Digital to digital convension

3 techniques : 1) Line coding (always need)

2) Block coding

3) Scrambling

Signal Element

smallest entity:
digital signal

what we **can** send
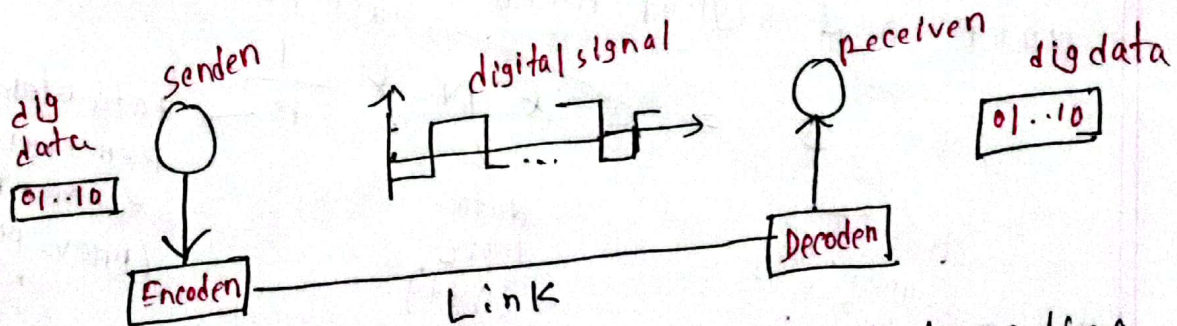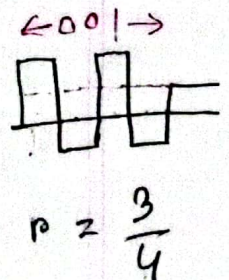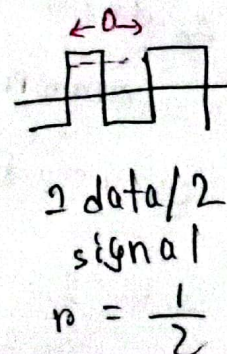
Data Element

bit

what we (need)
(to) send

dig data
01..10

Senden

digital signal

Receiver   dig data
01..10

Encoder ──── Link ──── Decoder

fig : Line coding and decoding

↑ 1 data element
← 0 →
↓ 1 signal
$r = \frac{1}{1} = 1$

← 0 1 →
2 data/ 1 signal
$r = \frac{2}{1} = 2$

← 0 →
2 data/ 2 signal
$r = \frac{1}{2}$

← 0 0 1 →
$r = \frac{3}{4}$
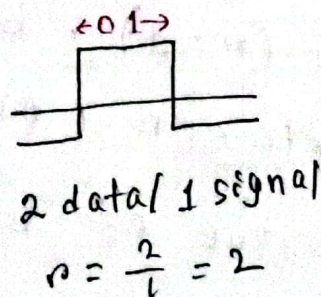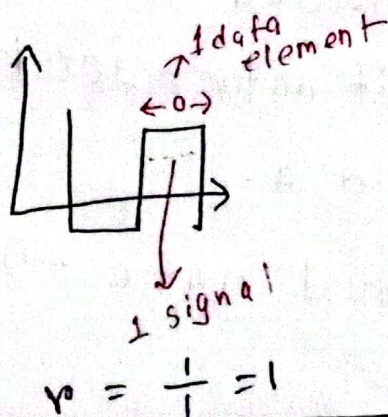
Data rate (N)	Signal rate (S)
no. of data elements (bits) sent in 1 S.	no. of signal elements sent in 1 s
unit : $\boxed{bps}$	unit: $\underline{baud}$
bit rate	✓pulse rate ✓modulation rate ✓baud rate

\# relationship between data rate and signal rate

$$S = c \times N \times \frac{1}{r}$$

→ case factor

c → No. of signal elements (baud)

N ↓ data rate (bit)

$\frac{1}{r}$ → data elements per signal element (prev. page pics)

Ex : A signal is carrying data in which 1 data element is encoded as 1 signal element (r = 1). bit rate = 100 kbps

c is between 0 and 1.

avg. value of baud rate = ?

$$\Rightarrow \quad S = \frac{0+1}{2} \times (100 \times 1000) \times \frac{1}{1} = 50\,000$$
$$\text{baud}$$

N.B: (Bandwidth) of digital signal

    → actual = ∞

    effective → finite

Ex: max. data rate, $N_{max} = 2 \times B \times \log_2 L$ →(bit rate)
               (nyquist)

  →yes

Does this agree with prev. formula?

           prev.: $S = c \times N \times \frac{1}{r}$

→ $\frac{1}{2} = c$ (assume) $N = \frac{S\,r}{c}$

$$\boxed{N_{max} = \frac{1}{\underset{\underset{1/2}{\uparrow}}{c}} \times B \times r} = 2 \times B \times \log_2 L$$

$$B_{min} = \frac{N\,C}{r}$$

* Baseline: In decoding a digital signal to digital data, the receiver calculates

   avg. of recieved signal power

$\rightarrow$ long string of o's and 1's sent

Baseline wandering: make difficult for
                        receiven to decode
                        correctly.

not good line
coding scheme

Ex: the recieven clock is 0.1% fasten than
sender clock. How many extra bps does the
receiven recieve, data rate = 1 kbps.
                                and 1 Mbps

$\Rightarrow$ 1) $N = 1000$ bps
$$\frac{+ \boxed{1}}{1001 \text{ bps}} \text{ (extra)}$$

$1000 \times \frac{0.1}{100}$

$= 1$

2) $N = 1,000,000$
$$\frac{+ 1000}{1001000 \text{ bps}}$$

$$\boxed{\begin{array}{c} 1,000,000 \\ \times \frac{0.1}{100} \\ = 1000 \end{array}}$$

DC components: $V = $ constant,
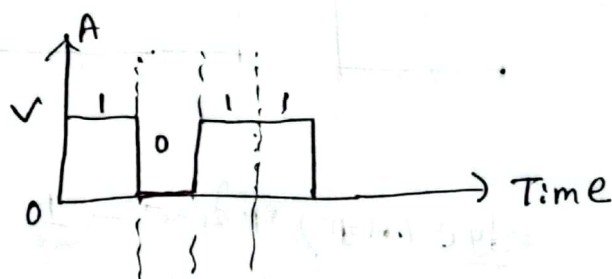 $f \rightarrow$ low

NRZ(L) → Level
, NRZ(I) → Invension

bit level
भी mid भी
zeno back
होता है

NRZ — Non-neturn to 0
AMJ — Alternate Mank Invension

Line coding schemes (5)

1) Unipolan — NRZ

2) Polan — NRZ, RZ, biphase
NRZL, NRZI

Manchesten
Differential Differential manchesten

3) Bipolan — AMI, pseudotennany

4) multilevel — 2B/1Q, 8B/6T, 4U-PAM 5

5) multitnansition — MLT-3

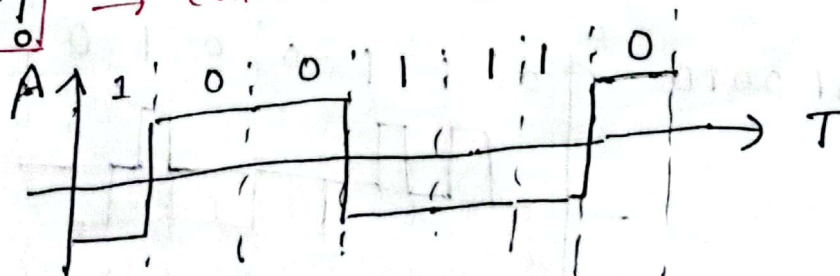Unipolan: all signal levels → on 1 side of time axis

positive V—1
zeno V— 0

Polan:
NRZ:
NRZ-L:

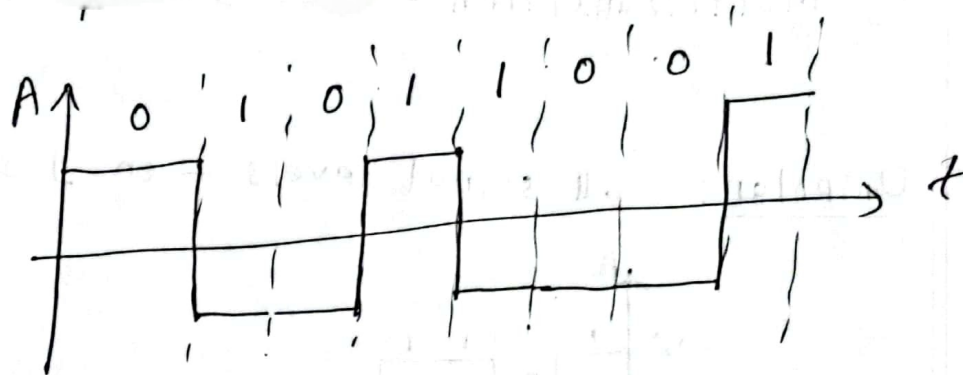1 → neg V
0 → pos V

100 111 → convent to dig. signal

A 1 0 0 1 1 1 0

NRZ-I

$1 \rightarrow$ transition

$0 \rightarrow$ no "

Q: 011001

data
to signal

সিগন্যাল 1
আসলে 0
add করে নিব

A↑ 0 | 1 | 0 | 1 | 1 | 0 | 0 | 1

→ t

signal to data: edge (লম্ফ) থাকলে — ①
                    নাথাকলে — 0

RZ:

1 0 → pos to zero
   0 → neg to zero

0110 0010   A↑ 0 | 1 | 1 | 0 | 0 | 1 | 0

→ t
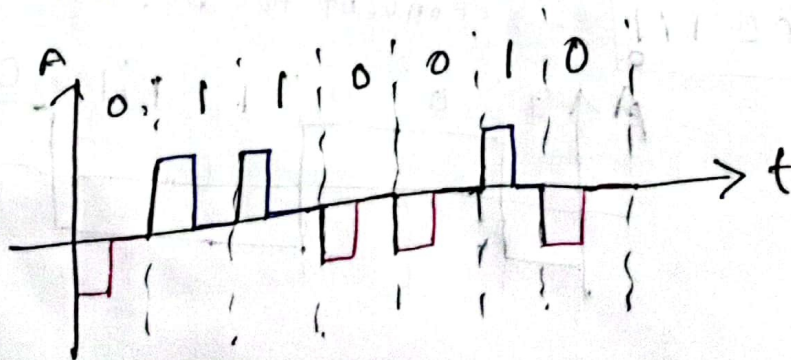
biphase: **manchesten:** $0 \rightarrow$ neg to pos
$1 \rightarrow$ pos to neg

10101100

A
1 0 1 0 1 1 0 0
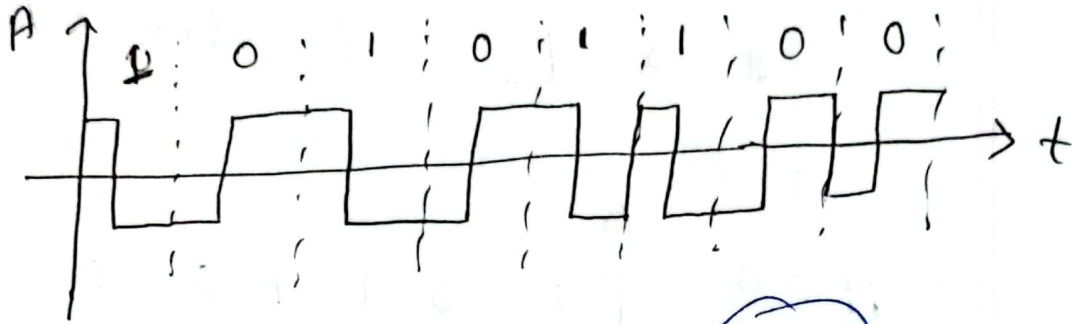
mention
এটা মূল আলোচনা
বাংলা
manchasten
follow
this

Differential manchesten / manchesten (কোন) → manchasten এর দরকার

$0 \rightarrow$ pos to neg
$1 \rightarrow$ neg to pos
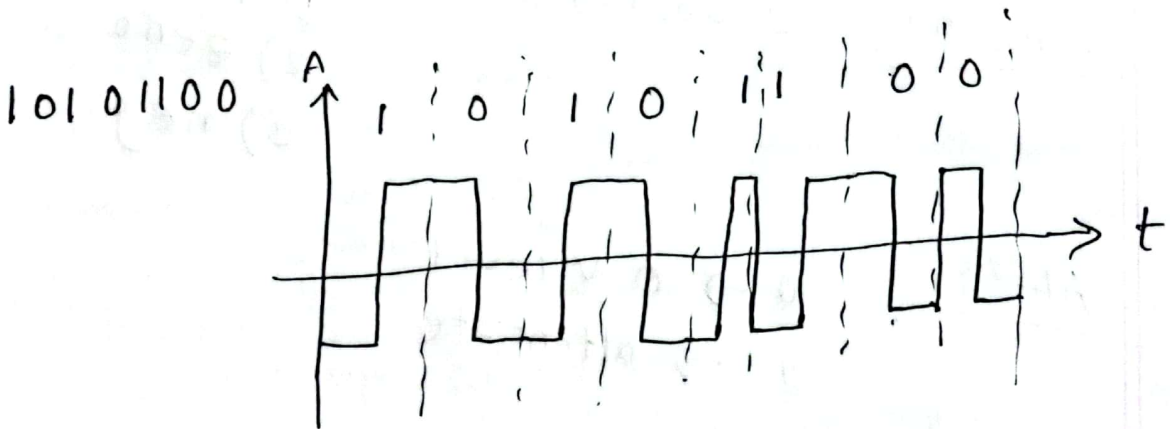
10101100 A
1 0 1 0 1 1 0 0

Diffenential Manchesen

$$0 \rightarrow \sqcap , \sqcup \quad (\text{transition})$$

$$1 \rightarrow \sqcap , \sqcup \quad (\text{no } \text{"})$$

1011 0 0
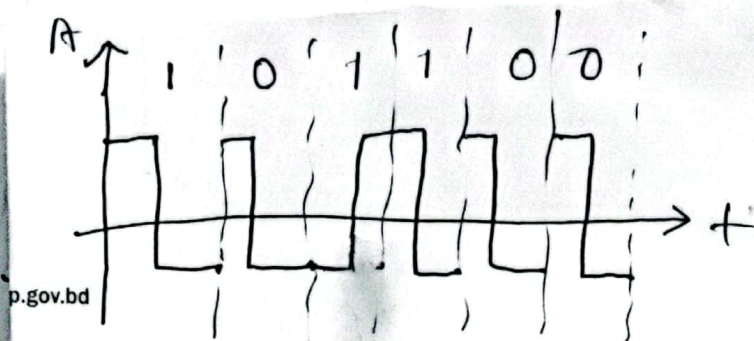
Bipolan: 3 voltage level: 1) pos
2) zeno
3) neg

Altennate mank invension.

AMI: $0 \rightarrow 0$ v level
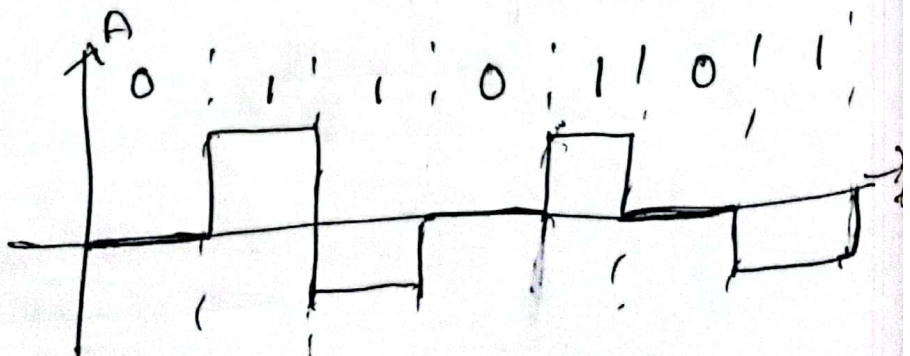$1 \rightarrow$ altennate

0110101:

Pseudoternary:

$1 \rightarrow$ zero voltage

$0 \rightarrow$ alternate

0 1 1 0 1 0 1
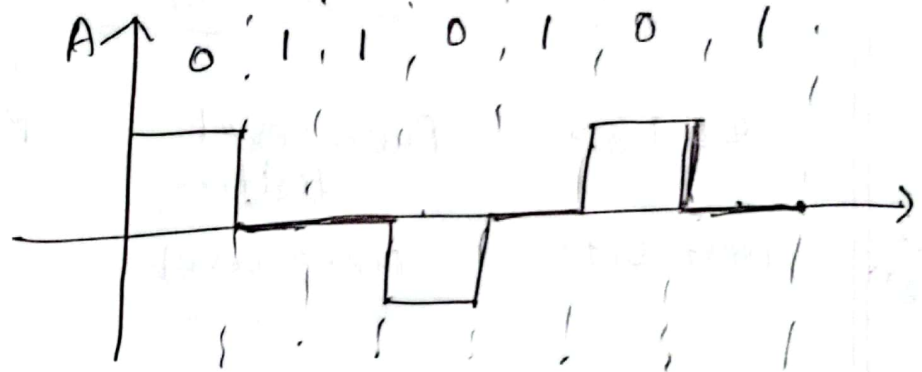
Multilevel: 2B1Q

mBnL

$m \rightarrow$ length of binary pattern   no. of data pattern $= 2^m$

$B \rightarrow$ Binary data

$n \rightarrow$ length of signal pattern   no. of signal pattern $= L^n$

$L -$ no. of levels in signaling

B (Binary) — $L = 2$

T (Ternary) — $L = 3$

Q (Quarternary) — $L = 4$

Sn (2B1Q) $m = 2$, $n = 1$, $L = 4$

00/10/11/01 no. of <s>da</s> binary pat. $= 2^n = 4$

$\pm1, \pm3 \leftarrow$ no. of signal pat. $= 4^1 = 4$

Table given

2B1Q	Prev. Level Positive	Prev. Level Negative
Next Bit	Next Level	Next level
0 0	+ 1	− 1
0 1	+ 3	− 3
1 0	− 1	+ 1
1 1	− 3	+ 3

Dig. data : 0 0 11 01 10 01

A ↑
+3 ┤ 00   11   0 1   10   01
+1
−1
−3   → time
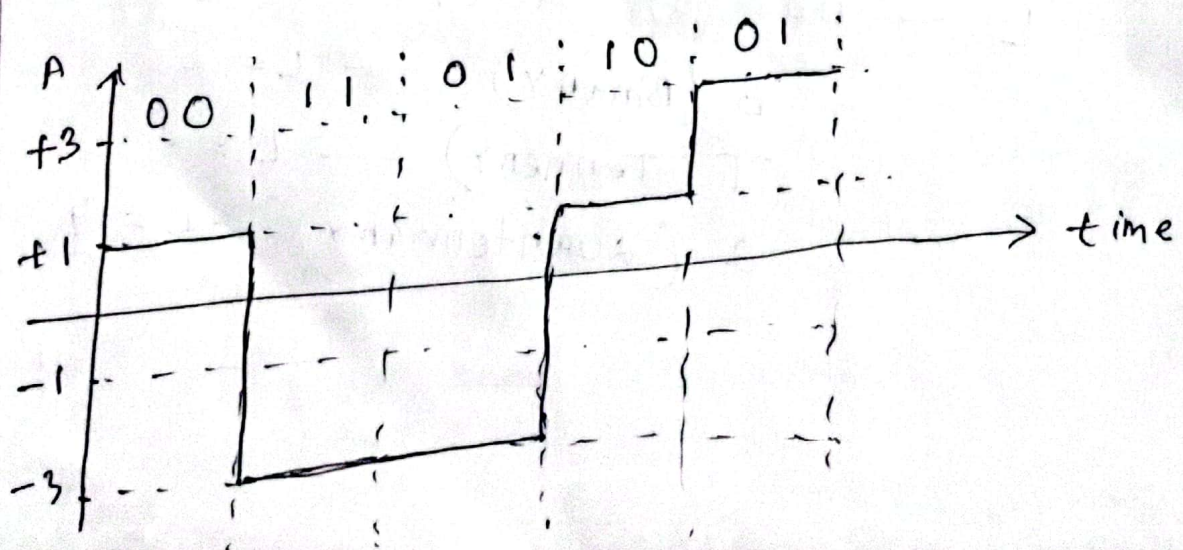
8 B 6 T :

$m = 8$, $n = 6$, $L = 3$

no. of binary pat $= 2^8 = 256$ 2^m

no. " signal " $= 6^3 = 216$

L^n $3^6 = 729$

unused

↖ Redundant signal $= 729 - 256 = 473$

- synchronization
- error detection
- DC balance

Hexadecimal

Data	Code
0 0	- + 0 0 - +
1 1	- 0 - 0 + +
0 A	0 - + + - 0
8 bit	6 bit

Data	Code
2 A	+ 0 + - 0 -
5 0	+ - - + 0 +
5 3	- + - + + 0
8 bit	6 bit

DC balance : - - + + 0 + : weight + 1

- 0 - 0 + + : weight 0

Dig. Data : 0 0 0 1 0 0 0 1   0 1 0 1 0 0 1 1   0 1 0 1 0 0 0 0

11 ↗   [0 0 0 1 0 0 0 1]

53 ↗   [0 1 0 1 0 0 1 1]
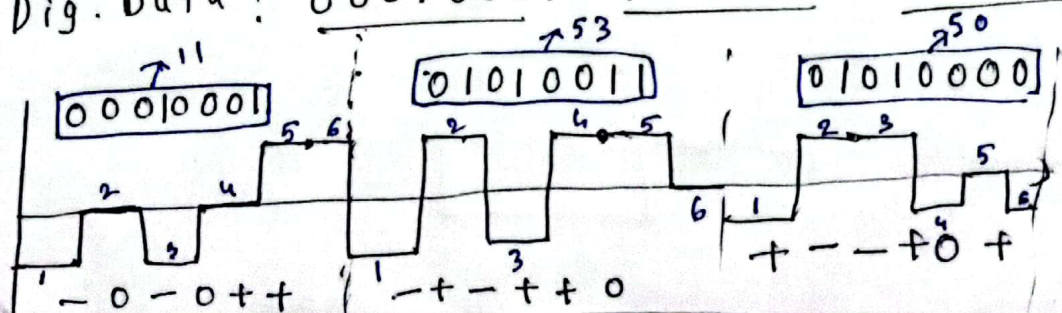
50 ↗   [0 1 0 1 0 0 0 0]

- 0 - 0 + +   - + - + + 0   + - - - + 0 +

Hex   Bin

0 0 0 1 . 0 0 0 1 → 11 → - 0 - 0 + +

                        weight: 0

0 1 0 1 0 0 1 1 → 53 → - + - + + 0

                              wt: + 1

                        [1st + 1 → no change]

                                            wt: +1

0 1 0 1 0 0 0 0 → 50 → **+ - - - + 0 +**

                                  2nd + 1 ; invent

                                    - + + - 0 -   [only for 2-3 के

            wt: -1 ←   (graph 'a . main करे चाहिए)

necieven

find negative

— इसके लिए invent

    करना रहेगा

So, pnev. graph total wt = 0 + (+1) + (-1)

                              = 0   (target)

$$2^8 = 256$$
$$5^4 = 625$$

Redundant → zero

$$= 625 - 256 = 369$$

4D – PAM 5

0 0 0 1 0 1 1 1

250 Mbps → 125 MBd

→ 125 MBd

→ 125 MBd

→ 125 MBd
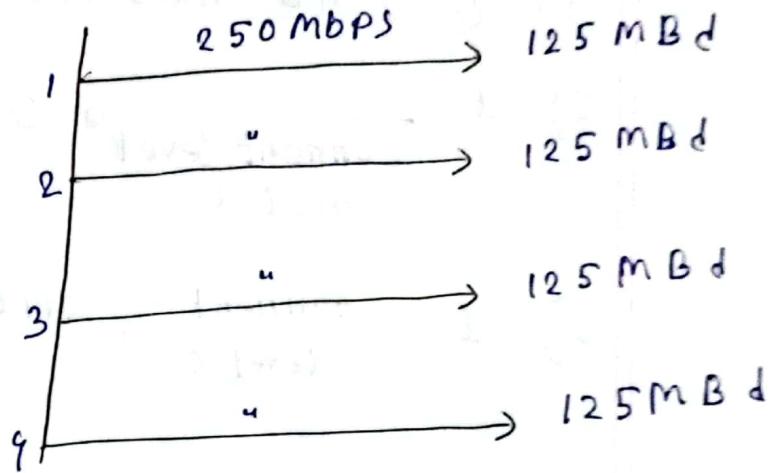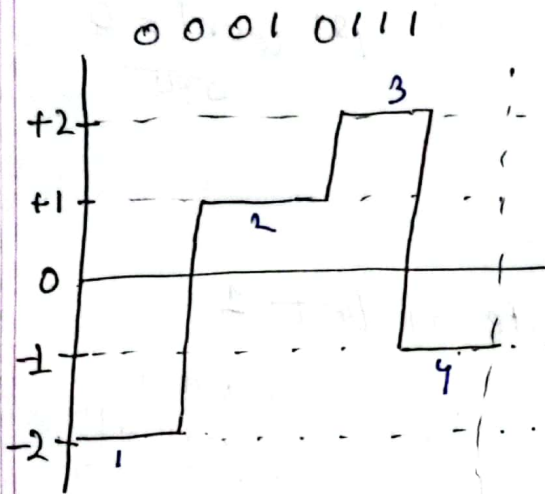
Suppose, wine no. = 1

0 → redundant (or)

this → 8 B 4 Q

no. of binary pattern $= 2^8 = 256$

" " signal " $= 4^4 = 256$

Multi transition:
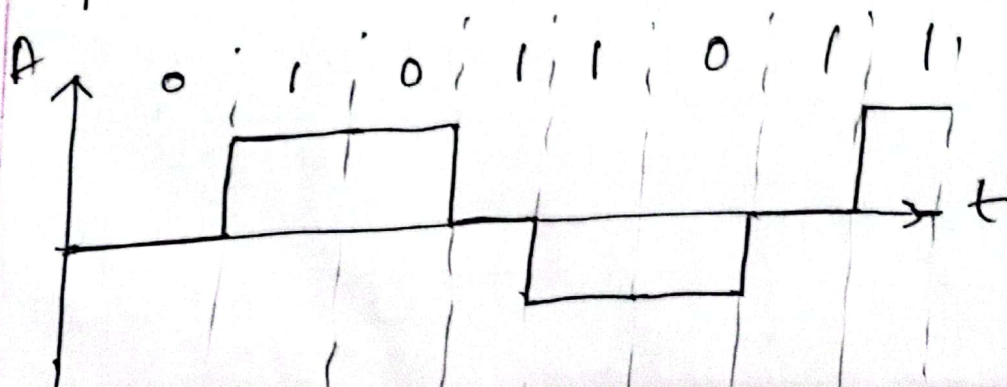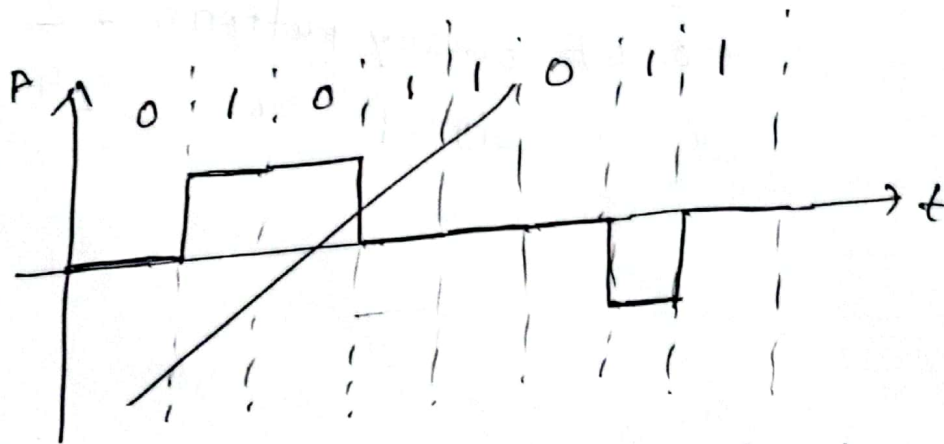## MLT-3

Rules:

$+$ 0 $-$

1) 0 → no transition

1st level = 0
5·व

2) 1 $\xrightarrow[\text{current level not 0}]{}$ 0

3) 1 $\xrightarrow[\text{level 0}]{\text{current}}$ opposite of last 1

↑ If ques में दिया गया हो

* Suppose, | last level = 0 V
           | last non-zeno = neg (-1)

Dig. data   01011011

A↑   0 ¦ 1 ¦ 0 ¦ 1 ¦ 1 ¦ 0 ¦ 1 ¦ 1 ¦

→ t

A↑   0 ¦ 1 ¦ 0 ¦ 1 ¦ 1 ¦ 0 ¦ 1 ¦ 1 ¦

→ t

Block Coding

bitno → increase
line coding → improve

— to gain redundancy   → 4B/5B

Division of a stream into m-bit groups

m/mB $m < r$

| 1 1 0 ... 1 | 0 0 0 ... 1 | ... | 0 1 0 ... 1 |
  m bits   m.bits   m bits

↓
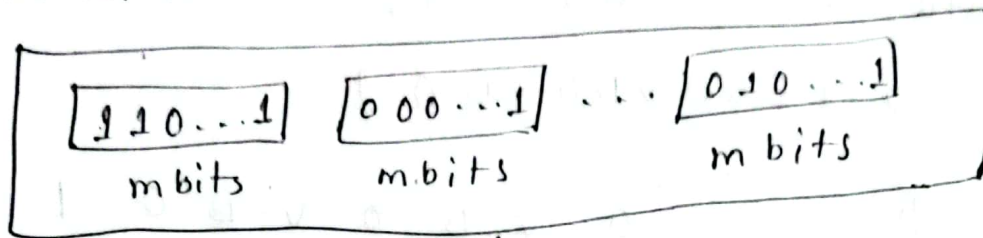
mB to nB
substitution

| 0 1 0 ... 1 0 1 | 0 0 0 ... 0 01 | ... | 0 11 ... 111 |
   n bits   n bits   n bits
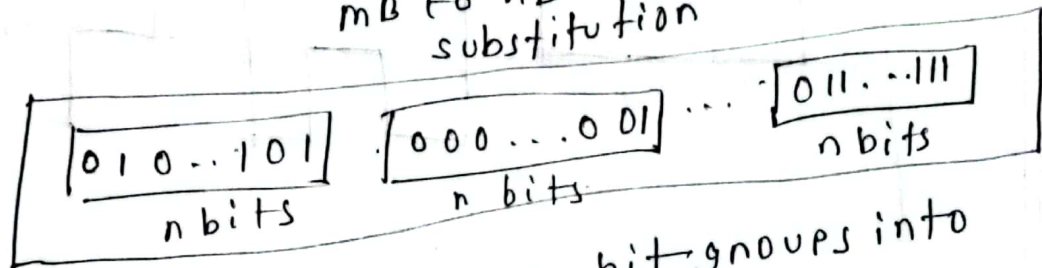
Combining n-bit groups into
a streams

mB/nB

Step: Division → substitution → Combi-
                                    nation

Scrambling ┌→ A.mp (improve)
           └→ Zero substitution

B 8 Z S → Bipolar with 8 zero substitution

8 zero ⟶ 0 0 0 VB 0 VB

V(violation) — same as last non-zero level

B (Bipolar) — opposite to last non-zero
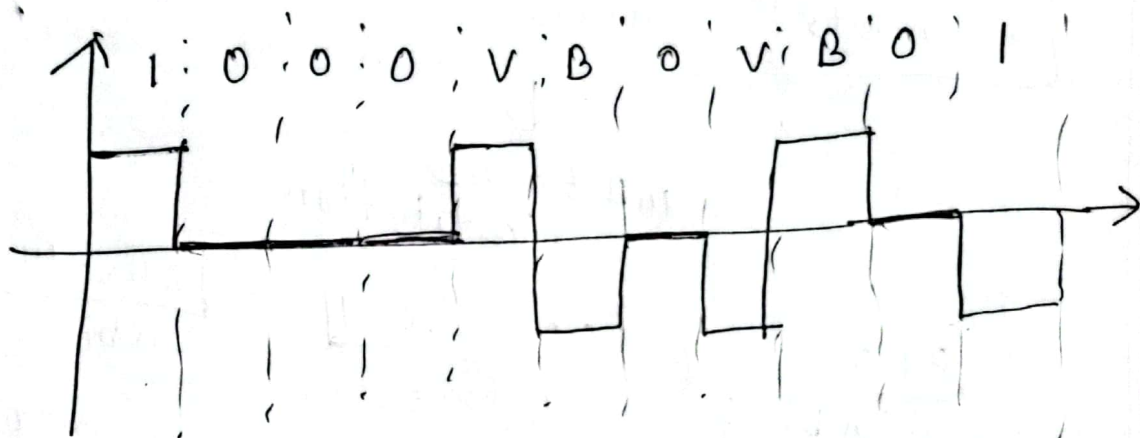   level

$0 \rightarrow$ zeno level

$1 \rightarrow$ opposite to last non-zeno level

Assume, last non-zeno (-1)

Data: $1\ 0\ 0\ 0\ 0\ 0\ 0\ 0\ 0\ 1$

$\rightarrow 1\ 0\ 0\ 0\ VB\ 0\ VB\ 0\ 1$

$1\ :\ 0\ :\ 0\ :\ 0\ ;\ V\ ;\ B\ ,\ 0\ ;\ V\ ,\ B\ ,\ 0\ ,\ 1$

(HDB3) High Density Bipolan 3 zeno

4 zenoes $\rightarrow \underline{000\ V}$ on $\underline{\underline{B00\ V}}$

last non-zeno के बाद के → odd — $000\ V$

even $\rightarrow B00\ V$

$V \rightarrow$ same as last non-zeno level

$B \rightarrow$ opposite to last non-zeno level

assume, last non-zeno negative

Dig. Data: 1 0 0 0011 0 0 0 0 0