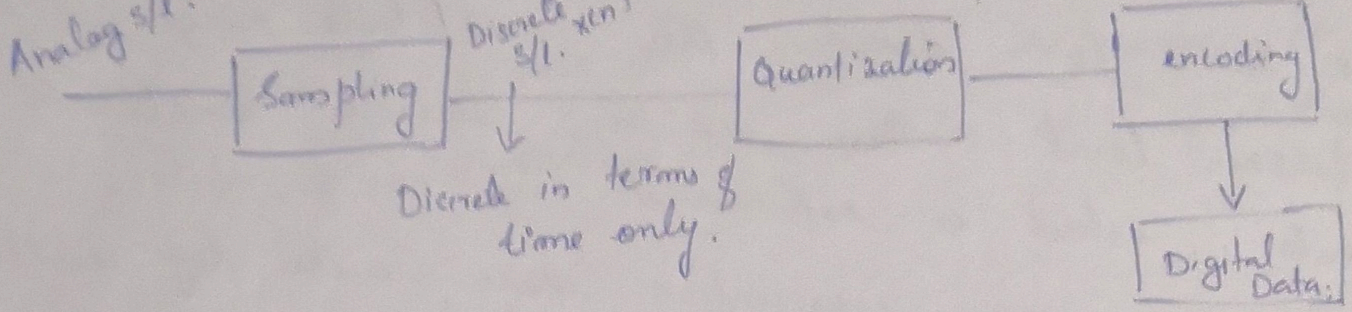
Quantisation:



we can represent analog signal as

$x(t) = \sin 2\pi f t$ → here t can take any values

such as .1, .11, .112 .113 ....

Discrete s/l

$X(n) = \sin(2\pi f n T_s)$ → here n take the discrete values

$n = 1, 2, 3 \ldots$

But this discrete signals are continuous in amplitude. Inorder to store in digital systems it is very compulsory to map the amplitude in to fixed magnitudes. For that we do quantisation.

Quantization is the process of converting continuous amplitude s/l in to discrete amplitude. We can also say it as approximation or rounding off.

therefor output of quantizer will be a digital s/l which is descrete in time and amplitude.

This quantised digital s/l will be encoded in the next stage of digital communication.

Consider a continuous s/l with amplitude range

[-max , max] → dynamic range.

we have to devide this amplitude range in to reference level. these are the discrete amplitude levels ; which is represented by no: of bits

Suppose we are representing these levels by 2 bits

ie; n = 2 bit.

∴ no: of quantized level (L) = 2^n

$$L = 2^2 = 4 \text{ levels}$$

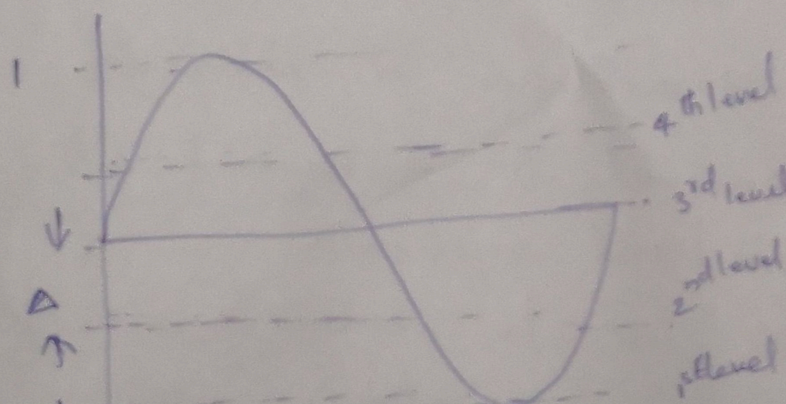
So total amplitude ~~levels~~ range is devided in to 4 reference level

These 4 quantized levels are defined by stepsize Δ

(Δ → difference b/w 2 quantization level).

Δ can be expressed as

$$\Delta = \frac{X_{max} - X_{min}}{L}$$



stepsize

$$\Delta = \frac{1 - -1}{4} = \frac{2}{4} = \frac{1}{2}$$

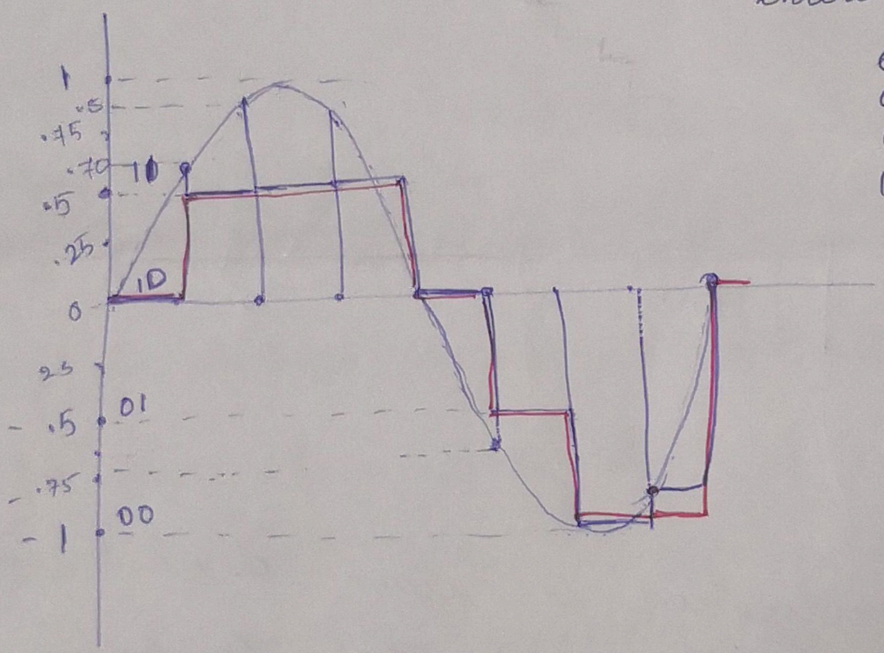
$$\Delta = .5$$

So the ~~difference~~ reference levels are defined at .5 intervals of amplitude.

we have to choose the nearest reference levels to define quantized magnitudes of amplitude.

Here 4 levels are encoded by 2 bits

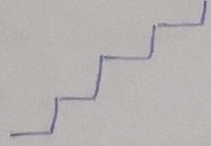
00
01
10
11



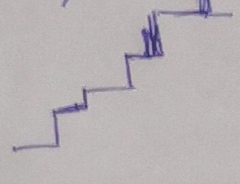
X = Sample value	0	.70	.8	-.75
X_q : quantized value	0	.5	.5	-.5
Quantized error $e_q = X_q - X$	0	.2	.3	-2.5
Digital signal	10	10	10	01

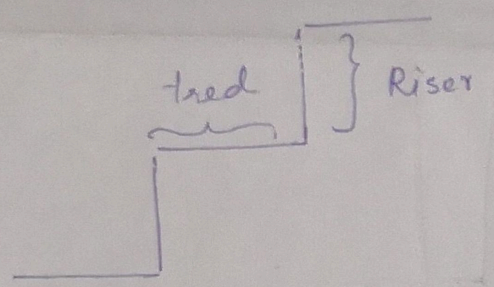
Depending upon the length of the slep size we can devide the quantization in to two classes.

1) uniform quantization : In this the slepsize Δ is constant along the quantization process



(2) Non uniform quantization: In this slep size will vary



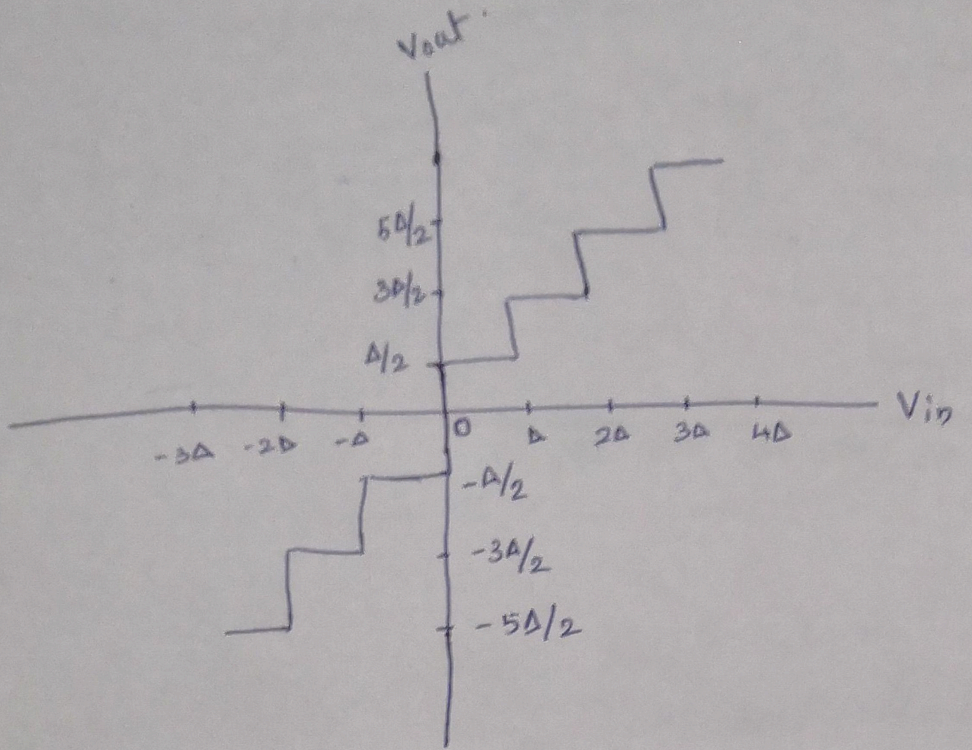


Uniform quantization is again devided in to two according to the characterestics drawn

Mid tred quantization → Origin lies at the centre of the tred.

Mid riser quantization → Origin lies at the centre of the riser.

Mid rise Quantisation

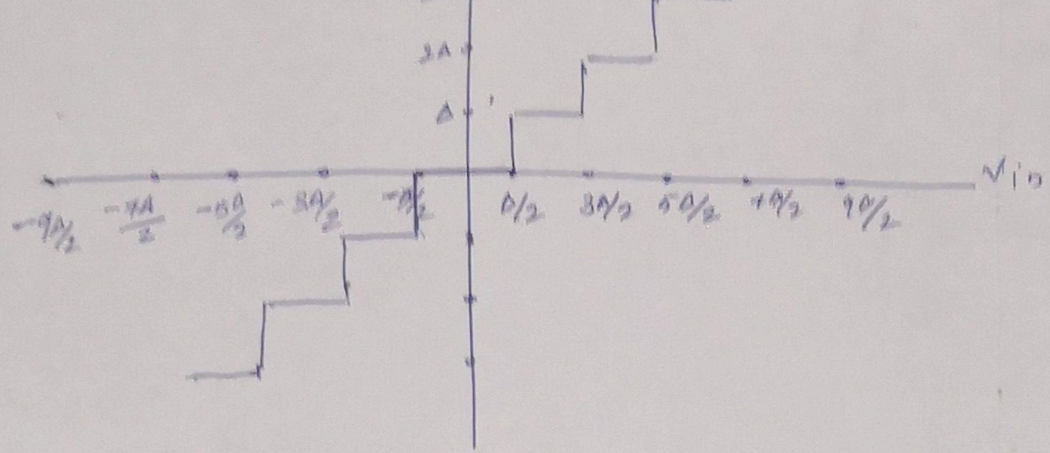


From the figure we can know that when input is between 0 and Δ output is Δ/2

when input is between Δ and 2Δ output is $\frac{3\Delta}{2}$.

From the fig it is clear that it is rising at the zero. ie; at zero it has a transition. There is no level which is denoted by zero.

Mid Tred quantization:



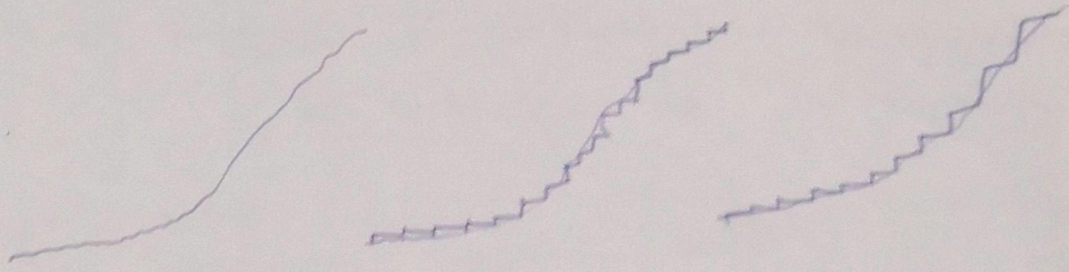
from the graph when V_{in} is between $-\Delta/2$ and $\Delta/2$

output is 0

~~anton~~ So here 0 is a level of output.

Non Uniform quantisation

Non uniform quantization means step size is variable.
if we consider a signal which is varying
slowly at a time and varying quickly some other
time.



if we are using small stepsize every where we have
to use more no: of bits to represent it.
so if we denote the smaller variations with small
stepsize and faster variations with larger step size
it will no: of levels will be reduced. so no: of
bits used to denote it can be reduced.
This is nonuniform quantization.
Non uniform quantization is achieved by
companding; which is a nonlinear mapping of input
to the output.