CO1 - ASSIGNMENT

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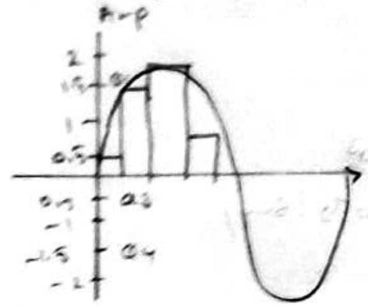
(1) Uniform quantization:

- It is the process of converting a continuous range of amplitude values into a finite number of discrete levels that are equally spaced.

⇒ Range of Signal is divided into equal parts of equal width . known as Step size (Δ).

- The midpoint of each part is represented as quantized level or value.



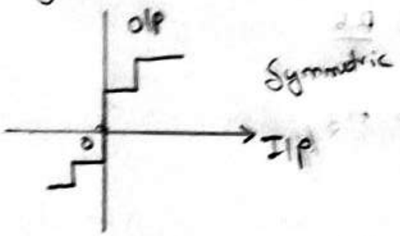
$$\text{Range} = 2-(-2) = 4$$

If $n = 2$ $\Rightarrow$ 24 levels

$$\Delta = \frac{\text{Range}}{2^n} = \frac{4}{4} = 1V$$

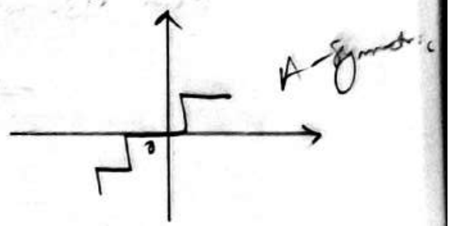
Mid rise

→ origin at mid-rise.



Mid trend

→ origin is at mid of trend



(2) Advantage

- Simpler compared to pcm.
- Requires lower bandwidth for transmission
- Better performance for slowly varying signals

w.k.t Nyquist $\rightarrow f_s = 2f_m$ **2310040111**

$$\Rightarrow f_m = \frac{f_s}{2} = \frac{7.14 \times 10^6}{2}$$

$$= \boxed{\simeq 3.57 \times 10^6 \text{ Hz}}$$

(6) Given $m(t) = 4 \sin(4000 * pi * t)$

levels = 8

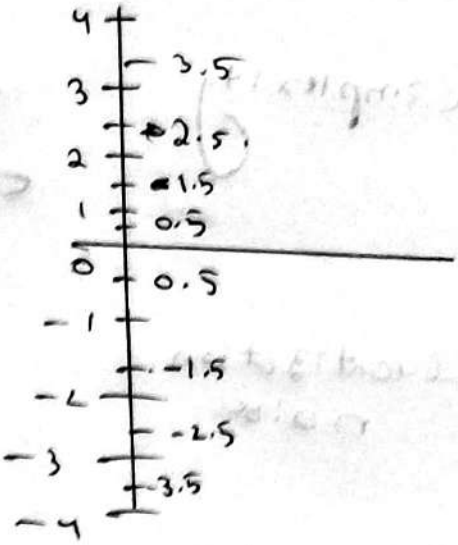
$\Rightarrow 2^n = 8 \Rightarrow n = 3$ bits

Range $= 4(-4) = 8$

$\boxed{QE = SV - QV}$

$$\Delta = \frac{\text{Range}}{L} = \frac{8}{8} = 1V.$$

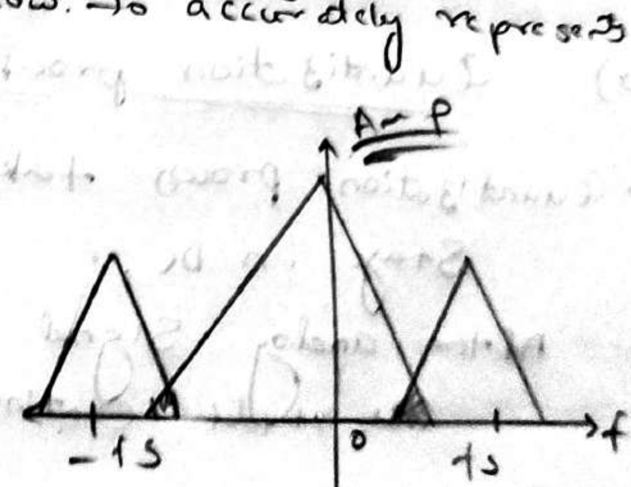
SV	Q.V	Q.E
−3.6	−3.5	−0.1
2.8	2.5	0.3
0.5	0.5	0
−1.4	−1.5	0.1
−3.23	−3.5	0.27



(7) **Aliasing**: its effect occurs when the signal is sampled at a frequency that is too low to accurately represents the original signal.

$\Rightarrow f_s < 2f_m$.

If sampling frequency is less than twice of frequency of message signal. (Nyquist rate)



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(4) Given data

$f_m = 5\ kHz$

$f_s = 50\ kHz$

$Input = 1.5 \sin(2\pi \times 2000\, t) \rightarrow m(t)$

(i) WKT, $\Delta = \left|\frac{d}{dt} m(t)\right| \cdot T_s$

$= \left|1.5 \times 2\pi \times 2000 \cos(2\pi \times 2000 t)\right| \cdot \frac{1}{50k}$

$= \frac{1.5 \times 2\pi \times 2\cancel{000}}{50,\cancel{000}}$

$\Rightarrow 0.377\ V$//

(ii) SQNR = ?

WKT levels = $\frac{Range}{\Delta} = \frac{3}{0.377} \approx 7.96 \approx 8$//

$\Rightarrow 2^n = 8 \Rightarrow n = 3$ bits

$\therefore SQNR = \frac{3 \cdot 4^n}{2}$

$= \frac{3 \cdot 4^3}{2} = 96$//

$SQNR_{dB} = 1.76 + 6.02(3) = 19.82\ dB$//

(5) $n = 7$

$\Rightarrow 2^n = 2^7 = 128$ levels $\qquad f_m = ?$

$R_b = 50$ bit/sec.

w.k.T = $R_b = n \times f_s$

$\Rightarrow 5 \times 10^6 = 7 \times f_s$

$\Rightarrow f_s = \frac{50 \times 10^6}{7} \approx 7.14 \times 10^6$ Sample/sec

Disadvantages:

[illegible]

- Overload error:

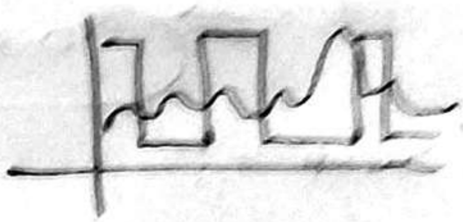
Occurs when input signal changes rapidly and modulator cannot keep up with the changes, resulting in large error

$$\frac{dm(t)}{dt} > \frac{\Delta}{T_s}$$

- Granular error

Occurs when input signal changes very slowly (or) is constant DM modulator oscillates b/w 2 quantization levels, creating noise.

$$\frac{dm(t)}{dt} < \frac{\Delta}{T_s}$$



(3) Quantization:

→ It is the process of mapping a continuous range of analog signals values to a finite set of discrete digital values.

→ It is a crucial step in Analog to Digital Conversion

→ Because for a continuous signal, there are infinite no. of values within range, we cannot assign a unique code to each value (finite storage) so we require quantization.

⇒ Each sampled value is mapped to quantized level.

⇒ This leads to quantization error (i.e. sampled value quantized value)

⇒ Goal of quantization is to minimize this error.

(8) Disadvantage of PCM :- 23100401111

- High bit rate :- converting an analog signal into a digital stream requires a high transmission bit rate.
- It requires high bandwidth.
- Complexity in encoding / decoding.
- Quantization error is high.

(9)

Feature	PCM	DM
Bit rate	Higher	lower
Complexity	more complex Encoding & decoding	Simpler hardware & algorithm.
Quantization noise	Can be low with many bits	Granual noise & overload noise.
Bandwidth	Requires more	Requires less.

(10) Quantization process in DC :-

- Quantization process takes place after the Sampling Stage in DC.
- After analog signal has been sampled the values are still continous in amplitude.
- Quantization stage maps these continous amp values to set of discerete levels.

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- Range is divided into finite pa
- Mid point of these parts are represented as quantized values / level.
- Each Sampled value is mapped to nearest quantization level / Value.
- This leads to quantization error (i.e Sampled value - quantization value).
- The quantization error must be as low as possible for receiving accurate original message signal.