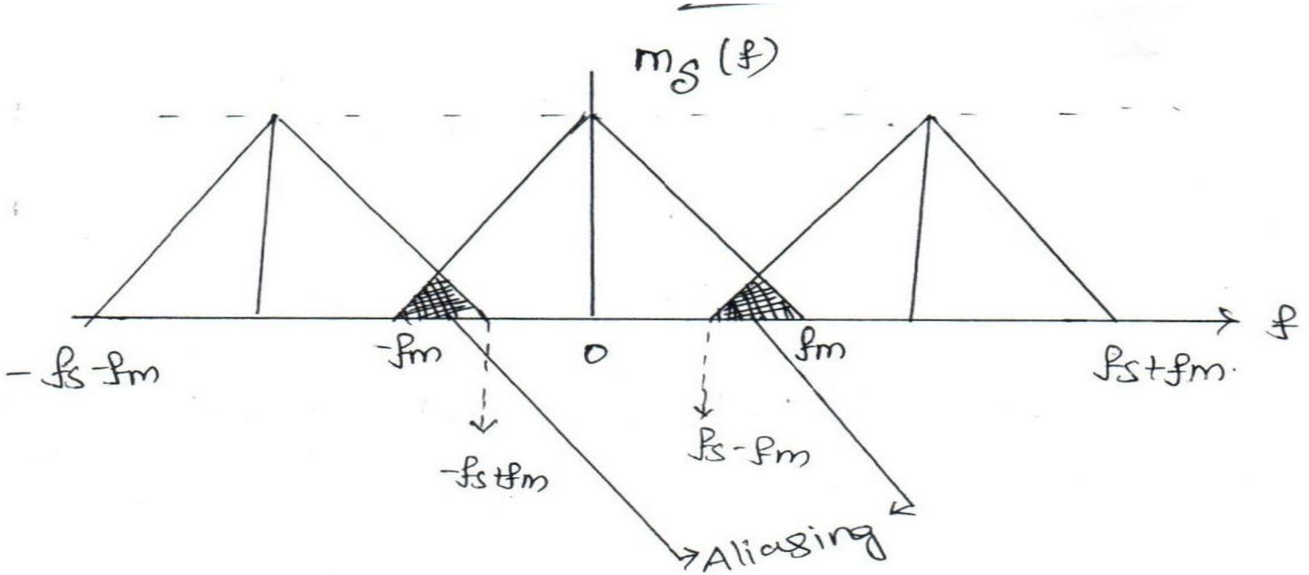


Fig 2.3 (c) Reconstruction of m(t) with $f_s < 2f_m$

* To avoid aliasing, prior to sampler low pass anti aliasing filter is used, it attenuat high frequency components.

* Filtered signal is sampled by selecting a sampling rate slightly greater than '$2f_m$'.

QUANTIZATION:-

* Discretisation in amplitude is simply defined as Quantization.

Definition:-

Quantization is the process of sampled discrete time signal into discrete amplitude signal.

* Quantized signal is discrete both in time and amplitude.

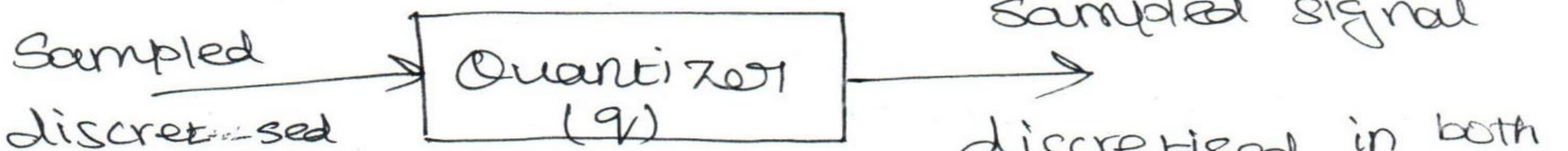


Fig:13 Quantizer diagram

QUANTIZATION ERROR

1.6.1 Quantization Error:- (q)

Quantization error is also called as Quantization Noise.

Definition:-

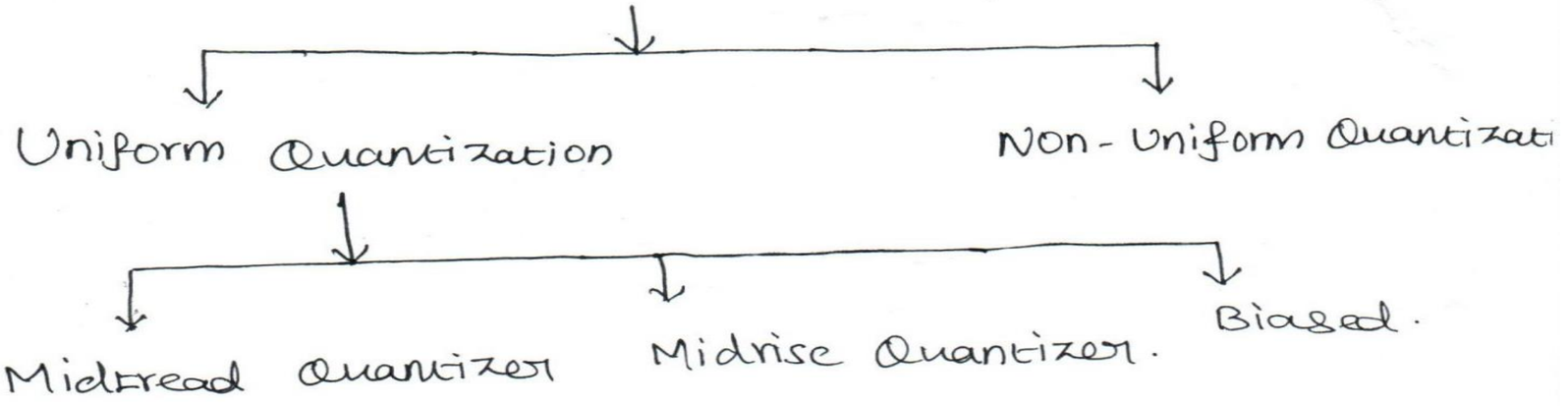
Difference between the instantaneous values of message signal and quantized signal is called as Quantization noise.

Where, $q = V - m$

m → Instantaneous value of message signal

V → Instantaneous value of quantized signal

1.6.3 Types of Quantization:-



Uniform Quantization:-

Step size between two quantization levels remains constant over the complete amplitude range

Midtread Quantizer:-

* Origin lies in the middle of a tread of the staircase.
* Quantizer output is zero when input is zero.

Nyquist's First Method for Zero ISI

➢ ISI can be eliminated by using an equivalent transfer function, $H_e(f)$, such that the impulse response satisfies the condition:

$$h_e(kT_s + \tau) = \begin{cases} C, & k = 0 \\ 0, & k \neq 0 \end{cases}$$

k is an integer, T_s is the symbol (sample) period

τ is the offset in the receiver sampling clock times

C is a nonzero constant

Now choose the $\frac{\sin x}{x}$ function for $h_e(t)$

$$w_{out}(t) = \sum_n a_n h_e(t - nT_s)$$

h_e is a Sa function

$$h_e(t) = \frac{\sin \pi f_s t}{\pi f_s t}$$