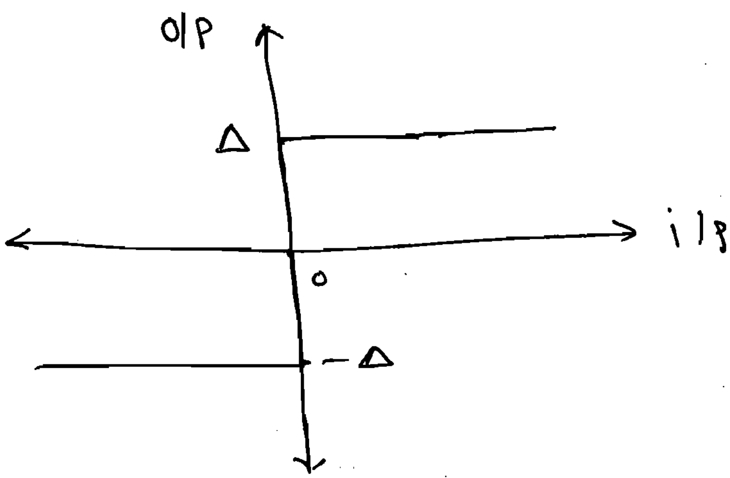
☆ Delta Modulation : (1 Bit DPCM).

⇒ Delta Modulation is used to reduce R_b (or) BW of the signal.

⇒ Delta modulator is consider as 1 bit DPCM system. So, the encoder is a 1 bit A to D Converter.

⇒ Two quantization levels are used which are $+\Delta$ and $-\Delta$. When the i/p to the Quantizer is +ve the o/p is Δ otherwise the o/p is $-\Delta$.

⇒ The transfer characterestics of the Quantizer is shown in figure:



⇒ In Delta modulation, the no. of samples and the no. of bits are same as $n=1$,

Bit rate = Sampling rate × n

So, Bit rate = Sampling rate.

$$\boxed{R_b = \text{Sampling rate.}} \leftarrow \text{M.B.}$$

* PCM, DPCM

$$R_b = \left(\frac{1}{T_s} \times n\right) \text{ bps.}$$

* DM (n=1)

$$R_b = \frac{1}{T_s} = \text{Pulse rate.}$$

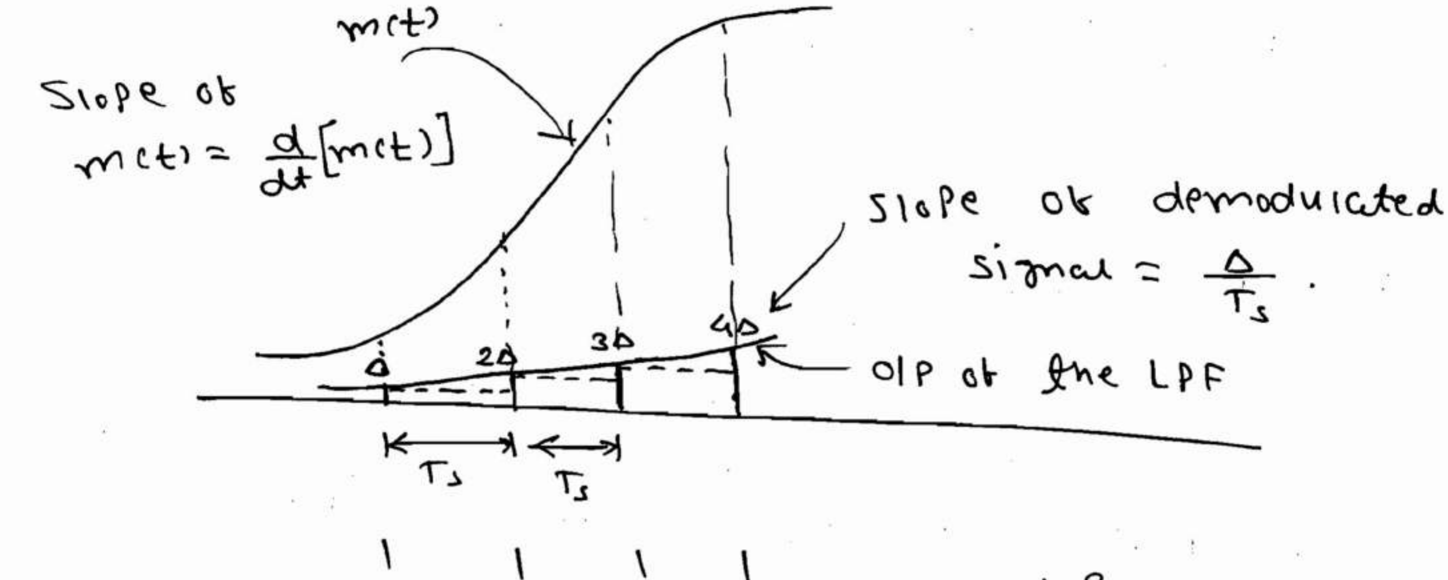
⇒ In PCM and DPCM n-bits are transmitted through the channel for every T_s seconds. So, $\boxed{T_b = T_s/n.}$

⇒ In DM, only one bit is transmitted through the channel for every T_s seconds. So, the pulse width is more in DM when compared with PCM & DPCM.

⇒ At the receiver binary symbol '1' is decoded as 'Δ' and '0' is decoded as −Δ. So, the input to the LPF is increases and decreases in steps of Δ. The signal construction depends on the

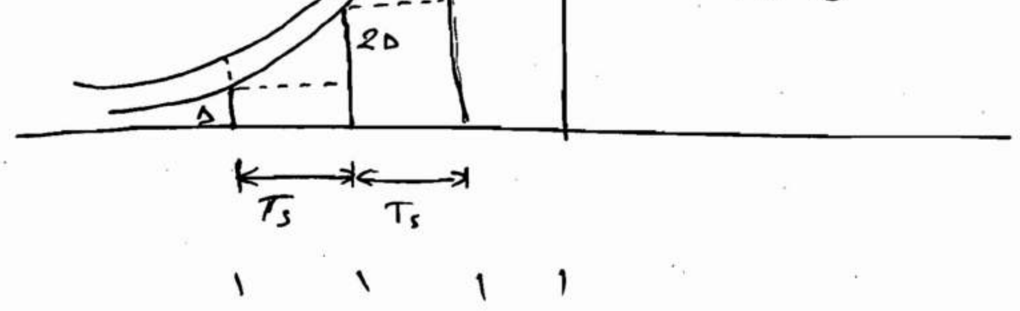
* Optimum Value of Δ:

⇒ ① Assume that the Δ is very small.



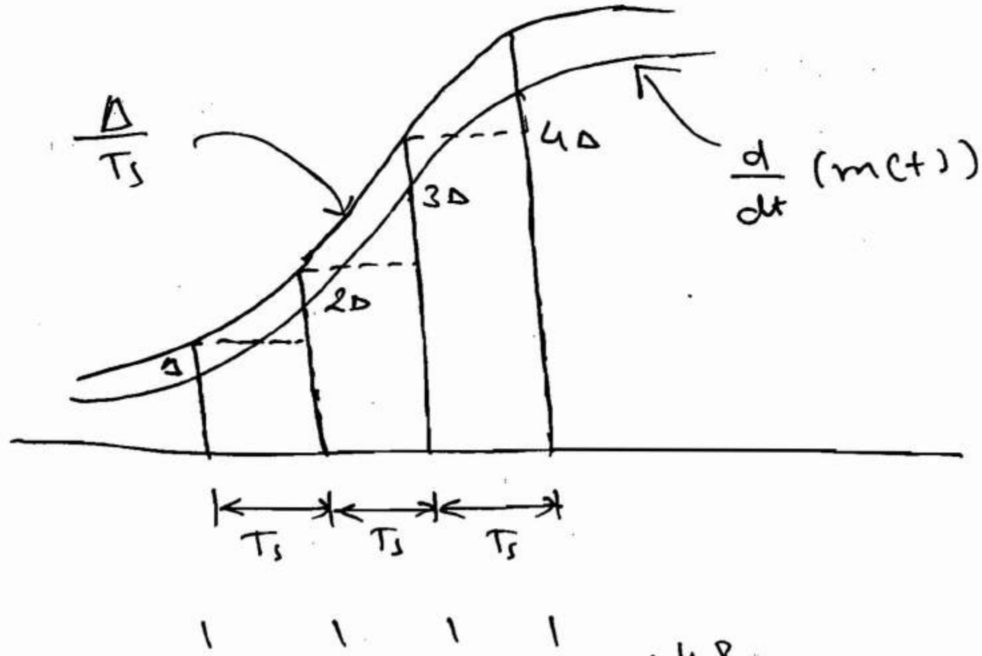
if $\boxed{\dfrac{\Delta}{T_s} < \dfrac{d}{dt} m(t)}$ → Slope over load. H.B

⇒ ② Assume that the Δ is large.



$$\therefore \quad \frac{\Delta}{} = \frac{d}{dt}(m(t))$$

③ Assume that Δ is very large,



← H.B

$\therefore$ $\boxed{\frac{\Delta}{T_s} > \frac{d}{dt} m(t).}$ → Granular Noise.

⇒ So, the optimum value of Δ is given by,

← H.B

$$\Rightarrow \boxed{\Delta = \frac{\frac{d}{dt} m(t)}{1/T_s}.}$$

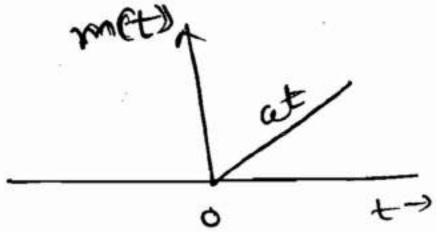
$$\boxed{\Delta = \frac{\text{Slope of the message signal}}{\text{Sampling rate.}}}$$

⇒ Granular Noise Power $= \dfrac{\delta^2 B}{3 f_s}$

$$\boxed{= \frac{\Delta^2 B}{3 f_s}} \leftarrow \text{H.B.}$$

Case-(i):

→ Assume that the message is a ramp signal $m(t) = at$



Slope $= \frac{d}{dt} m(t) = a$

$$\therefore \boxed{\Delta = \frac{a}{\text{samp. rate}}}$$

a Input to the DM is $m(t) = 5t$ and the sampling rate is 5000 samp/sec. Determine the step size.

Ans: here, $m(t) = 5t$, $a = 5$.

Sampling rate = 5000 samp/sec.

$$\therefore \quad \Delta = \frac{a}{\text{samp. rate}}$$

$$\Delta = \frac{5}{5000} = \frac{1}{(1000)}$$

$$\therefore \quad \boxed{\Delta = 1\text{mV}}$$

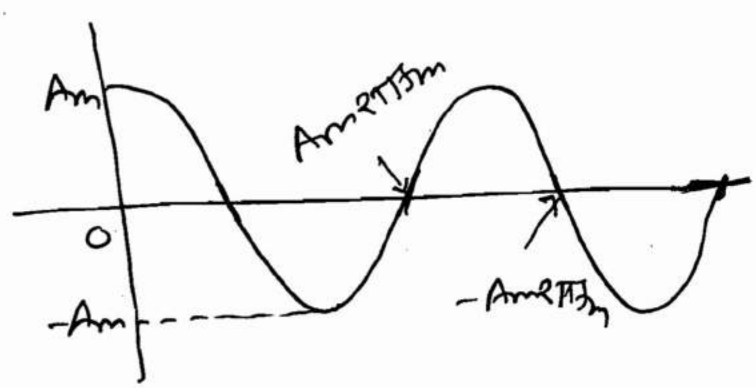
Case-(ii)

→ When $m(t) = A_m \cos 2\pi f_m t$

Slope of $m(t)$

$= \frac{d}{dt} m(t)$

$= -A_m 2\pi f_m \sin 2\pi f_m t$



$$\therefore \boxed{\Delta = \frac{A_m 2\pi f_m}{}} \leftarrow \text{H.B.}$$

Q The input to the DM $5\cos 1000t \times 2\pi$. The pulse rate is 36,000 pulses/sec. Determine the step size.

Ans:
$$m(t) = 5\cos 1000t \times 2\pi$$

$$A_m = 5, \quad 2\pi f_m = 2\pi \times 1000$$

$$\therefore \Delta = \frac{A_m 2\pi f_m}{1/T_s}.$$

Pulse rate = bit rate = Sampling rate
= 36,000.

$$\therefore \Delta = \frac{5 \times 2 \times \pi \times \cancel{1000}}{\cancel{36000}\ 36}$$

$$\boxed{\Delta = \frac{10\pi}{36}.}$$

Q The input to the DM is a sinusoidal signal whose freq. varies from 200 Hz to 4000 Hz. The Sampling rate is 8 times the nyquist rate. The peak amplitude of the signal is 1V. Determine the stepsize when the signal freq. is 800 Hz.

Ans: $f_m = 4000$ Hz.

Sampling rate = 8 × nyquist rate

Samp. rate = $8 \times 2 \times 4000$

$= 64000$ sample/sec.

$$\therefore \quad \Delta = \frac{A_m 2\pi f_m}{1/T_s}.$$

$$\therefore \quad \Delta = \frac{1 \times 2\pi \times \cancel{4000}^{\,500}}{\cancel{64000}\ 80}$$

$$\therefore \quad \boxed{\Delta = \frac{\pi}{40}\ V}$$

Q The input to the DM is $m(t) = A_m \cos 2\pi f_m t$. The stepsize $\Delta = 0.628V$ and the sampling rate is 40,000 sample/sec the combination of sinusoidal signal amplitude and freq. for which the slope overload distortion occurs.

A

	A_m	F_m
(A)	0.3 V	8 KHz
(B)	1.5 V	4 KHz.
(C)	3 V	1 KHz.
(d)	1.5 V	2 KHz.

Soln:

$\Delta = 0.628$ V , $\frac{1}{T_s} = 40{,}000$ samples/sec.

for slope over distortion

$$\frac{\Delta}{T_s} < \frac{d}{dt} m(t).$$

$$\therefore \quad A_m f_m > \Delta \times \frac{1}{T_s} \times \frac{1}{2\pi}$$

$$A_m \cdot f_m > \underset{\frac{1}{\cancel{10}}}{\cancel{0.628}} \times \underset{4000}{\cancel{40{,}000}} \times \frac{1}{2\pi}$$

$$\therefore \quad A_m \cdot f_m > 4000$$

So, Ans is (B) ~~because~~ because

$$A_m \cdot f_m = 1.5 \times 4 = 6000 > 4000.$$

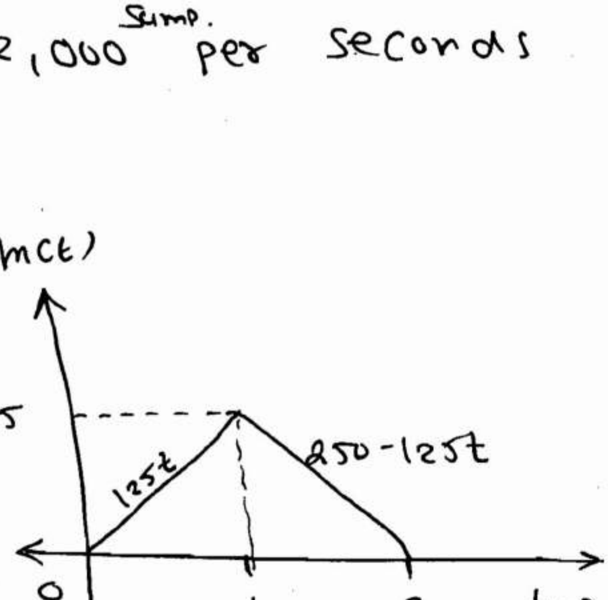
$\boxed{Q}$ Consider a message signal which is apply to a DM. $\cancel{m(t)} = 12$

$$m(t) = 125t\left[u(t) - u(t-1)\right] + (250 - 125t)\left[u(t-1) - u(t-2)\right].$$

The sampling rate is 32,000 samp. per seconds

Determine step size.

Sol^n:



$$\left|\frac{d(m(t))}{dt}\right|_{max} = 125$$

$$\frac{1}{T_s} = 32{,}000$$

$\therefore$

$$\Delta = \frac{\left|\frac{d}{dt} m(t)\right|_{max}}{1/T_s}.$$

$$\therefore \Delta = \frac{125}{32{,}000}.$$

$= 8$

⇒ In delta modulation the stepsize Δ is Constant and depends on the maximum slope. But the stepsize Δ should ~~should~~ be varied whenever the slope of signal changes.

⇒ In <u>Addeptive</u> <u>Delta</u> <u>Modulation</u> the stepsize is varied according to the slope of the message signal.

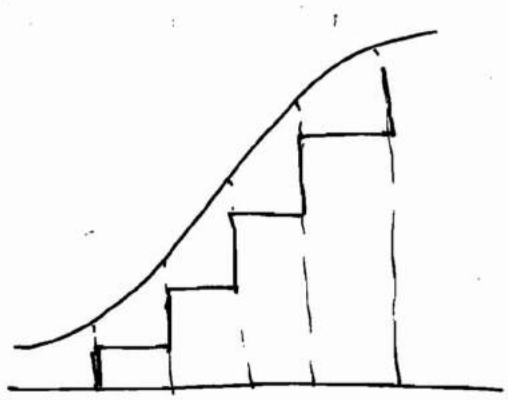
⇒ $\xrightarrow{i/p} \boxed{\alpha} \xrightarrow{o/p}$

$\Delta \propto$ Slope of the m(t).

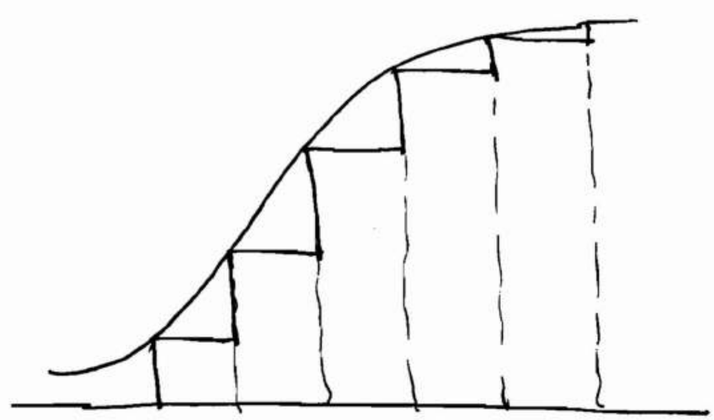
$\therefore \Delta \propto$ (present sample − previous sample).

$\Delta \propto$ i/p

(*)



(DM)



(ADM)