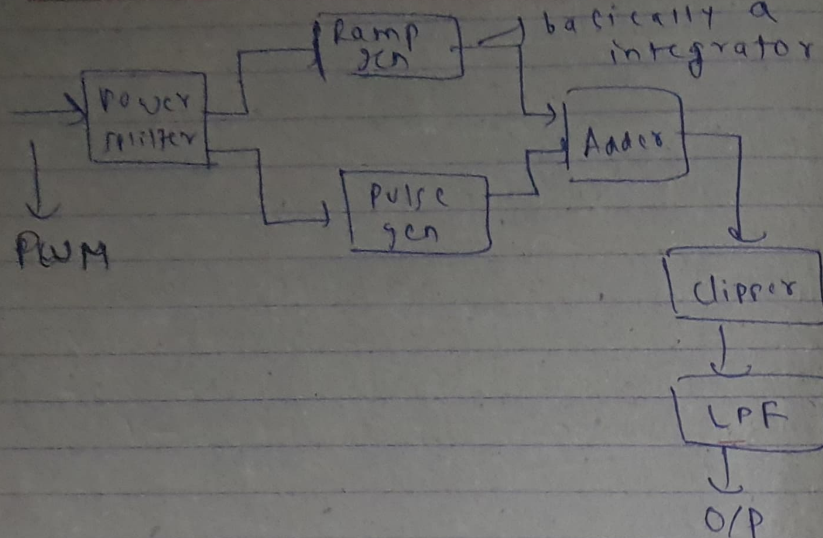
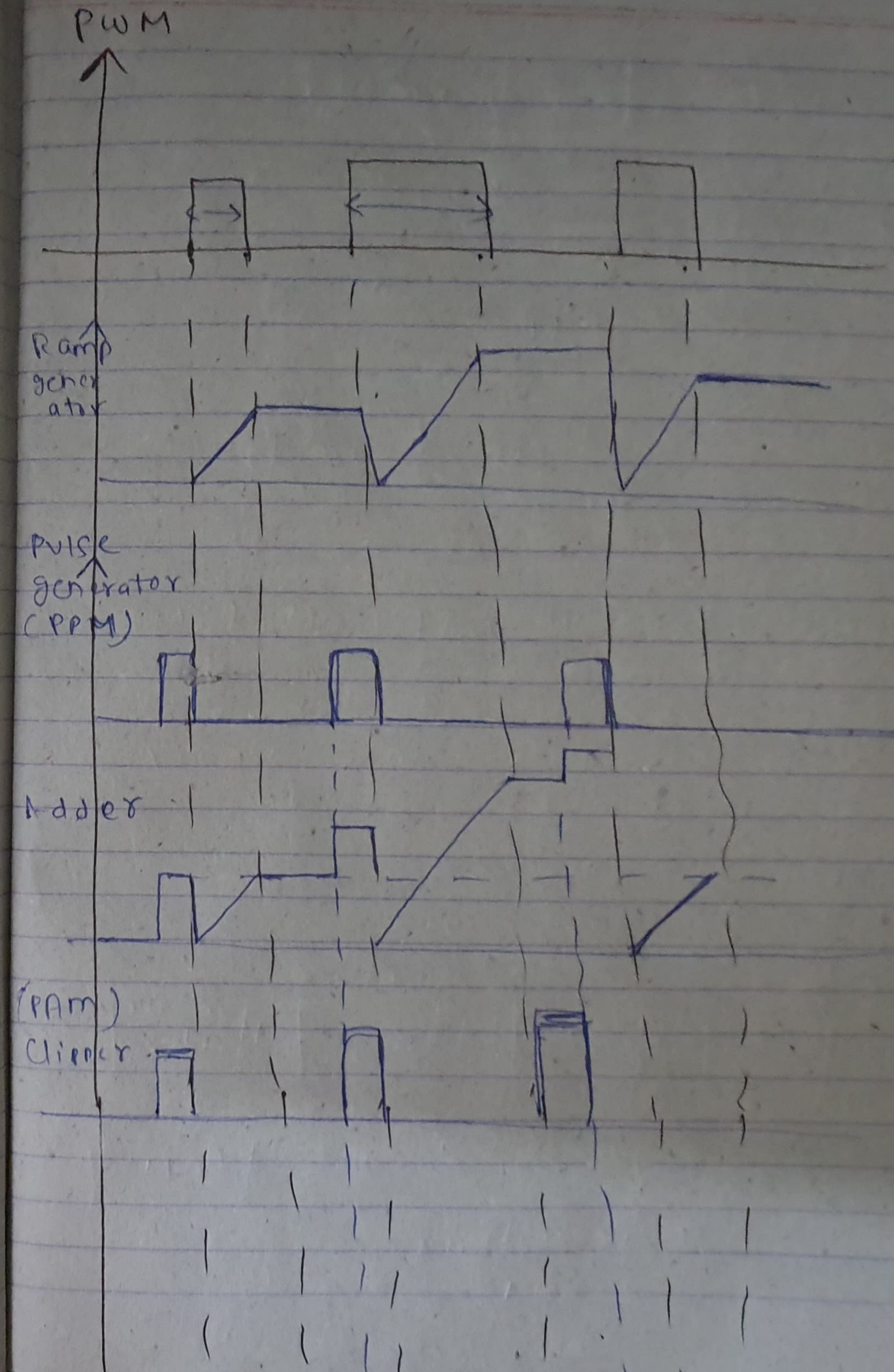
Lec 11

DETECTION OF PWM & PPM





Working:

Pulse gen = to generate PPM ⟹

generate PPM at each rising edge

Clipper = clips the DC component & convert this into a PAM signal

PAM → [LPF] → m(t)

* Overall summary

PWM/PPM → PAM → [LPF] → m(t)

PULSE CODE MODULATION (PCM)

purpose of PCM is to convert analog information into binary information.

Block Diagram

m(t) → [LPF] → [sampler] → [Quantizer] → [encoder ~~coder~~] → [PCM]

Transmitting end.

→ [regenerative repeaters (RR)] → [RR] → [Decoder] → [LPF] → m(t)

many RR

channel Transmission

receiver.

LPF: ① Band limit the signal

② avoids very high freq

③ Avoids aliasing
(Anti-aliasing filter
before the sampler)

Sampler: To obtain the instaneous
sample values of m(t)

Quantizer: rounding of the sampled value
to the nearest quantization level

encoder: To represent each quantized
~~level~~ value to a unique binary
code.

Importance of quantizer

$f_m = 1MHZ$

$F_s = 2\times10^6$ samples/sec

these many large samples
are to be taken to
encoder
a ~~quantizer~~, and encoding them

very different if Quantizer, does
not used & quantize (limit) the
samples

$\boxed{L = 2^n}$ → n bits for the sample

no of quantization levels

Q1) if $L = 4$, $n = 2$
2 bits

$$\begin{pmatrix} 0 & 0 \\ 0 & 1 \\ 1 & 0 \\ 1 & 1 \end{pmatrix}$$

RR: eliminate the channel noise
and resgenerate fresh copy of the
original signal.

Decoder: decode the pulse coded ~~encoding process~~ waveform

LPF: / Reconstruction filter:

To filter & read back the
original signal

Bit rate of PCM

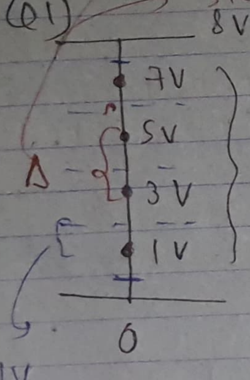
= no. of bits/sample × sampling rate

$= \boxed{n_b \times f_s}$

QUANTIZATION PROCESS

* rounding of the sample value to limit no. of samples to enable encoding process.

(Q1) → step size



four quantization level.

(SV) Sampled value		(QE) Quantization value
0.8 V	→	1V
2.2 V	→	3V
7.9 V	→	7V
7 V	→	7V

S.V = sampled value

Q.E = quantized value

Quantization error (S.V − Q.E)

1 − 0.8 = 0.2

0.8

0.9

0

* maximum value of quantization error

$\boxed{\max(Q_E) = \Delta/2}$; Δ = step size

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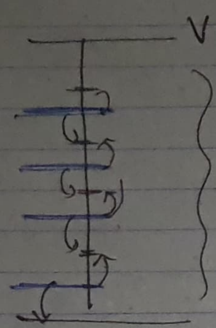
Quantization



range divided into L no. of equal of steps & middle point of each step = quantized level

L = no. of steps = no. of quantization level

$$\max(Q_E) = \Delta/2$$

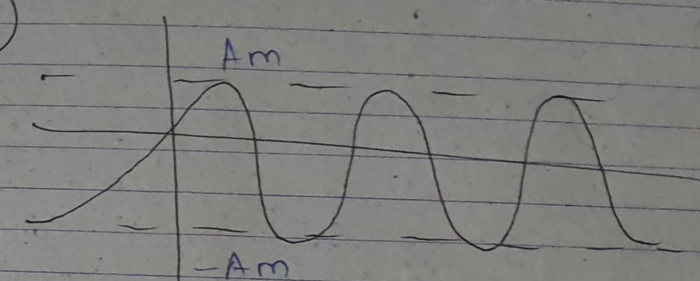
If n = no. of bits per sample

L = no. of quantization level

$$\boxed{L = 2^n}$$

$$\Delta = \frac{(V_{max} - V_{min})}{L}$$ → dynamic range (range in which samples = distributed)

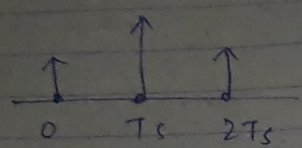
Ex)



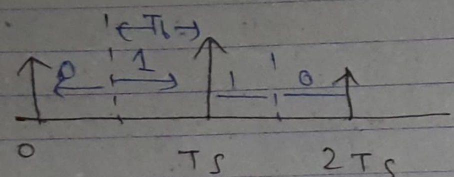
* $\Delta = \frac{Am + Am}{L} = \frac{2Am}{2^n}$

* $\boxed{Q_E = \text{Sampled valued} - \text{Quantized value}}$

T_s = sampling duration



Bit duration



$n = 2$ bits / sample

$$\boxed{T_b = T_s/2}$$

For n, no. of bits,

$$\boxed{T_b = \text{Bit duration} = T_s/n}$$

Bit rate (Bits/second) $= \dfrac{\text{bits}}{\text{sample}} \times \dfrac{\text{Sample}}{\text{second}}$

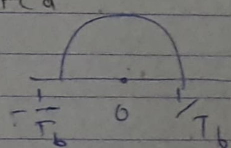
$$\boxed{R_b = n \cdot f_s}$$

$$\boxed{R_b = \frac{n}{T_s}}$$

MAX TRANSMITTER BW

1. 1 bit is Transmitted

$BW = 1/T_b$



2. 2 bits are transmitted

$BW = 1/2T_b$

3. 3 bits are transmitted

$BW = \dfrac{1}{3T_b}$

* $BW = \frac{R_b}{2}$, In practical scenario, atleast 2 bits are transmitted in a bunch,

It can easily transmit signals having bandwidth $\frac{R_b}{3}, \frac{R_b}{4}, \ldots \frac{R_b}{n}$

Q1) $m(t) = 10\cos(8\pi \times 10^3 t)$ is transmitted through 4 bit PCM. Find all the parameters?

Soln

$n = 4$ bits / sec

$m(t) = 10\cos(8\pi \times 10^3 t)$

$A_m = 10$

$f_m = 4KHZ$

$L = 2^n = 16$ quantization level

Step size $(\Delta) = \frac{V_{max} - V_{min}}{L}$

$= \frac{10-(-10)}{L}$

$= \frac{2 \times 10}{16}$

Sampling freq (f_s) $= 2f_m$

$= 2 \times 4K = 8K$

$(Q_e)_{max} = \pm \Delta/2 = \pm 20/32$ volts

bit rate $(R_b) = nf_s$

$= 4 \times 8 = 32K$

bit duration $(T_b) = 1/R_b$

max. $BW = R_b/2 = 16K$

Q2) $m(t)$ of $A_m = 20V$ & $f_m = 5KHZ$ is transmitted through 256 level PCM system.

Sampling rate = 25% higher than Nyquist rate. Find all the parameters?

Soln $A_m = 20V$

$f_m = 5KHZ$

$L = 256$

$f_s = NR + 25NR$

$L = 2^n$

$n = 8$ bits / sample

$NR = 2f_m = 10\,kHz$

$f_s = 10K + \frac{25}{100} = 12.5K$

$= 1.25 \times 10 = 12.5\,kHz$

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

$= \frac{2 \times 20}{256} = 0.15625\,V$

$(Q_e)_{max} = \pm \Delta/2$

$R_b = n f_s$

$T_b = 1/R_b$

$BW = R_b/2$

Q3) A sinusoidal msg signal is transmitted through PCM where $(Q_e)_{max}$ can be atmost 2% of peak to peak amplitude of msg signal. Find the no. of bits / sample required?

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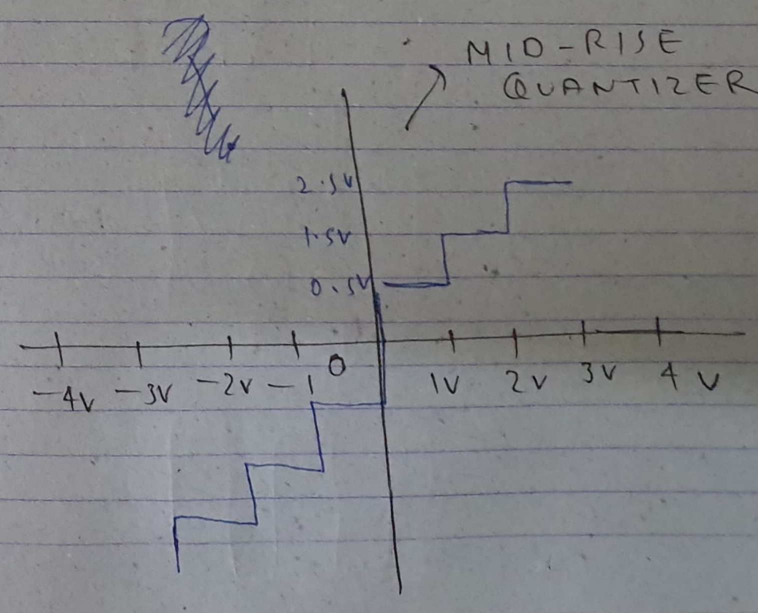
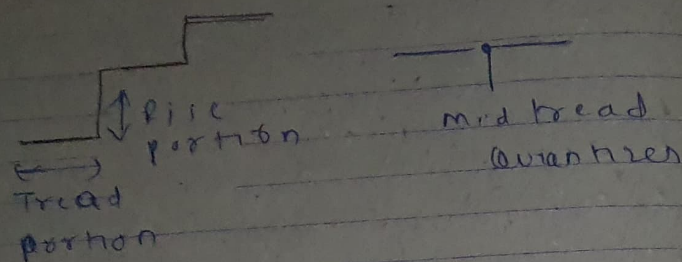
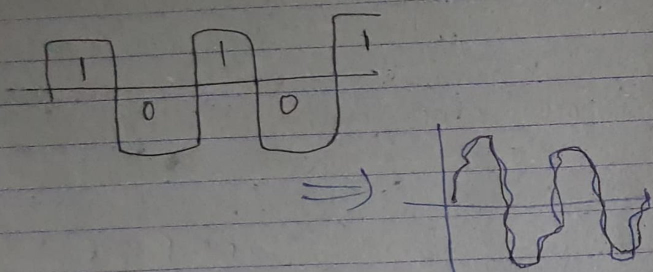
QUANTIZER CHARACTERISTICS



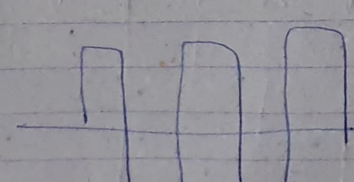


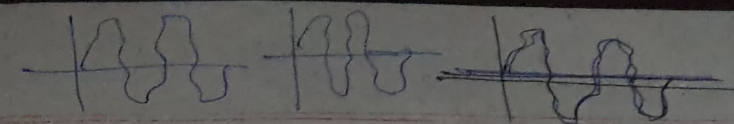
REGENERATIVE REPEATERS

→ threashold comparator



Threshold comparator (RR)

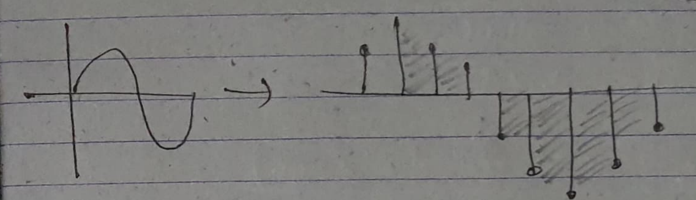


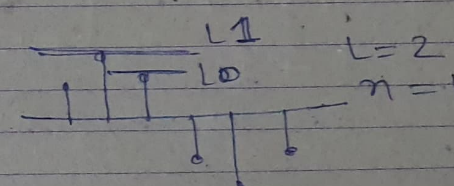


no. of regenerative repeaters

(1) ~~dcecbees~~ depend on distance b/w the transmitter & receiver

(2) Quality of channel





L0 = level 0
L1 = level 1

electrical representation in electrical waveforms of Binary signals

* Line coding Techniques

Line coding techniques

① **ON-OFF**

0 → 0V

1 → +ve

② **NRZ (non return to zero)**

0 → -ive

1 → +ve

③ **RZ (return to zero)**

0 → 0V

1 → $T_b/2$ (+ve)
    $T_b/2$ 0V

④ **differential encoding**

0 → complement of prev. o/p

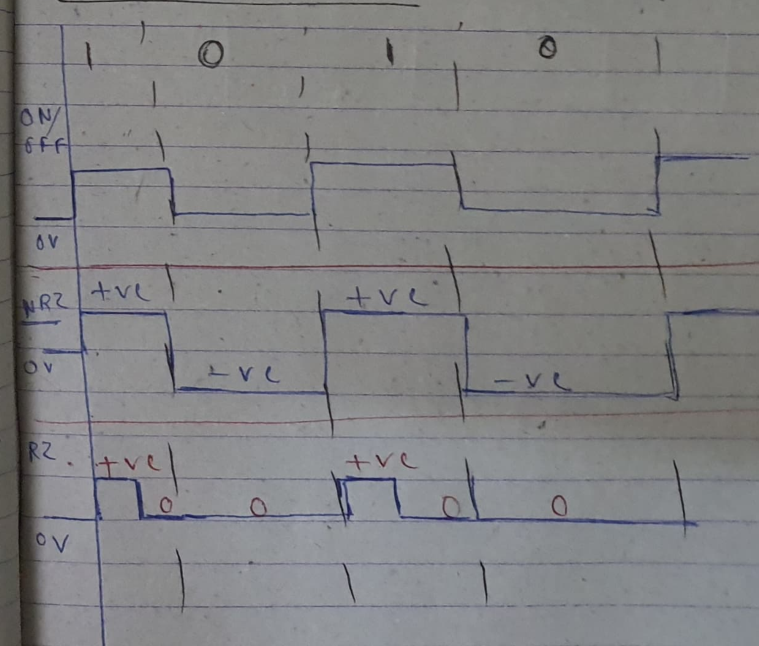
1 → same as previous o/p

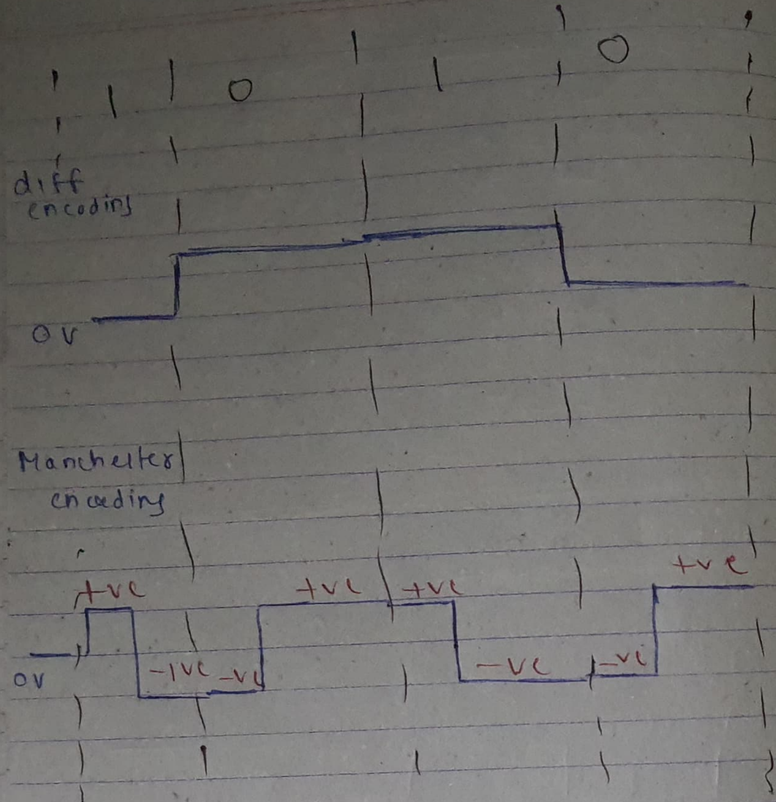
⑤ **Manchester encoding**

0 → $T_b/2$ (-ive) first half
    $T_b/2$ (+ive) for next half

1 → $T_b/2$ (+ve)
    $T_b/2$ (-ive)

let Bit sequence:





NOISES IN PCM System

1. channel noise
2. Quantization noise

Channel noise can be eliminated with help of regenerative repeaters

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Quantization noise

$$[Q_e]_{max} = \Delta/2$$

By reducing step size (Δ), the quantization error will reduce.

more no. of bits / sample

if $L=4$, $n=2$ bits/sample

$L=256$, $n=8$ bits/sample

if $n \uparrow$, BW reqd $\uparrow$

To decrease Δ, value of n has to be ~~decreased~~ increased

$$n\uparrow \Rightarrow \Delta\downarrow \Rightarrow Q_e\downarrow$$

But value of n cannot be increased to a very large value.

$$n\uparrow \Rightarrow BW\uparrow = n\,f_s/2$$

n should be such that BW is not high, & Q_e is minimum.