

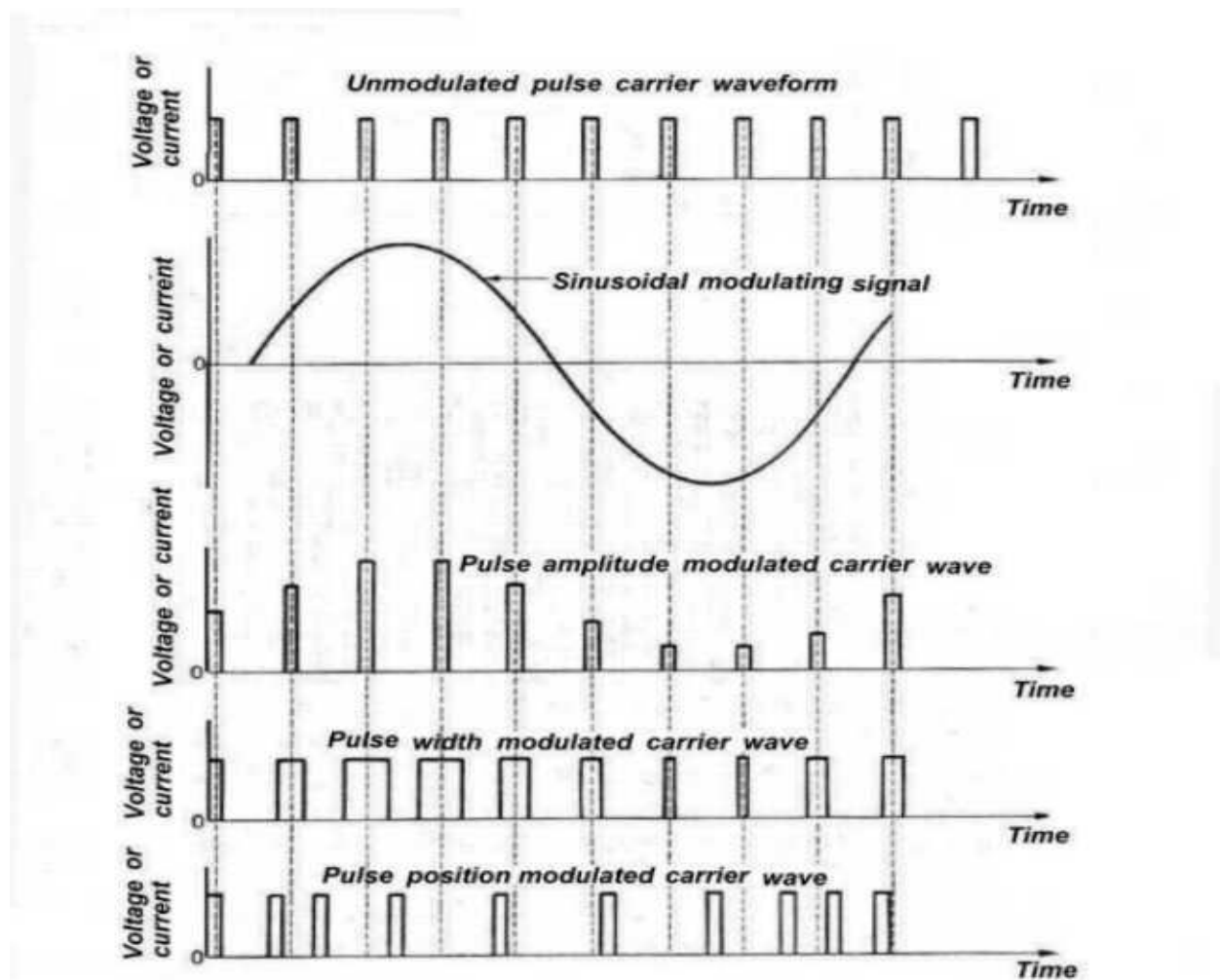
Topics Covered:

- 1) Pulse Modulation
- 2) Sampling
- 3) Quantization & Its types

Pulse modulation:

There is of two types of Pulse Modulation

- (1) Analog Pulse Modulation
 - (a) Pulse Amplitude Modulation (PAM)
 - (b) Pulse width Modulation (PWM)
 - (c) Pulse Position Modulation (PPM)



Analog Pulse Modulation Technique

(2) Digital Pulse Modulation

(a) Pulse code Modulation (PCM)

(b) Delta Modulation (DM)

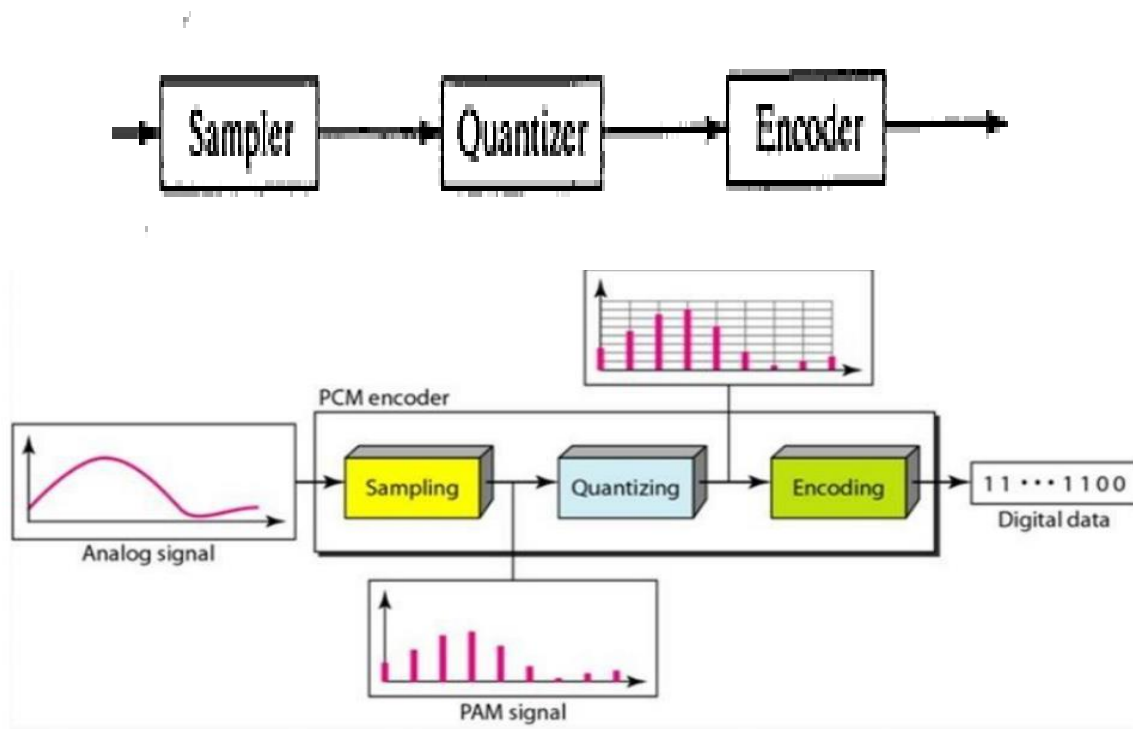
Pulse Code Modulation:

Three steps involved in conversion of analog signal to digital signal

(1) Sampling

(2) Quantization

(3) Binary encoding

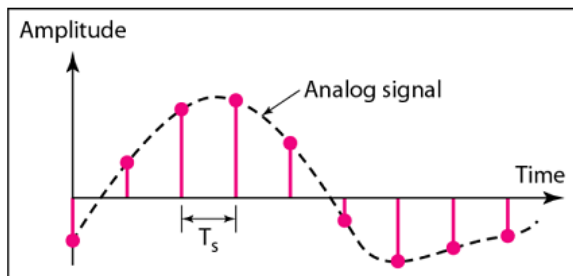


Sampling:

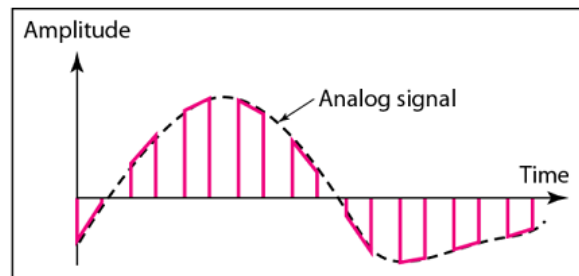
Statement: A continuous time varying signal can be represented into its samples form and can be recovered back when sampling frequency f_s is greater than or equal to the twice the highest frequency component of message signal. i.e $f_s \geq 2 f_m$

Types of Sampling techniques:

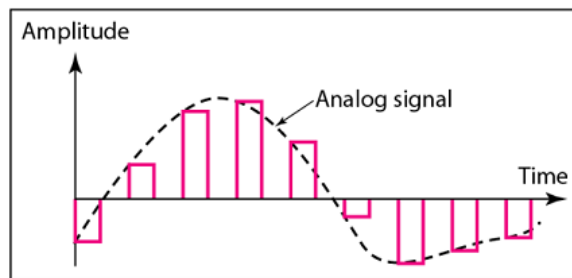
- **Ideal** – An impulse at each sampling instant.
- **Natural** – A pulse of Short width with varying amplitude.
- **Flat Top** – Uses sample and hold, like natural but with single amplitude value.



a. Ideal sampling



b. Natural sampling



c. Flat-top sampling

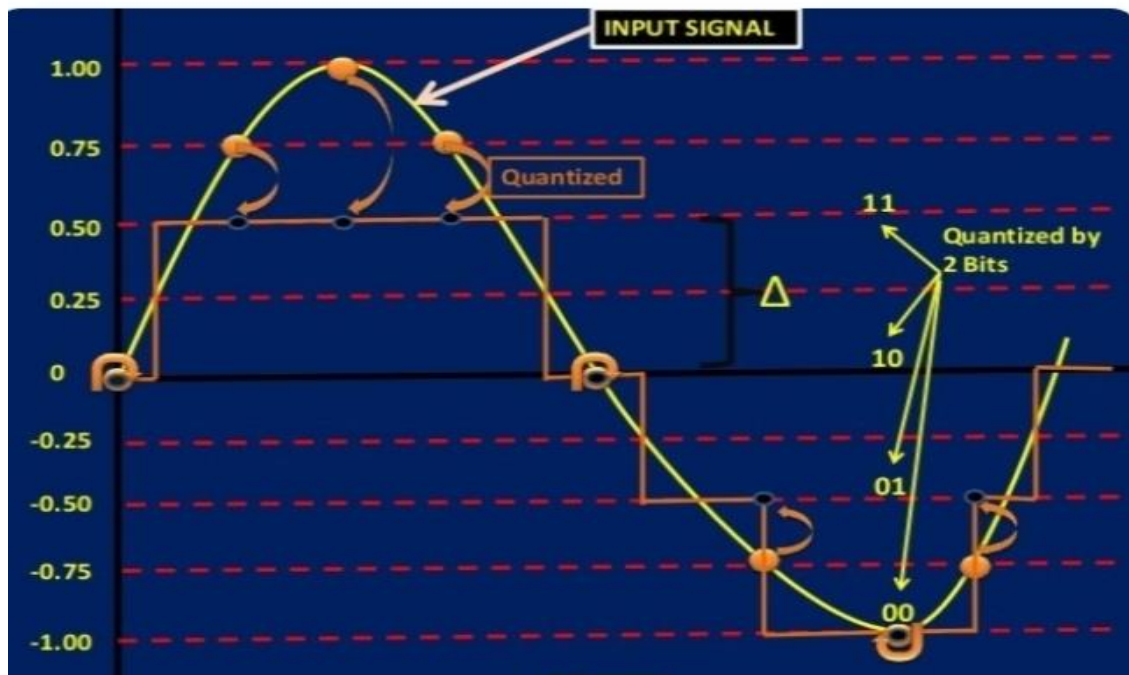
Quantization

- The quantizing of an analog signal is done by discretizing the signal with a number of quantization levels.

Quantization is representing the sampled values of the amplitude by a finite set of levels, which means converting a continuous-amplitude sample into a discrete-time signal.

The discrete amplitudes of the quantized output are called as representation levels or reconstruction levels.

The spacing between the two adjacent representation levels is called quantum or step-size.



Here we are taking 2 bits i.e. 4 levels in quantization.

Quantized step sized= $(X_{\max}-X_{\min})/2^n$

Where n is number of bits.

So Quantized step sized= $\{1-(-1)\}/2^2=0.5$

Types of Quantization:

There are two types of Quantization

- 1) Uniform Quantization
- 2) Non-uniform Quantization.

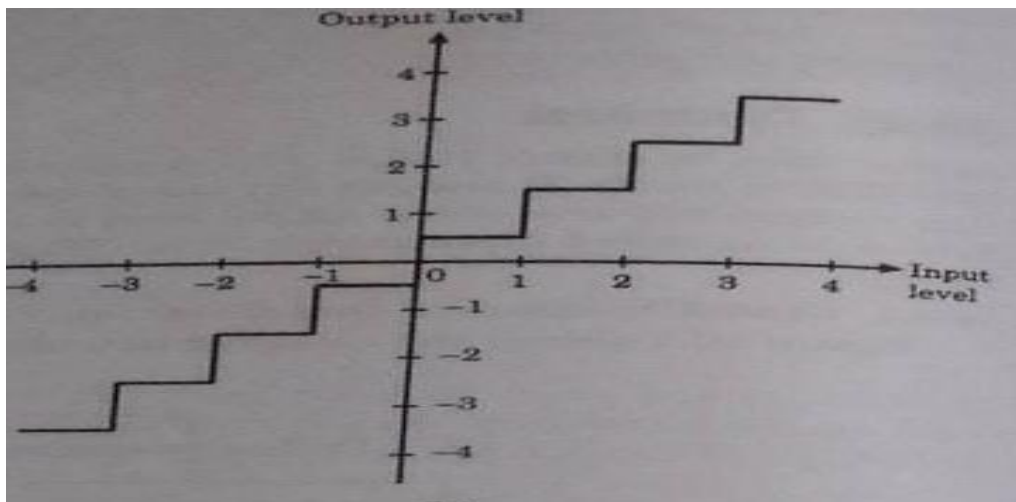
1)Uniform Quantization:

In uniform quantization, the step size is fixed.

Types of Uniform Quantization

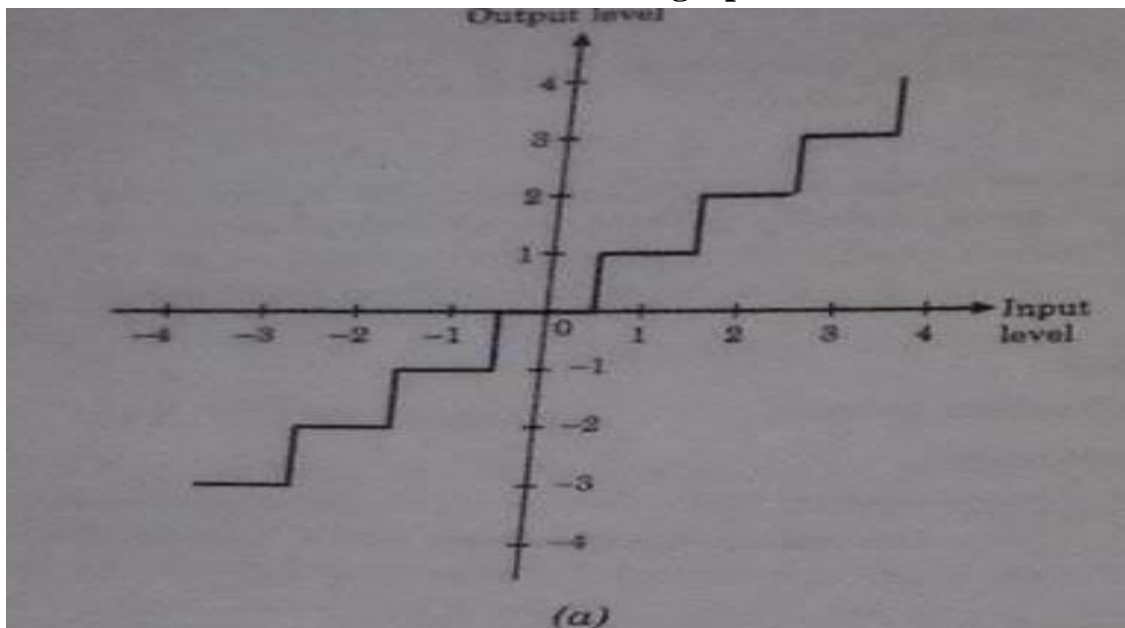
- (a) Mid-Rise type
- (b) Mid-Tread type

(a) Mid-Rise type: The Mid-Rise type is so called because the origin lies in the middle of a raising part of the stair-case like graph.



Mid-Rise type uniform Quantization

(b) Mid-Tread type: The Mid-tread type is so called because the origin lies in the middle of a tread of the stair-case like graph.



Mid-Tread type uniform Quantization

2) **Non-uniform Quantization:** In non-uniform quantization, the step size is not fixed. It varies according to certain law or as per input signal amplitude. The following fig shows the characteristics

