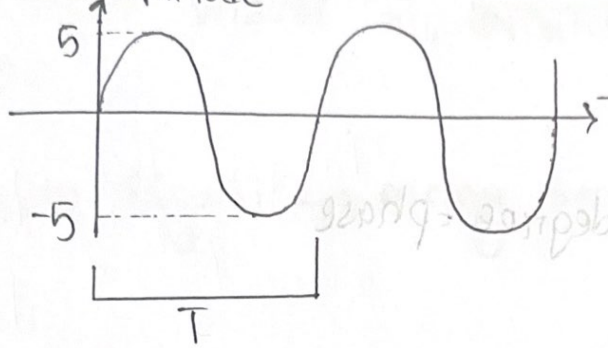
Period Frequency Phase Wave



Peak Amplitude = 5

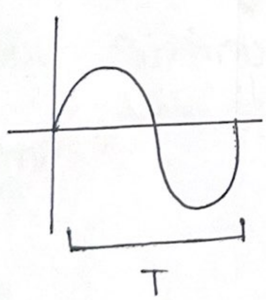
Peak to Peak = $|5+(-5)|$ = 10

Time Period = To complete a cycle.

Frequency = 1 second how many cycle.

$T = 1/f$ or, $f = 1/T$

Wavelength

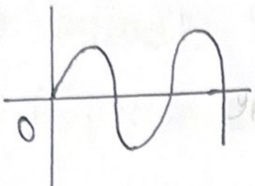


- Signal (যেটি single) যে time lagbe = wavelength.
- Propagation speed x Period

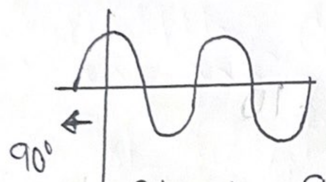
(λ) speed = $CT = C/f$

Ex: In a vaccum, light propagated with a speed of 3×10^8 m/s. Red light frequency = 4×10^{14} Hz. Wavelength of Red Light = $\frac{3.8 \times 10^8}{4 \times 10^{14}} = 750 \times 10^{-9}$

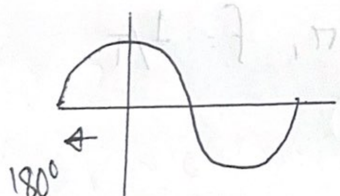
Phase



Start = 0 degree = phase

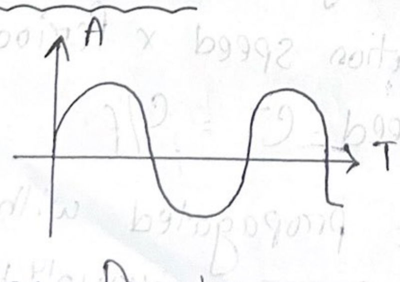


Start = 90 degree = phase.

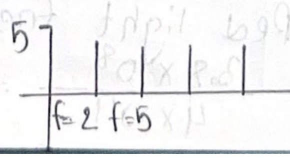


Start = 180 degree = phase

Time Domain



Frequency Domain

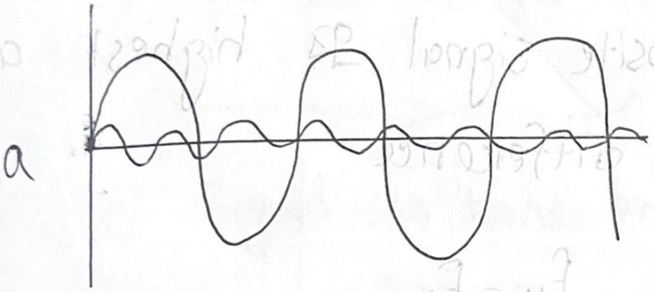


Peak amplitude and frequency representation.

Lecture : 07 Date: 23/02/24

Data communication এ আমরা single signal দিয়ে কাজ করতে পারবো না, আমাদের composite signal লাগবে।

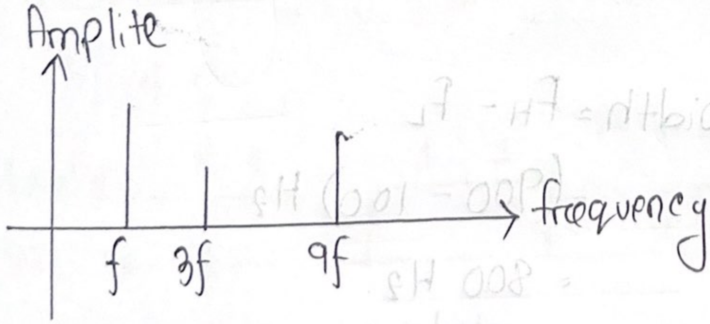
Composite signal → many simple sine signal.



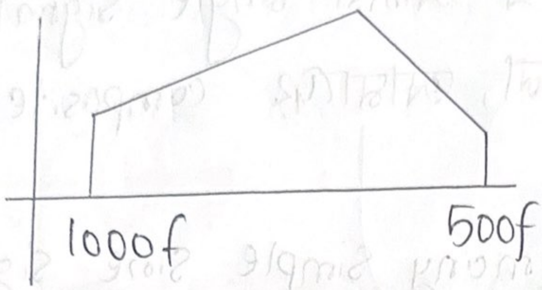
→ composite signal.

Composite signal যদি periodic হয় তাহলে decomposition করার সময় discrete frequency পাবো।

composite signal (aperiodic) → decomposition করার সময় continuous ~~signa~~ frequency পাবো।



[Representation of a Periodic]



non periodic signal

Bandwidth: Composite signal এর highest and lowest frequency difference

$$\text{Bandwidth} = f_H - F_L$$

Ex: 3

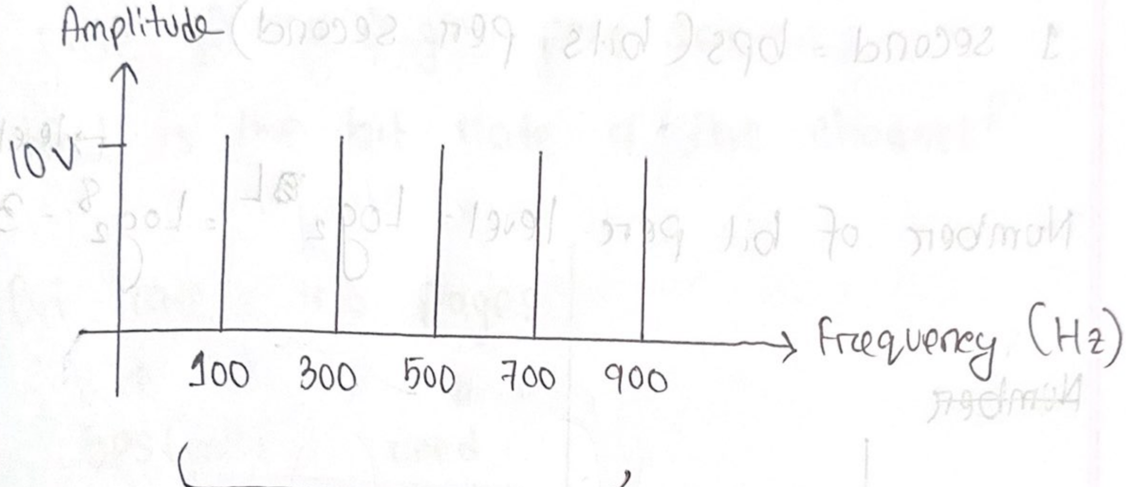
Composite periodic signal

5 sine signal.

Frequency = 100, 300, 500, 700, 900 Hz.

$$\text{Bandwidth} = F_H - F_L$$
$$= (900 - 100)\ Hz$$
$$= 800\ Hz.$$

And draw the spectrum assuming all component have a maximum amplitude of 10 v.



Signal এর bandwidth

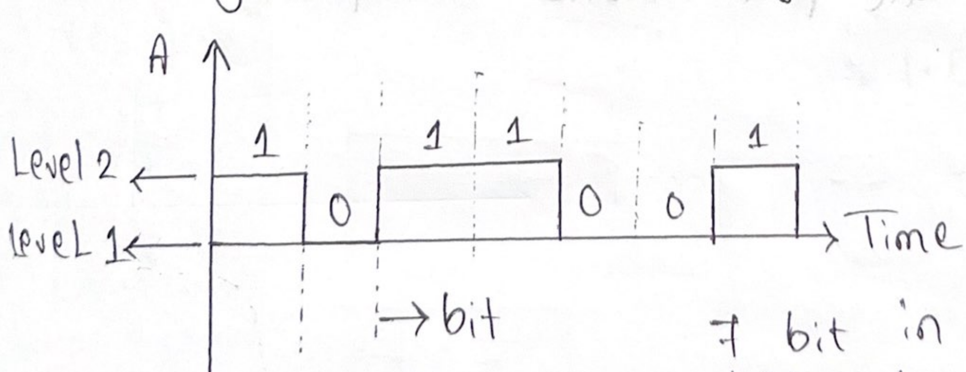
800 Hz.

<u>We basically work with digital signal.</u>

1/0 নিয়ে কাজ।

1 → positive voltage } দুটি দিয়ে 2 level এর

0 → negative voltage } বেশি signal হবে না।



7 bit in 1 sec

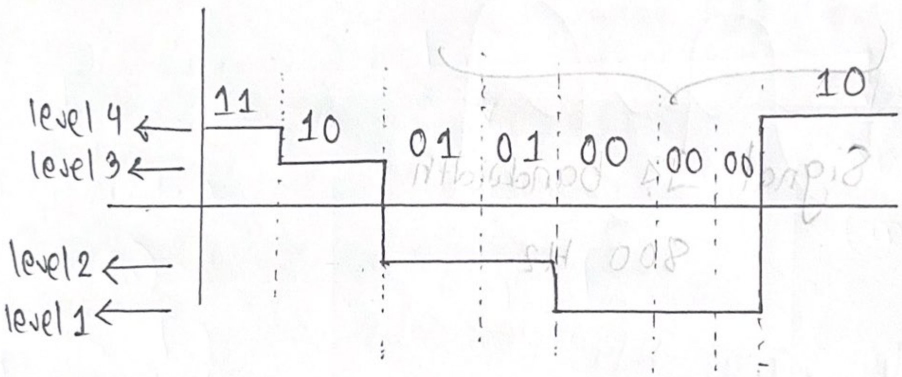
bit rate = 7 bps

Number of bits that we can ~~traverse~~ (send) in 1 second = bps (bits per second)

Number of bit per level = $\log_2 L = \log_2 8 = 3$

(L → level)

~~Number~~



Number of bits per level = $\log_2 L = \log_2 4 = 2$

16 bits $\rightarrow$ 1 second.

Bit rate per second : 16 bps.

Ex: 3.18 Assume you will download a documents at the rate of 100 pages per second.
What is the bit rate of the channel?

Bit rate = 100 pages

↑ bps (unit)

↓ need second.

→ 1 page → 24 line

→ 1 line → 80 character

→ 1 character → 8 bit

→ 1 page → $(24 \times 80 \times 8) = 15,360$ bits

→ 100 pages → $(100 \times 24 \times 80 \times 8) = 15,360,00$ bits.

$= 1.536$ Mbps.

Bit Length

Bit length = propagation speed × bit duration

Transmission Impairment:

Impairment

- Attenuation
- Distortion
- Noise

Attenuation

(math)

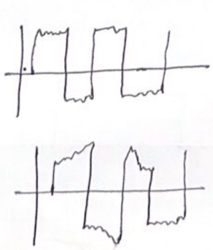
{ loss of energy }

Transmission medium এর resistance থাকে যার ফলে energy loss হয়। (amplify করে signal loss theke original signal এ নেই

Distortion

Change of form or shape.

Delay হতে পারে then phase change হয় and shape change হয়।



Noise

(math)

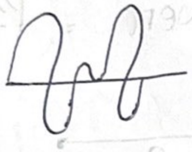
extra signal add

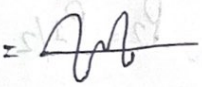
thermal / induced / cross talk

electron এর random motion এর কারণে thermal noise create হয়।

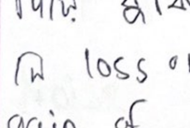
Source (motor / generator) এর মাধ্যমে কিছু extra noise create হয় যেটি induced noise.

Signal
এর shape
ঠিক থাকবে
but size
choto



= 

reciver end
এ আসলে
amplifier use
করে original
signal বানায়।

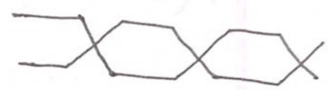


decibel(dB)
দিয়ে বুঝি
যে loss or
gain of
energy হচ্ছে
নাকি,

{ $dB = 10\log_{10} P_2/P_1$ }

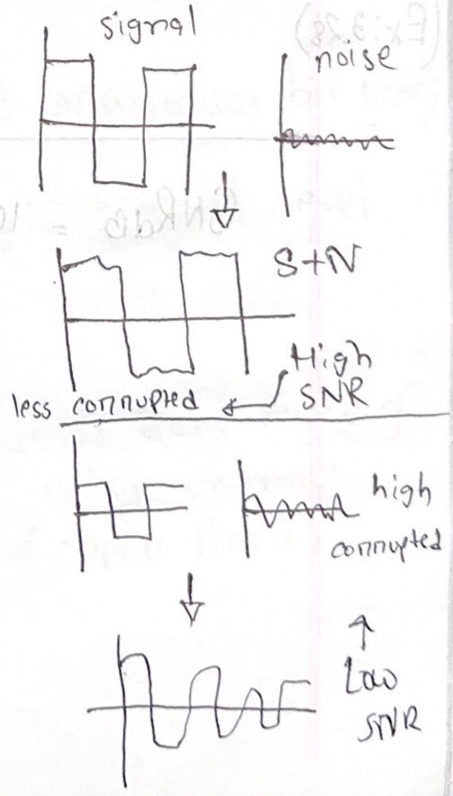
↳ strength

1টা wire এর
উপর আরেকটা
wire লাগালে
যে effect
হয় সেটা
cross-talk
noise.



Signal to Noise Ratio (SNR).

$$SNR = \frac{\text{average signal power}}{\text{average noise power}}$$



(Ex-3.26) Signal → end power reduced to one-half? Calculate attenuation or dB or loss / Gain?

$$dB = 10 \log_{10} P_2/P_1$$

$$= 10 \log_{10} \frac{0.5 \cancel{P_1}}{\cancel{P_1}}$$

$$= -3\ dB$$

↑ loss

Previous power = P_1

end power = $P_1/2$

P_1 —— $P_2 = P_1/2$

x: 3.28)

$$SNR_{dB} = 10 \log_{10} SNR$$

Conversion শিখতে হবে।

Data Rate Limit :

Data rate depends on 3 factors :

i) Bandwidth available

ii) Level of the signals

iii) Quality of the channel (level of noise).

Noiseless channel is theoritical and real life impossible.

Noiseless channel :

Nyquest Bit rate → (theoritical maximum bit rate)

$$\text{bitrate} = 2 \times \text{bandwidth} \times \log_2 L$$

L → signal level.

Noise Channel :

Shannon capacity → (theoritical highest data rate of a noisy channel) (upper limit).

$$C = \text{bandwidth} \times \log_2 (1 + SNR).$$

Ex: 3.41 Channel → 1 MHz bandwidth.

SNR = 63

bitrate and signal level.

$C = \text{bandwidth} \times \log_2(1+SNR)$.

$= 10^6 \times \log_2(1+63)$

bitrate = 6 Mbps [upper limit হটা, lower value 4 Mbps নিলে ভালো]

↳ Lower limit

bitrate = 2 × Bandwidth × $\log_2 L$ → level

6 Mbps নিয়ে ও maths হবে না, যারানো, 2 টাই দিব, ← 4 Mbps = $2 \times 10^6 \times \log_2 L$

∴ L = 4.

(Ans).

Lecture :08 Date: 24/02/2024

3.6 Performance

- Bandwidth → H_z ↑ , BPS ↑ } Proportional to each other. Theoritical value.

$\therefore$ Bandwidth $= F_H - F_L$ {(Highest - Lowest) frequency}.

- Throughput: How fast a data is transmitted.

BW = 10 Mbps

Throughput = 7 Mbps.

- Latency:

→ Propagation time
→ Transmission time
→ Queuing time
→ Processing time

} adding all four = Latency.

→ Propagation time = $\frac{\text{Distance}}{\text{Propagation speed}}$

→ Transmission time = $\frac{\text{Message size}}{\text{Bandwidth}}$

→ Queing time = Packet line

→ Processing time = Processor (slow/fast)

Ex-3.7 What are the Propagation time & transmission time for 5 Mbps message if the bandwidth of the network is 1 Mbps?

Assume, the distance between sender & Reciever is 12000 km and light travels at $2.4 \times 10^8 ms^{-1}$.

$$P.T = \frac{12000\ km\ (\times 1000\ m)}{2.4 \times 10^8 ms^{-1}}$$

$= 0.5$ second.

$$T.T = \frac{5\ MB}{1\ MBPS}$$

$$= \frac{5 \times 10^6 \times 8}{10^6}$$

$= 40$ S

{3.28, 3.18, $Log_2 L$ imp}

{SNR & SNR DB → conversion
1 byte → 8 bits
1 character → 8 bits}

Chaptere : 04

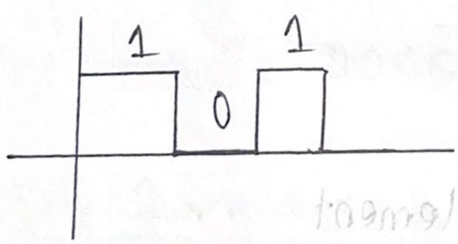
Digital Transmission

Digital to Digital Transmission
Analog to Digital Transmission

D-D

→ Line coding
→ Block coding
→ Scrambling

Signal Element :



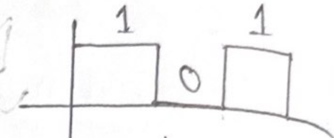
—— = signal element

Data Element :

1/0 = data element .

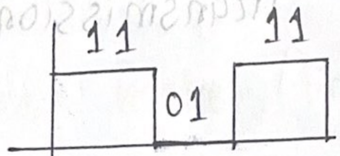
One data element per signal element (r)

$$r = \frac{\text{data element}}{\text{Signal element}} = 1/1 \longrightarrow$$



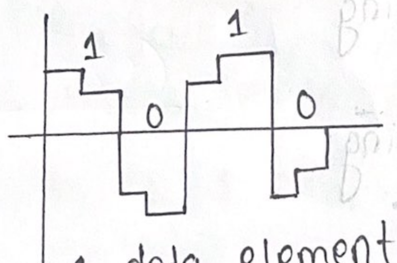
1 data element per signal element

$$r = 2/1$$



2 data element per signal element.

$$r = 1/2$$



1 data element per 2 signal element.

Signal Rate:

— 1 second → Signal element

Signal rate ← Pulse rate ← Bandwidth ← $S = N/r$

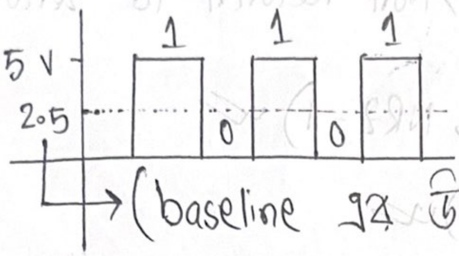
N → Data rate

r → (Proportion of Signal elem / data elem)

Data Rate: Same as bit rate.

Per second → how many bit.

Baseline Wandering:



(baseline এর উপরে kichu আসলে 1 dhorbo and baseline এর নিচে kichu আসলে 0 ধরবো)

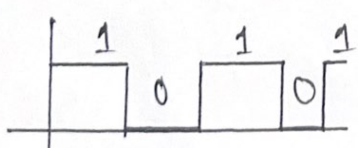
অনেক time 111111110 → আসলে, তখন 0 আর ধরতে পারে না।

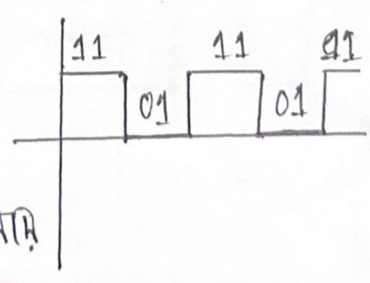
• DC Component:

frequency অনেক কমে যায়, voltage কমে যায়, তাই বেশি frequency আসলে ধরতে পারে না।

0000000001 → ধরতে পারে না

• **Self Syncronization:** Sender and Receiver এর clock same time এ না থাকলে sync হবে না।



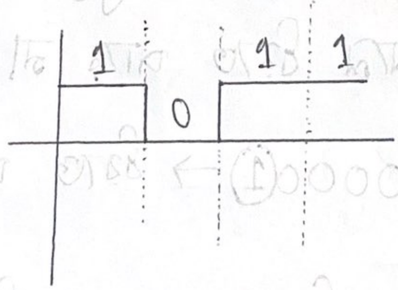


bit sync হয় নাই

Line Coding

- → Uni polar (NRZ → Non return to zero)
- → Polar (NRZ-L, NRZ-I)
- → Bi-polar (AMI)
- → Multi-level
- → Multi transmission (MLT-3)

• Uni Polar (NRZ):



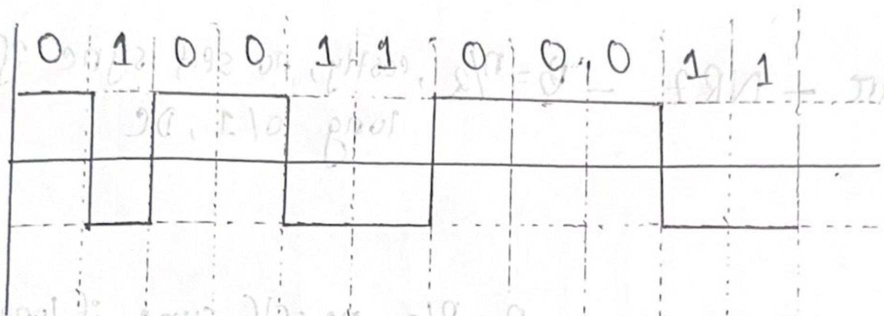
1 → +ve

0 → zero voltage.

যেকোন এক side এ হবে।

Lecture : 09 Date : 29/02/2024

NRZ-L & NRZ-I (Polar)



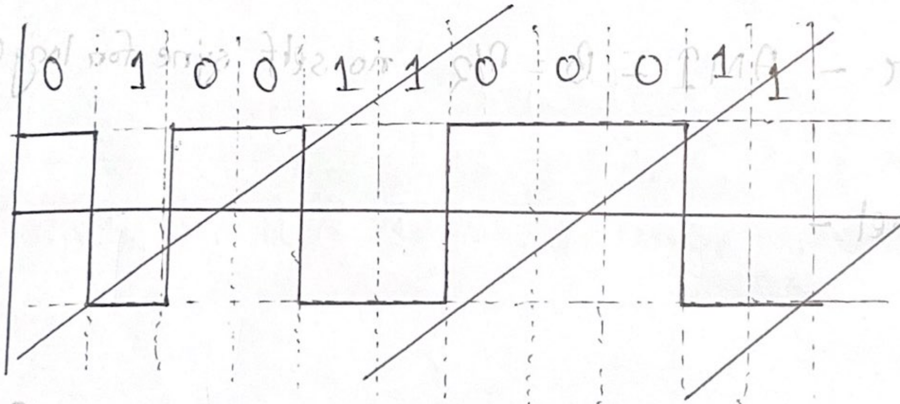
$S = N/r = 1$

$S = N$

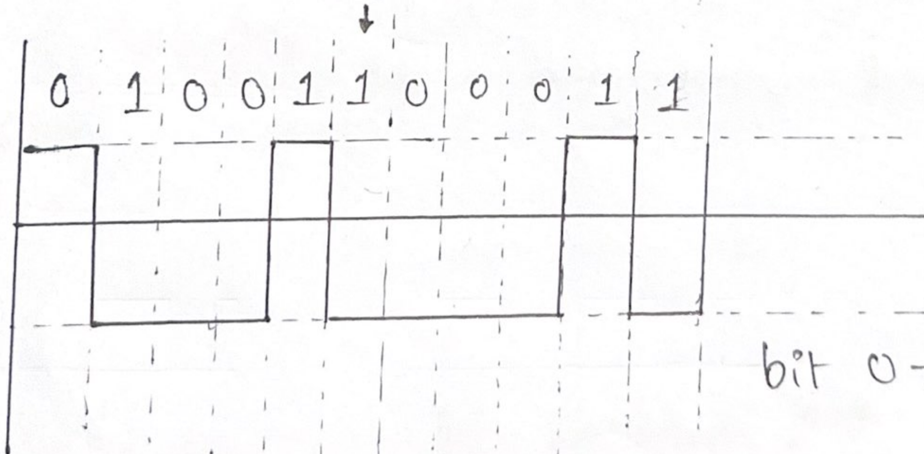
$S_{Average} = N/2$

$r = \frac{\text{data element}}{\text{signal element}} = 1/1 = 1$

NRZ-L → level $\begin{bmatrix} +ve \rightarrow 0 \\ -ve \rightarrow 1 \end{bmatrix}$



NRZ-I → inversion



bit 0 → no change

bit 1 → change

Summary of line coding schemes (table) 4.1

Unipolar – NRZ – $B = n/2$, costly, no self sync if long 0/1, DC

Polar – NRZ-L – $B = n/2$ no self sync if long 0/1, DC

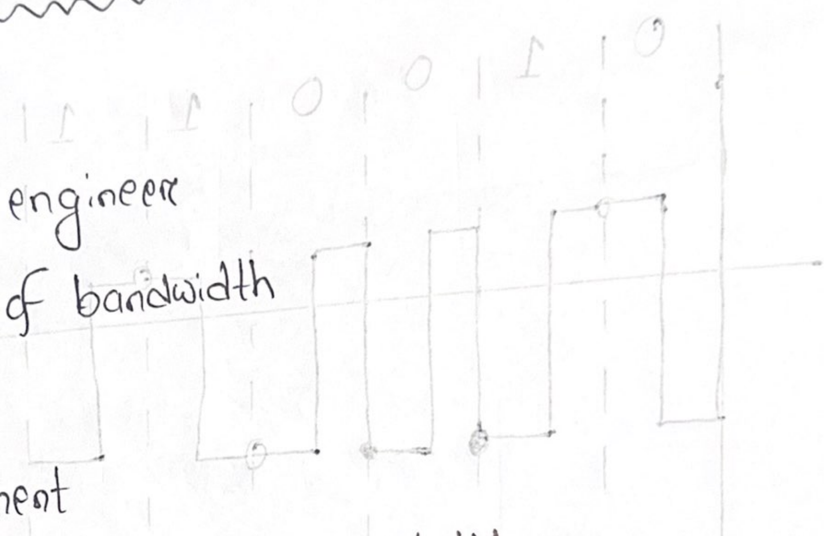
NRZ-I – $B = n/2$ no self sync for long 0, DC

Bipolar – AMI – $B = n/2$ no self sync for long 0, DC

Multilevel –

Multi transmission – MLT-3 – $B = n/3$ no self sync for long 0.

NRZ - Pros and Cons



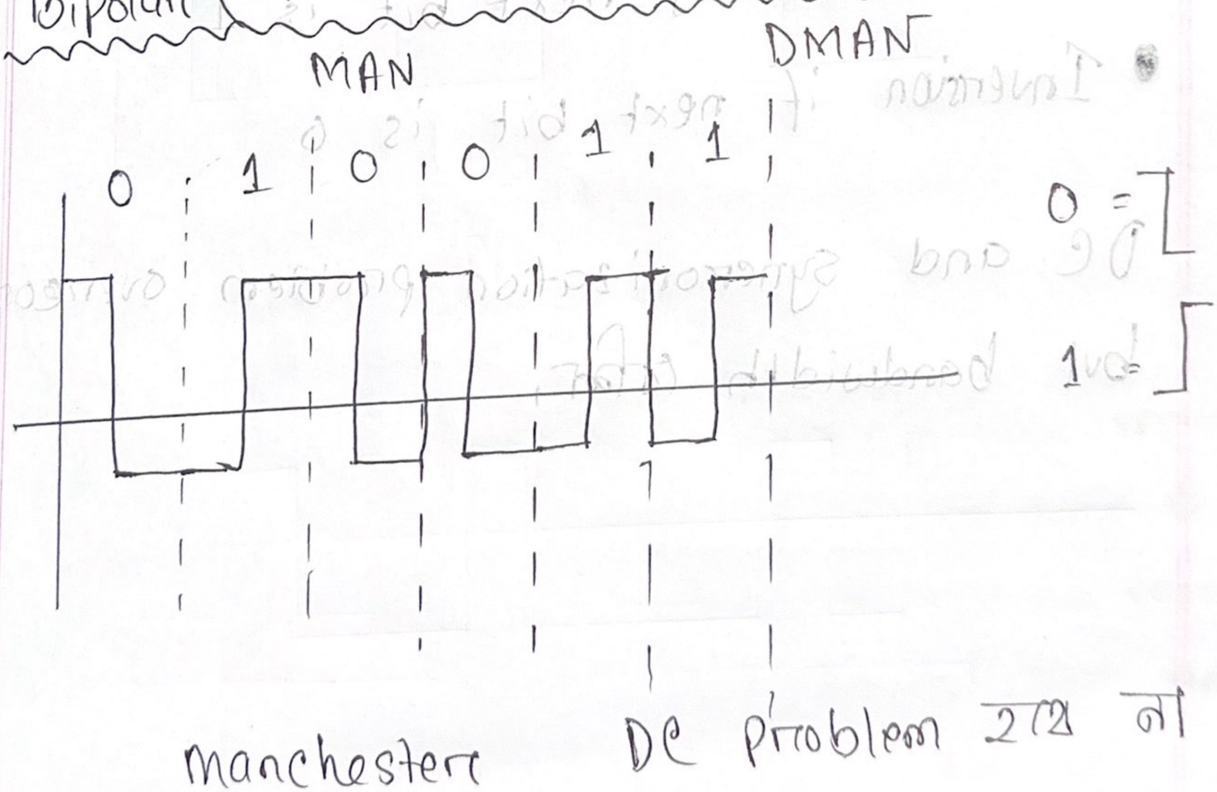
Pros
→ Easy to engineer

→ good use of bandwidth

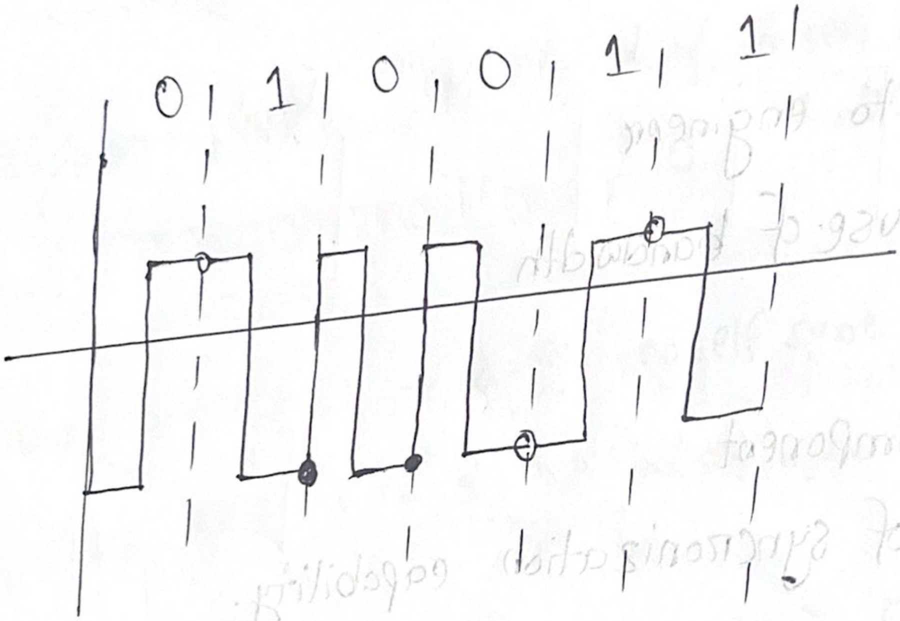
Cons
→ DC component

→ lack of syncronization capability.

Bipolar (Manchester and Differential Manchester)



manchester DC Problem হয় না



$\Pi = \frac{1}{2}$

$S = N/\Pi = 2N$

$S_{avg} = N$

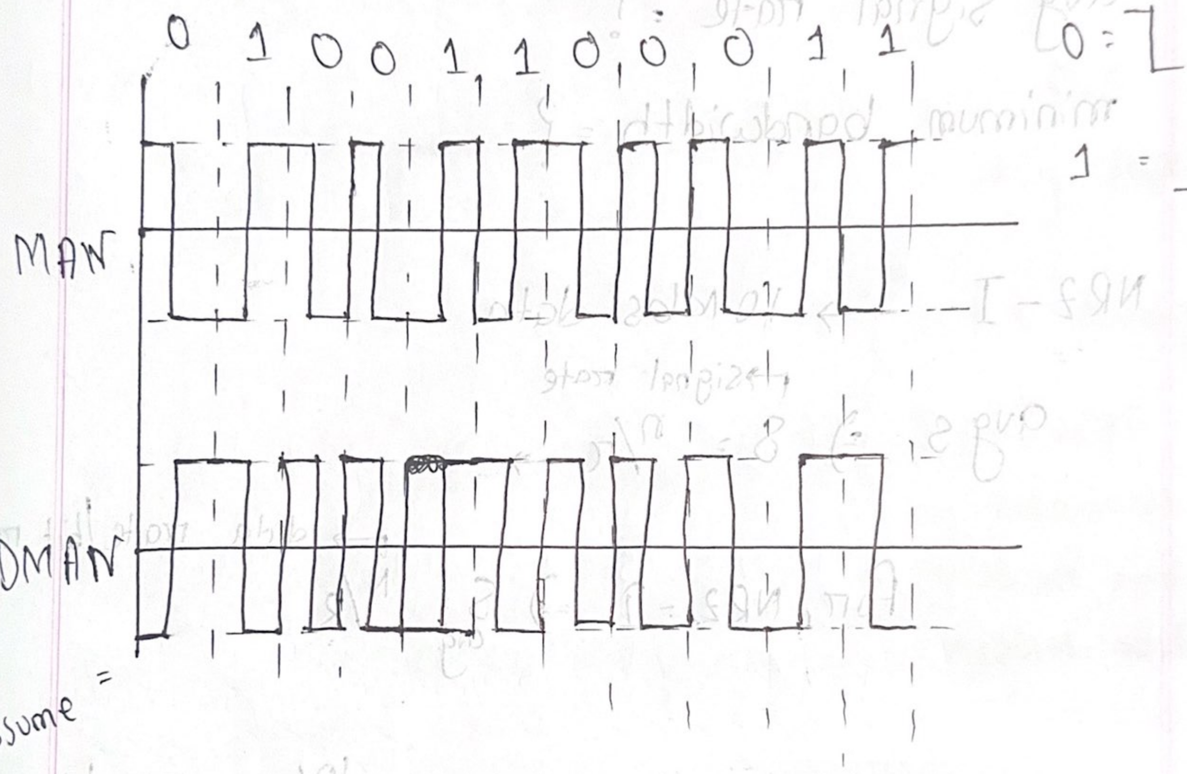
D-manchester

o No inversion if next bit is 1

● Inversion if next bit is 0

DC and syncronization problem overcome
but bandwidth বেশি,

Biphase (MAN and DMAN)



assume =

inversion = 0

no inversion = 1

Pros

→ Sync on mid transition

→ no dc

→ error detection

Cons

→ twice NRZ max

→ require more B.W

→ at least one transition per bit time and possibly two.

Ex - 4.4 math..

avg signal rate = ?

minimum bandwidth = ?

NRZ - I $\longrightarrow$ 10 Mbs data

signal rate

avg S $\Rightarrow$ $S = N/r$ $\longrightarrow$ data rate / bit rate

for, NRZ - I $\Rightarrow$ $S_{avg} = N/2$

$\therefore S_{avg} = 10/2 = 500kb$

$\therefore$ minimum bandwidth $= S_{avg} = 500 kHz.$